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UNCLASSIFIED 0008

DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT
Washington, D.C. 20523

PROJECT PAPER

Proposal and Recommendations
For the Review of the
Development Loan Committee

EGYPT - HELWAN AND TALKHA GAS TURBINE PLANTS, AMENDMENT I

AID-DLC/P-2165/1

UNCLASSIFIED

DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D.C. 20523

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AID-DLC/P-2165/1

September 13, 1977

MEMORANDUM FOR THE DEVELOPMENT LOAN COMMITTEE

SUBJECT: Egypt - Helwan and Talkha Gas Turbine Plants, Amendment I

Attached for your review are recommendations for authorization of an amendment to A.I.D. Loan No. 263-K-032 to the Arab Republic of Egypt increasing the amount of such Loan by Nineteen Million United States Dollars ($19,000,000) from Fifty Million United States Dollars ($50,000,000) to not to exceed Sixty-Nine Million United States Dollars ($69,000,000) to assist in financing the foreign exchange costs of goods and services required for the Helwan and Talkha Gas Turbine Plants.

No meeting is scheduled for this loan proposal. However, please advise us of your concurrence or objections as early as possible, but in no event later than close of business on Wednesday, September 21, 1977. If you are a voting member, a poll sheet has been enclosed for your response.

Development Loan Committee
Office of Development Program
Review and Evaluation

Attachments:
Summary and Recommendations
Project Analyses
Annexes A - R

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PROJECT PAPER FACESHEET

1. TRANSACTION CODE: A (A = ADD, C = CHANGE, D = DELETE)

PP

2. DOCUMENT CODE: 3

3. COUNTRY ENTITY: EGYPT

4. DOCUMENT REVISION NUMBER:

5. PROJECT NUMBER (7 digits): 263-0008

6. BUREAU/OFFICE: A. SYMBOL: NE; B. CODE: 03

7. PROJECT TITLE (Maximum 40 characters): Helwan and Talka Gas Turbines

8. ESTIMATED FY OF PROJECT COMPLETION: FY 79

9. ESTIMATED DATE OF OBLIGATION: A. INITIAL FY 77; B. QUARTER 4 (Enter 1, 2, 3 or 4); C. FINAL FY

10. ESTIMATED COSTS ($000 OR EQUIVALENT $1 –)

A. FUNDING SOURCE	FIRST FY B. FX	FIRST FY C. L/C	FIRST FY D. TOTAL	LIFE OF PROJECT E. FX	LIFE OF PROJECT F. L/C	LIFE OF PROJECT G. TOTAL
AID APPROPRIATED TOTAL						
(GRANT)	( )	( )	( )	( )	( )	( )
(LOAN)	(19000)	( )	( )	(19000)	( )	19000
OTHER U.S. 1.						
OTHER U.S. 2.						
HOST COUNTRY						
OTHER DONOR(S)						
TOTALS	19000			19000		19000

11. PROPOSED BUDGET APPROPRIATED FUNDS ($000)

APPROPRIATION	B. PRIMARY PURPOSE CODE	PRIMARY TECH. CODE C. GRANT	PRIMARY TECH. CODE D. LOAN	E. 1ST FY ___ F. GRANT	E. 1ST FY ___ G. LOAN	H. 2ND FY ___ I. GRANT	H. 2ND FY ___ J. LOAN	K. 3RD FY ___ L. GRANT	K. 3RD FY ___ M. LOAN
(1) SA			825		19000				
(2)									
(3)									
(4)									
TOTALS					19000				

A. APPROPRIATION	N. 4TH FY ___ O. GRANT	N. 4TH FY ___ P. LOAN	Q. 5TH FY ___ R. GRANT	Q. 5TH FY ___ S. LOAN	LIFE OF PROJECT T. GRANT	LIFE OF PROJECT U. LOAN
(1) SA						19000
(2)						
(3)						
(4)						
TOTALS						19000

12. IN-DEPTH EVALUATION SCHEDULED: MM 9 YY 80

13. DATA CHANGE INDICATOR. WERE CHANGES MADE IN THE PID FACESHEET DATA, BLOCKS 12, 13, 14, OR 15 OR IN PRP FACESHEET DATA, BLOCK 12? IF YES, ATTACH CHANGED PID FACESHEET

1 (1 = NO, 2 = YES)

14. ORIGINATING OFFICE CLEARANCE

SIGNATURE: Selig A. Taubenblatt

TITLE: Selig A. Taubenblatt, Director, NE/CD

DATE SIGNED: MM 09 DD 09 YY 79

15. DATE DOCUMENT RECEIVED IN AID/W, OR FOR AID/W DOCUMENTS, DATE OF DISTRIBUTION: MM DD YY

(1330-4 (1-78))

AMENDMENT

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EGYPT: HELWAN AND TALKHA

GAS TURBINE PROJECT

AMENDMENT

SUMMARY AND RECOMMENDATIONS

1. Borrower: The Arab Republic of Egypt. The project will be implemented by the Egyptian Electricity Authority, a separate entity within the Ministry of Electricity.

2. Loan:

   a. Amount: Not to exceed nineteen million dollars ($19,000,000) which increases an existing loan (263-K-032) for this project from fifty million dollars ($50,000,000) to sixty-nine million dollars ($69,000,000).

   B. Terms: Repayable in U.S. dollars in forty (40) years, including a grace period of ten (10) years, at an annual interest rate of two percent (2%) during the grace period and three (3%) during the principal repayment period.

3. Terms to the Implementing Agency: This loan together with the previous loan will be re-loaned by the Arab Republic of Egypt to the Egyptian Electricity Authority at an interest rate of eight and one-half percent (8.5%) per annum with repayment over twenty-five (25) years including a grace period of five (5) years.

4. Total Project Cost:

AID Loan 263-K-032	$50,000,000
This proposed amendment	19,000,000
Total foreign exchange cost	$69,000,000
Egyptian Government Contribution and local currency costs exclusive of land and internal engineering and administration cost	L.E. 3,095,000

5. Project Description: The construction of a 120 MW gas turbine generator plant at Helwan and a 180 MW gas turbine generator plant near the City of Talkha. The purpose of the project is to provide needed interim power generation, commencing in 1979, until planned thermal

power generating plants have been constructed and placed in operation. This project was originally funded in FY 1976 when the foreign exchange cost was estimated at $50 million. The current foreign exchange cost estimate is $69 million. This loan will provide the additional financing needed for the project.

6. Other Sources of Financing: Since gas turbine generators are to be purchased in the U.S. no other donor has indicated an interest in participating in financing the cost increases in this project.

7. Mission Views: The U.S. Mission in Cairo views this as a high priority project and strongly recommends financing of the project.

8. Statutory Checklist: All statutory criteria have been met.

9. Environment: Environmental considerations have been addressed.

10. Issues: None.

11. Recommendation: Authorization of a loan in the amount of $19 million to increase A.I.D. Loan 263-K-032 from $50 million to $69 million.

12. Project Committee:

Chairman:	Robert N. Bakley
Loan Officer:	Charles J. Patalive
Engineer:	John Callahan
Economist:	James Norris
Program Officer:	George Laudato
Attorney:	James Phippard

I. INTRODUCTION

1.01 On June 29, 1976, A.I.D. authorized a loan to the Government of the Arab Republic of Egypt for the construction of a 120 MW gas turbine generator plant near the city of Helwan and a 180 MW gas turbine generator plant near the city of Talkha. The agreement was signed on July 31, 1976 (AID Loan No. 263-K-032). The total project cost was then estimated at $50 million in foreign exchange (FX) and LE 4 million in local costs were to be provided by the Egyptian Electricity Authority (EEA), the implementing agency. Justification for the project was set forth in the A.I.D. project paper, "Egypt: Helwan and Talkha Gas Turbine Plants", AID-DLC/P-2165, May 27, 1976.

1.02 In June, 1977, Gilbert Associates, Inc., a prominent U.S. consulting firm under contract with EEA for project management, completed its "Preliminary Project Report" for the project, including a review of the cost estimate. Based on that review, Gilbert estimates the project cost at $69 million in FX and LE 2.9 million in local costs.

1.03 A.I.D.'s Loan Agreement requires, in Section 4.02, the GOE to provide all resources, in addition to A.I.D.'s Loan, needed to carry out the project. While the GOE recognizes and accepts this requirement, financially it is unable to comply with it on a timely basis. The GOE therefore sought assistance from other sources, but to date, it has not been successful. Consequently, the GOE has asked A.I.D. to increase its Loan amount from $50 million to $69 million. The GOE and EEA letters requesting A.I.D. assistance are included as Annex A to this paper.

1.04 In view of the delay in project commencement, and therefore completion, which would then further increase the project costs, and the importance of the project to Egypt, we are recommending that A.I.D. increase its Loan from $50 million to $69 million -- an increase of $19 million.

1.05 This paper provides an explanation of the cost increase, reviews the current status of the project and the revised project schedule and, where pertinent, reappraises the technical, economic and financial viability of the project.

II. BACKGROUND

2.01 The Helwan/Talkha project was appraised by Sanderson and Porter, Inc. (S&P), a U.S. consulting engineering firm, and A.I.D.'s Requirement Contractor for electric power projects. S&P's report was completed in November, 1975 and included load and generation forecasts, site selection and cost estimates.

2.02 Conditions Precedent to Initial Disbursement included legal opinions, specimen signatures and an executed contract with a consulting engineering firm for project management. The Terminal Date for meeting CP's was set at November 28, 1976, 120 days after Agreement signing. That date, however, proved unrealistic and CP's were eventually met in February, 1977. The critical date which delayed satisfying CP's was the selection of the consulting engineering firm. Table 1 lists chronologically the pertinent dates in the selection process.

TABLE 1

SELECTION OF CONSULTING ENGINEER

Date	Event
1976	
April 19	CBD notice published inviting firms to pre-qualify.
May 19	Pre-qualification material received from 17 firms.
June 29	Four firms short-listed.
July 6	Request for proposals mailed.
August 26	Proposals received.
October 7	Firm selected.
October 20	Negotiations started.
December 12	Negotiations completed.
December 20	EEA Board approval of contract.
1977	
January 5	Contract signed.
May 5	U. S. dollar letter of credit issued.

2.03 As can be seen from Table 1, selection of and contracting with the consulting engineer took 261 days, a time we find normal in host country contracting. Fortunately, we started the selection process 101 days before the Loan Agreement was signed, including asking the four short-listed firms to prepare technical proposals, or the meeting of CP's would have been further delayed.

2.04 The four month-delay in the opening of a letter of credit was caused by problems with local banks not being familiar with AID procedures, a problem that still haunts the Egypt capital development program. Progress is being made to eliminate this bottleneck.

2.05 The consulting engineering firm selected by EEA is Gilbert Associates, Inc., of Reading, PA. Gilbert's Scope of Work is shown in Annex E. The "Preliminary Project Report", required under Section 3.1, was completed by Gilbert in June, 1977 and delivered to EEA and AID in July, 1977.

III. CURRENT FINANCING REQUIREMENTS

A. Financing Gap

3.01 The revised cost estimate based on Gilbert's "Preliminary Project Report" is estimated at $69 million and LE 3,095,100. Table 2 below compares the current estimate with that shown in the original project paper.

TABLE 2

COMPARISON OF PROJECT COST

	S&P (10/75)	Gilbert (6/77)	Difference
U. S. Dollars	50,000,000	69,000,000	19,000,000
Egyptian Pounds	3,675,477 1/	3,095,100	(580,377)

B. Reasons for Increase

3.02 Table 3 below shows a comparison of the two cost estimates in detail.

TABLE 3

COMPARISON OF COST ESTIMATES

(U.S. $000)

Item	S&P	Gilbert	Difference
Equipment	33,000	45,073	12,073
Booster Compresser	-	1,660	1,660
Fuel Oil Treatment	-	710	710
Freight - insurance	4,480	4,656	176

1/ Interest during construction, included in original estimate, has been eleminated since EEA will finance LE costs from internal cash generations.

Item	S&P	Gilbert	Difference
Erection, Start-up and Testing	500	1,525	1,025
Training	-	400	400
Civil Works	-	537	537
Engineering - Supervision	1,100	1,855	755
Sub-Total	39,080	56,416	17,336
Escalation	4,706	9,266	4,560
Contingency	6,214	3,318	(2,896)
TOTAL	50,000	69,000	19,000

3.03 The causes for the increase in FX costs can be logically grouped into two categories: Equipment--price increases and additions; and a change in project execution. In the first category, the original equipment cost estimate was $33 million. Equipment is now estimated at about $45 million and accounts for 63 percent of the project cost increase. In addition, a booster compressor for the Helwan site (see paragraph 5.02) and fuel filtering facilities at both sites have been added. The estimated cost of these additional items is $2.4 million. The total increase attributable to equipment is $14.4 million.

3.04 The second category is project execution. Originally, civil works and equipment installation and erection was planned to be handled by Egyptian construction firms under contract to EEA. The U.S. firm supplying equipment was to be responsible for supervision of erection only. Gilbert has now completed its review of the capability of Egyptian firms to carry out this work and have concluded that the most capable firms are overloaded with work and are not available for this project. Other firms lack the necessary equipment, experience and supervisory staff for this project. Gilbert has therefore recommended that the prime U.S. firm be required to fully assume responsibility for civil works, installation and erection. The additional costs attributable to this decision are estimated at $2.3 million (erection, start-up and testing - $1.0 million; civil works - $537 thousand; and engineering supervision - $755 thousand).

3.05 EEA and A.I.D. fully concur in this change in project execution. The delays in the construction of EEA's two European-financed power projects (Kafr El Dawar and Abu Quir) have been attributed to delays by the Egyptian contractors, primarily because of outmoded (or non-existant) equipment and poor construction supervision. Unfortunately, for these two projects, the foreign supplier has little or no control over the Egyptian contractor since the Egyptian contractor's contract is with the owner (EEA) and not with the foreign supplier.

3.06 In addition to the above items, we have added $400 thousand for training of EEA personnel in shops and plants in the U.S. Initially, we had believed that EEA had an ample supply of trained operators which could be transferred to the Talkha and Helwan plants. This, however, is not the case. The emigration of EEA's personnel primarily to other Arab countries over the past years has so depleted EEA's reservoir of talent that it is presently having problems operating existing plants, let alone have personnel available for the new plant.

3.07 On the subject of training, A.I.D. is assisting EEA in solving this overall problem. At the project level, training is included in all existing and planned projects with EEA, and A.I.D. will finance the services of Overseas Advisory Associates, Inc. (OAAI), a non-profit organization created by senior U.S. executives in the electricity sector, to train approximately 200 middle-management personnel in the management techniques of electric utility companies. OAAI has previously completed successful programs in Iran and Saudi Arabia.

3.08 The cost estimate before provision for contingency and escalation is $56.4 million. Gilbert has added six percent ($3.3 million) for contingency and excalated prices at 7.5 percent per annum over the project life ($9.3 million). EEA and A.I.D. consider these estimates acceptable.

3.09 The detailed cost estimate for Helwan is shown in Annex F. The detailed cost estimate for Talkha is shown in Annex G.

IV. LOAD AND GENERATION FORECASTS

4.01 The load and generation forecasts included in the original Talkha-Helwan Project Paper were based on studies by S&P in November, 1975. For demand projections, two analyses were performed -- one using established methods of forecasting titled "Long Range Forecast" and a second which took cognizance of the Egyptian economy titled "Short Range Forecast". Both forecasts proved to be conservative at least for the first two years projected. Table 4 below shows a comparison of the two forecasts with the actual experience.

TABLE 4

ACTUAL VS. PROJECTED DEMAND
1975 - 1976
(Megawatts)

Year	Long-Range Forecast	Short-Range Forecast	Actual
1975	1,582	1,643	1,733
1976	1,766	1,867	1,909

4.02 As noted in the original Project Paper, EEA has continued the services of S&P with financing provided by UNDP and the World Bank acting as Implementing Agency. (S&P's scope of work for these services was included as Annex L in the Project Paper.) S&P, with EEA assistance, has prepared revised projections. These projections, including methodology, assumptions and conclusions are included as Annex H -- Sanderson & Porter, Inc., "Phase I System Planning and Diagnostic Report", April, 1977.

4.03 For demand projections, S&P again separated their projects into two parts -- a short-range forecast (1977 - 1985) and a long-range forecast (1985 - 2000). These forecasts are shown in pages eight and forty of Annex H.

4.04 On the projected generation side, four assumptions which formed the basis of the 1975 projections have proved to be incorrect. First, and most important, was the filling of Lake Nassar in 1976, an event not expected to occur until 1981, which allows the Aswan and High Dam hydroelectric plants to generate more energy. Second, is the delays in the construction of the Kafr El Dawar and Abu Quir thermal plants. Completion of these plants has been delayed one or two years, and the schedule is still slipping. Third is the further deterioration in EEA's existing system, with most plants not operating at rated capacity. Fourth, is the additional new

planned generation not anticipated -- especially the increase in the Abu Quir plant from 300 MW to 600 MW and the Suez plant of 300 MW. The net effect of these changes is that the installed generating capacity has increased, but not to a great extent. The unused available generating capacity, through 1982, is shown on page 13 of Annex H. (S&P's report also provides an in-depth analysis of the capability of the Aswan and High Dam hydro-electric plants, a controversial subject. In summary, despite the filling of Lake Nassar, the installed name-plate capacity of 2,445 MW cannot be effectively utilized)

4.05 The conclusions drawn by S&P is that all plants now under construction or in planning are justified; and EEA must immediately plan for another 600 MW plant to start commercial operation in 1983.

4.06 U.S.A.I.D. concurs in S&P's conclusions. We do, however, believe the situation is more critical than S&P's report indicates. First, we believe the demand projections are still understated and will more closely parallel those projected by the Nuclear Power Plants Authority shown on page ten of Annex H. Second, we believe S&P's schedule of when new generation capacity will come on stream is unrealistic, especially the projection that the third and fourth units of Abu Quir will start commercial operation in 1981, one year behind the start-up of units one and two, which itself is an optimistic schedule. Third, we believe S&P's projected output from the existing plants is optimistic, considering EEA's existing experience. Note that S&P projects most plants to operate at full capacity and projects output from the Aswan/High Dam hydroelectric units at 2,360 MW despite the fact that output will probably be limited to 2,010 MW because of the penstock design.

4.07 Assuming, however, that S&P's projections are correct, with the Talkha/Helwan gas turbine units and the Ismailia Steam Power Plant on stream, timely, EEA's situation remains poor and without these plants the situation is critical. EEA's system is such that a plus 30 percent reserve requirement is necessary for system stability. The following table shows EEA's reserve capacity, using S&P supply/demand projections, except as noted, with and without the Talkha/Helwan and Ismailia plants.

TABLE 5

AVAILABLE RESERVE

Year	Generating Capacity (MW)	Less Talkha-Helwan Ismailia	Net Capacity (MW)	Demand	Reserve With (Percent)	Reserve W/O (Percent)
1977	2711	-	2711	2192	19	19
1978	3271	-	3271	2470	17	17
1979	3568	300	3268	2678	25	18
1980	4075	300	3775	2942	28	23
1981	4343	300	4043	3192	27	21
1982	5250	600	4650	3578	32	23
1983	5511	600	4911	4028	27	18

1/ The commercial operating dates of the Talkha/Helwan and Ismailia projects do not agree with the present schedule. However, since these plants are deducted from the generating capacity, the illustration figures are accurate.

2/ Sanderson and Porter projections show the Abu Quir third and fourth units starting in 1981. It is not likely that the first and second unit will be in operation by 1981 let alone the next two units. We, therefore, have shifted the start-up to January 1, 1983

V. TECHNICAL ANALYSIS

5.01 There has been no change in the technical plans and design of the project with the exception of adding equipment to the gas turbine units to allow the buring of fire mazout oil. The Helwan plant shall have a rating of 120 MW with a minimum of four combustion turbine units. The Talkha plant shall have a rating of 180 MW with a minimum of six combustion turbine units. Each combustion turbine unit shall be a simple cycle pre-packaged electric power generating station with each unit containing all auxiliaries required to support the turbine and generator. Each unit shall be designed to operate on natural gas and distillate oil (solar) with the capability of being converted to fire mazout oil in the future. The units are expected to operate primarily on natural gas. The units shall be capable of automatic switching of fuels while under load.

5.02 The Helwan plant is located in the southern part of Helwan District approximately 30 KM south of the city of Cairo. The plant will have a distillate fuel oil storage and handling system, service building, machine shop, storage facilities and control room for gas turbine operations. The output of the generators shall be connected to on-site step-up transformers with the high voltage side connected through underground power cable to the new Tebbin Sub-station, located across the road from the plant site. Natural gas will be delivered to the site by a pipeline constructed by the Egyptian General Petroleum Corporation. Pipeline pressure is expected to vary between 60 and 100 psi; therefore, a pressure booster station will be required to increase the line pressure to the operating pressure required by the gas turbine suppliers. The proposed plot plant for the Helwan plant is shown in Annex I.

5.03 The Talkha site is located in the delta area approximately 100 KM north of Cairo and is immediately adjacent to the existing Talkha Power Plant. It will have the same associated facilities as for the Helwan plant. It shall also include an extension of the existing 200 KV sub-station to accommodate the electrical output of the gas turbine units. Natural gas shall be delivered to the site by a pipeline constructed by the Egyptian General Petroleum Corporation. The natural gas pipeline pressure at this site is of sufficient magnitude that nine pressure reducing stations shall be required instead of the pressurizing station as required at Helwan. The proposed plot plan for the Talkha is shown in Annex J.

VI. ENVIRONMENT

6.01 Environmental assessments of the Talkha and Helwan gas turbine plants have been examined by Sanderson and Porter in July 1976 and by Gilbert in April, 1977. Both assessments resulted from site visits and discussions with personnel in Egypt as well as perusal of various documents which were available.

6.02 Annexes K and L show in table form the potential significant impacts of the plants and, where appropriate, the mitigating measures recommended. Following is a narrative discussion of the environmental assessment.

A. Helwan

(1) Physical Environment

6.03 Water: Nile River water will be withdrawn at a rate of 500 gallons per day (GPD) from a four-inch water main crossing the Helwan site. The water main has been designed to serve the power plant and it will be expanded in the futrue to serve a new population center planned for 20,000 people located 2,500 feet (762 meters) north of the plant site. Sufficient water is available for the project. The small volume of water will neither tax the output of the filtration plant nor adversely impact the total flow of the Nile River.

6.04 Earthern dikes will be built around the oil tanks to prevent contamination from spills or reputered tanks. The oil unloading area will be provided with spillage containment and control.

6.05 Air: Approximately 2,500 feet (762 meters) from the site it is planned to construct a new community. If natural gas is burned, only, there will be no significant air emissions. If solar oil is burned, emissions could have a harmful effect on the residents in the planned community. However, given the gaseous emissions from Helwan steel mill, the adjacent power plant and other industry near the plant site, the emissions from burning solar fuel will be superimposed on the existing particulate and gaseous emissions. Controlling the emissions from the Helwan plant would be insignificant unless a program to control other massive sources of an emission is initiated.

(2) Biotic Environment

6.06 Neither flora nor fauna are evident at the site which is at the edge of the desert. Some mammals and reptiles now on the site will find suitable habitat in the adjacent sand and rocks.

(3) Human Environment

6.07 Land Use: Approximately 24 acres of desert will be utilized by the plant. The land is now idle and not suitable for agriculture.

6.08 Noise: Existing ambient noise at the site was measured at 20 dB (A) to 30 dB (A). Noise levels in the immediate vicinity of the gas turbines will exceed 90 dB (A) which will require personnel protection. Natural conditions and design features of the gas turbine will diminish the noise to an acceptable health level at the proposed residential colony (about 40 dB (A)); but will represent an annoyance to speech and sleep. The noise level will be less than those from the adjacent highway.

B. Talkha

(1) Physical Environment

6.09 Water: Approximately 500 GPD of filtered Nile River water will be consumed for domestic purposes and for providing make-up closed loop lube oil cooling system. This small volume (0.15 percent of the daily sand filter output) will neither tax the output of the filtration plant for the existing plant nor adversely impact the total flow of the Nile and its tributaries since they contain an excess of water. Disposal of the domestic wastes in a cesspool will provide a pathway for returning the water to the groundwater reservior.

6.10 Because the Talkha gas turbine facility is situated in close proximity to the emergency cooling water canals, which were initially used for the older 40 MW portion of the existing station, an oil spill could contaminate the Sahel Canal, a tributary of the Nile. Although the intake and discharge canals are still present and filled with water, they have not been used since the 90 MW extension was installed and water began to be withdrawn directly from the Nile. The cities of Talkha and El Mansoura both obtain their drinking water from the Nile. A ruptured tank could possibly contaminate the water supply of both of these cities. To prevent such an occurrence, earthen dikes shall be built around the solar oil storage tanks and shall be of sufficient volume to contain the contents (3,150,000 gallons or 10,000 metric tons) of each storage tank. Measures should also be implemented to control potential oil spills during oil deliveries.

6.11 Air: Impacts of air emissions from the gas turbine is a potential health hazard on workers in the residential colony 700 feet (213 meters) south of the site and the other residential colony 1,500 feet (457 meters) north of the site. The reported predominating wind direction is toward the southeast which will cause emissions to blow over the residential colony to the south. Air emissions from the gas turbines will be super-imposed upon those presently emitted from the existing 130 MW power generating facility which burns solar oil.

The two emissions of concern are oxides of nitrogen (NOx) and sulpher dioxide (SO2). Under certain wind speed and stability conditions, high levels of air pollutants could reach the residential communities when burning solar oil. When burning natural gas, which will be the dominant fuel, the NOx will be much lower, and the SO2 emissions almost non-existent.

(2) Biotic Environment

6.12 Habitats for the indigenous flora and fauna will be destroyed when the approximately 12 acres (49,000 m2) of the site are converted from prime Egyptian delta agricultural land to industrial land void of host terrestial habitats. Flora consists predominantly of Eucalyptus trees at the eastern border of the site and cultivated crops. In April, a mature grain crop and a newly planted bean crop were evident. No trees on the site will be removed unless they directly interfere with facilities. Plans for tree removal will be approved prior to the start of construction.

