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UNCLASSIFIED

DEPARTMENT OF STATE

AGENCY FOR INTERNATIONAL DEVELOPMENT

Washington, D.C. 20523

Project Paper

EGYPT: ISMAILIA THERMAL POWER PLANT - AMENDMENT

UNCLASSIFIED

Attachment 61. to HB 3 (TE 3.5)

AGENCY FOR INTERNATIONAL DEVELOPMENT

PROJECT PAPER FACESHEET

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PP

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7. PROJECT TITLE (Maximum 40 characters): ISMAILIA THERMAL POWER PLANT

8. ESTIMATED FY OF PROJECT COMPLETION: FY 82

9. ESTIMATED DATE OF OBLIGATION: A. INITIAL FY 76; B. QUARTER 4 (Enter 1, 2, 3, or 4); C. FINAL FY 77

10. ESTIMATED COSTS ($000 OR EQUIVALENT $1 - LE.70)

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	$99,000		$99,000	$141000		$141000
(GRANT)	(99,000)	( )	$99,000	($141000)	( )	($141000)
(LOAN)	( )	( )	( )	( )	( )	( )
OTHER U.S. 1						
OTHER U.S. 2						
HOST COUNTRY		LE24,000	$34,284		LE14,500	$20,713
OTHER DONOR(S)						
TOTALS			$133,284			$161,713

11. PROPOSED BUDGET APPROPRIATED FUNDS ($000)

A. APPROPRIATION	B. PRIMARY PURPOSE CODE	PRIMARY TECH CODE C. GRANT	PRIMARY TECH CODE D. LOAN	E. 1ST FY 76 F. GRANT	E. 1ST FY 76 G. LOAN	H. 2ND FY 77 I. GRANT	H. 2ND FY 77 J. LOAN	K. 3RD FY ___ L. GRANT	K. 3RD FY ___ M. LOAN
(1) SA	710B	141000		99000		42000			
(2)									
(3)									
(4)									
TOTALS				99000		42000			

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					141000	
(2)						
(3)						
(4)						
TOTALS					141000	

12. IN-DEPTH EVALUATION SCHEDULED: MM 07 YY 82

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: Director, Office of Capital Development, Bureau for Near East (NE/CD)

DATE SIGNED: MM 09 DD 01 YY 77

15. DATE DOCUMENT RECEIVED IN AID/W, OR FOR AID/W DOCUMENTS, DATE OF DISTRIBUTION: MM 09 DD 01 YY 77

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EGYPT: ISMAILIA THERMAL POWER PLANT - AMENDMENT

SUMMARY AND RECOMMENDATIONS

1. Grantee: The Government of the Arab Republic of Egypt. The grant application is attached as Annex A.

2. Grant Amount: $42 million, increasing Grant No. 263-12-220-009 from $99 million to $141 million.

3. Executing Agency: The Egyptian Electricity Authority, a separate entity within the Ministry of Electricity.

4. Terms to the Executing Agency: A grant, to form part of the Egyptian Electricity Authority's equity capital.

5. Description of Project: The construction of a 300 MW thermal power plant, near the Suez Canal City of Ismailia. The plant will provide power general capacity to the Egyptian electric power grid. The project is part of the U.S. assistance for the reconstruction and development of the Suez Canal area where principal cities, infrastructure and basic facilities, including power, have been extensively damaged during the longer period of intermittent warfare.

6. Purpose of Grant Amendment: To provide additional foreign exchange for an increase of the estimated project cost.

7. USAID/Cairo View: USAID/Cairo recommends that the proposed Grant Amendment by authorized.

8. Statutory Criteria: All statutory criteria have been satisfied; see Annex D.

9. Recommendation: Authorization of an Amendment to Grant No. 263-12-220-009 to increase it from $99 million to $141 million in accordance with the terms and conditions set forth in the draft Grant Authorization included as Annex B.

10. Project Committee:

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

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I. INTRODUCTION

1.01 On May 30, 1976, the Government of the Arab Republic of Egypt (GOE) and the United States of America signed a grant agreement (A.I.D. Grant No. 263-12-220-009) to assist in the financing of a 300 MW thermal power plant near the Suez Canal City of Ismailia. The total project cost was then estimated at $99 million in foreign exchange (FX) and LE 24 million local costs. AID's grant covered the estimated FX cost. The 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: Ismailia Thermal Power Plant", May, 1976.

1.02 In June, 1977, Gilbert Associates, Inc., a prominent U.S. consulting firm under contract to the EEA, completed its preliminary design report on Ismailia including a review of the cost estimate. Based on that review, the project cost is now estimated at $141 million in FX and LE 14.5 million in local costs.

1.03 AID's Grant Agreement requires, in Section 4.02, the GOE to provide all resources in addition to the Grant needed to carry out the project. While the GOE recognizes and accepts this requirement, financially it is unable to comply with it timely. The GOE therefore sought assistance from other sources -- the World Bank and Arab donors. The former organization declined and the latter organizations indicated that, prior to deciding whether they would provide assistance, they would require considerable time to appraise/review the project. Consequently, the GOE requested A.I.D. assistance in financing the increased FX cost of $42 million. The GOE's and EEA's letters requesting A.I.D. assistance are shown in Annex A-1 and Annex A-2, respectively.

1.04 In view of the substantial delay that will obtain by attempting to locate other sources fo FX -- which would then further increase the project cost -- and the importance of this project to Egypt, we are recommending that A.I.D. increase its Grant from $99 million to $141 million -- an increase of $42 million.

1.05 An additional consideration in recommending that A.I.D. fully fund the FX cost is the effect split funding could have on project design and implementation. As presently planned, this project will be contracted to a single responsible contractor (turn-key) which we, and the GOE, believe is the only way we can hope to complete the project within the proposed construction schedule; all of the EEA's existing projects, using split responsibility type contracts are behind schedule and still slipping. The GOE and EEA would like to see A.I.D.

duplicate the successful Cairo West Power Plant, a previous A.I.D. project completed on time and within budget and still considered the premier plant in EEA's system. Allowing other donors into the financing picture will have some effect on procurement since each will insist on international tendering; and A.I.D.'s overall control of the project will certainly diminish since we sould be required to coordinate our actions with others.

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

II. BACKGROUND

2.01 The Ismailia Thermal Power Project was appraised by Sanderson and Porter (S&P), a U.S. consulting engineering firm and A.I.D.'s Requirements 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. Subsequent to S&P's report and prior to A.I.D.'s project authorization the site was changed to a location adjacent to the Great Bitter Lake.

2.02 Conditions Precedent to Initial Disbursement (CP's) included legal opinions, specimen signatures, confirmation of the new site and an executed contract with a consulting engineering firm for project implemtnation. The Terminal Date for meeting CP's was set at Spetember 27, 1976, 120 days after agreement signing. The date, however, proved to be unrealistic and CP's were eventually met in February 1977. The critical event which delayed satisfying CP's was the election 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 prequalify.
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.

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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 on April 19, 1976, 41 days before the Grant Agreement was signed, or ther would have been further time required in satisfying CP's.

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 A.I.D. procedures; a problem that still haunts the Egypt capital development program.

2.05 The consulting engineering firm selected by EEA is Gilbert Associates, Inc. of Reading Penn. 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 A.I.D. in July, 1977.

III. CURRENT FINANCING REQUIREMENTS

A. Definition of the Financing Gap

3.01 The revised cost estimate based on Gilbert's "Preliminary Project Report" is estimated at $140,592,680 and LE 14,441,800. Table 2 below compares the current estimate with that shown in the original Project Paper.

TABLE 2

COMPARISON OF PROJECT COST ESTIMATES

	S&P (4/76)	Gilbert (6/71)	Difference
U.S. Dollars	99,000,000	140,592,680	41,592,680
Egyptian Pounds	24,000,000	14,441,800	(9,558,200)

B. Reasons for Increase

3.02 Analysis of the original and revised cost estimates has identified the following capital cost increases and decreases for the Ismailia thermal power plant: (1) increased dollar costs and reduced Egyptian pound costs due to the EEA-A.I.D. decision to seek full turn-key responsibility on the part of the prime U.S. contractor for civil works construction as well as for supply, erection, and installation of the equipment; (2) additional unanticipated equipment and other new or expanded items; (3) increased contingency amount; (4) increased engineering services costs.

3.03 The Pound to Dollar Shift: When the project was originally appraised in the May, 1976 project paper, a contract for the supply, erection, and installation of equipment, including responsibility for civil works, was then contemplated. It was further contemplated that local civil works would be carried out under the supervision of the U.S. prime contractor via sub-contracts with Egyptian construction firms that would use their own equipment and would supervise all civil construction subject to general overview by the prime contractor. Gilbert has now completed its review of the capability of Egyptian firms to carry out this work and concluded that the most capable Egyptian firms are overloaded with work and are not available for this project. Other firms lack the necessary equipment, experience and supervisory staff for this major task. Gilbert has therefore recommended that the prime contractor be required to fully assume responsibility for civil works and be required to provide his own construction equipment. Given also the responsibilities the contractor must assume, we believe the contractor will provide U.S. personnel for construction supervision.

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3.04 EEA and A.I.D. fully concur in this change in scope. The delays in the construction of EEA's two European-financed power projects (Kafr El Dowar and Abu Kir) have been attributed to delays by the Egyptian contractors, premarily 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.

3.05 Additional Items: Due to the nature of the project, a number of items are now included in the project that were not anticipated when the original grant was authorized. For example, due to severe shortages of cement, the turbine building has been redesigned to use a high level of U.S. structural steel. Rebar originally was planned to be a domestic input but based on further analysis and tests, the quality is such that prudence dictates that this item now be imported. Also, Gilbert has recommended additional fuel storage, increased warehouse and garage facilities, and a larger initial spare parts supply. And the training program for EEA's personnel has been expanded to ensure that, prior to start-up, staff will be adequately trained to operate and maintain the plant.

3.06 EEA and A.I.D. fully agree with Gilbert's recommendations. The additional hardware items -- structural steel, rebar -- make sense and the additional facilities -- warehouse, garages, fuel storage -- are needed given the degree of independence this plant must maintain given its location. Lack of spare parts is endemic throughout EEA's system and is the major cause of generation failure in Egypt today. And, initially, we had thought that EEA had an ample supply of trained operators which would be transferred to the Ismailia plant. This, however, is not the case. The emigration of EEA's peronnel 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 plants.

3.07 On the question of training, A.I.D. is assisting EEA in solving this overall problem. EEA has contracted with Overseas Advisory Associates, Incorporated (OAAI), a non-profit organization, whose raison d'être is to train middle-management personnel in the management techniques of operating a power system. OAAI has previously completed successful programs in Iran and Saudi Arabia. Under the EEA program, OAAI will train 200 personnel over a period of one year.

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3.08 Contingencies: The original contingency recommended by S&P was five percent of capital cost, equivalent to $4.6 million. Gilbert has now recommended that a 13 percent, or $15.6 million, contingency be used, primarily because the cooling water intake/outflow system may need to be changed (see technical section). This change has added approximately $11.0 million to the project cost.

3.09 Again, EEA and A.I.D. agree to this increase. Experience on existing projects in Egypt shows that ten percent is a more realistic figure than five percent, and is consistent with recent IBRD allowances for similar projects.

3.10 Engineering: The original cost estimate assumed that all engineering would be done by the supplier and would form part of his lump-sum bid with little additional engineering services needed. The original estimate for these additional services was $1.3 million. Based, however, on the detailed technical proposals of the four engineering firms short-listed (see Para 2.02) none viewed the work at the level estimated by S&P. EEA and A.I.D. made a detailed analysis of the levels of effort proposed and the tasks involved and considered the man-month estimates to be realistic. Another factor has been the rapid increase in the cost of foreign personnel. Man-month costs have increased from a range of $5-6 thousand per month in the past two years.

C. Cost Estimate

3.11 The revised cost estimate is shown in Table 3 below. Annex F provides the detailed cost estimate.

TABLE 3

Revised Cost Estimate

		U.S. Dollars	Egyptian Pounds
1.	Equipment	$ 52,243,000	LE 1,092,800
2.	Piping	3,908,000	570,000
3.	Civil Works	6,581,000	3,477,700
4.	Electrical	14,510,000	458,300
5.	Switchyard	4,207,000	367,100
6.	Miscellaneous Indirects	22,362,000	2,593,000
7.	A & E Services	4,589,680	316,800
8.	Contingency	15,572,000	2,140,000
9.	Escalation	16,620,000	3,426,100
10.	Totals	$ 140,592,680	LE 14,441,800
11.	Rounded Totals	$ 141,0 million	LE 14.5 million

IV. LOAD AND GENERATION FORECASTS

4.01 The load and generation forecasts included in the original Ismailia 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 prove 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 Ismailia 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 to the Project Paper.) S&P, with EEA assistance, has prepared revised projections. These projections, including methodology, assumptions and conclusions are included as Annex G -- Sanderson & Porter, Inc., "Phase I System Planning and Diagnostic Report", April 1977.

4.03 For demand projections, S&P again separated its projects into two parts -- a short-range forecast (1977-1985) and a long-range forecast (1985-2000). These forecasts are shown in pages 8 and 40 of Annex G.

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 are the delays in the construction of the Kafr El Dowar and Abu Kir 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

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-- especially the increase in the Abu Kir 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 G. (S&P's report also provides an in-depth analysis of the capability of the Aswan and High Dam hydroelectric 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 conclusion 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 USAID 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 10 of Annex G. 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 Kir 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 Talka/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% reserve requirement is necessary for stability. The following table shows EEA's reserve capacity, using S&P supply/demand projections except as noted, with and without the Talka/Helwan and Ismailia plants.

TABLE 5

AVAILABLE RESERVE

Year	Generating Capacity (MW)	Less Talka-Helwan Ismailia	Net Capacity (MW)	Demand	Reserve With 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 Talka/Helwan and Ismailia projects do not agree with the present schedule. However, since these plants are deducted from the generating capacity, the illustration figure are accurate.

2/ Sanderson & Porter projections show the Abu Kir's 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 fundamental alteration of the original technical configuration of the Ismailia steam plant. It will have two nominal 150 MW steam turbine generators arranged on a unit basis; that is, one steam generating unit will feed one turbine generator unit. Each unit will have a steam generator that will burn either heavy fuel oil or natural gas, unitized power generation auxiliaries, and a unit step-up transformer. Common facilities for the two units will include a 220 kilovolt switchyard, intake and discharge facilities,make-up water treating equipment, fuel handling facilities, and a service building.

5.02 The plant will be arranged for remote centralized control from a common control room between the units. The turbine steam cycle will have multiple stages of feed-water heating and one state of reheat. The initial steam conditions will be 1800 pounds per square inch, 950°F. with a 950° F reheat. The turbine generator will have the capability of operating at 105 percent of rated initial steam pressure and will have a five percent flow margin. The maximum generation under these conditions will be about 164,000 kilowatts. The generator and power generation auxiliaries will be sized on the basis of this maximum generation. The maximum output from the plant with a normal auxiliary power consumption will be about 310,000 KW. The generator rating will be 190,000 kilovolt amps at a 0.90 power factor. Auxiliary power will be distributed at 6.3 KV and 400 volts.

5.03 Condenser cooling water will be obtained from the Great Bitter Lake using an open cooling cycle. The design of the cooling water intake and discharge system depends upon precise knowledge of the underwater configuration of the lake. This configuration has recently been subjected to an unknown degree of future alteration because the Suez Canal Authority has given unlimited dredging and spoil discharge rights in the lake to a Japanese firm engaged for the Canal deepening and widening project. (That project is intended to permit the passage of the largest super-tankers through the Suez Canal.) If the spoil is discharged along the western shore, water depths, already shallow, could become so shallow that hot effluent would be recirculated through the intake system unless intake pipes were lengthened or cooling towers erected. To resolve this potential technical problem, the EEA intends to explore with the Suez Canal Authority various solutions that would involve limiting or redirecting the Japanese dredging contractor's unlimited spoil discharge rights. A.I.D. will make satisfactory resolution of this problem a further condition precedent to disbursement of grant amendment proceeds.

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5.04 Annex H shows the proposed plot plan; Annexes I and J show the proposed ground and operating floor arrangements; and Annex K shows the proposed arrangement of the operating sections.

