PN-ABA-098

ELECTRIC POWER PROBLEMS

KANDAHAR, GIRISHK AND ARGHANDAB

AFGHANISTAN

April 24, 1962

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-1- PN-ABA-098

Electric Power Problems Kandahar,
Arghandab and Girishk, Afghanistan

Pursuant to AID/W orders in response to the request of USAID Kabul the undersigned arrived Kabul March 14, 1962 to "bring together all available information and power problems related to Kandahar, Arghandab, and Girishk."

In Kabul brief discussions were held with Mr. Azizi, President of Industries, Ministry of Mines and Industries, Royal Government of Afghanistan, and his assistant, Mr. Mayar, and also with Mr. Howard Turner, Chief, Industry and Engineering Division, USAID Kabul. Mr. John Sanger participated in these discussions and in addition presented a detailed briefing of the project files.

Accompanied by Mr. Sanger I visited the power facilities in and related to Kandahar, Arghandab and Girishk. Mr. Wahhab, President Kandahar Electric Company, accompanied us to most of these facilities.

SECTION I STATUS OF FACILITIES AND RECOMMENDATIONS FOR PIECE MEAL CORRECTIVE ACTION

The philosophy of first providing physical facilities and hoping later to work out the staffing and training, maintenance, management, operation and business administration to effectively and efficiently conduct business is herein referred to as piecemeal actions.

1. Kandahar Diesels

A. The American-built and equipped diesel-electric plant in Kandahar, consisting of two 500-kilowatt White-Superior/Ideal units, and some associated electrical distribution, was the first power installation in the Helmand Valley in which ICA was involved. It had been recommended in the Tudor Engineering study of 1956 and was planned for installation under the terms of the Helmand Valley Authority - Morrison Knudsen Afghanistan - Export Import Bank contract, as an interim facility to serve the city of Kandahar until the Arghandab hydroelectric plant could be built, with the intention that thereafter it would be used as a standby. A Special Assistance Grant of $120,000 and a loan of $430,000 was made by ICA under the Arghandab Hydroelectric Project 041 by implementing documents dated November 6, 1957, and an equivalent of $156,000 in afghanis and Pakistani rupees was committed by the host government for local labor and materials and for transportation from Karachi to Kandahar. Engineering, procurement, installation, and construction was by International Engineering Company and Morrison Knudsen Afghanistan.

B. The completed plant was turned over to the Helmand Valley Authority by the contractor in July 1959. No adequately trained staff was provided by the recipient, and in the subsequent three years of operation by the Kandahar Electric Company there has been a minimum of maintenance. As a result both diesel units now require extensive repairs and overhaul.

C. The Kandahar diesel electric plant was visited March 26. At that time both units were said to be operable. Several deficiencies were brought to our attention:

(1) on one unit the flexible coupling containing glycerine had ruptured and the glycerine had escaped. The unit was reported to be operated nightly.

(2) one of the timing gears had been broken several times. A locally made replacement, having one less teeth, was in operation but it too was badly worn.

(3) the low-roofed metal building housing these units was reported to be extremely hot and noisy and was too low to provide headroom for repair work. There was no overhead crane.

Comment: These units, of relatively high speed, will require a continuing maintenance if they are expected to have a reasonable life and provide a dependable power supply at least until the Arghandab hydro plant is finished.

The engines run so hot that water is hosed onto the cooling radiators in an endeavor to dissipate the heat more rapidly. Mr. Wahhab, President Kandahar Electric Company, expressed his desire to build cooling towers for the engine coolant and requested Harza to provide him with a basic design. Mr. Van Hamel agreed to do this and also to obtain information on the commercially procurable equipment for this purpose.

Subsequent to inspection of the plant, the flexible coupling pulled apart and the unit was out of operation until a locally made coupling could be completed (about 11 days). The power company and the USAID personnel are to be complimented on their endeavors to get the unit back into operation as soon as possible. Most of this outage time and a great deal of expense could have been avoided had a replacement coupling been available.

Service from the diesel plant will be needed at least until Arghandab power becomes available, possibly three years hence, and may even be needed after that for more than standby. The Electric

Company therefore desires USAID assistance in putting the plant back in good operating condition. Also greatly needed is assistance in staffing and training for proper operation and maintenance in order to avoid recurrence of the breakdown cycle. Such a task is beyond the capabilities of the RGA and USAID Kabul personnel available. Mr. Azizi has pointed out that the Kandahar diesels are now outside the scope of the 041 project therefore ProAg and PIO amendments would be necessary. Mr. Azizi emphasized that all AID/A assistance to the Electric Company must be channeled through his office.

D. Recommendations:

(1) A supply of operating and maintenance spare parts sufficient for three years operation should be provided as soon as possible. In addition funds should be allocated and held in reserve for procurement of emergency replacements which cannot be anticipated.

(2) Additional ventilation is required and should be obtained either by raising the roof peak and providing vents along the edge of the raised portion or by installing additional louvered vents in the existing walls. This work can be accomplished by the Kandahar Electric Company.

(3) Thoroughly clean inside of existing radiators and remove anti-freeze, if any, during hot season. This work should be done by the Kandahar Electric Co.

(4) In the event engine cooling is not adequate after cleaning of radiators, recommended in C above, additional radiators or cooling towers will be required.

(5) The units should be placed in good operating condition under the direction of a diesel expert, preferably the diesel manufacturer's representative who, during the rehabilitation work and for a minimum period of one month thereafter, should supervise operation and conduct an in-service training of operation and maintenance.

(6) With the exceptions of (2) and (3) above, an engineering company, possibly, Harza, should be retained to accomplish the work.

2. Girishk Plant & System

A. History

The Girishk Power Plant and system were built chiefly to support the Helmand Valley Authority operations whose headquarters are at Lashkar Gah.

It was designed by International Engineering Company and built in 1956 to 1958 by Morrison Knudsen Afghanistan under terms of an Export-Import Bank loan and a contract directly between the Helmand Valley Authority and MKA, as a part of the overall valley development. Its cost was between 2 and 3 million dollars. The system was intended to initially serve a population of about 10,000, including nomads to be settled in villages of the newly irrigated areas.

The Girishk Plant, located about 3 kilometers below the Boghra diversion dam on the Helmand River, consists of two 1500 Kva Westinghouse alternators driven by Leffel vertical shaft Kaplan turbines. Space was provided for future installation of a third unit. "Firm power" capability at the Boghra drop, 25 feet, was estimated to be 3500 kilowatts; however the canal must be shut down for several weeks each year for maintenance. Therefore some source of standby power is required for essential loads.