6.13 Animals which have been observed by plant personnel at the site include rabbits and small brown sparrow-like birds which are common, and snakes and salamanders which are rare. No poisonous snake bites have been reported. Animals which are disturbed during construction can find suitable habitat in the agricultural land adjoining the site.

(3) Human Environment

6.14 Land Use: Approximately 12 acres (49,000 m2) of prime delta agricultural land will be utilized for the project. EEA will compensate farmers for this land. The site adjoins the existing plant to the east and a fertilizer production facility to the north. Similar agricultural land lies west of the site beyond the Sahel Canal and to the north. The size of the site has been minimized to limit the consumption of agricultural land.

6.15 Noise: Noise levels in the immediate vicinity of the gas turbines will exceed 90 dB (A) which will require personnel protection. Physical distance, a hedge row of trees, a concrete wall, orientation of the gas turbine and the configuration of the oil storage tanks will diminish the noise to an acceptable level at a residential colony to the south (700 feet) and to the north (1,500 feet).

6.16 The existing ambient noise was measured at 35 dB (A) to 45 dB (A) with the existing power plant at less than full operation. With the addition of the gas turbine units, the noise level will increase by about 20 dB (A) and should represent no health hazard to the nearby residential communities. Sound levels at the residences will be far below those even remotely associated with measurable hearing impairment. The noise, will however, represent an annoyance to sleep and speech.

VII. FINANCIAL ANALYSIS

A. General

7.01 In the June 1976 Project Paper, we described the current financial conditions of EEA and the actions underway to correct the problems. Those actions were: the act creating EEA which would allow it more freedom and independence on financial matters; the increase in tariffs; and the employment by EEA of Sanderson and Porter, financed by UNDP to study EEA's financial system and recommend corrections.

7.02 The new act creating EEA as a separate entity has only just been approved by all parties, and EEA has not yet exercised any of the authority it now has. Politcally, we expect EEA to move very cautiously on such matters as tariffs and additional compensation for employees in the form of incentives and bonuses. The important point, however, is that the act is now in place; and while moving EEA to implement the act may take time, we are at least at the starting gate.

7.03 The increase in the sales price of electricity described in Para 6.03 of the original Project Paper, has now been implemented and, as expected, it allowed EEA to earn its first profit in many years, the accounting policies it follows, or not follows as the case may be, and its bad debt experience, it will be many years before anyone can attest to EEA's financial statements.

7.04 Sanderson & Porter has now completed Phase I of its Scope of Work. Its report, dated November 1976, lists 58 recommendations or actions EEA should take in the areas of energy policy, organization and management, system operations, system planning, accounting and finance, tariffs and training.

7.05 Eighteen of the recommendations were in the areas of accounting and finance and five on tariffs. We have reviewed each of the recommendations and do not consider them appropriate for inclusion as additional conditions or covenants for the loan increase. The financial covenants proposed in the original Project Paper -- debt to equity ratio and return on investment -- have been accepted by the GOE and EEA and are included in the Loan Agreement. Also, the World Bank has concluded the same covenants as conditions to its loan to EEA for electric distribution.

B. Financing Plan

7.06 EEA's debt to equity ratio has further deteriorated from a ratio of 2.36:1 at December 31, 1974 to 2.50:1 at December 31, 1976. It will probably further deteriorate as disbursements increase on its two large loan-financed projects -- Kaft El Dawar and Abu Quir. On the other hand, EEA's assets are understated since some were financed by grant funds which were not accounted for on EEA's books.

In the original Project Paper, we stated that it was our intention to require the GOE to pass on the AID loan at an interest rate and repayment period to be determined by the Council of Ministers, in accordance with the new EEA act. To date the Council of Ministers has not set this rate. Therefore, the re-lending terms to EEA for the Talkha/Helwan project are still open. We recommend setting them as described below.

7.07 In September 1976 AID authorized a loan of $24 million to the GOE for the construction of a National Energy Control Center (A.I.D. Loan No. 263-K-037). For that project we required the GOE to relend the A.I.D. loan to EEA at an interest rate of 8.5 percent per annum over a 25-year period, including a grace period of five years. The selection of these terms was based on the then current average borrowing rate for utilities, the current rate charged by the World Bank for similar projects and the domestic Egyptian borrowing rate for foreign exchange. We have reviewed these rates again and believe that an 8.5 percent interest over a period of 25 years, with a five-year grace period is still the appropriate borrowing rate for EEA. We are, therefore, recommending that this rate be established for the Helwan/Talkha project, including both the original loan of $50 million and this proposed increment of $19 million.

C. Helwan and Talkha

7.08 Considering the new gas turbine installations as a separate entity, we have assumed that during the first five years of operation (1979-1984) they will operate on close to base load at 4,000 hours a year, and during the next ten years as peaking power at 2,000 hours per year. We have assumed a useful life of 15 years. During the first five years, annual revenues will be equivalent to $11,700,000 calculated on the basis of 900,000,000 KWH of salable electricty at an average sale price of 1.3¢ per KWH. Annual cash operating costs, based on the current subsidized price of fuel oil and the current low wage rate are as follows:

TABLE 6

ANNUAL OPERATING COSTS

Fuel and its transportation	$2,070,000
Operating and maintenance:	
Generation	99,000
Transmission and Distribution	567,000
	$2,736,000

Using these values the project has an internal financial rate of return of three (3) percent. The project will therefore make a marginal positive return to EEA. It will not be a return sufficient to meet the AID covenant of nine percent return on fixed assets, unless operating hours per year are greater than we estimate. The original Loan Agreement contains a covenant requiring EEA to price its electricity at a level to allow it to earn a nine percent return on its assets by June 1979. EEA accepts this covenant and is expected to take the necessary steps to comply.

D. Disbursements

7.09 Annex M shows the projected disbursements over the life of the project for both dollars and pounds. Annexes N and O show the projected disbursements by project inputs (except for disbursements for Gilbert's services).

E. Debt Service Capability

7.10 Egypt's external debt amounted to about $12 billion at the end of 1976. Of this, roughly one-third was to Eastern European countries and primarily for past military equipment imports. The $8 billion balance includes almost $2 billion in deposit liabilities of the Egyptian Central Bank to various Arab OPEC countries.

7.11 It is estimated that about $950 million in principal payments on medium and long-term debt were made in 1976. An amount estimated at $1.4 billion was owed on short-term bank credit facilities at the end of 1976. In 1977 Egypt received a loan of $1.5 billion from GODE which is being used to substantially reduce its current short-term debt problem.

7.12 Debt service requirements in the future depend heavily on the extent to which new short-term debt can be avoided. Over the near term, we expect the debt service ratio (including short-term debt) to move between 25 and 30 percent of export and service earnings.

7.13 In view of Egypt's heavy debt burden, A.I.D.'s normal concessional loan terms are proposed -- 40 years, including a 10-year grace period, with an interest rate of 2 percent per year during the grace period and 3 percent per year thereafter. With these terms, particularly the 10-year grace period, repayment prospects for this $19 million loan amendment appear reasonable.

VII. ECONOMIC ANALYSIS

A. General

8.01 The primary benefit of this project is the economic value of the electricity that will be generated by the Talkha/Helwan gas turbine units. The amount of usable electricity that will be produced and delivered to users, per year, is 900,000,000 KWH. The true economic value of a KWH of electric power should be based on an estimate of customer's willingness to pay, based in turn on the shape of direct demand curves for domestic users and prevailing market conditions for the products of commercial and industrial users. For Egypt, such an analysis is not possible given the subsidies and controls that permeate all sectors of the economy. For electricity, tariff structures are formulated by the Ministry of Electricity and EEA under guidelines established by the GOE. Tariffs for larger customers, such as aluminum, iron and steel and fertilizer are negotiated on an individual basis; and special rates are charged for other purposes, such as irrigation. Rates, therefore, are based on the Government's desires to subsidize the user.

8.02 Despite the wide rate variance between users, the GOE has tried to assure that overall average rates are set at a level which allows EEA a reasonable profit. The GOE's definition of a reasonable return is three percent over operating costs; not a normal method of setting rates. EEA's costs, however, are also to some extent subsidized; the most notable subsidy being the cost of fuel oil for its thermal power plants. Therefore, the overall average power rates, set at a level to allow EEA a reasonable return, represent an overall subsidy and a cost to the national economy. Our best guess is that the average overall rates would need to climb to about 3.5¢ to 4.0¢ per KWH from the present average of 1.3¢ per KWH if EEA were to pay full cost for all its inputs and average in the relatively cheap hydropower and the more expensive thermal power plants operating on fuel oil.

B. Helwan and Talkha

8.03 The internal economic rate of return of the Talkha-Helwan project is the discount rate which equates the present value of the time streams of the attributable costs and benefits over the project's assumed life of 15 years. At the present time, consumers of electricity in other countries at Egypt's approximate level of development are prepared to pay between 4¢ and 6¢ per KWH. Based on this, we have estimated the economic value of the electricity produced at 4.5¢ per KWH consumed. On the cost stream, we have included O&M for the distribution system, a capital recovery factor (using a 15 percent

discount factor) to account for the additional investment in the distribution and transmission system that will be required, and the impact of an estimated 17 percent loss factor. The current export price for fuel oil and a calculated real economic value for natural gas have been used rather than the subsidized domestic prices for fuel. With these adjustments to costs and using the parallel foreign exchange rate of $1.43/LE, the economic internal rate of return is calculated to be 24 percent. The calculation is shown in Annex P.

IX. IMPLEMENTATION

A. General

9.01 There has been no fundamental alteration to plans for project implementation. Design, engineering, supply of equipment and start-up will be the responsibility of one U.S. firm selected through competitive bidding. The Invitation for Bid (IFB) will require bidding on a lump-sum basis for both FX and local costs.

B. Schedule

9.02 The original project schedule planned for the consulting engineer to be employed by September 30, 1976, the IFB released by December 1, 1976, contract award for supply of equipment of May 1, 1977 and both units in commercial operation by January, 1979. Based on the revised schedule, the Helwan units are planned to be in commerical operation by July, 1979 and the Talkha units by October, 1979 -- a six and nine-month delay, respectively. The delay is attributable to the time required to employ the consulting engineer, as explained in Para 2.02.

9.03 The revised schedule is predicated on the release of the IFB on August 31, 1977. This date should be met. Six firms have been prequalified by Gilbert and approved by the EEA. The IFB has been drafted and is expected to be approved by EEA on August 25, 1977. Upon approval, Gilbert will release the IFB from their Reading Office. Contract award is expected by December 31, 1977. Annexes Q and R show the Critical Path on a Summary Level Milestone Schedule.

C. Terminal Dates

9.04 Conditions Precedent: Conditions Precedent to Disbursement were segregated in two categories in the original Loan Agreement. "Conditions Precedent to Initial Disbursement"(CPID) were designed to allow early funding of the constract for the consulting engineer. "Conditions Precedent to Disbursement for Specific Goods and Services" (CPGS) were the additional conditions that were required prior to the commencement of construction. All CPID have been met except for the requirement that the A.I.D. loan be re-lent by the GOE to EEA on terms and conditions satisfactory to A.I.D. This condition was transferred to the CPGS section and , as explained in Para 7.06, is still an open item. Satisfaction of all other CPGS is expected by December 31, 1977, the date by which funding will be needed for supply and construction of the plants. A condition of this proposed amendment will be the satisfactory resolution of the re-lending terms.

9.05 Letters of Commitment and Disbursements: The terminal date for the opening of Letters of Commitment was originally set at September 30, 1978. Given the present project schedule all commitments should be requested by that date and therefore no change is required. The Terminal Date for Disbursements was originally set at December 31, 1979, 12 months after the start of commercial operation. The present planned date for commencement of commercial operation at Talkah is September 30, 1979. Leaving the present date unchanged will allow only a three-month period, after start-up, to make final payment to the contractor. This period is too short and we therefore recommend that the Terminal Date for Disbursements be extended to December 31, 1980. This will allow ample time to make final payment to the contractor; and allow for a slippage in the schedule.

D. Evaluation

9.06 The purpose of the project is to help meet interim power needs in the cities of Helwan and Talkha, until planned thermal generator plants are constructed and in operation, and to meet the power demand of other areas by funding power into the Unified Power Services. The larger objective of providing the power is to avoid compromising industrial production and growth.

9.07 Upon completion of construction and the beginning of operation, USAID will prepare a formal evaluation report which summarizes how project construction time compared to schedule, how costs compared to estimates, whether the plants are able to provide the 300 MW incremental addition to the power gird, and any particular issues which remain to be addressed concerning the operation or management of the plants. Purpose level evaluation will be accomplished (1) by a series of plant audits to evaluate management operation and maintenance of each facility during its first year of operation; (2) by determining, during the period of plant operations, the annual kilowatt production as an indicator of utilization of plant capacity. Such data is monitored on an hours/day basis. If utilization was below that anticipated, this would signal the need for evaluation to determine whether the plant is not responding to needs, or whether the needs for electricity are not as projected.

9.08 After both generator plants have been in operation for one year, USAID will prepare an evaluation report describing the results of the plant audits, and the review of plant utilization. If no future difficulties are anticipated, USAID will only continue to spot monitor kilowatt production until planned thermal generators come into operation, and will report on this spot monitoring only if a problem arises.

9.09 It would be premature to go further to look at the project's impact on industrial production/growth as this project is directed only at an interim need, it is one of many projects in Egypt with this objective. There are so many other factors involved in industrial production/growth that it makes more sense to consider evaluation of this objective on a wider scope and at a later time.

9.10 Unless there should appear the need to look at the impact of specific factors such as power or foreign exchange on the industrial sector or at the impact on specific geographic areas, the Embassy economic reporting is expected to provide information on the overall levels of industrial production and growth.

X. RECOMMENDATION, CONDITIONS AND COVENANTS

A. Conditions and Covenants

10.01 All conditions and covenants recommended in the original project paper have been accepted by the GOE and EEA and incorporated in the original Loan Agreement. All conditions precedent to initial disbursement have been met except the requirement that the GOE re-lend the A.I.D. loan to EEA on terms and conditions established by the Council of Ministers. Based on the discussion in Section VII, we recommend that A.I.D. set the terms of the re-loan at 8.5 percent per annum with repayment over 25 years including a grace period of five years; and that Section 3.02 of the Loan Agreement be amended to include this condition. Additionally, the Loan Amendment will include in Section 3.02 of the original Loan as a condition precedent a legal opinion from the GOE attesting to the vaildity and legality of the Loan Amendment.

10.02 We recommend no additional covenants be incorporated in the Loan Agreement amendment. Those existing are adequate. Section 4.05 will be amended or deleted to reflect the interest rate requirement for the re-loan.

B. Recommendation

10.03 Subject to the conditions cited above, we recommend that A.I.D. authorize an amendment of $19 million to the existing Helwan-Talkha Gas Turbine Loan Agreement to finance the increased project costs.

Annex A

EGYPTIAN ELECTRICITY AUTHORITY

NASR CITY, ABBASSIA, CAIRO, EGYPT.

TELEGRAM: ELECTROCOP - TELEX: 2097 POWER U.N.

Ref: 362

Rec. 7/18/77

Cairo, 17 July, 1977

Mr. Donald S. Brown
Director USAID Mission
Cairo, Egypt.

ACTION TO CDE Info DXI
ACTION TAKEN _____ DATE Due 7/22
NAN _____ INITIALS _____

Dear Mr. Brown,

As you know we have received a draft copy of the preliminary project report for the Helwan/Talkha Gas Turbine Plants from our Consultants. The foreign exchange preliminary estimate contained in the draft report is US $ 25,90[illegible],000 for Helwan and US $37,535,000 for Talkha or a total of US $63,436,000 as against the estimated foreign exchange requirements of US $45,402,000 contained in the Sanderson & Porter report. This increase, we believe, is attributable to the delay in the project execution and the cost escalation that has occurred with respect to material and equipment. The completion dates on which the Sanderson & Porter estimate was based was 1976 for Helwan and 1978 for Talkha. The present scheduled completion date for both Helwan and Talkha is 1979.

As a result of our review of the draft report with our Consultants certain modifications have been agreed upon which will affect the estimated foreign exchange requirements for the project. Attached is a marked-up copy of the preliminary estimate, Table 9-1, of the draft preliminary project report, which shows the modifications that have been made to the estimate with the result that the foreign exchange estimate for Helwan is US $27,200,000 and for Talkha US $39,355,000 for a total of US $66,555,000.

The increase in the preliminary estimate of US $3,149,000 is primarily attributable to the addition of fuel treatment facilities for solar oil, increased provision for training, increased provision for spare parts, and additional machine shop capability and increases in the indirect costs attributable to these added costs.

The total estimated foreign exchange cost of US $66,555,000 set forth above does not include our contract with Gilbert Associates which presently provides for an expenditure of US $1,855,000. Therefore, our total foreign exchange requirement for the Helwan/Talkha Gas Turbine Project is US $68,410,000.

EGYPTIAN ELECTRICITY AUTHORITY
NASR CITY, ABBASSIA, CAIRO, EGYPT.
TELEGRAM: ELECTROCOP - TELEX: 2097 POWER U.N.

(2)

Loan Agreement No. 263-K-032 between USAID and the ARE executed on July 31st, 1976 provides for a maximum of US $50,000,000. In view of the presently estimated foreign exchange requirements for the Projects it is requested that the Loan Agreement be amended to provide for an amount not to exceed US $68,500,000 or an increase in the loan of US $18,500,000.

In view of the critical need for this additional generating capacity to meet our system demands and the schedule which our Consultants are trying to maintain, your early approval of our request will be greatly appreciated.

Very truly yours,

K. Nabih.

(Eng. Kamal Nabih)
Deputy Chairman.

ANNEX B

LOAN AMENDMENT AUTHORIZATION

Country: Arab Republic of Egypt

Name of Project: Helwan and Talkha Gas Turbine Plants

Loan No.: 263-K-032

Project No.:

Pursuant to Part 2, Chapter 4, Section 532 of the Foreign Assistance Act of 1961, as amended, I hereby authorize an amendment to A.I.D. Loan No. 263-K-032 to the Arab Republic of Egypt increasing the amount of such Loan by Ninteeen Million United States Dollars ($19,000,000) from Fifty Million United States Dollars ($50,000,000) to not to exceed Sixty-Nine Million United States Dollars ($69,000,000) to assist in financing the foreign exchange costs of goods and services required for the Helwan and Talkha Gas Turbine Plants.

In addition, the Loan Agreement dated July 31, 1976, will be amended to provide that proceeds of the Loan will be reloaned to EEPA at an interest rate of eight and one-half percent (8 1/2%) per annum and shall be repayable within twenty-five (25) years including a grace period of five (5) years.

All other provisions of the Loan Authorization approved on 1976, remain unchanged.

_____
Administrator

_____
Date

Annex B

DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON D.C. 20523

OFFICE OF
THE ADMINISTRATOR

A.I.D. LOAN NO. 263-K-032

LOAN AUTHORIZATION

Provided from: Foreign Assistance Act, Section 532
("Security Supporting Assistance Funds")

EGYPT: Helwan and Talka Gas Turbine Plants

Pursuant to the authority vested in the Administrator, Agency for International Development ("A.I.D.") by the Foreign Assistance Act of 1961, as amended, ("the Act")and the delegations of authority issued thereunder, I hereby authorize the establishment of a loan ("the Loan") pursuant to Part 2 Chapter 4 Section 532, Security Supporting Assistance, of said Act to the Government of Egypt ("Borrower") of not to exceed Fifty Million United States Dollars ($50,000,000) to assist in financing the foreign exchange costs of goods and services for the Helwan and Talka Gas Turbine Plants. The Loan will be subject to the following terms and conditions

1. Terms of Repayment and Interest Rate

The Borrower shall repay the Loan to A.I.D. in United States Dollars within forty (40) years from the date of the first disbursement under the Loan, including a grace period of not to exceed ten (10) years from said date. The Borrower shall pay to A.I.D. interest in United States at the rate of two percent (2%) per annum during the grace period and three percent (3%) thereafter on the outstanding balance of the Loan and any due and unpaid interest.

2. Source and Origin

Equipment, materials and services financed under the Loan shall have their source and origin in the United States.

3. Conditions Precedent to Disbursement

Prior to the first disbursement, or the issuance of any Letter of Commitment, under the Loan Agreement, the Borrower shall furnish, in form and in substance satisfactory to A.I.D.:

(a) An opinion of the Egyptian Minister of Justice, or other legal counsel satisfactory to A.I.D., that the Loan Agreement has been duly authorized and/or ratified by, and executed on behalf of the Arab Republic of Egypt, and that it constitutes a valid and legally binding obligation thereof in accordance with its terms.

(b) The names of the persons who will act as the representatives of the Borrower together with evidence of their authority and the specimen signature of each.

(c) Evidence that the loan proceeds will be made available to the Egyptian Electricity Authority on terms acceptable to A.I.D.

(d) An executed contract between the Egyptian Electricity Authority and a U. S. consulting engineer for the project acceptable to A.I.D.

4. Conditions Precedent to Subsequent Disbursement

Prior to any disbursement or the issuance of any letter of commitment under the Loan Agreement, for any purpose other than to finance the services of a consulting engineer, the Borrower shall furnish, in form and in substance satisfactory to A.I.D.:

(a) Evidence that all Egyptian currency required for the first fiscal year in which funds will be required, in an amount based on the estimate of the consulting engineer, and as approved by EEA, have been budgeted by the GOE and are available for expenditure by EEA.

(b) An executed contract for the supply, erection, construction and related services of gas turbine generator plants at Helwan and Talka.

(c) Evidence that EEA has obtained title to or adequate right to the use of the necessary land for the plant sites.

5. Covenants

The Borrower shall covenant to make available on a timely basis any Egyptian currency and any foreign currency in addition to the loan, for the punctual and effective carrying out of construction, maintenance, repair and operation of the projects.

6. The loan shall be subject to such other terms and conditions as A.I.D. shall deem appropriate.

Administrator

Date 6/29/76

ANNEX C

Certification Pursuant to
Section 611(e) of the
Foreign Assistance Act of 1961, as amended

I, Donald S. Brown, the Principal Officer for the Agency for International Development in Egypt, having taken into account, among other things, the maintenance and utilization of projects in Egypt previously financed or assisted by the United States, and the technical assistance and training planned for this project, do hereby certify that in my judgment Egypt has both the financial capability and human resources capability effectively to maintain and utilize the capital assistance to be provided for the construction of a 120 MW gas turbine plant near Helwan and a 180 MW gas turbine plant near Talkha.

Donald S. Brown
Director

8/31/77
Date

6C(2) - PROJECT CHECKLIST

Listed below are, first, statutory criteria applicable generally to projects with FAA funds, and then project criteria applicable to individual fund sources: Development Assistance (with a sub-category for criteria applicable only to loans); and Security Supporting Assistance funds.

CROSS REFERENCES: IS COUNTRY CHECKLIST UP TO DATE? IDENTIFY. HAS STANDARD ITEM CHECKLIST BEEN REVIEWED FOR THIS PROJECT?

A. GENERAL CRITERIA FOR PROJECT.

1. App. Unnumbered; FAA Sec. 653(b)

   (a) Describe how Committees on Appropriations of Senate and House have been or will be notified concerning the project; (b) is assistance within (Operational Year Budget) country or international organization allocation reported to Congress (or not more than $1 million over that figure plus 10%)?

   An "Advice of Program Change" has been prepared for transmittal to the appropriate committees of Congress. Obligations under this amendment will not take place prior to 15 days after the date of delivery of this notification. The intended obligation is within the level of funds appropriated for Egypt for FY 1977.

2. FAA Sec. 611(a)(1). Prior to obligation in excess of $100,000, will there be (a) engineering, financial, and other plans necessary to carry out the assistance and (b) a reasonably firm estimate of the cost to the U.S. of the assistance?

   The necessary planning and cost estimates have been completed.

3. FAA Sec. 611(a)(2). If further legislative action is required within recipient country, what is basis for reasonable expectation that such action will be completed in time to permit orderly accomplishment of purpose of the assistance?

   No further legislative action is required to implement the program other than ratification of the signed amendment to the loan agreement.

4. FAA Sec. 611(b); App. Sec. 101. If for water or water-related land resource construction, has project met the standards and criteria as per Memorandum of the President dated Sept. 5, 1973 (replaces Memorandum of May 15, 1962; see Fed. Register, Vol 38, No. 174, Part III, Sept. 10, 1973)?

   Not applicable. The project is not for water or water-related land resource construction.

5. FAA Sec. 611(e). If project is capital assistance (e.g., construction), and all U.S. assistance for it will exceed $1 million, has Mission Director certified the country's capability effectively to maintain and utilize the project?

   The Mission Director has so certified. See Annex H C.

A.

6. FAA Sec. 209, 619. Is project susceptible of execution as part of regional or multilateral project? If so why is project not so executed? Information and conclusion whether assistance will encourage regional development programs. If assistance is for newly independent country, is it furnished through multilateral organizations or plans to the maximum extent appropriate?

The project is not susceptible of execution as part of a regional or multilateral project. Egypt is not a newly independent country.

7. FAA Sec. 601(a); (and Sec. 201(f) for development loans). Information and conclusions whether project will encourage efforts of the country to: (a) increase the flow of international trade; (b) foster private initiative and competition; (c) encourage development and use of cooperatives, credit unions, and savings and loan associations; (d) discourage monopolistic practices; (e) improve technical efficiency of industry, agriculture and commerce; and (f) strengthen free labor unions.

The loan amendment will, together with the original loan, increase the flow of international trade and improve technical efficiency of industry, agriculture and commerce. See pages 9-12 of the original Project Paper (No. AID-DLC/P-2165).

8. FAA Sec. 601(b). Information and conclusion on how project will encourage U.S. private trade and investment abroad and encourage private U.S. participation in foreign assistance programs (including use of private trade channels and the services of U.S. private enterprise).

The great majority of funds expended will be for goods and services from private U.S. companies.

9. FAA Sec. 611(b); Sec. 636(h). Describe steps taken to assure that, to the maximum extent possible, the country is contributing local currencies to meet the cost of contractual and other services, and foreign currencies owned by the U.S. are utilized to meet the cost of contractual and other services.

The agreement will so provide.

10. FAA Sec. 612(d). Does the U.S. own excess foreign currency and, if so, what arrangements have been made for its release?

