DA AFGHANISTAN BRESHNA MOASSESSA

PRELIMINARY PLANS

KAJAKAI HYDROELECTRIC POWER PLANT

MAY 1970

IECO INTERNATIONAL ENGINEERING COMPANY, INC.
220 MONTGOMERY ST · SAN FRANCISCO · CALIFORNIA

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IECO INTERNATIONAL ENGINEERING COMPANY, INC.
220 MONTGOMERY ST. • SAN FRANCISCO • CALIFORNIA 94104

May 15, 1970

Mr. Hamidullah Hamid
General President
Da Afghanistan Breshna Moassessa
Kabul, Afghanistan

Dear Mr. Hamid:

In accordance with the provisions of Article 2.1 of the Agreement between DA AFGHANISTAN BRESHNA MOASSESSA (ABM) and INTERNATIONAL ENGINEERING COMPANY, INC. (IECO) for consulting engineering services for the Kajakai Hydroelectric Power Project, we herewith submit 15 copies of the "Preliminary Plans".

The comments and suggestions of ABM and AID concerning the IECO transmission line route studies and proposed basic criteria for Project design, presented in January 1970, are reflected in these "Preliminary Plans".

The "Preliminary Plans" also contain an outline of a program covering the training of Afghans connected with the Project and the two distributing agencies in Kandahar and Girishk, together with a program of U.S. advisors to counsel and work with ABM. It is our sincere belief that the implementation of these programs will result in a strengthening of the national and regional organizations responsible for management and administration of electric power generation and distribution in Afghanistan and will ensure the establishment of a cadre of trained personnel for safe and effective operation and maintenance of the Project.

The Project cost estimate is an important segment of the "Preliminary Plans". Assuming that project construction is started as scheduled, at the beginning of 1971, the capital costs are estimated to be $14,880,000 in U.S. currency plus the equivalent of $3,196,000 in local currencies for the payment of Afghani, Iranian Rial, and Pakistani Rupee costs. The total of $18,076,000 is some $2,676,000 more than the equivalent U.S. $15,400,000 estimated in 1966 and mentioned in the Agreement as available for financing the project.

INTERNATIONAL ENGINEERING COMPANY, INC.

Mr. Hamidullah Hamid, General President
Da Afghanistan Breshna Moassessa
Kabul, Afghanistan

May 15, 1970

Pending arrangements by your Government for the required additional funds, we cannot but again point out that the situation requires uninterrupted continuation of design engineering to allow for scheduled initiation of construction, since any delay in construction will further increase Project costs.

We appreciate the cooperation and assistance we have received from ABM and AID in our preparation of these "Preliminary Plans". We will be pleased to answer any questions that may arise during their review by ABM and AID.

Very truly yours,

Dale R. Shockley

Dale R. Shockley
Vice President

cc: AID/Kabul (3)
AID/Washington (2)

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ABBREVIATIONS AND EQUIVALENTS

%	percent
ABM	Da Afghanistan Breshna Moassessa
ac-ft	acre-feet (1 ac-ft = 0.0012 MCM)
ACI	American Concrete Institute
AID	United States Agency for International Development
amp	amperes
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing Materials
BHP	brake horse power
BIL	basic-impulse level
^{o}C	degrees Centigrade ($1^{o}C = 0.556(^{o}F - 32)$)
CFS	cubic feet per second
cm	centimeters
cm^2	square centimeters
CMS	cubic meters per second (1 CMS = 35.32 CFS)
CPM	critical path method
El	elevation above mean sea level
^{o}F	degrees Fahrenheit ($1^{o}C = 1.8 \times {}^{o}C + 32$)
ft	feet (1 ft = 0.305 meters)
ft/s	feet per second
g	grams
HV	high voltage
Hz	hertz
ID	interior diameter
IECO	International Engineering Company, Inc.
IEEE	Institute of Electrical and Electronic Engineers
in.	inches
kg	kilograms (1 kg = 2.205 lb)
km	kilometers (1 km = 0.621 miles)
kv	kilovolts
kva	kilovolt-amperes
kw	kilowatts

lb	pounds (1 lb = 0.454 kg)
LV	low voltage
m	meters (1 m = 3.28 ft)
m^3	cubic meters
max	maximum
mcm	thousand circular mills
MCM	thousand cubic meters (1 MCM = 811 ac-ft)
mi	miles (1 mile = 1.61 km)
min	minimum
mm	millimeters
m/s	meters per second
mw	megawatts
NEMA	National Electric Manufacturers Association
NESC	National Electric Safety Code
No.	number
OA	oil-immersed, air-cooled transformer
OA/FA	oil-immersed, air-cooled/forced-air transformer
psi	pounds per square inch
Q	flow
RMS	root mean square
rpm	revolutions per minute
sec	seconds
sym	symmetrical
T & D	transmission and distribution
USA	United States of America
US AID/A	United States Agency for International Development in Afghanistan
WK^2 (or WR^2)	rotating moment of inertia

CHAPTER I
INTRODUCTION

1.1 PROJECT DESCRIPTION

The Kajakai Hydroelectric Power Project under consideration in this report consists of: a powerhouse at the existing Kajakai Dam, an intake structure and shaft connecting the intake structure with the existing diversion tunnel, a tunnel plug and penstock, as well as a switchyard, 115 miles of transmission line and two substations, one in Kandahar and one in Girishk.

The preliminary design of the project is based in general on the "Loan Study Report" prepared by R.W. Beck and Associates in January 1967 and submitted to the U.S. Agency for International Development.

1.2 SCOPE OF WORK

This report summarizes the data that will be used as the basis for the design of the project and presents preliminary drawings showing conceptual design, location and parameters of structures. It also includes hydraulic data, capacity and characteristics of mechanical and electrical equipment, and design stresses. Data relating to subsequent phases of development are also included, where they are relevant to the present contract, which covers Phase IA (installation of two 16,500-kw units and provision of space for a third 16,500-kw unit). Phase IB (installation of the third 16,500-kw unit), Phase II (installation of two 25,000-kw units) and Phase III (installation of two additional 25,000-kw units) are for future development of the project.

CHAPTER II

SCHEDULES FOR IMPLEMENTATION OF THE PROJECT

To coordinate the activities involved in field investigations, design, engineering, procurement, and construction and to plan the implementation of the project, the following schedules, which are included in Appendix A, were developed:

- Design, Construction and Procurement Bar Schedule - Figure A-1.
- CPM Schedule for Design, Construction and Procurement - Figure A-2.
- Schedule of Procurement for Major Permanent Equipment - Table A-1.
- Preliminary Financial Plan - Table A-2.

As shown in Figures A-1 and A-2, the duration of the project, through completion of construction (but not including 10 months of power plant operation), will be 48 months. The timing of several of the activities involved in project implementation is critical in keeping the overall cost of the project as low as possible. Delays in these activities will result in higher project costs.

One critical activity is advertisement for bids on the turbines. Because of the relatively long time necessary for fabrication and shipment, the call for bids on this equipment should be advertised at the earliest possible time.

Another critical activity is advertisement for bids on the intake gate. Because there are only two times during the scheduled duration of construction when the reservoir can be lowered sufficiently to allow work on the intake structure, and because the reservoir cannot be lowered to

the required elevation of 994.0 in extremely wet years, the intake gate should be available for installation at the end of the first dry season. Therefore, early bidding is necessary.

A third factor that will affect the cost of the project is the time of year when the bids for the general construction contract are advertised. The results of studies made in the U.S.A. have shown that more favorable bids can usually be obtained in the winter than at other times of the year. Although, according to the CPM schedule (Figure A-2), the general construction bids will not be opened during the most favorable time of the year, a 2- or 3-month delay in the project will shift the bid opening into the most unfavorable time of the year. As a result, the bids might be 10% higher, thus increasing the cost of the project by approximately US $1,000,000. In addition, a delay of more than 3 months would cause the contractor to miss a dry period, when the reservoir could be drawn down to the required elevation, thus delaying construction another 5 or 6 months. At the present construction cost escalation rate of 9 to 10% per year, the project cost would be increased by approximately an additional $600,000, making the total increase US $1,600,000.

The part of the CPM schedule referring to construction is tentative and limited to the principal activities. After award of the contract, the general contractor will prepare his own, more detailed CPM schedule for construction. This master schedule will be revised as required.

To keep construction time to a minimum, separate bid documents will be prepared for the major pieces of permanent equipment, such as turbines, generators, transformers, valves and gates, and this equipment will be purchased by ABM. The call for bids for this major equipment will require alternative bid prices for delivery by the manufacturer to Karachi or Khorramshamr. The general contractor will select the port desired and will be responsible for the transportation to the jobsite.

Table A-1 shows the schedule of procurement for this equipment. Equipment that does not require long manufacturing time will be purchased by the general construction contractor.

The Preliminary Financial Plan (Table A-2) shows the estimated quarterly disbursements for major equipment and construction items for the duration of the project. This table will be revised periodically, as actual bid prices become available.

CHAPTER III

BASIC DATA

3.1 METEOROLOGIC DATA

The following information was collected from an observation station located on the left bank of the Helmand River about 2 km downstream from Kajakai Dam:

Temperature:	Average daily maximum	93.2°F (34.0°C)
	Average daily minimum	52.9°F (11.6°C)
	Maximum	120.0°F (48.9°C)
	Minimum	10.0°F (-12.2°C)
Precipitation:	Average yearly	197.8 mm (7.8 inches)

3.2 HYDROLOGIC DATA

Table A-3 shows the monthly and annual inflow to Kajakai Reservoir for the years 1947 through 1968. This information is based on records of the Water and Soil Survey Authority of the Royal Government of Afghanistan for the Helmand River in the Kajakai area.

Figure B-2 shows the outlet discharge curves for the 84-inch-diameter irrigation outlet valves, and the reservoir capacity curve.

CHAPTER IV
RESERVOIR LOWERING STUDY

As discussed in Chapter VI of this report, the reservoir must be drawn down to El 994 or lower before the intake tunnel shaft is daylighted and maintained at or below El 994 during construction of the lower portion of the power intake structure. The only means of lowering the reservoir below the crest of the ungated spillway, at El 1033.5, is through three 84-inch-diameter, hollow-jet, irrigation release valves in the outlet works tunnel (the discharge capacity curves for these valves are shown on Figure B-2 in Appendix B). The capability of these valves to lower the reservoir for the required length of time and the probability that the reservoir cannot be drawn down to the required elevation are factors that must be taken into account in design and construction.

A reservoir drawdown study was programmed for the computer to determine the degree to which the reservoir could have been drawn down during the 22-year period in which Helmand River flows were recorded. The monthly inflow records for Kajakai Reservoir for the 22-year period 1947 to 1968 are given in Table A-3. In the drawdown study, the monthly inflows were routed through the reservoir. The three irrigation release valves were assumed to be in the full open position during the entire drawdown period (when the reservoir was above El 994). The results of the study indicate that in an average year the reservoir could have been lowered to El 994 and maintained at or below El 994 for 4 months, from about December 15 to March 15.

Figure A-3 shows the variations in the water surface level determined from the study. It can be seen that during the wettest year of record (1957/1958) the reservoir could not have been lowered to El 994. It can also be seen that in 16 of the 22 years of the study the reservoir would have been filled so that spill would have occurred over the spillway.

5.1 HYDRAULIC DATA

A. Prior to Installation of Spillway Gates - The following data apply to the initial development (Phase I) of the project, with three 16,500-kw units:

1. Reservoir elevation	meters	feet
Max. operating water surface (crest of ungated spillway)	1033.5	3390
Min. operating water surface	1012.0	3319
Min. actual operating water surface	1008.0	3306

2. Tailwater elevation	meters	feet
Normal tailwater (three 16,500-kw units)	962.8	3158.0
Min. tailwater (one 16,500-kw unit)	962.5	3157.0
Max. tailwater (8496 CMS) (300,000 CFS)	973.0	3191.0

3. Reservoir storage	MCM	ac-ft
Gross storage (El 965.0 - 1033.5 m)	1844	1,495,000
Dead storage (El 965.0 - 1008.0 m)	543	440,000
Usable storage for power (El 1012.0 1033.5 m)	1166	945,000

4. Gross head	meters	feet
Max. head (El 962.5 - 1033.5 m)	71.0	232
Min. operating head (El 962.8 - 1012.0 m)	49.2	161
Min. actual head (El 962.8 - 1008.0 m)	45.2	148

5. Flow through turbines	CMS	CFS
Max. discharge through one 16,500-kw unit	29.5	1042
Max. discharge through three 16,500-kw units	88.5	3126

B. After Installation of Spillway Gates - The following data apply to the ultimate (Phase II and III) development of the project, with the addition of four 25,000-kw units:

1. Reservoir elevation	meters	feet
Max. operating water surface	1045.0	3428
Min. operating water surface	1012.0	3319
Min. actual operating surface	1008.0	3307

2. Tailwater elevation	meters	feet
Normal tailwater (three 16,500-kw units and four 25,000-kw units)	963.8	3161
Normal tailwater (ultimate development)	963.3	3160
Min. tailwater (one 16,500-kw unit	962.5	3157
Max. tailwater (8496 CMS) (300,000 CFS)	973.0	3191

3. Reservoir storage	MCM	ac-ft
Existing	1,850	1,495,000
Gross storage (El 965.0 - 1045.0 m)	2837	2,300,000
Dead storage (El 965.0 - 1008.0 m)	543	440,000
Usable storage for power (El 1012.0 - 1045.0 m)	2159	1,750,000

4. Gross head	meters	feet
Max. head (El 962.5 - 1045.0 m)	82.5	270
Min. operating head (El 962.8 - 1012.0 m)	49.2	161
Min. actual head (El 962.8 - 1008.2 m)	45.2	148

5. Flow through turbines	CMS	CFS
Max. discharge through each 25,000-kw unit	44.5	1570
Max. discharge through all four 25,000-kw units	178	6280

5.2 PENSTOCK AND TUNNEL VELOCITIES

	Max. Velocity (at max. turbine output) m/s	ft/s
A. Intake Shaft - diameter 7.0 m (23 ft), concrete lined		
Initial development with two 16,500-kw units (Q = 59 CMS)	1.5	4.9

	Max. Velocity (at max. turbine output) m/s	ft/s
Initial development with three 16,500-kw units (Q = 88.5 CMS)	2.3	7.5
Ultimate development with three 16,500-kw units and four 25,000-kw units (Q = 266.5 CMS)	6.9	22.6
B. Power Tunnel - unlined, horseshoe, diameter 10.5 m (34.6 ft)		
Initial development with two 16,500-kw units (Q = 59 CMS)	0.65	2.1
Initial development with three 16,500-kw units (Q = 88.5 CMS)	0.97	3.2
Ultimate development with three 16,500-kw units and four 25,000-kw units (Q = 266.5 CMS)	2.9	9.5
C. Penstocks		
1. Phase I Penstock - diameter 3.6 m (11.8 ft)		
With two 16,500-kw units (Q = 59 CMS)	5.9	19.4
With three 16,500-kw units (Q = 88.5 CMS)	8.8	28.9
2. Phase II and III Penstock - diameter 4.9 m (16.2 ft)		
With four 25,000-kw units (Q = 178 CMS)	9.4	30.8

5.3 POWER PLANT AND TRANSMISSION SYSTEM CHARACTERISTICS

A. Generators

1. Phase I

Number installed	
Phase IA	2
Phase IB	1
Phase I total	3
Rating at 60°C (temperature rise with cooling water not to exceed 20°C)	20,625 kva
Maximum continuous rating	23,725 kva
Power factor	80%
Rated power output	16.5 mw
Maximum power output	19.0 mw
Frequency	50 Hz
Speed	300 rpm
Rotation	Clockwise
Rated voltage	13.8 kv
Type of suspension	Conventional
WR^2	1.8×10^6 lb-ft^2
(WK^2)	(0.304×10^3 kg-m^2)

2. Phases II and III

Number installed	4
Rating at 60°C (temperature rise with cooling water not to exceed 20°C)	31,250 kva

Power factor	80%
Rated power output	25 mw
Frequency	50 Hz
Speed	250 rpm
Rotation	Clockwise
Rated voltage	13.8 kv
WR^2	4.6×10^6 lb-ft^2
(WK^2)	$(0.556 \times 10^3$ kg-m$^2)$

B. Generator Switchgear (Installed in Phases IA and IB only)

Number installed	
Phase IA	2 breakers
Phase IB	1 breaker
Phase I total	3 breakers
Continuous current rating	
Bus	3,000 amp
Breakers	1,200 amp
Interrupting rating	500 mva
Rated voltage	13.8 kv

C. Transformer Banks

1. Phase I

Number installed	
Phase IA	Three 1-phase units
Phase IB	One 1-phase unit (spare)
Unit rating (1 phase), OA/FA	18,000/24,000 kva
Rated voltage of windings (1 phase), HV/LV	93.2/13.8 kv

BIL class	
HV	650 kv
HV neutral	150 kv
LV	110 kv
Frequency	50 Hz
Bank connection, LV/HV	Delta/grounded wye
Bank rating, OA/FA	54,000/72,000 kva
Bank voltage, LV/HV	13.8/161 kv
Location	On transformer deck outside powerhouse

2. Phases II and III *

Number installed	4 Banks
Bank rating, OA/FA	23,700/31,500 kva

D. Turbines

1. Phase I

Number installed	
Phase IA	2
Phase IB	1
Phase I total	3
Best efficiency (guaranteed)	Not less than 90% at net head of 65.5 m
Required output	15,300 BHP at net head of 49.2 m and with efficiency of not less than 87%

* Detailed characteristics not included in the scope of the present project.

Speed	300 rpm
Type	Francis
Rotation	Clockwise
Elevation of distributor centerline	962.0 m (3155 ft)

2. Phases II and III

Number installed	4
Best efficiency (guaranteed)	Not less than 90% at net head of 65.5 m
Required output	21,100 BHP at net head of 49.2 m and with efficiency of not less than 87%
Speed	250 rpm
Type	Francis
Rotation	Clockwise
Elevation of distributor centerline	962.0 m (3155 ft)

E. Governors

Type	Cabinet type, hydraulic
Wicket gate closing time	
Phase IA	60 sec
Phase IB	60 sec

F. Turbine Shutoff Valves

1. Phase I

Number installed	
Phase IA	2
Phase IB	1
Phase I total	3
Type	Butterfly
Diameter	2.6 m (102 in.)
Closure time	3 min

2. Phases II and III

Number installed	4
Type	Butterfly
Diameter	3.2 m (126 in.)
Closure time	3 min

G. Pressure Regulator Valves

1. Phase I

Number installed	
Phase IA	2
Phase IB	1
Phase I total	3
Type	Howell-Bunger
Diameter	1.22 m (48 in.)
Opening time	3 sec

2. Phases II and III

Number installed	4
Type	Howell-Bunger
Diameter	2.36 m (60 in.)
Opening time	3 sec

H. Transmission Line (Phases IA and IB only)

Rated voltage	161 kv
Number of circuits	1
Conductor type	Flamingo
Conductor size	666.6 mcm
Insulation	
Suspension	Eleven 5-3/4-in. discs
Strain	Twelve 5-3/4-in. discs
Maximum span	365 m (1,200 ft)
Loading district (NESC)	Light

I. Switchyard and Substations (Phases IA and IB only)

1. Kajakai Switchyard

Incoming circuits	One 161 kv
Outgoing circuits	One 161 kv
HV switching equipment	
Number	1
Interrupting rating	4,000 amp (RMS-sym)

2. Girishk and Kandahar Substations

Incoming circuits	One 161 kv
Outgoing circuits	
Girishk	One 44 kv
Kandahar	One 13.2 kv

HV switching equipment	
Number	1
Interrupting rating	4,000 amp (RMS-sym)
LV switching equipment	
Number	1
Interrupting rating	500 mva
Transformer banks	
Number installed	
Girishk	Three 1-phase units
Kandahar	Three 1-phase units
Unit rating (1 phase), OA/FA	
Girishk	2,500/3,125 kva
Kandahar	7,000/9,333 kva
Rated voltage of windings (1 phase), HV/LV	
Girishk	93.2/44 kv
Kandahar	93.2/20 and 13.2 kv
BIL class	
HV	650 kv
HV neutral	150 kv
LV	
Girishk	250 kv
Kandahar	150 kv
Frequency	50 Hz
Bank connection, HV/LV	Ground wye/delta
Bank rating, OA/FA	
Girishk	7,500/9,375 kva
Kandahar	21,000/28,000 kva
Rated voltage of bank, HV/LV	
Girishk	161/44 kv
Kandahar	161/20 and 13.8 kv

LV neutral grounding transformer, three-phase, zigzag (Kandahar only)	
Continuous rating (price equiv)	2,400 kva
One min rating	24,000 kva
Rated voltage	13.8 kv

5.4 STANDARD DESIGN CODES AND ALLOWABLE STRESSES

The following design standards will be used for design and construction of the powerhouse and appurtenant structures.

A. Standard Design Codes

ACI - Manual of Concrete Practice.
AISC - design, fabrication and erection of structural steel for buildings.
Uniform Building Code, latest edition.
ASME - boiler and pressure vessel codes.
ASTM - test methods.
IEEE - design and test codes.
ANSI - standards for materials and equipment.
NEMA - electrical manufacturing standards.
NESC - safety code for power transmission and distribution.

B. Design Loads

1. General - Structures will be designed to sustain the maximum dead and live loads to which they may be subjected, including erection loads occurring during construction and all loads arising from earthquakes, winds, hydrostatic pressures and similar causes.

2. Dead loads - Dead load is the weight of a structure, itself, including walls, floors, roofs and all other permanent construction and fixed equipment. It is computed from the weights of the materials composing the structure and its permanent equipment.

3. Live loads - Live load is the weight of the machinery, equipment, stored materials, persons or other moving objects, cranes or other handling devices and their loads, impact loads, wind loads, construction loads, earthquake loads and loads due to maintenance.

4. Roof live loads - The roof of the powerhouse will be designed for a live load of 100 kg/m^2 (20 lb per ft^2).

5. Wind load - The structure will be designed to resist a wind load of 100 kg/m^2 (20 lb per ft^2) of projected area from any direction.

6. Seismic loads - The structure will be designed to resist a horizontal seismic load of 0.10 g.

7. Hydrostatic loads - The structure will be designed to withstand full hydrostatic loads, including uplift.

8. Combined loading

- Dead load $\pm$ live load $\pm$ impact load $\pm$ hydrostatic load $\pm$ earth load. No increase in permissible working stresses.

- Loading described in (1) above, plus any one of the following loads: wind load, seismic load, temperature-change load. Allow a 33% increase in permissible working stresses.

- Loading described in (1) above, plus seismic load and temperature-change load combined. Allow a 50% increase in permissible working stresses.

C. Concrete Characteristics

Unit weight	2,400 kg/m^3 (150 lb/ft^3)
Modulus of elasticity	210,000 kg/m^2 (3,000,000 psi)
Poisson's ratio	0.20
Coefficient of thermal expansion	5.6 x 10^{-6}
Minimum compressive strength at 28 days:	
Class "A" (for all structures exposed to weather or submerged and all structural members, including slabs, beams, girders, walls, columns, corbels and generator pedestals)	210 kg/cm^2 (3,000 psi)
Class "B" (for all unexposed mass concrete, heavy unreinforced footings where mass and not strength is the primary consideration)	175 kg/cm^2 (2,500 psi)
Class "C" (for backfill mass concrete)	140 kg/cm^2 (2,000 psi)
Thickness of concrete cover for steel reinforcement (not less than the diameter of the reinforcing steel):	
For surfaces in contact with the ground, submerged surfaces and surfaces exposed to the weather	7.5 cm (3 in.)
For beams, girders and columns	3.8 cm (1-1/2 in.)
For walls and slabs	1.9 cm (3/4 in.)

CHAPTER VI

PROJECT DESCRIPTION

6.1 INTAKE STRUCTURE

The power intake will be located on the left abutment approximately 150 meters upstream from the crest of the dam. An access road will run from the dam crest (El 1050) to the intake (El 1058). One advantage of locating the intake platform 8 meters higher than the crest of the dam is that less rock will have to be excavated for the road.

Most of the excavation for the intake was done at the time the dam was built to minimize the time required for construction of the intake structure with the reservoir lowered. To estimate the time during which the reservoir can be drawn down and maintained at El 994.0 (sill elevation of the intake), or below, a study was made using data on inflow to the reservoir from 1947 to 1968, as described in Chapter IV of this report.

The intake will have one fixed-wheel gate, which will be used only if repairs are necessary in the tunnel or penstocks. The normal operational closure will be performed by individual butterfly valves for each unit of the powerhouse. Since the gate will perform the function of a stoplog, stoplogs will not be provided.

To minimize the construction time of the intake, which is one of the critical components of the project, the structure will be simpliefied by:

- Using one large gate instead of two smaller gates, thereby permitting savings in both time and cost.

- Using fixed steel panels in fabrication of the trashrack structure, thus eliminating the structure usually required above the trashracks to remove and clean them.

The trashrack structure will be designed with sufficient net area to ensure a maximum velocity of 1.0 m/s. Since Kajakai Reservoir is essentially free of debris and the intake is at a considerable depth, no problem of trash accumulation is anticipated. Therefore, the trashracks will be designed to attain full working stress under the minimum recommended head differential of 5 feet. However, the supporting members will be designed for twice this head, or 10 feet. As protection against corrosion, all of the structural steel in the trashrack structure will be coated with coal tar epoxy resin.

The intake gate will be served by an electrically operated drum hoist with sufficient capacity to open the gate under balanced pressure. The hoist will be located above the intake, at El 1058. Under normal operating conditions, the gate will be stored above the tunnel entrance and raised and lowered at constant speed. A dial at the hoist will indicate the gate position at all times. It will be possible to effect emergency gate lowering either from the powerhouse or at the hoist. For inspection or repair of the gate, as well as for initial assembly, an enlarged area will be provided in the upper part of the intake structure entirely above the maximum water level in the reservoir, as shown on Figures B-6 and B-7.

6.2 POWER TUNNEL AND PLUG

A 60-meter-long, 7-meter-diameter, inclined shaft will connect the intake structure with the existing 10.5-meter-diameter, unlined, horseshoe-shaped diversion tunnel, which will serve as the power tunnel. Because the rock formation is sound and the maximum water velocity will be only 2.9 m/s in the ultimate development, the existing tunnel will not be lined. However, prior to the start of Phase II construction, this tunnel should be inspected, and if any areas show evidence of erosion, those areas should be lined with concrete.

Because of its proximity to the reservoir and the upstream end of the existing plug portion of the tunnel, the intake shaft will be lined with concrete. The lining will minimize friction losses in the shaft, where at ultimate development the maximum water velocity will be 6.9 m/s.

During excavation of the intake shaft, rock bolts will be used, as required, in the portal area and at the transition between the shaft and the tunnel. The concrete lining, which will be prestressed by grouting, will be designed to withstand the grout pressures. The lining will be reinforced to enable it to resist tensile stresses, which will exceed the compressive stresses resulting from the prestressing, and to prevent major cracks from forming in it. Because the tunnel is quite close to the ground surface, it will not be possible to raise the grout pressure enough to compensate for all of the hoop tension. On completion of the three-stage grouting operation, drainage holes will be drilled through the lining into the rock. This drainage will tend to alleviate any hydrostatic pressure that may build up behind the lining when the intake gate is closed and the tunnel emptied.

The intakes for the penstocks will be located in a concrete plug placed in the tunnel, approximately 100 meters from the downstream end. Two steel pipe sleeves, one 3.6 meters in diameter and the other 4.9 meters in diameter, will extend through the plug. The smaller sleeve will be coupled directly to the Phase I penstock, while the larger one will be capped for future connection with the Phase II penstock. The tunnel will be subjected to a maximum hydrostatic pressure of 75 meters at maximum water level in the reservoir, all of which must be resisted by the surrounding rock. The minimum rock cover for the tunnel (50 meters) occurs at the plug. The safety factor at this minimum cover is 1.7, which is sufficient to ensure that no lifting of the rock will occur.

6.3 PENSTOCKS

To minimize the construction cost, especially during Phase I, 8.8 m/s, which is close to the 30 ft/s recommended by the U.S. Bureau of Reclamation, was adopted as the maximum velocity. This relatively high velocity makes it possible to reduce the number of penstocks from the previously proposed three-penstock arrangement to a two-penstock arrangement (as shown on Figure B-6), which will be much simpler to construct.

It will not be necessary to enlarge the existing tunnel, and for Phase I a 3.6-meter-diameter penstock (instead of the previously proposed 4.2-meter-diameter penstock) will be sufficient. The higher velocity will result in somewhat greater friction losses in the smaller penstock than there would be in a larger penstock. However, these greater friction losses will be significant only at maximum discharge, which will occur when the head is approximately the rated head of 65.5 meters and all three units are operating. When the head is greater than 65.5 meters, smaller discharges will be required and the friction losses in the penstock will therefore be smaller.

A walkway will be provided above the Phase I penstock in the tunnel, at an elevation of approximately 967.0, which is above the maximum recorded tailwater level (El 965.6). A concrete anchorblock will be placed around the 30-degree bend in the penstock at the tunnel portal. This block will be large enough to absorb the hydrostatic and hydrodynamic forces resulting from the bend. To keep tailwater from entering the tunnel, the tunnel entrance will be closed, partly by the anchor block and partly by a temporary concrete wall. Since a considerable amount of water may seep into the tunnel through the tunnel walls, a drainpipe will be provided to convey this water to the sump in the powerhouse.

Outside the tunnel, the penstock will be encased in concrete, and backfill will be placed behind the powerhouse up to El 973.0 or 974.0. Downstream from the tunnel, the 3.6-meter-diameter penstock will trifurcate into three conduits, each 2.6 meters in diameter.

The penstock will be designed for the maximum hydrostatic pressure increased by the nominal amount of 10% to account for water hammer, with stresses not to exceed 18,000 psi. This small allowance for water hammer will be possible because pressure relief valves will be installed with the units in the powerhouse. The decision to use pressure relief valves instead of a surge tank was made because: 1) pressure relief valves are more economical and 2) if a surge tank were used, it would have to be built during Phase II (since funds are not available during Phase I), and power production at Kajakai would have to be shut down completely for 2 to 3 months while it is being built. Since Kajakai will be the main source of power for the area, and since a substitute source of power with comparable capacity is not available in the area, the surge tank solution was found to be impractical.

A high-ductility, low-carbon steel, such as ASTM 2855, Firebox quality, will be used in fabrication of the penstock, and the penstock will be painted with a protective asphaltic coating. A penstock and tunnel filling line will be installed to connect the existing outlet works with the penstock.

6.4 POWERHOUSE

As recommended in Beck's 1967 report, the first phase of the development of the powerhouse will include the installation of two 16,500-kw units, with provision for the installation of a third 16,500-kw unit at a future date. Characteristics of the Francis turbines, the generators

and the transformers are given in Chapter V of the present report. The general layout of the civil, structural, mechanical and electrical features of the powerhouse is shown on Figures B-9 through B-13.

The powerhouse will be located as close to the tunnel portal as possible while still allowing enough room between the powerhouse and the portal for the Phase I penstock bifurcation, future penstocks, and a vehicle turning area. Future extension of the powerhouse to house four 25,000-kw units will be taken into consideration in the design of the Phase I powerhouse, not only with respect to the location, but also with respect to the structural and equipment layouts. To prevent the backfill behind the Phase I powerhouse from infringing on the future construction site for the future powerhouse extension, a 20-meter-long retaining wall extending to the penstock anchor block at the tunnel portal will be built during Phase I.

The powerhouse will be of the indoor type. Since structural steel is not available in Afghanistan and would have to be imported and to make maximum use of the materials available in Afghanistan, the superstructure will be designed of reinforced concrete. A powerhouse crane and service bay for use in Phases I, II and III will be provided. The end wall of the powerhouse, between the Phase I and Phase II structures will be built of concrete blocks above the maximum water elevation (972.0) and of concrete, as thick as required to withstand water pressure, between El 972.0 and El 969.0. To avoid dividing the generator room in Phases II and III, the entire wall will be designed so that it can be removed, without interference with the structure, when the powerhouse is extended.

A. Mechanical Systems - The mechanical systems planned for the powerhouse will provide water, oil, compressed air and drainage for the generating units and the building.

- The penstock will supply raw water for the cooling systems, generator fire protection system, plant service system and domestic water system. An independent cooling water system will be provided for each generating unit.

- Collapsible rubber tanks, pumps, filters, associated hoses, valves, controls and instruments will be provided for handling, transfering, purifying and pumping the transformer oil and lubricating oil.

- Compressed-air hose connections will be installed in the machine shop area and throughout the plant for operation of air tools and the generating-unit brake system. The compressed air system will comprise two air compressor units, air receivers, pressure-reducing valves, pressure switches and alarms, piping and valves. The piping will slope so that condensate can be collected and drained into gutters in the floor.

- The heating and ventilating system will furnish fresh air from outside to all plant rooms and galleries. The toilet and janitor rooms will have independent air exhaust systems, which will discharge to the plant exterior. The plant will be heated by electric duct heaters or unit heaters, which will be controlled by thermostats in each room. The system will consist of fans, washable air filters, duct work, duct heaters, unit heaters (where required), louvers, dampers, damper motors and electric controls for automatic operation.

- The powerhouse will be equipped with a traveling bridge crane. A single trolley on the bridge will have a 150-ton hoist and a 50-ton auxiliary hoist. This crane will handle the assembly and maintenance of the generating unit, the installation and removal of turbine shutoff valves, and miscellaneous plant services. An operator's cab on the bridge will house the crane controls. A

gantry crane on the downstream side of the plant deck will handle the tailrace gates. This crane will not have a gantry drive mechanism; each gantry truck will be provided with pulling eyes to effect crane travel with rated load. Hoist controls will be installed on the crane gantry.

- Drainage and unwatering systems (for inspection and/or removal of the turbines) will be designed to permit the unwatering of each unit independently. The draft tube and floor gutters will drain by gravity to the plant sump. Water that accumulates in this sump will be pumped out to the tailrace by vertical turbine pumps. Pump operation will be automatic, actuated by a float switch in the sump. The system will consist of pumps, controls, alarms, piping and valves.

- Raw water for domestic use will be tapped from the penstock, chlorinated and stored in a holding tank. Waste water sewage from the plumbing fixtures will drain by gravity to the basin of a sewage ejector pump. A float switch on the basin will actuate the pump at predetermined levels. Sewage will be pumped to a septic tank outside the plant. After a detention period the fluids from the septic tank will be discharged into the soil outside the tank through a system of open-joint piping and/or a seepage pit. The plumbing system will consist of plumbing fixtures, sewage ejector pump, septic tank, chlorinator, valves and related piping, and necessary electrical controls.

- The machine shop and maintenance equipment will be located on the generator floor adjacent to the tool storage room. The primary purpose of this equipment is to provide facilities for repair, fabrication and reconditioning of small machine parts and tools. The equipment, which will be electrically operated, will consist prima-

rily of a bench lathe, pedestal drill, pedestal grinder, power hacksaw, anvil, arbor press, arc welder, pipe vise, machinist's vise, oxyacetylene welding unit, benches and cabinets. Hand tools will be stored in the tool room. They will include mainly air-operated tools, such as grinders, chisels, chipping hammers and drills. Miscellaneous tools will be provided for pipe threading, jacking, pulling, hammering, machine leveling, tapping, clamping and similar operations. Facilities for storing and shelving these tools, as well as spare parts for the various plant equipment, will be provided in the tool room.

B. Electrical Systems - The electrical systems planned for the powerhouse will serve two major functions:

- Switching and control of the main power generated and fed into the transmission system.

- Supply and control of station service power necessary for operation of station auxiliaries and power plant services.

1. Main power scheme - The main power switching scheme for the powerhouse and swithyard, which is shown on the Main One-Line Diagram (Figure B-14) is described below:

- The output of all three generators (the two initial 16,500-kw units and the future 16,500-kw unit) will be placed on a common 13.8-kv generator voltage bus.

- The generating units will be synchronized onto the bus or taken out of service through individual air circuit breakers.

- A bank of three single-phase transformers will be connected di-

rectly to the generator voltage bus and step up the generated power from 13.8 kv to the transmission voltage of 161 kv.

- A nonsegregated-phase bus system, 13.8 kv with a continuous rating of 1200 amp, will connect the generators with the 13.8-kv switchgear. A similar bus system, but having a continuous rating of 3000 amp, will connect the switchgear with the step-up transformer bank.

- Power for all station service needs will come from the main leads of each of the two initial generating units and be stepped down to the station service voltage of 380/220 volts through individual 300-kva, three-phase transformers. Each of these station service transformers will be sized to supply all station power needed for the Phase I (three-unit) powerhouse.

- All equipment has been selected on the basis of the installation of three generating units, taking into consideration the necessary capacities, short circuits and required features. All equipment will be standard, commercially available models. The special features of some items are listed below:

  1) Single-phase step-up transformers will provide the utmost flexibility without the need for a spare standby transformer. In the event of failure of a single transformer, the bank will be operated open-delta, open-wye, as discussed in detail in Section 6.6.

  2) Carrier current equipment will be provided for relaying and communication, as well as future high-speed relaying.

  3) Distribution transformers will be provided in the generator neutral to limit faults to less than three phases.

- Protective relaying, as shown on the Main One-Line Diagram, will be provided to protect the major equipment from damage during abnormal system disturbances.