The transmission system consists of 44 kilovolt line, on 40 to 45-foot steel poles (800' spans), with towers about every tenth structure for dead-ending and at turns. The sending-end station consists of three 1000 Kva power transformers. The following receiving stations are at the load ends:

Girishk town	100 Kva
Chah-i-Anjirs	400 Kva
Lashkar-Gah	1000 Kva
Nad-i-Ali	200 Kva
Marja	400 Kva
TOTAL	2100 Kilovolt amperes

The primary distribution systems (totaling over 20 kilometers) are at 3300 volts on No. 2 and No. 4 MHD copper and concrete poles (a few steel). The load pattern has changed since the time of construction; some anticipated load areas have not developed at all, and such centers as Chah-i-Anjirs and Lashkar Gah have grown, so that relocation of distribution transformers and the extension of primary feeders are needed. The receiving station transformers at Nad-i-Ali and Chah-i-Anjirs have been interchanged, and some distribution transformers from Nad-i-Ali removed for use in Lashkar Gah.

Under the MKA contract very little permanent-type secondary distribution was built. At the point where development of the electric system stopped, the contractor apparently made it clear that unless the HVA provided operators for the plant and some type of organization for running the system, the final steps of converting the end-use facilities from 60 cps diesel units to the new 50 cps power from Girishk could not reasonably be taken, and therefore the electric system would have to be turned

over to the HVA in an incomplete condition. Voltage incompatibility problems lay ahead because the diesel units furnished 110 volts single phase and 220 volts 3 phase, while "standard use" equipment in Afghanistan requires 220 volts single-phase and 380 volts 3-phase.

The existing secondary distribution is therefore largely the remains and outgrowth of the old radial lines from the diesel electric plants, and most of it is now extremely poor, inadequate, and overextended. The condition is particularly bad in the major load center Lashkar Gah, aggravated by the very long secondary runs on improvised construction, unmetered loads, extensive use of room and hot-water heaters and cooking appliances, extreme phase unbalance, inadequate and faulty grounding, overloaded distribution transformers, insulators broken or totally lacking hazardous interior wiring, unfused or improperly fused transformers and building entrances, and a variety of utilization equipment designed for different voltages and frequencies.

No provision had been made for supervisory, maintenance, and service personnel, operators, setting up and administering a utility system, establishing proper rates, requiring minimum standards of wiring and construction, metering all customers, converting existing equipment to use at new frequency and voltages, training Afghans, and phasing in on operation of the system. During the interim Lashkar Gah, Chah-i-Anjirs, and other settlements and villages continued to be marginally served by small diesel electric units, mostly those left over from MK construction equipment. These units were costly to operate and maintenance was practically non-existent, so that service deteriorated as loads increased.

Upon completion of the plant and of the system to the extent described above, they were turned over to the Helmand Valley Authority in 1958 by the contractor, after having been tested on a water rheostat and "mothballed", that is inactivated and readied for a protracted period of shut-down. Subsequently some repair work was done on the upper Boghra canal and following this at the request of HVA, in the spring of 1960 after about a two-year shutdown, the contractor again thoroughly checked, reconditioned, and made the plant ready for operation, under Adams, an MK engineer, and power plant technician Brooks, brought in for the purpose. Attempts to recruit third-country people under arrangements acceptable to the RGA were unsuccessful, so that the plant was again "mothballed", and Adams and Brooks left Afghanistan in June 1960.

Several endeavors to start up the plant were made by personnel unfamiliar with the equipment, and some damage was done to the plant and to end-use equipment. Power and distribution transformers were overloaded and some distribution transformers failed. In late winter of 1960 the plant and system were reportedly transferred from the Helmand Valley Authority to the Ministry of Mines and Industries and assigned to the

Electric Company. Through USOM, Ray Brooks TDY was again requested (December 1960) but contrary to advice of Mission and due to political pressures, the plant was started January 1961 before his arrival. Germans and Afghans put the plant in operation on a token load of about 250 kw with many difficulties due to unfamiliarity with the equipment. For example No. 1 unit was started while resting on the blocks, and brakes were burned out on No. 2 unit. Modifications were made to the governor mechanisms so that when they attempted to start the plant with rotors blocked, the linkages were damaged.

Ray Brooks arrived in March 1961, repaired damages, and tried to work out an employment arrangement with the RGA for a combined operation and training program, but was unsuccessful. After his departure the Electric Company put the plant in operation using German and Afghan personnel from Sarobi, in January of 1961.

In addition to the technical and management problems, the matter of transfer of the properties from the Helmand Valley Authority to the Ministry of Mines and Industries to the Electric Company was one which to appearances has never been cleared up. Supposedly some funds remained from the old XM loan for the completion and putting in operation of the system. These funds the Ministry desired transferred with the physical properties. HVA was reluctant to do this, and in addition apparently claimed credit, either funds or "free" services, for the cost of constructing the facilities. It is still a question how the Ministry of Mines and Industries and the Electric Company can equitably collect from HVA for electric services. The power struggle between HVA (under the Ministry of Finance) and the Ministry of Mines and Industries delayed implementation of plans to complete the system, provide a staff, and put the Girishk plant in full-scale operation.

In view of the continuing difficulties with Girishk, the ICA was requested to lend technical and financial assistance. An estimate made in summer of 1960 put necessary funds for Girishk system work at $421,000. As a full scale project to not only complete the system but select and train Afghans, and assist in setting up utility management, servicing, training, and operational follow thru, considerable additional funds would be required.

At the request of the RGA, the Girishk problem was included in project 041 with the expectation that it would be managed by the electric company and serve as the beginning of training for Arghandab operators. This was provided for by Revision No. 2 of the Project Agreement of 26 April 1961, and a PIO/T amendment No. 3 of June 28 '61 to furnish engineering service through the Harza contract out of funds previously committed to Arghandab. These called for all engineering services necessary to complete and put the system into full-scale operation; recruit and staff as

needed, and train Afghan personnel in operation, maintenance, and management; and oversee initial operation; and utilizing the facilities of the Afghan Construction Unit and the Electric Company, supervise and coordinate the necessary work. A sum of $100,000 of Arghandab funds was specified to be used for commodities and $80,000 for American technican hire, plus $10,000 for engineering services. The RGA commitment under the 041 project was increased by 1 million afghanis for local labor, materials, transportation, etc.

The project documents also provided for an overall valley power survey for future planning purposes.

Approval by AID/W has been given for implementing the Girishk system work under the 041 project, and the Harza contract was amended March 28 to cover the engineering survey.

B. Present Condition

The Girishk hydroelectric plant was visited on March 28. It is unfortunate that the governor nameplate shows the equipment to be manufactured under patents of 1870, 1889, and 1914. This probably has contributed to the feeling that the equipment is many years "out of date". The plant records indicate that winter peaks up to 900 kw have been carried. At present conditions, the daily load varies between 350 and 700 kw.