VI. ENVIRONMENTAL ASSESSMENT

6.01 The environmental assessments of the Ismailia Power Plant have been examined by S&P 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 Annex L shows in table form the potential significant impacts of the project and, when appropriate, the mitigating measures recommended. Following is the narrative discussion of the environmental assessment.

A. Physical Environment

6.03 Water: Water will be withdrawn from the Sweet Water Canal (See Annex H) at the approximate rate of 200 gallons per minute (0.9 cubic meters per minute), for use as boiler makeup, domestic, cleanup and for other miscellaneous water needs of the plant. The water in the Sweet Water Canal originates in the Nile and flows via canal South-east 135 KM to Ismailia and then to Suez. The 200 GPM proposed withdrawal for use at the Power Plant represents approximately 26 percent of the amount being used by the city of Ismailia now and 1.2 percent of the proposed use by Ismailia by year 2000. Both S&P and Gilbert have concluded that the withdrawal of 200 GPM from the Canal will not significantly affect the overall flow of the canal.

6.04 Cooling water will be withdrawn from and returned to the Great Bitter Lake at approximately 20,000 GPM. The lake is connected via the Suez Canal southward to the Red Sea and Northward to the Mediterranean Sea. The lake contains approximately 1.4 KM^3 of water and is 20.5 Km long and 11.5 Km wide. The withdrawal of 200,000 GPM is not expected to affect the physical characterisitcs of the lake. The water discharged will be approximately 10C (18F) above ambient lake temperature. The discharge of this water will be designed and located to avoid recirculation. The prevent damage to aquatic life in the lake, chlorine used to control bio-fouling in the condenser tubes will be controlled to limit free available chlorine concentration discharged into the lake to an average of 0.2 MG/l and a maximum of 0.5 MG/l. All other wastes produced by the plant will be disposed of in either percolation -- evaporation pools or in a cesspool; none will be discharged directly into Great Bitter Lake.

6.05 To protect against oil spills which would contaminate the Lake, dikes will be constructed around oil storage tanks and curbs will be constructed around unloading facilities. It is unlikely that any oil spill would contaminate the Sweet Water Canal since the ground slopes toward the lake and away from the canal.

6.06 Air dispersions from the plant will contain emissions of sulfer dioxide (SO_2) and Oxides of nitrogen (NO_x). The predominating wind direccion will carry the pollutants over the Great Bitter Lake away from the populated areas. However, when the wind changes, or when the wind blows perpendicular to the boiler, emissions will effect those working at the plant. To correct this problem, the stack height would have to be at least 75 meters above ground. Military restrictions, however, limit the stack height to only 40 meters (see Annex K). Fortunately, the plant is expected to burn almost sulfur free natural gas; therefore, emissions should be tolerable.

B. Biotic Environment

6.07 The intake structure for the fresh water supply from Sweet Water Canal will be designed with a trash rack and screen with a 3/8 inch mesh size to prevent entrainment of organisms and acquatic weeds and the approach velocity will be less than one foot per second to allow motil organisms to avoid entrainment.

6.08 The abundance of marine life in the Greater Bitter Lake has been documented in a 1977 report entitled, "Report on Some Information on Bitter Lakes Needed for Establishing Power Plant of 300 MW", by Dr. Sharar El Din, M. M. Osman and El-Maghraby of the Alexandria University Oceanographic Department. Forty species of fish from the Great Bitter Lake were reported.

6.09 The high water temperatures which will exist in the immediate area of the heated discharge plume in the Great Bitter Lakes during the summer will be lethal to most plants and animals. Pro and post larval stages of a mullet species (Mugil sp.) which breeds in the shallow waters of the Great Bitter Lake are killed by temperatures which exceed 32C (89.6F) (Krenkel, B.A. and F.L. Parker, 1968. Biological Aspects of Thermal Pollution. Vanderbilt University Press, Nashville, Tennessee). In July, the plume temperature may exceed 32C, 600 m away.

6.10 The result of the termal plume will be an area in the lake which is void of most flora and fauna. This condition will be created after the ecology of the lake has been severely disrupted and destroyed by the massive spoils disposal program which will take place between 1977 and the early 1980s when the Suez Canal is widened. Operation of the power plant and disposal of the heated water in the Great Bitter Lake will simply prevent recolonization of those areas affected by the hottest portions of the thermal plume.

6.11 During periods of migration or spawning, organisms could be so abundant that the screens at the intake structure could become clogged with indengous organisms such as mullet or mussels. Clogging has occurred at the 100 MW thermal power plant in Suez when mussels obstructed the five millimeter mesh self-cleaning rotating screens.

6.12 To avoid these potential impacts of impingement, entrainment and entrapment, the following measures will be considered during design of the intake structure.

1. Avoid placing the intake structure in vital areas including such entities as grass beds, shell-fish beds, cuts and passes, migration pathways, and spawning and nursery areas.

2. Provide maximum approach velocity to screen of 0.75 fps.

3. Provide through screen velocity of 1.5 fps.

4. Provide a trash rake.

5. Provide a screen mesh size of 3/8 in.

6.13 Terrestrial Ecology: Habitats for the indigenous flora and fauna will be destroyed when the approximately 50.08 acres (202,500 m2) of the site are converted from productive agricultural land to industrial land void of most terrestrial habitats. Existing flora consists predominately of cultivated crops. On April 26, 1977, bean, tomato, squash, wheat, hay and other crops were growing on the site. Animals which are disturbed during construction can find suitable habitat in the agricultural land adjoining the site.

C. Human Environment

6.14 The 50.08 acres (202,500 m2) of the site and the surrounding areas are in sparsely populated agricultural land. The nearest population center (Abu Soltan) is situated approximately one kilometer west of the power plant site. Land is presently used to grow crops which include beans, squahs, tomatoes, hay and wheat. At least 20 stone houses or barns are on the land. The negative aspect of removing the agricultural land from active production and resettling the residents is outweighed by the increased electricity (300 MW) provided by the project and the positive economic consequences of doing so. The Egyptian Government will compensate residents and/or owners of the land who are displaced as a result of the project.

VII. FINANCIAL ANALYSIS

A. General

7.01 In the May 1976 Ismailia 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 of EEA of Sanderson & Porter, financed by UNDP to study FEA'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 new authority it now has. Politically, 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, at least on paper. Given EEA's antiquated accounting system, the accouting policies it follows, or not follows as the case may be, and its bad debt experience, it will be many years before anyon 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 grant increase. The financial covenants proposed in the original Ismailia Project Paper -- debt to equity ratio and rentiurn on investment -- have been accepted by the GOE and EEA and are included in the Grant Agreement. Also, the World Bank has concluded the same convenants as conditions to its loan to the 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 -- Kafr El Dowar and Abu Kir. On the other hand, EEA's assest are understated since some were financed by grant funds which were not accounted for on EEA's books. Our existing Grant

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Agreement requires EEA to earn a nine percent return on its assets in operation appropriately valued and, from time to time, revalued. Sanderson & Porter, working with EEA, is now engaged in the valuation task. For AID's original grant for the Ismailia project, we recommend that it be passed on to EEA by the GOE as a contribution to EEA's equity capital, since our expectation is that even after assets are properly valued, EEA's debt to equity position will be less than satisfactory. We again believe this is the best method of helping EEA and therefore recommend that the grant increase of $42 million be passed on to EEA by the GOE as a contribution to EEA's equity capital. The local currency project costs of LE 14,441,800 will be provided by EEA from its internal cash generations.

C. Ismailia[1/]

7.07 Looking at Ismailia as a spearate entity, its annual revenues are equivalent to $21,840,000 calculated on the basis of 1,680,000,000 KWH of salable electricity (75 percent load factor, 8,760 hours per year and a 17 percent loss) at an average sale price of 1.3¢ per KWH. Annual cash operating ocsts, 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	$5,913,000
Operating and Maintenance Generation	169,000
Transmission and Distribution	281,000
	$6,363,000

Using these values, Ismailia has an internal financial rate to return of just about nine percent. Assuming the plant is depreciated over 25 years, it will show a profit, before interest, taxes, and head office administrative charges equivalent to $15.5 million per year.

7.08 The project, therefore, will make a positive cash contribution to EEA. Based on the current sales price and subsidized fuel costs, it will meet A.I.D.'s covenant that EEA earn a nine percent return on its assets. If, however, the price of fuel is increased, EEA sales price of electricity will have to be increased accordingly if EEA is to continue to operate at a profit.

1/ In the original project paper costs and revenues were shown in U.S. dollars converted at the official rate of exchange (LE .39 equals US $1.00). This paper uses the parallel market rate (LE .70 equal US $1.00) and therefore is more realistic. 23X

D. Disbursements

7.09 Except for payments to Gilbert, disbursements are not expected to commence until the third quarter of 1978. All disbursements will be completed by the third quarter of 1982. Annex M shows the project disbursements by quarter and Annex N shows the project disbursements by inputs.

VIII. 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 Ismailia thermal power plant. The amount of usable electricity that will be produced and delivered to users, per year, is 1,680,000,000KWH. 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 the products of commerical 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 a 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. Ismailia

8.03 The internal economic rate of return of the Ismailia project is the discount rate which equates the present value of the time streams of the attributable costs and benefits over the projects assumed life of 25 years. In the case of Ismailia, the real value of the benefits to the economy is estimated at 4.5¢ KWH. 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 has been used rather than the subsidized domestic price. 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 20.29.

25X

IX IMPLEMENTATION

A. General

9.01 There has been no fundamental alteration to plans for project implementation since preparation of the May, 1976 project paper, other than the revised concept for civil works execution described in para 3.03. Supply and erection of the plant will be carried out by a single-responsibility contractor who will design, engineer, supply equipment, supervise civil works and start-up services.

9.02 The proposed basis for reimbursement of the contractor is as follows:

1. A lump sum basis for:
   - A. Engineering, design, detailing, drawings, procedures and specifications.
   - B. Construction supervision, site engineering, inspection, and other related services.
   - C. Furnishing and delivering major U.S. furnished equipment including boilers, turbine-generators, main condensers, main pumps, heat exchangers, large transformers, switchgear, motor control centers, etc.
   - D. All other U.S. furnished material and equipemnt such as structural steel, piping, cable and conduit.
   - E. Spare parts for item "C".
   - F. Mobilization and demobilization.
   - G. All installation, testing, and start-up costs other than labor.
   - H. Bonds and insurance.
   - I. Training program.

2. A lump sum plus escalation based on standard U.S. indices for.
   - A. Installation and start-up labor (U.S. source and origin).

3. A direct cost, not to exceed a target cost, plus a fixed fee for locally procured items such as:
   - A. Earthwork.
   - B. Concrete and other local building materisls.

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C. Local transportation of material and equipment.

D. Installation, testing, and start-up labor.

B. Schedule

9.03 The original project schedule planned for both units to be in commercial operation by April 30, 1981. Based on the revised schedule, one unit is now planned to be put in commercial operation by August 30, 1981 and the second unit by June 30, 1982. The revised schedule is predicted on the release of the Invitation for Bid (IFB) on October 1, 1977 with contract award in April, 1978. This date appears very tight and will depend on EEA acting promptly on the bidders list. The IFB has been drafted and is now being reviewed by EEA. Prequalification material from interested firms is due on September 12, 1977. Annex P shows the Critical Path on the Summary Level Milestone Schedule. Annexes Q and R show the schedule on a bar chart format.

9.04 The total change in project schedule is 14 months. Seven of these months were the time required by EEA to employ the consulting engineer. Originally, we believed this could have been accomplished by September 30, 1976 since we had started the selection process prior to Grant Authorization. This, however, proved to be unrealistic as was explained in para 2.02. An additional three months were added to the time to review EEA's draft IFB and release the document to prequalified bidders. We had originally believed EEA's document was of the quality to allow its release almost concurrently with the effective date of the consulting engineer's contract. Further inspection proved this not to be the case. The remaining four months is Gilbert's current evaluation of delivery time for critical items. In summary, while the project will fall somewhat behind its original schedule, that original schedule was simply too optimistic.

C. Terminal Dates

9.05 Conditions Precedent: The initial conditions precedent to disbursement have been met. Conditions precedent to disbursement for specific goods or services (other than consulting engineer) have not yet been met. The final event will be the contract with the single-responsibility contractor. There is no terminal date for these subsequent CP's.

9.06 Letters of Commitment and Disbursement: The terminal date for the opening of Letters of Commitment was originally set at December 31, 1980 and the Terminal Date for disbursements at December 31, 1981. Based on the revised schedule, we recommend that the dates be shifted by one full year. Assuming both units are in commercial operation by June 30, 1982, this will allow six months for final contract payments.

27X

D. Evaluation

9.07 The purpose of the Ismailia Thermal Power Plant is to meet the energy requirements of reconstruction in the Suez Canal area, and to meet power demand of other areas of the country through connection with the national power grid. The primary goal of providing energy through the Ismailia Plant is industrial and household reconstruction and growth in the Suez Canal area.

9.08 During construction, satisfactory information for implementation management will be obtained from normal monitoring procedures, which will be based on a critical path network. A.I.D.'s financial disbursement records, and site visits.

9.09 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 plant is able to provide the 300 MW incremental addition to the power grid, and any particular issues which remain to be addressed concerning the operation or management of the plant. 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 were 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.

9.10 One year after each of the two units goes into commercial operation (approximately one year apart) USAID will prepare an evaluation report describing the results of the plant audits, and the review of utilization. If no future difficulties are anticipated, there will be only spot check monitoring. If any aspect of the physical plant fails to meet manufacturer's guarantees and warranties, which extend beyond one year, USAID would be notified.

9.11 The Mission does not feel it would be appropriate or necessary to evaluate industrial and residential reconstruction/growth of the Suez Canal area in the context of this particular project. This project is one of many efforts required to achieve this goal, and there are so many variables involved that it would be difficult to distinguish the impact of the project from other factors, thus it makes more sense to evaluate achievement of the objective on a wider scope at a later time. A special effort for such evaluation is not contemplated, as the normal course of GOE and Embassy reporting will provide the information.

X. RECOMMENDATION, CONDITIONS AND COVENANTS

A. Recommendation

10.01 All conditions and covenants recommended in the original project paper have been accepted by the GOE and incorporated in the original Grant Agreement. Subject to one additional condition, we recommend that A.I.D.'s grant to the GOE be increased from $99 million to $141 million-- an increase of $42 million. We further recommend that the proposed increase be passed on by the GOE to EEA as a contribution to EEA's equity capital.

B. Conditions

10.02 We recommend that we add to the three existing Conditions Precedent to Disburseemnt for Specific Goods and Services (Section 3.02 of the Grant Agreement) the following:

> Section 3.02 (d) A plan, agreed to with the Suez Canal Authority, which will allow the design and installation of cooling water intake and discharge into the Great Bitter Lake, that will allow the timely execution of the Ismailia Project.

- C O P Y -

ANNEX A

MINISTRY OF ECONOMY
AND ECONOMIC COOPERATION

Economic Cooperation Division
Office
of the Under Secretary

Mr. D.S. Brown
AID Representative
U.S. Embassy
Cairo

Dear Mr. Brown,

With reference to the letters of Eng. Kamal Nabih (Egyptian Electricity Authority) No. 362 & 363 dated 17 July, 1977 requesting AID to finance the foreign exchange overruns of $ 42 Million and $ 18.5 Million for the Ismailia Steam Power Plant Project and the Talkha/Helwan Gas Turbine Power Plants Project respectively.

I would like to inform you that the Ministry of Economy and Economic Cooperation agrees to increase the funds allocated for these projects with a sum of $ 68,5 Million from the remaining Fiscal Year 1977 AID funds.

Hoping you would take the necessary steps in this regard,

I remain,

Sincerely yours,

Gamal El Nazer
Deputy Chairman
For Investment Authority
In Charge of Economic Cooperation

CAIRO, 9 August, 1977

3 DX

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

Rec. 7/18/77

Ref: 363

Cairo, 17 July, 1977

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

ACTION TO CDE EXO DEV
ACTION TAKEN ..... DATE 7/29
NAN ..... INITIALS .....

Dear Mr. Brown,

As you know we have received a draft copy of the preliminary project report for the Ismailia Thermal Power Plant Project from our Consultants. The foreign exchange preliminary estimate contained in the draft report is US $128,832,000.

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 preliminary project report, which shows the modifications that have been made to the estimate with the result that the foreign exchange estimate for the Project is US $136,000,000.