Yes. Release by the GOE is not a problem at present.

B. FUNDING CRITERIA FOR PROJECT

1. Development Assistance Project Criteria

a. FAA Sec. 102(c); Sec. 111; Sec. 281a. Extent to which activity will (a) effectively involve the poor in development, by extending access to economy at local level, increasing labor-intensive production, spreading investment out from cities to small towns and rural areas; and (b) help develop cooperatives, especially by technical assistance, to assist rural and urban poor to help themselves toward better life, and otherwise encourage democratic private and local governmental institutions?

Not applicable.

B1

b. FAA Sec. 103, 103A, 104, 105, 106, 107. Is assistance being made available? [Include only applicable paragraph -- e.g., a, b, etc. -- which corresponds to source of funds used. If more than one fund source is used for project, include relevant paragraph for each fund source.]

(1) [103] for agriculture, rural development or nutrition; if so, extent to which activity is specifically designed to increase productivity and income of rural poor; [103A] if for agricultural research, is full account taken of needs of small farmers;

(2) [104] for population planning or health; if so, extent to which activity extends low-cost, integrated delivery systems to provide health and family planning services, especially to rural areas and poor;

(3) [105] for education, public administration, or human resources development; if so, extent to which activity strengthens nonformal education, makes formal education more relevant, especially for rural families and urban poor, or strengthens management capability of institutions enabling the poor to participate in development;

(4) [106] for technical assistance, energy, research, reconstruction, and selected development problems; if so, extent activity is:

(a) technical cooperation and development, especially with U.S. private and voluntary, or regional and international development, organizations;

(b) to help alleviate energy problem;

(c) research into, and evaluation of, economic development processes and techniques;

(d) reconstruction after natural or manmade disaster;

(e) for special development problem, and to enable proper utilization of earlier U.S. infrastructure, etc., assistance;

(f) for programs of urban development, especially small labor-intensive enterprises, marketing systems, and financial or other institutions to help urban poor participate in economic and social development.

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(5) [107] by grants for coordinated private effort to develop and disseminate intermediate technologies appropriate for developing countries.

c. FAA Sec. 110(a); Sec. 208(e). Is the recipient country willing to contribute funds to the project, and in what manner has or will it provide assurances that it will provide at least 25% of the costs of the program, project, or activity with respect to which the assistance is to be furnished (or has the latter cost-sharing requirement been waived for a "relatively least-developed" country)?

d. FAA Sec. 110(b). Will grant capital assistance be disbursed for project over more than 3 years? If so, has justification satisfactory to Congress been made, and efforts for other financing?

e. FAA Sec. 207; Sec. 113. Extent to which assistance reflects appropriate emphasis on; (1) encouraging development of democratic, economic, political, and social institutions; (2) self-help in meeting the country's food needs; (3) improving availability of trained worker-power in the country; (4) programs designed to meet the country's health needs; (5) other important areas of economic, political, and social development, including industry; free labor unions, cooperatives, and Voluntary Agencies; transportation and communication; planning and public administration; urban development, and modernization of existing laws; or (6) integrating women into the recipient country's national economy.

f. FAA Sec. 281(b). Describe extent to which program recognizes the particular needs, desires, and capacities of the people of the country; utilizes the country's intellectual resources to encourage institutional development; and supports civic education and training in skills required for effective participation in governmental and political processes essential to self-government.

B1

g. FAA Sec. 201(b)(2)-(4) and -(8); Sec. 201(e); Sec. 211(a)(1)-(3) and -(8). Does the activity give reasonable promise of contributing to the development: of economic resources, or to the increase of productive capacities and self-sustaining economic growth; or of educational or other institutions directed toward social progress? Is it related to and consistent with other development activities, and will it contribute to realizable long-range objectives? And does project paper provide information and conclusion on an activity's economic and technical soundness?

h. FAA Sec. 201(b)(6); Sec. 211(a)(5), (6). Information and conclusion on possible effects of the assistance on U.S. economy, with special reference to areas of substantial labor surplus, and extent to which U.S. commodities and assistance are furnished in a manner consistent with improving or safeguarding the U.S. balance-of-payments position.

2. Development Assistance Project Criteria (Loans only) — Not applicable.

a. FAA Sec. 201(b)(1). Information and conclusion on availability of financing from other free-world sources, including private sources within U.S.

b. FAA Sec. 201(b)(2); 201(d). Information and conclusion on (1) capacity of the country to repay the loan, including reasonableness of repayment prospects, and (2) reasonableness and legality (under laws of country and U.S.) of lending and relending terms of the loan.

c. FAA Sec. 201(e). If loan is not made pursuant to a multilateral plan, and the amount of the loan exceeds $100,000, has country submitted to AID an application for such funds together with assurances to indicate that funds will be used in an economically and technically sound manner?

d. FAA Sec. 201(f). Does project paper describe how project will promote the country's economic development taking into account the country's human and material resources requirements and relationship between ultimate objectives of the project and overall economic development?

e. FAA Sec. 202(a). Total amount of money under loan which is going directly to private enterprise, is going to intermediate credit institutions or other borrowers for use by private enterprise, is being used to finance imports from private sources, or is otherwise being used to finance procurements from private sources?

f. FAA Sec. 620(d). If assistance is for any productive enterprise which will compete in the U.S. with U.S. enterprise, is there an agreement by the recipient country to prevent export to the U.S. of more than 20% of the enterprise's annual production during the life of the loan?

3. Project Criteria Solely for Security Supporting Assistance

FAA Sec. 531. How will this assistance support promote economic or political stability?

This assistance will promote economic stability by increasing the efficiency of Egypt's electrical power system assisting the GOE in meeting critical short-term power needs, particularly in the major industrial areas of Helwan and Talka.

4. Additional Criteria for Alliance for Progress

[Note: Alliance for Progress projects should add the following two items to a project checklist.]

Not applicable.

a. FAA Sec. 251(b)(1), -(8). Does assistance take into account principles of the Act of Bogota and the Charter of Punta del Este; and to what extent will the activity contribute to the economic or political integration of Latin America?

b. FAA Sec. 251(b)(8); 251(h). For loans, has there been taken into account the effort made by recipient nation to repatriate capital invested in other countries by their own citizens? Is loan consistent with the findings and recommendations of the Inter-American Committee for the Alliance for Progress (now "CEPCIES," the Permanent Executive Committee of the OAS) in its annual review of national development activities?

6C(3) - STANDARD ITEM CHECKLIST

Listed below are statutory items which normally will be covered routinely in those provisions of an assistance agreement dealing with its implementation, or covered in the agreement by exclusion (as where certain uses of funds are permitted, but other uses not).

These items are arranged under the general headings of (A) Procurement, (B) Construction, and (C) Other Restrictions.

A. Procurement

1. FAA Sec. 602. Are there arrangements to permit U.S. small business to participate equitably in the furnishing of goods and services financed?	Procurement of goods and services will be pursuant to established A.I.D. regulations
2. FAA Sec. 604(a). Will all commodity procurement financed be from the U.S. except as otherwise determined by the President or under delegation from him?	Yes.
3. FAA Sec. 604(d). If the cooperating country discriminates against U.S. marine insurance companies, will agreement require that marine insurance be placed in the U.S. on commodities financed?	Yes.
4. FAA Sec. 604(e). If offshore procurement of agricultural commodity or product is to be financed, is there provision against such procurement when the domestic price of such commodity is less than parity?	There will be no such procurement.
5. FAA Sec. 608(a). Will U.S. Government excess personal property be utilized wherever practicable in lieu of the procurement of new items?	Consideration will be given to the use of excess property when practical.
6. MMA Sec. 901(b). (a) Compliance with requirement that at least 50 per centum of the gross tonnage of commodities (computed separately for dry bulk carriers, dry cargo liners, and tankers) financed shall be transported on privately owned U.S.-flag commercial vessels to the extent that such vessels are available at fair and reasonable rates.	Yes.
7. FAA Sec. 621. If technical assistance is financed, will such assistance be furnished to the fullest extent practicable as goods and professional and other services from private enterprise on a contract basis? If the facilities of other Federal agencies will be utilized,	Technical assistance, to the greatest extent practical, will be from private enterprise on a contract basis.

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are they particularly suitable, not competitive with private enterprise, and made available without undue interference with domestic programs?

8. International Air Transport. Fair Competitive Practices Act, 1974

If air transportation of persons or property is financed on grant basis, will provision be made that U.S.-flag carriers will be utilized to the extent such service is available? — Yes.

B. Construction

1. FAA Sec. 601(d). If a capital (e.g., construction) project, are engineering and professional services of U.S. firms and their affiliates to be used to the maximum extent consistent with the national interest? — Yes.

2. FAA Sec. 611(c). If contracts for construction are to be financed, will they be let on a competitive basis to maximum extent practicable? — Yes.

3. FAA Sec. 620(k). If for construction of productive enterprise, will aggregate value of assistance to be furnished by the U.S. not exceed $100 million? — Not applicable.

C. Other Restrictions

1. FAA Sec. 201(d). If development loan, is interest rate at least 2% per annum during grace period and at least 3% per annum thereafter? — Not applicable.

2. FAA Sec. 301(d). If fund is established solely by U.S. contributions and administered by an international organization, does Comptroller General have audit rights? — Not applicable.

3. FAA Sec. 620(h). Do arrangements preclude promoting or assisting the foreign aid projects or activities of Communist-Bloc countries, contrary to the best interests of the U.S.? — The loan agreement will so stipulate.

4. FAA Sec. 636(i). Is financing not permitted to be used, without waiver, for purchase, long-term lease, or exchange of motor vehicle manufactured outside the U.S. or guaranty of such transaction? — Financing is not permitted to be used for such purposes.

5. Will arrangements preclude use of financing:

a. FAA Sec. 114. to pay for performance of abortions or to motivate or coerce persons to practice abortions? **Yes.**

b. FAA Sec. 620(g). to compensate owners for expropriated nationalized property? **Yes.**

c. FAA Sec. 660. to finance police training or other law enforcement assistance, except for narcotics programs? **Yes.**

d. FAA Sec. 662. for CIA activities? **Yes.**

e. App. Sec. 103. to pay pensions, etc., for military personnel? **Yes.**

f. App. Sec. 106. to pay U.N. assessments? **Yes.**

g. App. Sec. 107. to carry out provisions of FAA Sections 209(d) and 251(h)? (transfer to multilateral organization for lending). **Yes.**

h. App. Sec. 501. to be used for publicity or propaganda purposes within U.S. not authorized by Congress? **Yes.**

SECTION 3

SCOPE OF WORK TO BE PERFORMED BY GILBERT

3.0 Gilbert will provide engineering, engineering administration and construction monitoring services in support of EEA for the Project. Gilbert will furnish the services of qualified personnel who will complement the capabilities of EEA by providing assistance and advice as described in this Section 3.

3.1 Preliminary Project Reports

3.1.1 Utilizing existing data made available by EEA to the maximum extent possible, Gilbert will prepare comprehensive plans which will define the overall design, and construction parameters, contract and contract administration plans and requirements, schedular requirements, and cost estimates for the Project.

3.1.2 Gilbert will review reports made available by EEA covering the archeological, geotechnical, ecological, hydrological, meteorological, and agronomy conditions that exist at both sites. In the event that the information is considered to be insufficient to adequately evaluate the environmental aspects of the design specifications to enable the prospective contractors to prepare their estimates in a competitive manner, or to satisfy the applicable A.I.D. environmental requirements, Gilbert will develop a program of

further investigation to provide the missing information. The cost of developing such a program of site investigation and of supervising any related field work is not included in the original estimate and the original cost estimate and fixed fee shall be adjusted accordingly.

3.2 Development of technical specifications for the Project. Based on information contained in the preliminary Project report, Gilbert will develop technical specifications including equipment performance requirements, for the design and installation of the Project.

3.3 Pre-qualification of bidders and preparation of Invitation for Bidders (IFB).

3.3.1 During the preparation of IFB, Gilbert will conduct the pre-qualification of interested bidders in accordance with established A.I.D. guidelines and the wishes of EEA.

3.3.2 The IFB, based on information from the earlier specifications developed by the EEA and the preliminary Project report, will outline contract terms and administration, describe the technical design parameters, and specify the requirements for installation and start up. Gilbert will prepare the IFB in accordance with standard US engineering practices, codes and standards and with applicable A.I.D. requirements

for sealed bid procurement. Equipment, services, and construction requirements will be fully and clearly defined. The IFB will also specify design drawings and documentation which the design/constructor and/or equipment vendor must provide in order to show compliance with design specifications and equipment performance requirements.

3.4 Review of Proposals and Award of Contracts

Gilbert will evaluate the responsiveness of the bidders to the invitation for bids, the reasonableness of the prices bid, submit recommendations and, if necessary, assist in negotiating the contract between the EEA and the selected bidders. To this end, Gilbert shall:

3.4.1 Prepare tabulations, analyses and evaluations of all bids.

3.4.2 Together with the EEA Evaluation Committee prepare final evaluation reports and issue final recommendation report.

3.4.3 Assist EEA in matters pertaining to contract preparation, negotiation and execution.

3.4.4 Prepare Notices of Award and rejection letters for issue by EEA.

3.5 Contract Monitoring and Administration (Design Phase)

3.5.1 Gilbert will provide professional services to assist the EEA in reviewing the work of the Contractors for compliance with all

specified contract requirements and good engineering practices.

Gilbert will review:

3.5.1.1 Systems designs (flow diagram, system design criteria and descriptions, instrument and control logics, electrical diagrams and electrical system criteria and design).

3.5.1.2 Equipment and material specifications.

3.5.1.3 Proposal of only the successful equipment bidder before equipment contract is awarded by the Contractor.

3.5.1.4 Selected manufacturers' spare parts, operations, and maintenance requirements.

3.5.1.5 Plant layout drawings, for compliance with accepted good practice, access for maintenance, provision for equipment removal if necessary, and economy of space.

3.5.1.6 General routing of major systems.

3.5.1.7 General outline drawings of major equipment and structures.

3.5.1.8 Constructability.

3.5.1.9 Review and witness factory inspection and tests.

3.5.2 Detail designs requires for construction and the checking of detailed design calculations and drawings will be performed by the Contractor.

3.5.3 The design review objective will be to determine that systems and structures will be capable of performing their specified function, and that adequate technical specifications and drawings exist for obtaining bids on equipment and components. Gilbert will review the adequacy of design and provide an administrative check on the Contractor's design functions. These review functions will not relieve the Contractor of its responsibility for the satisfactory performance of the plants.

3.5.4 Along with the technical surveillance, Gilbert will review Contractor's progress and expenditure reports for compliance with forecasts.

3.6 Contract Monitoring and Administration (Construction and Erection)

3.6.1 Gilbert will, as representative of EEA, administer the single responsibility design/construct contract and monitor the Contractor's work to verify that all contract work is accomplished in accordance with the plans, pecifications and contract documents. Gilbert will keep the EEA site representative informed of Gilbert's site actions, orders to, and correspondence with the Contractor. The single responsibility contract will assign to the Contractor sole responsibility for design, equipment selection, procurement, manufacturing, assembly, shipment,

construction/erection and commissioning of the complete plants. During the construction and erection of the Project, Gilbert will assign a resident staff to the Project sites. Gilbert's resident staff will be supported by Gilbert's home office as necessary. EEA shall provide office facilities at the Project sites and Gilbert will:

3.6.1.1 Establish lines of communication, reports and liaison among Gilbert, the EEA, and the Contractor. The EEA will carry out all liaison with ARE.

3.6.1.2 Act as the EEA's representative and provide engineering monitoring and detailed inspection of the performance of all construction/erection work to verify conformance with the plans and specifications; advise EEA on the plans and progress of the Contractor and advise EEA of delays, both actual and anticipated, which may effect the construction of the plants and means, where such exist, to overcome these delays.

3.6.1.3 Review work plans, progress schedules and financila schedules prepared by the Contractor and analyze and report on such schedules as necessary.

3.6.1.4 Prepare monthly progress reports and special reports as required by the EEA.

3.6.1.5 Monitor construction/erection progress and receipt, installation, and testing of equipment. Review the construction methods of the Contractor and his sub-contractors prior to application to avoid, insofar as possible, the use of unsafe or improper methods which could result in construction delays, defective work, adverse affects on work of others at the sites or intolerable exposure to hazards of property or persons.

3.6.1.6 Certify the validity of contractor's progress payment invoices before such invoices are submitted to the EEA and upon completion and acceptance of the Project, certify the release of final payments.

3.6.1.7 Interpret contracts, drawings, and specifications to obtain compliance with the contract documents and timely provision of services, equipment and materials.

3.6.1.8 Review and evaluate field design changes and revisions and advise EEA of the justifications of the Contractor's cost

proposals for any such changes or extra work. After obtaining EEA's approval prepare and issue changes or extra work orders as necessary.

3.6.1.9 Assist theEEA in obtaining appropriate agreements relative to the provision of utilities and infrastructures.

3.6.1.10 Monitor and advise the EEA of the progress of such on-site or off-site work directly related to the Project and coordinate such work with the requirements and work of the Contractor.

3.6.1.11 Inspect for proper installation of mechanical and electrical equipment together with related controls and instrumentation and witness performance testing of such equipment and make recommendations for acceptance.

3.6.1.12 Assist the EEA in performing final inspection and testing of facilities and in determining final acceptability of the work.

3.6.2 The anticipated schedule for assignment of Gilbert's Expatriate Employees is shown in Annex 1.

3.7 Test, Acceptance and Start Up

3.7.1 Gilbert will assist the EEA in monitoring and reviewing tests and start up of the facilities, through handing over the units to EEA.

3.7.2 Gilbert personnel will review test and initial operation procedures and recommend acceptance of or changes to them. Gilbert will:

3.7.2.1 Witness conduct of static checkouts (electrical, mechanical, instrumentation) by the Contractor to verify that components and systems are ready for initial operation.

3.7.2.2 Provide assistance to EEA operating personnel in the initial operation and shakedown of components and systems; maintain close contact with Contractor personnel to resolve problems which arise during initial operation.

3.7.2.3 Supervise turnover by the Contractor of the completed plant (or unit) to EEA at the completion of start up activities.

3.7.2.4 Review Contractor-prepared plant operational manuals in English for adequacy.

3.7.2.5 Witness and review performance testing of major equipment and systems in order to verify test results.

3.7.2.6 Review test calculations and submit test reports to EEA.

3.8 Training Program

3.8.1 Based on EEA's approved staffing pattern and an

assessment of available personnel capability, Gilbert will prepare and oversee the implementation of an operating and maintenance training program by performing the following:

3.8.1.1 Evaluate the competency level of personnel proposed by the EEA for training.

3.8.1.2 Ascertain that classroom training in plant theory, operations and maintenance will be provided along with vendor training which will be provided in accordance with the specifications.

3.8.1.3 Ascertain that on-the-job training during initial operation and shakedown of plant equipment is successfully completed.

3.8.1.4 Review training materials (visual aids, texts, etc.) to be used during training.

3.8.1.5 Evaluate the competence level of EEA personnel after training, and report results to EEA with recommendations for continuing training efforts.

3.8.1.6 Ascertain that facilities already available in the USA or ARE are utilized to the extent possible in meeting training requirements.

3.8.1.7 All instruction, training aids and any other instructional materials to be reviewed by Gilbert will be in the English language. If utilization of any other language is required in performing the tasks described in this Section 3.8, the EEA will supply qualified interpreters and/or translators, the cost of which shall be borne directly by the EEA.

3.9 Spare Parts and Inventory Control

3.9.1 Based on manufacturers' recommendations and Gilbert experience, Gilbert will prepare and assist in the implementation of a system for the supply, storage and issuance of spare parts. Gilbert will:

3.9.1.1 Confirm that the Contractor's spare parts list is complete and that a spare parts stock will be provided.

3.9.1.2 Assist EEA in placing initial orders for spare parts as required.

3.9.1.3 Establish receipt and disbursement control system for spare parts.

3.9.1.4 Establish a spare parts re-ordering system based on minimum/maximum levels.

TABLE 9-1
CAPITAL COST
120 MW GAS TURBINES
HELWAN, EGYPT

DESCRIPTION	QUANTITY	U.S. (DOLLARS) MATERIAL	LABOR	TOTAL	EGYPTIAN (LE) MATERIAL	LABOR	TOTAL
EQUIPMENT							
GAS TURBINES W/ DESERT FILTERS	4 EA	14,600,000	64,000	14,664,000	--	8,300	8,300
FUEL OIL TANKS	4 EA	266,000	33,000	299,000	--	17,600	17,600
FIRE/WATER TANK	2 EA	19,000	4,000	23,000	--	2,100	2,100
PUMPS, FIRE & FUEL	9 EA	54,000	4,000	58,000	--	500	500
BOOSTER COMPRESSOR	2 EA	1,600,000	60,000	1,660,000	--	7,800	7,800
FUEL OIL TREATMENT	1 LOT	270,000	15,000	285,000	--	2,000	2,000
TOTAL EQUIPMENT		16,809,000	180,000	16,989,000	--	38,300	38,300
PIPING							
FUEL OIL	1,500 LF	9,000	6,000	15,000	--	2,600	2,600
GAS	1,000 LF	5,000	4,000	9,000	--	1,600	1,600
FIRE PROTECTION	1,000 LF	8,000	3,000	11,000	--	1,500	1,500
DOMESTIC WATER	300 LF	2,000	2,000	4,000	--	300	300
SERVICE WATER	300 LF	2,000	2,000	4,000	--	300	300
DRAINS/VENTS	100 LF	1,000	2,000	3,000	--	300	300
TOTAL PIPING		27,000	19,000	46,000	--	6,600	6,600
CIVIL							
SITE WORK	1 LOT	--	--	--	147,100	104,000	251,100
CONTROL & SERVICE BUILDING	1 LOT	121,000	30,000	151,000	79,800	44,800	124,600
OUTDOOR EQUIPMENT FOUNDATIONS	--	--	--	--	--	--	--
GAS TURBINE	1 LOT	35,000	12,000	47,000	131,600	18,900	150,500
POWER TRANSFORMERS	1 LOT	1,000	2,000	3,000	2,800	1,300	4,100
FIRE PUMPS	2 EA	--	--	--	700	300	1,000
FUEL OIL PUMPS	7 EA	--	--	--	700	300	1,000
GAS REDUCTION STATION	1 LOT	--	--	--	700	300	1,000
FUEL OIL STORAGE TANKS	2 EA	7,000	12,000	19,000	14,700	17,600	32,300
FUEL OIL DAY TANK	2 EA	--	2,000	2,000	2,800	1,600	4,400
DIKES & LININGS	1 LOT	--	6,000	6,000	4,900	9,300	14,200
FIRE WATER TANK	1 EA	--	2,000	2,000	2,100	1,300	3,400
BOOSTER COMPRESSORS	2 EA	--	2,000	2,000	2,100	600	2,700
FUEL TREATMENT & UNLOADING	1 LOT	--	--	--	--	200	200
PIPE SUPPORTS	1 LOT	--	2,000	2,000	2,100	2,200	4,300
TOTAL CIVIL		164,000	70,000	234,000	392,100	202,700	594,800

TABLE 9-1
CAPITAL COST
120 MW GAS TURBINES
HELWAN, EGYPT

DESCRIPTION	QUANTITY	U.S. (DOLLARS) MATERIAL	LABOR	TOTAL	EGYPTIAN (LE) MATERIAL	LABOR	TOTAL
ELECTRICAL							
TRANSFORMERS	4	653,000	32,000	685,000	--	3,900	3,900
SWITCHGEAR	1	73,000	6,000	79,000	--	1,000	1,000
MISC. CONTROLS	1 LOT	2,000	2,000	4,000	--	300	300
CTR. RELAY & METERING	1 LOT	24,000	2,000	26,000	--	500	500
BUS DUCT	1,700 LF	235,000	24,000	259,000	--	3,100	3,100
CONDUIT	7,000 LF	53,000	52,000	105,000	--	7,000	7,000
CABLE	26,000 LF	38,000	22,000	60,000	--	2,900	2,900
GROUNDING SYSTEM	3,500 LF	10,000	6,000	16,000	--	1,000	1,000
YARD LIGHTING	50 EA	112,000	48,000	160,000	--	6,200	6,200
PAGING SYSTEM	24 EA	8,000	16,000	24,000	--	2,100	2,100
BOOSTER COMPRESSOR	1 LOT	37,000	22,000	59,000	--	3,100	3,100
SWITCHYARD (TIE-IN)	1 LOT	98,000	60,000	158,000	--	7,800	7,800
TOTAL ELECTRICAL		1,343,000	292,000	1,635,000	--	38,900	38,900
TOTAL DIRECTS		18,343,000	561,000	18,904,000	392,100	286,500	678,600
INDIRECTS							
SUB-CONTRACTORS' O.H., PROFIT, SOCIAL INSURANCE		--	--	--	--	171,900	171,900
SUBTOTAL		--	--	18,904,000	--	--	850,500
MATERIAL HANDLING, STORAGE & MARK-UP		--	--	--	78,400	--	78,400
SPARE PARTS & MACHINE SHOP EQUIPMENT		1,021,000	7,000	1,028,000	--	--	--
FREIGHT-TOTAL MATERIAL & SPARES		--	--	1,936,000	--	--	--
SUBTOTAL		--	--	21,868,000	--	--	928,900
TRAINING		--	200,000	200,000	--	1,000	1,000
SUBTOTAL		--	--	22,068,000	--	--	929,900
ENGINEERING		--	--	442,000	--	--	--
SUBTOTAL		--	--	22,510,000	--	--	929,900
CONTINGENCY		--	--	1,142,000	--	--	226,200
SUBTOTAL		--	--	23,652,000	--	--	1,156,100
ESCALATION		--	--	3,548,000	--	--	173,400
TOTAL PROJECT CAPITAL COST				27,200,000			1,329,500