- Metering of essential electrical quantities will be provided for startup and shutdown of units, monitoring during operation, station records and commercial revenue records.

- A detailed power switching scheme for the Phase II and III powerhouse expansion of four units is not included on the Main One-Line Diagram. The initial scheme is such that expansion through the installation of additional units will be feasible. One possible expansion scheme is shown on the Main One-Line Diagram.

2. Station service power scheme - All low-voltage station power required for the powerhouse will be supplied by two station service transformers fed directly from the generators. The complete station service power system, which is shown on the Auxiliary Power One-Line Diagram (Figure B-15), is described below:

- Air circuit breakers will be provided in the secondary circuit of the station service transformers, and the supply will be placed on a common 380/220 volt, three-phase, four-wire bus. An emergency station supply will be connected through a circuit breaker to the main station bus. The breakers will be interlocked and arranged so that only one station power souce at a time will be connected to the bus. Under normal operating conditions the station service supply will come from generating unit No. 1 or No. 2. In the event of the loss of this supply, an automatic transfer scheme will transfer the station supply to the other normal supply. A diesel generator will supply critical station power during complete loss of normal station supply or for startup of the powerhouse under "black" conditions.

- Separate feeders from the station service bus will supply the auxiliary power needs of each of the turbine-generating units Other feeders will supply power to the station auxiliaries, heating and ventilating equipment, switchyard and intake structure area.

- Distribution panels will be provided for protection and switching of feeders to auxiliaries for the turbine-generating units and station auxiliaries. Four separate panels will be provided initially. Individual motor starters and controls will be installed nearby or within the respective equipment, such as governor oil pumping unit, heating and ventilating centers, etc.

6.5 SWITCHYARD

The switchyard will be located approximately 200 meters behind the powerhouse. Sufficient area will be leveled at about El 990 for the initial structures and equipment to be installed at the switchyard. The switchyard will be surfaced with gravel and fenced for security purposes, with appropriate notices posted.

Overhead lines from the step-up transformer bank on the powerhouse deck will terminate at a steel box structure located at the switchyard. All 161-kv equipment, including busses, insulators, disconnect switches, circuit switcher and power line carrier coupling capacitors, will be arranged under or on the latticed steel box structure.

The outgoing 161-kv transmission line will be terminated at this box structure with wave traps inserted into the line.

The switchyard will be expandable for future addition of incoming generation circuits and transmission lines. Lighting will be provided for station operation. A complete grounding system will provide for the safety of the personnel and for the requirements of protective relaying. Space has been allocated for the addition of a 161-kv circuit breaker when the short circuit capacity exceeds the circuit switcher's interrupting capacity or when the system is interconnected, requiring fast and definite operating times.

6.6 TRANSMISSION SYSTEM

As discussed in detail in Chapter VIII, preliminary cost estimates and line performance studies were made to compare the feasibility of several alternative routes and voltages for the transmission line between Kajakai, Girishk and Kandahar. The results of these studies indicate that of the alternatives studied Alternative 2A is the most feasible. It consists of one continuous, single-circuit, 161-kv, 666.6-mcm ASCR line, which runs first along the Kajakai-Girishk road and then parallel to the Girishk-Kandahar highway. The total length of the line is 188 km. At approximately 72 km from Kajakai there is a 12-km tap to Girishk. The following discussion refers to Alternative 2A.

A. Design Details - Alternative 2A features the following arrangements, specifically aimed at reducing the initial cost without affecting the reliability of the system or its functions.

1. Elimination of overhead shield wire - Data on the isokeraunic level of the Kajakai area were obtained from the Director of Metereology of Kandahar Airport. Since these data indicate that the isokeraunic level of the area is about 5, use of continuous overhead shield wires was eliminated. However, additional lighting protection of terminal

equipment will be provided by means of overhead ground wires radiating out for approximately 1.6 km from the power plant and each step-down substation. This practice has been followed by several utility companies on the Pacific coast of the United States, where the isokeraunic levels are comparable. Specialists in this field were consulted and the conclusion was reached that elimination of shield wires for radial lines using steel supports is feasible. This practice has been followed for up to 500-kv radial lines. The number of outages due to lighting discharges is five times greater for lines without continuous shields than for lines using shield wires. This is approximately 2 per year per 100 miles (161 km) of line. However, the extent of damage because of direct lighting stroke is not increased by elimination of shield wire. Some of the utility companies consulted use the single-shot, rapid reclosing of such lines only to maintain continuity of service. Directional ground overcurrent relays (instantaneous elements) are used for protection against ground faults (230-kv lines). Some utility companies recognize that certain economic and operational advantages can be obtained by eliminating shield wires. Tower grounding resistance is a less critical requirement when shield wire is eliminated, although some utility companies still use 25 ohms per tower to reduce excessive step voltage levels.

2. Switching scheme - A three-phase, 161-kv circuit switcher will be provided at each terminal for normal energization or de-energization and isolation of the transmission line in case of line faults or station internal faults. The switcher will be capable of interrupting 4000-amp faults. Its tripping and reclosing times will be slightly longer than those of a circuit breaker, but will be fully acceptable for a radial system. At Kajakai, the scheme adopted will isolate the line in case of ground faults by tripping generator breakers and then opening the switcher if the first reclosing is not successful. In the case of phase faults (without reclosing), the switcher will trip first. The switcher

and generator circuit breakers are used as backup device, complementing each other upon failure of the primary device.

3. Transformer connections - All main transformers of the system will be wye-connected on the high-voltage side and delta-connected on the low-voltage side. In addition to the usual advantages of such a connection, this arrangement will also provide a source of zero sequence for line faults at all three terminals of the line to ensure positive action of ground overcurrent relays and isolate the generators at Kandahar or Girishk from line faults. Another advantage is the reduction in the cost of main transformers obtained by using graded insulation of high-voltage windings.

4. Substations - Receiving substations are located at Girishk and Kandahar, the terminal of the 161-kv line. Each of these substations is designed to step down the transmission voltage and put the Kajakai generation onto the existing systems at Girishk and Kandahar.

These substations are similar in design to the Kajakai switchyard. Lines will be terminated on box-type, lattice structures with grounding, lighting and fencing provided. Banks of single-phase transformers will be provided, without spares. This will allow continuity of service under reduced capability during emergency situations, when a single-phase transformer is out of service. Power from the system will be fed into the Girishk system at 44 kv, and into the Kandahar system at 13.8 kv, with provisions on the transformer for feeding the future secondary network at 20 kv, as planned by ABM. One 161-kv circuit switcher and one secondary-voltage oil circuit breaker will be installed at each substation. These devices will be tripped, in addition to the sequence required by the system, by transformer and secondary bus protective devices.

Grounding of the secondary system neutral has already been achieved at Girishk by the existing generating step-up transformer. Therefore, no additional equipment will be needed for this purpose.

At Kandahar, a grounding zigzag transformer will be provided to ground effectively the secondary system neutral. A tie transformer, rated 13.2/3.3 kv, will be installed by others within the contract for improvement of Kandahar distribution systems, prior to completion of the 161-kv system. This tie transformer does not satisfy the requirement for effective grounding since its X_o/X_1 ratio is 4.8.

B. Emergency Operation with Two Single-Phase Transformers - Initially, spare single-phase transformers will not be provided at any of the three terminals---Kajakai, Girishk or Kandahar. Assuming that no more than one single-phase unit will fail at the same time in any one location, the principle of the open-delta/open-wye scheme was selected to provide emergency service, with transmittal of power limited to 58% of the three-phase rating of the transformer bank.

The following steps must be taken to arrange the system for emergency operation:

- The faulty transformer and the corresponding-phase transformers at other terminals must be disconnected.

- The 161-kv phase conductor corresponding to the disconnected transformers must be connected to the neutral bus at each location without removing the ground from the neutral bus.

With the generators at Kajakai supplying three-phase, balanced voltage and current to the 13.8-kv open-delta windings, the current of the 161-kv line will be neither symmetrical nor balanced. The current of the phase

reconnected to the neutral bus will be 1.73 times the current of either of the remaining normally connected phases. The phase angle between this phase and either normal phase will be 150 degrees.

This asymmetrical system will, however, be converted to a symmetrical system at the receiving end open-wye/open-delta bank. The operation of lighting arrestors will not be affected. Line protection will be provided by overcurrent relays (normally used as backup), since the operation of distance relays will be affected by the unbalanced transmission line currents.

G. Requirements for Installation of a Third Unit - In the future, in addition to the third unit and its auxiliaries, the following major equipment will have to be purchased and installed to complete Phase I of the project:

For all stations:

- Spare transformers, one single-phase unit for each location.

For Girishk and Kandahar:

- Circuit switchers, one for each location.
- Secondary circuit breakers, one for each location.
- Main transformer banks, including spare unit, with half of the initially installed transformer bank capacity, one for each location.
- Secondary capacitor bank for improvement of power factor, at Kandahar only (if required).

7.1 KAJAKAI POWERHOUSE

Nine exploratory core holes were drilled at the powerhouse site to determine foundation conditions. These drill holes were located so as to obtain adequate information for use in the design of the units to be installed under the present contract, as well as to provide information on foundation conditions under the entire area that will be required for ultimate project development. The drill holes were also arranged to provide information regarding coffer dam requirements and best powerhouse location. The location of the drill holes and the drill logs are shown on Figure B-3.

The results of the geologic exploration indicate that the area of the proposed powerhouse is covered with sandy, gravelly alluvium to a maximum depth of 9.30 meters. These alluvial materials are underlain by horizontally bedded limestone. At invert elevation the entire powerhouse foundation will be on hard limestone, which provides an exceptionally good foundation. A small amount of treatment, such as consolidation grouting or concrete dental work, may be necessary in the vicinity of any minor shear zones, that may be uncovered during excavation. The exact amount of treatment required will be determined in the field when the foundation is exposed.

7.2 POWER TUNNEL AND INTAKE

The entire length of the existing power tunnel was excavated in limestone. Inspection of this tunnel downstream from the plug indicated

that the grouting done at the time of construction was effective. However, some seepage was observed from rock joints and shear zones.

The condition of the rock is such that lining will be required only at the intake shaft and outlet portal. However, some additional remedial grouting will be necessary to ensure that the rock will be sufficiently impermeable under the high water pressure that will be experienced during operation of the power plant.

Very little construction support will be required in the portion of the intake shaft that will be constructed under the present contract. Inspection of rock conditions suggested that rock bolts will be all that will be needed for protection against local roof fallout.

7.3 TRANSMISSION LINE

Eleven hand-dug test pits, ten power auger holes, five hand auger holes and four rotary exploration holes were drilled to determine footing and excavation requirements along the transmission line. Rotary drilling was done at the Helmand and Arghandab River crossings, where pile footings will be necessary. The location of the drill holes and the results of the geologic field inspection are shown on Figure B-4.

The results of this work suggest that rock footings will be required from km 0+00 to km 2+000 and from km 12+460 to km 13+860. With the exception of the Helmand and Arghandab River crossings, the rest of the transmission line route will cross areas underlain by gravelly sandy or clayey soil, in which holes for footings can be dug by hand or drilled with standard auger equipment. In some areas gravelly soils are very dense and difficult to dig by hand. Moreover, occasional hard pan or caliche layers up to 2 meters thick will be encountered, but in

general, holes for footings can be either hand dug or augered to the depth required for tower footings. The only soils encountered that have an allowable bearing capacity of less than 6 tons per square foot, are discussed below.

Rotary drilling indicated that both the Helmand and Arghandab Rivers are basically gravelly streams, with gravels exposed in the active floodplain. A layer of 1 to 2 meters of sandy silt covers gravels on overbank areas. Active floodplains of the Helmand and Arghandab Rivers, where streamflow velocities are sometimes high enough to promote scour problems, are approximately 1500 and 800 meters wide, respectively. Natural scour channels in both rivers are on the order of 3 to 4 meters deep.

Piling will be required at the major river crossings to protect the footings against scour in the active floodplains, and to provide adequate bearing capacity in the overbank areas, which are underlain by soft, silty soil. For design purposes it is assumed that the allowable bearing capacity of the sandy, gravelly alluvial deposits of the Helmand and Arghandab Rivers is on the order of 4 to 6 tons per square foot. The allowable bearing capacity of the sandy silts overlying the alluvial deposits ranges from 1 to 4 tons per square foot, depending on proximity to the water table.

A small amount of additional soils exploration will be required, particularly at the river crossings, after final tower locations have been made.

7.4 CONCRETE AGGREGATE

Two test pits were dug in a gravel bar on the Helmand River, 2 km downstream from Kajakai Dam in an area that is the most likely source of

aggregate for the powerhouse. A representative sample was prepared from these two pits and submitted for gradation analysis to the HACU soils laboratory at Chan I-Anjers. Gradation analysis of this sample showed that about 20% of the Helmand River sand and gravel deposit is greater than 1-1/2 inches in diameter, and the deposit is skip or gap graded in the coarse-sand range. Structural concrete requirements may necessitate the blending of coarse sand with the Helmand River gravels to decrease water requirements and increase workability. Good-quality coarse sand is available from Sangin Mandeh approximately 38 km downstream from Kajakai Dam, near the main Kajakai access road from the Kandahar-Girishk highway. Except for lack of the coarse fraction, the natural river gravels along the Helmand River are good-quality aggregate materials.

CHAPTER VIII
TRANSMISSION LINE ALTERNATIVES

Comparative preliminary cost estimates and line performance studies of several alternative routes, voltages and transmission structure types for the transmission of electrical power from Kajakai to Girishk and Kandahar were made in order to determine the most advantageous system. The initial results of these studies, particularly with regard to route selection, were presented in detail in IECO's report of December 1969, entitled "Kajakai Hydroelectric Power Project - Transmission Line - Selection of Route". These results, updated and supplemented for the present report, are presented in Tables VIII-2 and VIII-3 and discussed below.

8.1 ALTERNATIVE ROUTES AND VOLTAGES

The report mentioned above considered six alternatives on either of two routes. Since three of the alternatives have already been eliminated from further consideration, the following discussion is limited to two routes and three alternatives. The electrical performance of the line is summarized in Table VIII-1.

Route 1 has two sections, both originating at Kajakai. One section goes to Girishk and the other to Kandahar. The Kajakai-Girishk section, approximately 88 km in length, generally follows the existing Kajakai-Girishk road, while the 97 km Kajakai-Kandahar section crosses a remote area with mountainous terrain. The total length is 185 km. Alternative 1 consists of a 110-kv, 477-mcm ACSR, single-circuit line that follows Route 1.

Route 2 consists of one line going from Kajakai to Girishk along the existing Kajakai-Girishk road and then continuing from Girishk to Kandahar along the existing Girishk-Kandahar highway. The total length of this route is 188 km, which includes 20-km tap to Girishk, located approximately 68 km from Kajakai. Alternative 2A consists of a continuous, 161-kv, 666.6-mcm ASCR, single-circuit line that follows Route 2. Alternative 2B is the same as Alternative 2A, except that transmission is at 220 kv instead of 161 kv.

A. Alternative 1

1. Advantages

- Transmission could be at a lower voltage than would be possible with either of the alternatives that follow Route 2.

2. Disadvantages

- The construction cost of Alternative 1 would be prohibitively high because of the necessity of constructing 127 km of access road over extremely rough terrain. The only road in the area is one built by Morrison-Knudsen Company, Inc., in the 1950's. Although this road crosses Route 1 in two places, it does not follow it. For construction and later maintenance of the transmission line, a road following the route is necessary. The alignment, length and estimated cost of the required road, 127 km in length, were determined by assuming a maximum grade of 10%, a width of 4.5 meters and a 6-inch-thick gravel surface, which is the minimum surfacing for an all-weather road. Of the 127 km, 53 km were assumed to be in rocky terrain and 74 in relatively flat terrain. The estimated cost of this road, including an allowance for approximately three corrugated-metal-pipe culverts per kilometer, but not including any allow-

ances for bridges or operation and maintenance, is $24,000 per mile. This cost is not excessive when compared with the cost of other access roads in mountainous terrain. For example, four recent bids for a fire road (which is about the cheapest type of road) in mountainous terrain in the Sierra Nevada in California were $45,000, $79,000, $121,000 and $158,000 per mile, respectively.

- According to ABM's experience on existing transmission lines in Afghanistan, it would be nearly impossible to police a line going through such a remote area as Route 1 and prevent the Nomads from practicing one of their favorite pastimes--target shooting at the insulators on the transmission line.

- Although the Kajakai-Kandahar circuit would perform within tolerable limits during the initial phase (two generators at Kajakai and 24 mw maximum load at Kandahar),* overall regulation would become unacceptable after the installation of the third unit at Kajakai and the growth of the Kandahar load to 36 mw maximum, unless a second circuit were built or multiple corrective arrangements were made at Kandahar. Moreover, the ability of the Girishk plant to feed reactive power into the system to improve the overall regulation would be poor because Girishk is at the opposite end of the 185-km-long line.

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* During the initial phase this circuit would have line regulation of 9.0% and overall regulation without any corrective measures (medium-voltage bus at Kajakai to bus at Kandahar) of 21.4%.

B. Alternative 2A

1. Advantages

- The cost of Alternative 2A is lower than that of either of the other alternatives because Alternative 2A does not require construction of the long access road over rough terrain, a second circuit, or the more complicated switchyard arrangement at Kajakai, needed for Alternative 1; although higher than for Alternative 1, the requirement for high voltage equipment is less than for Alternative 2B.

- During the initial phase (two generators at Kajakai and 24 mw maximum load at Kandahar), the entire line would perform well within tolerable limits, with line regulation of 6.7% and overall regulation of 15.7%. After installation of the third unit at Kajakai and growth of the Kandahar load to 36 mw maximum, the overall uncompensated regulation would surpass the tolerable limits. However, it would be easy to compensate for this by simply providing automatic line-drop compensation for the voltage regulators at the Kajakai generators and seasonal changing of the no-load tap settings of the transformers at Kajakai and Kandahar. The ability of the Girishk plant to feed reactive power into the system would be feasible in this arrangement because the infeed point would be about midway of the line. Further improvement could be achieved by installing secondary capacitor banks at Kandahar.

2. Disadvantages

- The minimum voltage that could be used for transmission of the required power to Kandahar via Route 2 is 161 kv, which is higher than the transmission voltage for Alternative 1.

C. Alternative 2B

1. Advantages

- The line would perform within favorable limits of regulation, with minimum line losses.

2. Disadvantages

- The estimated cost of Alternative 2B is higher than that of Alternative 2A because of the higher voltage equipment required. Since 230-kv transformers of the required capacities are not of standard design or manufacture, the unit prices for transformers with these capacities are much higher than those for the smallest standard 230-kv transformers.

- Because the line-charging current largely exceeds the line-charging capacity of one generator at Kajakai, the capability of the generator would be overtaxed.

D. Selection of Recommended Alternative

Alternative 2A has been determined to be technically feasible and the most economical of the alternatives. Alternative 2A is recommended.

8.2 SELECTION OF TRANSMISSION TOWERS

Further studies were made to determine the best type of transmission tower. Steel, wood and concrete structures were considered.

The results of these studies indicated that although the estimated capital cost of wooden pole-towers is somewhat lower than that of either steel

or concrete towers, the annual cost for the transmission line with steel towers is the lowest. Therefore, it is recommended that steel be used for the Kajakai Project transmission line. Comparative cost data are given in Tables VIII-2 and VIII-3.

For the purpose of comparison, several lengths of wooden poles were considered, and 60-foot-long poles with a 600-foot ruling span were selected as the most economical. This alternative was then included in the comparison with steel and concrete towers. A study with 75-foot-long poles and a ruling span of 750 feet, which, according to USA West Coast utility companies, is the maximum span for wooden poles and the longest pole for lines without overhead wire, resulted in a transmission line capital cost of $3,537,000 and annual cost of $205,700. This capital cost is higher than that for the 60-foot pole alternative because the reduction in cost due to a smaller number of towers is more than offset by the increase in the cost of the individual poles and the additional cost for shipping and transportation of the longer poles. It was assumed that both steel towers and wooden poles would be purchased in the USA.

The main factors contributing to greater economy in the steel structure transmission line are: considerably lower shipping and transportation costs than for wooden poles, the development in recent years of especially light steel towers, and the longer life expectancy of 50 years for steel towers versus 30 years for wooden towers. An additional reason in favor of steel structures is that, according to ABM and IECO's own experience, it is impossible in Afghanistan to prevent wandering Nomads from cutting the wooden poles for fire wood and other purposes.

Prestressed, spun-type, sectionalized concrete poles were also considered for use in the project. The use of non-prestressed concrete poles is not recommended, for reasons given below, and was not eval-

uated in detail. Although substantially heavier than prestressed poles, the non-prestressed poles would have the advantage of being fabricated on-site. However, such poles have shorter life expectancies and much higher installation and maintenance costs than the prestressed poles. The estimated costs of concrete poles are based on manufacture in the USA, and the extremely high cost is due to the cost of transportation to the jobsite. Some cost reductions might be realized by prefabricating the steel portions of the poles (about 70% of the cost of manufacture) in the USA and completing the prestressing and concreting operations of the poles in Singapore, where such facilities are available. Further cost reductions would be possible if such facilities were available in Afghanistan. Without such a plant in Afghanistan, prestressed concrete poles are not economically competitive with steel towers or wooden poles.

TABLE VIII-1

SUMMARY OF ELECTRICAL DATA FOR TRANSMISSION LINE ALTERNATIVES

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
					Load mva (0.85 P.F.)		Line			Bus Voltage					+ 5% tr. tap at Kajakai Bus Voltage				+ 5% tap & LDC Kajakai Bus Voltage					
Alternative	Schematic	Rated Volt kv	Length km	Conductor	Gir.	Kand.	I^2R mw	Charge mvar	% Reg.	Kajakai NL	Kajakai FL	Kandahar NL	Kandahar FL	Kandahar % Reg w/o LDC	Kajakai NL	Kajakai FL	Kandahar NL	Kandahar FL	Kajakai NL	Kajakai FL	Kandahar NL	Kandahar FL	Kandahar % Reg. with LDC	Max. % Voltage on Kajakai bus
1		110	61 & 48	Hawk	8	24	1.1	6.4	9	14.7	14.7	14.7	12.1	21.4	14.0	14.0	14.7	12.1	12.6	14.0	12.6	12.1	4.1	101
					12	36	2.6	7.0	15	15.7	15.7	15.7	12.1	29.8	14.9	14.9	15.7	12.1	13.5	14.9	13.5	12.1	10.2	108
2A		110	188	Hawk	8	24	2.1	7.3	17	15.8	15.8	16.1	12.1	33.0	15.0	15.0	16.1	12.1	13.5	15.0	13.7	12.1	13.2	109
					12	36	5.3	8.5	27	17.1	17.1	17.4	12.1	43.8	16.3	16.3	17.4	12.1	14.7	16.3	15.0	12.1	24.0	117
2A		161	188	Flamingo	8	24	0.8	11.1	6.7	13.9	13.9	14.2	12.1	17.3	13.2	13.2	14.2	12.1	11.9	13.2	12.1	12.1	0	96
					12	36	1.8	12.5	12.4	15.2	15.2	15.5	12.1	28.0	14.5	14.5	15.5	12.1	13.1	14.5	13.3	12.1	9.9	105
2B		220	188	Flamingo	12	36	0.8	23.0	4.4	14.1	14.1	14.6	12.1	20.0	13.4	13.4	14.6	12.1	12.3	13.4	12.7	12.1	4.9	97

Notes: Columns 6-15 are taken from the calculations.
Columns 16 & 17 are 95% of columns 11 & 12.
Columns 18 & 19 are the same as 13 & 14.
Column 20 is 90% of column 16.
Column 21 is the same as column 17.
Column 22 is computed from column 20, eg., column 20/0.983.
Columns 15 & 24, reg. at Kandahar 13.8 kv bus = $(V_{nl} - V_{fl})/V_{fl}$.

+5% tap at Kajakai, reduces over voltage on Kajakai generator bus.

LDC stands for automatic Line Drop Compensation installed at Kajakai Power Plant.
NL stands for no load.
FL stands for full load.

TABLE VIII-2

KAJAKAI HYDROELECTRIC PROJECT

NOTE: No contingency or escalation included
All expressed in equivalent U.S. $
Currency exchange 1 Afghani = U.S. $0.0133

COMPARISON OF ALTERNATE SCHEMES - SINGLE CIRCUIT TRANSMISSION LINE

Item	Alt. 1 Steel 477 MCM 1000 Ft. Span 110 KV-184 Km-613 Towers			Alt.2A Steel 666 MCM 1200 Ft. Span 161 KV-188 Km 528-Towers			Alt.2B Steel 666 MCM 1200' Span 220 KW-188 Km 528 Towers			Alt.2A Wood 666MCM 600' Span 161 KV-188Km-1074-Towers			Alt.2A Conc. 666 MCM 1000 Ft. Span 161 KV188Km 650 Towers			Remarks
	Cost in $	Currency % US	L	Cost in $	Currency % US	L	Cost in $	Currency % US	L	Cost in $	Currency % US	L	Cost in $	Currency % US	L	
Single Circuit Trans Line																
Access Road	(1) 1 818 000			incl. w/Footings			incl.w/footings			incl.w/footings			incl.w/footings			(1) Access Road -127Km
Footings	(2) 134 000			(2) 103 000			(2) 103 000			(3) 278 000			126 000			(2) Grillage incl.w/Steel Towers
Towers	1 357 000			1 797 000			1 977 000			1 328 000			3 945 000			
Insulators & Fittings	205 000			176 000			190 000			354 000			176 000			(3) incl.Conc. Backfill $148,000 ±
Conductors & Ground	1 229 000			1 294 000			1 294 000			1 294 000			1 294 000			
TOTAL TRANS. LINE	4 743 000	78	22	3 370 000	83	17	3 564 000	83	17	3 254 000	79	21	5 541 000	82	18	
Switch Yard - Kajakai	396 000	76	24	200 000	76	24	321 000	76	24	200 000	76	24	200 000	76	24	
Substa.-Girishk & Kand'hr	718 000	82	18	850 000	82	18	1 367 000	82	18	850 000	82	18	850 000	82	18	
Diff. for Kajakai Transf.	θ			158 000	95	5	250 000	95	5	158 000	95	5	158 000	95	5	
TOTAL-INITIAL PHASE	5 857 000	79	21	4.578,000	83	17	5 502 000	83	17	4 462 000	80	20	6 749,000	83	17	
Less overinstalled Kajakai Transf. to 3rd Unit Cap.	θ			(94 000)	95	5	(69 000)	95	5	(94 000)	95	5	(94 000)	95	5	
TOTAL CHARGED - 2 UNITS	5 857 000	79	21	4 484 000	83	17	5 433 000	83	17	4 368 000	77	23	6 655,000	82	18	
Currency Split																
US $	4 627 000	79%		3 722 000	83%		4 495 000	83%		3 480 000	80%		5 454 000	82%		
Local as $	1 230 000		21%	762 000		17%	938 000		17%	888 000		20%	1 201 000		18%	
ADD FOR 3RD UNIT																
Transmission Line	1 633 000	82	18	θ			θ			θ						
Overinstalled 1st Phase	θ			94 000	95	5	69 000	95	5	94 000	95	5	94 000	95	5	
Kajakai Transformer	135 000	95	5	(4) 125 000	95	5	(4) 145 000	95	5	(4) 125 000	95	5	(4) 125 000	95	5	(4) Spare not connected.
Kajakai Switch Yard	142 000	76	24	θ			θ			θ			θ			
SUB STATIONS	495 000	82	18	592 000	82	18	829 000	82	18	592 000	82	18	592 000	82	18	
TOTAL FOR 3 UNITS	8 262 000	80	20	5 295 000	83	17	6 476 000	83	17	5 179 000	81	19	7 466 000	82	18	
Currency Split																
US $	6 610 000	80%		4 415 000	83%		5 378 000	83%		4 173 000	81%		6 147 000	82%		
Local as $	1 652 000		20%	880 000		17%	1 098 000		17%	1 006 000		19%	1 319 000		18%	

ANNUAL COST COMPARISON FOR TRANSMISSION LINES

	Steel Tower	Wood H Frame	Concrete Pole
Construction costs	$ 3 370 000	$ 3 254 000	$ 5 541 000
Interest during construction	105 000	102 000	173 000
Capital costs	3 475 000	3 356 000	5 714 000
Assumed Life of Line - Years	50	30	55
Capital recovery	122 530	160 350	192 280
Interim replacements	3 470	6 700	5 700
O & M	20 000	25 000	15 000
Total Annual Cost	$ 146 000	$ 192 050	$ 212 980

TABLE VIII-3

CHAPTER IX

TRAINING AND ADVISORY SERVICES PROGRAMS

9.1 CONTRACTUAL REQUIREMENTS

In compliance with requirements of the Agreement between the Royal Government of Afghanistan, represented by Da Afghanistan Breshna Moassessa, and International Engineering Company, Inc., the training and advisory services programs are outlined herein.

Section 9.2 covers the training of Afghan personnel in accordance with clause 2.1.1.7 of the Agreement which is quoted below:

> "2.1.1.7 INTERNATIONAL's outline of a training program for Afghans which will assure a cadre of trained and skilled engineers, technicians, and operators for the safe and satisfactory construction, operation and maintenance of the Project. INTERNATIONAL shall also provide an outline of a training program for Afghans connected with the Project and the two distributing agencies at Kandahar and Girishk in meter reading, billing, collecting, and accounting practices. The outlines will show the positions for which Afghans will be trained, the number for each position, the type, kind and location of the training, the duration of the training for each position, and cost estimates for the training program.
>
> In outlining the training program, INTERNATIONAL shall consider, without limitation, such pertinent programs as developed in Afghanistan Institutes, schools and by the A.I.D. participant training program".

The training program for Afghan personnel includes their training during the initial operation period of the Kajakai Power Project, in accordance with clause 4.1.1, which is quoted below:

"4.1 Generation and Transmission Project Operators

4.1.1 INTERNATIONAL shall provide the services of an electrical engineer experienced in power project operation, three experienced and skilled operators for the Generation Project, and one for the Transmission Project to assist OWNER in the initial operations and maintenance of the Project. The electrical engineer and the three operators for the Generation Project will be available during acceptance tests and for ten months and the Transmission Project operator for four months after initial operations, and shall be responsible for control of the operation and maintenance of the Project during this period. They will work closely with such Afghan counterparts as OWNER may designate to assure the safe and satisfactory operation and maintenance of the Project. INTERNATIONAL shall prepare reports from time to time but at least quarterly on the progress of the Afghan counterparts in developing the necessary skills to operate the Project without outside expertise. With respect to Afghan personnel, INTERNATIONAL shall, if conditions so warrant, recommend the addition of personnel, changes in assignment, removal, additional specific training, or such other actions as INTERNATIONAL deems necessary or appropriate to assure the succesful operation and maintenance of the Project. At the conclusion of INTERNATIONAL's services under this Article 4.1, a final report shall be prepared by INTERNATIONAL giving its comments and recommendations with respect to the continued successful operation and maintenance of the Project. Reports and

correspondence mentioned in this section shall be prepared in ten copies, five for OWNER and five for A.I.D."

Section 9.3 covers the advisory services to ABM in accordance with clause 2.1.1.8; which is quoted below:

> "2.1.1.8 INTERNATIONAL's outline of a U.S. Advisor's program to counsel and work with OWNER. U.S. Advisors with extensive backgrounds in utility management will be required to develop a management capability. The outline will show positions for which U.S. Advisors will be required, number of advisors, duration for each position, duties of each advisor and cost estimates for the advisor program."

The outlines of both programs, number of trainees and advisors, length of time for training and advisory services and respective cost estimates have been established on the basis of surveys and investigations performed by IECO in January 1970 in Afghanistan and Iran.

9.2 TRAINING PROGRAM FOR AFGHANS

A. Scope - The scope of work will involve development of the program details and provision of training for a group of 56 Afghan administrators, engineers, technicians and skilled craftsmen. The purpose of this training program will be to develop a cadre of managerial, administrative and technical personnel for the Kajakai Hydroelectric Power Project and the Electric Power Distributing Agencies of Kandahar and Boghra. By the end of the initial operation period of the project, the personnel trained under this program, together with subordinate personnel selected from the Contractor's work force, should be able to perform their functions safely, efficiently and economically, without the need for continuous assistance from foreign experts and advisors.

B. Prerequisites for Training - Prior to the assignment for training, the US AID/A Training Officer will review the qualifications of each applicant and test his proviciency in English. Proficiency requirements are commensurate with the category of the training position for which application is made:

- Managerial positions require proficiency in speaking, understanding and writing English.

- Professional positions do not require proficiency in writing unless so stipulated in the qualifications for a particular position.

- Craftsman positions require knowledge of basic English, plus the technical terms applicable to the particular skill.

Based on the results of the initial tests, the candidates who show deficiencies will attend courses in English to reach the required level of proficiency.

USA-bound trainees will attend courses in English, organized by US AID/A in Kabul, until they pass the completion tests. The maximum time needed by a candidate for full training in English is estimated to be 12 months. It is recommended that trainees for professional positions, who are not scheduled for USA training, but for whom proficiency in English is stipulated under "Subjects of Training", also attend those courses in English.

Trainees other than those mentioned above will be given practical training in English by Peace Corps Volunteers at the jobsite. US AID/A has indicated the possibility that such an arrangement could be made between them and the Peace Corps management.

The training in English by the Peace Corps should also be extended to Afghan employees of the General Contractor working on the project and potential candidates for the permanent staff of the Kajakai Power Development.

Health and accident insurance will be required for all trainees going abroad. Arrangements for the necessary documents, such as passports, visas and health cards, will be made by the trainees prior to their departure.

All trainees will join the construction work force during construction of the project. The General Construction Contract will include a clause requiring the Contractor to allocate a reasonable amount of the Contractor's supervisor's time for training and guidance of the trainees. Every procurement contract for equipment will also contain a clause requiring the manufacturer to accept some trainees in the USA during fabrication and testing of the equipment, as well as to enroll them in maintenance courses, if such are organized by the contracted manufacturer. The cost of the training with the manufacturer should be included with the equipment cost as one bid item.

The services of a Training Coordinator should be procured before actual training starts. The Training Coordinator will organize the details of the training in Afghanistan, the USA and Iran, administer implementation of the program, give trainees any assistance required while they are in the USA, control the progress of the training, and submit an evaluation of each trainee and his capabilities upon completion of his training abroad. The Training Coordinator will also train the Afghan Plant Manager in procedures of personnel training so that the Plant Manager can function as the Field Training Coordinator after returning from his training abroad.

C. Trainee Assignment Policies - After completion of their training abroad, the personnel participating in the training program will follow the construction of the project through to completion. These personnel will be assigned to work with the Contractor in fields that are commensurate with their specialization and abilities.

During construction of the project, the Field Training Coordinator will observe the performance of the Contractor's employees in such positions as helpers (mechanics, electricians and linemen), oilers, riggers, plumbers, carpenters, operators, of construction power plant, accountants, clerks, timekeepers and safety inspectos. Personnel for subordinate positions in similar fields on the project will be selected from among those who have demonstrated above-average competence.

During the initial 10-month operation period, trainees and selected subordinate employees will occupy the positions for which they were initially selected. Individuals who prove to be unsuitable for their assigned positions will be reclassified or replaced as early as possible. Upon completion of the initial operation period, these personnel should be permanently assigned to these positions. They should not be released to occupy other positions or transferred to other projects until they have fully trained reliable and competent substitutes.

During the training period, the management of ABM should give careful consideration to all recommendations of the Training Coordinators as to reclassification, rejection or promotion of trainees.

D. Organization Charts - The training program is based on the proposed organization chart for the Kajakai Hydroelectric Power Project (Chart IX-1) and a typical organization chart for the Kandahar and Boghra Distributing Agencies (Chart IX-2). The latter incorporates proposed modifications in the existing organization charts for these agencies.

Positions that require any training are indicated on the proposed charts by prefixes within parenthesis. The following coding is used to indicate the training requirements.

(a) Managerial or professional type in Afghanistan, the USA and Iran, as specified in this outline.

(b) Managerial or professional type in Afghanistan and Iran, as specified in this outline.

(c) Personnel to be selected from the Contractor's work force.

(e) Same as (c), but with some requirements of proficiency inEnglish.

(p) Presently employed and presumably competent personnel of Kajakai Dam organization who will be transferred to the project.

E. Training Schedules - The training schedules are shown on Figure IX-1, sheets 1, 2 and 3. Trainees will be grouped in four categories: Managerial, Professional, Craftsmen and Subordinate Personnel.

Training in the Managerial category will be aimed at acquainting each trainee with all aspects and routines connected with the management of a power plant or system. Positions in this category are:

Plant Manager
Chief Maintenance Engineer
Chief Operating Engineer
Chief Transmission and Distribution Engineer.

Training in the Professional category will be directed toward fully acquanting each trainee with details of the equipment and systems of the project, giving him specialized training in the field of his principal duty and developing his leadership ability. Positions in this category are:

Mechanical Maintenance Engineer
Electrical Maintenance Engineer
Transmission Line Maintenance Engineer
Area Engineer
Administrative Assistant
Chief of Administration
Mechanical Foreman

Electrical Foreman
Line Foreman
Shift Operator
Substation Operator.

Training in the Craftsman category will be aimed at developing each trainee's previously acquired skills and knowledge and acquainting him with modern methods of work. Positions in this category are:

Relay Technician
Communication Technician
Mechanic
Electrician and Lineman.