In Kandahar, prior to visiting Girishk, we were shown two bearing caps with breaks through the bolt holes. In the Girishk plant we were able to see the shaft which this bearing supports. This shaft is the mechanical linkage between the governor and the turbine gate control mechanism. This unit was parallelled with the number 2 unit so that we could see it in operation. From the noise and vibration of this shaft, during movement of the governor, it is obvious that corrective action is necessary. We were told that the turbine runner and gates had been inspected just two days prior to our visit and that they were in good condition. At the time of our visit the frequency meter on the control board indicated a rapid variation between 49 and 50.2 cycles. This was accompanied by variable voltage. The indicating instruments on the governor were rapidly variable and were vibrating constantly.

It was noted that the canal was carrying considerable debris and that the vertically slotted trash rack was permitting a good portion to enter the intake.

It was reported that the gate above the turbine, which is operated by hand with overhead chain falls, requires four hours to open or close,

Comment: The hand operated gate mechanism, except for the amount of labor involved, is not serious. If an inexpensive way to resolve this problem can be found it should be considered. Inasmuch as the debris in the canal is from vegetation growing there, the trash rack problem is not serious and unless debris prevents proper operation of the turbine gates no corrective action is necessary. The operating personnel made no complaint about this item.

C. Recommendation

(1) That Harza, either with its own or Loffels mechanical engineer, inspect the turbine, turbine gates, and alignment of linkages with the governor concurrent with the bringing of a Woodward Governor/representative to adjust the governor operation.

(2) It is further recommended that the governor representative give a short instruction and demonstration (say 7 days) in maintenance and adjustment of the mechanism. Such instruction should be given to at least the two top plant engineers.

(3) That Harza provide supervision of operation and an in-service improvement in operations and maintenance by the fulltime assignment of one experienced hydropower plant engineer for a minimum of one year.

3. Arghandab Hydroelectric Project 041

A. History

A multipurpose dam controlling a 400,000 acre-feet reservoir was completed in 1952 on the Arghandab River, about 24 miles north of Kandahar, under a Helmand Valley development contract between Morrison-Knudsen Afghanistan and the Government of Afghanistan, with funds provided by an Export-Import Bank loan. The dam is a rolled earth structure 160 feet high by 1760 feet long. Provisions were made for future installations of a powerhouse, which as originally planned was to consist of two 3200 kilowatt vertical shaft hydroelectric units.

The preliminary design of the power plant and transmission/distribution system was done by International Engineering Company under the Mk-RGA-XM contract prior to its expiration in 1954. Electrical development was low in priority within the Helmand Valley Authority, with the result that renewal provisions did not provide power system funds for continuation of the Arghandab project, but only for the Girishk development on the Helmand River (see section on Girishk Plant & System).

Kandahar was however in such serious need for relief that ICA was requested to set up a project to cover funding, in November of 1957, of a diesel electric plant, along with some distribution lines in Kandahar, for interim service until the Arghandab power source could be developed (see section on Kandahar diesels).

Arghandab power first became part of the ICA assistance program by its inclusion piecemeal in various projects of the Helmand Valley agricultural development operations. Then on 28 June 1957 a PPA was issued to pick up the major parts of the Arghandab power proposal under an ICA project 06-22-041 in which the Helmand Valley Authority was still the project sponsor. Two 3200 kilowatt vertical shaft hydroelectric units and a transmission line to Kandahar were proposed as before in the MK-IEC plan for which $2,801, 300 of SA funds, and an RGA contribution of Afs 8,960,000 and Pak Rps 1,311,000 were committed.

In 1958 the Kandahar diesel plant and the associated distribution were under construction with ICA funds, and no work was done on the Arghandab project. By 28 June 1959 a Project Agreement and a PIO/T had been written and signed, covering the proposed Arghandab development, with the same funding ($2,801,300) and essentially the same criteria and scope of work as the PPA had provided.

A number of factors appear to have contributed toward the earlier delays in implementing the Arghandab work:

(1) The power problems in the Valley were approached as parts of other programs and projects, and only recently have these parts been brought together as a unified problem.

(2) Political and personality differences between the major contractor in the Valley and the RGA, and between various agencies and officials within the RGA, were deterrants.

(3) Awaiting findings from consultants to have been provided under project 06-99-050, and waiting for recommendations on implementation of the project, with respect to such matters as staffing, training, management, administration, coordination on water use, and relation to over-all Valley power development, were retarding factors.

(4) Electric power considerations and support have suffered from a low priority in the HVA and ICA administrative organizations.

In an attempt to break the stalemate and make a new approach the project was transferred in November 1959 from the Helmand Valley Authority to the Ministry of Mines and Industries as the project sponsor.

Project Agreement Revision No. 1 dated 11 April 1960 reflected this change and redefined the project in the light of changed conditions. Funding remained as before, but the scope of the project has increased by the addition of such items of required work as:

(a) Review and update surveys and engineering work previously done, to reflect increased load requirements in the area, additional hydrological data, etc.

(b) Include engineering for secondary distribution and street lighting in Kandahar.

(c) Include transmission line to Kandahar International Airport, and two additional receiving stations.

(d) Include a staffing and training program, and supervision of initial operation of the facilities.

ICA total funding of $3,351,000 has been carried over from years prior to FY 61 from which has been expended $550,000 for the diesel plant and primary distribution in Kandahar. The balance was available for engineering services, procurement of long lead items, and some of the costs of construction, installation, and additional commodities. In FY '61, $50,000 was provided for project technicians and participants. There had been tentatively approved an additional $3,814,000 of SA and DL funds for FY '62, based on the engineers preliminary estimate. However now only $50,000 of this amount is permitted to be obligated (due to border situation). The RGA is committed to providing the equivalent of $570,000 for local materials, labor, transportation, etc.

A 1961 estimate of the total dollar size of the 041 project, including the Girishk component, was a little over seven million dollars. Following is a brief breakdown of this estimate.

Kandahar diesel plant and distribution (expended)	$ 550,000
Arghandab power plant & transmission/distribution system, engineering & construction (Harza prelim. estim.)	5,800,000
Construction eqpt.., contingencies	500,000
Girishk system work (initial phase)	250,000
	$7,100,000

This estimate did not include any funds for the rehabilitation of the Kandahar diesels, or for protracted follow-through of operation and management assistance.

Harza Engineering Company of Chicago is now engaged in field surveys and design of plant and system, consisting of four 4250 kva horizontal-shaft hydroelectric units, a 69 kv transmission system, and primary and secondary distribution. A draft of machinery specifications has been submitted to AID/W, AID/A, and the Ministry of Mines and Industries for comments.

B. Present Condition

The Arghandab dam was visited March 27. There is a considerable power potential at this location which Harza Engineering Company, in Summary Report "Arghandab Hydroelectric Power Project" dated April 1961, estimated to be four 3400 kw units. Of this amount 7,500 kw, at a 40% load factor, was estimated to be firm. This report contains a cost estimate of $5,800,000 for the generating plant, afterbay dam, transmission to Kandahar and to International Airport and distribution system for Kandahar.