FIGURE 9-1
CAPITAL COST
180 MW GAS TURBINES
TALKHA, EGYPT

DESCRIPTION	QUANTITY	U.S. (DOLLARS) MATERIAL	LABOR	TOTAL	EGYPTIAN (LE) MATERIAL	LABOR	TOTAL
EQUIPMENT							
GAS TURBINES W/ DESERT FILTERS	6 EA	21,900,000	96,000	21,996,000	--	12,500	12,500
FUEL OIL TANKS	4 EA	266,000	33,000	299,000	--	17,800	17,800
FIRE/WATER TANK	2 EA	19,000	4,000	23,000	--	2,100	2,100
PUMPS, FIRE & FUEL	9 EA	53,000	5,000	58,000	--	300	300
FUEL OIL TREATMENT	1 LOT	400,000	25,000	425,000	--	3,300	3,300
TOTAL EQUIPMENT		22,638,000	163,000	22,801,000	--	35,800	35,800
PIPING							
FUEL OIL	3,000 LF	19,000	10,000	29,000	--	5,500	5,500
GAS	2,000 LF	6,000	4,000	10,000	--	2,100	2,100
FIRE PROTECTION	2,000 LF	14,000	5,000	19,000	--	2,300	2,300
DOMESTIC WATER	1,500 LF	3,000	4,000	7,000	--	800	800
SERVICE WATER	1,500 LF	3,000	4,000	7,000	--	800	800
DRAINS/VENTS	100 LF	1,000	2,000	3,000	--	300	300
TOTAL PIPING		46,000	29,000	75,000	--	11,800	11,800
CIVIL							
SITE WORK	1 LOT	--	--	--	76,300	51,200	127,500
CONTROL & SERVICE BUILDING	1 LOT	152,000	40,000	192,000	99,400	54,400	153,800
OUTDOOR EQUIPMENT FOUNDATIONS	--	--	--	--	--	--	--
GAS TURBINES	1 LOT	52,000	20,000	72,000	197,400	28,200	225,600
POWER TRANSFORMERS	1 LOT	2,000	2,000	4,000	3,500	1,900	5,400
FIRE PUMPS	2 EA	--	--	--	700	300	1,000
FUEL OIL PUMPS	5 EA	--	--	--	700	300	1,000
GAS REDUCTION STATION	1 LOT	--	--	--	700	300	1,000
FUEL OIL STORAGE TANKS	2 EA	7,000	12,000	19,000	14,700	17,600	32,300
FUEL OIL DAY TANK	2 EA	--	2,000	2,000	2,800	1,600	4,400
DIKE & LINING	1 LOT	--	8,000	8,000	4,900	10,200	15,100
FIRE WATER TANK FOUNDATION	1 EA	--	2,000	2,000	2,100	1,300	3,400
FUEL TREATMENT & UNLOADING	1 LOT	--	--	--	--	200	200
PIPE SUPPORT	1 LOT	--	4,000	4,000	4,900	6,100	11,000
TOTAL CIVIL		213,000	90,000	303,000	408,100	173,600	581,700

TABLE 9-1
CAPITAL COST
180 MW GAS TURBINES
TALKHA, EGYPT

DESCRIPTION	QUANTITY	U.S. (DOLLARS) MATERIAL	LABOR	TOTAL	EGYPTIAN (LE) MATERIAL	LABOR	TOTAL
ELECTRICAL							
TRANSFORMERS	6 EA	950,000	46,000	996,000	--	6,200	6,200
SWITCHGEAR	3 EA	96,000	10,000	106,000	--	1,300	1,300
MISC. CONTROLS	1 LOT	12,000	2,000	14,000	--	500	500
CTR. RELAY & METERING	1 LOT	24,000	2,000	26,000	--	500	500
BUS DUCT	2,200 LF	298,000	32,000	330,000	--	4,400	4,400
CONDUIT	6,000 LF	48,000	46,000	94,000	--	6,200	6,200
CABLE	36,000 LF	37,000	32,000	69,000	--	4,200	4,200
GROUNDING SYSTEM	4,000 LF	13,000	10,000	23,000	--	1,600	1,600
YARD LIGHTING	50 EA	112,000	48,000	160,000	--	6,200	6,200
PAGING SYSTEM	24 EA	8,000	16,000	24,000	--	2,100	2,100
SWITCHYARD - 220 KV	1 LOT	1,277,000	274,000	1,551,000	56,000	83,500	139,500
TOTAL ELECTRICAL		2,875,000	518,000	3,393,000	56,000	116,700	172,700
TOTAL DIRECTS		25,772,000	800,000	26,572,000	464,100	337,900	802,000
INDIRECTS							
SUB-CONTRACTORS' O.H., PROFIT, SOCIAL INSURANCE		--	--	--	--	202,700	202,700
SUBTOTAL		--	--	26,572,000	--	--	1,004,700
MATERIAL HANDLING, STORAGE & MARK-UP		--	--	--	92,800	--	92,800
SPARE PARTS & MACHINE SHOP EQUIPMENT		1,390,000	7,000	1,397,000	--	--	--
FREIGHT-TOTAL MATERIAL & SPARES		--	--	2,720,000	--	--	--
SUBTOTAL				30,689,000	--	--	1,097,500
TRAINING		--	240,000	240,000	--	1,000	1,000
SUBTOTAL		--	--	30,929,000	--	--	1,098,500
ENGINEERING		--	--	1,083,000	--	--	--
SUBTOTAL		--	--	32,012,000	--	--	1,098,500
CONTINGENCY		--	--	1,600,000	--	--	266,000
SUBTOTAL		--	--	33,612,000	--	--	1,364,500
ESCALATION		--	--	5,743,000	--	--	231,900
TOTAL PROJECT CAPITAL COST				39,355,000			1,596,400

POWER SECTOR SURVEY
ARAB REPUBLIC OF EGYPT

PHASE I SYSTEM PLANNING DIAGNOSTIC REPORT - SECTION I

APRIL 1977

TEAM ROSTER

POWER SECTOR SURVEY TEAM

April 1977

Paul G. Wallace Consulting Engineer Former Vice President & Chief Engineer Texas Power & Light Co.	Team Leader Utility Management Specialist
Robert B. Boyd Power System Consultant Former Deputy Chief Bureau of Power Federal Power Commission	Assistant Team Leader System Operating Engineer
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GLOSSARY OF SYMBOLS AND ABREVIATIONS

gigawatt	GW	1,000,000	kilowatt
gigawatthour	GWH	1,000,000	kilowatthours
kilovolt	kV	1,000	volts
kilowatthour	kWh	1,000	watthours
megawatt	MW	1,000	kilowatt
megawatthour	MWH	1,000	kilowatthours
terawatt	TW	10^{12}	kilowatt
terawatthour	TWH	10^{12}	kilowatthours

btu	British Thermal Unit of heat
calorie	Metric Thermal Unit of heat
FOR	Forced outage rate
mazout	Approximately No. 5 fuel oil burned in fossil fuel power plants in ARE

ARE	Arab Republic of Egypt
EEA	Egyptian Electricity Authority
GEEC	General Egyptian Electricity Corporation (Superceded by EEA)
IAEA	International Atomic Energy Agency
IBRD	International Bank for Reconstruction and Development
NPPA	Nuclear Power Plant Authority
UPS	Unified Power System
USA	United States of America
USAID	United States Agency for International Development
LOWER EGYPT	Cairo and the Delta, Alexandria and Canal Zone
UPPER EGYPT	Area south of Cairo to Aswan

SHORT RANGE GENERATION EXPANSION STUDY (1977-1985)

Summary and Conclusions

A short-range load forecast and a companion generation expansion study for the Egyptian Electricity Authority through the year 1985 were prepared with the aid and cooperation of the EEA engineers of the planning group of the Studies and Research Sector.

The load forecast was arrived at after giving lengthy consideration to the various facets of the present and expected future growth in the demands for electric power in Egypt. It was then used to determine the future yearly maximum demand and energy requirements of the Unified Power System. It was decided that the power requirements (exclusive of large industrial loads) probably would grow at a rate of 10.4 percent (load doubling in seven years) up through the year 1980 and then at a reduced rate of 9.4 percent (load doubling in slightly less than eight years) up through the year 1985. Because of the high percentages of large industrial loads that presently comprise or are expected to be added to the Unified Power System, such industrial loads were analyzed on a separate basis. The results were then combined with the expected growth of the remainder of the loads. The load growth predictions thus obtained were normalized to reduce any yearly inconsistencies and allow for any delay in commissioning of the large industrial loads which is expected (as past history has indicated) to occur. This provided a composite expected system load growth from 1976 through 1985 of 11.4 percent for the peak power demands and 11.3 percent for the energy requirements.

EEA's latest generation expansion plan was reviewed and several of the indicated dates of initial operation of new units were revised because it was not believed that the time remaining was sufficient to meet the originally planned target dates. An analysis was made of both the existing gas turbine,steam and hydro generating plants and the new gas turbine and steam (both fossil fuel and nuclear) power plants expected to be added to the EEA system in the future.

Due regard was given to the deteriorated condition of a large number of existing thermal units and to the usually large amounts of outage time that has been experienced with some of these. Outage records were studied and estimates were made of both expected future scheduled and unscheduled maintenance requirements.

Hydroelectric limitations due to the reduced capability of the Aswan units, the unusually lengthy maintenance outage time, and the limitation in power transfer capability due to stability restraints of the 500 kV High Dam - Cairo transmission lines were also considered.

The sizing and expected [illegible] for both scheduled and proposed new generating facilities were studied. It was decided that under the present status of financing and other contractual arrangements it very likely would be impossible to have the proposed first 600 MW unit of the Sidi Kreir nuclear power station in commercial operation before year 1985.

After considering projected generating capability, system maintenance requirements, spinning reserve capacity, and load forecasts together with forecasting error possibilities, it was concluded that additional generating capacity definitely would be needed by the year 1984 and should be scheduled so it can provide firm dependable capacity by that time. Otherwise the EEA cannot adequately and reliably meet the forecast demands for electric power in an expanding Egyptian economy.

Therefore it is recommended that EEA consider immediately the construction of an additional 2 x 300 MW steam power station with the first 300 MW unit to be scheduled for commercial operation not later than the third quarter of 1983 and a second 300 MW unit a few months later.

Load Forecast

Load forecasts with high accuracy are the foundation for efficient usage of limited capital resources. Accurate forecasts are difficult, however, and the problem is compounded by the past and present economic conditions existing in the Arab Republic of Egypt. As the era of low cost energy ends, it becomes even more difficult to accurately forecast future loads. Because electric power use is sensitive to variable parameters over which no one has absolute control, forecasting at best remains an educated guess no matter how sophisticated the procedures used. Additionally, every power system has local conditions that significantly influence electric power usage in its service area, and a successful forecasting technique utilized in one area or country may not necessarily serve adequately in another.

The Egyptian Electricity Authority has undertaken many load forecast studies for the determination of the future electric power demand of Egypt until 1985 as well as the general trend until the year 2000. Most of the presently employed methods of load forecasting (the accumulative method, the extrapolation method, the sentiment method, and the correlation between the national economy and the energy demand including the Aoki method) have been extensively studied by the planning personnel of EEA.

None of these methods has seemed entirely satisfactory for application to the Unified Power System and the final method chosen as best suited was that of a gradually decreasing annual rate of growth of the power demand and system energy

requirements through the year 2000. A higher growth rate of peak load and energy use can be expected at first to compensate for the low and erratic growth rates that prevailed because of the war years. An initial high growth rate also can be expected in connection with the new changes in Egypt's economic policies. Using these criteria, it was forecasted that up through 1980 the load will double at a seven year interval rate; in other words at a cumulative annual growth rate of 10.4 percent. Studies undertaken by the planning group of the Studies and Research Sector of EEA have shown that the average rate of growth of electrical energy consumption in Egypt for the last decade excluding large industries, even though erratic on a year-by-year basis, has been at an average rate of 10.44 percent. Separate individual studies of the various sectors of the Egyptian economy (residential, commercial, small industrial, agricultural etc.) up through the year 1980 have indicated an expected continuation of this 10.4 percent growth rate. For these reasons, it is expected that such a growth rate of 10.4 percent will continue up through the year 1980. It is also highly improbable that such a rate can be maintained indefinitely. Therefore, it is assumed that after 1980 up through the year 1985 the normal load will grow at a rate which would cause it to double again in a little less than eight years or at an annual cumulative rate of 9.4 percent.

Because of the very large power and energy requirements of some planned new loads and the projected expansions of existing large high load factor industrial loads, the forecast for such loads has been analyzed separately. The results were then combined with the expected normal growth rate of the rest of the system to obtain a composite load forecast.

Table I-1 is a tabulation of an analysis of the large industrial loads resulting from the planned installation and expansion of large industries up through the year 1985. The data listed in the table was obtained from and verified by various sources including the Ministries of Industry and Mineral Wealth and of Petroleum. Although considered complete for the five-year plan up through the early 1980's, it is felt that other large industrial loads in addition to those listed in the table will undoubtedly develop for the years 1983 through 1985.

A coincidence factor to provide for diversity in the non-coincidental peak industrial demands as well as system generation and transmission line loss factors for both power and energy requirements has been utilized to reflect all such large industrial demand and energy requirements to that of a system gross generation level. Such a gross generation requirement is part of the input data used in the generation expansion program.

A tentative composite Peak Demand and Energy Forecast on a yearly basis for the Unified Power System up through the year 1985 was compiled. The original forecasted peak demands and energy requirements are shown in Table I-2. Using the above

Table I-1 LARGE INDUSTRIAL ELECTRICAL LOADS IN EGYPT 1976-85
(in Megawatts & Gigawatt Hours)

		Est. Ann. Load	1976		1977		1978		1979		1980		1981		1982		1983		1984		1985	
Iron & Steel	**Location**	**Factor**	MW	GWH	MW	GWH	MW	GWH	MW	GWH	MW	GWH	MW	GWH	MW	GWH	MW	GWH	MW	GWH	MW	G
Integrated Mill	Tebbin 1	70	64	394	64	392	64	392	64	392	64	394	64	392	64	392	64	392	64	394	64	[illegible]
(1.5 Min Tons)	Tebbin 2	70	70	430	72	442	72	442	72	442	72	443	72	442	72	442	72	442	72	443	72	[illegible]
(1.5 Min Tons)	Helwan	70	63	387	63	386	63	386	63	386	63	387	63	386	63	386	63	386	63	387	63	[illegible]
Sponge Iron	Alexandria	85									30	224	60	447	60	447	60	447	60	448	60	[illegible]
Sponge Iron	Sadat City	85											20	149	40	298	40	298	40	298	40	[illegible]
Electric Steel	Alexandria	45											40	158	70	276	100	394	100	394	100	[illegible]
Electric Steel	Sadat City	45													50	197	150	591	250	986	300	1[illegible]
Chemical Projs.																						
Nitrates	Ras Gharib*	80											20	140	50	350	50	350	50	350	50	
Fertilizer Kima	Aswan*	80	250	1757	250	1752	250	1752	250	1752	250	1757	250	1752	250	1752	250	1752	250	1757	250	1[illegible]
Ferro-Silicon	Aswan(Edfu)*	80			10	70	50	350	50	350	80	562	120	841	120	841	120	841	120	843	120	[illegible]
Urea(German Uda)	Alexandria	80							15	105	15	105	15	105	15	105	15	105	15	105	15	[illegible]
Caustic Soda	Alexandria	75			20	131	20	131	20	131	20	132	20	131	20	131	20	131	20	132	20	[illegible]
NH_3NO_3 & Urea	Talkha	80	35	246	55	385	55	385	60	420	75	527	75	526	75	526	75	526	75	527	75	[illegible]
Phosphate Projs.																						
Mining	Esna*	70	10	61	10	61	10	61	10	61	10	61	10	61	10	61	10	61	10	61	10	
Elemential Phosphate(Cancelled 340MW)	Nag Hammadi	-																				
Fertilizer Mine	Abu Tartur*	80																				
Textiles (50MW isolated Generation being installed Textile Plant)	Mehalla El Koubra-												90	631	90	631	90	631	90	631	90	
Textile & Weaving Complex	Alexandria	75					30	197	120	788	150	988	150	986	150	986	150	986	150	988	150	
Aluminium Smelter (Eventually 166,000Tons)	Nag Hammadi*	95	150	1252	220	1831	220	1831	300	2497	370	3088	400	3329	400	3329	400	3329	400	3338	400	3
Petroleum Refinery	Alexandria	85							20	149	20	149	20	149	20	149	20	149	20	149	20	
Petroleum Refinery	Alexandria	85									20	149	30	223	30	223	30	223	30	224	30	
Oil Pipeline Sumed340km 2x42"Alex.(80after 1980)	Suez	65-80	50	285	130	740	150	854	150	854	150	854	150	1051	150	1051	150	1051	150	1054	150	1
Oil Pipeline 2x36"100MW Cancelled	Suez-Port Said																					
Cement Expansion 700,000 Tons	Helwan "(Torah)	80							35	245	40	281	40	280	40	280	40	280	40	281	40	
Cement Plant 600,000 Tons	Assiut*	80							35	245	35	246	35	245	35	245	35	245	35	246	35	
Cement Plant 1,000,000 Tons	Suez	80									50	351	50	350	50	350	50	350	50	351	50	
TOTAL LOAD			692	4812	894	6190	984	6781	1264	8817	1514	10698	1794	12774	1924	13448	2054	13960	2154	14387	2204	14
Coincidence Factor 92%			636	---	822	---	905	---	1163	---	1393	---	1650	---	1770	---	1890	---	1982	---	2028	
Generation&Transmission Losses (10% of Peak			64	317	82	407	91	442	116	588	139	726	166	883	177	890	189	889	198	884	202	
TOTAL GENERATION			700	5129	904	6597	996	7223	1279	9405	1532	11424	1816	13657	1947	14338	2079	14849	2180	15271	2230	1[illegible]
LARGE INDUSTRY LOAD FACTOR			83.4		83.3		82.8		83.9		84.9		85.8		84.1		81.5		79.7		79.[illegible]	

*All located in Upper Egypt

TABLE I-2

INITIAL PEAK DEMAND & ENERGY FORECAST

	10.4% Normal Load Growth (System Less Large Industrial Loads)					9.4% Normal Load Growth (System Less Large Industrial Loads)				
	76	77	78	79	80	81	82	83	84	85
BALANCE OF SYSTEM	1209	1335	1474	1627	1796	1965	2149	2352	2573	2815
LARGE INDUSTRY	700	904	996	1279	1532	1816	1947	2079	2180	2230
PEAK DEMAND- MW	1909	2239	2470	2906	3328	3781	4096	4431	4753	5045
BALANCE OF SYSTEM	6.51	7.19	7.93	8.76	9.67	10.58	11.57	12.66	13.85	15.15
LARGE INDUSTRY	5.13	6.60	7.22	9.41	11.42	13.66	14.34	14.85	15.27	15.43
ENERGY- BILLION kWh	11.64	13.79	15.15	18.17	21.09	24.24	25.91	27.51	29.12	30.58
ANNUAL LOAD FACTOR	69.4	70.3	70.0	71.4	72.1	73.2	72.2	70.9	69.7	69.2

NORMALIZED VALUES FOR FINAL PEAK DEMAND AND ENERGY FORECAST*

	76	77	78	79	80	81	82	83	84	85
PEAK DEMAND- MW	1909	2192	2470	2678	2924	3192	3578	4028	4518	5045
ENERGY- BILLION kWh	11.64	13.50	15.15	16.75	18.52	20.47	22.63	25.02	27.66	30.58
ANNUAL LOAD FACTOR	69.4	70.3	70.0	71.4	72.1	73.2	72.2	70.9	69.7	69.2

*Value Used in Short Range Generation Expansion Plan (1976-1985)

method of load forecasting produced a very large rate of growth for the years 1976 through 1980 and a suppressed growth rate for the years 1980-1985. This is shown in the Energy Forecast Curve shown in Graph I-1 in which a decided irregularity is shown in the initial energy load growth curve between the years 1978 and 1985.

Historical records of the schedule dates for commissioning new large industrial loads have shown inherent delays due to lags in financing, construction, etc. Also since the load forecast for such large industries is based on information from the optimistic five-year plans of the various ministries, it is felt that there most probably will be a delay in the achievement dates for such expected load growth. It was decided therefore to normalize the initial forecast curve for the expected energy growth to produce the final expected energy load forecast. Such a normalized load growth pattern also is shown in Graph I-1 and tabulated in the bottom half of Table I-2.

Table I-3 shows the Projected Growth of Total Installed Effective Generating Capacity, Maximum Demand and Generated Energy. The Percentages of annual yearly increase of both maximum demand and energy are shown as well as the average expected yearly increase from 1976 through 1985. It is noted that the average cumulative growth rates for 1976 through 1985 are 11.4 percent for peak demand and 11.3 percent for energy requirements, which are somewhat higher than the growth rate chosen for the rest of the existing system exclusive of large industrial loads. Graph I-2 shows the Forecasted Peak Loading and Generation Expansion Program from 1977 to 1985 for the UPS.

Finally Table I-4 shows a comparison of three different load forecast studies made for the Egyptian Electricity Authority system. Two of these represent the results of recent studies, while the International Atomic Energy Agency Study was an extensive and comprehensive one performed in 1973. The results of such load forecast were obtained by employing the "Aoki" method. Mr. H.Aoki developed curves for the relationship between Gross Electrical Generation per Capita (kWh/Capita) and the Gross National Product per Capita (US$/Capita). After studying this relationship for many countries, he arrived at a recommended universal curve. Such a method was employed in the International Atomic Energy Agency Study in 1973 for their market survey for nuclear power for Egypt.

GRAPH I-1

ENERGY FORECAST (1963-2000)

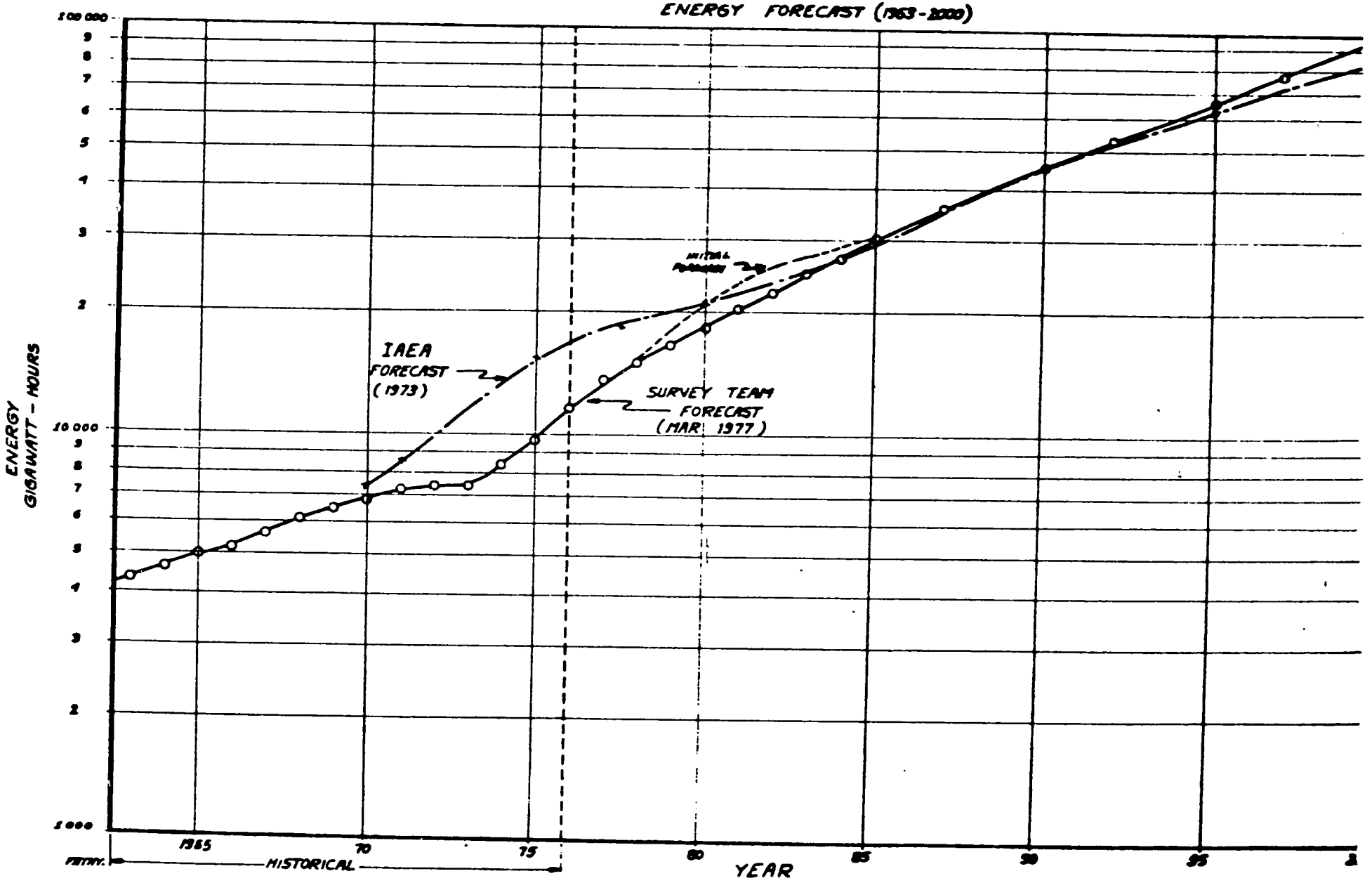


TABLE I-3

PROJECTED GROWTH OF TOTAL INSTALLED EFFECTIVE GENERATING CAPACITY MAXIMUM DEMAND AND GENERATED ENERGY

Year	Installed effective generating capacity[a]	Maximum Demand		Generated energy		Annual load factor (%)
		MW	Annual increase (%)	GWH	Annual increase (%)	
1970 b		1091		6800		71.2
1971 b		1121	2.7	7300	7.4	74.3
1972 b		1176	4.9	7400	1.4	71.6
1973 b		1248	6.1	7400	0	67.6
1974 b		1433	14.8	8500	14.9	67.7
1975 b		1733	20.9	9800	15.3	64.6
1976 b	2477	1909	10.2	11640	18.8	69.4
1977	2711	2192	14.8	13500	16.0	70.3
1978	3271	2470	12.7	15150	12.2	70.0
1979	3568	2678	8.4	16750	10.6	71.4
1980	4075	2924	9.2	18520	10.6	72.1
1981	4643	3192	9.2	20470	10.5	73.2
1982	5550	3578	12.1	22630	10.6	72.2
1983	5811	4028	12.6	25020	10.6	70.9
1984	6111	4518	12.2	27660	10.6	69.7
1985	6675	5045	11.7	30580	10.6	69.2