For the rest of their scheduled training, personnel in the Managerial, Professional and Craftsman categories, except personnel from the Distributing Agencies, will work on the construction of the Kajakai Hydroelectric Power Project in Afghanistan (under the supervision of the Contractor), attend local, available professional courses and visit existing power plants and power installations. Chief T & D Engineers of the Distributing Agencies will be assigned to construction of the transmission system for 12 months.

The Plant Manager will continue his on-the-job training in Afghanistan working on construction of the Kajakai Hydroelectric Power Project as the Field Training Coordinator and assisting the Project Director of ABM.

Training in the Subordinate Personnel category will cover the training of all personnel working in various positions for the Contractor during construction of the project. Personnel in this category are not shown on the schedules.

F. Description of Training Positions - The qualifications, duties, responsibilities and subjects of training of the personnel who will participate in the training program are described below:

1. Plant Manager

a. Qualifications - Graduate civil engineer, with a basic knowledge of electrical and mechanical principles and additional education or training in economics and management of personnel. Two years of previous experience in supervising a group of engineers and technicians or administrative personnel required.

b. Duties - Policy-making decisions; overall planning of operation; coordination of operation, maintenance and administration; liaison with the top management; enforcement of rules and regulations; arbitration of any disputes that cannot be solved at lower levels; control of financing; supervision and enforcement of implementation of in-house training of new personnel.

c. Responsibilities - Responsible to the top management for the safe economical and efficient production of energy, as required by the system demand, ensuring the longest possible life and best condition of the plant and equipment, and for maintaining the highest skill level of the personnel and safe working conditions.

d. Subjects of training - Management of hydro power plants and systems. Management and training of personnel. Doctrine of the PREVENTIVE MAINTENANCE. General principles of economics, accounting procedures and administration. Principles of civil, hydraulic, mechanical and electrical systems design, construction and operation. Special emphasis on familiarity with equipment for the project or similar equipment. Industrial and personnel SAFETY rules.

2. Chief Maintenance Engineer

a. Qualifications - Graduate mechanical or electrical engineer, with a basic knowledge of the principles of other engineering field and some education and training in management of personnel. Three years of previous experience with maintenance and repair of equipment for hydroelectrical plants required. Additional experience working as a craftsman desirable.

b. Duties - Acting as the Plant Manager during his absence; enforcing implementation of rules for PREVENTIVE MAINTENANCE and SAFETY of the entire plant and transmission system; approving improvement of maintenance rules, as recommended by the respective maintenance engineers; developing SAFETY programs; initiating purchase of spare parts and supplies and following up the procurement process.

c. Responsibilities - Responsible to the Plant Manager for proper PREVENTIVE MAINTENANCE of the Kajakai system, for proper and efficient functioning of the Kajakai system, for the performance of subordinates, and for the enforcement of safety rules.

d. Subjects of training - Similar to, but less intensive in management and economics than, the program for the Plant Manager. Special emphasis on: PREVENTIVE MAINTENANCE procedures and rules; familiarization with details of project equipment and systems; purchasing, stock-keeping procedures, and control of materials; and details of SAFETY program.

3. Chief Operating Engineer

a. Qualifications - Graduate electrical engineer, with managerial abilities and at least 2 years of experience as shift operator.

b. Duties - Administration of operating personnel and coordination of their work; enforcement of SAFETY rules, schedules and general order of the plant; provision of advice and assistance in emergency situations; supervision of correct maintenance of production records and compilation of statistical data; planning of generation in accordance with load demand and maintenance and SAFETY requirements.

c. Responsibilities - Responsible to the Plant Manager for efficient and continuous operation of the plant and the performance of the operators.

d. Subjects of training - PREVENTIVE MAINTENANCE and work SAFETY rules. Operation rules and procedures. Statistical records of plant operation. Load dispatching principles. Management of personnel.

4. Mechanical Maintenance Engineer

a. Qualifications - Graduate mechanical engineer with fair knowledge of electrical principles and practical methods. Two years of previous experience with hydro/mechanical equipment and systems required. Some experience working as a mechanic, millwright or plumber desirable.

b. Duties - Enforcing implementation of recommended schedules and procedures for PREVENTIVE MAINTENANCE of mechanical systems; recommending improvements of such procedures, in accordance with local conditions, with the aim of prolonging the life of the equipment; maintaining a stock of spare parts and supplies; devising and

manufacturing spare parts or devices not readily available; administering the work of mechanics and lubrication men and their respective helpers; training of subordinate personnel.

c. Responsibilities - Responsible to the Chief Maintenance Engineer for proper maintenance and reliable functioning of all hydro/mechanical equipment and systems and for the performance of subordinates.

d. Subjects of training - PREVENTIVE MAINTENANCE of hydro/mechanical equipment and systems. SAFETY rules. Details of hydro/mechanical equipment of the plant, including testing, assembly and repair methods.

5. Electrical Maintenance Engineer

a. Qualifications - Graduate electrical engineer with fair knowledge of mechanical principles and practical methods. Two years of previous experience with electrical equipment and systems required. Some experience working as an electrician or control man desirable.

b. Duties, responsibilities and subjects of training - Same as for Mechanical Maintenance Engineer, but in the field of electrical equipment and systems.

6. Transmission Maintenance Engineer

a. Qualifications - Graduate engineer with fair knowledge of electrical and structural design of transmission lines. Previous experience with construction and maintenance of transmission lines required. Some knowledge of land surveying desirable.

b. Duties - PREVENTIVE MAINTENANCE of transmission line; supervision of line patrolling and repair; maintenance of a stock of spare parts and supplies; administration and training of subordinate personnel.

c. Responsibilities - Responsible to the Chief Maintenance Engineer for proper maintenance of the transmission line and for the performance of subordinates.

d. Subjects of training - Personnel management, maintenance and SAFETY rules. Substation equipment. Construction methods. Proficiency in speaking and understanding English.

7. Communication Maintenance Engineer

a. Qualifications - Electronic or electrical engineer or technician with experience in repair and adjustment of power line carrier, protective relaying instrument maintenance.

b. Duties - Maintenance of project communication systems, relays and instruments with minimal technical advice. Supervision and training of subordinate personnel.

c. Responsibilities - Responsible to the Electrical Maintenance Engineer for proper maintenance of all precision instruments, relays and communication equipment of the project and for the performance of subordinates.

d. Subjects of training - Practical training in workshops, manufacturers' plants and utilities. Work participation during construction of the project.

8. Shift Operators

a. Qualifications - Technician with previous experience as plant operator.

b. Duties - In charge of a shift; control of the plant and system operation; maintenance of operation records; supervision and training of assistant operators and apprentices.

c. Responsibilities - Responsible to the Chief Operating Engineer for plant operation during the shift and for the performance of subordinates.

d. Subjects of training - Practical training in hydro power plants and system operation. Load dispatching principles. Full familiarity with Kajakai installation and operation procedures. SAFETY rules.

9. Maintenance Crew Foremen (Mechanical, Electrical, Line)

a. Qualifications - Technician with extensive previous experience as a craftsman and some experience in supervision of personnel.

b. Duties - Direct supervision of working crews; guidance and training of subordinates; observation of SAFETY rules in work.

c. Responsibilities - Responsible to the respective Maintenance Engineer for work and the performance of crews under his supervision.

d. Subjects of training - Crew supervision; modern methods of work; use of time- and labor-saving devices and tools; improvement of his craftsmanship; and English (to give him some proficiency in understanding English).

10. Administrative Assistant

a. Qualifications - Administrator with some knowledge of engineering and a basic knowledge of filing system, and personnel handling. Knowledge of English.

b. Duties - Routine administrative work on behalf of the Plant Manager; maintenance of technical records and library.

c. Responsibilities - Responsible to the Plant Manager for technical office work.

d. Subjects of training - Personnel management, office routines, work disciplines. English (to enable him to become proficient in speaking, understanding and writing English).

11. Chief of Administration

a. Qualifications - Administrator/Accountant, organizer.

b. Duties - Plant accounting and financial matters, personnel administration.

c. Responsibilities - Responsible to the Plant Manager for general office work, personnel welfare and payroll.

d. Subjects of training - Personnel management, accounting, cost control. English (to enable him to become proficient in speaking and understanding English).

12. Area Engineer

a. Qualifications - Graduate civil engineer with some previous experience in reservoir operation, administration of general services, road building and housing maintenance.

b. Duties - Maintenance of the project area facilities, such as the camp, intake structures, dam, roads and respective utilities. Operation of irrigation outlet valves in coordination with power plant schedules and irrigation requirements (if not controlled by another agency).

c. Responsibilities - Responsible to the Plant Manager for the performance of subordinates, for proper maintenance of the Kajakai project, and for operation of the reservoir and outlet valves.

d. Subjects of training - General services for hydroelectric plant areas; reservoir operation; maintenance of roads, houses and structures; handling of and protection against landslides.

13. Chief Transmission and Distribution Engineer, Boghra Distributing Agency

a. Qualifications - Electrical engineer with experience in maintenance of distribution systems and substations. Full familiarity with the Agency's area.

b. Duties - Design and construction supervision of the distribution system; maintenance of subtransmission and distribution lines and substations.

c. Responsibilities - Responsible to the Agency's Chief Engineer for proper operation and maintenance of transmission and dis-

tribution systems, for taking care of expansion, and for the performance of subordinates.

d. Subjects of training - Same as for position No. 6 above, plus distribution systems (HV and LV).

14. Chief of Administration, Boghra Distributing Agency

a. Qualifications - Accountant with experience in cost control, budgeting and revenue collection.

b. Duties - Maintenance of cost and revenue accounts; formulation of budgets; budget control; study of tariffs; collection of revenue; control of meter readings.

c. Responsibilities - Responsible to the Agency's Manager on financial matters.

d. Subjects of training - Cost and revenue accounting, revenue collection and meter reading methods. English (to enable him to become proficient in speaking and understanding English).

15. Substation Operators, Boghra Distributing Agency

a. Qualifications - Technician with some experience as operator.

b. Duties - In charge of a substation or a shift; control of operation of the system pertaining to the respective substation; operation of incoming HV equipment, if any, in accordance with procedures and directives received from Kajakai shift operator.

c. Responsibilities - Responsible to the Chief Transmission and Distribution Engineer for operation of substation and associated dis-

tribution system, for maintenance of operation records and for supervision and training of subordinates.

d. Subjects of training - Operation of HV and LV distribution systems. Familiarity with Kajakai power system and its operating procedures. SAFETY rules.

16. Chief Transmission and Distribution Engineer, Kandahar Distributing Agency - Same as position No. 13 above.

17. Chief of Administration, Kandahar Distributing Agency - Same as position No. 14 above.

18. Substation Operators, Kandahar Distributing Agency - Same as position No. 15 above.

19. Communication Technicians

a. Qualifications - Technicians with some experience in repair, maintenance and adjustment of power line carrier, VHF radio and telephone equipment.

b. Duties - Maintenance of project communication systems and equipment with minimal supervision and technical advice.

c. Responsibilities - Responsible to the communication maintenance Engineer for proper maintenance of communication equipment of the project.

d. Subjects of training - Practical training in workshops, manufacturers' plants and utilities; work participation during construction of the project.

20. Relay and Instrument Technicians

a. Qualifications - Technicians with some experience in repair, maintenance and adjustment of protective relays and instruments.

b. Duties - Maintenance of project relays and instruments with minimal supervision and technical advice.

c. Responsibilities - Responsible to the Communication Maintenance Engineer for proper maintenance of all precision instruments and relays of the project.

d. Subjects of training - Practical training in workshops, manufacturers' plants and utilities; work participation during construction of the project.

21. Skilled Craftsmen (9) - Mechanics, Electricians and Linemen

a. Qualifications - Technicians with craftsman's experience.

b. Duties - Performance of all assigned work well and with minimal supervision.

c. Responsibilities - Responsible to the respective Maintenance Crew Foreman.

d. Subjects of training - Practical training in workshop or in field; improvement of craftmanship; operation of machine tools or other tools and devices, as required for particular trade.

22. Communication Technicians, Boghra and Kandahar Distributing Agencies (one at each location) - Same as for position No. 19 above.

23. Relay and Instrument Technicians, Boghra and Kandahar Distributing Agencies (one at each location) - Same as for position No. 20 above.

24. Linemen, Boghra and Kandahar Distributing Agencies (two at each location) - Same as for position No. 21 above, but with special emphasis on HV & LV distribution lines.

* * *

In view of the past worldwide experience of IECO and M-K in personnel training and project management of similar types of projects, the number of trainees and type of supervised training they will receive is considered to be adequate. Each of the 56 trainees will be taught, to a certain extent, the necessity of training others and sharing their knowledge with the subordinate or less experienced personnel.

IECO's and M-K's past experience has shown that the contractor's work force is an excellent source of manpower to fill the manpower requirements for the subordinate positions listed in the organization chart. Thus, the only special training contemplated for these personnel is that which they will receive during the initial operation period from their previously trained supervisors and from the American operators.

G. Training Agencies and Institutions - The following list contains the names of agencies and institutions that can participate in the training of the Afghan personnel covered by this program.

1. USA

- Bonneville Power Administration, Portland, Oregon - Construction, operation and maintenance of transmission lines and substations; work and equipment safety codes; operating procedures; personnel training.

- Tennessee Valley Authority, Knoxville, Tennessee - Operation and maintenance of power systems; utility management; budgeting and cost control; laboratory of projects; work and equipment safety codes; personnel training; tariff structures.

- U.S. Bureau of Reclamation, Denver, Colorado - Operation maintenance of hydroelectric plants; work and equipment safety codes.

- Public Utilities District No. 1, Chelan County, Wenatchee, Washington - Same as Bureau of Reclamation above. Already had two Afghan trainees with good results.

- International Engineering Company, San Francisco, California - Design details, specifications and procurement phase of Kajakai project. General familiarization with equipment selection and characteristics.

- International Engineering Company, Kajakai office - Operation and maintenance of the project during the initial operation period.

- U.S. Department of Army, Oakland, California - Conference on Personnel Management for Executives.

- American Management Association - Various seminars on problems connected with management.

- Industrial Education Institute, Boston, Massachusetts - Various seminars on practical subjects connected with administration, warehousing, accounting, budgeting and maintenance.

- Leeds & Northrup, Philadelphia, Pennsylvania - Seminar on Energy Conversion and Electric Power Dispatching.

- Multi Amp Institute, Cranford, New Jersey - Seminars and laboratory on relay maintenance, protection coordination and instrumentation.

- Manufacturers of equipment purchased for the project - Observation of fabrication and testing of equipment for the project or similar equipment. Attendance of maintenance or other pertinent seminars or courses, where such programs can be arranged.

2. Iran

- Tehran University, Faculty of Public and Business Administration, Tehran - Management development program organized by Tehran University in cooperation with Stanford University's Graduate School of Business, Administrative Staff College of England and various industries. This program, which is given in two versions, English and Farsi, provides training in the modern management field. It is equivalent to the aforementioned conference on Personnel Management for Executives, adapted to local conditions.

- Kuzistan Water and Power Agency, Ahvaz - Operation and maintenance of the power system, transmission lines and hydro generating plant; utility management, accounting, warehousing and tariff structure.

- Tehran Municipal Electric Utility, Tehran - Power distribution; marketing; revenue collection; accounting; tariff structure.

- Ministry of Water and Power, Tehran - Planning of developments; tariff structure.

- Manpower Development Institute, Ministry of Water and Power (at present in formulation phase), Tehran - Practical training of skilled craft personnel for the power industry.

3. Afghanistan

- Afghan Institute of Technology, Kabul - Technician training; source of qualified craftsmen.

- Kabul University, Faculty of Engineering, Kabul - Advisory services, possible future postgraduate summer courses.

9.3 ADVISORY SERVICES PROGRAM

A. Scope - The number and type of advisory personnel, their scope of work and the length of each assignment have been selected on the basis of a review and evaluation of the existing organizational setup and functioning of ABM and the two distributing agencies. This review was supplemented by discussions with the management of ABM and officials of US AID/A.

The scope of work of the advisors will involve the provision of assistance and advice to ABM on all matters connected with the general, technical and financial management and effective functioning of a power utility. Specifically, the work will consist of, but not be limited to, a thorough review of the organizational structure of ABM and regional agencies, recommendations regarding any changes in this structure that will improve the managerial capacity of the organization, recommendations regarding further services of special consultants in the fields that need extensive improvement, and work, as may be required in some cases, in counterpart capacity to a managerial position needing special attention. The two fields that require the most assistance are the central engineering and maintenance organizations. One advisor for each of these fields will be provided for a 2-year term because it is anticipated that each of these advisors may at first be required to act as the counterpart, since these positions have not been filled.

B. Work Plan - The advisory team will be headed by a Manager and Advisor on Management and composed of four advisors: 1) a Technical Advisor, 2) an Advisor on Maintenance, 3) an Advisor on Accounting and Finance, and 4) an Advisor on Kajakai Operation and Maintenance.

The team Manager and Advisor on Management, in addition to providing general advisory services to the management of ABM, will establish a detailed work program for the team and coordinate the team's activities.

The Technical Advisor will establish the organization and functional responsibility of the central engineering division of ABM for efficient utilization of the technical manpower available in Afghanistan, either recent graduates of Kabul University or older graduates with some experience and foreign training. Contributions of technical advisors from other nations, who are assisting ABM, will be consolidated to

form an effective engineering work program. The present engineering organization of ABM has neither a scope of work nor an established organizational structure.

The Advisor on Maintenance will establish the organization and functional responsibility of a new central maintenance division of ABM for efficient, effective, coordinated maintenance of the entire power system of Afghanistan. All available information from manufacturers and contributions of other consultants will be consolidated to form a coordinated maintenance program.

The Advisor on Accounting and Finance will work with a well-established organization of ABM. The present accounting and revenue collection procedures are adequate and cannot be improved very much without changing the social and economic structure of the country. Improved warehousing procedures should be recommended by this advisor.

The Advisor on Kajakai Operation and Maintenance will establish a general program for planning and operation of the generation and load dispatching facilities, with particular attention to the operation of the Kajakai Power System. He will also advise on implementation of the overall maintenance program. His assignment will begin late in 1974, after the engineering and maintenance organizations are fully operative and the initial operation period of Kajakai Power System is complete.

G. Advisory Services Schedule - To accomplish the scope of work described above, the advisory team will perform the entire work in Afghanistan, as shown on the following schedule.

Advisory Team	1971	1972
(1) Team Manager	xxxxxxxxxxxx	xxxxxxxxxxxx
(2) Technical Advisor	xxxxxxxxxxxx	xxxxxxxxxxxx
(3) Advisor on Maintenance	xxxxxxxxxxxx	xxxxxxxxxxxx
(4) Advisor on Accounting and Finance		xxxxxxxxxxxx
(5) Advisor on Kajakai O&M		starts August 1974 & terminates July 1975

D. Description of Advisory Positions - The qualifications and duties of the advisors are as follows:

1. Team Manager and Advisor on Management

a. Qualifications - BBA, BSE or BEE with extensive experience in power utility management and management consulting.

b. Duties - Coordination of advisory team work. Advisor to the General Manager of ABM. Review and recommendation of changes in organizational structure of ABM. Principles of assignment and division of duties and responsibilities; effective use of delegation of authority; coordination of efforts; and effective leadership.

2. Technical Advisor, counterpart to Technical Director

a. Qualifications - BSE or BEE with experience in management of power utility engineering department.

b. Duties - Assisting, or acting as, Technical Director of ABM. Establishment of the Central Engineering Division. Standarization of systems equipment and engineering methods. Planning of power development. Power survey principles.

3. Advisor on Maintenance, counterpart to Maintenance Director

a. Qualifications - BSEE, BEE or BSME with experience in management of power utility maintenance department and warehouses.

b. Duties - Assisting, or acting as, Maintenance Director of ABM. Establishment of the Central Maintenance Division. Introduction of PREVENTIVE MAINTENANCE principles. Maintenance methods and schedules. Repair work principles. Spare part stock standarization, control and purchasing principles. Reorganization of central instrument and relay testing laboratory and repair shop.

4. Advisor on Accounting and Finance

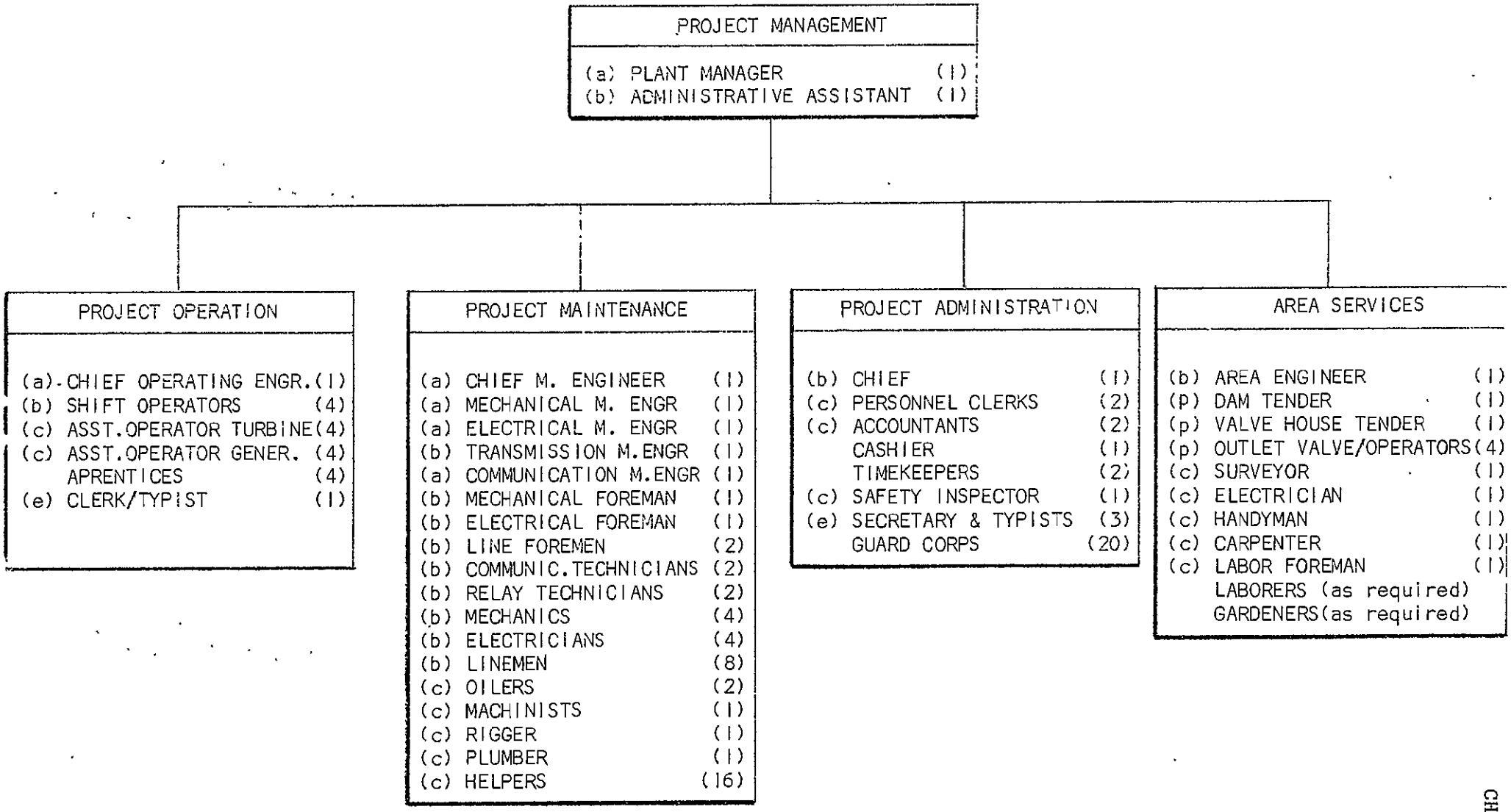
a. Qualifications - Accountant, BBA with experience in management of power utility finances.

b. Duties - Advising the Director of Finances or Controller of ABM. Review of revenue collection and accounting, cost accounting and budgeting methods. Control of accounts and modern methods. Preparation of financial statements for management. Study of tariffs and recommendations for improvements. Review of warehouse stock control and procedures.

5. Advisor on Kajakai Operation and Maintenance

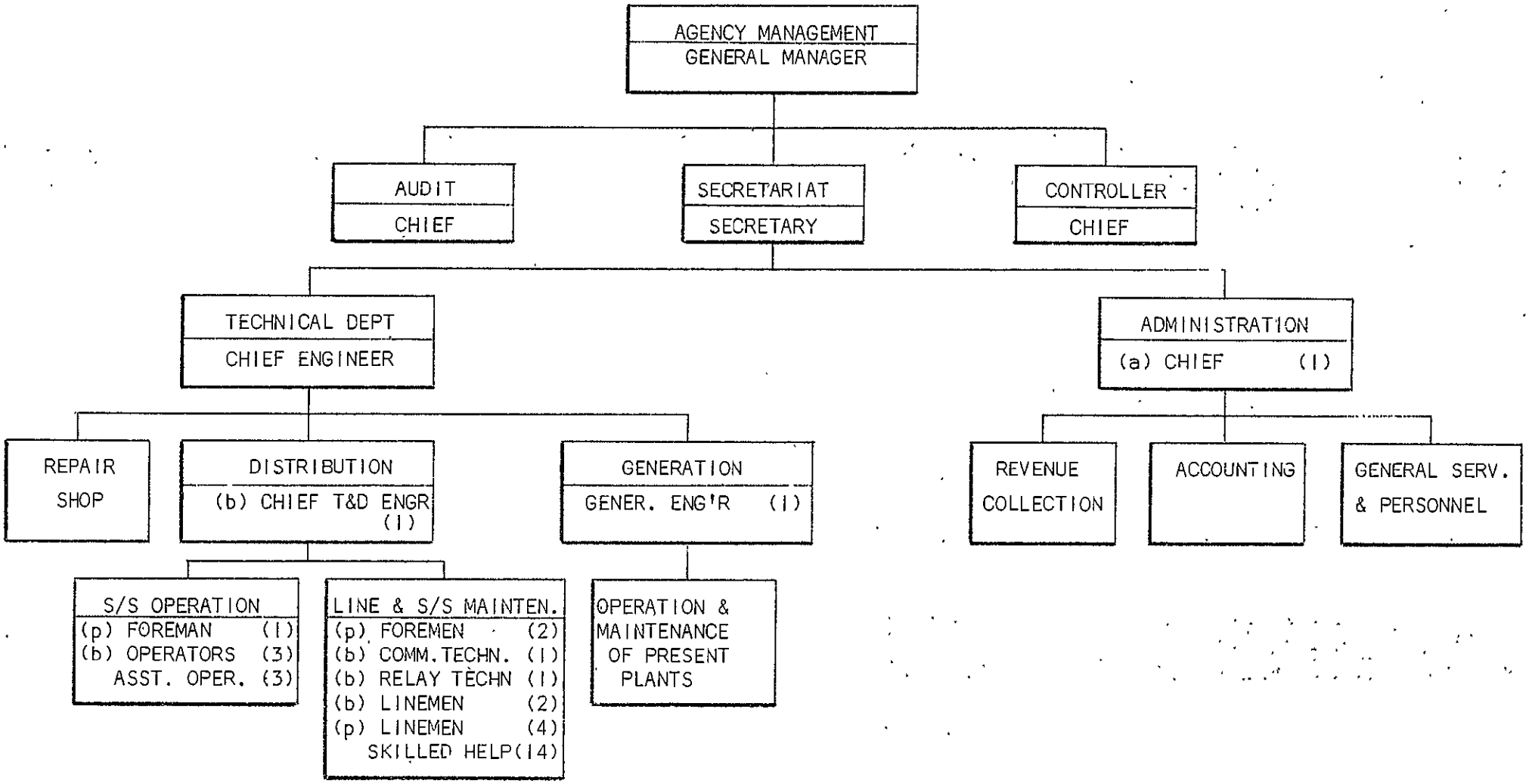
a. Qualifications - BSEE, BSME or BEE with experience in management of hydroelectric generation and transmission department.

b. Duties - Advisor to Kajakai Plant Manager and Director of Generation of ABM. Enforcement of PREVENTIVE MAINTENANCE at Kajakai, in particular, and overall ABM system, in general. Load dispatching. Operation procedures, routines and statistics. SAFETY rules.



KAJAKAI POWER PROJECT ORGANIZATION CHART

CHART IX-1



DISTRIBUTING AGENCY ORGANIZATION CHART

CHART IX-2

FIGURE IX-1

TRAINING PROGRAM

Sheet 1 of 3 Sheets

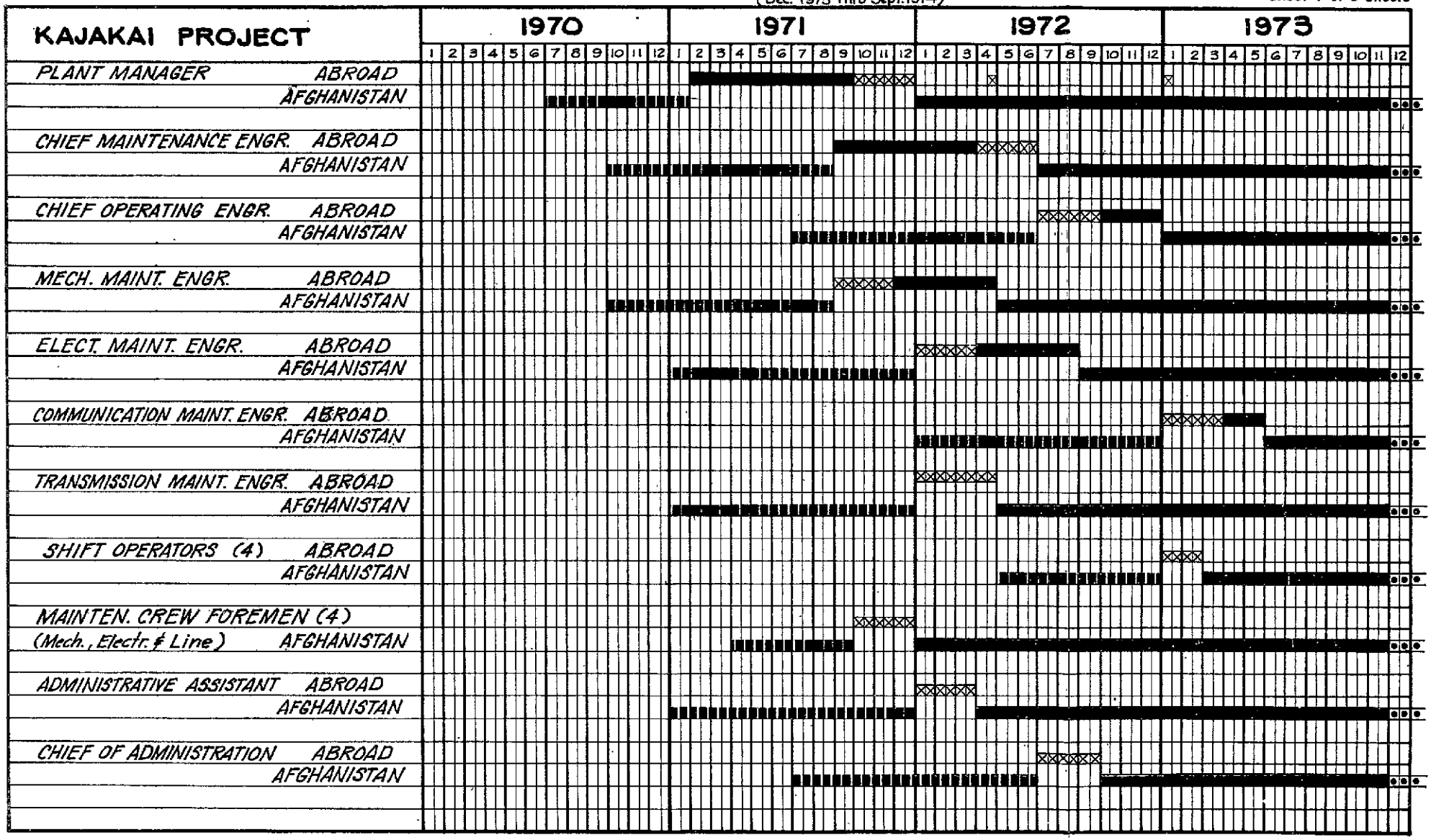


FIGURE IX-1

TRAINING PROGRAM

Sheet 2 of 3 Sheets

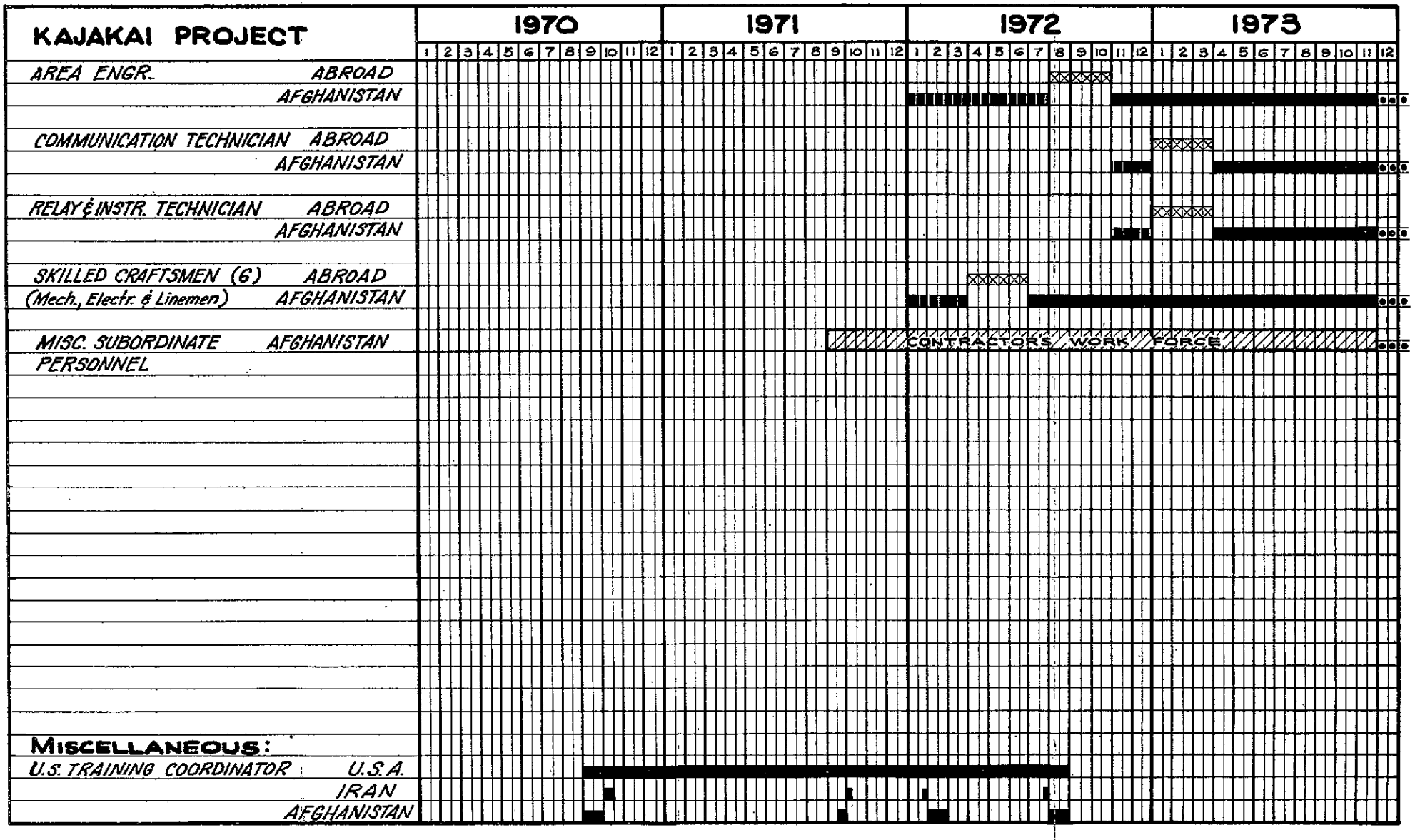
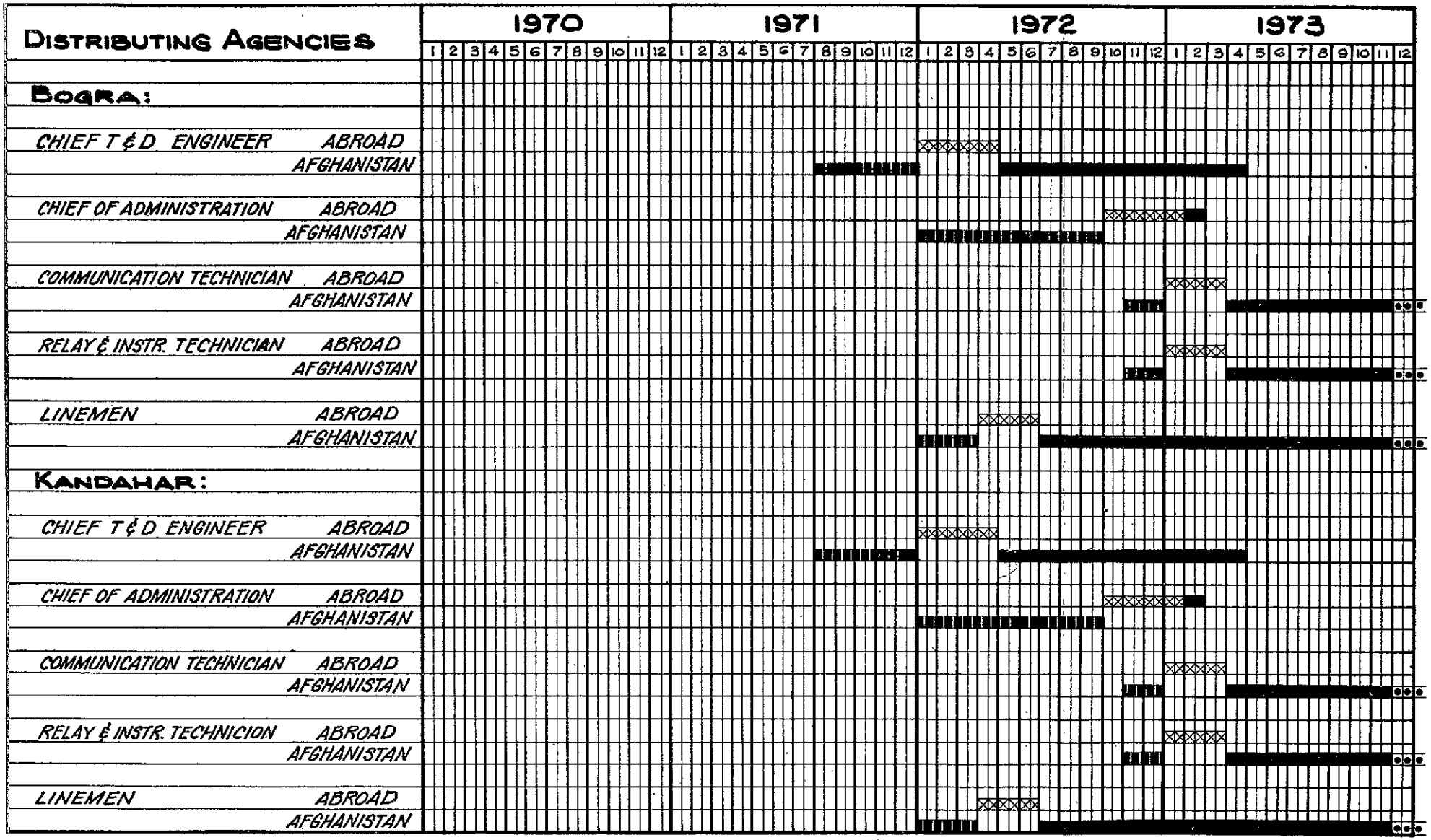