The $5,800,000 estimate which apparently was used for preliminary computation of economic feasibility does not include any allocation of the cost of the dam to the power project. The Tudor Engineering Company's report on "Development of Helmand Valley" dated November 1956 stated that about $1,800,000 (one quarter of the cost of the dam) had been allocated to power. This was called to the attention of Mr. Van Hamel, Harza's representative, for use in economic feasibility calculations and also to force recognition of a cost if the power company is in fact going to be required to pay for it. Mr. Azizi declined to answer this question on the basis that both projects were government owned and that it would be determined later - probably with no portion of the cost of the dam being allocated to the power project.

Harza recommended the initial installation of all four units on basis that load growth will require full capability by 1970 and for economic benefits of performing all the work at one time. Discussions with Mr. Wahhab, President Kandahar Electric Company and with Mission staff indicate that the load growth may be even faster than anticipated by Harza. The rate at which the power is sold and the ability of the power company to collect an equitable rate from <u>all</u> consumers will have some effect on the load growth.

C. Comments

Despite the fact that there appears to be an urgent need for the development of the Arghandab project, it would be practically useless, based on previous experience at Girishk and Kandahar Diesel Plant, until the engineer or the contractor:

(1) be provided with an adequate Afghan staff to train in management, operations and maintenance;

(2) be retained indefinitely to supervise operation and maintenance;

(3) operating and maintenance spare parts are available as needed;

(4) the power company be placed on a business basis as outlined in other sections of this report.

D. Recommendations

It is therefore recommended that until the problem of importing equipment for this plant and the project sponsor is able to comply with items (1) through (4) above, the Arghandab project be deferred. In view of the urgency of the need for this facility it should be constructed immediately upon satisfactory resolution of the above problems. Upon completion of the power plant its operation should be supervised indefinitely by either the engineer or the constructor.

4. Distribution Systems - Lashkar Gah & Kandahar

A. Existing Conditions

Existing conditions and types of construction observed in Lashkar Gah and Kandahar distribution systems endanger life and equipment and result in unnecessarily large losses of energy.

In both Lashkar Gah and Kandahar, 3,300 volt transformers without guard fences were located on or near the ground within easy reach of children.

Countless distribution service drops (from pole to house) were observed running through holes in poles or over notched poles without insulation. Frequently wires were observed touching together. These conditions increase losses and place undue hardship on fuses and breakers.

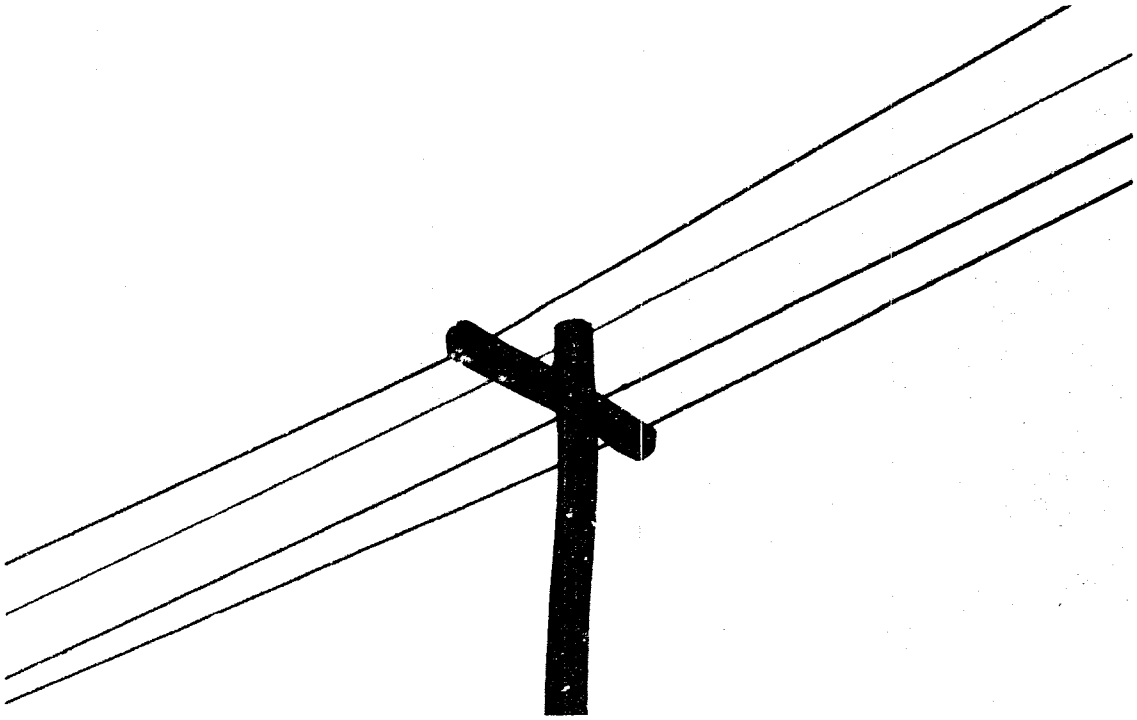
It was also noted that bare wire was used in some places and that the size of the wire varied considerably.

Service drops were extended for long distances and in some cases reversed direction thus causing unnecessary voltage drop and loss of KWH.

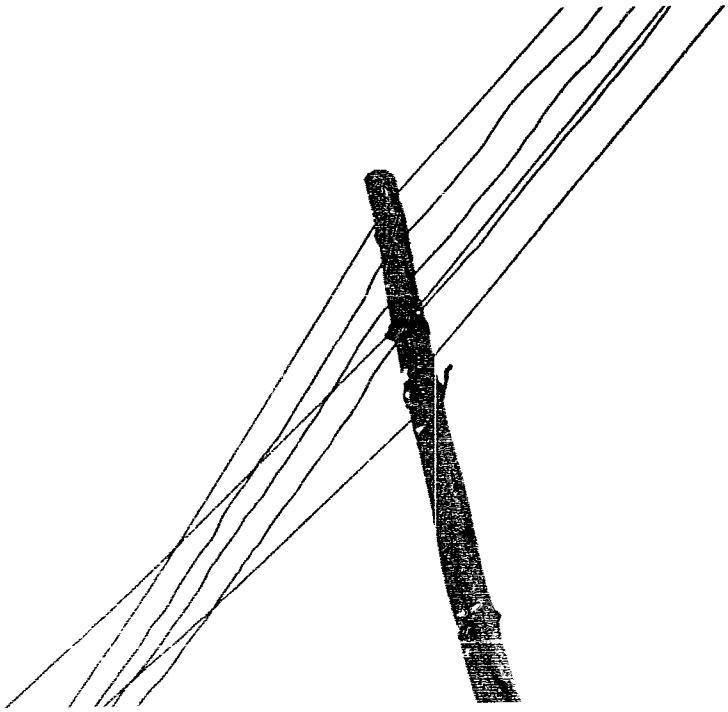
With service drops running over and through the walls prior to being metered it is highly probable that some power is used which is not recorded on the meter.

Street lights were observed burning throughout the 24 hours of the day.