Maximum Demand Compound Rate %		Generated Energy Compound Rate %	
(1952-76)	12.6[b]	(1952-76)	11.1[b]
(1970-76)	9.8[b]	(1970-76)	9.4[b]
(1976-80)	11.2	(1976-80)	12.3
(1981-85)	12.1	(1981-85)	10.6
(1976-85)	11.4	(1976-85)	11.5

Total installed effective generating capacity = combined contributions of Aswan Dam and High Dam towards meeting annual maximum demand + installed and projected effective capacity of all other plant.(Does not account for shceduled or unscheduled equipment outages)

Historical Data

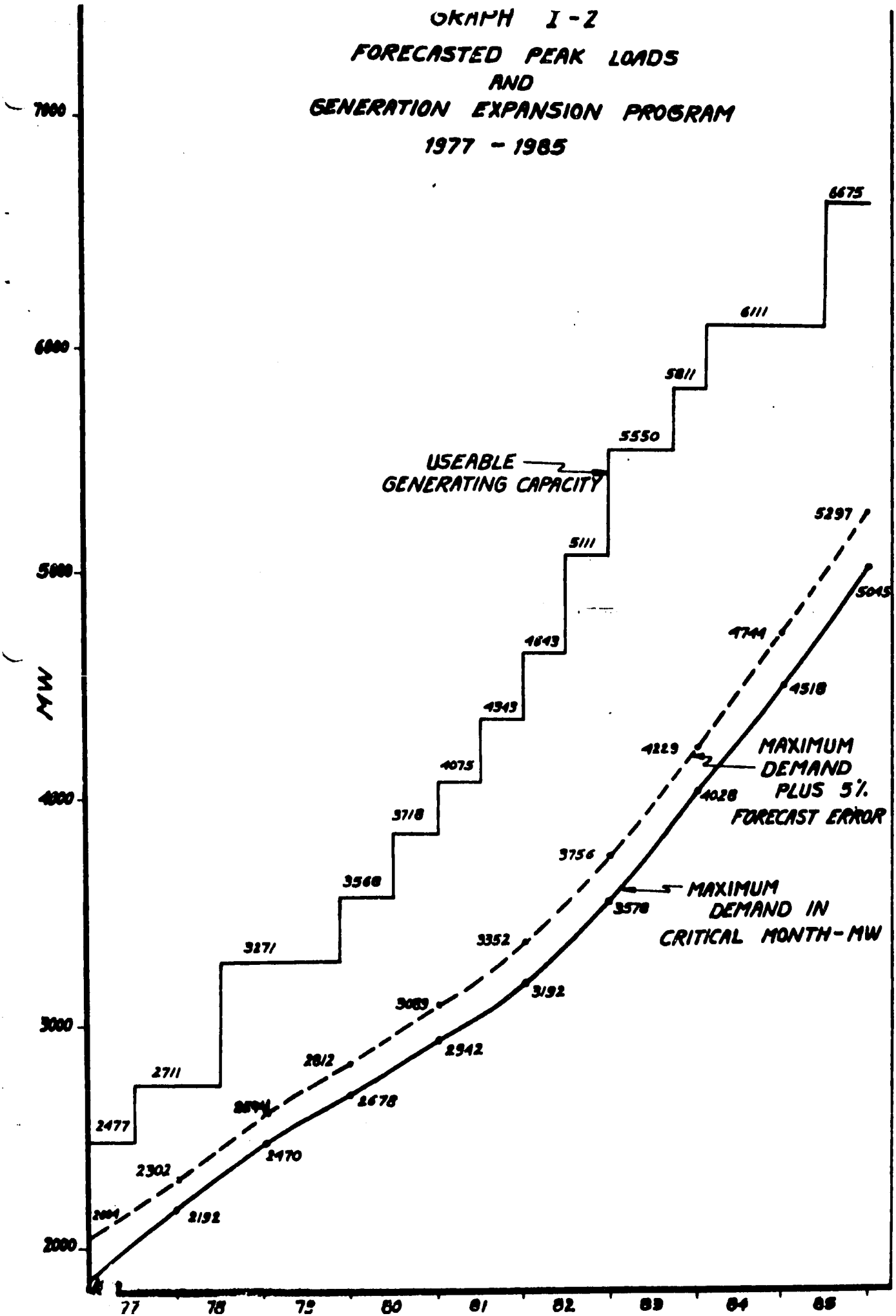

GRAPH I-2
FORECASTED PEAK LOADS
AND
GENERATION EXPANSION PROGRAM
1977 - 1985
MW
7000
6000
5000
4000
3000
2000
USEABLE
GENERATING CAPACITY
MAXIMUM
DEMAND
PLUS 5%
FORECAST ERROR
MAXIMUM
DEMAND IN
CRITICAL MONTH-MW
2477
2711
3271
3568
3718
4075
4349
4643
5111
5550
5811
6111
6675
2004
2302
2594
2812
3089
3352
3756
4229
4744
5297
2192
2470
2678
2942
3192
3578
4028
4518
5045
77
78
79
80
81
82
83
84
85

TABLE I-4

COMPARISON OF FORECASTS OF ENERGY AND MAXIMUM DEMAND

Year	Sanderson & Porter (Apr. 1977)			Nuclear Power Plants Authority (Nov.1976)			International Atomic Energy Agency (Sept. 1973)		
	Energy (GWh)	Load Factor (%)	Maximum Demand (MW)	Energy (GWh)	Load Factor (%)	Maximum Demand (MW)	Energy (GWh)	Load Factor (%)	Maximum Demand (MW)
1976	11640[a]	69.4	1909[a]						
1977	13500	70.3	2192	15200	77.1	2250			
1978	15150	70.0	2470	18100	78.0	2650	18408	71.9	2923
1979	16750	71.4	2678	20800	77.4	3050	19504	71.9	3097
1980	18520	72.1	2924	21900	76.9	3250	20669	71.9	3282
1981	20470	73.2	3192	23100	76.4	3450	22136	71.9	3516
1982	22630	72.2	3578	27300	76.0	4100	23717	70.9	3766
1983	25020	70.9	4028	28700	75.3	4350	25427	69.7	4091
1984	27660	69.7	4518	30300	75.2	4600	27157	68.8	4445
1985	30580	69.2	5045	32000	75.3	4850	29125	67.9	4831

a Historical Data.

Generating Capability and Expansion through 1985

This section of the report examines generating capabilities and needs of the Unified Power System through the year 1985. It discusses several special considerations pertaining to the UPS which were not particularly obvious at the outset of the present study but which became more apparent during a relatively detailed review of various aspects of power system conditions and performance. Among the areas of particular significance are:

1. Conditions and limitations of existing steam generating plants.
2. Hydroelectric capacity and restrictions regarding its use.
3. Problems in providing for new capacity.
4. Proposed capacity additions through the year 1985.

Some of the more specific problems and related considerations in each of the broad areas are analyzed in the following paragraphs.

Conditions and Limitations of Existing Steam Plants

The active steam power plants in the Unified Power System include an unusually large number of generating units which comprise a total nameplate capacity of 1265 MW. There are 37 units in a variety of sizes from 7.5 to 87 MW. The oldest of these was installed almost 30 years ago while the newest went into service about 9 years ago. Multi-unit plants almost invariably are constituted of units of different manufacturers. Obviously this compounds maintenance and spare parts problems over what they are in many power systems. All of the units are of foreign manufacture and needed replacement parts sometimes constitute very difficult problems particularly with the older machines. Difficulties in obtaining such parts sometimes leave equipment out of service for months or even years in a few cases.

The following Table I-5 shows the installed capacity of the existing generating plants and also the expected useable power capability of these plants year-by-year through 1985. It also shows the scheduled and recommended generating capacity additions for the same time period.

The sum of the nameplate ratings of all of the existing thermal generating units, together with the hydroelectric capacity gives a rather impressive total installed capacity in terms of system loads. It has been found, however, that the system dependable capacity is considerably less than the sum of the nameplates and that significant limitations in both steam and hydroelectric components must be considered carefully when looking at system capability from the viewpoints of both system planning and system operations.

Many of the existing steam units are reported to be incapable of producing rated output for various reasons. The problems range from improper boiler design to damaged water walls, high cooling water temperature, and inadequate control systems and safety devices. Many of the boiler problems are attributed to the burning of crude oil during the war years when mazout was not available. All of these considerations are aside from any that may relate more directly to thermal efficiency which has not been a primary concern to date since fuel oil has been available to EEA at a very modest price (currently about $U.S.11.25/ton compared to an international price of $U.S.67/ton). It has been stated that one plant still in operation consumes as much as 700 grams of mazout per kWh, a very excessive heat rate (more than 26,000 btu/kWh or 6229.5 k calories/kWh). At times, however, there have been few options to utilizing whatever generating capacity was available for service to meet peak load.

In addition to any limitations in the power output capabilities of the units, the high incidence of outages of many of the units must be considered in preparing future system expansion plans and schedules.

With reference to certain values shown in Table I-5 of Generating Capabilities, some explanation is in order. For the Cairo West Station shown on the top line of the table, the usable power from the three original units is shown to increase from 150 MW in 1979 to 187 MW in 1980, to 224 MW in 1981, and to 261 MW in 1982. This is based on the assumption that rectoration will be accomplished on one unit per year and for the new 4th unit now under construction and shown in the 12th line of the table is available for service. The Karmouz capability is increased in 1977 because of new cooling towers which should permit increased unit loading when they are completed during the first half of the year. The ratings shown for the combustion turbine units are for winter temperature conditions and the available output is less under summer conditions.

Hydroelectric Capacity and Limitations in Its Use

On the basis of nameplate ratings of hydroelectric generators and a widespread but erroneous concept of virtually unlimited hydro capability because of the impressive size of the Aswan and High Dam complex, it has been easy to assume that little else should be needed to supply much of Egypt's total electric power needs for an indefinite period. Obviously these facilities have an extremely important role in an economical power supply for the Unified Power System, but at the same time there are restrictions and limitations which must be observed. Furthermore, these apply in somewhat different ways depending upon whether current operation or future system planning is involved. This report is concerned largely with the system planning aspect and recognizes the restraints on water use as imposed by the treaty with the government of Sudan concerning

INSTALLED AND PROJECTED GENERATING CAPACITY OF UPS POWER STATIONS

TABLE I-5

Name of Station	Installed Power Megawatts: Number and Capacity of Units	Installed Power Megawatts: Total	Maximum Capability in Megawatts (Assuming All Generating Units in Service): 1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1. Cairo West	3 x 87	261	150	150	150	150	150	187	224	261	261	261	261
2. Cairo South	4 x 60	240	180	240	240	240	240	240	240	240	240	240	240
3. Cairo North	2 x 30 + 1 x 20 + 2 x 15	100	75	75	75	75	75	75	75	75	36	36	0
4. El-Tebbin	3 x 15	45	28	40	40	40	40	40	40	40	40	40	40
5. Talka	3 x 12.5 + 3 x 30	127	116	116	116	116	116	116	116	116	116	116	116
6. Damanhour	2 x 15 + 3 x 65	225	195	195	195	195	195	195	195	195	195	195	195
7. El-Seyouf	2 x 26.5 + 2 x 30	113	100	100	100	100	100	100	100	100	100	100	100
8. Tarmouz	4 x 16	64	30	30	45	45	45	15	0	0	0	0	0
9. Assiut	3 x 30	90	60	90	90	90	90	90	90	90	90	90	90
10. Suez (Damaged)	4 x 25	100	---	---	---	---	---	---	---	---	---	---	---
11. Kafr El-Dawar	3 x 110	330	---	---	---	110	220	220	220	330	330	330	330
12. Cairo West	1 x 87	87	---	---	---	---	87	87	87	87	87	87	87
13. Abu Qir I	2 x 150	300	---	---	---	---	---	300	300	300	300	300	300
14. Ismailia	2 x 150	300	---	---	---	---	---	---	---	150	300	300	300
15. Abu Qir II	2 x 150	300	---	---	---	---	---	---	300	300	300	300	300
16. Suez I	2 x 150	300	---	---	---	---	---	---	---	300	300	300	300
17. New Plant I	2 x 300	600	---	---	---	---	---	---	---	---	300	600	600
18. Sidi Krir I	1 x 600	600	---	---	---	---	---	---	---	---	---	---	600
Total			934	1035	1051	1151	1355	1665	1957	2734	2995	3293	3559
COMBUSTION TURBINE STATIONS*													
1. El-Max	2 x 14	28	12	24	24	24	24	24	24	24	24	24	24
2. Suez	1 x 17			17	17	17	17	17	17	17	17	17	17
3. Ismailia	1 x 23				23	23	23	23	23	23	23	23	23
4. Cairo North	1 x 23				23	23	23	23	23	23	23	23	23
5. Port Said	2 x 23								46	46	46	46	46
6. Fayum	1 x 23				23	23	23	23	23	23	23	23	23
7. Helwan	120 MW Total					120	120	120	120	120	120	120	120
8. Talka	180 MW Total					180	180	180	180	180	180	180	180
Total			12	41	110	410	410	410	456	456	456	456	456
HYDRO STATIONS**													
High Dam	12 x 175	2100***)	1400	1550	1700	1800	2000	2200	2360	2360	2360	2360	2360
Aswan	7 x 46 + 2 x 11.5	345***)											
Total System Capability			2477	2711	3271	3563	4075	4843	5550	5811	6111	6375	

*Winter Ratings.

**Hydro Capability varies as a function of load magnitude and distribution in the UPS network.

***High Dam output is usually limited to 1750 MW because units must be removed from service in pairs when under maintenance due to common penstock arrangements, and one or more units are consistently out for maintenance. Aswan capability is 260 MW due to reduced head after construction of High Dam.

Nile water resources and water allocations to the two countries. It should be noted that actual water availability and its potential for power production at any given point in time may permit operational considerations that would be beneficial to EEA and perhaps involve amounts of water greater than the basic allocations mentioned in the specific terms of the treaty. It is not valid however, to plan future electric system expansion except on the basis of the specific understandings and agreements expressed in the treaty, and as interpreted by EEA and other government offices. This currently limits planned use to 55 billion cubic meters per year.

A discussion of the possible overall potential of the Nile in relation to the electric power system appears in the Power Sector - Phase I Diagnostic Report issued in November 1976. The discussion there is largely in terms of operational possibilities based on average annual river flows considerably in excess of 55 billion cubic meters. Such considerations cannot, however, be used in planning for future generation expansion to meet projected peak loads as long as there are restrictions in water use such as those prevailing today.

Moreover, it will be noted later in this report that the maximum capacity of the hydroelectric plants has been used in scheduling resources to meet projected peak demands. Under that condition any greater utilization pertains only to energy generation and not peaking capacity.

The following excerpt from an English translation of the treaty with Sudan describes the allocation of Nile water to the two countries under the conditions and terms of that agreement.

"First: Presently accepted rights:

1. What UAR uses from the water of the River Nile up to the signing of this agreement, is the established right to it (UAR) prior to obtaining the benefits which will occur because of the river control projects and increasing the yield of water which is the subject of this agreement, and the amount of this right is 48 billion cubic meters; estimated yearly at Aswan.

2. What the Sudan Republic uses from the water of the River Nile up to the signing of this agreement is its established right before obtaining the benefits of the mentioned projects; the amount of this right is 4 billion cubic meters, estimated yearly at Aswan.

Second: The projects for river control and distribution of its benefits between the two Republics:

1. To control the river water and to prevent the flow of its water to the sea. The two Republics agreed that,

UAR is to construct the reservoir of the High Dam at Aswan, as the first step in the series of projects for the continuous storage of the Nile water.

2. To enable the Sudan to use its share, the two Republics agreed that: the Republic of Sudan is to construct the reservoir at Roseires on the Blue Nile, and any other works which the Republic of Sudan considers to be necessary for the use of its share.

3. The average benefits from the High Dam are calculated according to the natural yield of the River at Aswan. During the present century there has been about 84 billion cubic meters yearly. There should be deducted from this quantity the established rights of the two Republics, which were mentioned in item "First", as estimated at Aswan. Also there should be deducted from it, the continuous storage loss in the High Dam. The balance of this will be the "Net Benefit" which will be distributed between the two Republics.

4. The Net Benefit of the High Dam which has been mentioned in the previous item is allocated between the two Republics at 14.5 billion for the Sudan and 7.5 billion for UAR, as long as the average yield in the future is still in the range of the average yield mentioned above.

This means, if the average yield remains equal to the average of the previous years of the present century, which is estimated at 84 billion, and if the storage losses continue as estimated now at 10 billion, the Net Benefit of the High Dam in this case will be 22 billion, and the share of the Sudan Republic out of that will be 14.5 billion, and the share of UAR will be 7.5 billion.

When these two shares are added to their established rights, their shares from the net yield of the Nile after the full operations of the High Dam will be 18.5 billion for the Sudan Republic, and 55.5 billion for UAR.

5. "If the average flow increases, the increase in the Net Benefit which results from the increase in the yield is to be divided into two equal shares between the two Republics".

On the above basis, the annual hydroelectric contribution to Egypt's total energy requirement in this system planning study is based on 55.5 billion cubic meters of water per year. Furthermore, the amounts of electric energy assumed to be produced from water power were derived from ratios based on past actual operation records rather than effective heads and turbine efficiencies because of some apparent but unidentified discrepancy between the actual and theoretical efficiencies of

the hydroelectric plants. More information on this aspect, together with calculations of an example load dispatch schedule for the forecast peak load day of December 1983, appears later in this chapter of the report.

Distribution of water releases over the year are not controlled by EEA or the Ministry of Power and Energy but by the Ministry of Irrigation and the foremost consideration in scheduling water releases relates to seasonal irrigation needs. Of course, due attention must be given to control of reservoir elevations in terms of the annual flood season in late summer and fall when the major portion of the total water for the year flows from the Upper Nile tributaries.

The Power Survey Phase I report strongly recommended closer coordination between EEA and the Ministry of Irrigation in the belief that more effective use of available water may be possible. Current thinking and customary scheduling of water releases throughout the year have normally provided for discharges of 100 million cubic meters per day in the months of December and January. These are the months of minimum irrigation needs and in former years, these low water periods have been used for canal cleaning operations. The latter is not thought to be of as much importance today, however, since heavy mechanical equipment is used for much of the dredging and low water levels are not so necessary.

Special permission was obtained by EEA to release 130 million cubic meters of water per day in December 1976 and January 1977 but this was a special provision because of limited available thermal generating capacity in the UPS. Although it might be possible to effect similar agreements in the future, there is great sensitivity throughout the government to releases of water other than in direct relation to irrigation or other physical needs as contrasted to use for electric power generation. With water releases of 100 million cubic meters per day, the hydroelectric stations can generate about 17 million kWh per day and this is the amount considered in the present study. X 365 days/yr = 6.2 x 10^9 kWh/yr

As regards peaking capacity of the hydroelectric facilities, the maximum nameplate rating of the High Dam is 2100 MW (12 x 175 MW units) and Aswan is 345 MW (7 x 46 + 2 x 11.5 MW units). As was noted in the preceding Table, however, the dependable capabilities of both of the hydroelectric plants are reported to be significantly less than the nameplate ratings would indicate. At the High Dam, each penstock serves two turbines, and it is necessary to remove both of these from service when maintenance work is being performed on either of them. Historically, there have virtually never been more than ten of the twelve units available for operation at the same time. Therefore EEA believes that it is not accurate to assume that the dependable capacity of the High Dam is any more than 1750 MW. Aswan Dam maximum output is now limited to about 260 MW because of the low head normally

prevailing since construction of the High Dam. Furthermore, at least one unit is characteristically out of service for maintenance and the plant capability is usually about 225 MW. Therefore the total maximum hydroelectric peaking capability for both plants may be only about 1975 MW most of the time.

Because of system stability limitations, the total permissible generation at the hydro plants under certain conditions is a function of the load magnitude and distribution in the UPS system. Several previous studies and reports were examined and from these a few values were obtained and used to establish reference points from which a rudimentary graph of 500 kV transmission capability was plotted. Interpolated values were then obtained for the load levels projected for the years 1977 through 1985, and it is these values that appear in the generation capability table as hydroelectric capability. Although it is recognized that the approach employed does not represent a sophisticated or refined method, it is believed that the resulting approximations are sufficiently accurate to permit relatively reliable indications of transmission capability for present purposes.

Under 1976-77 conditions, the hydro capability limit is of the order of 1500 MW but under anticipated load growth, this is expected to gradually increase by 1982 to the maximum hydroelectric capability even if all units were to be in service at the same time. It should not be forgotten, however, that it is very unlikely that all units will be in service simultaneously unless greatly improved performance and substantially reduced maintenance outage time can be achieved.

The foregoing discussion provides some additional insight with regard to earlier suggestions concerning 500 kV line improvements. It is important that the reliability of the lines be improved but it seems questionable that any increase in transmission capability through the addition of static capacitors is justified under present conditions.

The matter of restraints on hydroelectric generation because of transmission stability consideration is discussed further in a following section entitled "Hydro Generation and 500 kV Transmission Line Transfer Capability".

Problems in Providing New Capacity

Financing of new power facilities has been a sizeable problem for Egypt and has frequently caused delays in arrangements for new installations. Entering into the total picture at times may have been the previously mentioned widespread idea stemming from international publicity that the mighty Aswan Dam was the answer to all of the country's power needs of the indefinite future and therefore no other facilities should be needed for a long time. Some of the relevant considerations in this area have been discussed in the foregoing part of this report.

Another impediment has been the lack in some earlier reports of solid substantiating data to support projections concerning loads, energy requirements, load factors, and related items. It has been found extremely difficult to establish firm support for some of these. The load forecast is perhaps the most difficult because there is nothing for many years that can be considered to represent a normal growth trend. In fact there is no normal growth trend because of the effects of the war years--military action, dislocation of population in many areas, and economic effects of both direct military activities and the impacts on other programs of huge military expenditures.

Once an agreement has been reached about the need for a new power facility, then the dealings with foreign governments, financing arrangements, contract negotiations, and the like are very time consuming and it has been extremely difficult to meet anticipated schedules. In some instances, even after construction has been arranged, shortages of construction and heavy erection equipment have produced difficult problems and consequent delays.

Similar to experiences of recent years in many other countries, there has been local opposition to power plant siting in Egypt which resulted in a change of location of at least one new plant within the past year. It is likely that problems of this nature will continue.

Proposed Capacity Additions through 1985

One of the problems in formulating capacity expansion plans and related schedules of needed generating capacity additions for the future has been that of knowing what part of the existing installed capacity can reasonably be expected to be serviceable at any given time.

Expressed concerns of EEA officials about ability to meet peak loads at particular times and frequent reports of large blocks of capacity out of service for maintenance led to a concerted effort to evaluate the amount of reserve capacity required for reliable service to system loads.

Some earlier reports indicated a need for relatively large percentages of reserves but some offered little substantiation of the amounts suggested. After considerable discussion with EEA people and review of available data, it was concluded that a more realistic approach than trying to derive a percentage figure applying to the total installed capacity (or possibly peak load) would be to develop a needed kilowatt capacity reserve margin taking into account the poor condition of many of the existing units and the number and sizes of future units together with their expected normal maintenance requirements. Using this approach, the system requirements were examined year-by-year on the basis of the forecast peak demand and annual energy amounts presented earlier.

Outage statistics for the years 1971 through 1975 (the latest year readily available when this report was being prepared) were studied and summarized as shown in the accompanying Table I-6 entitled "Summary of Thermal Power Generating Capacity Outages 1971-75". Using these results, an outage projection was made for the generation block represented by those of the present units that are expected to still be in service in 1983. The total capacity projected to be out of service was split into two components, one for scheduled and one for non-scheduled maintenance. Similar projections were made for the group of new units to be installed between 1978 and 1983, for the combustion turbines, and for the hydroelectric plants. These were combined to produce a total of the generating capacity that on the average can be reasonable expected to be out of service for maintenance at the time of monthly peak loads in 1983. In order to enable a comparison between the expected average conditions and a reasonably possible worse condition, a comparison projection was prepared based on the average of the worst month of each of the 1971-75 years of records and the assumption of simultaneous outages of more than one of the newer steam units and hydroelectric units. These appear in the Table I-6 entitled "Projected Average Simultaneous Outages for Year 1983". After the table was prepared supplementary information was received on capacity availability during 1976. A note added to the Table compares the 1976 experience with the earlier 5-year period.

Using the projected outage information as described, another table was developed to show relative system capability in comparison with the forecast peak demand for 1983. Table I-7 is entitled "Load and Generating Capability Analysis - Year 1983". To the forecast peak demand was added an extra increment of 5 percent as a safeguard against forecasting errors. Five percent was chosen because of its conformity with the U.S. Edison Electric Institute's accepted allowance for errors of this type.

It will be noted that a spinning reserve allowance equal to the capacity of the largest unit (175 MW) was used. This provides less than EEA's normal allowance of reserve equal to the two largest units but it was considered appropriate since allowances had already been made for all expected outages both scheduled and non-scheduled. Therefore spinning reserve equivalent to the one largest unit should be sufficient to meet any remaining emergency contingencies.

The end result of the 1983 analysis shows that a surplus somewhere between 16 and 219 MW should be available at the time of peak demand under the projected outage conditions. Therefore, if equipment problems should result in total capacity outages equivalent to the average of the "Highest Month" conditions, the capacity margin in December 1983 would be only 16 MW and the presently planned capacity would be sufficient to meet anticipated peak demands through less than the first half of 1984.