FIGURE IX - I

TRAINING PROGRAM

Sheet 3 of 3 Sheets



KAJAKAI TRAINING PROGRAM

COST ESTIMATE

SUMMARY

		Man-Months				U.S. Dollars or Dollar Equivalents			
	No.	Afg.	Iran	USA	Total	Afghanis	Rials	U.S.	Total
Afghan Trainees	56	1,557	171	32	1,760	81,700	61,500	38,800	182,000
Training Coordinator	1	P.D.	P.D.	24	24	2,100	1,400	82,200	85,700
IECO Training Services	7	55	-	3	58	8,000	-	235,000	243,000
Subtotal-Training Program	64	1,612	171	59	1,842	91,800	62,900	356,000	510,700
Mgm't Advisory Service	5	96	-	-	96	48,000	-	435,600	483,600
TOTAL	69	1,708	171	59	1,938	139,800	62,900	791,600	994,300

Currency Split:

U. S. Dollars	791,600
Afghanis & Rials (Equiv. U.S. Dollars)	202,700
T O T A L	994,300

TABLE IX-1

KAJAKAI TRAINING PROGRAM

COST ESTIMATE

AFGHAN TRAINEES - AFGHANI COSTS

		Man-Months				Afghani Costs in Equivalent U. S. Dollars					
	No.	Afg.	Iran	USA	Total	Rate/Yr.	Total Salary *	Misc. Costs	Travel to Tehran	Travel to U.S.A.	Total
KAJAKAI POWER PLANT											
(1) Plant Manager	1	39	4	8	51	750	3,188	20	220	1,400	4,828
(2) Ch. Maint. Engr.	1	39	3	7	49	670	2,736	20	-	1,400	4,156
(3) Ch. Operating Engr.	1	33	3	3	39	510	1,658	20	-	1,400	3,078
(4) Mech. Maint. Engr.	1	41	3	5	49	460	1,878	20	-	1,400	3,298
(5) Electr.Maint. Engr.	1	37	3	5	45	460	1,725	20	-	1,400	3,145
(6) Transm.Maint.Engr.	1	42	3	-	45	460	1,725	20	110	-	1,855
(7) Comm. Maint. Engr.	1	28	3	2	33	440	1,210	20	-	1,400	2,630
(8) Shift Operators	4	124	8	-	132	390	4,290	80	440	-	4,810
(9) Maint. Foremen	4	156	12	-	168	440	6,160	80	440	-	6,680
(10) Admin. Assistant	1	42	3	-	45	460	1,725	20	110	-	1,855
(11) Chief of Admin.	1	36	3	-	39	510	1,658	20	110	-	1,788
(12) Area Engineer	1	30	3	-	33	510	1,403	20	110	-	1,533
(19) Communic. Techn.	2	38	8	-	46	410	1,572	40	220	-	1,832
(20) Relay & Instr. Techn.	2	38	8	-	46	410	1,572	40	220	-	1,832
(21) Skilled Crafts Men (4 Mechanics, 4 Electricians, 8 Linemen)	16	480	48	-	528	390	17,160	320	1,760	-	19,240
Subtotal	38	1,203	115	30	1,348		49,660	760	3,740	8,400	68,560
DISTRIBUTION AGENCIES											
(13)&(16) Chief T&D Engr.	2	32	8	-	40	510	1,700	40	220	-	1,960
(14)&(17) Chief of Admin.	2	18	8	2	28	510	1,190	40		2,800	3,030
(15)&(18) S/Stn.Operators	6	108	12	-	120	390	3,900	120	660		4,680
(22) Communic. Techn.	2	38	8	-	46	410	1,572	40	220	-	1,832
(23) Relay & Instr. Techn.	2	38	8	-	46	410	1,572	40	220	-	1,832
(24) Linemen	4	120	12	-	132	390	4,290	80	440	-	4,810
Subtotal	18	354	56	2	412		14,224	360	1,760	2,800	19,144
TOTAL	56	1,557	171	32	1,760		63,884	1,120	5,500	11,200	81,704

* Salaries of Afghan Trainees for entire training period paid in Afghans.

TABLE IX-3

KAJAKAI TRAINING PROGRAM

COST ESTIMATE

AFGHAN TRAINEES - IRANIAN RIAL COSTS

			Iranian Rial Costs in Equivalent U.S. Dollars						
	No.	Man-Months	Per Diem	Training Aide	Tuition Fees	Insurance	Misc. Costs	Local Travel	Total
KAJAKAI POWER PLANT									
(1) Plant Manager	1	4	1,080	40	550	48	60	150	1,928
(2) Ch. Maint. Engr.	1	3	810	30	550	36	20	50	1,496
(3) Ch. Operating Engr.	1	3	810	30	490	36	20	50	1,436
(4) Mech. Maint. Engr.	1	3	810	30	60	36	20	50	1,006
(5) Electr. Maint. Engr.	1	3	810	30	60	36	20	50	1,006
(6) Transm. Maint. Engr.	1	3	810	30	60	36	20	50	1,006
(7) Comm. Maint. Engr.	1	3	810	30	60	36	20	50	1,006
(8) Shift Operators	4	8	2,160	80	160	96	80	200	2,776
(9) Maint. Foremen	4	12	3,240	120	240	144	80	200	4,024
(10) Admin. Assistant	1	3	810	30	490	36	20	50	1,436
(11) Chief of Admin.	1	3	810	30	490	36	20	50	1,436
(12) Area Engineer	1	3	810	30	60	36	20	50	1,006
(19) Communic. Techn.	2	8	2,160	80	160	96	40	100	2,636
(20) Relay & Instr. Techn.	2	8	2,160	80	160	96	40	100	2,636
(21) Skilled Craftsmen (4-Mechanics 4-Electrician 8-Linemen	16	48	12,960	480	960	576	320	800	16,096
Subtotal	38	115	31,050	1,150	4,550	1,380	800	2,000	40,930
DISTRIBUTION AGENCIES									
(13)&(16) Chief T&D Engr.	2	8	2,160	80	980	96	40	200	3,556
(14)&(17) Chief of Admin.	2	8	2,160	80	1,100	96	40	100	3,576
(15)&(18) S/Stn. Operators	6	12	3,240	120	240	144	120	300	4,164
(22) Communic. Techn.	2	8	2,160	80	160	96	40	100	2,636
(23) Relay & Instr. Techn.	2	8	2,160	80	160	96	40	100	2,636
(24) Linemen	4	12	3,240	120	240	144	80	200	4,024
Subtotal	18	56	15,120	560	2,880	672	360	1,000	20,592
TOTAL - RIAL COSTS	56	171	46,170	1,710	7,430	2,052	1,160	3,000	61,522

KAJAKAI TRAINING PROGRAM

COST ESTIMATE

AFGHAN TRAINEES - DOLLAR COSTS

			Costs in U.S. Dollars						
	No.	Man-Months	Per Diem	Training Aids	Tuition Fees	Insur-ance	Misc. Costs	Local Travel	Total
KAJAKAI POWER PLANT									
(1)Plant Manager	1	8	4,800	120	4,400	96	80	200	9,696
(2)Chief Maintenance Engineer	1	7	4,200	105	3,850	84	70	200	8,509
(3)Chief Operating Engineer	1	3	1,800	45	1,650	36	30	75	3,636
(4)Mechanical Maint. Engineer	1	5	3,000	75	2,750	60	50	100	6,035
(5)Electrical Maint. Engineer	1	5	3,000	75	2,750	60	50	100	6,035
(6)Comm. Maintenance Engineer	1	2	1,200	30	1,100	24	20	50	2,424
Subtotal	6	30	18,000	450	16,500	360	300	725	36,335
DISTRIBUTION AGENCIES									
(14)&(17)Chief of Administration	2	2	1,200	30	1,100	24	20	100	2,474
TOTAL-Dollars	8	32	19,200	480	17,600	384	320	825	38,809

TABLE X-4

KAJAKAI TRAINING PROGRAM

COST ESTIMATE

TRAINING SERVICES

(Costs in U.S. Dollars or U.S. Dollar Equivalents)

	Man-Mo.	Personnel costs	Lv. Allow. or Per Diem	Processing	Travel Per Diem	Tr. Aids & Misc.	Local Travel	Int'l. Travel	Misc. Other Direct	Total
TRAINING COORDINATOR										
Field Trips - Afghanistan (Afghanis)										
1970	1.0		450			50	100			600
1971	0.5		225			50	100			375
1972	2.0		900			100	150			1,150
Subtotal - Afghanis	3.5		1,575			200	350			2,125
Field Trips - Iran (Rials)										
1970	0.5				350	100	50			500
1971	0.5				350	50	50			450
1972	0.5				350	50	50			450
Subtotal - Rials	1.5				1,050	200	150			1,400
Field Trips - U.S.A. (Dollars)										
1970	4	12,480		200	90	250		1,400		14,420
1971	12	37,440		50	90	500		1,400		39,480
1972	8	24,960		100	180	250		2,800		28,290
Subtotal - Dollars	24	74,880		350	360	1,000		5,600		82,190
TOTAL	29	74,880	1,575	350	1,410	1,400	500	5,600		85,715
ECO TRAINING SERVICES										
Home Office	3									
Field E. Engr.	13									
Plant Oper. (2)	36									
Trans. Oper (1)	6									
Total man months	58									
Subtotal - Afghanis			6,650				200		1,150	8,000
Subtotal - Dollars		182,150	12,220	1,250	1,020	10,210		21,375	6,775	235,000
TOTAL		182,150	18,870	1,250	1,020	10,210	200	21,375	7,925	243,000
ANAGEMENT ADVISORY SERVICES										
Afghanistan Costs (Afghanis)										
1. Advisor	24		12,000							12,000
2. Advisor	24		12,000							12,000
3. Advisor	24		12,000							12,000
4. Advisor	12		6,000							6,000
5. Advisor	12		6,000							6,000
Subtotal	96		48,000							48,000
U.S.A. Costs (Dollars)										
1 a. Advisor	24	103,680		150	90	4,000		1,400		109,320
b. Family				300	180			2,800		3,280
2 a. Advisor	24	103,680		150	90	4,000		1,400		109,320
b. Family				300	180			2,800		3,280
3 a. Advisor	24	103,680		150	90	4,000		1,400		109,320
b. Family				300	180			2,800		3,280
4. Advisor	12	46,080		150	90	1,200		1,400		48,920
5. Advisor	12	46,080		150	90	1,200		1,400		48,920
Subtotal	96	403,200		1,650	990	14,400		15,400		435,640
TOTAL	96	403,200	48,000	1,650	990	14,400		15,400		483,640

BASIC RATES FOR KAJAKAI TRAINING PROGRAM COST ESTIMATES

(In U.S. Dollars or Equivalent U.S. Dollars)

Trainees

Local salary, per year, receivable by trainees during the entire period of training abroad or at home.

Training position No.		
(1)		750
(2)		670
(3), (11), (12), (13), (14), (16) & (17)		510
(4), (5), (6) & (10)		460
(7) & (9)		440
(19), (20), (22) & (23)		410
(8), (15), (18), (21) & (24)		390
Living allowance, per diem		
Iran		9
USA		20
Training aids, per month		
Iran		10
USA		15
Tuition fees, per month		
Iran		20
USA		550
Special courses in Iran in English		550
Special courses in Iran in Farsi		490
Travel (Y-class)		
To and from Iran and USA	(each)	1,400
To and from Iran only	(each)	110
Within USA		
1- to 2-month assignment	(each)	50
3-month assignment	(each)	75
5-month assignment	(each)	100
Executive assignment	(each)	200
Within Iran, per assignment		50
Insurance, per month		12
Processing and miscellaneous		
Local	(total)	20
Iran	(total)	20
USA	(per mo.)	10

BASIC RATES FOR KAJAKAI TRAINING PROGRAM COST ESTIMATES

(In U.S. Dollars or Equivalent U.S. Dollars)

USA Personnel	
Local salary per year	
Training coordinator (@ $1300/month)	15,600
Management advisor, 1st category (@ $1800/month)	21,600
Management advisor, 2nd category (@ $1600/month)	19,200
Markup for overhead and fee - (1.4 times salary)	
Temporary assignment, per diem	
Afghanistan	15
Iran	25
USA	25
Living allowance, per month, Afghanistan (Management advisors on long-term assignments)	500
Travel - Same as for Afghan Trainees	
Travel living allowance (6 days per round trip @ $15/day)	90
Processing, per person	150
Household effects	
Single status	1,200
Family status	4,000

CHAPTER X
COST ESTIMATES

Estimates of quantities and costs of the project features are presented at the end of this chapter. The quantity estimates of the power intake, power tunnel, penstock, plug and powerhouse are based on takeoffs from the drawings. The costs of work items were estimated according to the equipment, materials, supplies and labor needed for the work, and according to the production rates that can be expected. These costs include special costs associated with the establishment of a camp and staff at the site by a USA construction company.

Estimates for the Kajakai switchyard, the Girishk and Kandahar substations, and the transmission line are based on manufacturers' quotations for equipment and structures and on experience records for costs of site preparation and foundation and erection work for similar facilities.

Basic cost data, such as local wage rates, material costs, and local and ocean freight rates, were collected during a site investigation.

Materials and supplies produced in Afghanistan and Afghan personnel will be used as much as possible in construction. One example is locally produced cement, which has been used successfully in similar projects and which will be used in the construction of the Kajakai Project. Equipment, materials and supplies required for the work, but not available locally are assumed to be of USA origin. The major permanent equipment items, such as turbines, generators and transformers, will be obtained through procurement contracts, separate from the general contract. These procurement contracts will include shipment

to Karachi, Pakistan, or Khorramshahr, Iran, as determined by the general contractor, who will be responsible for further transportation to the site and installation. The procurement and construction contracts, as presently planned, are listed in Table A-1.

The estimated costs include an allowance for the amount of escalation that can be expected during construction as presently scheduled and shown on Figures A-1 and A-2.

The capital cost of the project, which is summarized in Table X-1, includes a 10% allowance for contingencies in the estimated costs of construction, engineering and the training program.

TABLE X-1

KAJAKAI HYDROELECTRIC POWER PROJECT

SUMMARY OF ESTIMATED COSTS

	U.S.$	Local $ Equiv.	Total U.S. $
CONSTRUCTION			
Mobilization	100,000	100,000	200,000
Power intake	682,000	231,000	913,000
Power tunnel	256,000	127,000	383,000
Penstock & plug	691,000	260,000	951,000
Power plant	5,292,000	839,000	6,131,000
Switchyard - Kajakai	195,000	62,000	257,000
Substation			
Kandahar	381,000	83,000	464,000
Girishk	314,000	72,000	386,000
Transmission line	2,782,000	588,000	3,370,000
Subtotal	10,693,000	2,362,000	13,055,000
(currency split in %)	(82)	(18)	(100)
Contingency (10%)	1,069,000	236,000	1,305,000
TOTAL CONSTRUCTION COST	11,762,000	2,598,000	14,360,000
Interest on construction (2-1/2 % on U.S. $)	-	294,000	294,000
Engineering *	2,042,000	75,000	2,117,000
Training **	793,000	201,000	994,000
Engineering & Training contingencies (10%)	283,000	28,000	311,000
TOTAL CAPITAL COST - Phase IA	14,880,000	3,196,000	18,076,000

* Excluding IECO training activities

** Includes IECO training activities

COST ESTIMATE

POWER INTAKE

Description	Quantity	Unit	Costs in U.S. $ and U.S. $ Equivalents			
			Unit Cost	Local Equiv.	U.S.	Total
POWER INTAKE						
Access road						
Excavation	16,000	m^3	3.00	9,600	38,400	48,000
Base	1,200	m^2	0.90	700	380	1,080
Guard rail	150	l.m.	20.00	600	2,400	3,000
Excavation - intake	500	m^3	6.00	600	2,400	3,000
Drill & grout anchor holes	750	l.m.	4.60	1,170	2,280	3,450
Drill grout holes	600	l.m.	6.50	1,200	2,700	3,900
Grout foundation	2,000	sack	5.70	6,200	5,200	11,400
Concrete	3,200	m^3	90.00	125,300	162,700	288,000
Reinforcing steel	320,000	kg	0.66	46,200	165,000	211,200
Misc. metal	10,000	kg	2.10	3,400	17,600	21,000
Install fixed wheel gate and hoist	L.S.	-	-	18,500	18,500	37,000
Furn. & install trash racks	50,000	kg	2.00	13,600	86,400	100,000
Electrical	L.S.	-	-	3,300	11,200	14,500
Miscellaneous	L.S.	-	-	330	1,200	1,530
Subtotal				230,700	516,360	747,060
Furnish fixed wheel gate and hoist				-	165,640	165,640
TOTAL - POWER INTAKE				230,700	682,000	912,700

TABLE X-2

COST ESTIMATE

POWER TUNNEL, PENSTOCK AND PLUG

Description	Quantity	Unit	Unit Cost	Costs in U.S. $ and U.S. $ Equivalents: Local	U.S.	Total
POWER TUNNEL						
Excavation	3,100	m^3	30.00	18,200	74,800	93,000
Concrete plug in tunnel	1,580	m^3	56.00	43,650	44,830	88,480
Concrete lining	740	m^3	118.00	34,361	52,959	87,320
Reinforcing	60,000	kg	.66	7,671	31,929	39,600
Steel supports	50,000	kg	.89	7,730	36,770	44,500
Drill grout holes	800	l.m.	5.70	1,040	3,520	4,560
Grout	2,600	sack	9.60	13,200	11,760	24,960
Drill drain holes	100	l.m.	5.70	440	130	570
TOTAL - POWER TUNNEL				126,290	256,710	383,000
PENSTOCK & PLUG						
Excavation - Plug	900	m^3	30.00	5,280	21,720	27,000
Concrete plug	2,728	m^3	56.00	101,200	51,600	152,800
Concrete anchors & encase.	2,200	m^3	67.00	90,550	56,850	147,400
Reinforcing	181,000	kg	.66	23,137	96,323	119,460
Penstocks	360,000	kg	1.35	37,282	448,718	486,000
Fill line	4,000	kg	.80	638	2,562	3,200
Misc. metal	4,000	kg	2.70	1,262	9,538	10,800
Electricity	L.S.	-	-	90	910	1,000
Paint	L.S.	-	-	664	2,276	2,940
TOTAL - PENSTOCK & PLUG				260,100	690,500	950,600

TABLE X-3

COST ESTIMATE

POWER PLANT

Description	Quantity	Unit	Costs in U.S. $ and U.S. $ Equivalents: Unit Cost	Local Equiv.	U.S.	Total
Dewater - cofferdam	L.S.	-	-	10,000	26,000	36,000
Excavation - channel	10,000	m^3	5.40	11,600	42,400	54,000
Excavation - common	15,000	m^3	2.50	8,700	28,800	37,500
Excavation - rock	5,000	m^3	5.40	5,800	21,200	27,000
Compacted backfill	5,500	m^3	2.00	3,150	7,850	11,000
Riprap	800	m^3	18.00	4,700	9,700	14,400
Drill grout holes	700	l.m.	5.70	930	3,060	3,990
Foundation grouting	2,300	sack	9.60	11,680	10,400	22,080
Concrete:						
Substructure	2,100	m^3	60.00	61,740	64,260	126,000
Inter structure	2,100	m^3	62.50	64,310	66,940	131,250
Superstructure	620	m^3	100.00	30,400	31,600	62,000
2nd stage	1,000	m^3	65.00	31,850	33,150	65,000
Retaining walls	1,100	m^3	85.00	45,820	47,680	93,500
Reinforcing steel	700,000	kg	.66	101,000	361,000	462,000
Misc. metal	15,000	kg	2.10	5,100	26,400	31,500
Furnish and install:						
Draft tube gates	L.S.	-	-	11,600	68,500	80,100
Crane - (10-T)	L.S.	-	-	2,400	14,300	16,700
Powerhouse crane - 125T	L.S.	-	-	36,000	252,000	288,000
Architectural work	L.S.	-	-	36,200	50,100	86,300
Furnish and install:						
Water system	L.S.	-	-	46,700	8,300	55,000
Sewer system	L.S.	-	-	8,400	1,400	9,800
Oil system	L.S.	-	-	3,300	20,700	24,000
Compressed air	L.S.	-	-	3,000	14,900	17,900
CO_2 system	L.S.	-	-	3,200	15,300	18,500
Pipe, pumps	L.S.	-	-	7,100	34,600	41,700
Heat and ventilation	L.S.	-	-	5,800	27,900	33,700
Station serv. switchgear	L.S.	-	-	16,100	91,600	107,700
Conduit, lighting, wiring	L.S.	-	-	43,000	295,000	338,000
Misc. controls	L.S.	-	-	6,900	34,500	41,400
Install:						
Butterfly valves	L.S.	-	-	16,500	19,200	35,700
Pressure relief valves	L.S.	-	-	15,700	17,600	33,300
Turbines and governors	L.S.	-	-	67,200	75,000	142,200
Generators	L.S.	-	-	80,900	237,700	318,600
Main control switchgear	L.S.	-	-	17,900	33,600	51,500
Transformers	L.S.	-	-	14,500	18,400	32,900
Subtotal				839,180	2,111,040	2,950,220
Furnish:						
Butterfly valves	L.S.	-	-	-	283,000	283,000
Turbines and governors	L.S.	-	-	-	1,235,000	1,235,000
Pressure relief valves	L.S.	-	-	-	262,000	262,000
Generators & transformers	L.S.	-	-	-	1,200,000	1,200,000
Main control switchgear	L.S.	-	-	-	201,080	201,080
TOTAL - POWER PLANT				839,180	5,292,120	6,131,300

APPENDIX A

FIGURES AND TABLES

▽ SUBMIT TO ABM & AID FOR APPROVAL
□ APPROVAL BY AID
▼ ADVERTISE FOR BIDS
⊕ CONTRACT AWARD

FIGURE A-1

KAJAKAI HYDROELECTRIC PROJECT
BAR SCHEDULE FOR
DESIGN, CONSTRUCTION & PROCUREMENT

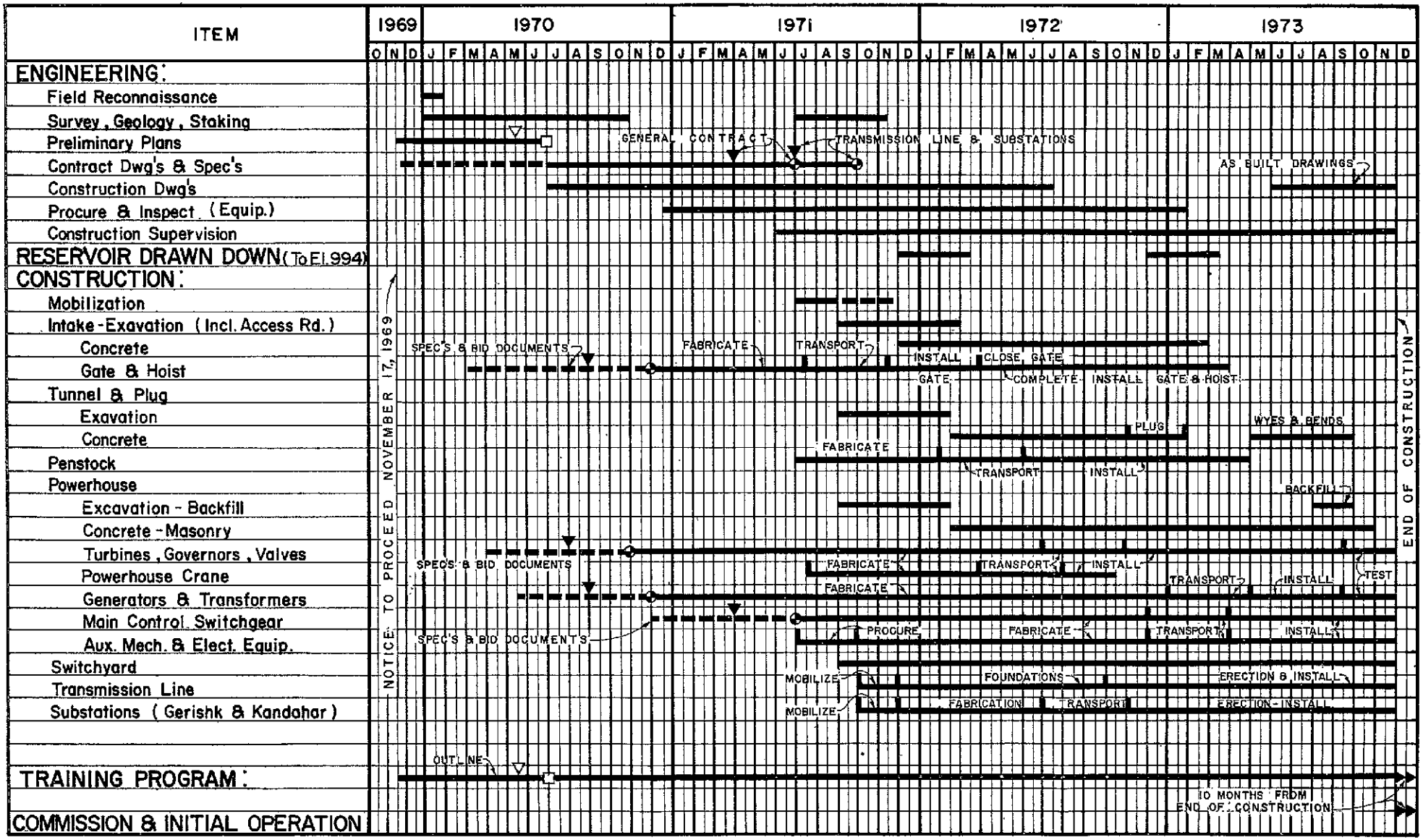


FIGURE A-2

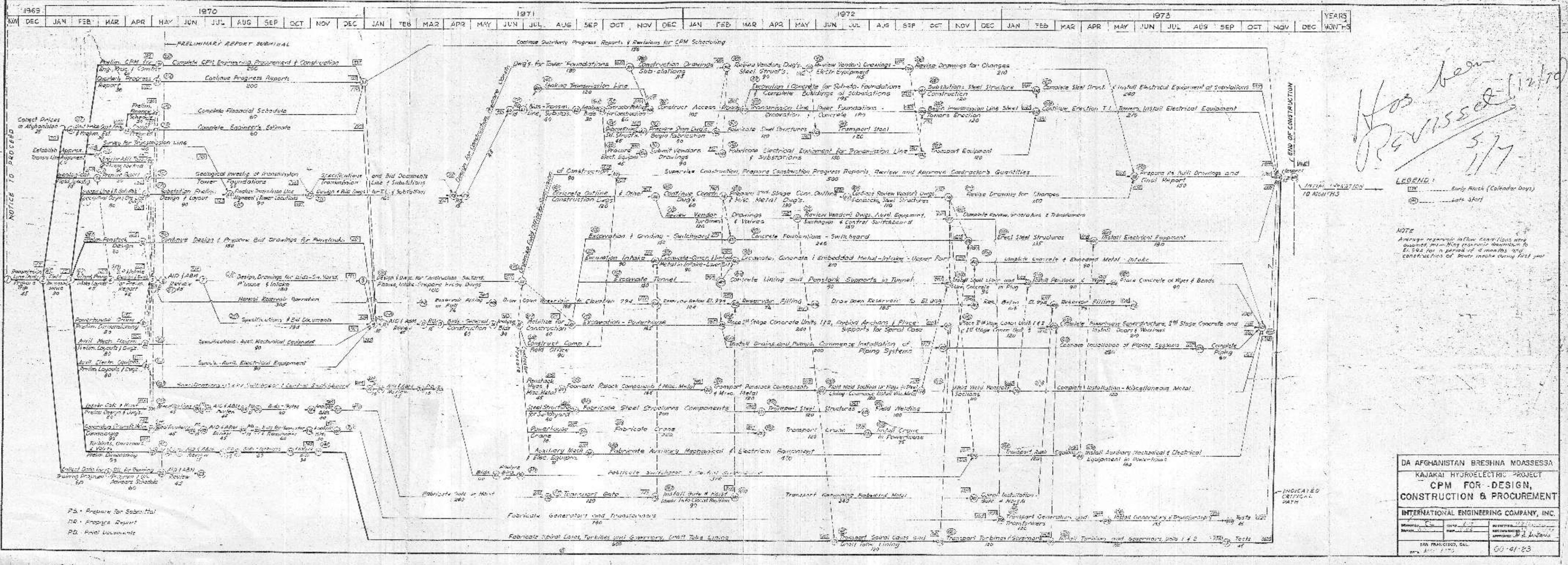
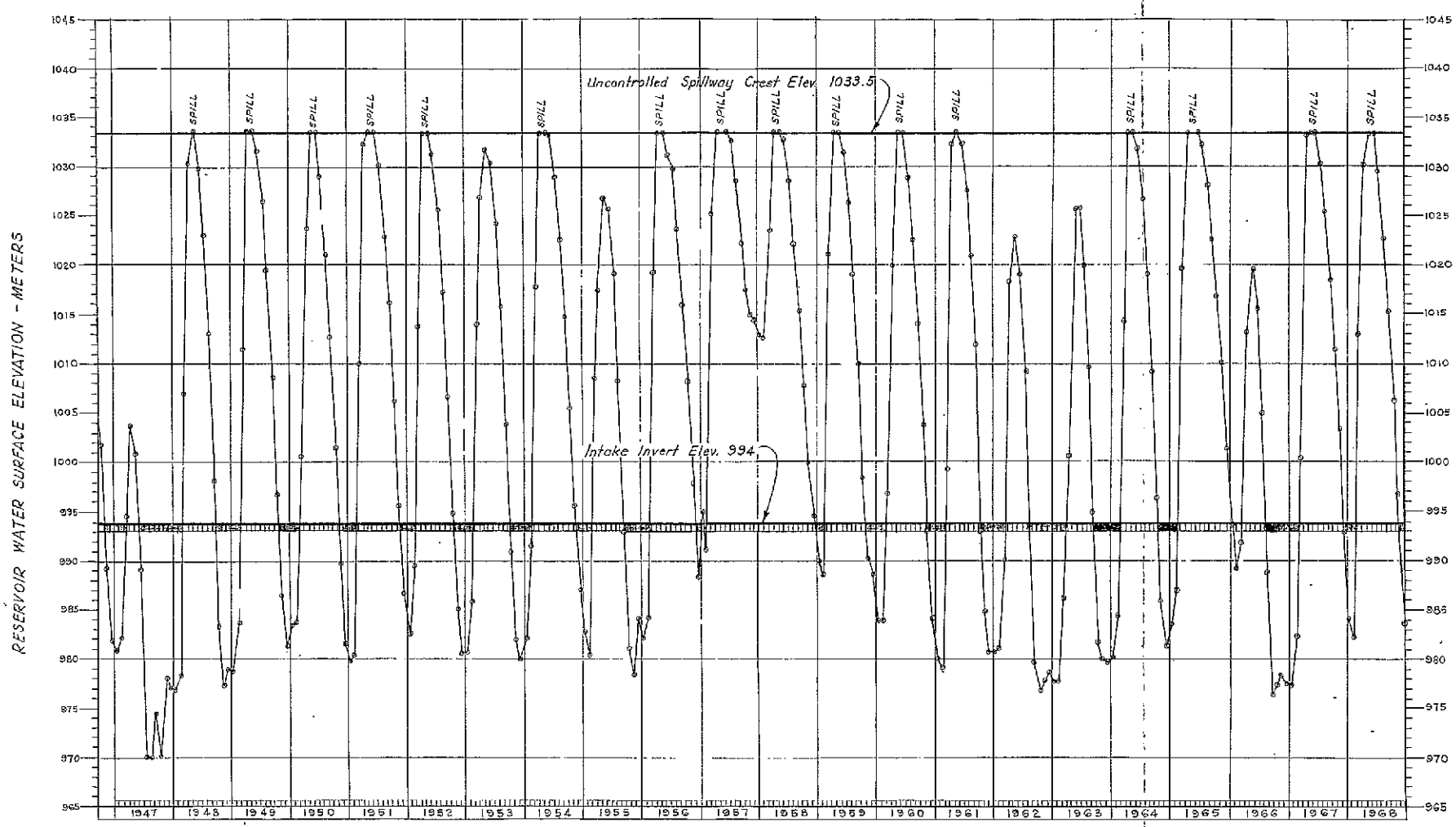

1969
1970
1971
1972
1973
YEARS
MONTHS
NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
NOTICE TO PROCEED
PRELIMINARY REPORT SUBMITTAL
Continue Quarterly Progress Reports & Revisions for CPM Scheduling
Complete CPM Engineering, Procurement & Construction
Continue Progress Reports
Complete Financial Schedule
Complete Engineer's Estimate
Collect Prices in Afghanistan
Survey for Transmission Line
Geological investig. of transmission Tower Foundations
Substation Prelim. Design & Layout
Continue Design & Prepare Bid Drawings for Penstocks
Normal Reservoir Operation
Specifications & Bid Documents
Specifications - Auxil. Mechanical Equipment
Spec's. - Auxil. Electrical Equipment
Dwg's. for Tower Foundations
Construction Drawings Sub-stations
Staking Transmission Line
Construct Access Roads
Transmission Line Tower Foundations - Excavation & Concrete
Transport Steel
Fabricate Electrical Equipment for Transmission Line & Substations
Supervise Construction, Prepare Construction Progress Reports, Review and Approve Contractor's Quantities
Substations Steel Structure Construction
Begin Transmission Line Steel Towers Erection
Continue Erection T.L. Towers, Install Electrical Equipment
Complete Steel Struct. & Install Electrical Equipment at Substations
Transport Equipment
Prepare As Built Drawings and Final Report
END OF CONSTRUCTION
INITIAL OPERATION 10 MONTHS
Excavation & Grading - Switchyard
Concrete Foundations - Switchyard
Erect Steel Structures
Install Electrical Equipment
Excavation Intake
Excavate Tunnel
Concrete Lining and Penstock Supports in Tunnel
Reservoir Filling
Draw Down Reservoir to El. 939
Excavation - Powerhouse
Construct Camp & Field Office
Install Drains and Pumps, Commence Installation of Piping Systems
Complete Piping
Fabricate Steel Structures Components
Transport Steel Structures
Field Welding
Fabricate Crane
Transport Crane
Install Crane in Powerhouse
Fabricate Auxiliary Mechanical & Electrical Equipment
Install Auxiliary Mechanical & Electrical Equipment in Powerhouse
Fabricate Gate or Hoist
Transport Gate
Install Gate & Hoist
Fabricate Generators and Transformers
Transport Generators and Transformers
Install Generators & Transformers
Tests
Fabricate Spiral Cases, Turbines and Governors, Draft Tube Lining
Transport Spiral Cases and Draft Tube Lining
Transport Turbines & Governors
Install Turbines and Governors Units 1 & 2
INDICATED CRITICAL PATH
P.S. - Prepare for Submittal
P.R. - Prepare Report
P.D. - Print Documents
LEGEND:
Early Finish (Calendar Days)
Late Start
NOTE
DA AFGHANISTAN BRESHNA MOASSESSA
KAJAKAI HYDROELECTRIC PROJECT
CPM FOR DESIGN, CONSTRUCTION & PROCUREMENT
INTERNATIONAL ENGINEERING COMPANY, INC.
SAN FRANCISCO, CAL.
00-41-23

FIGURE A-3



NOTE:
Kajakai reservoir drawdown study was based on the following data:
(a) Monthly inflow to, and evaporation from the reservoir
(b) Monthly discharge from irrigation outlets (Three 84" hollow jet valves, 100% open)
(c) Reservoir capacity surveyed by U.S.G.S. in 1968.