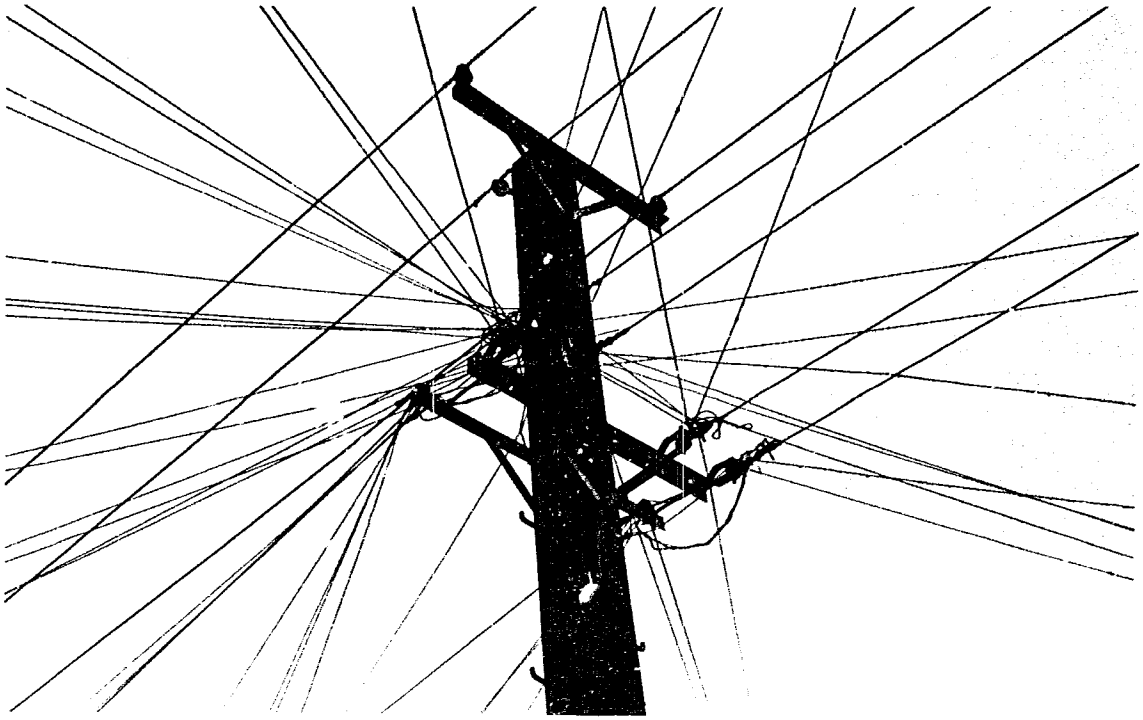
The following photographs indicate the general conditions described above.



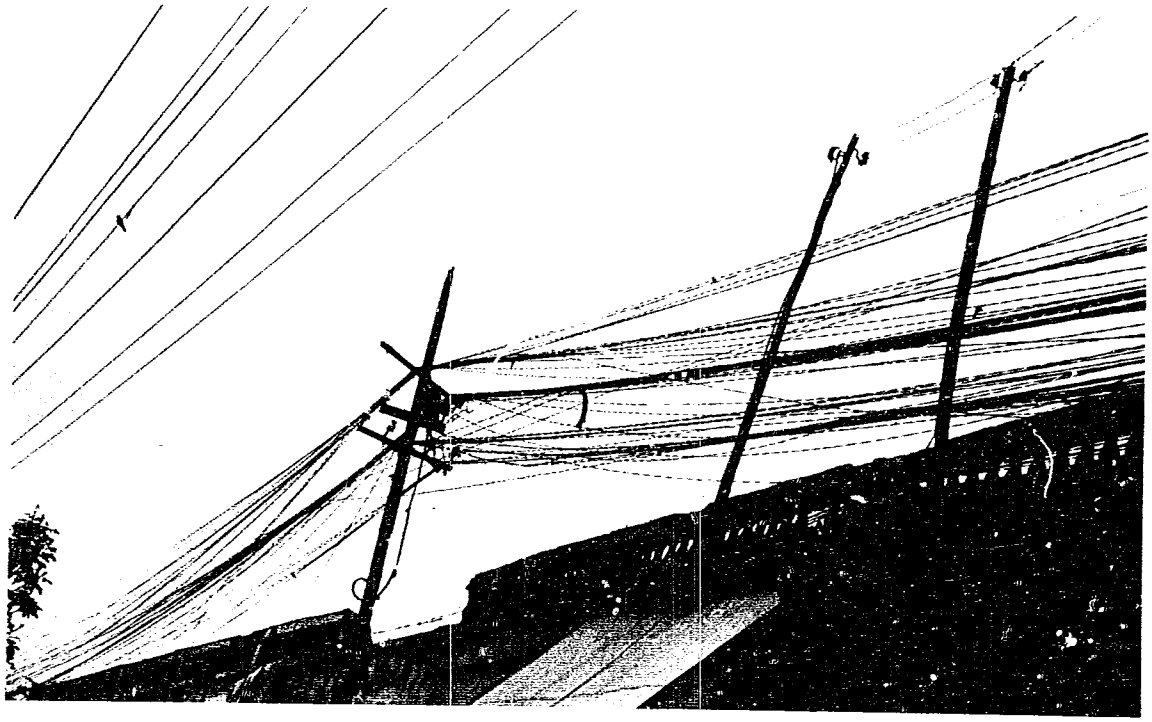
DISTRIBUTION CIRCUITS RUNNING THROUGH WOOD CROSSARM WITHOUT INSULATION. (KANDAHAR)



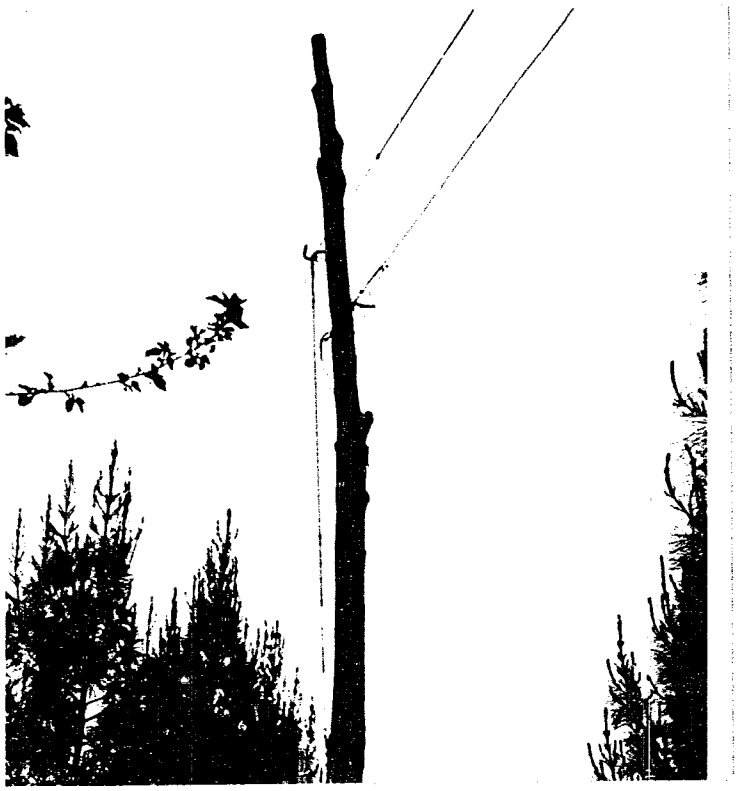
DISTRIBUTION CIRCUITS RUNNING THROUGH HOLES IN WOOD POLE WITHOUT INSULATION. (KANDAHAR)