TABLE I-6

SUMMARY OF THERMAL POWER GENERATING CAPACITY OUTAGES*

1971 - 1975

Average Outages (MW) For Scheduled and Non-Scheduled Maintenance At Times of Monthly Peak Loads

	Average of 12 Months				Highest Month of Year				
ear	Scheduled MW	Non-Scheduled MW	Total MW	% of Installed Capacity	Month	Scheduled MW	Non-Scheduled MW	Total MW	% of Installed Capacity
971	198.8	161.2	360	29.3	Dec.	230	200	430	35.0
972	232.5	113.3	346	28.0	Dec.	265	200	465	37.0
973	237.9	105.4	343	28.4	May	300	150	450	37.2
974	185.8	184.2	370	31.3	Apr.	160	300	460	38.9
975	95.8	210.4	306	25.9	Oct.	75	425	500	42.3
verage	190.2	154.9	345	28.6		206	255	461	38.2

PROJECTED AVERAGE SIMULTANEOUS OUTAGES FOR YEAR 1983

	Average of 12 Months				Highest Month of Year			
	Sched. MW	Non-Sched. MW	Total MW	% of Installed Capacity	Sched. MW	Non-Sched. MW	Total MW	% of Installed Capacity
ld Steam Units (1078 MW)	171	140	311	28.8	186	230	416	38.6
ew Steam Units (1617 MW)	150	0	150	9.3	150	87	237	14.7
onbus. Turbines (456 MW)	30	12	42	9.2	30	23	53	11.6
ydroelectric (2360 MW)	385	0	385	16.3	385	0	385	16.3
otal(5511 MW)	736	152	888	16.1	751	340	1091	19.8

See EEA Dispatching Inspectorate Report No. 6-1976 for detailed outage statistics.

ote: Information on generating capacity availability for 1976 received after above statistics were accumulated indicates for that year an average UPS available generating capability of 2694 MW. This may be compared with totals of 2754 MW and 2649 MW at time of monthly peak loads as derived from the above figures for Average of 12 Months and Highest Month of Year respectively.

TABLE I-7

LOAD AND GENERATING CAPABILITY ANALYSIS - YEAR 1983

ed Capacity*		
Units (Prior to 1970)	1078 MW	
Units (1978 and Later**)	1617 MW	(Includes Kafr El Dawar, New Cairo West, Abu Qir, Ismailia & Suez I but not New Plant I)
stion Turbines	456 MW	
electric	2360 MW	
Total	5511 MW	

sis of Estimated Available Capacity for Average Month and High Maintenance of 1983***

	Average Month	High Month
alled Capacity (Without New Plant I)	5511 MW	5511 MW
uled Maintenance Outage	736 MW	751 MW
	4775 MW	4760 MW
Scheduled Maintenance Outages	152 MW	340 MW
	4623 MW	4420 MW
ning Reserve (Equiv. to Largest Unit)	175 MW	175 MW
Net System Capability	4448 MW	4245 MW
cast Load	4028 MW	4028 MW
ecast Load (+ 5% for Margin of Error)	4229 MW	4229 MW
city Minus Load (Based on Forecast + 5%)	219 MW	16 MW

e Accompanying Table - "Installed and Projected Generating Capacity"

o New Steam units were installed between 1970 and the scheduled 1978 in-service dates for 2 units at Kafr El Dawar.

ee Accompanying Tables-"Summary of Thermal Generation Outages 1971-1975" and "Projected Average Simultaneous Maintenance Outages for year 1983"

The results of using the preceding method of reserve analysis gives a conservative or "optimistic" reserve requirement.

In order to gain greater insight into the maximum possible system reserve requirements several computer runs using probability methods were performed. The program utilized in the first group of these studies was based on the "loss of capacity probability" method using the binomial distribution for the state of the different units running in the power system. The on-line units were combined into any number of groups having the same size and same forced outage rates. For each group, the number of similar units, the MW rating of each and the rate of forced outage were input data. The output of the program gave the cumulative probability of loss of capacity for each group and for the total combination of groups.

The big disadvantage of this method is that it assumes the daily system peak demand exists for twenty four hours (in other words a system load factor of 100%) and as such gives a "pessimistic" result.

In order to evaluate the effect of an increased forced outage rate for the older presently existing thermal units sensitivity studies were performed with a 50% and 100% increase in the original forced outage rates of such units. The forced outage rates of the hydro, combustion turbine and new steam units were held constant in all these additional studies. The normal EEA reliability rate used in probability studies is 0.999 corresponding to a one day system outage in four (250 working days) years. Practice in the United States is one day in ten years or a reliability level of .9997, a Egyptian six day work week. Other reliability levels were also used in the sensitivity studies.

The results of such studies are tabulated in Table I-8

TABLE I-8

RESULTS OF RELIABILITY STUDY USING PROBABILITY METHODS

Case 1: FOR as adopted in the previous EEA studies

Reserve Requirement:

425 MW	for	0.99	Reliability Level	(1 day in 100 days)
615 MW	"	0.999	" "	(1 day in 4 years)
720 MW	"	0.9998	" "	(1 day in 20 years)

Case 2: FOR increased 50% for older thermal units

Reserve Requirement:

495 MW	for	0.99	Reliability Level
640 MW	"	0.999	" "
725 MW	"	0.9998	" "

Case 3: FOR increased 100% for older thermal units

Reserve Requirement:

525 MW	for	0.99	Reliability	Level
670 MW	"	0.999	"	"
755 MW	"	0.9998	"	"

The required system reserve requirement using the above more "pessimistic" method of analysis would be:

Scheduled Maintenance	736 MW
Spinning Reserve for system (Reliability Level 0.999)	615 MW*
Forecasting Errors (5%)	201 MW
	1552 MW

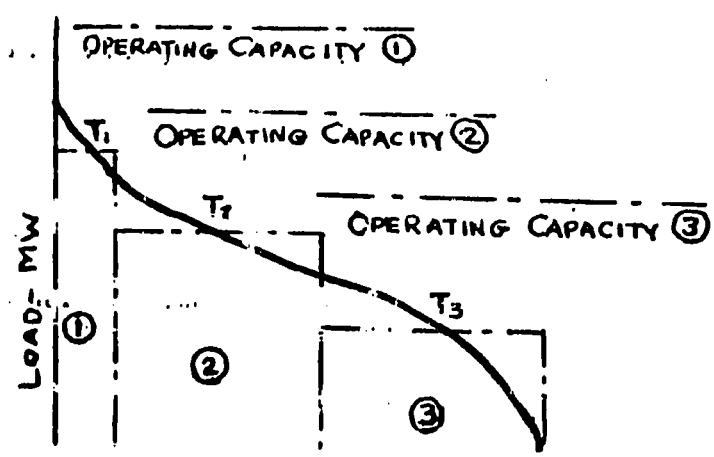
Percent Reserve Margin on Peak Demand = 38.5%

* In the former optimistic analysis using scheduled and non-scheduled maintenance this value was 327 MW giving a total reserve requirement of 1264 MW or 31.4% of the peak demand.

The preceding "loss of capacity" method gave on overall 24 hour system reliability result much greater than that used in the study. This was due to the fact that it considered a load duration curve with a 100 percent load factor and with a constant 24 hour demand equal to the daily maximum demand. Consequently it gave an excess reserve requirement. In order to obtain more meaningful results a "loss of load probability" study was next run. For this type of study the daily load duration curve for December, Graph I-4 was used with the FOR's to determine the loss of capacity not available during different periods of the day. For the study the load duration curve was divided into three finite increments as shown in Graph I-3 below:

GRAPH I-3

LOAD DURATION CURVE AND TIME PERIODS FOR LOSS OF LOAD PROBABILITY STUDY



A typical generation dispatch for each of the operating periods was then prepared. The first dispatch considered all units (less those out for scheduled maintenance) to be on the line; the second dispatch considered the combustion turbines shut down and reduced hydro capacity; the third dispatch considered additional reduced hydro capacity. Separate "loss of capacity probability" studies were run for each block of the load duration curve and the results then evaluated by using the percent time periods of the load duration curve affected by such loss. The results were then plotted in the form of a graph using semi-logarithmic paper. On this graph the required reserve to meet the reliability levels were obtained. For a reliability level of 0.999 (the EEA standard) a reserve requirement of 430 MW is required. For a reliability level of 0.9997 (1 day in 10 years) a reserve requirement of 510 MW is required. Both of these high reserve requirement values obtained by the "loss of load probability" method reinforce the original recommendation that additional generation in required in 1983 if the EEA's installed generation is to reliably serve the forecasted peak loads.

Since several months are likely to be required for a new unit to reach commercial maturity, it is recommended that such a unit be scheduled for operation no later than the third quarter of 1983. The peak demand in 1984 is forecasted to increase by 490 MW over the preceding year. Therefore, more new capacity will be needed to meet the anticipated load requirements at that time.

Any of the capacity additions suggested by this study indicate that unit sizes larger than the 150 MW ratings utilized through 1982 (Suez I Plant) should be considered for the future. The subject of unit sizes however, is discussed separately in a subsequent section of this chapter.

In view of the indicated capacity situation, the expected loads, and the ever-present difficulty of meeting scheduled dates for installation of new facilities, it is recommended that plans be made promptly for the addition of a 2 x 300 MW unit steam plant with an installation schedule to provide for initial operation of the first unit during the third quarter of 1983, which is probably about as early as it is possible to have such a unit in initial operation. The second unit should be scheduled to follow within a few months.

Load and Generation Analysis

December 1983 Forecast Peak Load Day

The following is an analysis of generation required under the assumed conditions as specified to meet a load of 4229 MW and 75664 MWH possible on the peak load day of December 1983. It is presented to illustrate how the available sources of generation might be used to meet the load requirement. The accompanying Graph I-4 shows the projected hourly load distribution and the division of energy supply between hydro and thermal sources. The analysis presents the conditions which would have to be met if, because of forecast errors, the demand and energy requirements should exceed the forecast values by five percent as explained earlier.

Assumptions

100,000,000 M^3/DAY Water allocation at High Dam*

4229 MW Peak Load (Forecast + 5%)

75664.05 MWH/DAY Energy Requirement

Hydraulic Efficiencies

In order to eliminate possible questions about the accuracy of hydraulic turbine and generator efficiencies and their effects on electrical output from the hydro plants, the overall water flow to electricity conversion ratios used here have been derived from EEA operation records for the past two years rather than utilizing assumptions as to theoretical turbine efficiencies, heads, standardized hydraulic power formulas, and the like. Reported monthly water discharges through the turbines and the energy generated yield the following results:

	1975 M^3/kWh		1976 M^3/kWh	
	High Dam	Aswan	High Dam	Aswan
Jan.	8.398	19.910	7.413	22.630
Feb.	8.247	22.423	7.271	21.967
Mar.	8.422	21.198	7.484	23.206
Apr.	8.497	21.605	7.581	23.053
May	8.184	20.830	7.523	23.012
June	8.624	20.582	7.237	23.035
July	8.914	20.597	7.567	22.401
Aug.	8.874	26.950?	7.371	22.186
Sep.	7.964	20.087	7.268	22.839
Oct.	7.506	18.445	7.105	22.321
Nov.	7.429	19.811	7.143	22.999
Dec.	7.329	19.405	7.232	22.723
		20.987?	7.350	22.698
Average	8.199	20.445	7.350	22.698

Based on the above, the following water use values were selected for this analysis:

High Dam 8 M^3/kWh

Aswan 22 M^3/kWh

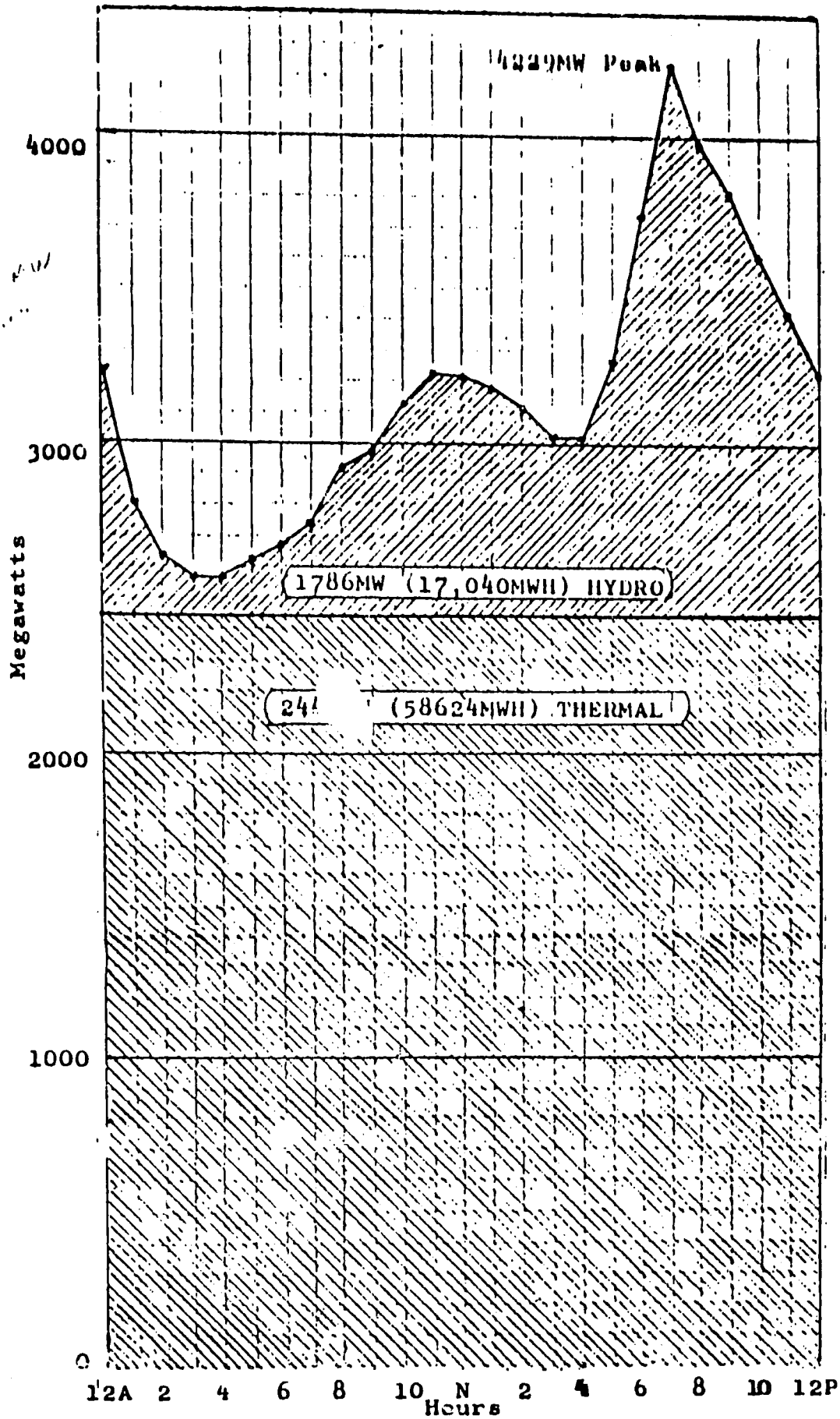
* This is the amount of water normally scheduled by Ministry of Irrigation for the months of December and January.

Computation of Generation Requirements

		Forecast +5%
Energy from Hydroelectric Sources:		
High Dam - $\frac{100,000,000\ M^3/Day}{8}$	=	12,500,000 kWh
Aswan Dam - $\frac{100,000,000\ M^3/Day}{22}$	=	4,540,000 kWh
Total Hydro Energy/Day	=	17,040,000 kWh
With Peak Day Energy Total	=	75,664,050 kWh
and Hydro contribution	=	17,040,000 kWh
Thermal Energy Requirement	=	58,624,050 kWh
Thermal Capacity Required	=	$\frac{58624050}{24}$ = 2443 MW

Summary		Average Maintenance	High Maintenance
Peak Load	=	4229 MW	4229 MW
Needed Thermal Capacity	=	2443 MW	2443 MW
Needed Hydro Capacity	=	1786 MW	1786 MW
Anticipated System Capability (see table of generating capabilities through 1985 elsewhere in this report)			
Hydro - High Dam (12 x 175 MW Units)		2100 MW*	2100 MW
Aswan (7 x 46 + 2 x 11.5 MW)		260 MW	260 MW
Total Hydroelectric		2360 MW	2360 MW
Thermal - Steam		2695 MW	2695 MW
Gas Turbines		456 MW	456 MW
Total Thermal		3151 MW	3151 MW
Total Installed Capacity		5511 MW	5511 MW
Maintenance Outages (see table in Report Text)		888 MW	1091 MW
Capacity Available at Peak Load		4623 MW	4420 MW
Spinning Reserve (Equal to Largest Unit)		175 MW	175 MW
Remaining Available capacity		4448 MW	4245 MW
Maximum Load		4229 MW	4229 MW
Standby Reserve		219 MW	16 MW

* This is derated value used instead of 345 MW for Aswan plant capability because of limiting low head conditions since High Dam closure.


4229MW Peak
4000
3000
2000
1000
0
Megawatts
1786MW (17,040MWH) HYDRO
24
(58624MWH) THERMAL
12A 2 4 6 8 10 N 2 4 6 8 10 12P
Hours

GRAPH I-4

Planned Dates of Commercial Operation for Expected New Generating Plants

The following Table I-9 shows the scheduled or otherwise anticipated dates of commercial operation for the new generating units to be added to the Unified Power System through the year 1985.

TABLE I-9

ESTIMATED DATES OF COMMERCIAL OPERATION OF GENERATING UNITS

Plant Location	Size	Type	EEA's Date	Survey Team's Date
Helwan	120 MW Total	Gas Turbine	1977	1978
Talkha	180 MW Total	Gas Turbine	1978	1978
Kafr El Dawar	3 x 110 MW	Steam	1978-79-82	1978-79-82
Cairo West 4th Unit	1 x 87 MW	Steam	1979	1979
Abu Qir 1st Phase	2 x 150 MW	Steam	1980	1980
Abu Qir 2nd Phase	2 x 150 MW	Steam	1981	1981
Ismailia	2 x 150 MW	Steam	1981	1982
Suez I	2 x 150 MW	Steam	1982	1982
New Plant I	2 x 300 MW	Steam	1982	1983
Sidi Kreir I	1 x 600 MW	Nuclear	1983	1985

EEA's schedule of dates for commercial operation of the Helwan gas turbines, the Ismailia steam power plant; the New Plant I, and the first unit of the Sidi-Kreir nuclear power plant appears optimistic, and it is the Survey Team's opinion that the scheduled dates of commercial operation for these plants cannot be met.

Generation programming is governed by lead time including the time required from the initiation of the project study to the completion of construction including commissioning. Typical present day lead times for plant construction in developing countries is shown in Table II-10

TABLE I-10

LEAD TIME-MONTHS

	Study-Financing-Specifications & Bidding Time (Months)	Plus Engineering, Manufacturing and Construction time (Months)	Total (Months)
Gas turbines small/large	6	18/24	24/30
New fossil fuel steam small/large	12/18	48/60	60/78
Nuclear	24	78	102

The Survey Team's estimate of completion dates is given in the last column of the Table I-9 "Estimated Dates of Commercial Operation". It has been arrived at after considering the present status of the financing, procurement and construction schedules for the previously mentioned power plants and after extensive discussions with both EEA officials and outside sources.

Of particular interest to the present study is the timing of the proposed fossil fuel power plant, identified in this study as the "New Plant I", and the proposed first unit of the Sidi Kreir nuclear power station. The earliest estimated date for commercial operation of the New Plant I is 1983 based on a schedule of one to one and a half year financing and procurement time and of a four to five year construction schedule. The earliest estimated date for commercial operation of the first unit of the Sidi Kreir nuclear power station is 1985, based on a minimum time of two years for financing and contractual arrangements and a minimum construction time of six to six and one-half years.

It is concluded that the likely unavoidable delay in the commissioning date for the Sidi Kreir nuclear power plant to at least 1985 makes it mandatory that EEA consider interim sources of power generation such as the proposed 2 x 300 MW New Plant I in order to be able to satisfy the power and energy requirements of the Egyptian economy for the years of 1983-1985.

Turbine-Generator Unit Size and Type

Up through 1982 the largest generator unit size planned to be added to the Unified Power System is a 150 MW unit.

Four units of 150 MW size are planned at the Abu Qir Plant, two units of 150 MW size at the Ismailia plant, and two units of 150 MW size at the Suez T plant for a total of eight 150 MW units.

In 1983 the forecasted peak load will be 4028 MW and in 1984 it will be 4518 MW. The corresponding installed maximum effective generating capacity is expected to be approximately 5511 MW for both 1983 and 1984. The addition of a new 300 MW generating unit in 1983 would make this 5811 MW and the addition of a second 300 MW unit in 1984 would make this 6111 MW.

A "rule of thumb" often used in sizing new generating additions to an electric utility system is that the largest unit size should be between seven and ten percent of the installed generating capacity.

The following Table I-11 entitled "Relationship of Maximum Unit Size and Peak Demand" was taken from the Market Survey for Nuclear Power in Developing Countries- 1974 Edition". It covers all types of power plants and appeared as Table XI, page 18, of that report and was used in the International Atomic Energy Agency generation expansion study for Egypt.

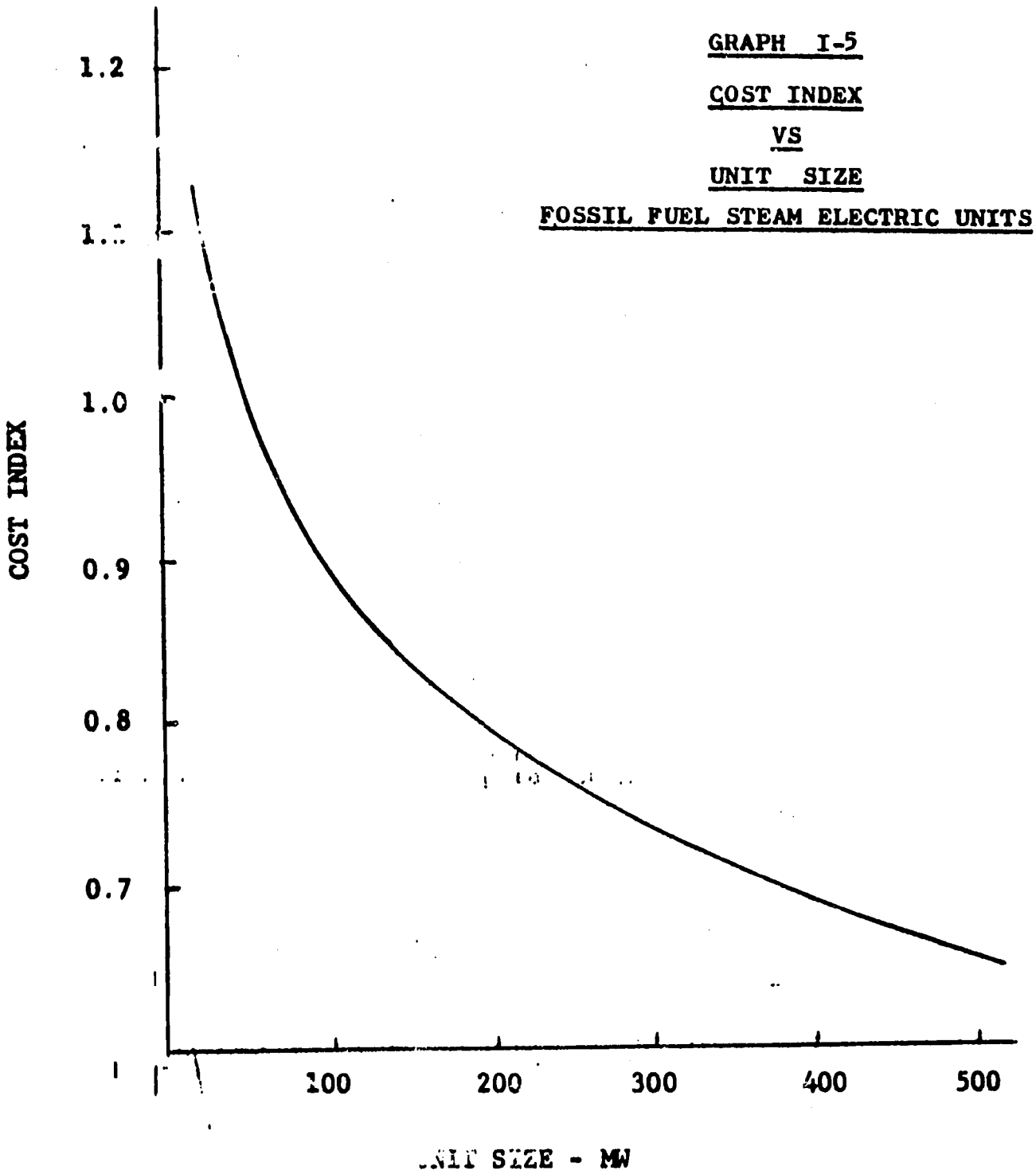
TABLE I-11

RELATIONSHIP OF MAXIMUM UNIT SIZE AND PEAK DEMAND

Peak demand (MW)	Maximum unit size (MW)	Percentage of peak demand
250	50	20.0
400	75	19.0
550	100	18.2
700	125	17.8
850	150	17.6
1500	200	13.3
2000	250	12.5
2500	300	12.0
3700	400	10.8
5400	500	9.3
7000	600	8.6
9600	700	7.3
12000	800	6.7
17000	1000	5.9
22000	1200	5.5
30000	1500	5.0

The size and peak demand relationships show that the maximum turbine generator unit size used in the IAEA study was approximately 450 MW for additions to the system in 1983-84. (That study assumed a forecasted peak load of approximately 4200 MW).

The following Graph I-5 shows the economy of scale relationship of the cost index and unit size for fossil fuel steam electric units up to 500 MW.



Graph I-5 shows that there is approximately a nine percent saving in unit cost (U.S.$/KW) in installing a 300 MW steam turbine generator over installing two 150 MW steam turbine generators and approximately a sixteen percent saving in unit cost (U.S.$/KW) in installing a 450 MW steam turbine generator over three 150 MW units. In addition there is often a three to four percent improvement in plant heat rate to be gained from the installation of the larger more efficient units.

After considering many aspects of the Unified Power System and its future operation, it is recommended that the next steam power plant unit size to be added to the EEA system be 300 MW. Generating expansion studies should be performed up through the year 2000 to determine the optimum size of later units, taking into account both scheduled maintenance and system spinning reserve requirements. The change to a 300 MW size is undoubtedly justified at present in view of the high forecasted loads and EEA's planned intention to shortly thereafter add a 600 MW nuclear unit to the system.