Above items are furnished by "WATER AND SOIL SURVEY AUTHORITY OF AFGHANISTAN" and are shown on FIG. B-2 of the Appendix B.

DA AFGANISTAN BRESHNA MOASSESSA		
KAJAKAI HYDROELECTRIC PROJECT KAJAKAI RESERVOIR DRAWDOWN DURING CONSTRUCTION		
INTERNATIONAL ENGINEERING COMPANY, INC.		
DESIGNED K.C.S. DRAWN DWS	CHKD. AAO. / RKT. INSP.	SUBMITTED AAO. / RKT. RECOMMENDED Engineer APPROVED
SAN FRANCISCO, CAL. DATE APRIL 22, 1970		GG-41-11A

Use with caution - See Revised CPM. S.17

SCHEDULE OF PROCUREMENT

FOR

MAJOR PERMANENT EQUIPMENT

No.	Description	Scheduled Target Dates: Submit Specs. for Review (ABM-AID)	Advertise for Bids	Award Contract	Required Delivery At site
1	Turbines, governors and pressure relief and turbine shutoff valves	6/1/70	8/1/70	11/1/70	10/15/72 to 2/15/73
2	Generators and transformers	7/1/70	9/1/70	12/1/70	5/1/73
3	Fixed wheel gate and hoist - intake	6/15/70	8/15/70	11/15/70	12/1/71
4	Generator switchgear and main control switchboard	1/1/71	3/1/71	6/1/71	1/1/73 to 7/1/73
5	General construction contract	2/1/71	4/1/71	7/1/71	As required
6	Transmission line and substations (if possible included in General Contract)	4/15/71	6/15/71	9/15/71	As required

Notes:

1. Equipment in Nos. 1, 2, 3, and 4 to be purchased by Owner.
2. Nos. 5 and 6 include equipment to be furnished under the construction contract.

TABLE A-1

PRELIMINARY FINANCIAL PLAN AND CASH FLOW ANALYSIS

(In Thousands of U.S. Dollars and Dollar Equivalents)

Item	* Total Amount	Estimated Cash Requirements by Quarters								Annual Cash Requirements			
		1970				1971							
		1	2	3	4	1	2	3	4	1972	1973	1974	1975
ENGINEERING SERVICES	2,117	159	164	138	155	150	130	150	150	471	400	50	-
TRAINING PROGRAM	994	8	-	4	5	31	80	80	80	290	220	155	41
PROCUREMENT	**												
Turbines, governors, and butterfly and pressure relief valves	1,824	-	-	-	138	276	302	259	259	408	-	182	-
Generators and transformers	1,231	-	-	-	111	222	222	166	166	221	-	123	-
Intake gate and hoist	170	-	-	-	15	30	30	24	23	31	-	17	-
Main and control switchgear	206	-	-	-	-	-	19	37	37	92	-	21	-
Subtotal - Procurement	3,431	-	-	-	264	528	573	486	485	752	-	343	-
CONSTRUCTION CONTRACTS	**												
Mobilization	203	-	-	-	-	-	-	203	-	-	-	-	-
Power intake	760	-	-	-	-	-	-	80	50	453	100	77	-
Power tunnel	390	-	-	-	-	-	-	40	20	240	50	40	-
Penstock and plug	968	-	-	-	-	-	-	100	35	594	140	99	-
Powerhouse	3,003	-	-	-	-	-	-	300	190	1,646	565	302	-
Switchyard	261	-	-	-	-	-	-	25	20	90	100	26	-
Transmission line	3,439	-	-	-	-	-	-	-	340	2,054	700	345	-
Substations	867	-	-	-	-	-	-	-	90	590	100	87	-
Subtotal - Construction	9,891	-	-	-	-	-	-	748	745	5,667	1,755	976	-
GRAND TOTAL	16,433	167	164	142	424	709	783	1,464	1,460	7,180	2,375	1,524	41

* Contingencies are not included

** Total amounts under procurement and construction contracts include 2-1/2 % interest during construction.

TABLE A-3

MONTHLY AND ANNUAL INFLOW TO KAJAKAI RESERVOIR MINUS EVAPORATION FROM THE RESERVOIR

(Discharges are in Acre-Feet)

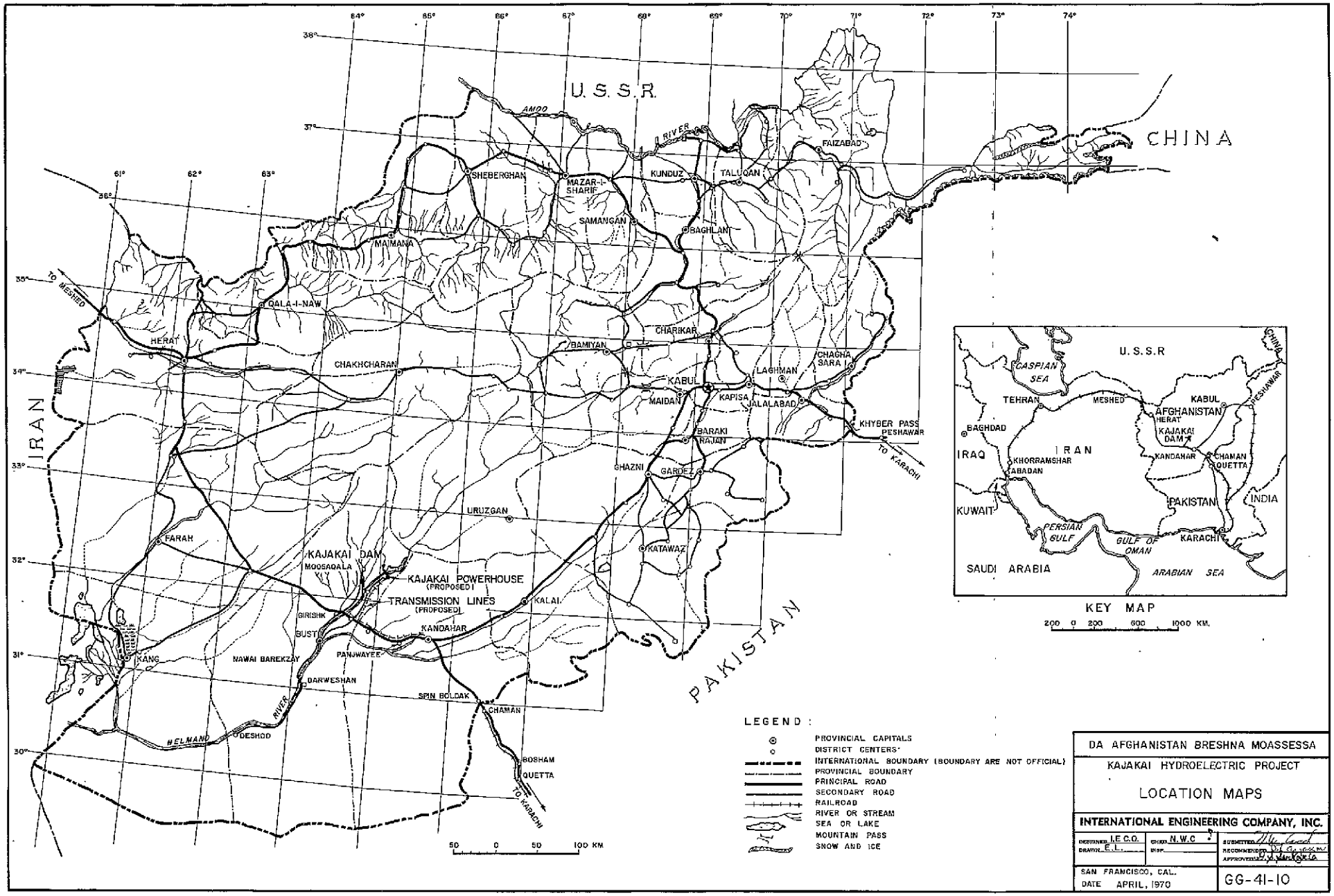
Water Year	Monthly												Annual
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	
1947	131,690	151,160	171,250	185,440	200,650	373,680	461,920	305,060	158,750	67,640	41,840	50,920	2,300,000
1948	84,000	111,100	132,600	129,600	144,800	595,300	1,261,200	809,400	255,000	119,400	71,600	81,600	3,795,600
1949	115,500	140,600	154,200	155,500	222,000	711,000	1,824,200	1,008,200	357,800	179,200	122,400	112,400	5,103,000
1950	151,400	173,500	186,000	221,600	224,900	479,100	1,016,200	1,689,200	591,000	209,200	112,700	110,700	5,165,500
1951	147,000	157,500	163,200	169,400	175,500	668,200	1,329,200	1,983,200	745,900	270,200	141,600	129,700	6,080,600
1952	152,000	176,600	187,300	195,700	298,900	749,300	1,359,200	905,700	331,700	160,300	103,400	116,700	4,736,800
1953	155,100	173,400	179,800	181,800	255,800	771,200	928,300	717,600	383,900	143,700	105,300	113,900	4,109,800
1954	145,400	157,300	173,700	210,800	334,200	862,000	1,623,400	1,312,400	454,500	222,800	143,600	132,500	5,772,600
1955	173,700	192,800	191,500	199,500	179,200	630,300	643,300	817,300	384,900	174,400	99,100	100,100	3,786,100
1956	132,900	153,000	225,600	208,400	230,200	963,500	2,256,500	974,400	319,600	401,100	142,600	139,100	6,146,900
1957	188,200	184,700	183,300	361,600	253,600	1,167,600	2,424,100	2,532,000	1,028,000	420,400	233,100	166,100	9,142,700
1958	230,700	337,200	395,300	357,800	388,600	798,100	1,264,700	786,900	412,100	240,900	159,000	166,800	5,538,100
1959	202,800	223,500	251,200	237,340	255,410	1,035,950	1,283,100	766,700	340,740	197,420	121,300	144,360	5,059,820
1960	156,380	205,710	253,880	205,970	228,000	412,490	943,020	1,367,600	465,880	206,210	147,410	125,700	4,718,250
1961	153,890	177,160	174,890	172,140	165,060	451,200	1,504,010	1,287,240	410,600	195,080	138,280	127,240	4,956,790
1962	26,485	179,011	183,780	183,590	191,040	310,910	* 900,000	606,760	278,710	121,110	94,080	106,860	3,182,336
1963	135,850	139,580	151,480	143,860	142,280	259,430	471,050	1,110,400	455,200	171,580	109,650	101,260	3,391,620
1964	127,390	172,620	167,910	173,900	235,930	790,850	1,614,950	977,760	367,330	178,160	118,530	106,400	5,031,730
1965	153,140	166,680	186,860	226,430	271,020	961,430	1,756,240	1,911,510	900,470	393,110	233,240	185,120	7,345,250
1966	214,040	216,780	204,110	219,890	233,720	305,800	705,870	622,000	287,720	131,490	101,980	105,340	3,348,740
1967	136,324	148,080	141,670	136,680	201,414	470,774	1,534,270	1,566,980	634,160	291,290	188,750	157,300	5,607,692
1968	195,490	209,650	180,830	177,450	206,430	753,590	1,126,010	* 1,100,000	565,710	226,190	135,680	148,770	5,025,800
1969	170,880	194,200	137,230										

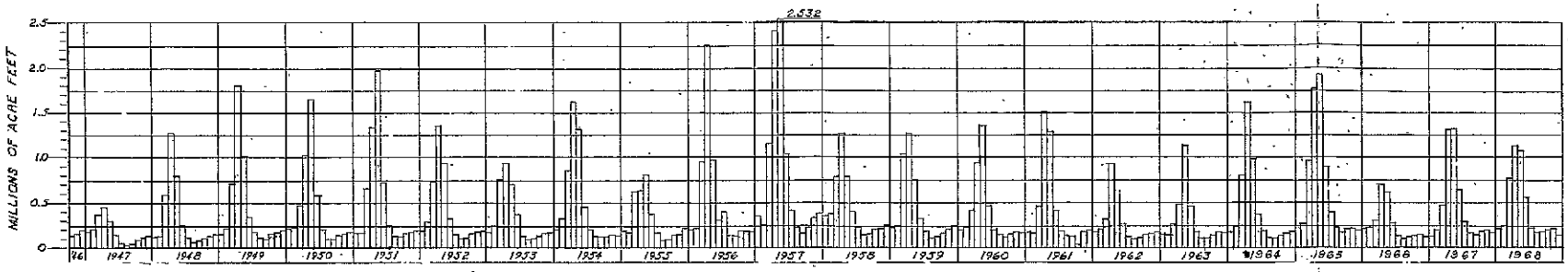
* Approximate data, record not available.

APPENDIX B

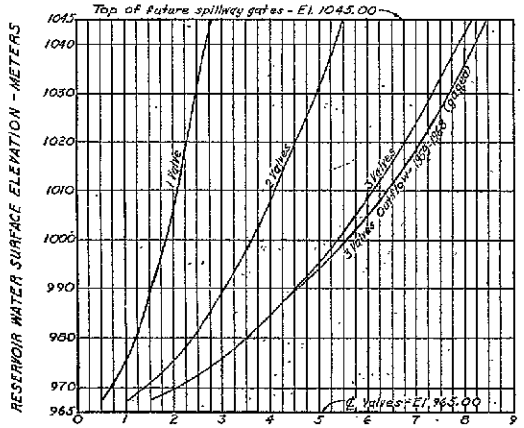
DRAWINGS

FIGURE B-1

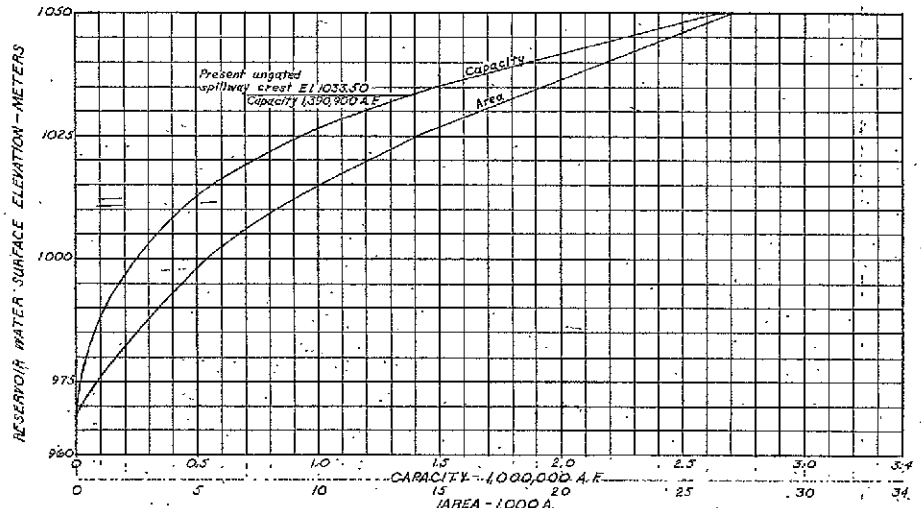

U.S.S.R.
CHINA
IRAN
PAKISTAN
AMOO RIVER
FAIZABAD
SHEBERGHAN
MAZAR-I-SHARIF
KUNDUZ
TALUQAN
SAMANGAN
BAGHLAN
MAIMANA
DALA-I-NAW
HERAT
TO MESHED
CHARIKAR
BAMIYAN
CHAGHA SARA
CHAKHCHARAN
KABUL
LAGHMAN
MAIDAN
KAPISA
JALALABAD
KHYBER PASS
PESHAWAR
TO KARACHI
BARAKI RAJAN
GHAZNI
GARDEZ
URUZGAN
FARAH
KATAWAZ
KAJAKAI DAM
MOOSADALA
KAJAKAI POWERHOUSE (PROPOSED)
TRANSMISSION LINES (PROPOSED)
KALAI
GIRISHK
BUST
KANDAHAR
KANG
NAWAI BAREKZAY
PANJWAYEE
DARWESHAN
SPIN BOLDAK
CHAMAN
HELMAND RIVER
DESHOD
BOSHAM
QUETTA
TO KARACHI
KEY MAP
U.S.S.R
CASPIAN SEA
TEHRAN
MESHED
AFGHANISTAN
HERAT
KABUL
KAJAKAI DAM
PESHAWAR
CHINA
BAGHDAD
IRAQ
IRAN
KHORRAMSHAR
ABADAN
KANDAHAR
CHAMAN
QUETTA
KUWAIT
PAKISTAN
INDIA
PERSIAN GULF
GULF OF OMAN
KARACHI
SAUDI ARABIA
ARABIAN SEA
200 0 200 600 1000 KM.
LEGEND:
PROVINCIAL CAPITALS
DISTRICT CENTERS
INTERNATIONAL BOUNDARY (BOUNDARY ARE NOT OFFICIAL)
PROVINCIAL BOUNDARY
PRINCIPAL ROAD
SECONDARY ROAD
RAILROAD
RIVER OR STREAM
SEA OR LAKE
MOUNTAIN PASS
SNOW AND ICE
50 0 50 100 KM
DA AFGHANISTAN BRESHNA MOASSESSA
KAJAKAI HYDROELECTRIC PROJECT
LOCATION MAPS
INTERNATIONAL ENGINEERING COMPANY, INC.
DESIGNED I.E.C.O.
DRAWN E.L.
CHKD N.W.C.
INSP.
SUBMITTED
RECOMMENDED
APPROVED
SAN FRANCISCO, CAL.
DATE APRIL, 1970
GG-41-10



RESERVOIR INFLOW MINUS LOSSES



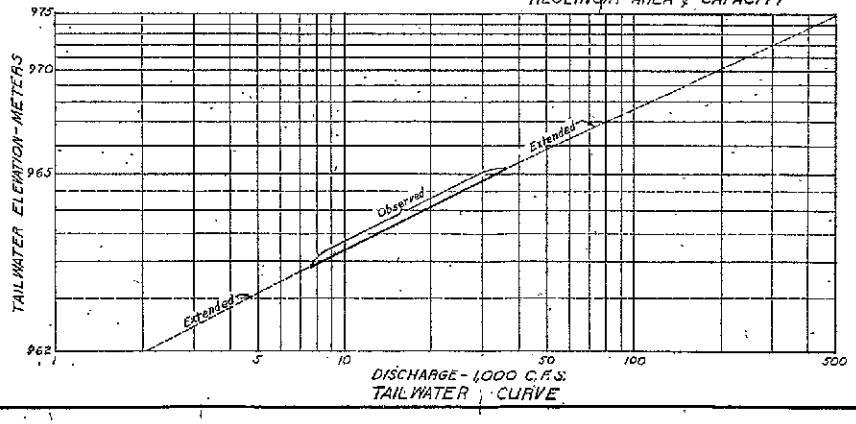
OUTLET DISCHARGE CURVES-
84" HOLLOW JET VALVES



RESERVOIR AREA & CAPACITY

NOTES:

1. The reservior capacity curve is revised according to data from the 1968 Sedimentation Survey Report for the Kajakai Reservoir by USGS.
2. The outlet discharge capacity curve for 8-84" Hollow Jet Valves has been revised according to reservoir operation records of the Water and Soil Survey Authority of AFGHANISTAN for period of 1959-1968.



TAILWATER CURVE

DA AFGHANISTAN BRESHNA MOASSESSA

KAJAKAI HYDROELECTRIC PROJECT

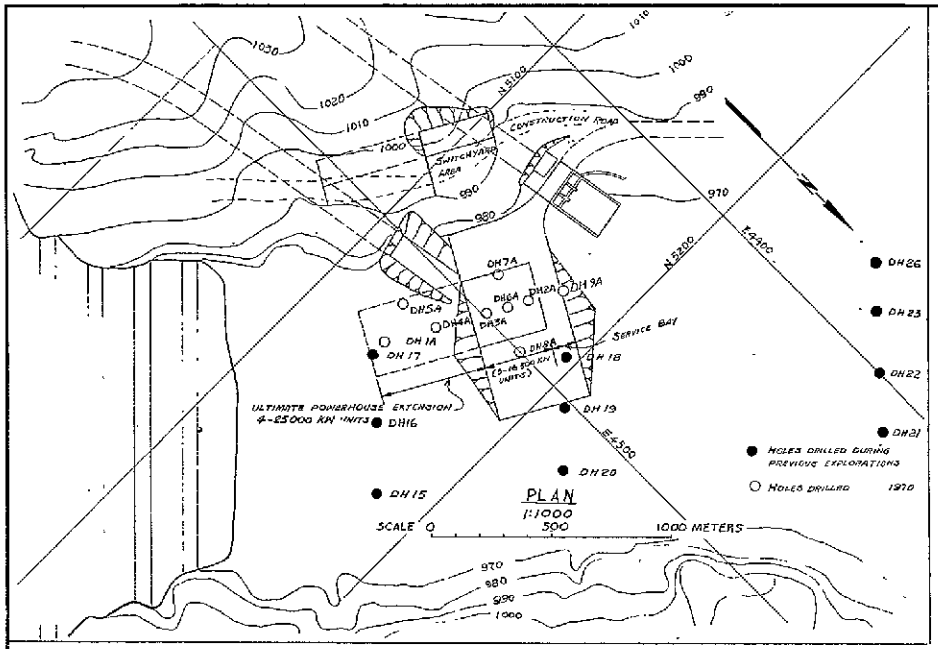
HYDROLOGY

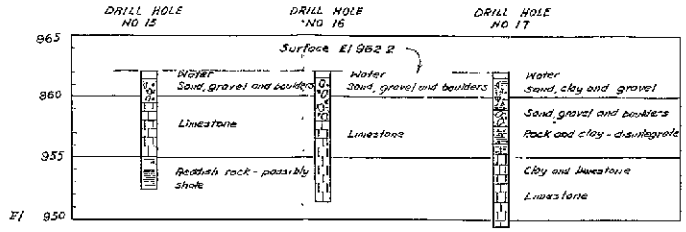
INTERNATIONAL ENGINEERING COMPANY, INC.

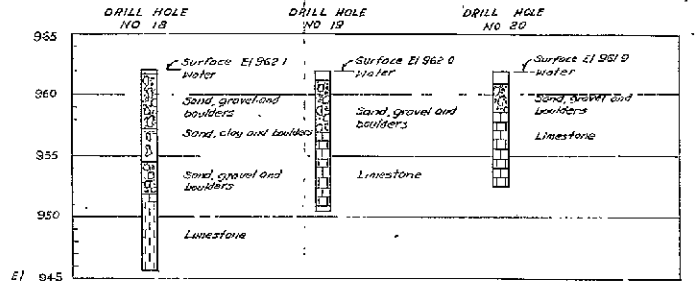
DESIGNED IECO
DRAWN JAVD
CHKD. HWC/MAO
INSP.
SUBMITTED
RECOMMENDED
APPROVED

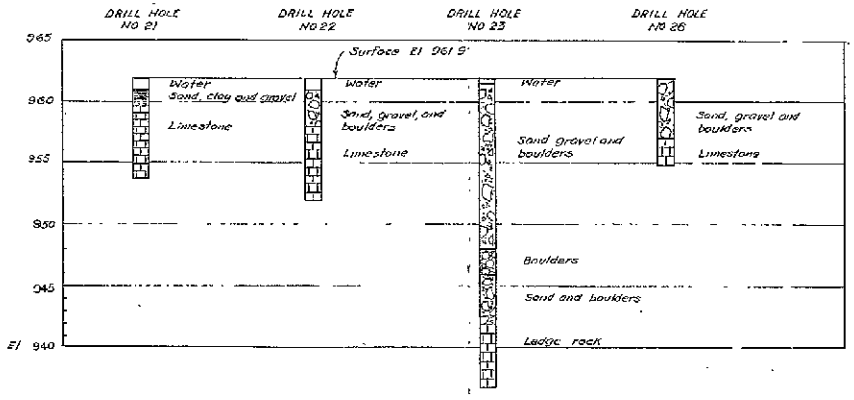
SAN FRANCISCO, CAL.
DATE APRIL 1970

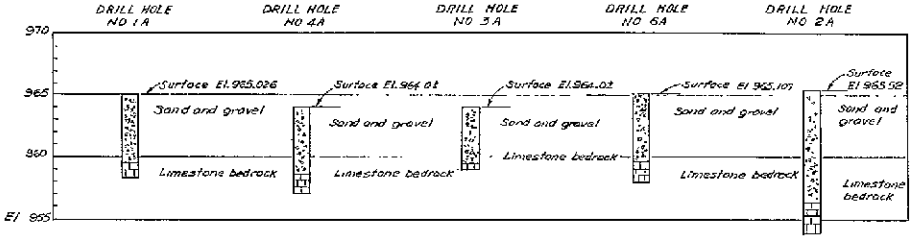
GG-41-11

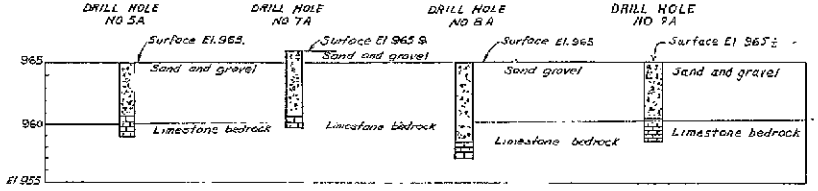












DA AFGHANISTAN BRESHNA MOASSESSA

KAJAKAI HYDROELECTRIC PROJECT

GEOLOGY

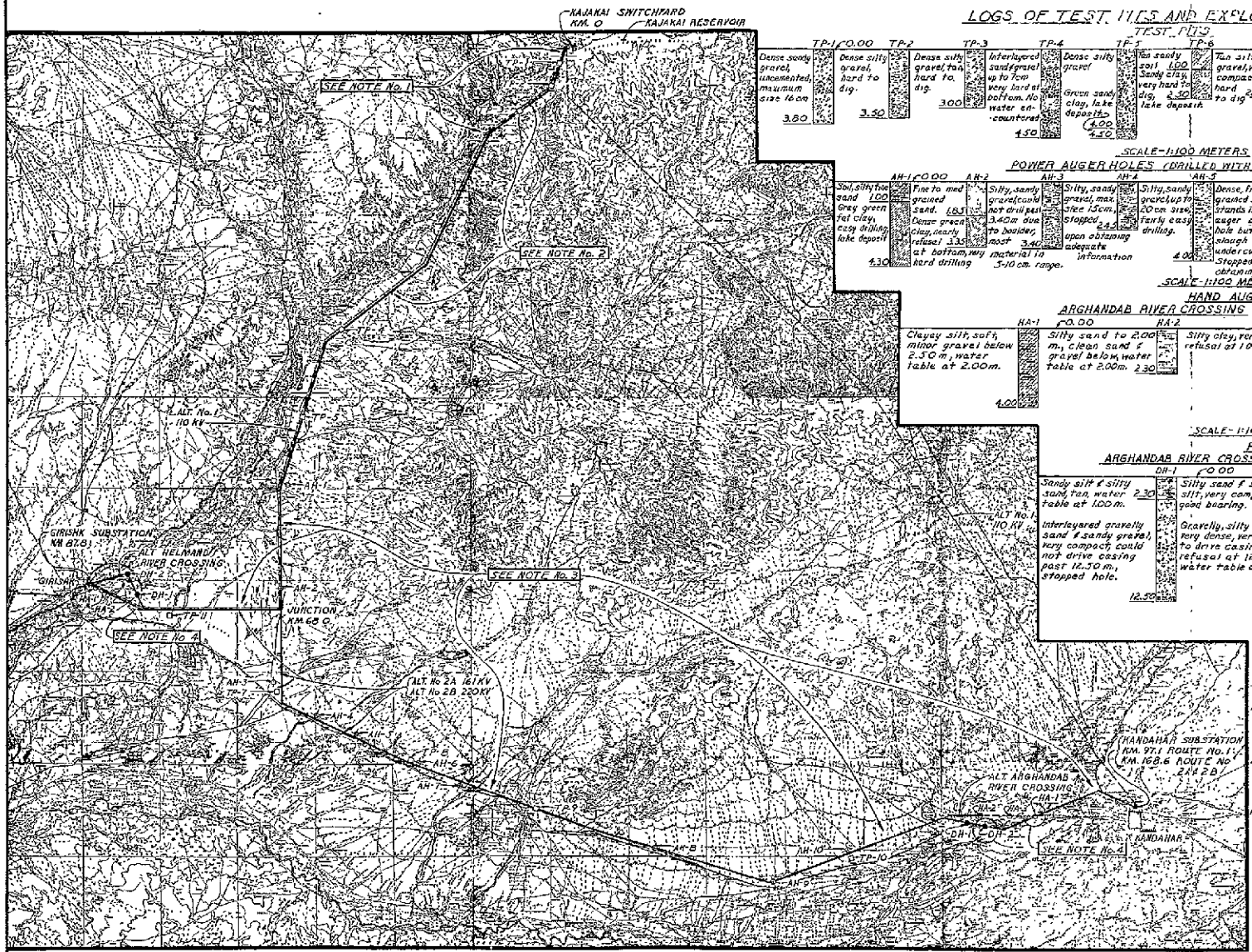
POWERHOUSE

LOCATION AND LOGS OF DRILL HOLES

INTERNATIONAL ENGINEERING COMPANY, INC.

DESIGNED IECO	CHKD. Hug c.	SUBMITTED
DRAWN V.H.	INSP. —	RECOMMENDED
		APPROVED
SAN FRANCISCO, CAL.		GG-41-12
DATE APRIL 1970		

FIGURE 8-4



LOGS OF TEST PITS AND EXPLORATION HOLES

TEST PITS

TP-1 (0.00): Dense sandy gravel, uncemented, maximum size 16 cm — 3.80
TP-2: Dense silty gravel, hard to dig. — 3.50
TP-3: Dense silty gravel, tan hard to dig. — 3.00
TP-4: Interlayered sand & gravel up to 7cm very hard at bottom. No water encountered — 4.50
TP-5: Dense silty gravel. Green sandy clay, lake deposit — 4.00
TP-6: Tan sandy soil 1.00. Sandy clay, very hard to dig, lake deposit. — 4.50
TP-7: Tan silty gravel, very compact, hard to dig — 2.40
TP-8: Very hard caliche or limestone 2.20. Sand 2.70 med. grained, compact *Required 3½ days to dig with pick, bar & shovel.
TP-9: Sand & gravel maximum size 15 cm. loose river gravel in Rode Keskene bud — 3.00
TP-10 (0.00): Very dense sandy, silty gravel, very hard to dig — 3.00
TP-11: Sand, fine grained, tan, compact — 3.00

SCALE-1:100 METERS

POWER AUGER HOLES (DRILLED WITH 20" SPIRAL BOOM AUGER)

AH-1 (0.00): Soil, silty fine sand 1.00. Grey green fat clay, easy drilling, lake deposit — 4.30
AH-2: Fine to med grained sand. 1.65. Dense gravel, clay, nearly refusal 3.35 at bottom, very hard drilling
AH-3: Silty, sandy gravel, could not drill past 3.40 due to boulder, most material in 5-10 cm. range.
AH-4: Silty, sandy gravel, max. size 1.5cm, stopped 2.44 upon obtaining adequate information
AH-5: Silty, sandy gravel, up to 20 cm size, fairly easy drilling. — 4.00
AH-6: Dense, fine grained sand strands in auger 2.15. Hole but may slough if undercut. Stopped hole upon obtaining adequate information.
AH-7: Silty, sandy gravel, up to 20 cm, easy drilling 2.15. Sandy, gravel very dense, refusal at 1.80m but dense. Stopped hole upon obtaining adequate information
AH-8: Silty, sandy gravel, drilled to max. depth of equipment, last 35 cm very hard drilling — 4.30
AH-9 (0.00): Sandy, gravel refusal 1.00 m
AH-10: Sandy, gravel refusal 1.00 m

SCALE-1:100 METERS

HAND AUGER HOLES

ARGHANDAB RIVER CROSSING

HA-1 (0.00): Clayey silt, soft, minor gravel below 2.50 m, water table at 2.00m. — 4.00
HA-2: Silty sand to 2.00 m., clean sand & gravel below, water table at 2.00m. 2.30
HA-3: Silty clay, very dense, refusal at 1.00m. 1.00

HELMAND RIVER CROSSING

HA-1 (0.00): Sandy silt, tan, fairly soft. 2.00. Fine sand, gray, wet, easy drilling to 3.60m. Sandy gravel, 3.80 2-5cm size, refusal at 3.80m.
HA-2: Silty sand, tan, damp at 80 cm 1.00. Sandy gravel, wet, max. size 3cm, refusal at 1.20m, water table at 1.00m.

SCALE- 1:100 METERS

ROTARY DRILL HOLES

ARGHANDAB RIVER CROSSING

DH-1 (0.00): Sandy silt & silty sand, tan, water table at 1.00m. 2.30. Interlayered gravelly sand & sandy gravel, very compact, could not drive casing past 12.50 m., stopped hole. — 12.50
DH-2: Silty sand & sandy silt, very compact, good bearing. 3.00. Gravelly, silty sand, very dense, very hard to drive casing, refusal at 12.70 m., water table at 8.70m — 12.70

HELMAND RIVER CROSSING

DH-1 (0.00): Tan, silty sand, compact, water table at 1.00 m. 1.35. Sandy gravel, compact, could not drive casing past 7.60 m. 7.60 attempted to core, destroyed bit, probably conglomerate bedrock.
DH-2: Interlayered sandy gravel & gravelly sand, ranging up to 3cm., compact, water table at 1.55m. 1.00. Fine to med. grained sand, very dense, could not drive casing past 11.60 m., stopped hole.

SCALE 1:200 METERS

LEGEND

- ⊡ - HAND DUG TEST PIT
- ⊕ - POWER AUGER HOLE
- ● - HAND AUGER HOLE
- ● - ROTARY DRILL HOLE

NOTE No 1 - Limestone requiring rock footings.

NOTE No. 2 - Area underlain by well cemented conglomerate which might require a small number of rock footings. Most will be common excavation and will be adequate for pressed plate or grillage footings.

NOTE No 3 - Mostly gravelly soil of good bearing capacity with occasional caliche beds and very dense gravel beds. Nearly all will be common excavation and will be adequate for pressed plate or grillage footings.

NOTE No. 4 - Pile footings will be required.

SCALE 1:100 0 5 10 METERS

SCALE 1:200 0 5 10 20 METERS

DA AFGHANISTAN BRESHNA MOASSESSA

KAJAKAI HYDROELECTRIC PROJECT

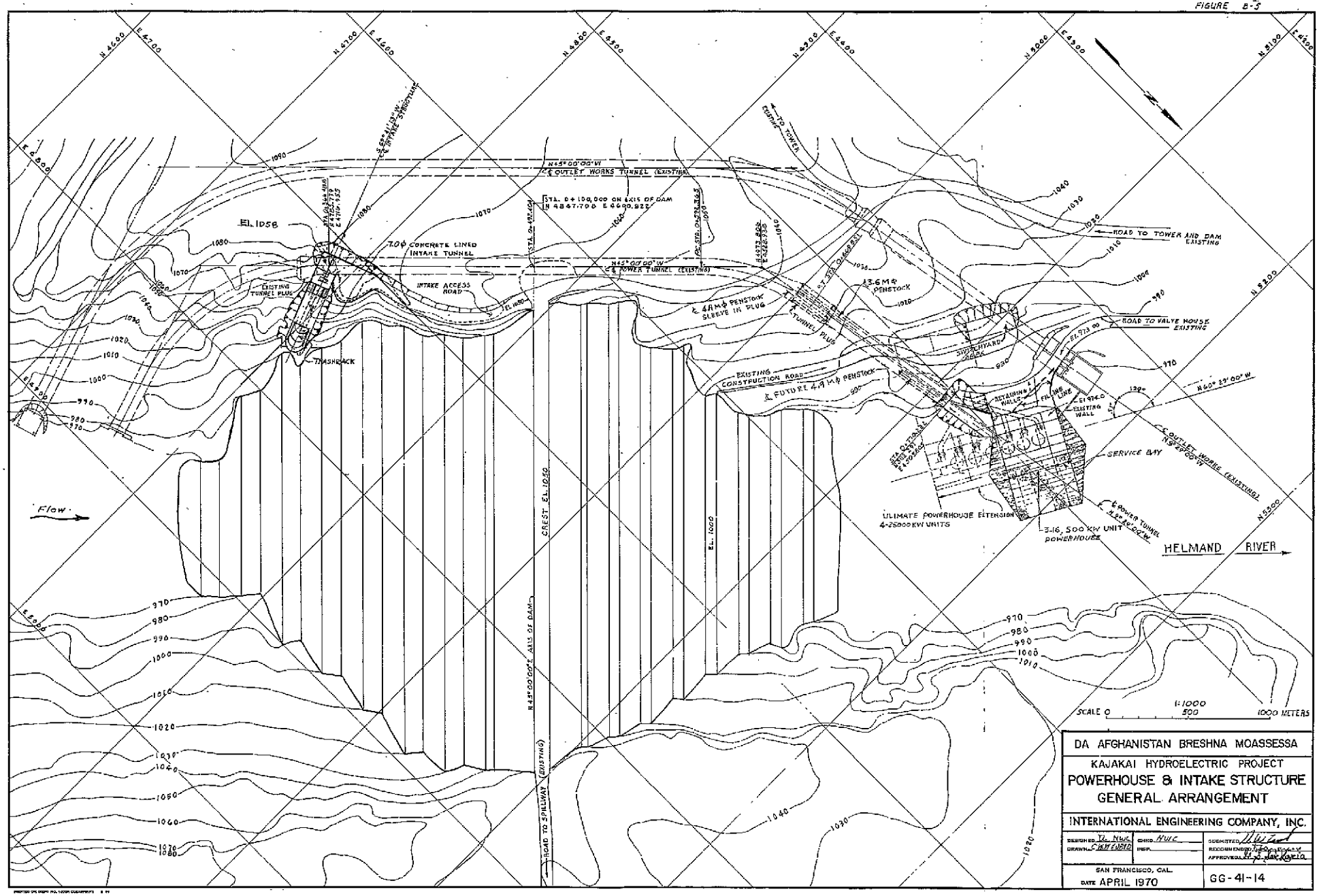
GEOLOGY EXPLORATION

TRANSMISSION LINES

INTERNATIONAL ENGINEERING COMPANY, INC.