The increase in the preliminary estimate of US $7,168,000 is attributable to additional fuel storage, additional fire protection, changing the turbine building to a wholly structural steel building increasing the warehouse and garage facilities, increased allowance, for spare parts and adjustments to the indirect costs.

The total estimated foreign exchange cost of US $136,000,000 set forth above does not include our contract with Gilbert Associates which presently provide for an expenditure of US $4,600,000. Therefore our total foreign exchange requirement for the Ismailia Thermal Power Plant Project is US $140,600,000.

Grant Agreement No. 263-12-220-009 between USAID and the ARE executed on May 30, 1976 provides for a maximum of US $99,000,000. In view of the presently estimated foreign exchange requirement for the project, it is requested that the Grant Agreement be amended to provide for an amount not to exceed US $141,000,000 or an increase in the Grant of US $42,000,000.

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

(2)

As you are aware the Sanderson & Porter Feasibility Report was the basis for the USAID extending the present grant of US $99,000,000. At the time the Sanderson & Porter report was prepared it was anticipated that the erection of the equipment and the civil works would be performed essentially by Egyptian contractors. Conditions today are markedly different to the extent that the capable Egyptian contractors are overloaded with work and are unable to complete their present projects in accordance with their schedules.

It is critical to our system requirements that the Ismailia Thermal Power Plant be completed on schedule to meet our system demands in 1981 and 1982. Therefore, it is anticipated that this Project would be executed by a large US contractor and while he would make maximum use of Egyptian labor and subcontractors he would also provide enough expatriate supervision at the working level and proper construction equipment to complete the project on schedule. While this approach has not materially changed the total estimated cost of the Project from that which was set forth in the Sanderson & Porter report it has resulted in an increase in the foreign exchange requirements and a decrease in the Egyptian Pound requirements.

In attempting to locate another source for the additional foreign exchange requirements we have had some contact with the World Bank and the various Arab Funds. However, as you are aware, obtaining a commitment from any of these funds would entail a considerable amount of time for their appraisal review and decision resulting in delay to the Project and an increase in Project cost through escalation. As stated above our system requirements are critical and this additional generating capacity is badly needed at the presently scheduled project completion date. Our present schedule requires our Consultants to issue the IFB by October 1, 1977 and a decision in this matter is required prior to this date to permit the IFB to be issued.

In view of the foregoing your favorable consideration and early approval of our request for an amendment to the Grant Agreement to provide an additional US $42,000,000 for this Project will be greatly appreciated.

Very truly yours,

K. Nabih.

(Eng. Kamal Nabih)
Deputy Chairman.

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DRAFT

ANNEX B

Grant Amendment Authorization

Country: Arab Republic of Egypt

Name of Project: Ismailia Thermal Power Plant - Amendment

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. Grant No. 263-12-220-009 to the Arab Republic of Egypt (the "Cooperating Country") increasing the amount of such Grant by Forty-Two Million United States Dollars ($42,000,000) from Ninety-Nine Million United States Dollars ($99,000,000) to not to exceed One Hundred Forty-One Million United States Dollars ($141,000,000) to be made available to the Egyptian Electric Power Authority to assist in financing the foreign exchange costs of a 300 MW thermal power plant near the city of Ismailia.

Prior to the first disbursement of funds under the Grant for any purpose other than to finance the services of the consulting engineer, or to the issuance of commitment documents with respect thereto, the Cooperating Country shall, except as A.I.D. may otherwise agree in writing, furnish to A.I.D. in form and substance satisfactory to A.I.D., in addition to other materials already required under the Grant Agreement for this purpose, a plan developed in consultation with and approved by the Suez Canal Authority for conducting dredging and spoil discharge operations along the western shore of the Great Bitter Lake in a manner t t does not unduly interfere with the effective implementation of the Project.

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All other provisions of the Grant Authorization approved on May 28, 1976, remain unchanged.

_____
Administrator

_____
Date

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 the 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 technical assistance and training planned under 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 300 MW steam power plant near the city of Ismailia.

Donald S. Brown

Date August 24, 1977

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.

App. Unnumbered; FAA Sec. 653(b)	
1) Describe how Committees on Appropriations of Senate and House have been or will be notified concerning the project; if assistance within (Operational 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 assertation 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 confirmation action pertaining to 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 C.

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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 e forts 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 amendment will, together with the original grant, increase the flow of international trade and improve technical efficiency of industry, agriculture and commerce. See pages 3-12 of the original Project Paper and pages 1-2 of this Project Paper.

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. concerns.

9. FAA Sec. 612(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, but all local currency requirements to be financed under the project will be provided by GOE and not by USG.

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.

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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 [illegible]-developed" country)?

[illegible] Sec. 110(b). Will grant capital [illegible] be disbursed for project over [illegible] 3 years? If so, has justifi- [illegible] satisfactory to Congress been made, [illegible] for other financing?

[illegible] Sec. 207; Sec. 113. Extent to [illegible] assistance reflects appropriate [illegible] on; (1) encouraging development [illegible] cratic, economic, political, and [illegible] institutions; (2) self-help in [illegible] the country's food needs; (3) [illegible] ing availability of trained worker- [illegible] in the country; (4) programs [illegible] to meet the country's health [illegible] (5) other important areas of [illegible], political, and social develop- [illegible], including industry; free labor [illegible], cooperatives, and Voluntary [illegible]; transportation and communica- [illegible]; planning and public administration; [illegible] development, and modernization of [illegible] laws; or (6) integrating women [illegible] the recipient country's national [illegible].

[illegible]. FAA Sec. 281(b). Describe extent to [illegible] program recognizes the particular [illegible], desires, and capacities of the [illegible] of the country; utilizes the [illegible] ntry's intellectual resources to [illegible] rage institutional development; [illegible] supports civic education and training [illegible] skills required for effective partici- [illegible] in governmental and political [illegible] esses essential to self-government.

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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, nd will it contribute to realizable ong-range objectives? And does project aper provide information and conclusion an ctivity's economic and technical ndr ss?

F/ Sec. 201(b)(6); Sec. 211(a)(5), (6). tion and conclusion on possible of the assistance on U.S. economy, ecial reference to areas of sub- l labor surplus, and extent to U.S. commodities and assistance furnished in a manner consistent with oving or safeguarding the U.S. balance- ayments position.

lopment Assistance Project Criteria ns only)

Not applicable.

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

FAA Sec. 201(b)(2); 201(d). Infor- on and conclusion on (1) capacity of 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.

FAA Sec. 201(e). If loan is not ide pursuant to a multilateral plan, nd the amount of the loan exceeds 100,000, has country submitted to AID n application for such funds together ith assurances to indicate that funds ill be used in an economically and echnically sound manner?

FAA Sec. 201(f). Does project paper escribe how project will promote the ount 's economic development taking into count the country's human and terial resources requirements and lat nship between ultimate objectives the project and overall economic velopment?

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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 support economic stabili by contributing to the reconstruction and rehabilitation of the Suez Canal area whose principal cities, infrastructure and basic facilities, such as power, were extensively damaged during the long period of intermitten warfare.

4. Additional Criteria for Alliance for Progress

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

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?

Not applicable.

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. FAA 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?

B. 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? — Assistance contemplated under this Grant will exceed the aggregate value of $100 million for construction of a productive enterprise, but will not be furnished until after the express approval of Congress is obtained.

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 grant 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.

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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. [illegible] for CIA activities? Yes.

e. App. Sec. 105. 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 F.A. Sections 209(d) and 251(h)? (transfer to multilateral organization for lending). Yes.

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

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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 the site. 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 AID 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 AID 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

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accordance with standard U.S. engineering practices, codes and standards and with applicable ATD 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.

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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 required for construction and the checking of detail 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 Contractors' 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, specifications 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 site. 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 A.R.E.

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 affect the construction of the plant and means, where such exist, to overcome these delays.

3.6.1.3 Review work plans, progress schedules and financial 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 effects on work of others at the site 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.

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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 justification for such changes/revisions and 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 the EEA 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.

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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.

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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 competency 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 U.S.A. or A.R.E. 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 reordering system based on minimum/maximum levels.

TABLE 9-1

CAPITAL COST

2 - 150 MW OIL FIRED PLANT
ISMAILIA, EGYPT

DESCRIPTION	QUANTITY	U.S. (DOLLARS) MATERIAL	LABOR	TOTAL	EGYPTIAN (LE) MATERIAL	LABOR	TOTAL
EQUIPMENT							
TURBINE GENERATOR & ACCESSORIES	2 EA	18,800,000	620,000	19,420,000	--	187,200	187,200
TOTAL	--	18,800,000	620,000	19,420,000		187,200	187,200
STEAM GENERATOR & ACCESSORIES	2 EA	16,040,000	2,040,000	16,080,000	--	619,800	619,800
TOTAL	--	16,040,000	2,040,000	16,080,000		619,800	619,800
DRAFT SYSTEM							
DRAFT EQUIPMENT	1 LOT	1,465,000	56,000	1,521,000		16,900	16,900
AIR/GAS DUCTS	1 LOT	780,000	206,000	986,000		62,400	62,400
TOTAL	--	2,245,000	262,000	2,507,000		79,300	79,300
CONDENSER & AUXILIARIES							
CONDENSER	2 EA	1,460,000	108,000	1,568,000	--	32,800	32,800
PUMPS	1 LOT	394,000	8,000	402,000	--	2,600	2,600
TANKS	2 EA	140,000	46,000	186,000	--	13,800	13,800
TOTAL		1,994,000	162,000	2,156,000		49,200	49,200
FEEDWATER SYSTEM							
PUMPS	6 EA	540,000	20,000	560,000	--	6,000	6,000
HEATERS & DEAERATOR	1 LOT	932,000	14,000	946,000	--	4,400	4,400
TOTAL	--	1,472,000	34,000	1,506,000	--	10,400	10,400
CIRCULATING WATER SYSTEM							
PUMPS	18 EA	1,407,000	24,000	1,431,000	--	7,500	7,500
COOLERS	4 EA	360,000	2,000	362,000	--	800	800
TRAVELING SCREEN EQUIPMENT	1 LOT	298,000	18,000	316,000	--	5,500	5,500
TOTAL	--	2,065,000	44,000	2,109,000	--	13,800	13,800
FUEL OIL SYSTEM							
PUMPS	18 EA	121,000	6,000	127,000	--	1,600	1,600
TANKS	5 EA	1,630,000	250,000	1,880,000	--	75,400	75,400
AUXILIARY BOILER/RE-BOILER	1 LOT	657,000	20,000	677,000	--	6,500	6,500
TOTAL	--	2,408,000	276,000	2,684,000	--	83,500	83,500

TABLE 9-1

CAPITAL COST

2 - 150 MW OIL FIRED PLANT
ISMAILIA, EGYPT

DESCRIPTION	QUANTITY	U.S. (DOLLARS) MATERIAL	LABOR	TOTAL	EGYPTIAN (LE) MATERIAL	LABOR	TOTAL
EQUIPMENT (CONT'D)							
MISCELLANEOUS EQUIPMENT							
CRANES/HOISTS	1 LOT	340,000	12,000	352,000	--	3,900	3,900
COMPRESSORS	4 EA	82,000	4,000	86,000	--	1,600	1,600
TOTAL	--	422,000	16,000	438,000	--	5,500	5,500
WATER TREATMENT SYSTEM							
WATER TREATMENT EQUIPMENT	1 LOT	1,057,000	70,000	1,127,000	--	21,300	21,300
FIRE/SUMP PUMPS	43 EA	86,000	8,000	94,000	--	2,300	2,300
TOTAL	--	1,143,000	78,000	1,221,000	--	23,600	23,600
SERVICE EQUIPMENT							
VEHICLES/TRACTOR/LOCOMOTIVE	1 LOT	952,000	--	952,000	--	1,900	1,900
MACHINE SHOP	1 LOT	550,000	--	550,000	--	6,400	6,400
INSTRUMENT SHOP	1 LOT	70,000	--	70,000	--	1,000	1,000
CHEMICAL LABORATORY	1 LOT	100,000	--	100,000	--	1,600	1,600
SAMPLING LABORATORY	1 LOT	40,000	--	40,000	--	1,000	1,000
SERVICE BUILDING OFFICE EQUIPMENT	1 LOT	100,000	--	100,000	--	1,600	1,600
TOTAL	--	1,812,000		1,812,000		13,500	13,500
TOTAL MECHANICAL	--	48,401,000	3,532,000	51,933,000		1,085,800	1,085,800
PIPING (LARGE & SMALL)							
MAIN, EXTRACTION, AUXILIARY STEAM	--	498,000	146,000	644,000	--	76,200	76,200
CONDENSATE, FEEDWATER, VENTS & DRAINS	--	742,000	262,000	1,004,000	--	136,000	136,000
AUX. COOLING, VACUUM & WATER TREATMENT	--	248,000	142,000	390,000	--	73,600	73,600
OTHER SYSTEMS	--	894,000	444,000	1,338,000	--	230,400	230,400
HOT & COLD REHEAT	--	380,000	78,000	458,000	--	40,800	40,800
TOTAL PIPING	--	2,762,000	1,072,000	3,834,000	--	557,000	557,000

TABLE 9-1

CAPITAL COST

2 - 150 MW OIL FIRED PLANT
ISMAILIA, EGYPT

DESCRIPTION	QUANTITY	U.S. (DOLLARS) MATERIAL	LABOR	TOTAL	EGYPTIAN (LE) MATERIAL	LABOR	TOTAL
CIVIL							
SITEWORK	1 LOT	117,000	254,000	371,000	382,900	162,600	545,500
TOTAL	--	117,000	254,000	371,000	382,900	162,600	545,500
TURBINE BUILDING							
BLDG., FOUNDATION, & PILING	1 LOT	305,000	50,000	355,000	57,400	32,600	90,000
BLDG., CONCRETE WALLS	1 LOT	120,000	102,000	222,000	126,700	65,900	192,600
TURBINE GENERATOR FOUNDATION & PEDESTAL	1 LOT	726,000	150,000	876,000	114,800	96,300	211,100
STRUCTURAL STEEL	1 LOT	1,212,000	74,000	1,286,000	--	47,000	47,000
ARCHITECTURAL & BUILDING SERVICES	1 LOT	302,000	88,000	390,000	218,400	56,300	274,700
TOTAL	--	2,665,000	464,000	3,129,000	517,300	298,100	815,400
BOILER AREA							
AREA FOUNDATION & PILING	1 LOT	117,000	22,000	139,000	16,800	14,700	31,500
STRUCTURAL STEEL	1 LOT	219,000	14,000	233,000	--	8,300	8,300
ARCHITECTURAL	1 LOT	58,000	8,000	66,000	4,900	5,800	10,700
TOTAL	--	394,000	44,000	438,000	21,700	28,800	50,500
SERVICE BUILDING							
BLDG., FOUNDATION, & PILES	1 LOT	231,000	290,000	521,000	318,500	185,000	503,500
STRUCTURAL STEEL	1 LOT	44,000	2,000	46,000	--	1,900	1,900
ARCHITECTURAL & BUILDING SERVICES	1 LOT	12,000	58,000	70,000	123,200	37,400	160,600
TOTAL	--	287,000	350,000	637,000	441,700	224,300	666,000
WATER TREATMENT BUILDING							
BLDG., FOUNDATION, & PILES	1 LOT	67,000	142,000	209,000	200,900	91,200	292,100
STRUCTURAL STEEL	1 LOT	24,000	2,000	26,000	--	1,000	1,000
ARCHITECTURAL & BUILDING SERVICES	1 LOT	--	24,000	24,000	56,000	15,700	71,700
TOTAL	--	91,000	168,000	259,000	256,900	107,900	364,800