NOTE TANGLES OF SERVICE DROP WIRING AT INSULATORS
(KANDAHAR)



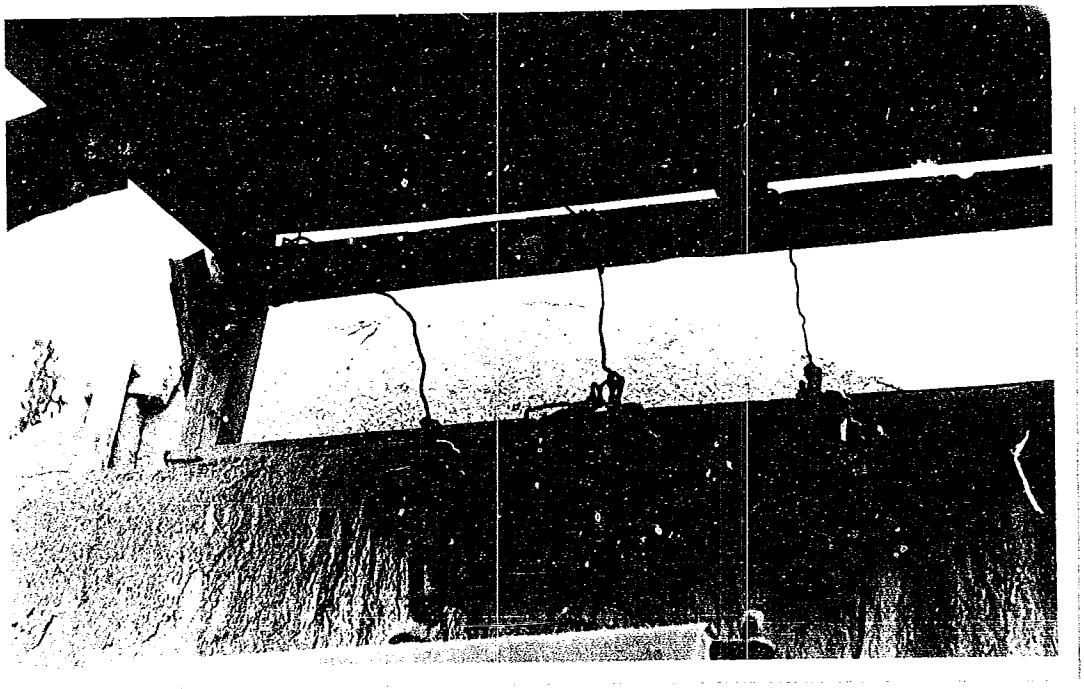
DISTRIBUTION WIRING RUNNING THROUGH A MAZE
OF TELEPHONE LINES. (KANDAHAR)



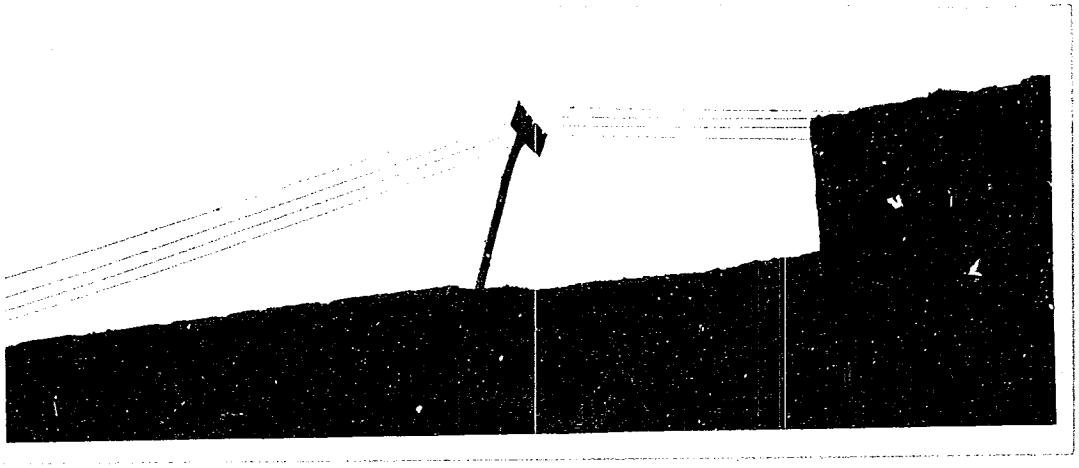
DISTRIBUTION WIRING WRAPPED AROUND METAL INSULATOR SUPPORTS ON WHICH THERE ARE NO INSULATORS. (KANDAHAR)

DISTRIBUTION WIRES RUB TELEPHONE LINES AFTER LEAVING INSULATORS AT TOP OF POLE. (KANDAHAR)

DISTRIBUTION WIRES TOUCHING A MAZE OF TELEPHONE LINES. (KANDAHAR)



THE 3,300 VOLT WIRES COMING DOWN FROM POLE ARE WRAPPED AROUND THE 4"X4" ROOF SUPPORT WITHOUT INSULATION. THIS IS A FIRE HAZARD AND ALSO ENDANGERS EQUIPMENT HERE AND AT FEEDER SUBSTATION. (KANDAHAR)



DISTRIBUTION WIRING RUBBING OVER NOTCHED WOOD WITHOUT INSULATION. (KANDAHAR)

AID FINANCED TRANSFORMER WITHIN EASY REACH OF CHILDREN. TOUCHING A 3,300 VOLT WIRE WOULD PROBABLY RESULT IN DEATH. (KANDAHAR)

3,300 VOLT TRANSFORMERS ON GROUND
(LASHKAR GAH)
Top and Bottom

B. Comments: The portion of the distribution system constructed by the Morrison Knudsen Company appears adequate and in good condition. In Nad-i-Ali, particularly, the load has not grown as expected and there were some feeders on which were no consumers and some feeders on which there were only a very few. From this and similar areas the poles and lines should be moved if study indicates they will not be economically used within a reasonable time. In discussions with Mr. Wahhab he indicated a desire for replacement of most existing service drops and provision for a 100% increase in Kandahar consumers at the time of completion of the Arghandab project. If an electric rate, based on cost of service, is charged it is doubtful that this rate of growth will be attained. Mr. Azizi pointed out that all development projects were sponsored by the Ministry of Mines and Industries and that the Ministry would direct the work as it sees fit. At the discretion of the Ministry it may be transferred to the Kandahar Electric Company at a later time. The fullest cooperation and coordination between the Ministry and the power company is essential to the solution of this problem.