DESIGNED J.S.L.	CHKD J.S.L.	SUBMITTED	
DRAWN JWD	DISP.	RECOMMENDED	
		APPROVED	
SAN FRANCISCO, CAL.			GG-41-13
DATE APRIL 1970			

FIGURE 8-3



DA AFGHANISTAN BRESHNA MOASSESSA

KAJAKAI HYDROELECTRIC PROJECT

POWERHOUSE & INTAKE STRUCTURE GENERAL ARRANGEMENT

INTERNATIONAL ENGINEERING COMPANY, INC.

DESIGNED Y.L. NUR | CHKD. NUR | SUBMITTED
DRAWN C.W. FORD | INSP. | RECOMMENDED
APPROVED

SAN FRANCISCO, CAL.

DATE APRIL 1970

GG-41-14

FIGURE B-6

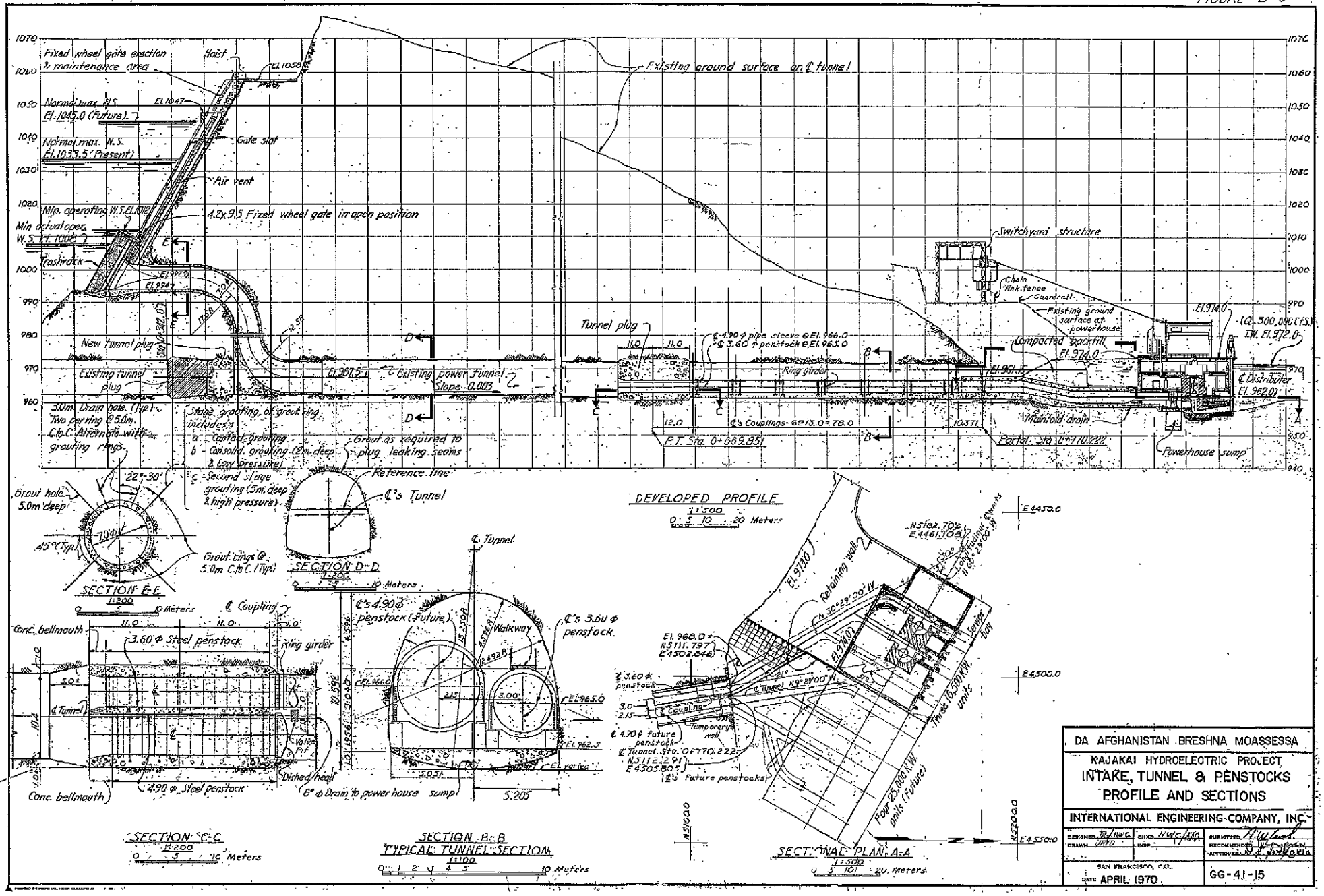
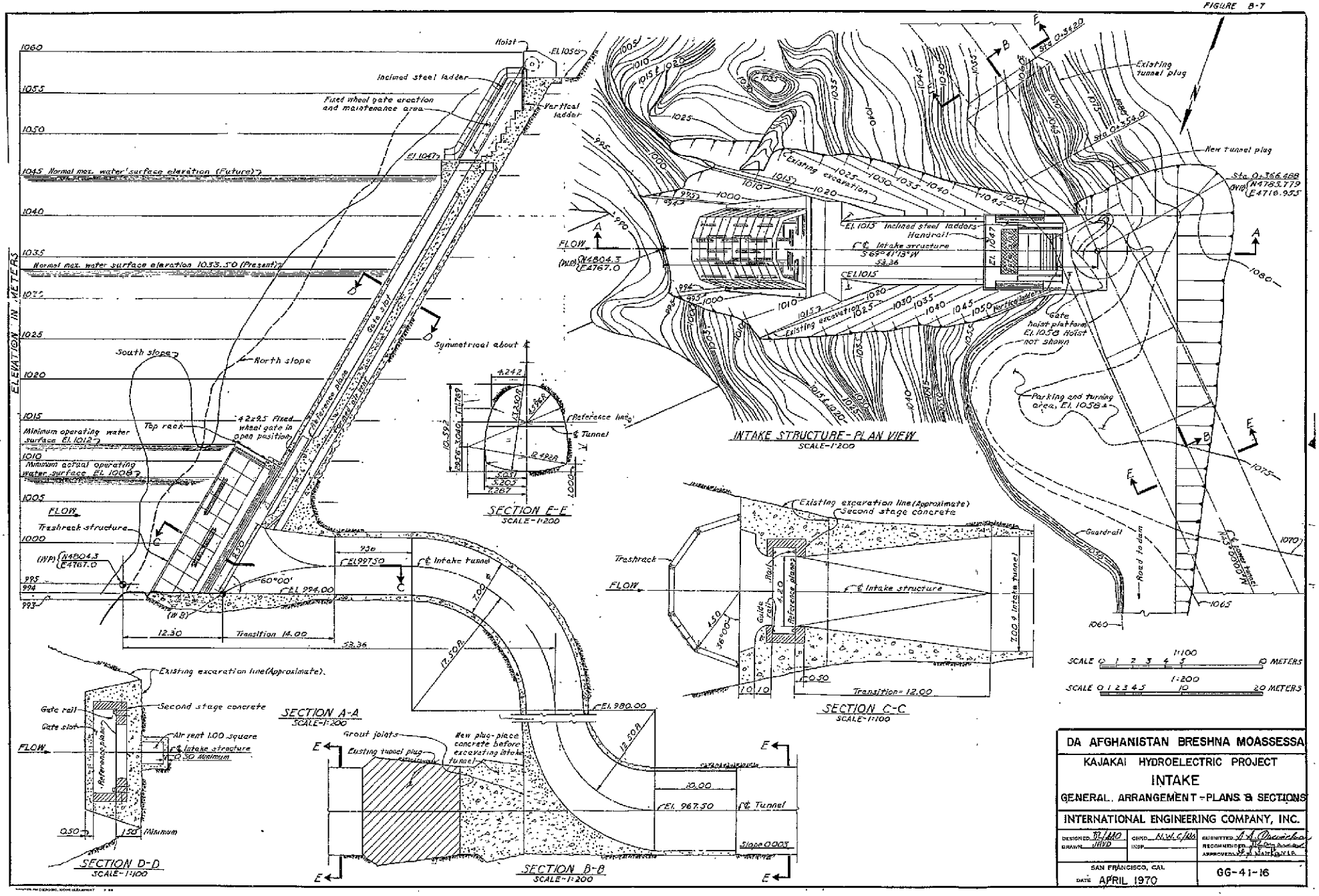

Fixed wheel gate erection & maintenance area
Hoist
EL 1058
Existing ground surface on ℄ tunnel
Normal max. W.S. El. 1045.0 (Future)
EL 1047
Normal max. W.S. El. 1033.5 (Present)
Gate slot
Air vent
Min. operating W.S. El. 1016
4.2x9.5 Fixed wheel gate in open position
Min actual oper. W.S. El. 1005
Trashrack
Switchyard structure
Chain link fence
Guardrail
Existing ground surface at powerhouse
Compacted backfill El. 974.0
El. 914.0
(Q. 300,000 CFS) TW. El. 972.0
Tunnel plug
℄ 4.90 ϕ pipe sleeve @ El. 966.0
℄ 3.60 ϕ penstock @ El. 965.0
Ring girder
New tunnel plug
Existing tunnel plug
El. 967.5
Existing power tunnel Slope 0.003
3.0m Drain hole. (Typ.) Two per ring @ 5.0m. C.to C. Alternate with grouting rings.
Stage grouting of grout ring includes:
a - Contact grouting
b - Consolid. grouting (2m. deep & Low pressure)
c - Second stage grouting (5m. deep & high pressure)
Grout as required to plug leaking seams
P.T. Sta. 0+669.85
℄'s Couplings - @ 13.0 = 78.0
Portal Sta. 0+710.222
Manifold drain
Powerhouse sump
℄ Distributor El. 962.0
DEVELOPED PROFILE
1:500
0 5 10 20 Meters
Grout hole 5.0m deep
22°-30'
45° (Typ.)
Grout rings @ 5.0m C.to C. (Typ.)
SECTION E-E
1:200
Reference line
℄'s Tunnel
SECTION D-D
1:200
℄ Tunnel
℄'s 4.90 ϕ penstock (Future)
Walkway
℄'s 3.60 ϕ penstock
℄ Coupling
Conc. bellmouth
3.60 ϕ Steel penstock
Ring girder
℄ Tunnel
Valve pit
Dished head
4.90 ϕ Steel penstock
6" ϕ Drain to power house sump
SECTION C-C
1:200
0 5 10 Meters
SECTION B-B
TYPICAL TUNNEL SECTION
1:100
0 1 2 3 4 5 10 Meters
Retaining wall
Temporary wall
Service bay
Three 16,500 KW units
Four 25,000 KW units (Future)
℄'s future penstocks
SECTIONAL PLAN A-A
1:500
0 5 10 20 Meters
DA AFGHANISTAN BRESHNA MOASSESSA
KAJAKAI HYDROELECTRIC PROJECT
INTAKE, TUNNEL & PENSTOCKS
PROFILE AND SECTIONS
INTERNATIONAL ENGINEERING COMPANY, INC.
SAN FRANCISCO, CAL.
DATE APRIL 1970
GG-41-15

FIGURE B-7



DA AFGHANISTAN BRESHNA MOASSESSA

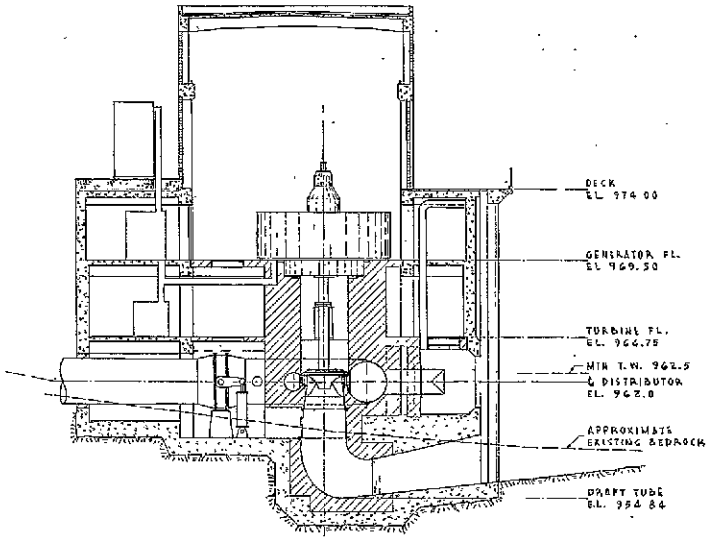
KAJAKAI HYDROELECTRIC PROJECT

INTAKE

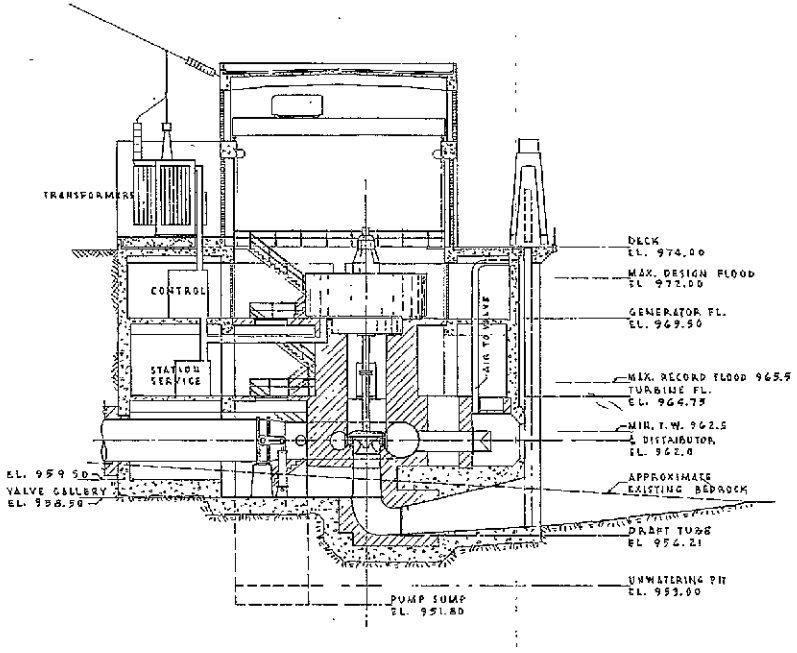
GENERAL ARRANGEMENT - PLANS & SECTIONS

INTERNATIONAL ENGINEERING COMPANY, INC.

DESIGNED B.A.A.O. DRAWN J.A.V.D.	CHKD. N.W.C./M.O. INSP.	SUBMITTED A. A. Quraishi RECOMMENDED APPROVED
SAN FRANCISCO, CAL. DATE APRIL 1970		GG-41-16



SECTION AT 25000 K.W UNITS
FUTURE POWERHOUSE EXTENSION



SECTION AT UNITS 1, 2 & 3
16500 K W UNITS

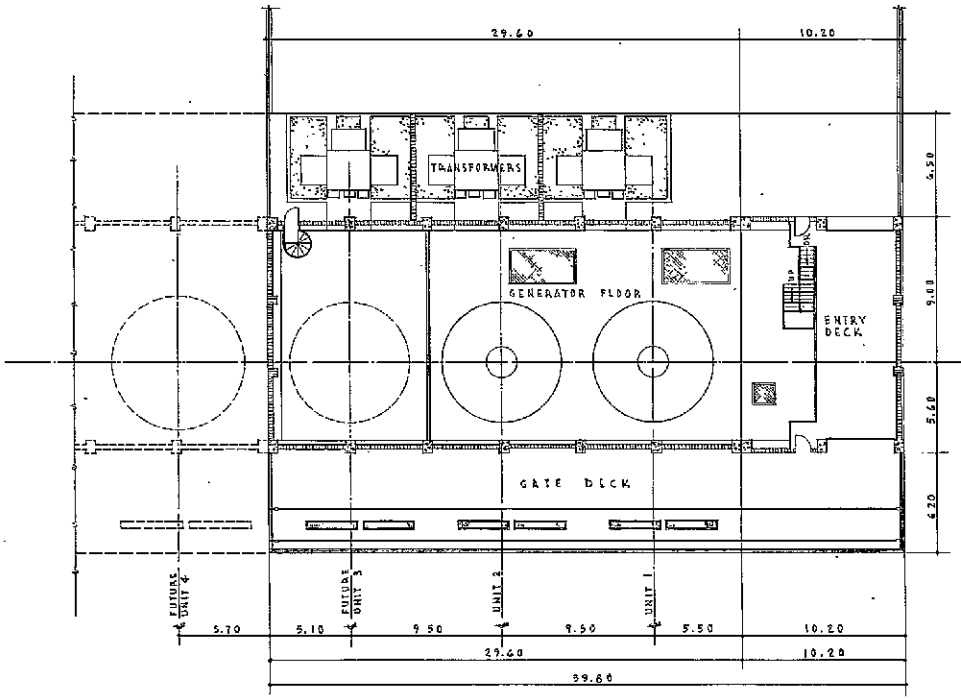
SCALE 0 1:150 5 10 METERS

DA AFGHANISTAN BRESHNA MOASSESSA

KAJAKAI HYDROELECTRIC PROJECT
POWERHOUSE
GENERAL ARRANGEMENT
TRANSVERSE SECTIONS

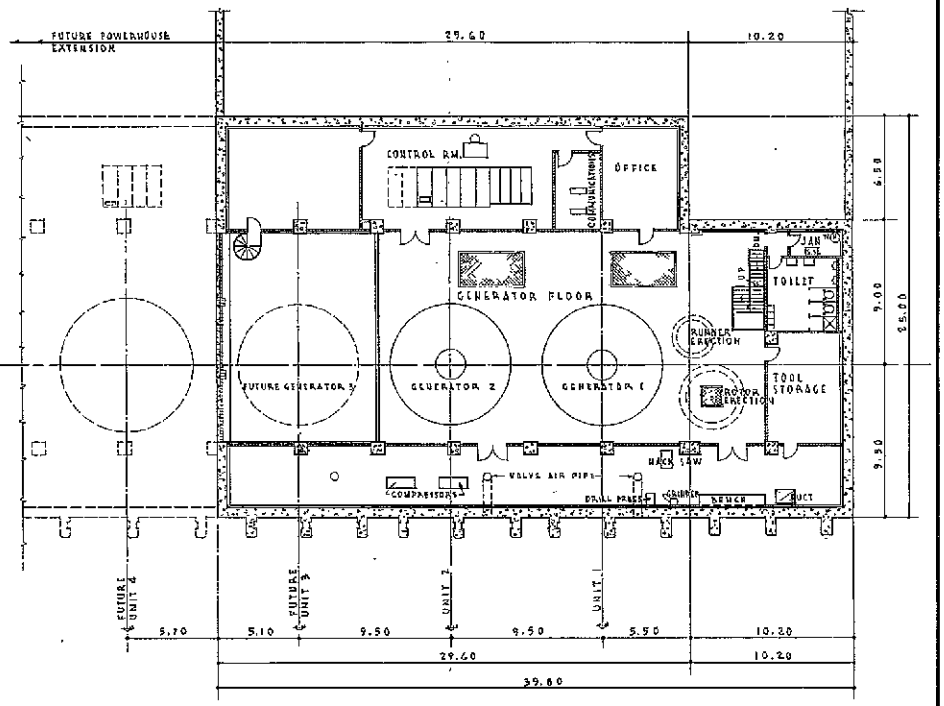
INTERNATIONAL ENGINEERING COMPANY, INC.

DESIGNED D. DRAWN C.W.W	CHKD. NWC INSP. C.W.W	SUBMITTED C. Wilson RECOMMENDED [illegible] APPROVED [illegible]
SAN FRANCISCO, CAL. DATE APRIL 1970		GG-41-17



DECK PLAN

ELEVATION 974.00



GENERATOR FLOOR

ELEVATION 969.50

SCALE 0 1:150 5 10 METERS

DA AFGHANISTAN BRESHNA MOASSESSA

KAJAKAI HYDROELECTRIC PROJECT

POWERHOUSE

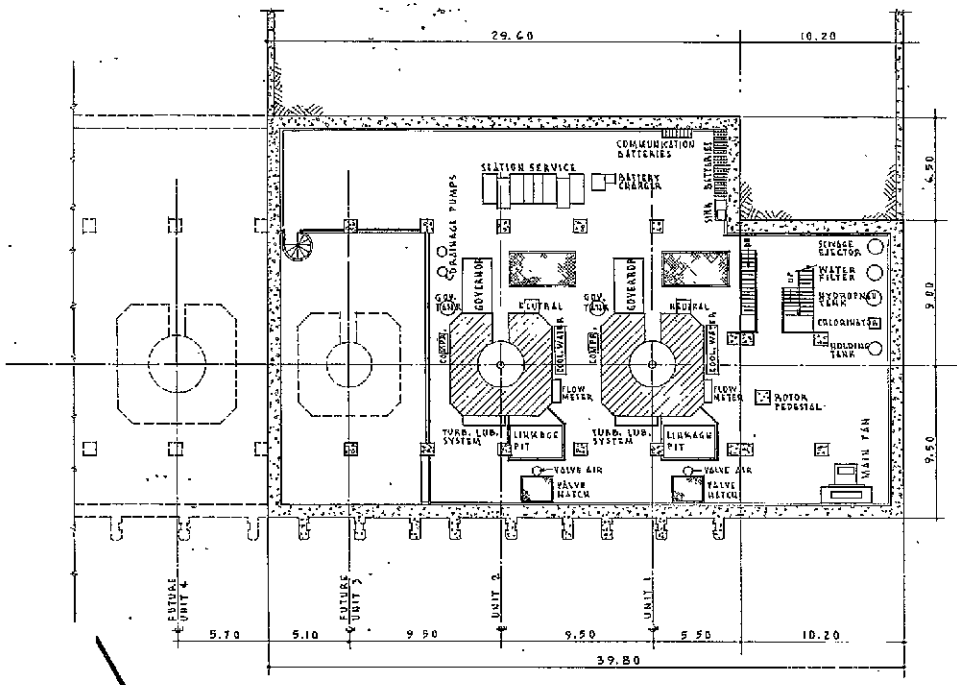
GENERAL ARRANGEMENT

PLANS AT EL 974.0 & GENERATOR FLOOR

INTERNATIONAL ENGINEERING COMPANY, INC.

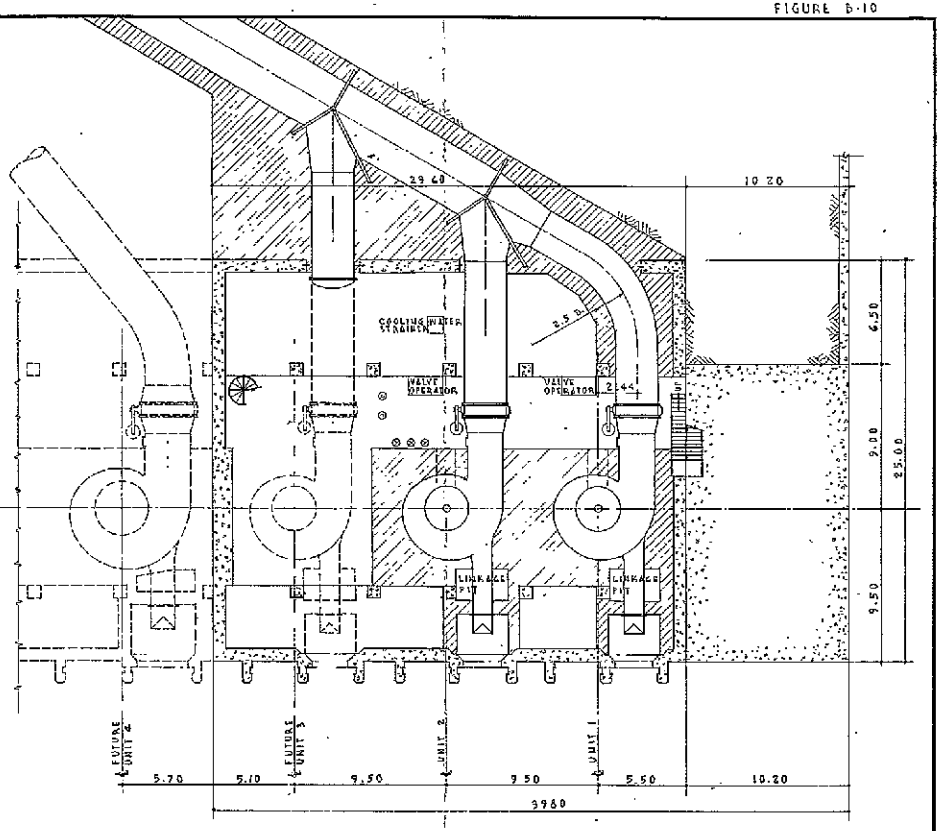
DESIGNED CL	CHKD. N W C	SUBMITTED
DRAWN	SUP. C W N	RECOMMENDED
		APPROVED
SAN FRANCISCO, CAL.		GG-41-18
DATE APRIL 1970		

FIGURE 8-10



TURBINE FLOOR PLAN

ELEVATION 964.75



PLAN AT ℄ DISTRIBUTOR

ELEVATION 962.00

SCALE 0 1:150 5 10 METERS

DA AFGHANISTAN BRESHNA MOASSESSA

KAJAKAI HYDROELECTRIC PROJECT

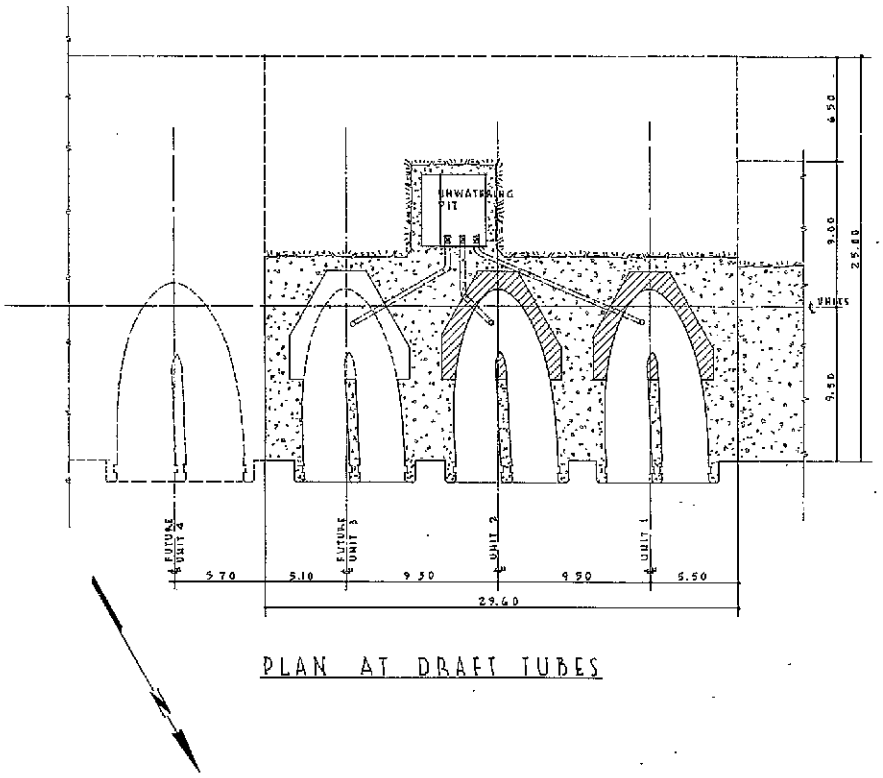
POWERHOUSE

GENERAL ARRANGEMENT

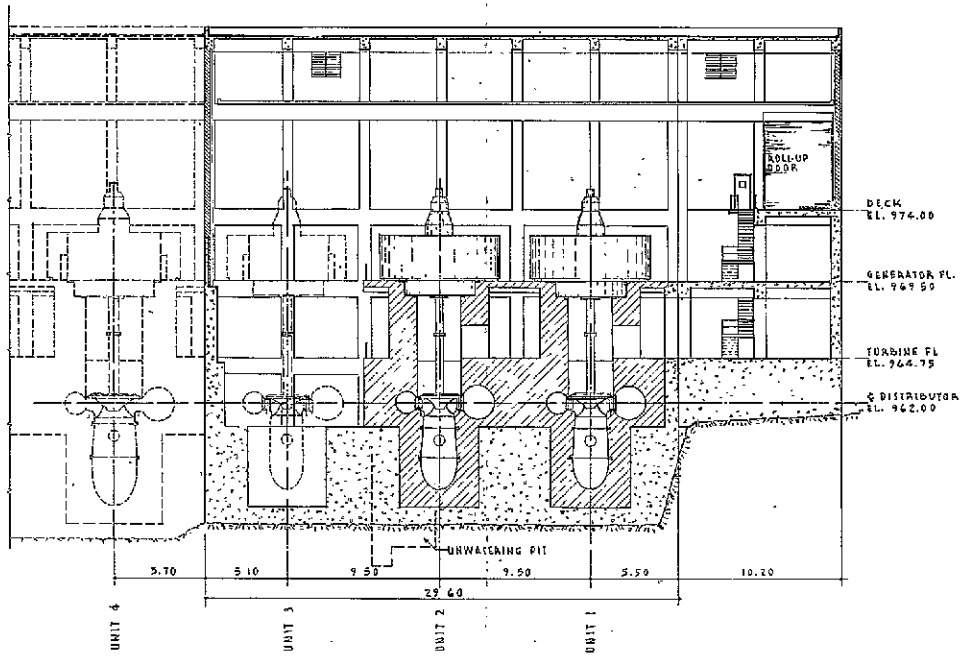
PLANS AT TURBINE FL. & ℄ DISTRIBUTOR

INTERNATIONAL ENGINEERING COMPANY, INC.

DESIGNED R.	CHKD. N.W.C.	SUBMITTED C. Wilson
DRAWN C.W.W.	DISP. P.W.L.	RECOMMENDED [illegible]
		APPROVED [illegible]
SAN FRANCISCO, CAL.		GG-41-19
DATE APRIL 1970		



PLAN AT DRAFT TUBES



LONGITUDINAL SECTION

SCALE 0 5 10 METERS 1:150

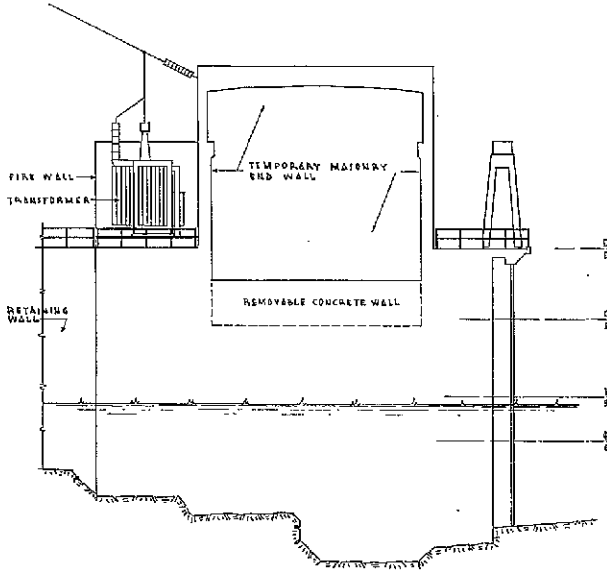
DA AFGHANISTAN BRESHNA MOASSESSA

KAJAKAI HYDROELECTRIC PROJECT
POWERHOUSE
GENERAL ARRANGEMENT
DRAFT TUBE & LONGITUDINAL SECTIONS

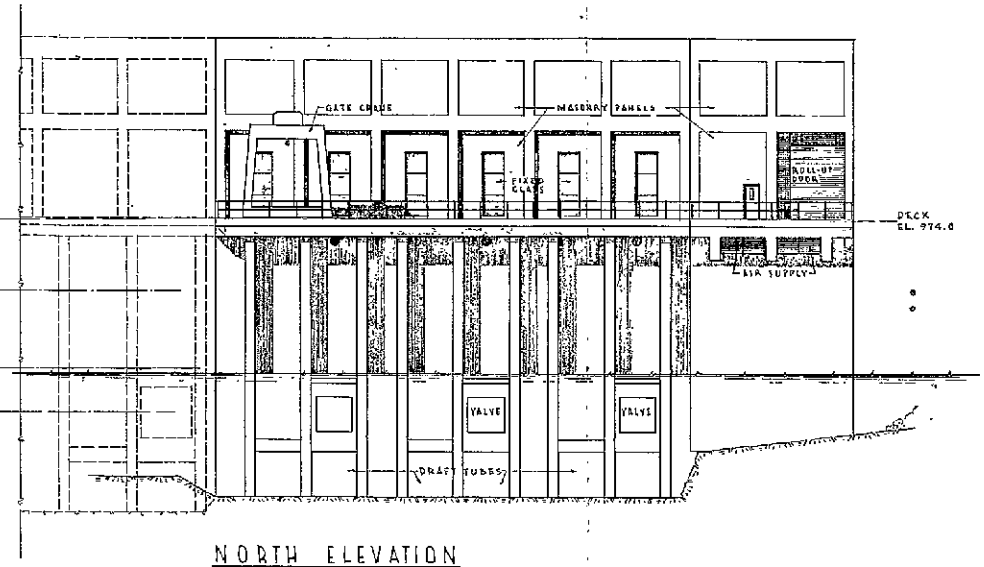
INTERNATIONAL ENGINEERING COMPANY, INC.