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TABLE 9-1

CAPITAL COST

2 - 150 MW OIL FIRED PLANT
ISMAILIA, EGYPT

DESCRIPTION	QUANTITY	U.S. (DOLLARS) MATERIAL	LABOR	TOTAL	EGYPTIAN (LE) MATERIAL	LABOR	TOTAL
CIVIL (CONT'D)							
CONSTRUCTION WAREHOUSE							
BUILDING FOUNDATIONS & PILES	1 LOT	93,000	102,000	195,000	148,400	65,900	214,300
STRUCTURAL STEEL	1 LOT	15,000	--	15,000	--	600	600
ARCHITECTURAL & BUILDING SERVICES	1 LOT	3,000	18,000	21,000	31,500	11,500	43,000
TOTAL	--	111,000	120,000	231,000	179,900	78,000	257,900
PUMPHOUSES & TUNNELS							
CIRCULATING WATER	1 LOT	92,000	26,000	118,000	36,400	16,300	52,700
MAKE-UP WATER	1 LOT	22,000	8,000	30,000	11,900	4,800	16,700
CIRCULATING WATER TUNNELS	1 LOT	74,000	168,000	242,000	153,300	107,200	260,500
CIRCULATING WATER DISCHARGE STRUCTURE	1 LOT	33,000	8,000	41,000	3,500	5,800	9,300
TOTAL	--	221,000	210,000	431,000	205,100	134,100	339,200
OUTDOOR FOUNDATIONS							
FUEL OIL STORAGE TANK	1 LOT	29,000	40,000	69,000	49,700	25,600	75,300
LIGHT OIL TANKS	1 LOT	2,000	2,000	4,000	3,500	1,900	5,400
FUEL OIL STORAGE AREA DIKES & LINING	1 LOT	23,000	36,000	59,000	--	23,400	23,400
FUEL OIL PUMPS	1 LOT	4,000	2,000	6,000	2,800	1,300	4,100
CONDENSATE, ACID & FILTER WATER	1 LOT	8,000	12,000	20,000	16,100	7,000	23,100
AUXILIARY BOILER	1 EA	1,000	2,000	3,000	1,400	600	2,000
EMERGENCY GENERATION UNITS	2 EA	39,000	4,000	43,000	5,600	2,900	8,500
POWER TRANSFORMERS	7 EA	7,000	10,000	17,000	14,000	7,000	21,000
TRANSFORMER FIREWALLS	1 LOT	16,000	6,000	22,000	4,900	3,500	8,400
TOTAL	--	129,000	114,000	243,000	98,000	73,200	171,200
OTHERS							
EVAPORATION POND	1 LOT	--	--	--		9,600	9,600
TURBINE & SERVICE BLDG. ELEVATED WALKWAY	1 LOT	2,000	--	2,000	3,500	600	4,100
GATE HOUSE	1 LOT	2,000	4,000	6,000	7,700	2,600	10,300
GAS REDUCING STATION	1 LOT	38,000	16,000	54,000	24,500	10,600	35,100
TOTAL	--	42,000	20,000	62,000	35,700	23,400	59,100
TOTAL CIVIL	--	4,057,000	1,744,000	5,801,000	2,139,200	1,130,400	3,269,600

TABLE 9-1

CAPITAL COST

2 - 150 MW OIL FIRED PLANT
ISMAILIA, EGYPT

DESCRIPTION	QUANTITY	U.S. (DOLLARS) MATERIAL	LABOR	TOTAL	EGYPTIAN (LE) MATERIAL	LABOR	TOTAL
ELECTRICAL							
GAS TURBINES	2 EA	3,800,000	60,000	3,860,000	--	18,200	18,200
TRANSFORMERS	10 EA	2,528,000	58,000	2,586,000	--	17,400	17,400
SWITCHGEAR (6.3 KV)	3 LOTS	894,000	26,000	920,000	--	7,800	7,800
UNIT SUBSTATION (400 V)	8 EA	362,000	16,000	378,000	--	4,400	4,400
MOTOR CONTROL CENTER (400 V)	10 LOTS	108,000	8,000	116,000	--	2,600	2,600
BUS DUCT	1 LOT	489,000	134,000	623,000	--	40,300	40,300
CABLE, CONDUIT, TRAY & CONNECTIONS	1 LOT	1,960,000	752,000	2,712,000	--	228,300	228,300
GROUNDING, CATHODIC & LIGHTNING PROTECTION	1 LOT	63,000	18,000	81,000	--	5,500	5,500
LIGHTING	1 LOT	174,000	112,000	286,000	--	33,500	33,500
COMMUNICATIONS	1 LOT	31,000	18,000	49,000	--	5,200	5,200
DIRECT CURRENT SYSTEM	1 LOT	222,000	24,000	246,000	--	7,500	7,500
INSTRUMENTS & CONTROLS	1 LOT	2,344,000	280,000	2,624,000	--	84,500	84,500
MISCELLANEOUS	1 LOT	19,000	10,000	29,000	--	3,100	3,100
TOTAL ELECTRICAL	--	12,994,000	1,516,000	14,510,000	--	458,300	458,300
SWITCHYARD							
RIGID BUS	1 LOT	24,000	180,000	204,000	--	23,400	23,400
DISCONNECT SWITCHES	45 EA	206,000	90,000	296,000	--	12,000	12,000
CIRCUIT BREAKERS	12 EA	900,000	134,000	1,034,000	--	17,400	17,400
LIGHTNING ARRESTORS	6 EA	17,000	1,000	18,000	--	100	100
COUPLING CAPACITOR POTENTIAL DEVICE	29 EA	115,000	10,000	125,000	--	1,600	1,600
WAVE TRAPS	8 EA	35,000	2,000	37,000	--	300	300
CONDUIT	1 LOT	24,000	44,000	68,000	--	6,000	6,000
CABLE - POWER & CONTROL	1 LOT	139,000	176,000	315,000	--	22,900	22,900
FOUNDATIONS	1 LOT	--	60,000	60,000	178,500	7,800	186,300
STRUCTURAL STEEL	1 LOT	600,000	120,000	720,000	--	15,600	15,600
INSULATORS	1 LOT	108,000	12,000	120,000	--	1,600	1,600
OVERHEAD & STATIC CABLE	1 LOT	18,000	90,000	108,000	--	11,700	11,700
GROUNDING	1 LOT	60,000	98,000	158,000	--	12,700	12,700
MISCELLANEOUS STATION SERVICE	1 LOT	8,000	2,000	10,000	--	500	500
DIRECT CURRENT SYSTEM	1 LOT	38,000	2,000	40,000	--	500	500
INSTRUMENTS & CONTROLS	1 LOT	420,000	90,000	510,000	--	11,700	11,700
HARDWARE, LIGHTNING, & SECURITY	1 LOT	228,000	118,000	346,000	--	15,600	15,600
CONTROL BUILDING	1 LOT	24,000	14,000	38,000	18,900	8,300	27,200
TOTAL SWITCHYARD		2,964,000	1,243,000	4,207,000	197,400	169,700	367,100

TABLE 9-1

Sheet 6 of 6
June 14, 1977

CAPITAL COST

2 - 150 MW OIL FIRED PLANT
ISMAILIA, EGYPT

		U.S. (DOLLARS)			EGYPTIAN (LE)		
DESCRIPTION	QUANTITY	MATERIAL	LABOR	TOTAL	MATERIAL	LABOR	TOTAL
TOTAL DIRECTS		71,178,000	9,107,000	80,285,000	2,336,600	3,401,200	5,737,800
INDIRECTS							
SUBCONTRACTORS' OVERHEAD, PROFIT, SOCIAL INSURANCE		--	--	--	--	2,044,300	2,044,300
SUBTOTAL		--	--	80,285,000	--	--	7,782,100
ENGINEERING		--	--	4,014,000	--	--	389,100
MATERIAL HANDLING, STORAGE & MARK-UP		--	--	--	467,300	--	467,300
SPARE PARTS		4,000,000	--	4,000,000	--	--	--
FREIGHT - TOTAL MATERIAL & SPARES & CONSUMABLES		11,400,000	--	11,400,000	--	--	--
CONSUMABLES (1 - YEAR OPERATION)		400,000	--	400,000	--	--	--
SUBTOTAL		--	--	100,099,000	--	--	8,638,500
TRAINING		--	250,000	250,000	--	3,000	3,000
SUBTOTAL		--	--	100,349,000	--	--	8,641,500
CONTINGENCY		--	--	15,052,000	--	--	1,296,200
SUBTOTAL		86,978,000	9,357,000	115,401,000	2,803,900	5,448,500	9,937,700
ESCALATION		10,437,000	2,994,000	13,431,000	336,500	1,743,500	2,080,000
TOTAL PROJECT CAPITAL COST				128,832,000			12,017,700

POWER SECTOR SURVEY
ARAB REPUBLIC OF EGYPT

PHASE I SYSTEM PLANNING DIAGNOSTIC REPORT - SECTION I

APRIL 1977

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TEAM ROSTER

POWER SECTOR SURVEY TEAM

April 1977

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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

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CHAPTER I

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 dates of commercial operation 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

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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	GWH
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 Mln Tons)	Tebbin 2	70	70	430	72	442	72	442	72	442	72	443	72	442	72	442	72	442	72	443	72	44
(1.5 Mln Tons)	Helwan	70	63	387	63	386	63	386	63	386	63	387	63	386	63	386	63	386	63	387	63	38
Sponge Iron	Alexandria	85									30	224	60	447	60	447	60	447	60	448	60	4
Sponge Iron	Sadat City	85											20	149	40	298	40	298	40	298	40	2
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	118
Chemical Projs.																						
Nitrates	Ras Gharib*	80											20	140	50	350	50	350	50	350	50	35
Fertilizer Aswan	Aswan*	80	250	1757	250	1752	250	1752	250	1752	250	1757	250	1752	250	1752	250	1752	250	1757	250	175
Ferro-Silicon	Aswan(Edfu)*	80			10	70	50	350	50	350	80	562	120	841	120	841	120	841	120	843	120	84
Urea(German Uda)	Alexandria	80							15	105	15	105	15	105	15	105	15	105	15	105	15	10
Caustic Soda	Alexandria	75			20	131	20	131	20	131	20	132	20	131	20	131	20	131	20	132	20	1
NH_4NO_3 & Urea	Talkha	80	35	246	55	385	55	385	60	420	75	527	75	526	75	526	75	526	75	527	75	52
Phosphate Projs.																						
Mining	Esna*	70	10	61	10	61	10	61	10	61	10	61	10	61	10	61	10	61	10	61	10	6
Elemental Phosphate(Cancelled 340MW)	Nag Hammadi	-																				
Fertilizer Mine	Abu Tartur*	80											90	631	90	631	90	631	90	631	90	6
Textiles (50MW Isolated Generation being installed Textile Plant)	Mehalla El Koubra-																					
Textile & Weaving Complex	Alexandria	75					30	197	120	788	150	988	150	986	150	986	150	986	150	988	150	98
Aluminium Smelter (Eventually 100,000Tons)	Nag Hammadi*	95	150	1252	220	1831	220	1831	300	2497	370	3088	400	3329	400	3329	400	3329	400	3338	400	332
Petroleum Refinery	Alexandria	85							20	149	20	149	20	149	20	149	20	149	20	149	20	14
Petroleum Refinery	Alexandria	85									20	149	30	223	30	223	30	223	30	224	30	22
Oil Pipeline Sumed 340km 2x42" Alex. (80 after 1980)	Suez	65-80	50	285	130	740	150	854	150	854	150	854	150	1051	150	1051	150	1051	150	1054	150	105
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	28
Cement Plant 600,000 Tons	Assiut*	80							35	245	35	246	35	245	35	245	35	245	35	246	35	24
Cement Plant 1,000,000 Tons	Suez	80									50	351	50	350	50	350	50	350	50	351	50	35
TOTAL LOAD			692	4812	894	6190	984	6781	1264	8817	1514	10698	1794	12774	1924	13448	2054	13960	2154	14387	2204	1455
Coincidence Factor 92%			636	---	822	---	905	---	1163	---	1393	---	1650	---	1770	---	1890	---	1982	---	2028	--
Generations&Transmission Losses (10% of Peak			64	317	82	407	91	442	116	588	139	726	166	883	177	890	189	889	198	884	202	82
TOTAL GENERATION			700	5129	904	6597	996	7223	1279	9405	1532	11424	1816	13657	1947	14338	2079	14849	2180	15271	2230	1543
LARGE INDUSTRY LOAD FACTOR			83.4		83.3		82.8		83.9		84.9		85.8		84.1		81.5		79.7		79.0	

All located in Upper Egypt

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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.

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GRAPH I - 1

ENERGY FORECAST (1963-2000)

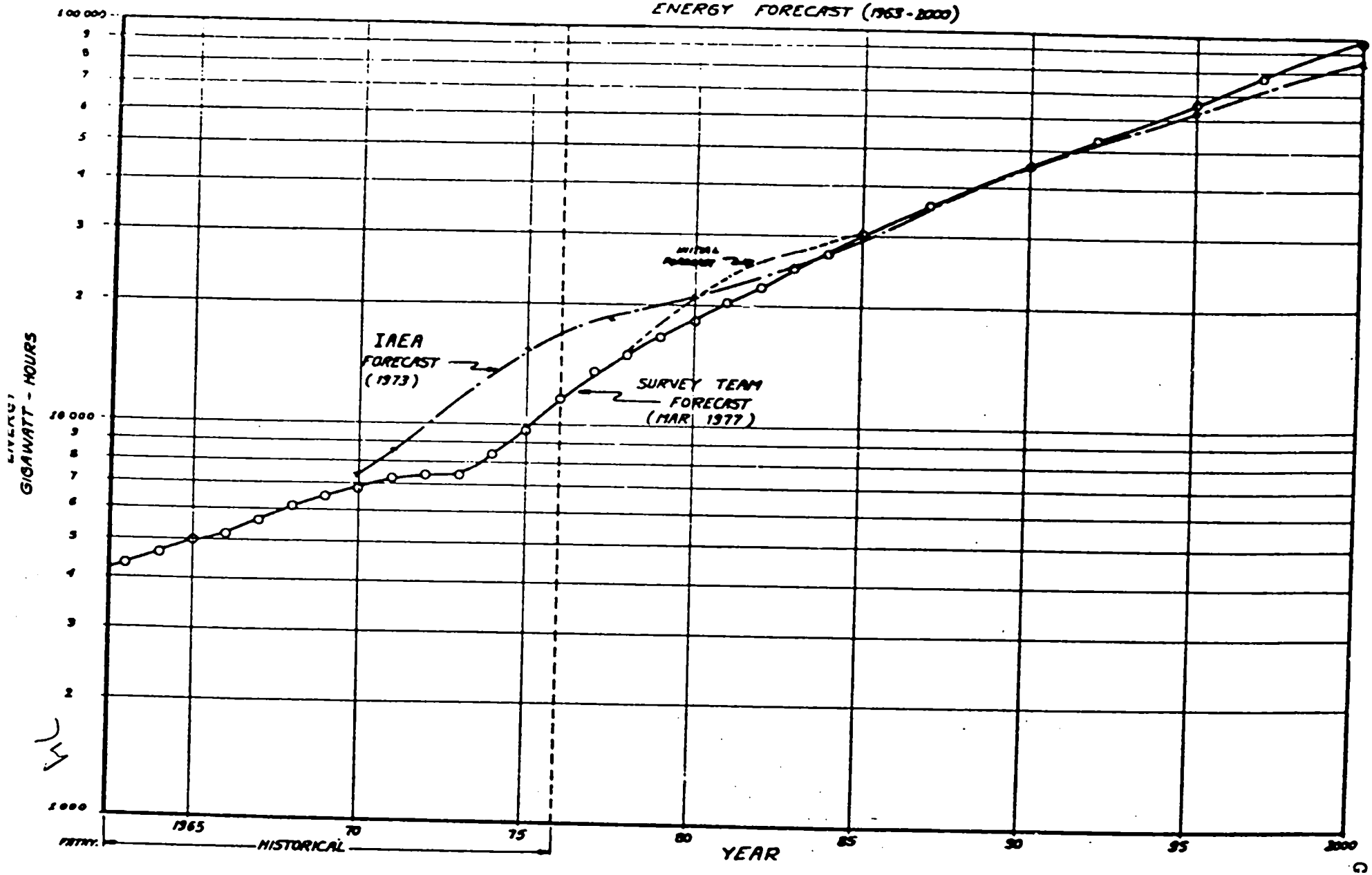

TABLE I-3

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	18.3	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	(1981-35)	10.6
(1976-85)	11.4	(1976-85)	11.5

a 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)