C. Recommendations:

(1) Distribution transformers be located high on poles.

(2) Where size and weight precludes putting transformer on poles, a guard fence should be installed.

(3) Upon receipt and review of the Harza Engineering Company's report, USAID Kabul should decide what goal it will support in improvement of existing lines and the degree to which existing service drops will be replaced. Engineering design should, however, be complete to the customer utilization point. Also, the rate of growth must be determined for Goal purposes.

(4) That no allocation or expenditure of funds for distribution lines be made prior to above determination.

(5) That a minimum of one distribution feeder and all its service drops be designed and installed as a model of proper equipment, techniques and procedures which should be used in a good distribution system.

(6) That at least one heavy duty line truck complete with tools and equipment for boring holes and setting poles be provided.

(7) That one light truck each for Kandahar and Lashkar Gah and suitable for installation of locked bins in side panels be provided for housing parts and installation of service drops, meters and general light maintenance.

(8) That at least three general purpose vehicles (jeep station wagons or equal) be purchased for project use to be assigned to the electric company upon completion of the project.

(9) To expedite the furnishing of the above equipment, it is recommended it be procured through the engineering contractor.

(10) To the extent that it is necessary and desirable to do the rehabilitation and extension work in the distribution systems in Lashkar Gah and Chah-i-Anjirs at the earliest possible time, it is considered desirable that under the engineering contractor's supervision, a line construction foreman and helper, experienced in American overhead practice, be placed in charge of such work until the ACU and electric company personnel have shown necessary proficiency to continue unassisted.

5. KAJAKAI DAM

A. History: The Kajakai irrigation dam, completed in 1953, was visited March 31 - April 1. The power potential has been estimated by Morrison Knudsen at 120,000 kw. The Tudor report of 1956 considers the firm power potential as 65,000 KVA and 90,000 KVA firm at a 50% load factor. The 1953 estimate of cost was $10,000,000 exclusive of the transmission and with no apportionment of the cost of the dam to the power project. The transmission distance to Kabul is about 300 miles. Alternately, other small load centers also would require extremely long transmission lines.

B. Comment: At present there is no use for this amount of power within a reasonable transmission distance. The development of the first one or two units would necessitate the expenditure of a disproportionately large amount of the total cost of the project if the eventual development is to be most economical. Even if only one unit were to be installed, the power house should be designed and constructed for all units and the transmission line should be designed and built for the full plant capability.

C. Recommendations:

(1) The Kajakai project should not be developed at this time.

(2) As system growth justifies additional generating capability in this area Kajakai, among other potential projects, should be considered in the economic analysis to determine the most economical development to meet this need.

(3) The interconnection of Arghandab and Girishk should be deferred indefinitely. Under the present conditions there is no justification for the interconnection.

6. STANDARDS & CODES

A. Present Conditions: In discussions with Mr. Azizi and Mr. Wahhab and with USAID Kabul personnel, it was determined that there are no Afghan laws, edicts or regulations covering standards of electrical construction, operation or maintenance. For instance:

(1) The designer or constructor may build a transmission line of any voltage and at any ground clearance.

(2) Transformers and other equipment may be placed on the ground without any protective fence.

(3) Distribution lines are run through wood poles without insulation.

(4) 3.3 kv lines are wrapped around wood poles without insulation.

(5) Service is extended from house to house without power company consent.

(6) Any wire size and of any type of insulation may be used for any purpose.

(7) Poles of any length may be used regardless of distribution line clearance with homes or other buildings.

(8) Power and telephone companies do not cooperate to reduce noise on telephone circuits by improved construction procedures.

B. Comment: The above items affect safety of personnel and equipment. The size of wire determines the loss by heat. A standard construction design helps in preparing bills of materials.

Wire of adequate size minimizes heat loss and voltage drop thus minimizing KWH which are not revenue-producing and serves the customer with a voltage for which his lights and equipment are designed.

C. Recommendation: The RGA should be given encouragement and assistance in the formal establishment of standards and codes to require safe, dependable and efficient construction.

7. GENERAL STATEMENT

The diversity of the problems and the necessity for their concurrent solutions makes it almost impossible to attain a high standard by piecemeal endeavors. The solution to each problem depends, to some degree, upon the solution of each of the others. In the most simple terms it could be stated as follows:

The building of a facility connot be justified unless it can be operated and maintained.

Operation and maintenance cannot be performed without adequate skilled personnel, equipment and funds.

Funds cannot be obtained without adequate revenue and/or subsidy.

Revenue cannot be obtained without an adequate rate.

A rate is adequate only if, after efficient and economical operation, there is funding sufficient to pay all the true costs of doing business.

One of the true costs of doing business is the repayment of indebtedness of development. Failure to repay this indebtedness should result in inability to obtain loans for new development.

The continuing struggle within the RGA for development and management authority can only result in detriment to the power system. This problem should be permanently resolved.

Until such time as the importance of these problems is recognized and effective steps are taken to solve them concurrently, the electric power industry will never be able to serve its customers in the most reliable, efficient and economical manner. It is therefore suggested that sincere consideration be given to the following section of this report which deals with the problem in an over-all manner.

SECTION II THE OVER-ALL PROBLEM AND SUGGESTIONS FOR ITS SOLUTION

A. Scope of Problem: A power company, whether large or small, has the same general problems. In the broadest of terms these are management, operations, maintenance and planning for the future.

From discussions with Afghan Government officials and inspection of power facilities in the Helmand Valley it is

quite apparent that the RGA needs a great deal of assistance in the establishment and training of a management, operations, maintenance and planning staff to effectively and efficiently conduct the business of the power industry. The building of new facilities can never be justified unless the existing facilities are operated to serve their consumers to the maximum extent of their capability and maintained to assure economical operation throughout a reasonable life span. The training and improvement in management may be done concurrently with the development of new facilities but should never lag behind. It should be recognized this is a long-range problem requiring many years to attain and that a number of management, engineering and technical specialists will be required to attain even a minimum degree of competence throughout the range of problems facing the power industry. It could only be accomplished by the fullest of cooperation and determination by the RGA including the availability of the best of qualified personnel and the assurance that after receiving the training they would remain in the electric utility business within the range of employment for which they are qualified.

B. Goal: It is presumed that the goal is the provision of an adequate and economical power supply capable of meeting the present and growing needs of the industrial, commercial and domestic needs of anywhere, Afghanistan, and that the consumer will be charged a rate equal to the true cost of providing his service.