DESIGNED TD	CHKD. N.W.C	SUBMITTED C. Wilson
DRAWN C.W.W	RESP. C.W.W	RECOMMENDED D. Dayanand
		APPROVED W. J. Harrison
SAN FRANCISCO, CAL.		GG-41-20
DATE APRIL 1970		

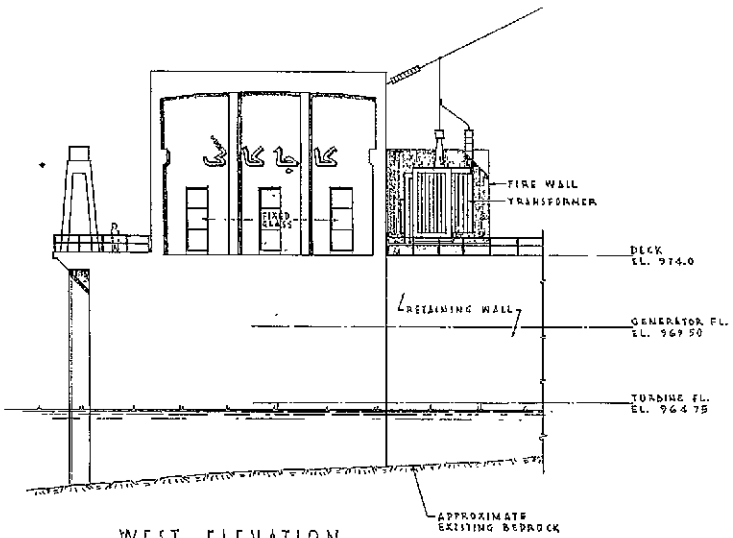
FIGURE B-12



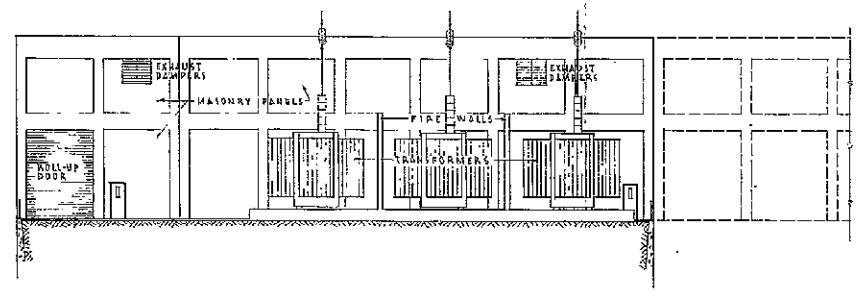
EAST ELEVATION



NORTH ELEVATION



WEST ELEVATION



SOUTH ELEVATION

SCALE 0 1:150 5 10 METERS

DA AFGHANISTAN BRESHNA MOASSESSA

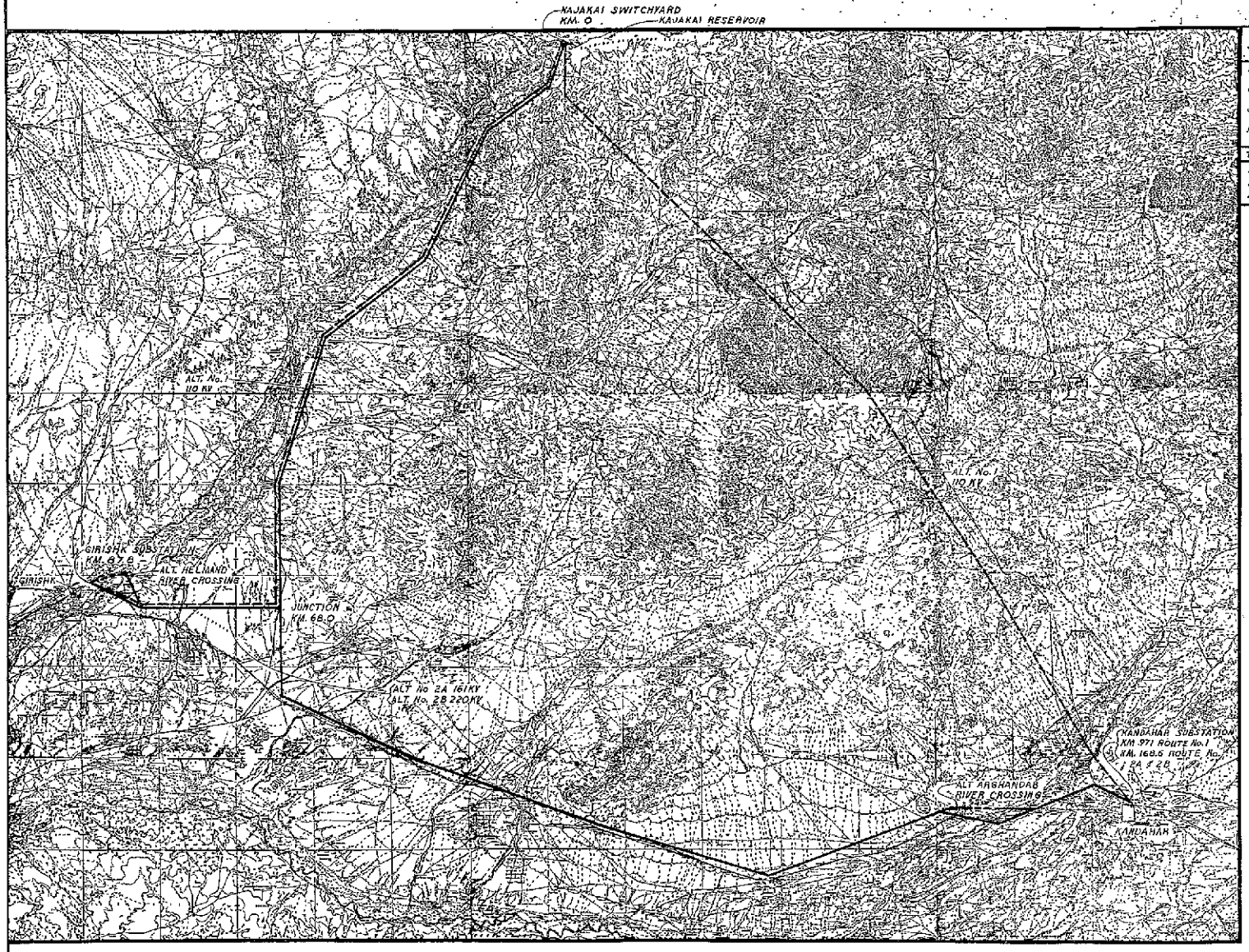
KAJAKAI HYDROELECTRIC PROJECT

POWERHOUSE

ARCHITECTURAL ELEVATIONS

INTERNATIONAL ENGINEERING COMPANY, INC.

DESIGNED CWW	CHKD NWC	SUBMITTED
DRAWN CWW	INSP	RECOMMENDED
		APPROVED
SAN FRANCISCO, CAL.		GG-41-21
DATE APRIL 1970		



SCALE 0 5 10 20 KILOMETERS 1:200,000

STATIONS	ALIGNMENT DISTANCE IN KM		
	ALT. No 1-110KV	ALT No. 2A-161KV	ALT No 2B-220KV
KAJAKAI - JUNCTION	68.0	68.0	68.0
JUNCTION - GIRISHK	19.8	19.8	19.8
JUNCTION - KANDAHAR	——	100.6	100.6
KAJAKAI - KANDAHAR	97.1	——	——
TOTAL	184.9	188.4	188.4

- - - - - - - - ROUTE No. 1
———— ROUTE No. 2
— — — — ALT. RIVER CROSSING

DA AFGHANISTAN BRESHNA MOASSESSA

KAJAKAI HYDROELECTRIC PROJECT

TRANSMISSION LINES

LOCATION

INTERNATIONAL ENGINEERING COMPANY, INC.

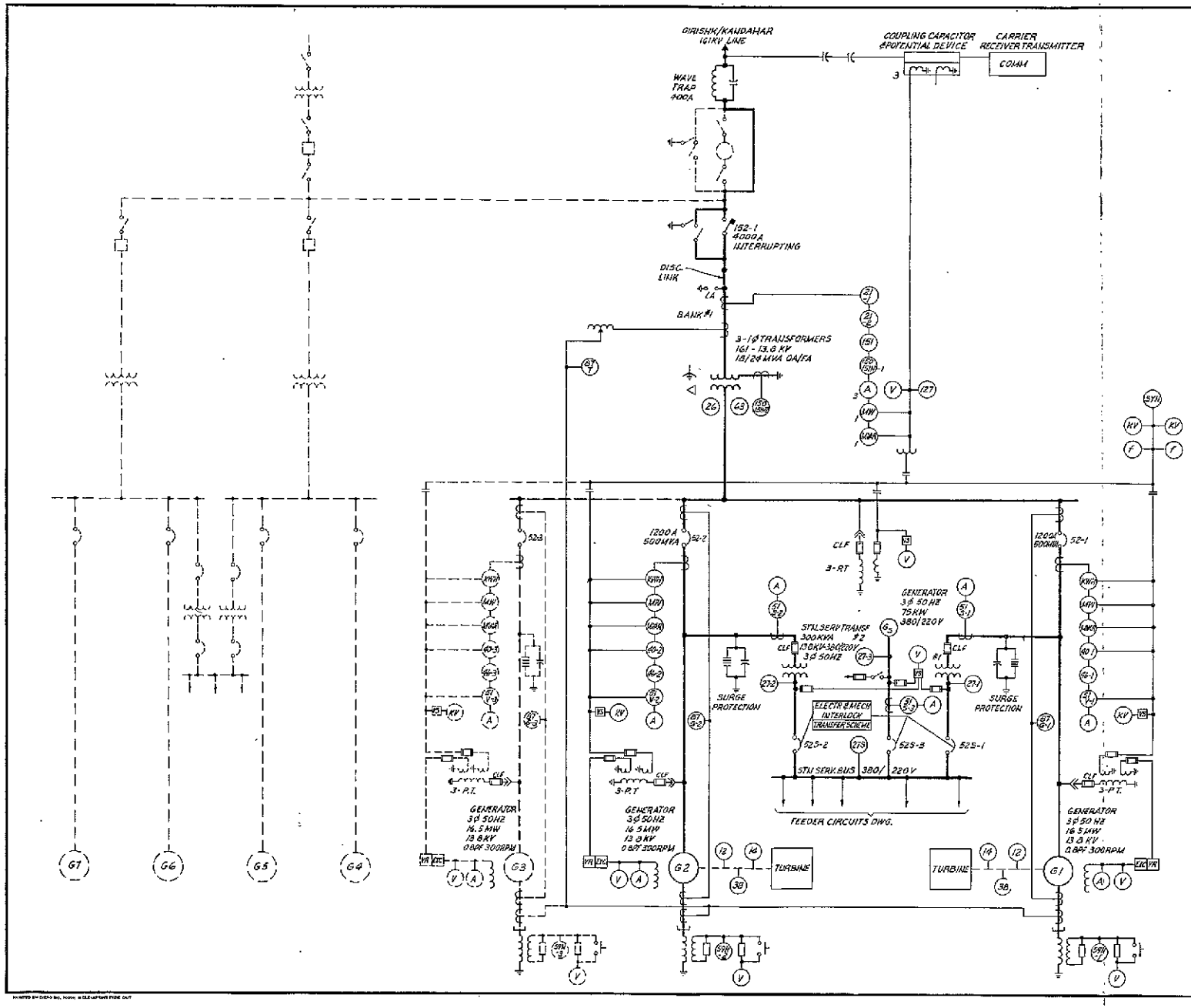
DESIGNED IECO CHKD. H.W.C. SUBMITTED
DRAWN JREU DIFF. RECOMMENDED
APPROVED

SAN FRANCISCO, CAL.

DATE APRIL 1970

GG-41-22

FIGURE B-14



DEVICE Nº	DESCRIPTION	SECT.
27-1,-2,-3	UNDERVOLTAGE RELAY STATION SERVICE 1,2,3	
27S	UNDERVOLTAGE RELAY STATION SERVICE BUS	
52-1,-2,-3	AIR CIRCUIT BREAKER UNITS 1, 2, 3	
52S-1,-2,-3	AIR CIRCUIT BREAKER, STATION SERVICE 1,2,3	
87G-1,-2,-3	DIFFERENTIAL RELAY, GENERATOR 1,2,3	
87 T	BUS DIFFERENTIAL RELAY	
127-1	LINE UNDERVOLTAGE RELAY	
152-1	CIRCUIT SWITCHER	
51V -1,-2,3	OVERCURRENT RELAY, VOLTG. RESTR., GEN. 1,2,3	
51S-1,-2	OVERCURRENT RELAY STN SERV. TRANSF. 1,2	
51S-3	OVERCURRENT RELAY 75KW GENERATOR	
59 N-1,2,3	NEUTRAL OVERVOLTAGE RELAY, GEN. 1,2,3	
40-1,-2,-3	LOSS OF EXCITATION RELAY, GEN. 1,2,3	
46-1,-2,-3	NEGATIVE PHASE SEQUENCE RELAY, GEN 1,2,3	
21-1	IMPEDANCE RELAY, ZONE 1	
21-2	IMPEDANCE RELAY, ZONE 2	
150/51	OVERCURRENT RELAY	
150/51N	RESIDUAL OVERCURRENT RELAY	
63	TRANSFORMER SUDDEN PRESSURE	
26	TRANSF. OIL TEMP. INDICATOR	
12	OVERSPEED SWITCH	
14	UNDERSPEED SWITCH	
38	GEN BEARING TEMP. DETECTOR	

Nº	DATE	REVISIONS	BY	CHK	APPD

DA AFGHANISTAN BRESHNA MOASSESSA

KAJAKAI HYDROELECTRIC PROJECT

POWERHOUSE AND SWITCHYARD

MAIN POWER ONE LINE DIAGRAM

INTERNATIONAL ENGINEERING COMPANY, INC.

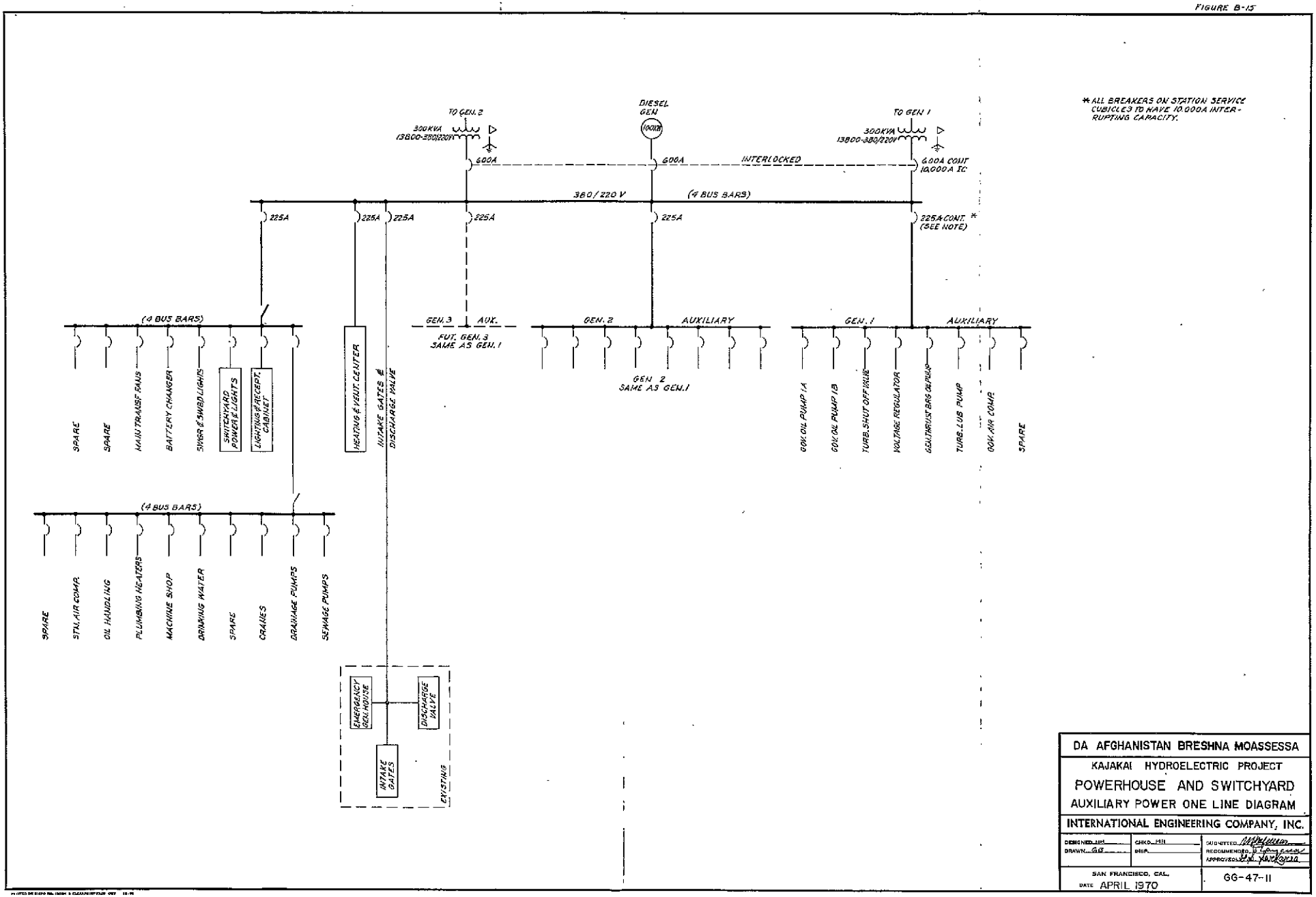
DESIGNED HH | CHKD HH | SUBMITTED
DRAWN GG | INSP. | RECOMMENDED
APPROVED

SAN FRANCISCO, CAL.

DATE APRIL 1970

GG-47-10

FIGURE B-15



DA AFGHANISTAN BRESHNA MOASSESSA

KAJAKAI HYDROELECTRIC PROJECT

POWERHOUSE AND SWITCHYARD

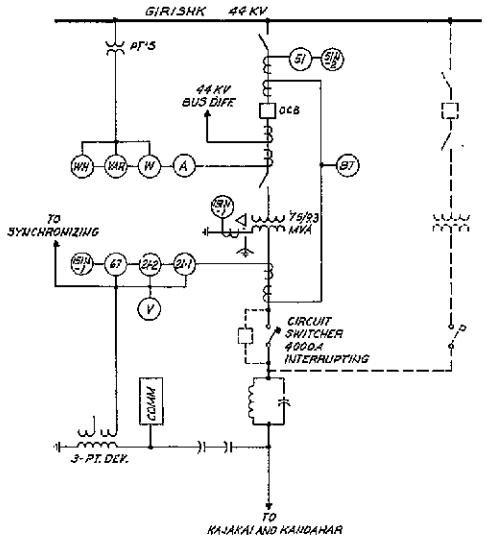
AUXILIARY POWER ONE LINE DIAGRAM

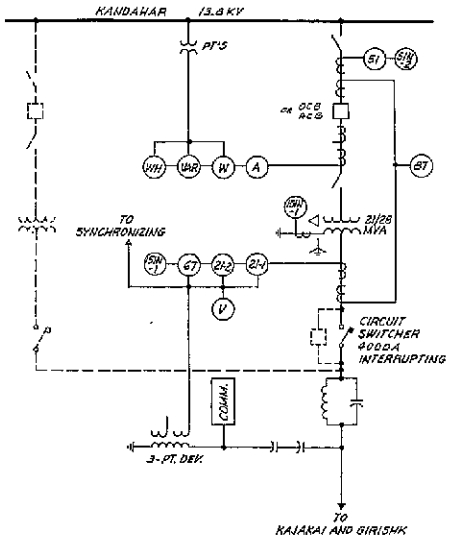
INTERNATIONAL ENGINEERING COMPANY, INC.

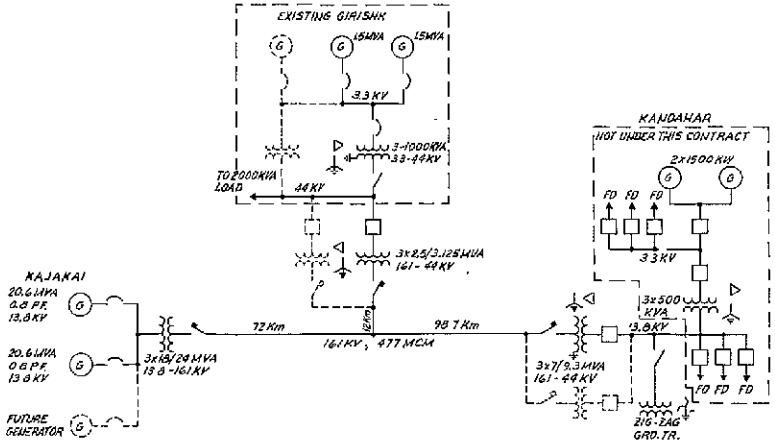
DESIGNED HH	CHKD. HH	SUBMITTED
DRAWN GR	DISP.	RECOMMENDED
		APPROVED
SAN FRANCISCO, CAL.		66-47-11
DATE APRIL 1970		

FIGURE B-16

DEVICE	DESCRIPTION	SECT.
21-1	IMPEDANCE RELAY, ZONE 1	
21-2	IMPEDANCE RELAY, ZONE 2	
51	OVERCURRENT RELAY	
51N	OVERCURRENT RELAY, RESIDUAL	
150N	OVERCURRENT RELAY, RESIDUAL	
67	REVERSE POWER RELAY	
87	TRANSFORMER DIFFERENTIAL RELAY	







KAJAKAI - GIRISHK - KANDAHAR TRANSMISSION LINE

DA AFGHANISTAN BRESHNA MOASSESSA

KAJAKAI HYDROELECTRIC PROJECT
GIRISHK AND KANDAHAR SUBSTATIONS
ONE LINE DIAGRAMS

INTERNATIONAL ENGINEERING COMPANY, INC.

DESIGNED DMH CHKD. DMH SUBMITTED
DRAWN GG INSP. RECOMMENDED
APPROVED

SAN FRANCISCO, CAL.
DATE APRIL 1970

GG-59-11

Economic Study
Kajakai Delayed Project
Footnotes

Cols 3 and 4 — System Losses added - 15% for diesel operation, 20% for Kajakai Operation

Column 6 — 2 MW units added as needed. All units removed in 1972.

Columns 8 — Investment costs based on Fairbanks Morse (Colt Industries) 1969 Bids escalated ~~to~~ 1972 — $280 per KW. All units removed in 1982. Credit taken for their salvage value ~~discount~~ at that year discounted back to 1972. Salvage value determined by using 20 year life ~~=~~ adjusted for ~~set~~ removal & storage costs assumed to be equal to 2 additional years depreciation at 5% per year.

Column 9 — Hydro costs based on 1971 and 1972 bids & IECO 1972 cost estimates.

Column 10 — Fuel costs FOB Kandahar on 5.5 Afs per litre (~~[illegible]~~) plus Operations, Maintenance, and Interim Replacements. Used Fairbanks-Morse guarantee and Industry standards adjusted to Afghanistan conditions — 2.4¢ per KWH (approximately)

Column 11 — Kajaka ~~Investment~~ costs estimates from Federal Power Commission studies including interim replacements (adjusted to Afghanistan conditions), $20000 ~~Generator~~ per year added for storage & handling for turbine & intake gates (sunk investment) pending delayed installation

(cont)

GENERAL

1. INVESTMENTS CONSIDERED as SUNK – Girishk Hydro, Kandahar Diesels (original 2 - 1.5 new installation), and all Kajdcai costs not recoverable UNLESS Kajdcai is built. ESTIMATED at $3,000,000.

2. Costs considered as common to both this plan and the Kajdcai Project plan – operating costs of Girishk hydro, all INVESTMENT + OPERATING COSTS of EXISTING DISTRIBUTION + transmission system, and all new ~~distr~~ or planned distribution and sub transmission lines not involved in transmitting Kajdcai power to the loadcenters.

3. 2015 year solvage to account for ~~different life~~ equipment installed at different times but having about the same expected life.

ECONOMIC STUDY

Kajakai Project

2-16.5 MW Units 1975, 1-16.5 MW Unit 1980

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)		(14)	
CALENDAR YEAR	MWH	GENERATED		MW DEMAND	IN OPERATION		INVESTMENT CASH FLOW (1000's) $	OPERATING COST CASH FLOW (1000's) $			TOTAL CASH FLOW (1000's) $	DISCOUNTED CASH FLOW 6%		8%	
	SALES	DIESEL	HYDRO		DIESEL	HYDRO	DIESEL	HYDRO	DIESEL	HYDRO		Factor	AMT $ 1000's	Factor	AMT $ 1000's
1973								8500			8500	.94	7990	.93	7905
4								8500			8500	.89	7565	.86	7310
5	36401	100	45400	11.6		33.0			50	350	400	.84	336	.79	316
6	40465	100	50400	12.8					50	350	400	.79	316	.74	296
7	44052	100	55000	14.0					50	350	400	.75	300	.68	272
8	47589	100	59400	15.1				2000	50	350	2400	.70	1680	.63	1512
9	51538	100	64100	16.4				2000	50	350	2400	.67	1608	.58	1392
1980	55546		69500	17.7	-3	16.5	-330			370	40	.63	25	.54	22
1	59829		74800	19.0						370	370	.59	218	.50	185
2	64913		81000	20.6						370	370	.56	207	.46	170
3	70413		88000	22.3						370	370	.53	196	.43	159
4	76418		95500	24.1						370	370	.50	185	.40	148
2015	SALVAGE							-300			-300	.10	-30	.05	-15
TOTAL													20596		19672

ECONOMIC STUDY
Kajakai Delayed Project
(Diesel initially, Kajakai 3-16.5MW
Units Installed for 1982 Operation)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)		
CALENDAR YEAR	MWH Sales	MWH Generated Diesel	MWH Generated Hydro	DEMAND	MW OPERATION Diesel	MW OPERATION Hydro	Invst. Cash Flow ($-1000's)		Oper. Cost Cash Flow ($1000's)		Total Cash Flow ($1000's)	Discounted Cash Flow 6% Factor	8% Amt. ($1000's)	Factor	Amt ($1000'
1973							1680			20	1700	.94	1598	.93	1581
4							1680			20	1700	.89	1513	.86	1462
5	36401	34800	8900	11.6	12		560		825	20	1405	.84	1180	.79	1110
6	40465	39700	8900	12.8			560		953	20	1533	.79	1211	.74	1134
7	44052	43900	8900	14.0	4		280		1052	20	1352	.75	1014	.68	919
8	47589	48300	8900	15.1			280		1159	20	1459	.70	1021	.63	918
9	51538	53000	8900	16.4	2		280	8500	1270		10050	.67	6734	.58	5829
1980	55546	57900	8900	17.7			280	8500	1388		10168	.63	6406	.54	5491
1	59829	62900	8900	19.0	2			4000	1508		5508	.59	3250	.50	2754
2	64913		81000	20.6	-23	49.5	-3766			370	-3396	.56	-1902	.46	-1562
3	70413		88000	22.3						370	370	.53	196	.43	159
4	76418		95500	24.1						370	370	.50	185	.40	148
2015	Salvage							-3000			-3000	.10	-300	.05	-150
TOTAL													22106		19793

ECONOMIC STUDY

Kajakai Delayed Project

Footnotes

Columns 3 and 4	-	System losses added-15% for diesel operation, 20% for Kajakai Operation
Column 6	-	2 MW units added as needed. All units removed in 1972
Column 8	-	Investment costs based on Fairbanks Morse (Colt Industries) 1969 Bids Escalled 1972 - $280 per KW. All units removed in 1982-Credit taken for their salvage value at that year discounted back to 1972. Salvage Value determined by using 20 year life adjusted for removed and storage costs assumed to be equal to 2 additional years depreciation at 5% per year.
Column 9	-	Hydro costs based on 1971 and 1972 bids & IECO 1972 Cost Estimates.
Column 10	-	Fuel costs FOB Kandahar are 5.5 Afs per litre plus Operations, Maintenance, and Interim Relacements. Used Fairbanks - Morse guarantee and Industry Standards adjusted to Afghanistan conditions - 2.4 per KWH (approximately)
Column 11	-	Kajakai costs estimated from Federal Power Commission studies including interim replacements (adjusted to Afghanistan conditions). $20000 per year added for storage and handling for Turbine and Intake Gates (Sunk Investment) pending delayed installation.

Escallated

General

1. Investments considered as Sunk-Girishk Hydro, Kandahar Diesels (original 2-1.5 MW installation), and all Kajakai costs not recoverable unless Kajakai is built estimated at $3,000,000.

2. Costs considered as common to both this plan and the Kajakai Project Plan - Operating costs of Girishk hydro, all investment and operating costs of existing distribution and transmission system, and all new or planned distribution and sub-transmission lines not involved in transmitting Kajakai power to the load centers.

3. 2015 year Salvage to account for equipment installed at different times but having about the same expected life.

Economic Study

Kauakai Delayed Project
(Diesel initially, Kauakai 3-16.5MW units installed for 1982 operation)

OMIT THIS COLUMN

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)		(15)	
	MWH			MW			INVESTMENT CASH FLOW ($1000's)		OPERATING COSD CASH FLOW ($1000's)		TOTAL CASH FLOW ($1000's)	DISCOUNTED CASH FLOW				
												6%		8%		10%
CALENDAR YEAR	Sales	Generated DIESEL	Generated HYDRO	DEMAND	OPERATION DIESEL	OPERATION HYDRO	DIESEL	HYDRO	DIESEL	HYDRO		F	Amt ($1000's)	F	Amt ($1,000's)	F	Amt ($1,000's)
1973							1680			20	1700	.94	1598	.93	1581		
4							1680			20	1700	.89	1513	.86	1462		
5	36401	34,800	8900	11.6	12		560		835	20	1405	.84	1180	.79	1110		
6	40466	39,700	8900	12.5			560		953	20	1533	.79	1211	.74	1134		
7	44052	43,900	8900	14.0	4		280		1052	20	1352	.75	1014	.68	919		
8	47589	48,300	8900	15.1			280		1159	20	1459	.70	1021	.63	918		
9	51538	53,000	8900	16.4	2		280	8500	1270		10050	.67	6734	.58	5829		
1980	55546	57,900	8900	17.7			280	8500	1388		10168	.63	6406	.54	5491		
1	59824	62,900	8900	19.0	2			4000	1508		5508	.59	3250	.50	2754		
2	64413		91,000	20.6	-23	495	-3366			370	-3396	.56	-1902	.46	-1562		
3	70413		88,000	22.3						370	370	.53	196	.43	159		
4	76415		95,500	24.1						370	370	.50	185	.40	148		
2015	Salvage							-3000			-3000	.10	-300	.05	-150		
													22106		19793		

See attached sheet for footnotes

Economic Study

Kajakai ~~Delayed~~ Project

~~(Diesel [illegible])~~

~~[illegible]~~

2-16.5 MW units 1975 / 1-16.5 MW unit 1980

OMIT THIS COLUMN

CALENDAR YEAR	(2) MWH Sales	(3) MWH Generated DIESEL	(4) MWH Generated HYDRO	(5) MW DEMAND	(6) MW IN OPERATION DIESEL	(7) MW IN OPERATION HYDRO	(8) INVESTMENT CASH FLOW ($ 1000's) DIESEL	(9) INVESTMENT CASH FLOW ($ 1000's) HYDRO	(10) OPERATING COSD CASH FLOW ($ 1000's) DIESEL	(11) OPERATING COSD CASH FLOW ($ 1000's) HYDRO	(12) TOTAL CASH FLOW ($ 1000's)	(13) DISCOUNTED CASH FLOW 6% F	(13) DISCOUNTED CASH FLOW 6% Amt ($ 1000's)	(14) DISCOUNTED CASH FLOW 8% F	(14) DISCOUNTED CASH FLOW 8% Amt ($ 1000's)	(15) DISCOUNTED CASH FLOW 10% F	(15) DISCOUNTED CASH FLOW 10% Amt ($ 1000's)
1973								8500			8500	.94	7990	.93	7905		
4								8500			8500	.89	7565	.86	7310		
5	36401	100	45400	11.6		33.0			50	350	400	.84	336	.79	316		
6	40465	100	50400	12.8					50	350	400	.79	316	.74	296		
7	44052	100	55000	14.0					50	350	400	.75	300	.68	272		
8	49589	100	59400	15.1				2000	50	350	2400	.70	1680	.63	1512		
9	51538	100	64400	16.4				2000	50	350	2400	.67	1608	.58	1392		
1980	55546		69500	17.7	-3	16.5	-330			370	40	.63	25	.54	22		
1	59829		74800	19.0						370	370	.59	218	.50	185		
2	64413		81,000	20.6						370	370	.56	207	.46	170		
3	70413		88,000	22.3						370	370	.53	196	.43	159		
4	76415		96,500	24.1						370	370	.50	185	.40	148		
2015		SALVAGE						-300			-300	.10	-30	.05	-15		
TOTAL													20596		19672		

See attached sheet for footnotes covering "Kajakai ~~Dam~~ DELAYED PROJECT" which apply for the "Kajakai Project" where appropriate.

160

NESA/CDE, Mr. Don Reese

November 19, 1970

THRU: NESA/CDE/ENGR, Emory Roberts

NESA/CDE/ENGR, Ray P. Stokely

Helmand Valley Electric Power Project, 041

Attached are copies of

1. John W. Callahan's memo of 11/7/70 commenting on
2. Hans Koski's (PSC AID 306-772) final report--4/4/70 to 10/3/70 and
3. Hans Koski's expansion proposal (Kandahar and Girishk distribution expansion) dated 9/29/70.

Although this is a grant financed project, it deals with the distribution systems required for the 009 Kandahar Diesels and 013 Kajakai loan projects. You will note that Koski estimates a total $1,513,000 ($1,213,000 foreign exchange and $300,000 local currency) will be required over the next five years starting in 1971. This amount is not included in any U.S. grant or loan project as of this date.

cc:
NESA/SA:CGurney (w/cc reports & Callahan memo)
NESA/CO:FMoulton (")

NESA/CDE/ENGR:RPStokely:cak

BEST AVAILABLE

STANDARD FORM NO. 64

Office Memorandum • UNITED STATES GOVERNMENT

TO : Mr. Ray P. Stokely, Electrical Engineer, NESA/CDE DATE: Nov. 7, 1970
THRU: Mr. Aldelmo Ruiz, Chief, Eng. Div., USAID/Afghanistan
FROM : John W. Callahan, Electrical Engineer-Power

NOV 18 1970

SUBJECT: Helmand-Arghandab Valley Electric Power Project #041

Forwarded for your information are five copies of Hans H. Koski's Final Report prepared in accordance with Article I B-4 of PSC Contract AID-306-772. This report covers the six month period from April 4, 1970 to October 3, 1970.

Mission comments concerning the report are as follows:

Paragraph #3: Materials withheld by HACU did not cause four months' delay in construction, but only four months' delay in completion of the line to Dea Khoja and Chouni in Kandahar. HACU has since released the #041 commodities to ABM, and Mr. Peabody, NRECA, is assisting ABM in transfer and completion of line work.

Paragraphs #4, #5, and #6: Sub-station work will be completed as soon as materials arrive. The Bolan Farm transformer will be repaired as soon as repair instructions are received from General Electric. The Bolan Farm sub-station will be energized using jury rig lighting protection and without metering after the transformer is repaired.

Paragraph #15: ABM is presently using European standards except in special cases such as in the Helmand Valley. The standards in the Helmand Valley were established before ABM existed. House service standards need improvement and the Mission will continue working with ABM on this problem.

Also enclosed for your information are five copies of Koski's report for future expansion of the distribution systems, prepared in accordance with Article I-B-3 of PSC Contract AID 306-772.

Enclosures
1. Final Report (5 cys)
2. Report on Distribution Systems (5 cys)

18 NOV 1970

NOV 18 1970

FINAL REPORT
of
Activities, Accomplishments and Recommendations
Contract #AID 306-772 - HANS H. KOFOD
October 3, 1970

1 The purposes of Contract #AID 306-772 were to complete construction work, advise Kandahar and Boghra Breshna on operation and maintenance, and to prepare a program for expansion of the systems for future load.

2 The accomplishment of these objectives involved staking of lines, inspecting construction, tabulating and checking construction items for the Contractor's billing, checking generation and line operation, and studying ways of building up the systems for the future.

3 Construction was quite limited during the contract period and did not meet its goals. Lack of delivery of materials and stoppage of issuance of materials reduced construction to about the first half of the contract period. During this time line construction in Dea Khoja and Chouni in Kandahar was almost completed. Line materials were withheld by HACU causing four months' delay. The remaining line materials represent about three months of line work. Most of the remaining construction is for new secondaries to replace long unsafe and inadequate services.

4 Substation construction was limited by lack of materials. The Kandahar International Airport (KIA) transformer that had been damaged and repaired in the U. S. arrived but was not installed. Some connections and switches are still required to complete this installation. The KIA installation will not be of service until the two-1500 KW diesels are in service. Then the airport can be served, but the airport should use its own diesel power during winter peak load time.

5 The Bolan Farm transformer fins arrived to replace broken ones, but the manufacturer's installation instructions did not arrive. Lightning arrestors and metering still were lacking for Bolan Farm.

6 Kandahar substation lacked metering and control power. It could be placed in service with temporary control circuits if necessary.

7 The construction contract that was set up with HACU in 1966 for the rehabilitation program was quite complicated for accounting of construction. The final tabulations of construction items and the field checking for billing verification were done during this contract period. The HACU contract would

have been much simpler if it had been done similar to an REA contract. Unfortunately, the contract was prepared before ABM existed and ABM inherited it as prepared. An opportunity was lost on this construction to obtain good construction cost information, but neither HACU nor ABM did any research on this. If future line work is done on contract it would simplify the paperwork to pattern it to the REA.

8 Transferring of the remaining materials on the project to the Breshna was prepared on paper, but the physical transfer did not take place. Hopefully, this was to occur soon. Maps were corrected to show final construction on the project. These are the basis for a more systematic operation. The maps were placed on the walls in the Breshna Offices, giving the personnel a beginning in orientation in their use.

9 A study of the immediate generation needs of Kandahar Breshna was made. As a result, the installation at the USAID power plant was completed to allow feeding out up to 500 KVA to the Kandahar system. This operation began July 7, 1970 and served several beneficial functions. First, it gave service to customers who would have been receiving limited service; second, service was improved, setting a standard of continuity and voltage that the customers and utility recognize; third, it gave the utility operating experience in trying to give the customer an improved service; fourth, it improved communication on an operating level between utility workers and advisors.

10 Troubles in operating with the USAID power involved circuit switching and load control. Past operation of the utility power has had the same problems, but this operation is a beginning in trying to change a cut-and-dry operation to a map and record operation. The installation of the two-1500 KW diesels should reduce the operating problems, but will at the same time show the greater need for getting system information on record.

11 Improved generation from the Filkoh hydro plant was studied. Only one of the two generations was in operation, but Breshna took action to start repair of the other machine and to repair the governors. With water spilling over the canal drop structure it appeared that improvement could be made with added flashboards and possible extension of the storage pond. This plant will give economical power until the Kajakai plant is in operation.

12 Plans for expansion of the systems for utilization of Kajakai power brought out some thoughts on overall system reliability. With the new hydro source it should be expected that reliability would increase. As the Kajakai project was planned, with a substation at Girishk, it was obvious that reliability would be no better than the original feed from the Girishk hydro. If the sub-

station were located farther north [illegible] Kandahar [illegible] 44 KV transmission, then the line is fed from both ends, [illegible] Ultimate economic, reliable development follows from this [illegible]

13 The Kandahar system, with feed from Kajakai, would burn the two-1500 KW diesels as back-up, but as loads increase they would serve only a small part of the load in an emergency. If Arghandab power is at all feasible, it should be considered as a firming development possibly before the third Kajakai unit.