b Historical Data

ASL

FORECASTED PEAK LOADS AND GENERATION EXPANSION PROGRAM 1977 - 1985

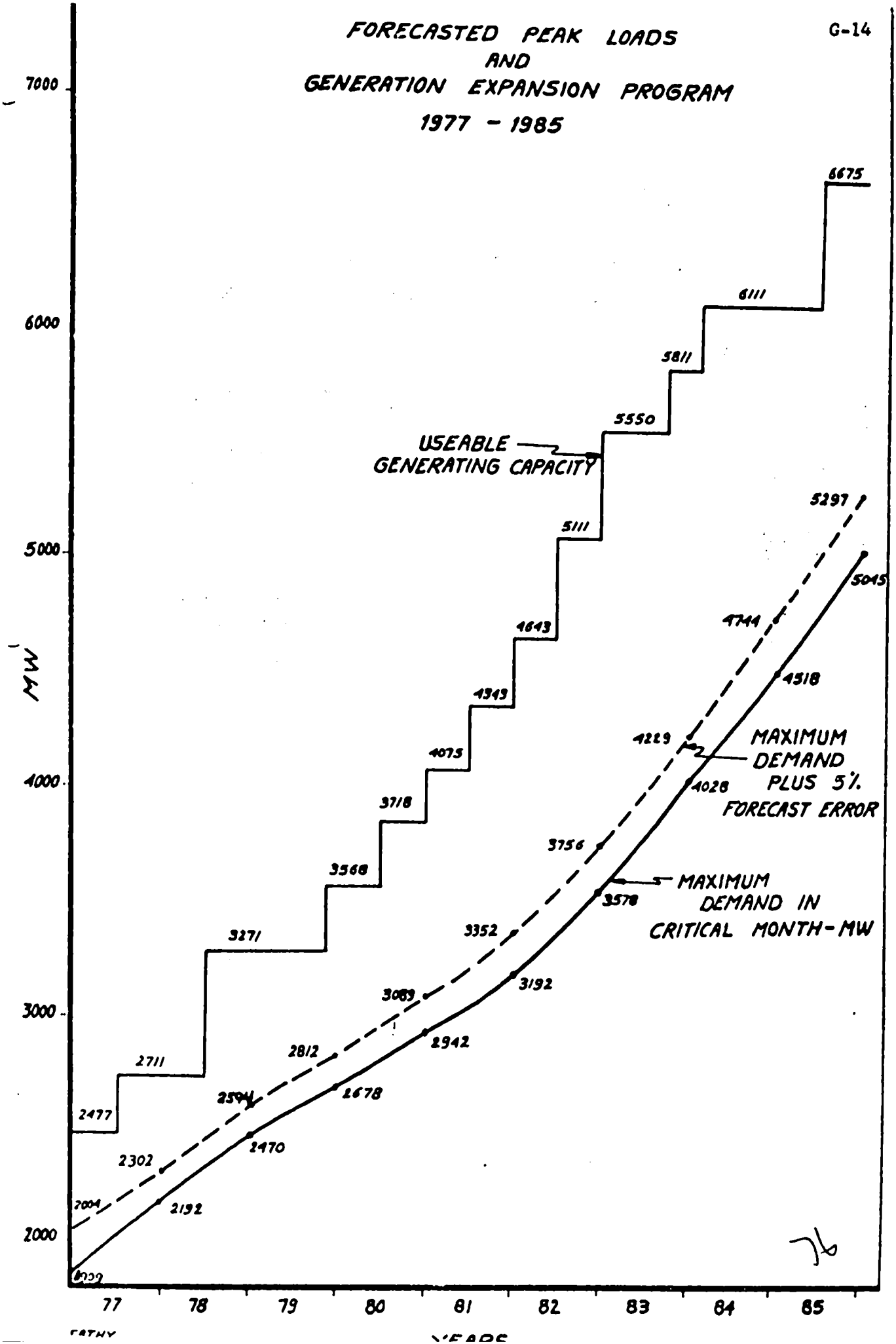

TABLE I-4

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.

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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 in the top line of the table, the useable 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 after 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

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INSTALLED AND PROJECTED EXISTING CAPACITY OF UPS POWER STATIONS

TABLE I-3

Name of Station	Installed Power Megawatts: Number and Capacity of Units	Maximum Capability in Megawatts (Assuming All Generating Units in Service): Total	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	130	240	240	240	240	240	240	240	240	240	240
3. Cairo North	2 x 30 + 1 x 20 + 2 x 10	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. Karmouz	4 x 16	64	30	30	45	45	45	45	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	---	---	---	---	---	---	---	300	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	1036	1051	1161	1358	1465	1937	2734	2995	3205	3459
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***)											
Aswan	7 x 46 + 2 x 11.5	345***)	1400	1550	1700	1800	2000	2200	2360	2360	2360	2360	2360
Total System Capability			2477	2711	3271	3568	4075	4643	5550	5511	6111	6675	

*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,

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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 Rosserous 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.

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.

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

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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 juntified 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.

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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.

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TABLE I-5

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				
Year	Scheduled MW	Non-Scheduled MW	Total MW	% of Installed Capacity	Month	Scheduled MW	Non-Scheduled MW	Total MW	% of Instal Capacity
1971	198.8	161.2	360	29.3	Dec.	230	200	430	35.0
1972	232.5	113.5	346	28.0	Dec.	265	200	465	37.0
1973	237.9	105.4	343	28.4	May	300	150	450	37.2
1974	185.8	184.2	370	31.3	Apr.	160	300	460	38.9
1975	95.8	210.4	306	25.9	Oct.	75	425	500	42.3
Average	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
Old Steam Units (1078 MW)	171	140	311	28.8	186	230	416	38.6
New Steam Units (1617 MW)	150	0	150	9.3	150	87	237	14.7
Combus. Turbines (456 MW)	30	12	42	9.2	30	23	53	11.6
Hydroelectric (2560 MW)	385	0	385	16.3	385	0	385	16.3
Total (5511 MW)	736	152	888	16.1	751	340	1091	19.8

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

Note: 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.

TAB I-7

LOAD AND GENERATING CAPABILITY ANALYSIS - YEAR 1983

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

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

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

* See Accompanying Table - "Installed and Projected Generating Capacity"

** No New Steam units were installed between 1970 and the scheduled 1978 in-service dates for 2 units at Kafr El Dawar.

*** See 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	"	"

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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

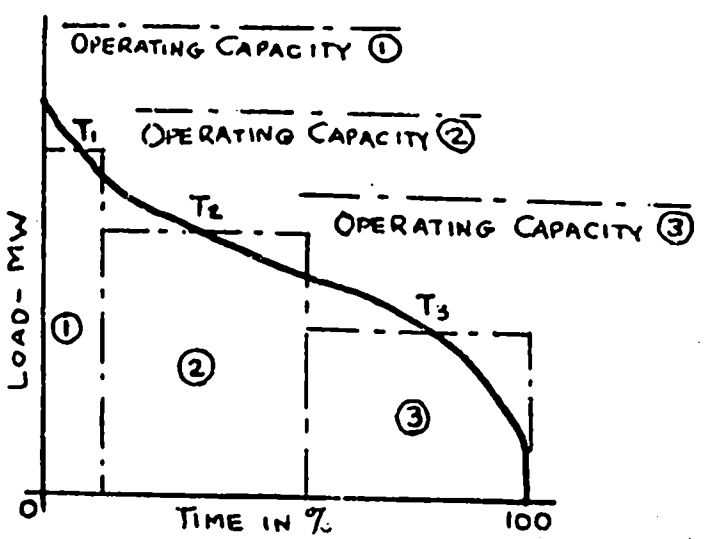
Percent Reserve Margin on Peak Demand = 38.5%

* 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



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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. From 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.

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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 utilizying 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.

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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.

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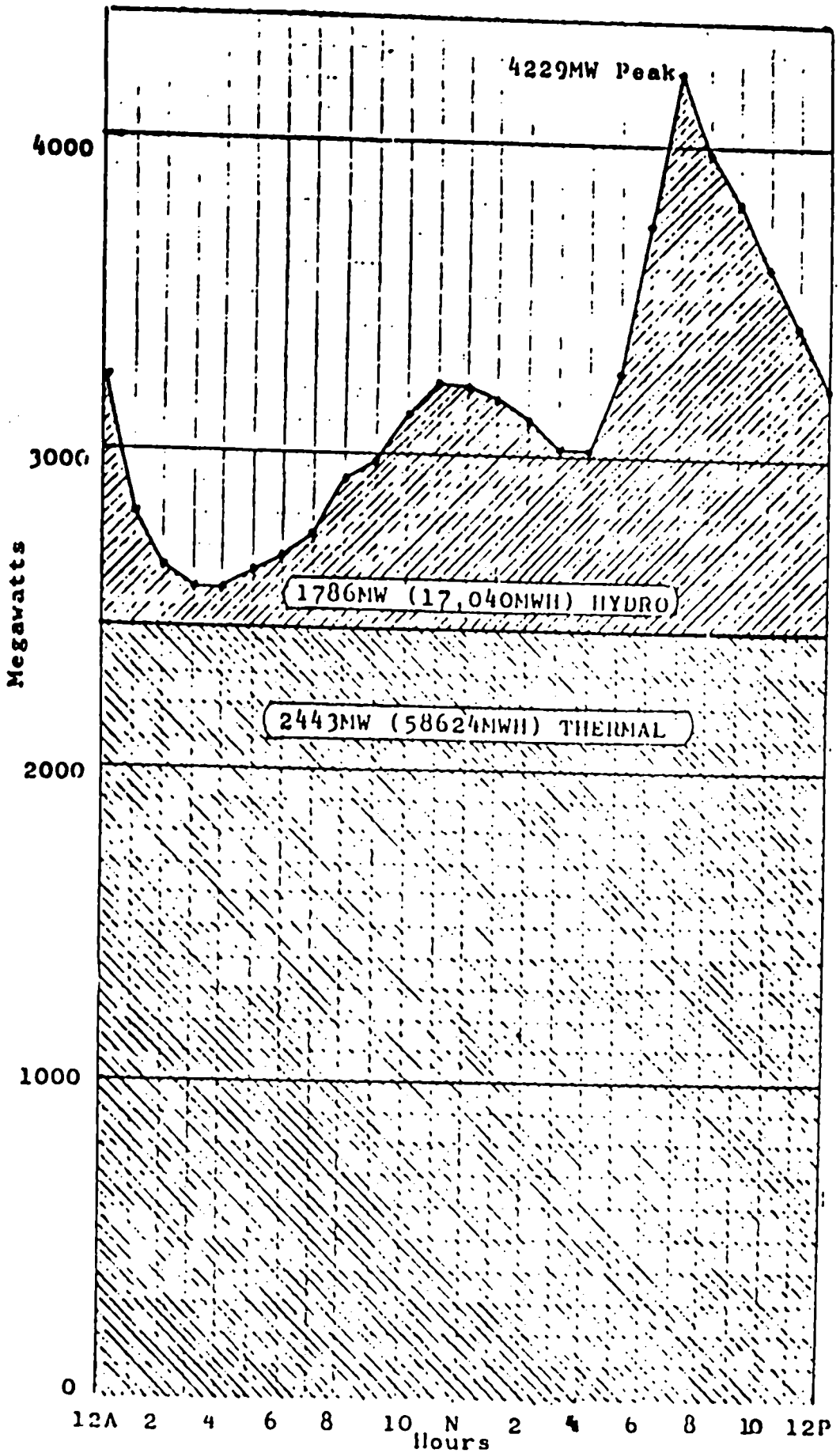

GRAPH I-4

EXAMPLE 24 HOUR LOAD CURVE FOR FORECAST PEAK DAY OF DECEMBER 1983

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 I-10

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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 I 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 s e 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).

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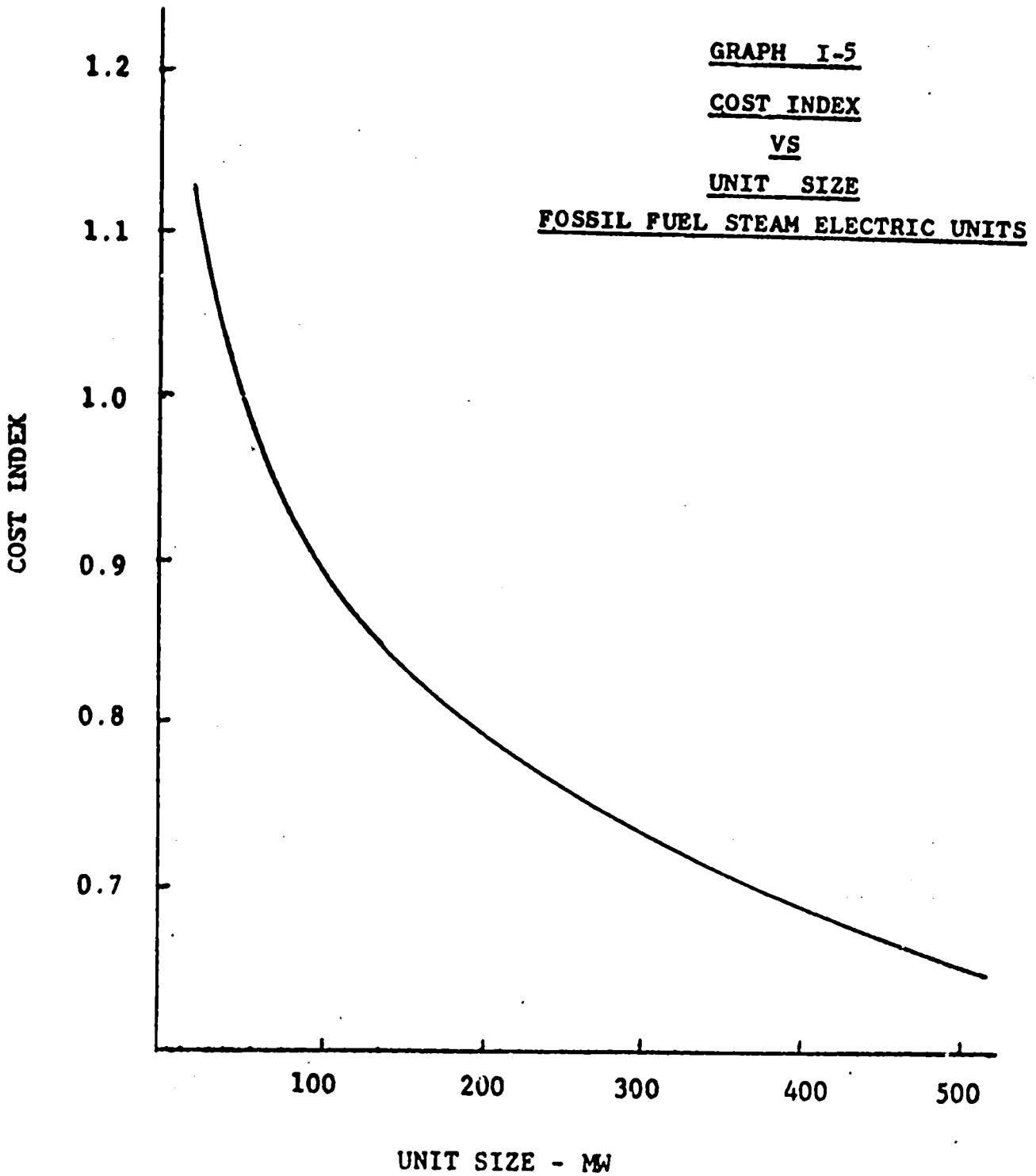
The following Graph I-5 shows the economy of scale relationship of the cost index and unit size for fossil fuel steam electric units up to 500 MW.



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 300 MW 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 used in other countries of locating power plants near coal deposits and transmitting the generated electric

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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 those 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 these 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 brings 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:

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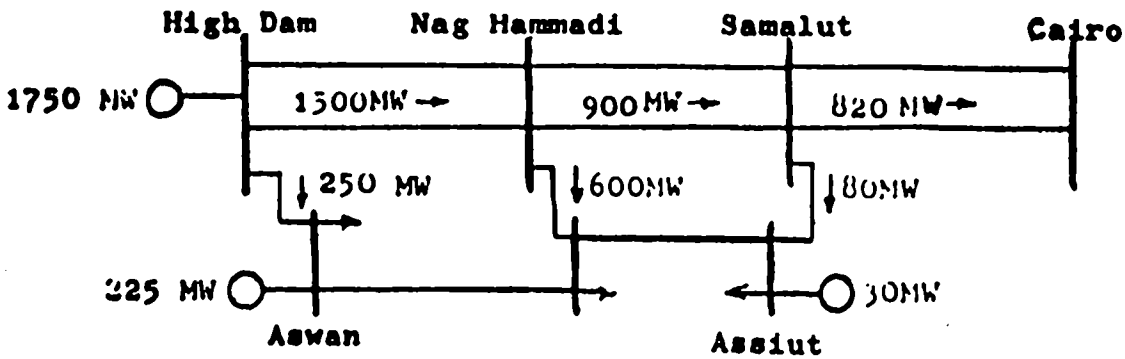
FIGURE I-1

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 out 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

(CL)

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 year 2000. Sanderson 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	11.4%	11.3%
1985-1995	8.9%	8.3%
1976-1995	10.1%	9.7%
1976-2000	9.6%	9.3%

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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
Venozuela	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.	62.3	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	83.5	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
Generally Planned Economics						Aver.	60.3	59.8	60.5
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 energy information.