Another alternative to be considered and studied is the possible construction of a combined cycle plant with its lower dollar per kilowatt installed cost. It is estimated that a 3[illegible] combined cycle plant would cost approximately 25 percent less than a conventional steam power plant and has the additional advantage of a better heat rate (possibly 9600 btu/kWh compared to 9000 btu/kWh). One proposal put forth by the EEA's staff is that of considering the use of the 180 MW of combustion gas turbines presently scheduled to be installed at Talkha as part of a combined cycle plant. It is likely, however, that such an installation would require original plans based on this design, and that an initial independent combustion turbine station of usual design would not be feasible for later adaptation to combined cycle application.

Plant Type and Location

The previous discussion covers the recommendation that a new power plant preferably of the 300 MW size be added to the EEA system before the third quarter of 1983 with a second unit to be scheduled for commercial operation a few months later.

The site location of such a power plant needs to be studied. One possible site proposed is that south of the city of Suez at Ain Sokhna, the location of the terminal of the SUMED petroleum oil pipeline. Another location to be considered is further south on the Gulf of Suez in the vicinity of the Ras Gharib location, where the oil and gas fields are situated. This latter site would necessitate a substantial extension (200 km or more) of the EEA transmission system. This would be no different, however, to the plan use [illegible] other countries of locating power plants near coal deposits and transmitting the generated electric

power for distances as great or greater than those suggested here.

The use of the sites discussed above is predicated upon the possible use of otherwise flared gas as the plant fuel. Load predictions for the reasonable future do not indicate sufficient load growth in the Canal Zone and Gulf of Suez area to justify the construction at this time of any more generating capacity in these areas than that which is already planned unless there is some other reason for building a new plant there. It has been thought that the Gulf and the Red Sea coastal areas might offer considerable promise as future industrial development areas because of the gas and petroleum resources, the availability of sea transportation, and the nearness of reported mineral deposits.

At present a large volume of gas (4 million cubic meters/day) is being flared wastefully at the oil fields in the Gulf of Suez, and this may be a strong inducement to locate a power plant nearby if arrangements can be made to take advantage of this otherwise wasted source of fuel.

Another matter that might be studied is the possible construction of a combination power/water desalting plant in the Gulf of Suez Area as presently there is no available potable water in the lower Gulf area and all fresh water must be brought by tanker from the port of Suez.

All those alternates should be studied before a final decision on the type plant and its location is made.

Hydro Generation and 500 kV Transmission Line Transfer Capability

Previous studies by the Russians and others have shown that the maximum through transfer capability governed by steady state stability considerations of the two 500 kV transmission lines between the High Dam and Cairo is of the order of 1700-1800 MW. This assumes no intermediate loads between the High Dam 500 kV bus and the Cairo 500 kV bus, and is the maximum capable stable power transmission limit between the High Dam source and the lower Egypt load when the system is subjected to small disturbances. At this point the internal angle between the hydro generators in Upper Egypt and generators in Lower Egypt would be the maximum possible with the system on the verge of instability.

A cursory check of such steady state stability limit utilizing a power circle diagram with ten of the High Dam hydro units and all of the Aswan hydro units in operation has indicated a maximum limit of the order of 1540 MW. This analysis however, disregarded line capacitance, synchronous condensers, etc. so the 1700-1800 MW maximum transfer capability is believed to be a realistic value.

The philosophy of the EEA in operating the 500 kV transmission system is to allow a reasonable safety margin. The safety factor normally considered is expressed as follows:

$$Ks = \frac{Pmax - Ptr}{Ptr} \times 100$$

where: Pmax = maximum power transmitted
Ptr = normal transmitted power
Ks must be equal or greater than:
20% for normal operation
8% for short term condition after fault clearance

Normal utility practice is to operate within a "safe area" where system stability is assured. A usual practice is to allow a 20 percent safety margin with the limit extended by the use of automatic voltage regulators particularly when fast acting regulators such as those of the electronic type are used. When applied to the UPS, this can be interpreted to mean that for normal operation the through transfer power limit between the High Dam 500 kV switchyard and the Cairo 500 kV switchyard would be of the order of 1420-1500 MW.

Such limiting values were considered in determining the useable peak hydro generation capability on a yearly basis to employ in the generation expansion study. The other limitation was that of limiting the Aswan hydro dam to a capability of 260 MW because of the reduction in head experienced by the Aswan Dam after the construction of the High Dam.

By the year 1983, the following large industrial loads are expected to be operating in Upper Egypt:

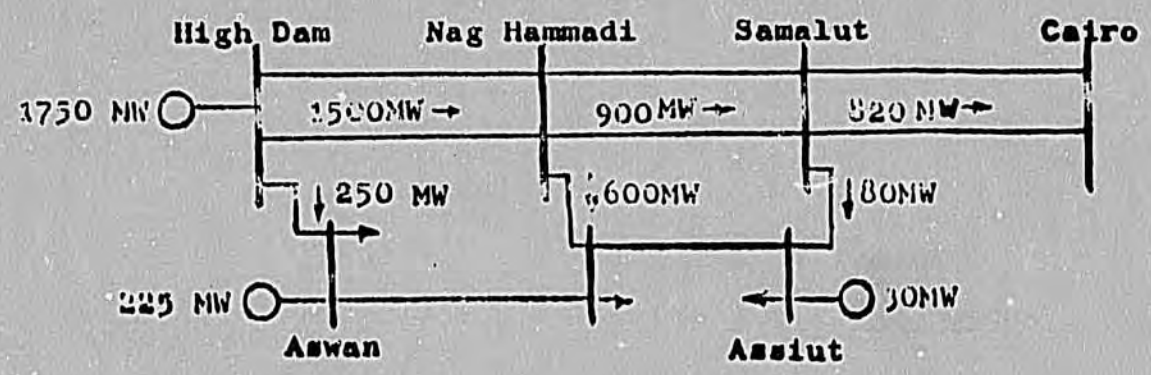
	INDUSTRY	
1.	Ras Gharib Nitrates	50 MW
2.	Kima Fertilizer	250 MW
3.	Ferro Silicon at Edfu	120 MW
4.	Mining at Esna	10 MW
5.	Mine Fertilizer at Abu Tartur	90 MW
6.	Aluminium Smelter at Nag Hammadi	400 MW
7.	Cement Plant at Assiut	35 MW
	Total	955 MW

These loads coupled with the normal growth of the other sectors of Upper Egypt [illegible] the forecasted load in that area to approximately 1240 MW for the year 1983.

Assuming ten of the twelve 175 MW hydro units at the High Dam in operation (two units out because of maintenance work) and all but one of the Aswan Dam hydro units in operation the expected approximate maximum power flow in the two circuit 500 kV transmission line as shown in Figure I-1 "Load Flow Diagram - Upper Egypt" would be:

FIGURE I-1

LOAD FLOW DIAGRAM - UPPER EGYPT (1983)



Note: All 500 kV transmission line losses (normally 5-6 percent of transmitted power) have been neglected.

It can be seen from the above load flow diagram that the system is operating well outside the 20 percent safety margin that the EEA requires for normal operation. An A.C Network Analyzer study has verified the above load flow normal stability safety limit transfer capability of the 500 kV transmission lines.

It is on this basis that the full operating capability of the High and Aswan Dams complex of 1975 MW (1750 MW H.D. and 225 MW Aswan Dam) was considered as being easily within the safe transmission capability limit in the 1980's. It is also for this reason that any series capacitor line compensation or the building of a third 500 kV transmission line is believed unnecessary under the presently anticipated future load conditions. However, improvement in reliability of the two existing 500 kV transmission lines is necessary if the full capability of such lines is to be available on an adequately dependable basis.

The capability of the hydro complex for the years preceding 1983 has been roughly determined considering both transmission line stability and system dynamic stability as restraints limiting the hydro output at time of peak.

CHAPTER II

LONG RANGE LOAD FORECAST (1985-2000)

Summary and Conclusions

Because of the urgent requirement for an approximate long-range load forecast to be used in financial analyses, such a load forecast is included at this time in the Planning Diagnostic Report. Although the Terms of Reference require a forecast only through the year 1995, a forecast through the year 2000 is included here. A section on the controversal subject of the EEA's forecasted system load factors is also included in this chapter of the Diagnostic Report.

Both these items will be reevaluated and determined with greather accuracy during the implementation portion of the power survey but are presented at this time for the aforementioned reasons.

Long Range Load Forecast

Several long-range load forecasts exist for the EEA electric power system up through the year 2000. The most comprehensive is that published by the International Atomic Energy Agency in their report "Market Survey for Nuclear Power in Developing Countries - Arab Republic of Egypt". This load forecast, identified in the IAEA report as Table X-3, was used with the Wien Automatic System Planning Package (WASP) for the generation expansion study of the EEA. It is reproduced in Table II-1 below.

TABLE II-1

LOAD DESCRIPTION-WASP PROGRAM DATA

Year	Max. demand (MW)	Quarterly load factors(%)					Energy (GWh)
		1st	2nd	3rd	4th	Annual	
1978	2923	76.01	77.99	74.04	73.01	71.89	18408.2
1979	3097	76.01	77.99	74.04	73.01	71.89	19504.0
1980	3282	76.01	77.99	74.04	73.01	71.89	20669.0
1981	3516	76.01	77.99	74.04	73.01	71.89	22136.4
1982	3766	76.01	77.99	74.04	73.01	71.89	23717.1
1983	4091	75.00	76.01	73.01	73.01	70.95	25426.7
1984	4445	73.01	75.00	71.92	71.97	69.74	27156.5
1985	4831	71.97	74.04	71.04	71.04	68.82	29124.8
1986	5392	71.04	73.01	71.01	70.01	67.86	32053.1
1987	6019	70.01	71.97	68.99	68.99	66.88	35263.0
1988	6720	68.99	71.04	68.01	68.01	65.94	38819.0
1989	7505	68.01	70.01	66.97	66.92	64.97	42710.8
1990	8383	66.92	68.99	65.99	65.99	64.00	47001.9
1991	8914	66.92	68.99	65.99	65.99	64.00	49984.8
1992	9479	66.92	68.99	65.99	65.99	64.00	53141.4
1993	10080	66.92	68.99	65.99	65.99	64.00	56516.7
1994	10719	66.92	68.99	65.99	65.99	64.00	60093.9
1995	11398	66.92	68.99	65.99	65.99	64.00	63906.5
1996	12104	66.92	68.99	65.99	65.99	64.00	67864.8
1997	12853	66.92	68.99	65.99	65.99	64.00	72064.4
1998	13650	66.92	68.99	65.99	65.99	64.00	76533.0
1999	14495	66.92	68.99	65.99	65.99	64.00	81276.3
2000	15393	66.97	68.99	65.99	65.99	64.00	86305.7

This forecast is based on the "Aoki" method of load forecasting obtained from historical data (1961-1968) of the growth rate of gross national product (GNP) and of energy generation for 111 countries. It assumes that a correlation exists between the Gross Electricity Generation per Capita (kWh/capita) and the Gross National Product per Capita (US $/capita). Of course, the resultant accuracy of any load forecast utilizing such a method depends upon the ability to accurately forecast both a country's gross national product and its population growth. The "Aoki" method has been used successfully for long-range load forecasts in many countries such as Iran where it has correlated closely with other methods such as the Elasticity Method and the Stanford Method.

Another approach employed by EEA for their long-range load forecast is the same as that utilized for the short-range load forecast in which the electrical load is first assumed to double in seven years, then again doubling in approximately eight years, then in nine years, and finally in ten years out to the year 2000.

If we continue the short-range load forecast of Chapter I on the above basis and assuming that the 1985 system load factor of 69.2 percent is gradually reduced to a load factor of 64 percent (the same load factor for the year 2000 as that employed by the IAEA in their study), we obtain the long-range load forecast for the period 1986-2000 shown in the lower half of Table II-2, "Load Forecast 1976-2000".

System Annual Load Factors

A discussion is included in this Diagnostic Report covering system load factors because of the exceedingly high system load factors utilized in previous long-range load forecasts. This matter is presently under study and definitely will be ascertained with reasonable accuracy during the implementation portion of the survey.

The system load factor for the year 1976 was 69.4 percent and from 1960 to 1976 it varied between 66.0 and 76 percent. The load factor for the remainder of the 1976 system, less the heavy industry, as listed for that year in Table I-2 entitled "Initial Peak Demand and Energy Forecast" was 61.3 percent.

Table II-3 shows the forecasted load factors for various developing countries of the world for the years 1980, 1990 and 2000. It averages between 60 and 61 percent. The 1976 average load factor of the 100 largest electric utilities in the United States, a very heavy industrialized nation, was 58.3 percent.

Previous load forecasts of the EEA have utilized very high load factors such as 81.5 percent for 1985 and 74.4 percent for the [illegible] 2000. [illegible]nderson and Porter's load factor estimate for the same years are 69.2 percent for 1985 and

64.0 percent for the year 2000. Even these are some of the highest in the world.

By 1980 it is expected that the industrial sector of the Egyptian economy will account for approximately 60% of the country's energy consumption and that much of such consumption will be by large high load factor industries. After 1985 the percentage growth of such industries is expected to be reduced drastically while the consumption of the lower load factor residential, light industrial, and commercial enterprises is expected to increase and to account for the greater portion of Egypt's load growth out to the year 2000.

At the present time 65 percent of Egypt's electrical energy requirement is produced by hydro power from the High and Aswan Dams. By 1985 this percentage of hydro production to the total system electric energy requirement will have been reduced to 40 percent and by the year 2000 to less than 15 percent. The era of inexpensive hydro power will have passed and all new industrial tariffs will have to be predicated on the incremental cost method of the more expensive nuclear and fossil fuel means of power production. This will reduce the attractiveness of establishing additional high load factor large industrial loads, and will likely affect the load growth patterns correspondingly. At the present time, Egypt's large industrial expansion program is not based on incremental costs, and in some instances large industries are being subsidized at costs well below the actual energy production costs utilizing fossil fuel power sources. For the above reasons, it is suggested that the system load factor of EEA will decrease in the future to a value approaching that of the other countries in the world.

TABLE II-2

LOAD FORECAST 1976-2000

	Year	Max. Demand (MW)	Energy (GWH)	Energy Growth (Percent)	Load Factor (Percent)
SHORT RANGE LOAD FORECAST	1976	1909	11640	18.8	69.4
	1977	2192	13500	16.0	70.3
	1978	2470	15150	12.2	70.0
	1979	2678	16750	10.6	71.4
	1980	2924	18520	10.6	72.1
	1981	3192	20470	10.5	73.2
	1982	3578	22630	10.6	72.2
	1983	4028	25020	10.6	70.9
	1984	4518	27660	10.6	69.7
	1985	5045	30580	10.6	69.2
LONG RANGE LOAD FORECAST	1986	5527	3360	9.1	68.9
	1987	6066	36400	9.1	68.5
	1988	6629	39710	9.1	68.2
	1989	7221	42890	8.0	67.8
	1990	7834	46320	8.0	67.5
	1991	8510	50020	8.0	67.1
	1992	9208	54030	8.0	66.8
	1993	10032	58350	8.0	66.4
	1994	10884	63020	8.0	66.1
	1995	11826	68060	8.0	65.7
	1996	12794	73500	8.0	65.4
	1997	13941	79380	8.0	65.0
	1998	15015	85100	7.2	64.7
	1999	16197	91230	7.2	64.3
	2000	17395	97790	7.2	64.0

Compound Growth Rate	Max. Demand	Energy
1952-1976	12.6%	11.9%
1976-1985	[illegible].4%	11.3%
1985-1995	8.9%	8.3%
1976-1995	10.1%	9.7%
1976-2000	9.6%	9.3%

TABLE II-3

FORECAST PEAK DEMAND (GW) AND ELECTRICITY GENERATION (TWh)* AND LOAD FACTOR BY REGION

	GW			TWh			% Load Factor		
	1980	1990	2000	1980	1990	2000	1980	1990	2000
Central and South America									
Brazil	21.4	52.8	101.0	119.3	294.6	563.5	63.5	63.7	63.5
Mexico	13.5	33.3	70.0	73.3	180.3	380.2	61.8	62.0	61.8
Argentina	8.2	16.5	29.0	42.0	83.2	148.0	58.3	57.6	58.1
Venezuela	6.2	11.9	21.0	32.4	62.7	110.4	59.5	60.1	59.8
Columbia	4.8	9.6	18.0	25.2	50.5	94.6	59.8	60.1	59.8
Peru	2.7	5.2	9.6	14.0	27.5	50.5	59.0	60.4	59.9
Chile	2.2	4.5	8.1	10.9	22.7	41.0	56.4	57.6	57.6
Cuba	1.9	3.6	6.6	9.9	19.1	34.7	59.3	60.6	59.9
Uruguay	1.0	2.0	3.8	5.3	10.5	20.0	60.3	59.9	59.9
Jamaica	0.8	2.2	6.1	4.9	13.7	37.4	69.7	71.1	69.8
Costa Rica	0.4	1.0	2.3	2.3	5.5	12.1	65.5	62.8	59.9
Dominican Rep.	0.4	1.0	2.2	2.2	5.2	11.3	62.6	59.4	58.5
Ecuador	0.4	1.0	2.2	2.2	5.2	11.3	62.6	59.4	58.5
Panama	0.4	1.0	2.2	2.2	5.2	11.3	62.6	59.4	58.5
Bolivia	0.4	0.9	1.9	1.9	4.5	9.7	54.1	57.1	58.1
Guatemala	0.3	0.8	1.7	1.7	3.9	8.7	64.5	55.7	58.3
El salvador	0.3	0.8	1.6	1.6	3.8	8.3	60.7	54.2	59.1
Asia & Far East						Aver.	61.2	60.1	60.1
India	40.0	88.0	190.0	210.0	462.0	1000.0	59.8	59.9	59.9
Iran	7.5	21.0	39.0	39.4	110.4	205.0	59.8	60.0	59.8
Taiwan	7.3	17.4	33.0	38.2	91.2	173.4	59.6	59.8	59.8
Korea	5.4	13.2	27.5	31.0	76.3	159.0	65.4	66.0	65.8
Pakistan	4.4	10.7	22.7	23.0	56.4	119.2	59.5	60.2	59.8
Thailand	2.7	6.5	13.4	20.0	36.6	75.4	84.3	64.1	64.1
Philip. (Luzon)	2.6	6.2	13.9	13.7	32.5	72.8	60.0	59.8	59.6
Hong Kong	2.5	5.6	10.1	13.1	29.5	53.0	59.7	60.1	59.7
Singapore	1.5	4.7	12.0	8.7	26.5	68.6	66.0	64.4	65.1
Malaysia(Penin.)	1.4	3.4	7.0	7.5	17.8	37.0	61.0	59.8	60.2
Indonesia(Java)	1.0	3.4	8.0	5.3	17.9	42.0	60.3	60.1	59.8
Rep. Vietnam	1.1	2.9	6.5	5.8	15.0	34.0	60.0	59.0	59.5
Bangladesh	1.0	4.5	9.7	4.8	21.7	51.0	54.6	55.0	59.9
						Aver.	60.2	60.6	61.0

Table (cont.)

	GW			TWh			% Load Factor		
	1980	1990	2000	1980	1990	2000	1980	1990	2000
Europe, Middle East and Africa									
Spain	24.8	46.6	93.5	130.4	245.0	438.9	59.9	60.0	59.8
Yugoslavia	15.1	26.5	46.1	79.5	139.4	242.2	59.9	60.0	59.8
Turkey	5.2	14.6	33.6	28.6	80.6	185.4	62.6	63.0	62.8
Greece	4.5	9.3	18.3	25.5	52.6	103.5	64.5	64.6	64.4
Egypt	3.3	8.4	15.4	20.7	47.0	86.3	71.4	63.9	63.7
Israel	3.0	6.2	10.3	15.6	32.8	54.1	59.2	60.4	59.8
Kuwait	0.9	2.0	4.3	4.9	10.5	22.6	62.0	59.9	59.8
Iraq	0.8	1.7	3.5	4.3	8.9	18.1	61.2	59.8	58.9
Ghana	0.8	1.1	1.6	4.0	5.8	8.4	56.9	60.2	59.8
Morocco	0.7	1.3	2.5	3.6	6.9	13.1	58.5	60.6	59.7
Nigeria	0.7	1.4	3.5	3.4	7.4	18.1	55.3	60.3	58.9
Algeria	0.6	1.3	2.7	3.2	6.7	14.2	60.7	58.8	59.9
Lebanon	0.5	1.0	1.9	2.6	5.1	10.2	59.2	58.2	61.1
Syria	0.5	1.1	2.5	2.4	5.7	13.1	54.6	59.2	59.7
Cameron	0.4	0.7	1.1	2.3	3.7	5.9	65.5	60.3	61.1
Albania	0.4	0.9	2.2	2.0	4.8	11.6	56.9	60.9	60.0
Uganda	0.4	0.9	2.0	1.9	4.5	10.5	54.1	57.1	59.8
Tunisia	0.4	0.9	2.0	1.9	4.5	10.5	54.1	57.1	59.8
Zambia	0.3	0.8	1.8	1.7	3.9	9.5	64.5	55.7	60.1
Saudi Arabia	0.3	0.8	1.8	1.7	3.9	9.5	64.5	55.8	60.1
						Aver.	60.3	59.8	60.5
Generally Planned Economics									
Poland	22.9	37.9	59.7	120.1	199.0	315.8	59.7	59.9	59.8
Czechoslovakia	15.2	23.2	32.1	80.0	122.0	169.0	59.9	60.0	59.9
Romania	14.8	26.3	46.1	77.8	138.0	242.5	59.8	59.9	59.9
Bulgaria	7.8	13.0	21.3	40.9	68.3	111.7	59.7	60.0	59.7
Hungary	6.6	11.7	20.8	34.9	61.5	109.4	60.2	60.0	59.9
						Aver.	59.9	60.0	59.8
	All Countries			Composite Aver.			60.9	60.1	60.4
	All Countries			Composite Aver. (1980-1990-2000) =			60.5		

GW = gigawatt=10^3 MW
TWh = terawatt hour=10^9kWh.

* Information on Forecasted Peak Demand and Electricity Generation obtained from pages 16 and 17 "Market Survey for Nuclear Power in Developing Countries-1974 Edition" by International Atomic Energy Agency. Data for Load Factors derived from the above peak demand and