14 The development of the systems to utilize the Kajakai power will require rural extensions. These extensions should be at a higher voltage, and the 20 KV standard should be used to conform with Afghan standard desires. Errors have been made in the past in trying to compromise American standards with European standards. This 20 KV standard could possibly work with the American 23 KV standard, but there should be no real need for compromise. Insulators, cutouts, and switches could be used interchangeably, but transformer voltages and ratios should be kept to one standard.

15 Overall standards in electrical work are needed in Afghanistan. ABM should initiate standards. With technical advice from many sources probably non-standardization is gaining and could lead to ultimate confusion. Simple standards, such as house service entrance standards which are sorely needed, should be set up and enforced by ABM. The problem of properly using the service wire from the #041 project hinges on such a standard.

16 In the six months period of this contract no basic change in operation has occurred but there seems to be more awareness in the management of Kandahar Breshna to keep the generating systems up to serve the customers. In the Boghra Breshna system there seems to be more desire to get new customers connected and to try to make the revenue collections more effective. These are hopeful indications that with the better future in power availability these organizations will be working for the customers' benefit.

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UNITED STATES GOVERNMENT

2-Way Memo

STOKELY FIELDING

March 72

DATE OF MESSAGE
March 16, 1972
DATE OF REPLY

INSTRUCTIONS
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SENDER:
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Subject: Loan 306-H-013, Kajakai Hydro-Betoma Concrete Pole Plant

Ref: State 041243

To: Mr. Emory Roberts, Chief of Engineering
Agency for International Development
ASIA/CDE Room 4241 NS
Washington, D. C. 20523

5027-101

FOLD — FOLD

USE BRIEF, INFORMAL LANGUAGE

On March 9, the writer visited Mr. Abady, General Superintendent of ABM for the Betoma concrete pole plant. Mr. Abady is a graduate (USSR) electrical engineer with five years experience since graduation, most of which was gained in residence at Russian hydro stations in the Kabul Gorge. Together we visited the site where the Betoma pole plant will be erected some 6 Kms. East of Kabul on the road to Jallalabad. The site is within the compound walls of the Pul-i-Charkhi electric substation, is level and appears to be well drained. An existing 500 volt electric line now in the yard will have to be moved but there is adequate power for the plant.

The Construction Division of ABM, staffed with civil engineers, will construct the plant because the only quotation received from Afghan contractors was 120% over ABM's estimate. We understand the construction drawings are in hand. Actual construction will start as soon as the weather clears (site now under 1 ft. of snow). Until a deep well is drilled, water will be hauled in tank trucks. The project for drilling the well is now before the council of ministers for approval.

German Advisors checked raw material sources before the contract for the plant was signed and, while it is admitted that supervision of raw material quality control is necessary, no real difficulties are expected in this regard.

In response to reftel we have the following additional comments (keyed to the paragraphs of reftel):

1. (A) We have been told that 90% of the plant has now been paid for by ABM and the balance of 10% will be paid when the plant is delivered, put into operation and accepted. The bank has forwarded to Betoma the change in the letter of credit including an extension of validity.

From: Winthrop A. Stiles
Kabul (ID)
Department of State
Washington, D. C. 20521

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UNITED STATES GOVERNMENT

2-Way Memo

Subject: Loan 306-H-013, Kajakai Hydro-Betoma Concrete Pole Plant

DATE OF MESSAGE: March 16, 1972

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To: Mr. Emory Roberts, Chief of Engineering

5027-101

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(E) ABM will forward soon the change order to Betoma for additions to present order for Kajakai requirements

(F) ABM intends to order 50 tons of DIN spec steel wire from KRUPP, Germany but preparation of the order depends upon council of ministers decision now expected within 1-2 weeks.

(G) Drawings received and foundations are designed.

(I) ABM feels they will need one training advisor for about two to four months and will arrange at proper time.

ABM has also had under consideration purchase of a new truck for hauling the poles and has settled upon a 12 ton German diesel with dolly. This is very similar to our West Coast logging trucks. The order has not been placed yet because the appropriation is before the council of ministers for approval. As back-up for this equipment ABM has an older truck of adequate capacity to fill in.

In addition to the overhead bridge crane coming with the Betoma plant, ABM has a mobile crane to come from another construction site. Crane rails to suit the wheel size and runway length of the bridge crane are on hand.

From:

The Files

February 21, 1972

ASIA/CDS/ENR, Eugene Tierney

Kajakai Hydroelectric Project Loan 306-H-013
Project Information to be provided by USAID/A

February 14, 1972, Mr. Stiles, USAID/Afghanistan, and I discussed the various items of information needed here in AID/W to complete the project status review. Mr. Stiles departed for Afghanistan immediately after our discussion; and due to the predeparture confusion, I failed to make a copy of the listed items for our files. Listed below are the items as I remember them at this time.

1. Electric Power Statistics

   a. Update power requirements using the operating logs for Girishk Hydroelectric and Kandahar Diesels showing KWH generated, KWH sold and KW maximum demand.

   b. The Koski Report of September 29, 1970 should be made current and include all of the areas of potential growth such as the Shanalen area.

2. Description of impending rate legislation and status of implementation.

3. Evaluation of present AEMI and Kajakai service area electric utility management capability, outlining the implemented improvements since 1966.

4. Betoma Pole Plant

   a. Procurement Status

      (1) Delivery Date (Kabul)
      (2) Installation time schedule (recommended by Betoma)
      (3) Financing

   b. Site preparation and operating procedures

      (1) Equipment Foundations
      (2) Building erection and locally procured equipment
      (3) Utilities
      (4) Material Procurement Contracts (concrete, aggregate, re-rod, etc.)
      (5) Organization for plant operation (when will required men be on job?)
      (6) Transportation of poles to Kandahar.

cc: W. Stiles, USAID/Kabul

USAID/Kabul, Mr. Winthrop A. Stiles March 9, 1972

ASIA/RCD, John Standish

Kajakai Hydroelectric Power Plant, Loan 306-H-013

REF: Project Review - February 11 and 14, 1972

This will confirm the above referenced discussions during which we reviewed the status of the Kajakai Hydroelectric Power project and reached agreement to update information from that contained in the Project Capital Assistance Paper (CAP). In our review, you will recall the major area of concentration by your office would involve updating the information on demand or market data, the institutional capability of AEM, questions of electric power rate structure and any known problems or short falls of the project since its authorization. In this regard you will also recall that we agreed the information contained in Hans H. Koski's report of September 29, 1970 was a big step in furnishing updated information, however, that the information contained therein was in some cases no longer timely or should be expanded to reflect the current status of the subject.

In order to expedite and facilitate our review of the project, please respond to the following questions and provide us with the requested data. As mentioned in our discussions, we do not expect you to provide any narratives except where you feel it required to supplement the basic data. We will collate the material here upon receipt of all the requested information.

I. Introduction

What is the total of the A.I.D. grant assistance to the Helmand-Arghandab Valley since the Capital Assistance Paper (CAP) in 1967?

II. Background

Excluding the existing 391-H-009 and 013 loans, what is the amount of A.I.D. funds which have been provided to the RGA for power related activities in the Helmand-Arghandab Valley Region since 1967?

III. Electrification Plan

(A) Distribution and Transmission

The Koski report dated September 29, 1970 contains the most recent information on this topic. However, even that information is no longer current. As per our discussion, a supplement to the Koski Report will be prepared showing the present condition of the Generating Facilities, distribution improvements and system expansions completed after September, 1970 and list any new load areas that have emerged since completion of the report.

(B) Generation

What is the KWH generated and KW maximum demand for each generating plant for the last four or five years? This information should be obtained from the plant operating logs and totalized by months. Also we would like to have the KWH billed or sold by AEM during the corresponding period of the record generated power.

IV. Economic Aspects

Furnish any information, readily available, on load growth over the last two or three years that may be used by AID/W to verify the Annual Projected Totals shown in the CAP. Please use the following breakdown in reporting your findings:

a. Residential (please include number of residents and average KWH energy use per residence).

b. Small Commercial (please include number of SC's and average KWH use per SC).

c. Individual Large Loads (such as industrial, army, airport, tubewells, etc. These should be individually and specifically identified by location, demand, and energy use).

V. Implementing Agency

What organizational and managerial improvements have been made within AEM since 1967? What expatriate advisors have been, are, or will be utilized by AEM? What training, domestic or international, has been done, currently in progress, or is contemplated?

Please provide an organization chart of AEM and biographic data on the key people and the positions they occupy. Our reference to AEM includes the Kabul organization as well as the Kandahar and Girishk distribution sectors.

[illegible] Mr. Harthorn [illegible]

[illegible] Financial Aspects

What are the rate structures currently in use? What changes are [illegible] planned and [illegible] for Angola [illegible]?

ASIA/NCD:JStandish:cak

Clearance:
ASIA/NCD:WTierney_____
ASIA/NCD:RESteckely_____
ASIA/NCD:ERoberts_____
ASIA/NCD:TLustig_____

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MAY 1962 EDITION
GSA FPMR (41 CFR) 101-11.6

UNITED STATES GOVERNMENT

Memorandum

FASHDC

TIERNEY

TO : Mr. Winthrop A. Stiles, ENG

DATE: March 11, 1972

FROM : Hans H. Koski, ENG

SUBJECT: Electric Load Growth-Helmand-Arghandab Valley

Load growth in the Helmand-Arghandab Valley was projected in relation to the installation of interim diesel power at Kandahar and the installation of generation at Kajakai. This projection was made in the Beck 1964 report on Kajakai power. The capital assistance paper on this project modified the projection. The tabulation of this projection is shown on Table I. Also shown on Table I is the actual load growth of the Kandahar and Girishk systems. The time scale of the projection was moved ahead 3 years to correspond with the present schedule of the Kajakai installation, assumed to be late 1974.

The Kandahar system load has been limited by available generating capacity. During the years prior to 1971, generating facilities deteriorated so that in a 10 year period the output actually decreased about 10%. The interim diesels were installed in April 1971 and in almost a year's operation the estimated full yaar of operation will produce an increased output 130% above the 1970 output.

The Girishk system has been growing at about 7% per year over 8 years. During the present winter the peak load exceeded the full output of the Girishk hydro plant. If the load continues to increase at 7%, then in 3 years 900 Kw would be required beyond the hydro plant capacity. This can be supplied by the 1000 Kw diesel or by the Bost Oil Mill. There is no reserve capacity so the next 3 years will be a risk operation.

The Kandahar interim diesel plant capacity was also exceeded by about 300 Kw. Of the smaller diesel units only one 300 Kw German and a 150 Kw and a 350 Kw Caterpillar were operable. Coming winter loads will require rehabilitating one of the 500 Kw white-superior diesels. Parts are expected in 1972 for this rehabilitation. During the present winter the canal hydros have not been operable due to the lack of water. The Kandahar operation is and will be a risk operation.

Growth will be limited by the generating capacity so that the 1974 Kwh projection will not be reached. Probably the 1973 projection will be reached and restrictions will be needed to keep within capacity. The projections in the capital assistance paper are not realistic in that they are based on a 45% load factor. From past records it appears that 37% might be more realistic. For this reason the peak Kw in 1974 as projected might be reached but output would be approximately equal to the 1973 Kwh projection.

5010-108

Buy U.S. Savings Bonds Regularly on the Payroll Savings Plan

The program for growth as outlined in the "Proposal for 1971 - 1975 construction" (Koski September 1970) has been followed during 1971 with the addition of 1270 services in Kandahar and 225 services in the Girishk area, bringing the total number of services to 7223.

The Director at Kandahar proposes to add 500 services in 1972 and in the Girishk area possibly 200 would be added.

Facilities were built in 1971 to serve Kandahar International Airport and the Kandahar Woolen Mill. Also service was installed for two ice plants and the USAID Compound. These loads are all kept off during peak load time. There are potential loads at a new tannery and a shoe factory. Also the possibility of renewed operation of the Kandahar Fruit Co. is expected. Many small flour mills have been kept off the line during peak load. The total demand of the installed facilities approximates 700 Kw and the other potential loads about 300 Kw. At Lashkar Gah, the Bost Oil Mill would demand 700 Kw but presently lacks transformer capacity. These loads alone would bring the total system demand to about 9000 Kw. after the first year of Kajakai operation.

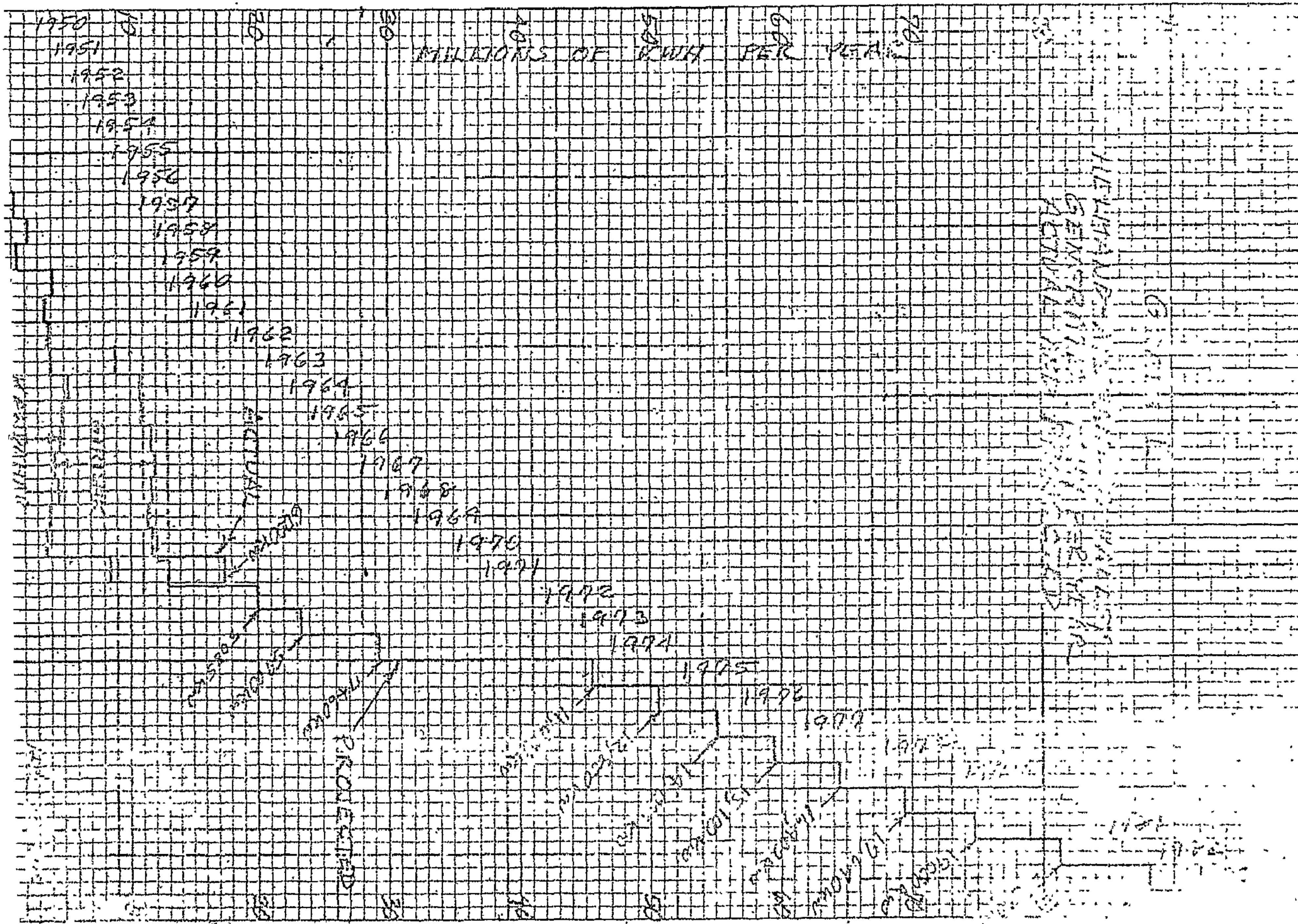
To fill out the required projection it will be necessary to add all the remaining residences and shops and to begin rural expansion. The connection of 1270 services in 1971 indicates that a good percentage of the unserved 9000 residences and shops would want service by 1974. This would bring the load approximately to the 1975 projection. A 9% growth per year after that would be sustained with the rural expansion and normal urban growth.

The start of the Shamalan Project and the recent growth of farmers' income of about 15% per year should give a good rural demand in the areas of the Helmand Valley. In Kandahar area, the initial rural construction south of the city will add the more populated and prosperous villages.

The present growth trend is encouraging, and, if timely action is taken on extension of the systems, future growth to full loading of the initial Kajakai installation will progress on schedule.

Additional information is shown on the following attachments:

Table I - Projected and actual loads
Graph I - Table I, data plotted.
Table II - Output of the interim diesels at Kandahar
Table III - 2-year monthly load growth on the Girishk system



MILLIONS OF KWH PER YEAR
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
ACTUAL
PROJECTED

TABLE (1)

KWH generated on the Kandahar and the Girishk systems, year 1949 through 1971, and Projected KWH 1970 through 1984

Year	Kandahar	Girishk	Total	Projected
1949	204,000		204,000	
1950	299,000		299,000	
1951	259,000		259,000	
1952	347,000		347,000	
1953	429,000		429,000	
1954	822,000		822,000	
1955	875,000		875,000	
1956	780,000		780,000	
1957	1,305,000		1,305,000	
1958	2,175,000		2,175,000	
1959	1,387,000		1,387,000	
1960	4,090,000		4,090,000	
1961	3,663,000		3,663,000	
1962	3,756,000		3,756,000	
1963	3,832,000	5,144,000	8,976,000	
1964	5,166,000	5,600,000(est)	10,766,000(est)	
1965	4,791,000	6,100,000(est)	10,891,000(est)	
1966	4,722,000	6,785,000	11,567,000	
1967	4,176,000	7,777,000	11,953,000	
1968	4,603,000	7,108,000	11,711,000	
1969	3,982,000	7,462,000	11,444,000	
1970	3,645,000	8,000,000(est)	11,645,000(est)	11,987,000
1971	8,400,000(est)	8,940,000(est)	17,340,000(est)- -(based on 11 months)	12,996,000
1972				19,960,000
1973				25,206,000
1974				29,283,000
1975				45,501,000
1976				50,581,000
1977				55,065,000
1978				59,486,000
1979				64,422,000
1980				69,432,000
1981				74,786,000
1982				81,142,000
1983				88,039,000
1984				95,552,000

TABLE II

KWH generated at Preshna Kot, Fairbanks Morse generators

1971	Unit #1	Unit # 2	Total
April	76,300	71,200	147,500
May	216,900	225,600	442,500
June	203,000	226,000	429,000
July	263,000	246,000	509,000
August	288,000	304,000	592,000
September	390,000	220,000	610,000
October	440,000	380,000	820,000
November	425,000	290,000	815,000
December	575,000	453,000	1,028,000
1972			
January	210,000	779,000	989,000
February	246,000	775,000	1,021,000
		Eleven month total	7,403,000

Additional generation from USAID and from other diesel units possibly added another 100,000 to total generation and some use of hydro power early in the year contributed some. The total 12 month year corresponding with the Afghan year 1350 probably will have a total of about 8,400,000 KWH.

Load was controlled during various times of the year with restrictions on use by small flour mills, the woolen mill, the airport.

TABLE III

Two year growth on the Girishk system

Monthly generation at Girishk hydro plant

Month	1969-70	1971-72	Change
April	468,000	527,000	12%
May	405,000	522,000	28%
June	430,000	530,000	23%
July	480,000	602,000	25%
August	423,000	613,000	44%
September	400,000	516,000	28%
October	414,000	642,000	54%
November	527,000	813,000	54%
December	888,000	909,000	2%
January	1,023,000	1,166,000	14%
February	1,144,000	1,220,000	7%
March	850,000	880,000(est)	3%(est)
Total	7,462,000	8,940,000	20%

UNITED STATES GOV' IMENT

2-Way Memo

Subject: Loan 306-H-013 Kajakai Hydro-electric Project - Comments on and up-dating of loan Paper

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Associate Director
ASIA/CDE Room 4241 NS
Agency for International Development
Washington D.C. 20523

5027-101

FOLD — USE BRIEF, INFORMAL LANGUAGE — FOLD

The following comments are forwarded as agreed during my recent TDY in the Bureau. I understand the information is wanted by Ray Stokely and Gene Tierney to be fitted in with other up-dating analyses for Ted Lustig.

1. STATUS OF POWER RATE STRUCTURE

The first ABM draft proposal during Summer, 1971 was prepared by Dr. Hadi Kamal with the assistance of German advisor, Svendolfsky. It was somewhat revised and formally presented to H.E. Lalee, Minister of Mines and Industries early in 1972. The Minister has recently asked USAID to comment upon the proposal as now constituted. Translation is almost finished and we anticipate a discussion with minister Lalee on our analyses during the week of March 19th. Based upon outcome of that discussion we will forward this package to AID/W with USAID comments.

2. TRAINING PROGRAM STATUS

International Engineering has proposed the outline of a personnel training program including the number and qualifications of personnel, scope and location of training. Exploratory talks have been conducted in Iran with Harza Engineering Co., Philco - Ford Co. and the Iranian power Authority to determine scope, cost and arrangements for training of management and technician level personnel in that country. Unofficially, at this point, it appears that the Iranian training facilities can be made available at little or no cost to ABM. The management courses will be conducted

From: Winthrop A. Stiles
Kabul (ID)
Department of State
Washington D.C. 20521

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from June, 1972 on and technician training programs will be scheduled from January, 1973 on. Mr. Wahdat Shah, a senior administrative engineer with previous experience in the Morrison - Knutsen Afghanistan organization, was appointed as Training Coordinator for ABM in December, 1971.

As soon as it is clear that the Kajakai construction contract will go forward and a construction schedule is established, further implementation of the training program will be done.

3. DEMAND FOR ELECTRIC POWER AND LOAD GROWTH

A copy of Mr. Koski's memo of March 11, 1972 is attached. It is interesting to note the 130% increase in demand in the Kandahar area due to start-up of the new Fairbanks-Morse diesels in April, 1971, and this increase has been realized in spite of partial rationing of power to major users and a continuing back-log in residential service connections.

Although projected demand for power in the whole Kandahar/Girishk area has been moved forward three years (from the Loan Paper), it is clear that demand has always exceeded dependable supply. Also it is shown that, given dependable power, the utilization thereof soon follows. We estimate at the present rate of installing residential service connections, ABM (Kandahar/Girishk) will run out of materials by late 1972. Hopefully new supplies will be forthcoming so that the rate of adding connections will ensure the load growth required to economically utilize Kajakai power.

From:

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The probable effect on demand as a result of the new proposal rate sturcture will be analyzed in connection with (1) above.

Mr. Koski's comments on auxiliary diesel generators and canal hydros should be interpreted in the light that all of these units (except new Fairbanks - Morse) are strictly marginal and cannot be depended upon except for emergency and peak loads.

An additional potential (but unproven) power demand may be deep water well pumping. USGS studies indicate that water tables in the project area have been falling for the past 10 years. In some places the water table is approaching a depth which will make tube wells more practical and economical. The accelerated growth of agriculture may see this demand increase before Kajakai power becomes available. No provision has been made for this in Mr. Koski's figures and what the ratio between diesel and electric pumping would be is not determinable now. Present ABM policy is not to provide diesel-generated power for irrigation water pumping.

4. PRESENT ABM AND KAJAKAI PROJECT ORGANIZATION

A current plan of the organization of ABM ~~is attached.~~ WILL FOLLOW. The only major change is the appointment of Mr. Wahdat Shah as Training Coordinator for Kajakai. This gentleman is a close friend of the Minister and may in future months assume a more direct role in the total project.

Discussions with Dr. Abdul Hadi Kamal, Chief Finance Officer of ABM,

From:

Received: Carolyn Proctor
Date: March 24, 197

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Associate Director

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indicate that he is keenly aware of the need for cost accounting the Kajakai Project as a basis for more accurate rate structure calculations. The implementation of cost accountant training under Wahdat Shah is shaping up. Dr. Kamal is also aware of the plan (AID-financed) to install an IBM 360-30 computer with Bank - i Milli. We are urging Dr. Kamal to follow this development with a view to computerizing monthly "receivables" and possible application to cost accumulation and analysis for Kajakai Project.

cc:
Mr. Emory Roberts
ASIA/CDE/ENG

From: Winthrop A. Stiles
Kabul (ID)
Department of State
Washington D.C. 20521

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UNITED STATES GOVERNMENT

To: Standish

APR 1972

2-Way Memo

Subject: Loan 306-H-013, Kajakai Hydro-Proposed Electric Power Rate Structure

DATE OF MESSAGE March 27, 1972

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Chief of Engineering
Agency for International Development
ASIA/CDE Room 4241 NS
Washington D. C. 20523

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After several false starts a proposed power rate structure got off the ground in early 1972, and got out of ABM's shop and over to the Minister of Mines and Industries where it has been languishing for some time.

We were provided with a copy in Farsi which has now been translated, re-arranged etc. and is attached to this Memo.

The Minister asked for our comments and, since this is our third "run" at it, we are pretty familiar with the rationale used to make it up. In fact, this latest version includes several of the features suggested in the past by USAID.

Attached are our comments to Minister Lalee and we will be happy to also pass on to him the thoughts of AID/W if you care to comment.

It has been reported to us from various sources in a position to know that, under the present rate structure, the total ABM annual costs are subsidized to the extent of somewhere between 100-150,000,000 Afghanis. This loss, however, is not entirely due to power rates because it is also estimated that between 45-50% (including generating and line losses) of the electricity is not paid for at all. Over the years the public has become accustomed to having the RGA furnish subsidized power and attempts to reverse this ingrained thinking naturally meets political flak. ABM's approach to this problem is as follows:

1. Recognize the situation and first stabilize the pricing of power rather than continue to be pressured by the politicians into the present "flexible" system so adaptable to satisfying political problems.

BEST AVAILABLE

Copy retained 4/13/72

From:
Winthrop A. Stiles
Kabul (ID)
Department of State
Washington, D. C. 20521

OPTIONAL FORM 27
OCTOBER 1962
GSA. GEN. REG. NO. 27

1. TO BE RETAINED BY ADDRESSEE

UNITED STATES GOVERNMENT

2-Way Memo

DATE OF MESSAGE ~~March 27,~~ 1972

DATE OF REPLY

INSTRUCTIONS
Use routing symbols whenever possible.
SENDER:
Forward original and one copy. Conserve space.
RECEIVER:
Reply below the message, keep one copy, return one copy.

Subject: Loan 306-H-013, Kajakai Hydro-Proposed Electric Power Rate Structure

To: Mr. Emory Roberts, Chief

5027-101

FOLD FOLD

USE BRIEF, INFORMAL LANGUAGE

2. Establish an interim rate structure (the attachment) designed to recover up to 70-80% (estimated) of costs. A previous study (Hendrixon) requested by the Ministry of Planning has provided a neutral basis as a start for a rate structure. It is acknowledged that a basic lack of cost accounting up to the present makes the Hendrixon figures controversial; however, their figures probably represent the most authoritative basis available.

3. Strengthen the operational base of ABM including such features as:

A. Improvement in management capabilities

B. Establishing project cost accounting as a solid base for a final rate structure

C. Improve the "Accounts Receivable" picture considerably by better supervision of meter installations and reading; faster and more complete billings and collection (perhaps using the IBM 360-30 computer facilities being installed by Bank Melli).

4. Work toward a "final" rate structure for the whole country which will not only recover costs but will provide working capital and put ABM on a selfliquidating bases as far as capital investment loan servicing is concerned.

The foregoing is essentially the thinking of the ABM hierarchy as we have gleaned in verbal discussions with them. The implementation of such a program is, naturally, full of frustrations as evidenced by the resistance encountered even in introducing an interim rate structure of such modest proportions.

Some comments on the inability of ABM to make full collection of electricity bills owed to them is in order. The following system is in operation in Lashkar Gah and seems to be the most efficient in the country:

From: Winthrop A. Stiles

OPTIONAL FORM 27
OCTOBER 1962
GSA, GEN. REG. NO. 27

1 TO BE RETAINED BY OFFICE

UNITED STATES GOVERNMENT

2-Way Memo

DATE OF MESSAGE ~~March 27~~ April 4, 1972

DATE OF REPLY

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Page 3.

To: Mr. Emory Roberts, Chief

5027-101

FOLD — FOLD

USE BRIEF, INFORMAL LANGUAGE

1. A meter reader's list is made up in the accounting office. This has accounts by account number giving name and location of customers and the previous meter reading.

2. The meter reader reads the customer's meter, records the reading and calculates the bill. The list has several lines for a systematic way of calculating.

3. Each customer has an account book (purchased from Breshna for 10 Afs). The meter reader copies the billing into the customer's book.

4. The customer goes to the bank, pays his bill, receives a receipt. The bank sends Breshna a copy of the receipt.

5. Breshna accounting office has a file of individual customers. The receipt from the bank is recorded on the customer account.

6. The bank receipts are recorded on a ledger and totaled for monthly revenue collected.

7. A delinquent list is made up from the customer accounts. Before the next meter reading time (2 months) these are followed up, and the money is collected or the customer is disconnected. The average number of delinquents is about 50 and about half of them pay up.

8. HAVA is the biggest delinquent, having forced a cut to the ½ Af rate and having renounced past bills, and still is not paying the reduced bills.

9. The revenue account in the bank is under control of ABM, Kabul.

10. Another account is used for collection of installation fees, also controlled by ABM, Kabul.

From: Winthrop A. Stiles

OPTIONAL FORM 27
OCTOBER 1962

UNITED STATES GOVERNMENT

2-Way Memo

DATE OF MESSAGE	April 4 ~~March 27~~, 1972
DATE OF REPLY	

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Page 4.

To: Mr. Emory Roberts, Chief

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FOLD — FOL

USE BRIEF, INFORMAL LANGUAGE

Obviously close supervision of this collection system is essential and 100% probably never will be achieved. Full scale inspections of meter installations, by-passessetc. should be made. Typical problems in billing are that there are no house numbers and few street names (like in Kabul) so how can bills be mailed?

HAVA's attitude in not supporting electric power charges is and has been of major concern to us. We would certainly hope that any new power rate structure will be backed up by the support necessary to forestall such unrealistic situations.

From: Winthrop A. Stiles

OPTIONAL FORM 27

Da Afghanistan Breshna Moassessa (ABM)

Proposed Electricity Rate Structure-as of February-March 1972

(Current Exchange 84 Afghanis (84 Afs) = $1,00)

Group I

Applies to residences, hospitals, holy places, mosques, schools, educational institutions and welfare places.

Fixed Price (Demand Charge or Minimum Bill)

Per month for one consumer meter (single phase) - 20 Afa.
Per month for one consumer meter (three phase) - 50 Afa.

Variable Cost

Consumption in Kilowatt Hours	Rate Per KWH
0 - 30	1 Af
31 - 200	2 Afs
201 - 300	1.5 Afs
301 - 400	1 Af
401 and above	0.5 Afs

Penalty for non-Payment of Bills

If the consumer does not pay his electric bill in the current year, he must pay a 10% fine. If he does not pay for the next year he must pay another 10% of the total cost for each year.

Regulations

ABM will provide the consumer with a special book in which will be entered the monthly cost of electricity and the payment for it. If he does not bring the book and write in the expenditure he will pay another 10% fine. ABM reserves the right to discontinue service to anyone who has not paid his bill.

The right to have electrical service will be given to those who apply with their true name and residence.

No consumer will have the right to give electricity to anyone else.

The consumer in the first category (i.e., from 0 - 30 KWH) will not be charged the fixed price when monthly consumption does not exceed 30 KWH.

If the consumer operates a Group II, (see below) activity as part of a Group I, activity, he shall install a second meter and pay Group II, rates for Group II, activities.

If a Group I, consumer does not install a separate line and meter for Group II, activities, his Group I, electricity supply will be charged at Group II, rates.

Group II

Applies to government and quasi-government departments, municipalities, official departments, embassies, apartment houses, offices, commercial enterprises, shops, hotels, restaurants, clubs, theatres, cinemas, recreational places.

Fixed Price (Demand Charge or Minimum Bill)

Per month for one consumer meter (single phase) - 90 Afs.

Variable Cost

Standard rate for all - 2 Afs per KWH

NOTE: The same penalties and regulations apply to Group II, consumers as are stated above for Group I, consumers.

Group III

Applies to factories registered with Ministry of Mines and Industrial, water pumps and deep well pumps all of which use three phase, 380 volt power with line capacity up to 70 KW and not exceeding 300 meters of service line.

Fixed Price (Demand Charge or Minimum Bill)

Per month for one consumer meter is as follows:

Ampere capacity of meter	Single phase	Three phase
10 - 30 (fuse 20 Amp)	200 Afs	600 Afs
20 - 60 (fuse 35 Amp)	400 Afs	1200 Afs
30 - 90 (fuse 62 Amp)	-	1800 Afs
50 -150 (fuse 100 Amp)	-	3000 Afs
100 -700 (fuse 160 Amp)	-	6000 Afs

Variable Cost

Standard rate for all - 1 Af per KWH

BEST AVAILABLE

Regulations

1. All those penalties and regulations applying to Group I, consumers also apply to Group III.

2. If a Group III, consumer wishes service beyond 300 meters from the power source, he shall provide his own line.

3. ABM will supply a three phase meter (only type allowed) free of charge for Group III, consumers.

4. Fuse capacities shall not be exceeded. If they are, the maximum fixed price will be charged for all year.

If the capacity of the wiring exceeds 70 KW the rates of Group IV will be charged.

Group IV

Applies to heavy industrial power usage (over 380 volts).

Fixed Price (Demand Charge or Minimum Bill)

Per consumer per month - 50 Afs for each Amp of installed transformer capacity regardless of amount of power used.

Regulations

1. All those penalities and regulations applying to Group I, consumers also apply to Group IV.

2. These consumers will advise ABM - (A) how much power they need (B) whether they need a new power line or an extension and (C) what name to use for the account.

3. Three consumers will advise ABM the capacity of their transformer at the first of each year. If it is discovered that their installed transformer size exceeds the size reported he will pay the fixed price of the larger transformer for the whole year.

4. These consumers will procure their own transformers and meters to ABM specifications.

Group V

Applies to agricultural usage such as operating pumps or irrigating plants and power will supplied only to those places where hydro power is available. Diesel-generated power will not be supplied for agricultural use.

Fixed Price (Demand Charge or Minimum Bill)

If wiring capacity is 70 KW or less from three phase power, the charge per meter per month will be as follows:

Ampere capacity of meter	Fixed charge
20 - 60 (fuse 35 A)	600 Afs
30 - 90 (fuse 62 A)	900 Afs
50 -150 (fuse 100 A)	1500 Afs
100 -200 (fuse 160 A)	3000 Afs

Variable Cost

Standard rate for all - 0.50 Afs per KWM

Regulations

1. The amperage will not exceed the meter and fuse size. If it does the consumer will be charged at the actual rate for the whole year.

2. ABM will provide a three phase meter free of charge

3. As the use of power for agriculture varies greatly from season to season, the rate can be fixed by agreement.

4. If the place where the power is used exceeds 300 meters from a transformer station, the consumer will have to provide his own line and transformer.

5. If the wire capacity exceeds 70 KW, the power rate will be charged at 50 Afs for each KW ampere capacity of the transformer.

6. If the customer exceeds 390 volts, he will provide his own wire and transformer.

7. Power to agricultural residence will be charged at Group I, rates if a separate meter is installed at the residence; otherwise power will be charged at Group V rates.

Group VI

Diesel Power

There will be a purchase of 2 Afs per KWH above all the rates for Groups I, II, III and IV. No diesel power will be furnished for Group V.

General

In 1968, the Ministry of Planning requested the HENDRIXON GROUP to study the actual cost of electricity per KWH. The following figures on three bases were exeipted from their report.

	1966	1967	1968	1969	1970	1971
	Afs	Afs	Afs	Afs	Afs	Afs
1. Without profit on capital or consideration of foreigh exchange	1.66	3.17	2.92	2.60	2.60	2.40
2. With profit on capital and no difference in foreign exchange	2.19	4.15	3.81	3.39	3.32	3.06
3. With profit on capital and consideration of foreigh exchange	2.19	4.15	4.60	4.12	4.05	3.71

Da Afghanistan Breshna Moassessa (ABM)

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Fixed Price (Demand Charge or Minimum Bill)

Per month for one consumer meter (single phase) - 90 Afs.

Variable Cost

Standard rate for all - 2 Afs per KWH

NOTE: The same penalties and regulations apply to Group II, consumers as are stated above for Group I, consumers.

Group III

Applies to factories registered with Ministry of Mines and Industrial, water pumps and deep well pumps all of which use three phase, 380 volt power with line capacity up to 70 KW and not exceeding 300 meters of service line.

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Variable Cost

Standard rate for all - 1 Af per KWH

Regulations

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Ampere capacity of meter	Fixed charge
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100 -200 (fuse 160 A)	3000 Afs

Variable Cost

Standard rate for all - 0.50 Afs per KWM

Regulations

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2. ABM will provide a three phase meter free of charge

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