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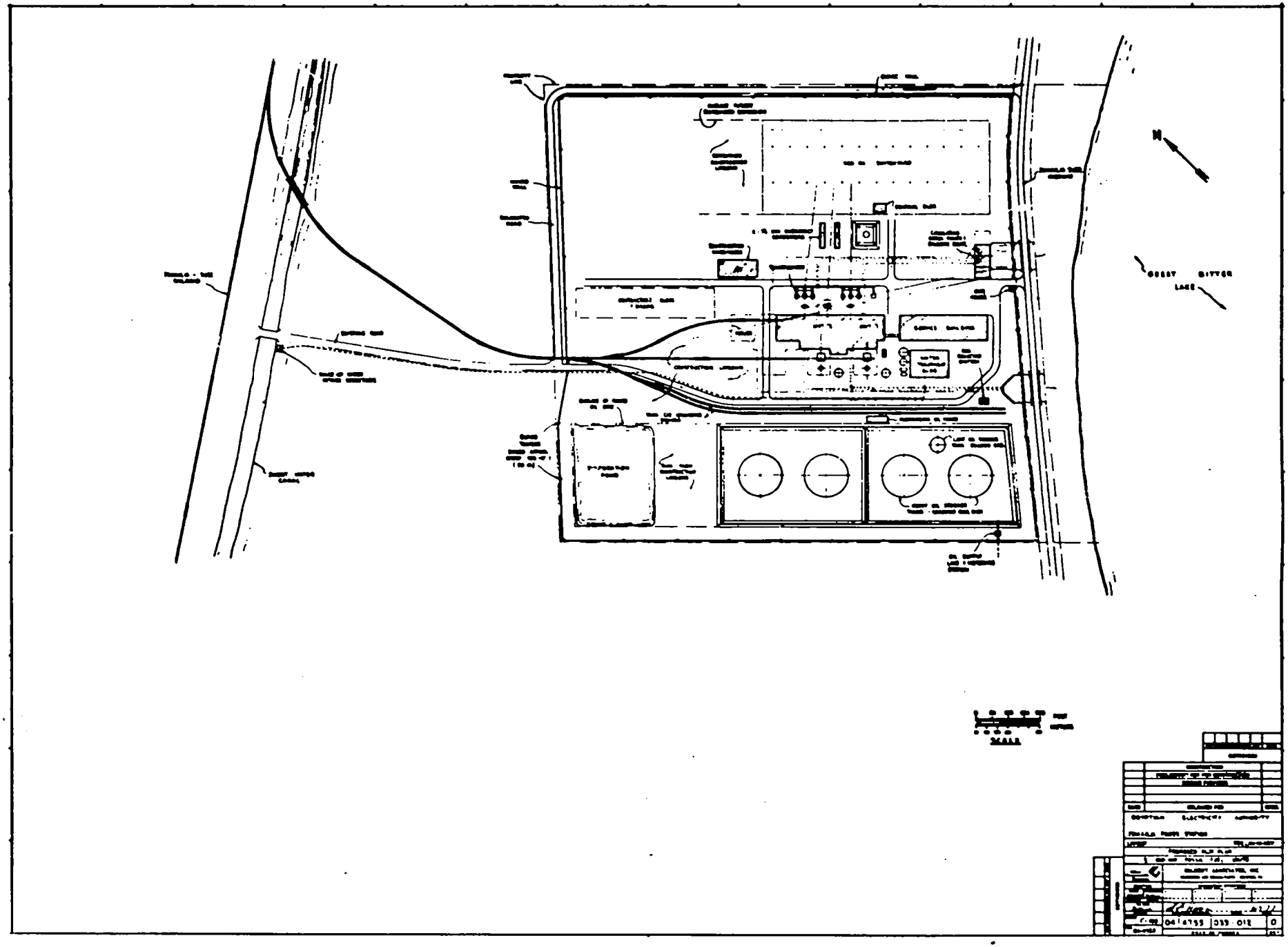
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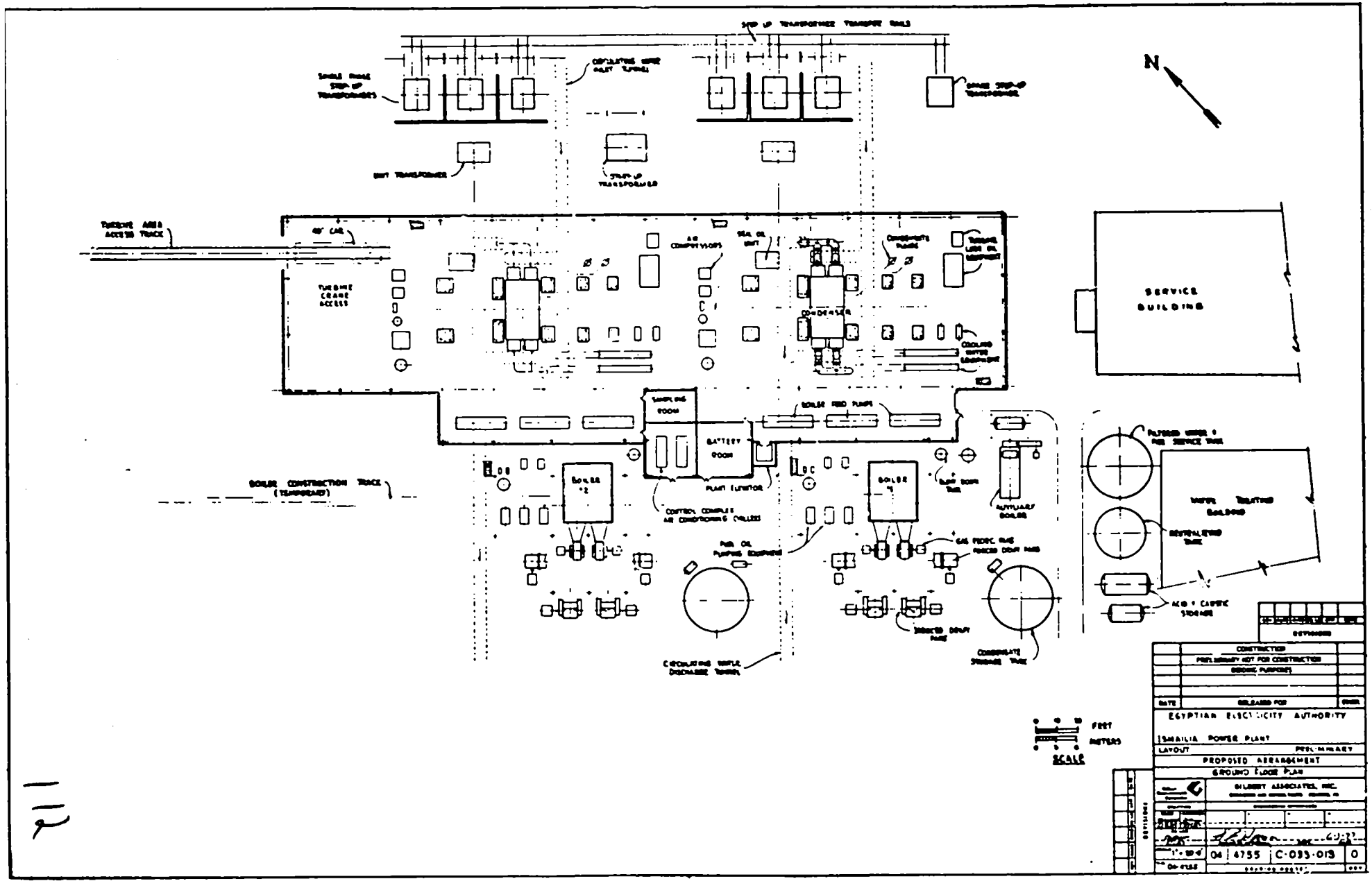
SCALE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BOILER CONSTRUCTION TRACK (TEMPORARY)
BOILER #2
BOILER #1
BATTERY ROOM
SAMPLING ROOM
BOILER FEED PUMPS
PLANT ELEVATOR
AUXILIARY BOILER
CONDENSATE STORAGE TANK
CIRCULATING WATER DISCHARGE TUNNEL
FEET
METERS
SCALE
EGYPTIAN ELECTRICITY AUTHORITY
ISMAILIA POWER PLANT
LAYOUT
PRELIMINARY
PROPOSED ARRANGEMENT
GROUND FLOOR PLAN
GILBERT ASSOCIATES, INC.
04 4755 C-035-013 0

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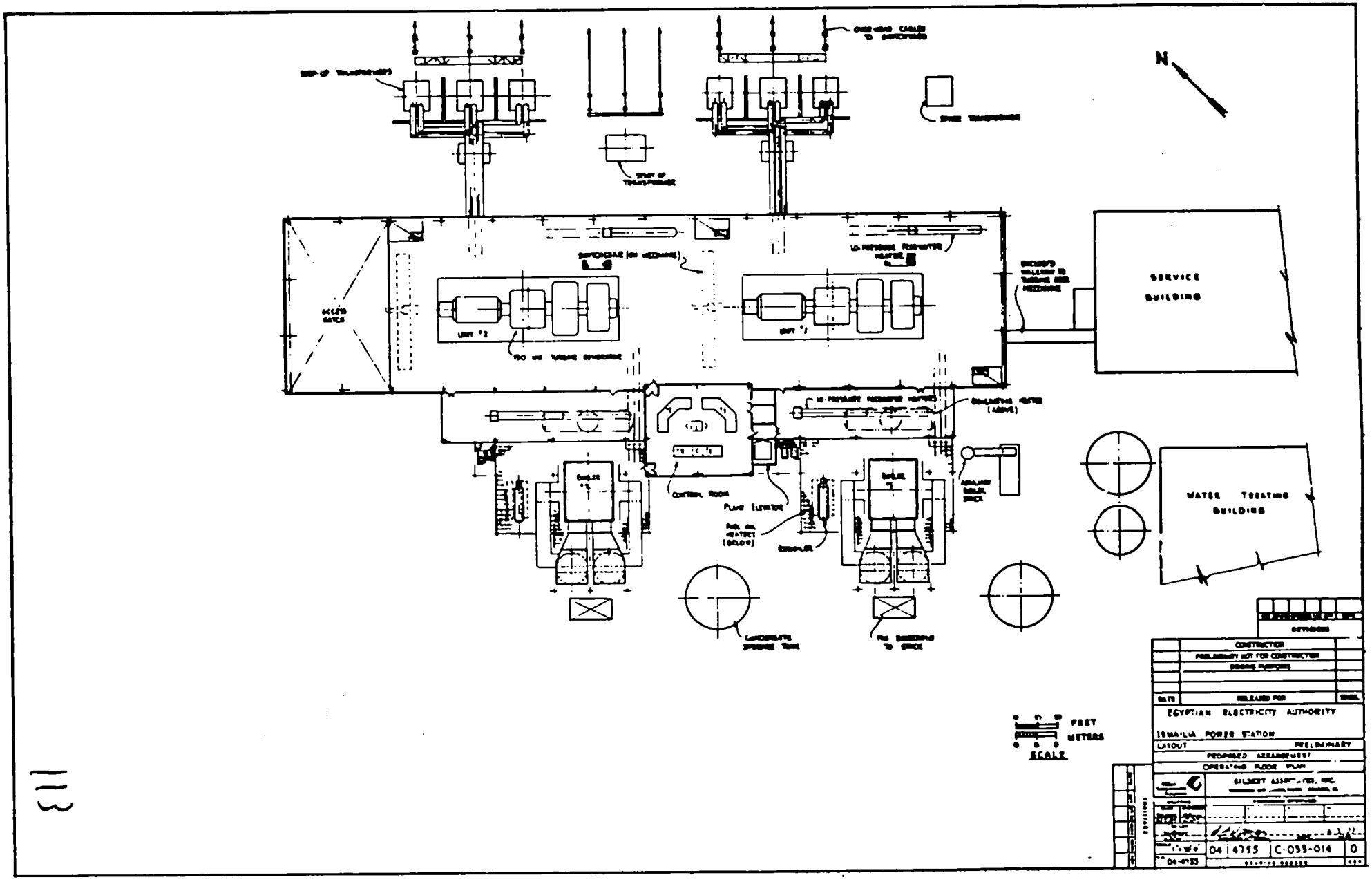
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FLUE TUNNEL
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UNIT #1
BOILER #2
BOILER #1
FEET
METERS
SCALE
CONSTRUCTION
PRELIMINARY NOT FOR CONSTRUCTION
DRAWING PURPOSES
RELEASED FOR
EGYPTIAN ELECTRICITY AUTHORITY
ISMA'ILIA POWER STATION
LAYOUT
PRELIMINARY
PROPOSED ARRANGEMENT
OPERATING FLOOR PLAN
GILBERT ASSOCIATES, INC.
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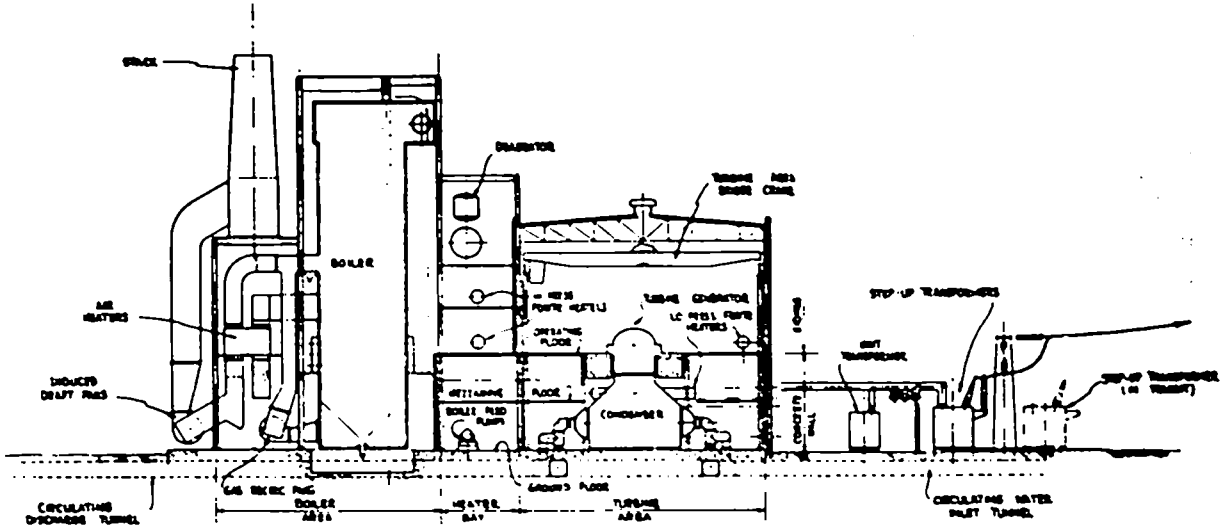

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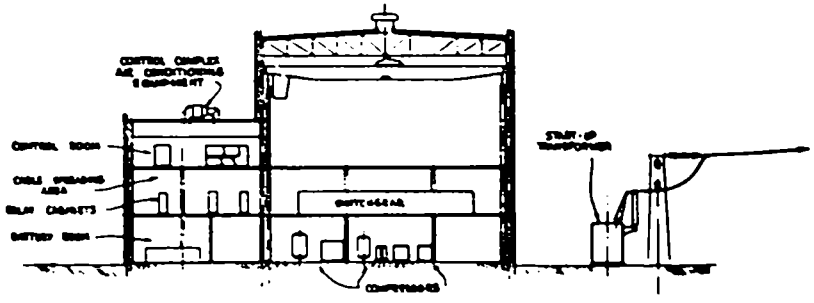

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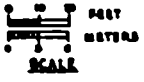

	CONSTRUCTION	
	PRELIMINARY NOT FOR CONSTRUCTION	
	ISSUED FOR REVIEW	
DATE	RELEASED FOR	CHKD.