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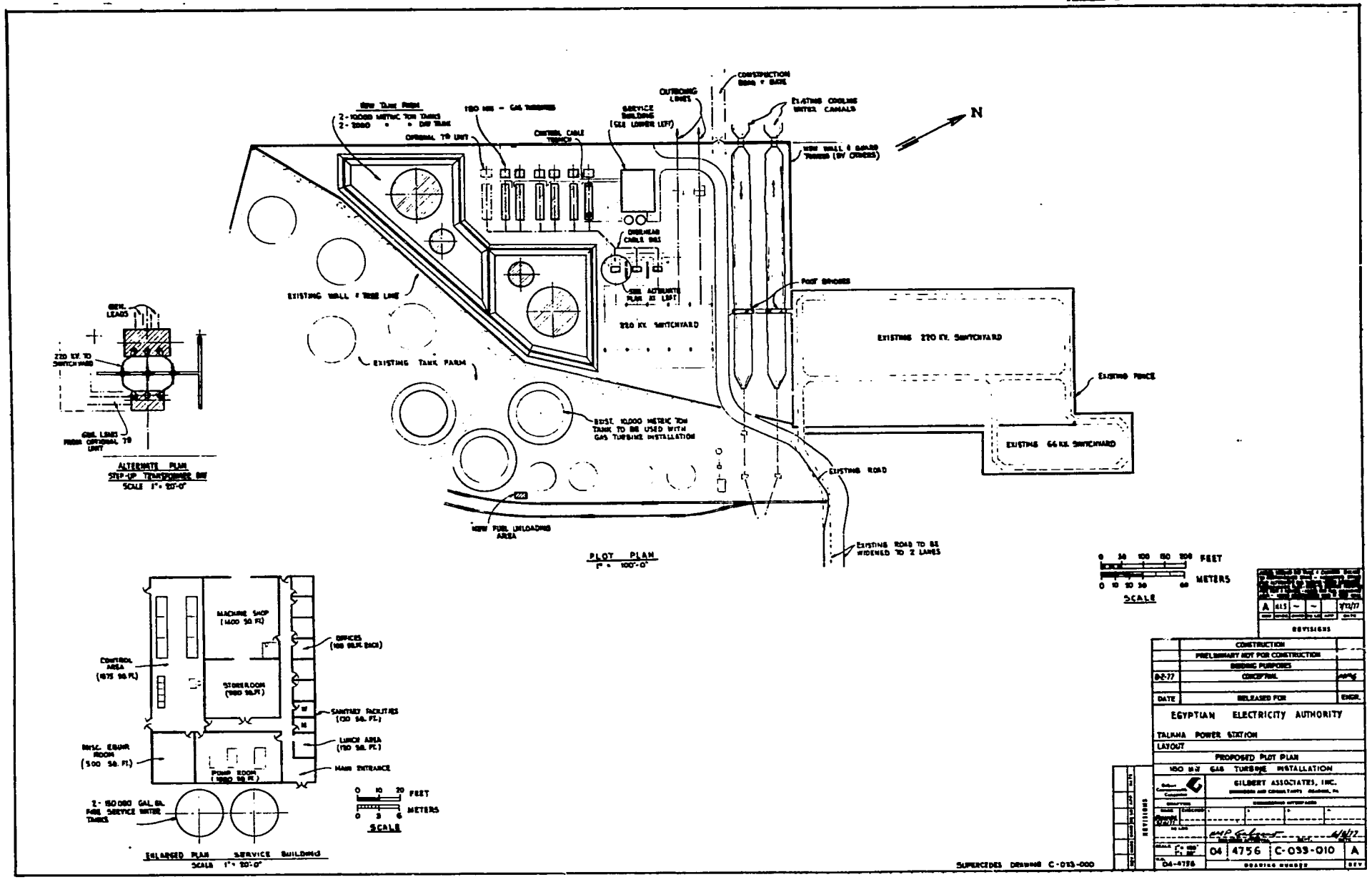
ANNEX I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EXISTING TANK FARM
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220 KV. SWITCHYARD
EXISTING 220 KV. SWITCHYARD
EXISTING 66 KV. SWITCHYARD
EXISTING FENCE
EXISTING ROAD
EXISTING ROAD TO BE WIDENED TO 2 LANES
NEW FUEL UNLOADING AREA
PLOT PLAN
1" = 100'-0"
ALTERNATE PLAN
STEP-UP TRANSFORMER BAY
SCALE 1" = 20'-0"
220 KV. TO SWITCHYARD
MACHINE SHOP (1400 SQ. FT.)
CONTROL AREA (1075 SQ. FT.)
STOREROOM (1980 SQ. FT.)
MISC. EQUIP. ROOM (500 SQ. FT.)
PUMP ROOM (1980 SQ. FT.)
OFFICES (100 SQ. FT. EACH)
SANITARY FACILITIES (120 SQ. FT.)
LUNCH AREA (120 SQ. FT.)
MAIN ENTRANCE
2 - 150,000 GAL. EA. FUEL SERVICE WATER TANKS
ENLARGED PLAN SERVICE BUILDING
SCALE 1" = 20'-0"
FEET
METERS
SCALE
SUPERCEDES DRAWING C-033-000
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BIDDING PURPOSES
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EGYPTIAN ELECTRICITY AUTHORITY
TALKHA POWER STATION
LAYOUT
PROPOSED PLOT PLAN
100 MW GAS TURBINE INSTALLATION
GILBERT ASSOCIATES, INC.
REVISIONS
04 4756 C-033-010 A
DRAWING NUMBER
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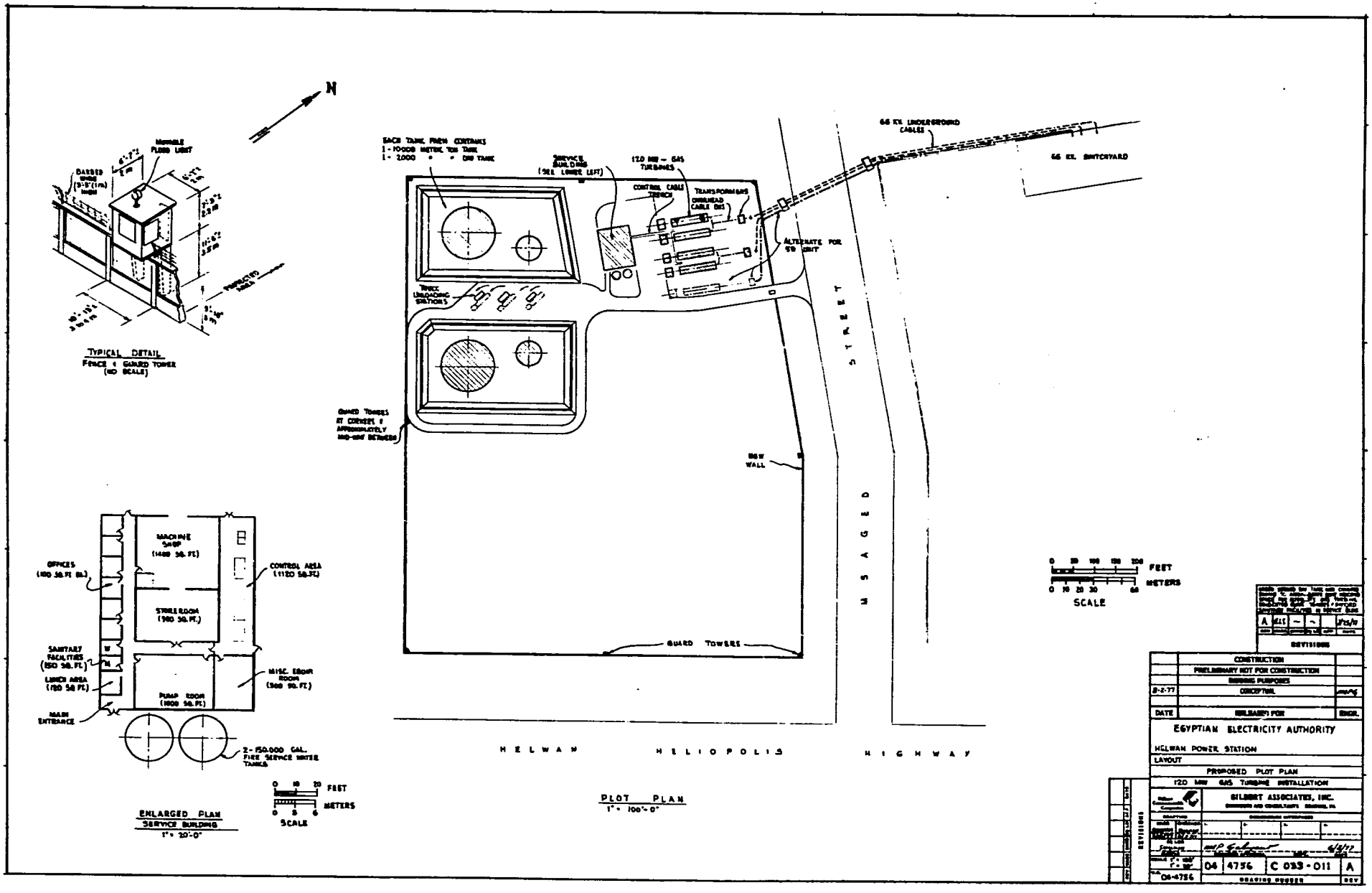
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TYPICAL DETAIL
FENCE & GUARD TOWER
(NO SCALE)
ENLARGED PLAN
SERVICE BUILDING
1" = 20'-0"
MACHINE SHOP
STORE ROOM
PUMP ROOM
OFFICES
CONTROL AREA
SANITARY FACILITIES
LUNCH AREA
MAIN ENTRANCE
MISC. EQUIP. ROOM
2 - 150,000 GAL. FIRE SERVICE WATER TANKS
FEET
METERS
SCALE
SERVICE BUILDING
120 MW - GAS TURBINES
CONTROL CABLE TRENCH
TRANSFORMERS
OVERHEAD CABLE DUCT
ALTERNATE FOR 50 UNIT
66 KV. UNDERGROUND CABLES
66 KV. SWITCHYARD
GUARD TOWERS
MSAGED STREET
HELWAN HELIOPOLIS HIGHWAY
PLOT PLAN
1" = 100'-0"
EGYPTIAN ELECTRICITY AUTHORITY
HELWAN POWER STATION
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PROPOSED PLOT PLAN
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CONSTRUCTION
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TABLE 4.1-1

POTENTIAL ENVIRONMENTAL IMPACTS
HELWAN

120 MW GAS TURBINE PROJECT
EGYPTIAN ELECTRICITY AUTHORITY

Impact	Significance of Impact	Recommended Mitigating Measures
PHYSICAL ENVIRONMENT		
WATER		
Surface Water Used		
Consumption of approximately 500 gpd Nile River water for makeup to closed loop lube oil cooling system, cleanup and domestic purposes.	Sufficient water available.	None required.
Domestic Wastewater Discharged		
500 gpd domestic wastewater discharged into cesspool at site. Possible eventually discharged into sewer lines for proposed community of 20,000 people 2,500 ft (762 m) from the site.	Percolation characteristics of soil are suitable for cesspool.	Cesspool shall be designed to accommodate the wastewater flow.
AIR		
2,844 lbs/hr SO_2, 1260 lbs/hr NO_x and 9.5 lbs/hr particulate emissions from burning solar oil, 648 lbs/hr NO_x emissions from burning natural gas.	Existing air pollution very serious due to steel and cement mills. Controlling air emissions from gas turbine would be futile without controlling emissions from other sources in area. No local air pollution regulations will be exceeded.	Maximize use of natural gas to minimize emissions.

TABLE 4.1-1 (Continued)

Impact	Significance of Impact	Recommended Mitigating Measures
BIOTIC ENVIRONMENT		
FLORA AND FAUNA		
Habitats for indigenous plants and animals will be neutralized.	Few if any plants or animals exist at the site since the site is undeveloped desert. None were observed in April 1977.	Displaced flora and fauna can repopulate similar nearby desert.
HUMAN ENVIRONMENT		
LAND USE		
24 acres of undeveloped desert will be converted to a positive industrial function.	Idle land currently useless for agricultural purposes will perform a productive function.	None required.
TRANSPORTATION		
Truck, rail, auto and river traffic will increase - mostly during construction.	Transportation routes are adequate.	None required.
HUMAN INTEREST		
Noise		
Noise is produced by gas turbines during operation.	Residential community planned 2,500 ft (762 m) away. Existing ambient noise measured at 20dB(A) to 30dB(A).	Target sound pressure levels will be developed at appropriate distances.
ECONOMY		
Employment-creation of new jobs during construction and operation of the plant.	Most of jobs (approximately 100) will be during construction only. Ten full time employees will be required.	None required.
120 MW electricity added to Egyptian power network.	Electricity demand expected to double seven years. Existing facilities are inadequate. Shall provide for new industries needed to supply goods and create jobs.	None required.

TABLE 4.1-1

POTENTIAL ENVIRONMENTAL IMPACTS
TALKHA

180 MW GAS TURBINE POWER PROJECT
EGYPTIAN ELECTRICITY AUTHORITY

Impact	Significance of Impact	Recommended Mitigating Measures
PHYSICAL ENVIRONMENT		
WATER		
Water Used		
Surface Water Used		
Consumption of approximately 500 gpd Nile River water for makeup to closed loop lube oil cooling system, cleanup and domestic purposes.	Excess of Nile River water available. 0.15% of output of sand filters serving existing units.	None required.
Water Discharged		
Domestic Wastes		
500 gpd domestic wastewater discharged into cesspool at site.	Percolation characteristics of soil are suitable for a cesspool.	Cesspool shall be designed to accommodate the wastewater flow.
Oily Wastes		
Ruptured storage tanks or spills during oil delivery could contaminate Nile tributaries.	Tributaries flow into Nile which serves as a water supply for the nearby cities of Talkha and El Mansura.	Earth dikes shall be built around the tanks to contain oil should tanks rupture.
AIR		
4265 lbs/hr SO_2, 1890 lbs/hr NO_x, 14 lbs/hr particulate emissions from burning solar oil, 972 lbs/hr, NO_x emissions from burning natural gas.	No local air regulations will be exceeded.	Maximize the use of natural gas to minimize emissions.
BIOTIC ENVIRONMENT		
FLORA AND FAUNA		
Habitats for indigenous plants and animals will be neutralized.	Beans and wheat crops were evident in April 1977. Animals which have been reported include rabbits, birds, salamanders, snakes. Eucalyptus trees line the eastern boundary of the site.	Size of site has been kept to a minimum. Displaced animals can repopulate similar agricultural land to the west and north. Trees shall not be removed unless they obstruct facilities.

TABLE 4.1-1 (Continued)

Impact	Significance of Impact	Recommended Mitigating Measures
HUMAN ENVIRONMENT		
LAND USE		
12 acres of prime agricultural land will be converted to heavy industrial land.	Prime agricultural land is rare in Egypt. Several crops are currently grown on the site providing food to an expanding nation which imports food.	Size of site has been minimized to limit consumption of agricultural land.
TRANSPORTATION		
Truck, rail and auto traffic will increase - mostly during construction.	Transportation routes are considered adequate.	None required.
HUMAN INTEREST		
Noise		
Noise is produced by gas turbines during operation.	Residential colonies of workers are located 700 ft (213 m) to the south and 1500 ft (457 m) to the north.	Install sound suppressing equipment. Retain all trees on the site. Plant additional trees between turbines and surrounding colonies. Retain existing walls. Place oil tanks to block sound from colonies. Workers can use noise suppressing equipment. Target sound pressure levels will be developed at appropriate distances.
ECONOMY		
Employment - creation of new jobs during construction and operation of the plant.	Most of jobs (approximately 100) will be temporary during construction. Ten full time employees will be required.	None required.
180 MW electricity added to Egyptian power network.	Load expected to double in seven years. Existing facilities are inadequate. Shall provide power for new industries needed to supply goods and create jobs.	None required.

TALKHA-HELWAN

PROJECTED CASH DISBURSEMENTS

YEAR QUARTER	HELWAN US $	HELWAN LE	TALKHA US $	TALKHA LE	TOTAL US $	TOTAL LE
1977						
2nd	74200	7000	111000	9200	185200	16200
3rd	74200	7000	111000	9200	185200	16200
4th	74200	7000	111000	9200	185200	16200
Total	222600	21000	333000	27600	555600	48600
1978						
1st	1518100	7000	2373500	9200	3891600	16200
2nd	4179700	8300	6459300	11700	10639000	20000
3rd	4179700	435900	6459300	314400	10639000	750300
4th	12030300	356600	16586900	421900	28617200	778500
Total	21907800	807800	31879000	757200	53786800	1565000
1979						
1st	4771700	363900	4815300	382400	9587000	746300
2nd	528000	199800	2199900	359800	2727900	559600
3rd	747900	4600	977100	161400	1725000	166000
4th	-	-	617700	9600	617700	9600
Total	6047600	568300	8610000	913200	14657600	1481500
	28178000	1397100	40822000	1698000	69000000	3095100

ANNEX M

TABLE 10-2

CASH FLOW FORECAST - HELWAN

		1978				1979				
		1st	2nd	3rd	4th	1st	2nd	3rd	4th	Total
CIVIL/STRUCTURAL	U.S. Dollars				194,000	25,000	15,000			234,000
	Egyptian (LE)			251,000	180,000	107,100	56,600			594,800
MECHANICAL EQUIPMENT	U.S. Dollars	1,100,000	3,300,000	3,300,000	6,780,000	1,991,000	80,000	438,000		16,989,000
	Egyptian (LE)					23,000	15,300			38,300
PIPING	U.S. Dollars				27,000	8,200	10,800			46,000
	Egyptian (LE)					2,800	3,800			6,600
ELECTRICAL	U.S. Dollars				1,136,000	288,000	146,000	65,000		1,635,000
	Egyptian (LE)					20,000	18,900			38,900
SUBTOTAL-DIRECT COSTS	U.S. Dollars	1,100,000	3,300,000	3,300,000	8,137,000	2,312,200	251,800	503,000		18,904,000
	Egyptian (LE)	-	-	251,100	180,000	152,900	94,600	-		678,600
INDIRECT COSTS	U.S. Dollars	310,900	772,500	772,500	3,786,100	2,352,300	169,000	132,700		8,296,000
	Egyptian (LE)	-	1,300	177,800	169,600	204,000	98,200	-		650,900
TOTAL-DIRECT AND INDIRECT COSTS	U.S. Dollars	1,410,900	4,072,500	4,072,500	11,923,100	4,664,500	420,800	635,700		27,200,000
	Egyptian (LE)	-	1,300	428,900	349,600	356,900	192,800	-		1,329,500

TABLE 10-2
CASH FLOW FORECAST

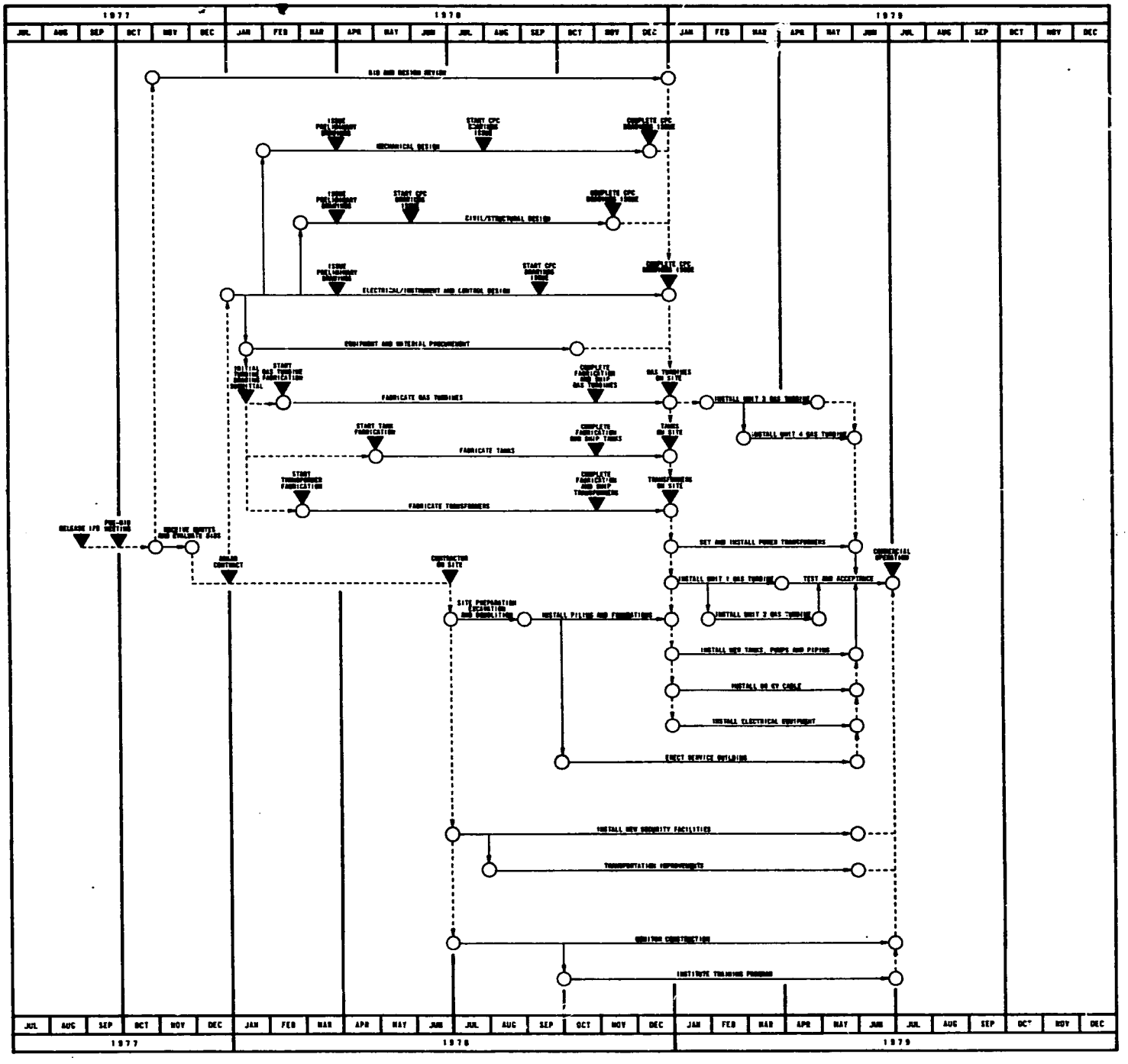
		1978				1979				
		1st	2nd	3rd	4th	1st	2nd	3rd	4th	Total
CIVIL/STRUCTURAL	U.S. Dollars				243,000	26,000	17,000	17,000		303,000
	Egyptian (LE)			127,500	223,000	133,000	66,300	31,900		581,700
MECHANICAL EQUIPMENT	U.S. Dollars	1,650,000	4,950,000	4,950,000	8,474,000	967,000	1,115,000	257,000	438,000	22,801,000
	Egyptian (LE)					9,600	19,700	6,500		35,800
PIPING	U.S. Dollars				46,000		14,500	14,500		75,000
	Egyptian (LE)						5,200	6,600		11,800
ELECTRICAL	U.S. Dollars				2,187,000	672,000	290,000	244,000		3,393,000
	Egyptian (LE)					37,500	101,700	33,500		172,700
SUBTOTAL-DIRECT COSTS	U.S. Dollars	1,650,000	4,950,000	4,950,000	10,950,000	1,665,000	1,436,500	532,500	438,000	26,572,000
	Egyptian (LE)	-	-	127,500	223,000	180,100	192,900	78,500	-	802,000
INDIRECT COSTS	U.S. Dollars	567,400	1,353,300	1,353,400	5,480,900	2,994,300	607,400	288,600	137,700	12,783,000
	Egyptian (LE)	-	2,500	177,700	189,700	193,100	157,700	73,700	-	794,400
TOTAL-DIRECT AND INDIRECT COSTS	U.S. Dollars	2,217,400	6,303,300	6,303,400	16,430,900	4,659,300	2,043,900	821,100	575,700	39,355,000
	Egyptian (LE)	-	2,500	305,200	412,700	373,200	350,600	152,200	-	1,596,400

TALKHA-HELWAN
ECONOMIC RATE OF RETURN

YEAR	CAPITAL	COSTS OPERATING AND MAINT.	TOTAL	BENEFITS	NET BENEFITS		DISCOUNTED AT 24%
1977	625	-	625	-	625	-	504
1978	56023	-	56023	-	56023	-	36435
1979	16774	10400	26400	18900	7500	-	3934
1980	-	29800	29800	54000	24200	+	10236
1981	-	29800	29800	54000	24200	+	8255
1982	-	29800	29800	54000	24200	+	6657
1983	-	29800	29800	54000	24200	+	5369
1984	-	19400	19400	35100	15700	+	2809
1985	-	14900	14900	27000	12100	+	1746
1986	-	14900	14900	27000	12100	+	1408
1987	-	14900	14900	27000	12100	+	1135
1988	-	14900	14900	27000	12100	+	916
1989	-	14900	14900	27000	12100	+	738
1990	-	14900	14900	27000	12100	+	596
1991	-	14900	14900	27000	12100	+	480
1992	-	14900	14900	27000	12100	+	387
1993	-	14900	14900	27000	12100	+	312
1994	-	14900	14900	27000	12100	+	252
					REMAINDER	+	423

ANNEX P

ANNEX Q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1978
1979
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MECHANICAL DESIGN
CIVIL/STRUCTURAL DESIGN
ELECTRICAL/INSTRUMENT AND CONTROL DESIGN
EQUIPMENT AND MATERIAL PROCUREMENT
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FABRICATE TANKS
FABRICATE TRANSFORMERS
INSTALL UNIT 3 GAS TURBINE
INSTALL UNIT 4 GAS TURBINE
SET AND INSTALL POWER TRANSFORMERS
INSTALL UNIT 1 GAS TURBINE
TEST AND ACCEPTANCE
INSTALL UNIT 2 GAS TURBINE
INSTALL PILING AND FOUNDATIONS
INSTALL NEW TANKS, PUMPS AND PIPING
INSTALL 66 KV CABLE
INSTALL ELECTRICAL EQUIPMENT
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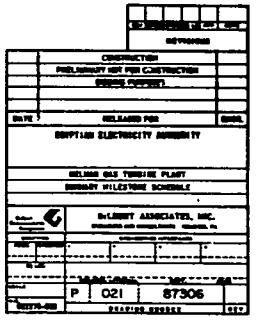
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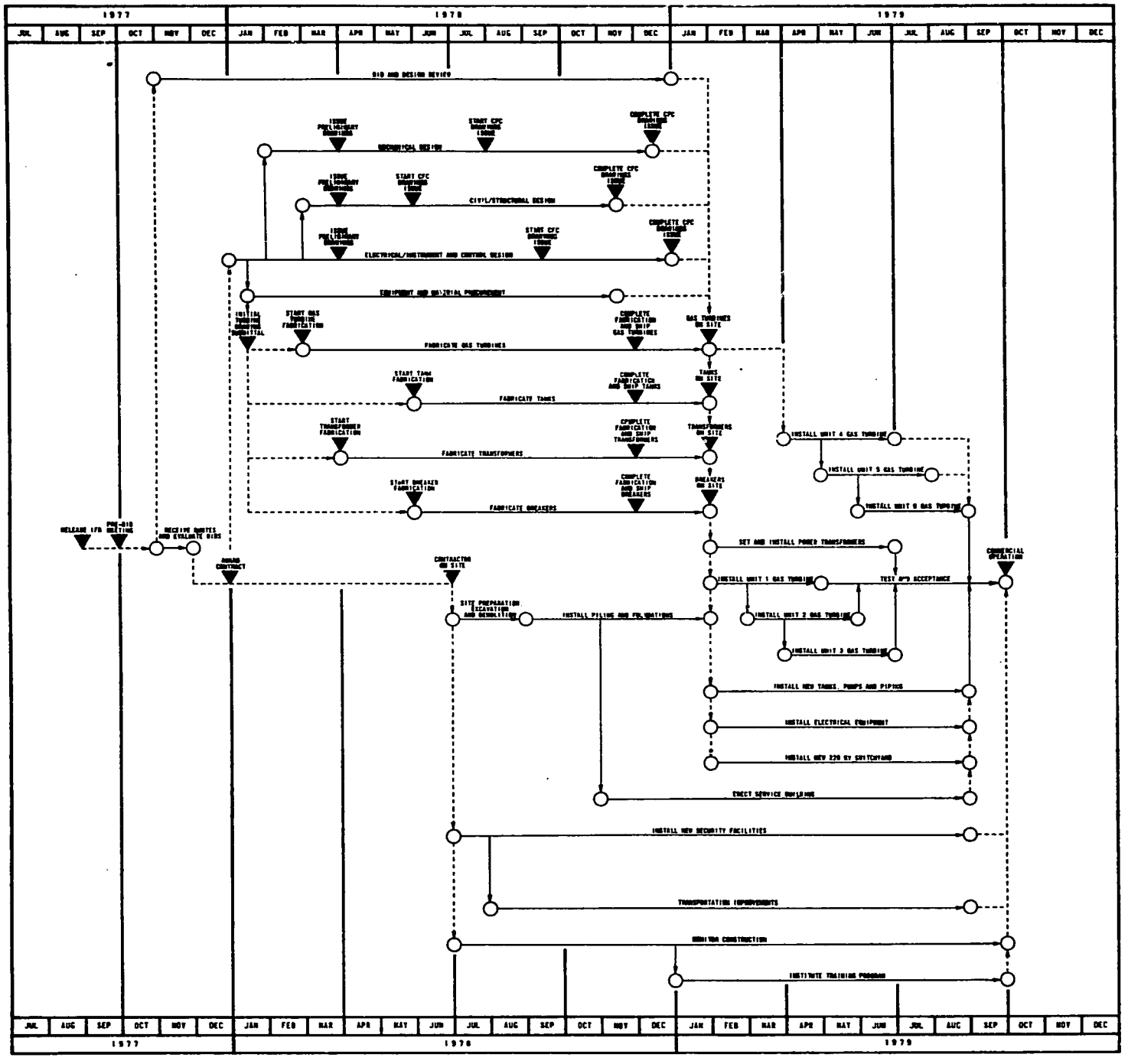

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TALLKHA GAS TURBINE PLANT
SUMMARY MILESTONE SCHEDULE

GILBERT ASSOCIATES, INC.

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