EGYPTIAN ELECTRICITY AUTHORITY

ISMAILIA POWER STATION

LAYOUT — PRELIMINARY

PROPOSED ARRANGEMENT

SECT-ONE

GILBERT ASSOCIATES, INC.

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TABLE 4.1-1 (Cont'd)

Impact	Significance of Impact	Recommended Mitigating Measures
HUMAN ENVIRONMENT		
LAND USE		
50.8 acres of agricultural land will be converted to heavy industrial land	Crops of beans, tomatoes, squash, wheat and hay are currently grown on land.	None Required
Houses will be destroyed to accomodate the power plant facility.	At least 20 houses and farms exist on the site.	Families displaced by the project will be compensated by the Egyptian Government.
TRANSPORTATION		
Increased traffic, mostly during construction.	Roadways are considered adequate	None Required
Increased barge traffic during construction and operation.	Volume of boat traffic small compared to normal traffic on Great Bitter Lake.	None Required
HUMAN INTEREST		
Noise		
Construction and operation activities will cause substantially more noise than presently exists at the site.	Nearest population center (Abu Sultan) is approx. 1 km away. Scattered dwellings are adjacent to southern boundary.	None Required
ECONOMY		
Employment		
Creation of a max. of approx. 3000 new jobs during construction and approximately 100 during operation.	Long term impact not significant	None Required
Electric Power production		
300 MW electricity provided by facility.	Load is anticipated to double in 7 years. Existing facilities inadequate for present demand. Will provide power for new industries needed to supply goods and create jobs.	None Required

ANNEX L

TABLE 4.1-1 (Cont'd)

Impact	Significance of Impact	Recommended Mitigating Measures
BIOTIC ENVIRONMENT		
TERRESTRIAL		
Habitats for indigenous plants and animals will be neutralized	Crops of beans, tomatoes, squash, wheat and hay were evident on 4/26/77.	Displaced animals can repopulate adjoining land.
AQUATIC		
Economically important fish and shellfish in Great Bitter Lake potentially killed by thermal plume	Variety of economically important fish and shellfish are present. Gray mullet (*Mugil cephali*) breeds in shallow near shore waters	a. Maximize diffusion of thermal plume by employing multiple discharge points b. Locate discharge in non-vital area c. Locate discharge in diked area d. Use cooling towers e. Limit concentration of free available chlorine in discharge to an average of 0.2 mg/l and a maximum of 0.5 mg/l and minimize chlorination time.
Impingement, entrapment and entrainment of organism in cooling water withdrawn from Great Bitter Lake	Massive clogging of intake structure could close down plant. Most organisms withdrawn will be killed. Populations of economically important fish and shellfish could be destroyed.	a. Locate intake structures where economically important organisms neither live or migrate. b. Design intake structure configuration so that motile aquatic organisms can avoid it. - Provide max. approach velocity to screen of 0.75 fps - Provide through screen velocity of 1.75 fps - Provide trash rack and provide screen mesh size of 3/8 inch to prevent entrainment of large organisms.
Impingement, entrapment and entrainment of organisms in fresh water withdrawn from Sweet Water Canal	Aquatic life and trash is abundant in canal. Could cause unnecessary clogging of water treatment system.	Design intake structure with a trash rack and screen as described in "b" above.

TABLE 4.1-1

POTENTIAL ADVERSE ENVIRONMENTAL IMPACTS
ISMAILIA

300 MW THERMAL ELECTRICAL PROJECT
EGYPTIAN ELECTRICITY AUTHORITY

Impact	Significance of Impact	Recommended Mitigating Measures
PHYSICAL ENVIRONMENT		
WATER		
Water Used		
Approx. 200,000 gpm withdrawn from Great Bitter Lake for once through cooling	Insignificant effect on lake due to size (20.5 km long by 11.5 km wide; total volume 1.4 cu km^3)	None Required
Approx. 40 gpm withdrawn from Sweet Water Canal for human, boiler makeup and other in-plant uses	Sufficient volume available	None Required
Water Discharged		
Approx. 200,000 gpm salt cooling water discharged into Bitter Lake at approx. max. 37C (98.5F) in July	Max. 11C (19F) above Lake temp. at discharge.	
Approx. 40 gpm water from non-cooling in-plant uses discharged	Could cause localized pollution of lake with oil, grease, dissolved and suspended solids and domestic waste. Could interfere with recreational bathing and fishing in area.	Prevent discharges to Great Bitter Lake. Discharge all non-cooling wastewaters into percolation-evaporation lagoon.
In Great Bitter Lake recirculation of heated cooling water into cooling water intake	Creation of warm water sink in Lake. Decreased efficiency of power plant.	Develop recirculation model for Lake and design and locate intake and discharge structures to avoid recirculation.
Ruptured oil storage tanks or spills during oil delivery could contaminate Great Bitter Lake	Oil spill in Lake would not readily be dispersed. Could spoil beaches for recreational uses and harm fishing industry.	Dikes will be built around storage tanks and delivery areas.
AIR		
SO_2 and NO_x emissions from burning oil	No local air regulations will be violated. Prevailing winds blow emission over Great Salt Lake.	Maximize use of natural gas to minimize emissions.

TABLE A

YEAR	PERIOD	CURRENCY U.S. DOLLARS	CURRENCY EGYPTIAN (L.E.)
1978	1st Q	--	--
1978	2nd Q	--	--
1978	3rd Q	395,000	13,000
1978	4th Q	1,954,000	25,000
	Total 1978	2,349,000	38,000
1979	1st Q	2,070,000	335,000
1979	2nd Q	4,492,000	921,200
1979	3rd Q	10,440,800	1,807,700
1979	4th Q	10,060,700	1,905,700
	Total 1979	27,063,500	4,969,600
1980	1st Q	13,465,000	1,077,700
1980	2nd Q	17,332,500	627,500
1980	3rd Q	19,509,000	1,211,100
1980	4th Q	17,202,000	1,375,100
	Total 1980	67,508,500	4,291,400
1981	1st Q	8,541,200	1,200,400
1981	2nd Q	10,268,000	1,034,500
1981	3rd Q	10,757,000	892,700
1981	4th Q	5,014,500	828,900
	Total 1981	34,580,700	3,956,500
1982	1st Q	2,145,300	636,300
1982	2nd Q	1,433,000	233,200
1982	3rd Q	1,056,000	--
	Total 1982	4,634,300	869,500
Total Project Capital Cost		136,136,000	14,125,000

TABLE 3

CASH FLOW FORECAST - ISMAILIA

		1978		1979				1980				1981				1982			
		3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	Total
CIVIL/STRUCTURAL	DOLLARS				587,000	1,013,800	1,033,700	1,376,000	274,500	758,000	1,094,000	203,700	158,000	61,000	58,000	11,300			6,581,000
	L.E.				348,300	830,000	825,500	390,000	133,500	294,800	338,300	64,900	118,000	86,900	28,500	17,000			3,960,600
MECHANICAL EQUIPMENT	DOLLARS		846,000	846,000	2,044,000	2,892,000	3,492,000	5,504,000	6,691,000	8,735,000	7,186,000	3,505,500	4,016,000	4,045,000	1,163,500	390,000	515,000	470,000	52,243,000
	L.E.							4,000	29,000	112,600	188,300	219,600	115,100	140,300	164,000	86,000	33,300		1,085,900
PIPING	DOLLARS							70,000	308,000	498,000	539,000	672,000	673,000	505,000	395,000	196,000	50,000		3,906,000
	L.E.								22,000	48,000	71,000	88,000	94,000	82,000	83,000	42,000	30,000		557,000
ELECTRICAL	DOLLARS				184,000	3,052,000	971,000	796,000	7,881,000	1,851,000	1,637,000	401,000	1,139,000	1,372,000	585,000	216,000	83,000		14,510,000
	L.E.					3,700	20,400	9,900	1,000	30,000	54,200	68,800	78,800	49,000	50,000	64,000	36,500		438,300
SWITCHYARD	DOLLARS					17,000	936,000	1,081,700	802,000	607,000	344,000	300,000	150,000	50,000					6,387,000
	L.E.				40,000	82,000	64,800	45,500	37,000	33,700	31,100	34,000	30,000	7,000					367,100
SUBTOTAL-DIRECT COSTS	DOLLARS	--	846,000	846,000	2,819,000	6,976,800	6,404,700	9,267,000	10,956,500	12,449,000	10,818,000	4,982,700	6,138,000	5,913,000	2,201,500	713,300	648,000	470,000	81,449,000
	L.E.	--	--	--	388,300	933,700	950,700	449,400	244,500	519,100	584,800	467,100	423,900	365,100	525,500	229,000	81,700	--	5,966,700
INDIRECT COSTS	DOLLARS	395,000	1,188,000	1,224,000	1,673,000	3,444,000	3,656,000	5,188,000	6,376,000	7,060,000	6,384,000	3,559,000	4,130,000	4,044,000	2,813,000	1,452,000	785,000	586,000	54,687,000
	L.E.	19,000	25,000	233,000	533,000	872,000	955,000	628,300	383,000	695,000	790,300	733,300	608,600	527,600	303,600	407,300	151,300	--	8,136,300
TOTAL DIRECT AND INDIRECT COSTS	DOLLARS	395,000	1,934,000	2,070,000	4,492,000	10,440,800	10,060,700	13,443,000	17,332,500	19,509,000	17,202,000	8,541,700	10,268,000	10,757,000	5,014,500	2,165,300	1,433,000	1,056,000	136,136,000
	L.E.	19,000	25,000	233,000	921,200	1,807,700	1,905,700	1,077,700	627,500	1,211,100	1,375,100	1,200,400	1,034,500	892,700	828,900	636,300	233,300	--	14,123,000

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ISMAILIA
ECONOMIC RATE OF RETURN
(DOLLARS IN MILLIONS)

YEAR	CAPITAL	COSTS OPERATING AND MAINT.	TOTAL	BENEFITS	NET BENEFITS		DISCOUNTED AT 20%
1977	.5	-	.5	-	.5	-	.42
1978	1.8	-	1.8	-	1.8	-	1.25
1979	31.0	-	31.0	-	31.0	-	17.94
1980	66.0	-	66.0	-	66.0	-	31.83
1981	36.0	13.6	49.6	22.2	27.4	-	11.01
1982	4.7	40.9	45.6	66.5	20.9	+	7.0
1983	-	54.6	54.6	88.7	34.1	+	9.52
1984	-	54.6	54.6	88.7	34.1	+	7.93
1985	-	54.6	54.6	88.7	34.1	+	6.61
1986	-	54.6	54.6	88.7	34.1	+	5.51
1987	-	54.6	54.6	88.7	34.1	+	4.59
1988	-	54.6	54.6	88.7	34.1	+	3.82
1989	-	54.6	54.6	88.7	34.1	+	3.19
1990	-	54.6	54.6	88.7	34.1	+	2.66
1991	-	54.6	54.6	88.7	34.1	+	2.21
1992	-	54.6	54.6	88.7	34.1	+	1.84
1993	-	54.6	54.6	88.7	34.1	+	1.54
1994	-	54.6	54.6	88.7	34.1	+	1.28
1995	-	54.6	54.6	88.7	34.1	+	1.07
1996	-	54.6	54.6	88.7	34.1	+	.89
1997	-	54.6	54.6	88.7	34.1	+	.74
1998	-	54.6	54.6	88.7	34.1	+	.62
1999	-	54.6	54.6	88.7	34.1	+	.51
2000	-	54.6	54.6	88.7	34.1	+	.43
2001	-	54.6	54.6	88.7	34.1	+	.36
2002	-	54.6	54.6	88.7	34.1	+	.30
2003	-	54.6	54.6	88.7	34.1	+	.25
2004	-	54.6	54.6	88.7	34.1	+	.21
2005	-	54.6	54.6	88.7	34.1	+	.17
					REMAINDER	+	.80

ANNEX O

Footnotes - Economic Rate of Return

1. Plant life is estimated at 25 years with no salvage value.
2. Capital costs are the unescalated current estimate with disbursements based on Annex M.
3. Egyptian Pounds have been converted at the parallel market rate (LE .70 equals US $ 1.00) .
4. Plant start-up is based on CDM chart in Annex P.

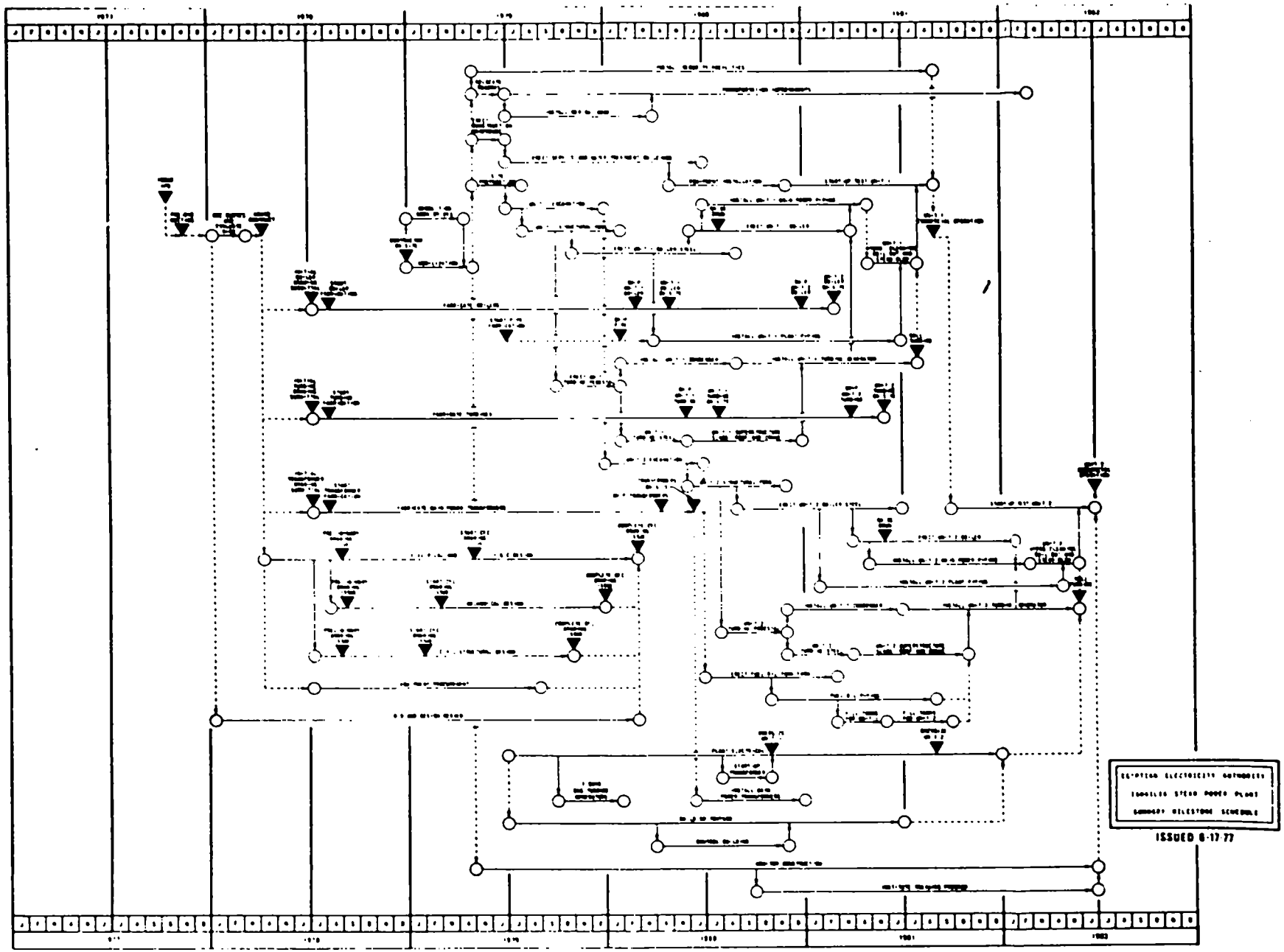
ISSUED 6-17-77

FIGURE 1

EGYPTIAN ELECTRICITY AUTHORITY

CITY ISMAILIA

PROJECT

GILBERT ASSOCIATES, INC.
READING, PENNSYLVANIA

JUNE 30 19 77

1 SHEETS NO. 1

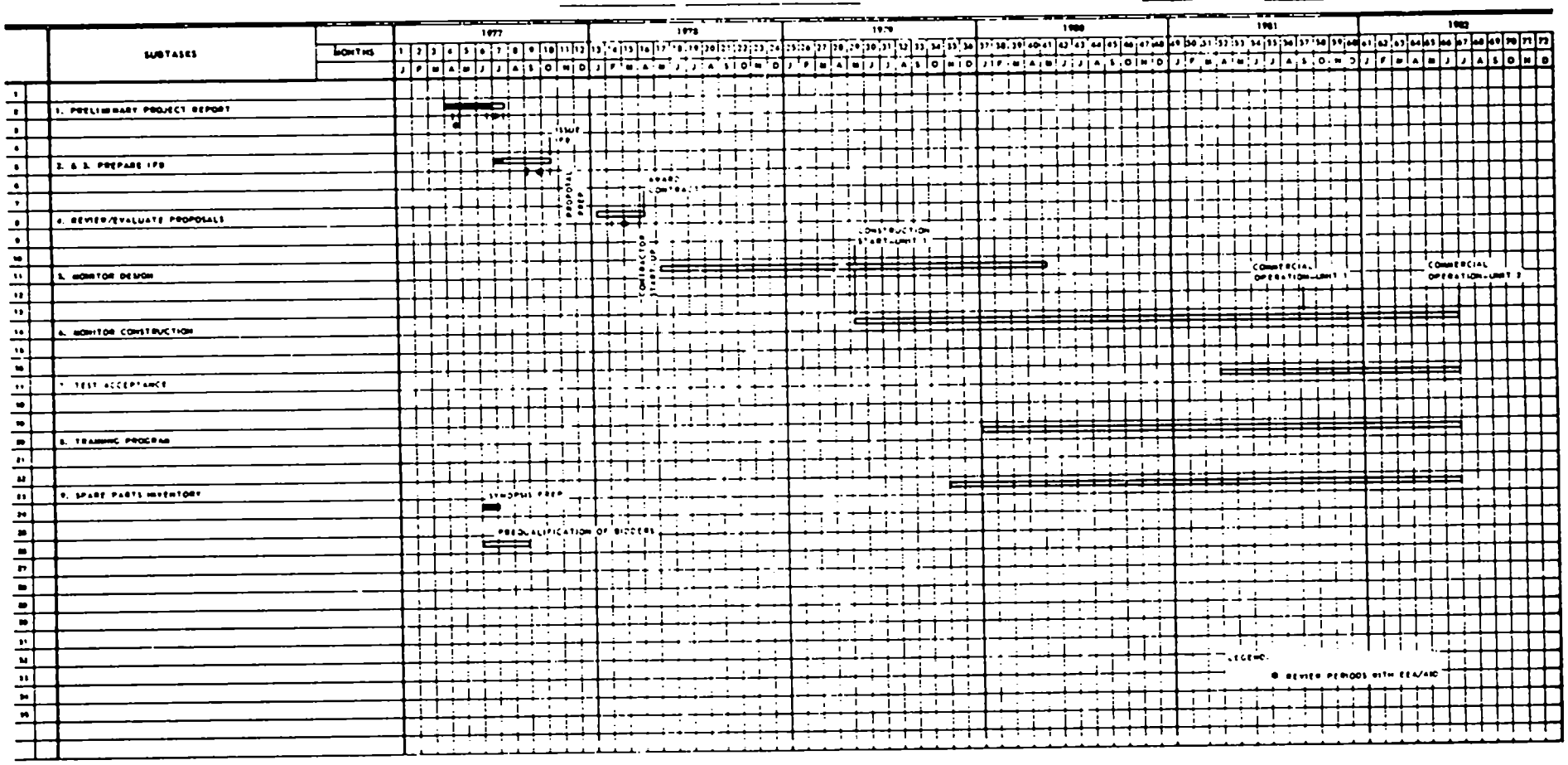

FIGURE 2

EGYPTIAN ELECTRICITY AUTHORITY

ISMAILIA

PROJECT

GILBERT ASSOCIATES, INC.
READING, PENNSYLVANIA

JUNE 30 19 77

1 SHEETS NO. 1

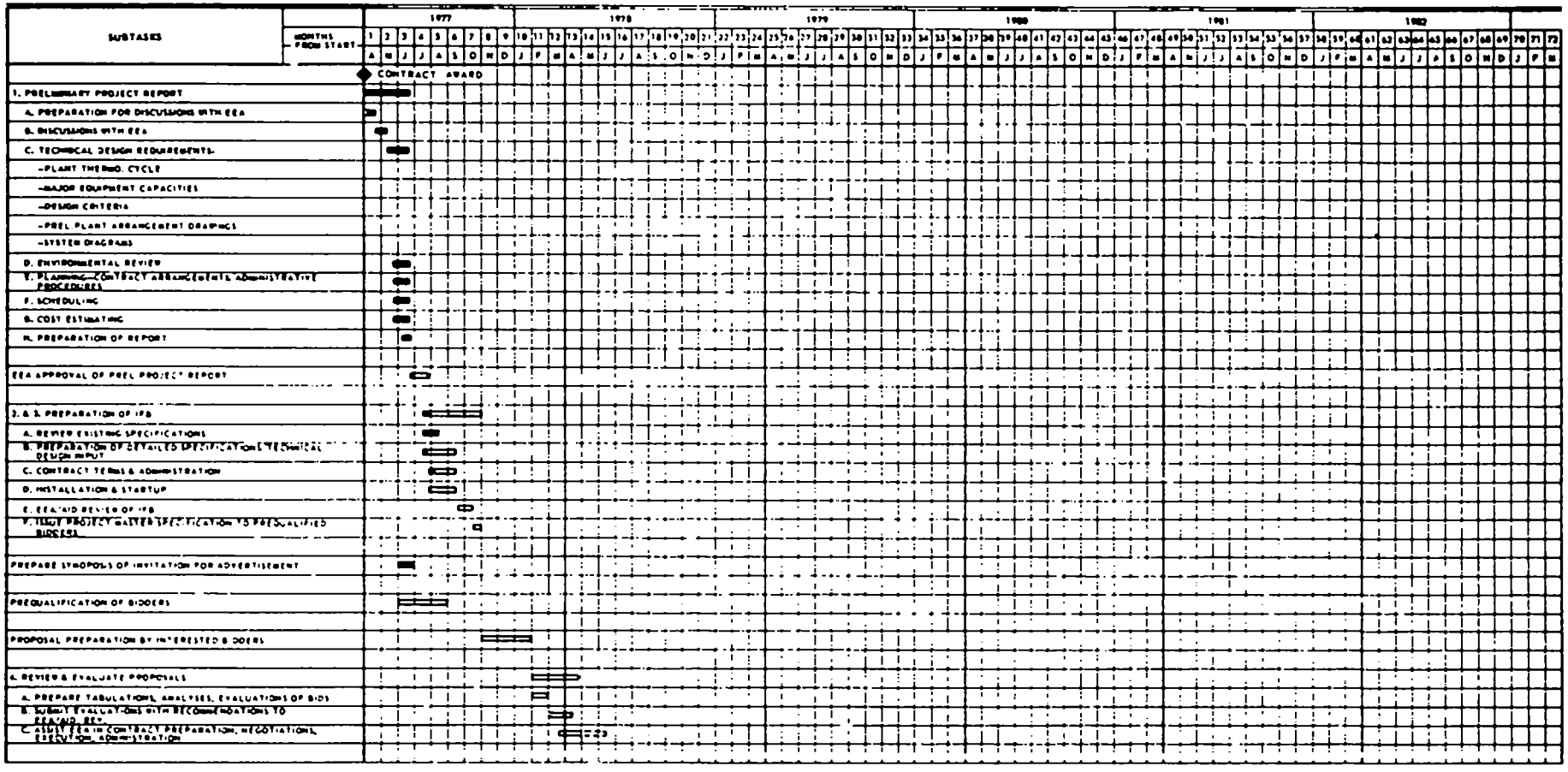

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FIGURE 2

EGYPTIAN ELECTRICITY AUTHORITY
CLIENT
ISMAILIA
PROJECT

GILBERT ASSOCIATES, INC.
READING, PENNSYLVANIA
JUNE 30 19 77
3 SHEETS NO. 2

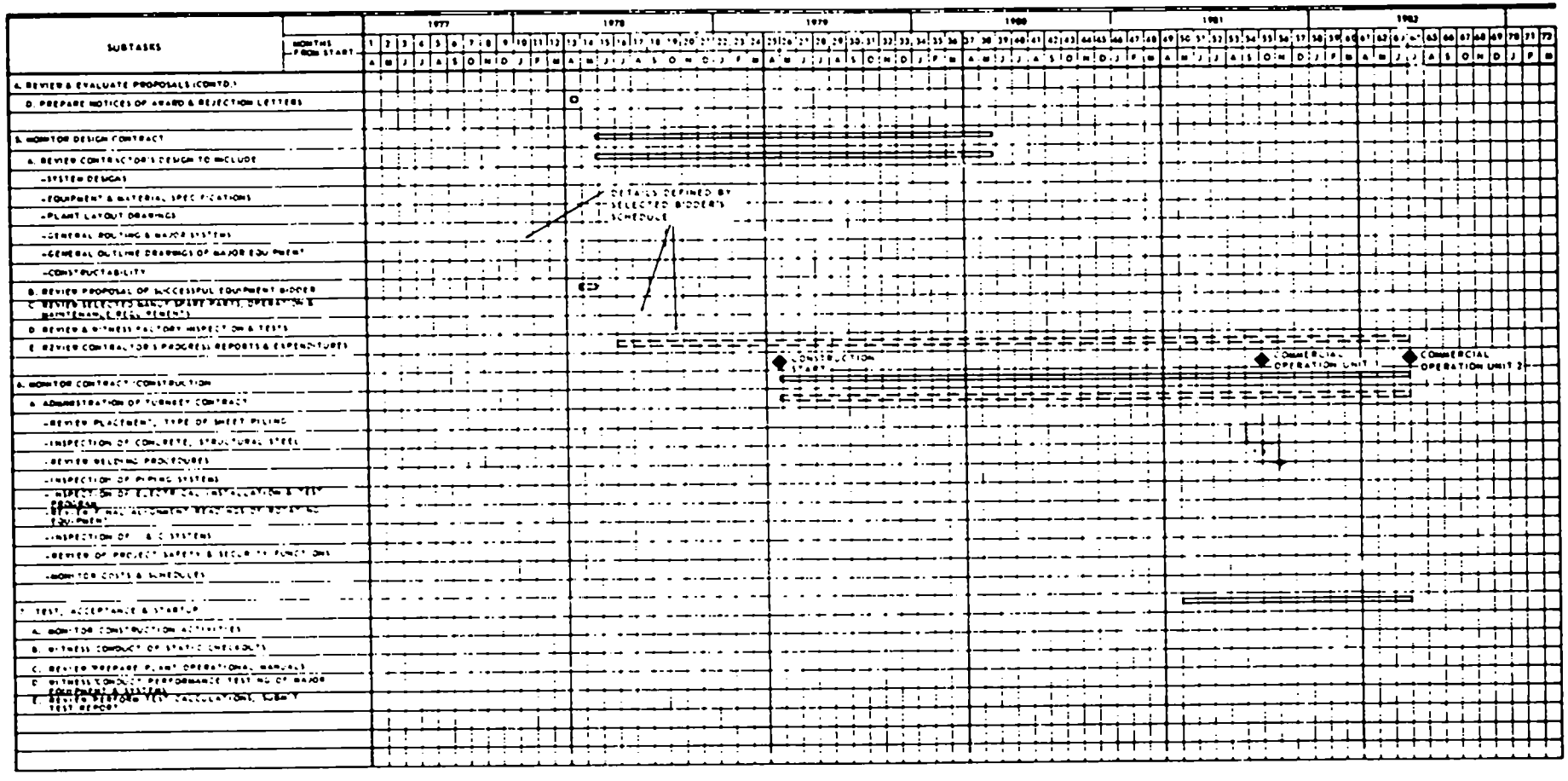
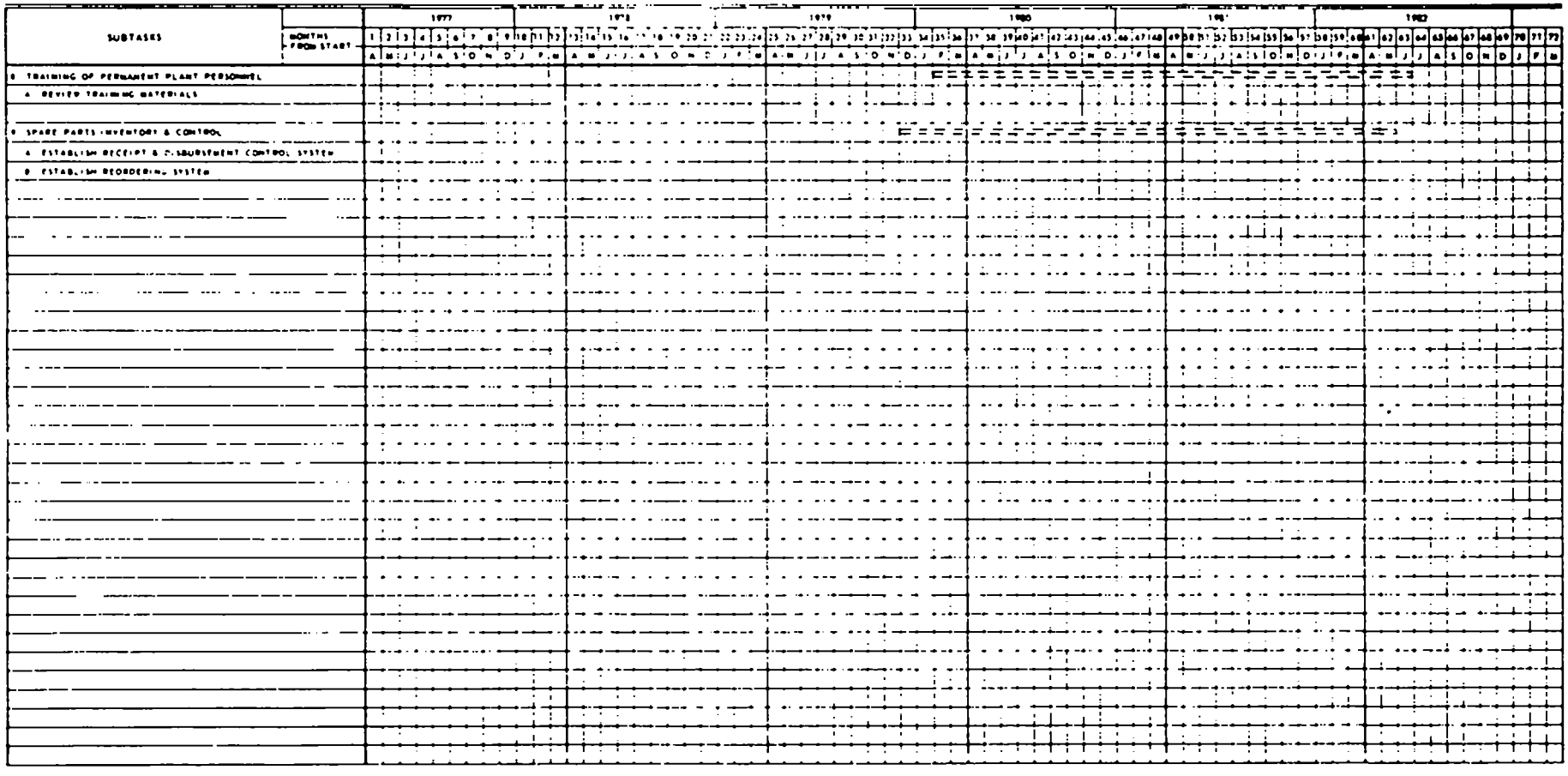


FIGURE 2

EGYPTIAN ELECTRICITY AUTHORITY

ISMAILIA

GILBERT ASSOCIATES, INC.
READING, PENNSYLVANIA

JUNE 30 19 77

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