C. Major Problems:

(1) Management: Good management provides for and requires -

(a) the recognition of the problems

(b) the employment of the proper number of skilled personnel in the categories required

(c) the delegation of authority necessary to accomplish the goal

(d) the procurement of operating and maintenance supplies, both foreign and domestic, as required to provide dependable service and to assure a reasonably efficient life span

(e) the collection of revenue sufficient to pay the interest on and the amortization of the indebtedness, the true costs of operation and maintenance, and a reasonable return on the investment

(f) the training and development of personnel

(g) the establishment of standards and codes for ease and safety of operations

(h) the establishment of a standard system of accounting in sufficient detail to dependably reflect the true costs of doing business and permit financial planning

(i) the study and preparation of a financially feasible and economically desirable long-range plan of development

(2) Operations: Satisfactory operation requires:

(a) the serving of the consumer with standard (non-variable) voltage and frequency with an absolute minimum of interruptions

(b) the maximum utilization of all available existing facilities and equipment to meet the consumers' needs

(c) the training of personnel in the techniques and procedures of safe and efficient operations

(3) Maintenance: Good maintenance includes:

(a) scheduling of routine repairs and overhaul to keep facilities and equipment in efficient and safe operating condition with the least inconvenience to the consumer

(b) repair and proper storage of equipment out of service to facilitate placing it in service when needed

(c) Establishment of maintenance manuals and procedures to insure timely inspection, cleaning, adjustment and lubrication of equipment to improve its efficiency, safety and reliability and to insure a reasonable life expectancy.

(d) provision of the proper types and adequate quantities of lubrication and insulating oils to maintain and safeguard equipment

(e) Provision of spare parts for operation and maintenance in order that outage time may be reduced to a minimum.

(b) Training of personnel in the proper techniques and procedures to perform maintenance quickly, efficiently and with the least inconvenience to the consumer.

(4) Future Planning: Inasmuch as the actual construction of a power generating plant requires 30 to 60 months after financing and placing of the contract, it is essential that the planning and construction be started long before the service is actually required. The minimum time coverage should include those plants and facilities required to be in operation during the next ten years. A careful study of the load and its growth during this period is an essential step in determining what new generation, transmission and distribution facilities will be needed. The economic and technical feasibility of possible developments must be determined. Sites must be determined and prepared. The financing must be arranged, contracts let and construction started on a realistic schedule to meet operating date requirements.

Economic feasibility should be based on following considerations:

(a) There is actual need for the capacity

(b) There is a ready sale of the capacity at a price covering the true cost of production

(c) The proposed project will accomplish the goals in the most economical way when compared to alternate projects

(d) The sale of the product will pay interest on the investment, amortize its cost within a reasonable period, (say eight years for a diesel plant, twenty years for a steam plant, and thirty years for a hydro plant) pay the true costs of operation and maintenance and pay a reasonable return on the investment.

D. Other Considerations:

(1) Effect of rates on load growth - Consideration should be given to the effect of rates upon demand for service. An electric rate below the actual cost of service will encourage uses of power which will be costly to continue to subsidize and will tend to increase this kind of load. On the other hand, if an equitable rate is collected, the power company will have no difficulty in serving it

and would entertain no objection to its growth.

(2) Hydroelectric Power: In Afghanistan, as in many other countries, there is a feeling that hydroelectric power is "free" because the falling water is provided by nature. Education of the public to the fact that interest on and repayment of the investment, operation and maintenance of the plant, transmission and distribution facilities all require funding. Also, it must be remembered that there is usually more than one generating plant on the system and the rate charged must cover the costs of the over-all operation.

(3) Finance: It is essential to the provision of adequate and economical service that the power company be capable of paying its costs, including interest on and amortization of its debt, operations, maintenance and preparation for the future. This may be done by Government subsidy, from taxes, if the funding is to be available as required. This would be a never-ending and increasing burden. A much more preferable method would be the establishment of a rate which would permit collection from each consumer the actual cost of providing service to a consumer of his class. This method would not penalize one class of consumer for the benefit of others. Funds would be available for operations as required. Maintenance could be performed to enhance safety, reliability of service, economy and a reasonable life span.

(4) Free Service: Free service can only be provided at the expense of others and should be abolished. Non-payment for electric service should result in immediate disconnection.

(5) Conflict of Interest with Telephone System: A cooperative effort with the telephone system in standardizing of construction and a joint use of facilities would be helpful in minimizing noise on the telephone system in an economical manner. This is important as both systems are growing and any delays will increase the cost of correction at a later date.

(6) Advantage of System vs. Isolated Plant Operation: Small isolated plants must have the capability of carrying the peak of their isolated loads regardless of the length of time the peak lasts. To be reliable each isolated plant must have a reserve capacity of 50% to 100%.

The diversity of consumers loads makes it possible to serve them from a system with a capacity considerably less than the sum of the individual peak loads and with a much smaller reserve capacity. This, of course, would

permit a smaller capital investment and tend to improve cost and efficiency of operation without lowering the quality or reliability of service. The fact that the system could utilize larger units would also tend to improve costs and efficiencies.

(7) Legal Matters: As the system grows in size its operations become more complex. It is essential that laws and regulations be established regarding standards and codes for safety and effectiveness of operations. The penalties for non-payment and the conflict of interests between the power company and the general public must be resolved by legal means. Laws are necessary to enable the regulation of the power industry in fairness to the nation as a whole.

(8) Regulation:

(a) Rates: The electric power industry is by nature a monopoly. A means to control the industry in fairness to the consumer and to the company is essential. Service of good quality requires good management, operation and maintenance, and heavy expenditures for equipment. This costs money; therefore, the company is entitled to collect revenue to pay these costs. In performing these services, the power company should be required to exercise good judgment and develop only those projects which are most economical. The power company should not be permitted to charge more than the actual costs of doing business plus a reasonable profit. The approval of rates, on a non-political basis, with provision for adjustment to meet changing conditions is therefore a responsibility of the regulatory body.

(b) Standards and codes: For safety, economy, effectiveness and efficiency of operations and to minimize conflict of interest with other utilities, the establishment of standards and codes is necessary. The regulatory body should, in cooperation with the power company and all other interested or affected organizations, develop and establish standards and codes. Standards of voltage, frequency and other characteristics of generating plants and transmission and distribution facilities should be established and/or approved by the regulatory body to facilitate the exchange of equipment between load centers as required by changing load conditions. This standardization would also make it possible to interconnect systems if and when it becomes economically and technically desirable to do so.

E. Staff Requirements: The effective and efficient conduct of business requires the services of a competent, patient and dedicated staff.

(1) Present Staff: The personnel who now are doing the work, particularly those in foremen or supervisory positions, should be given every opportunity to upgrade their qualifications. This probably could best be done by bringing specialists to Afghanistan to conduct in-service training. On occasion it may require the sending of certain personnel to other countries for periods of time up to one year. Training in other countries might include management and accounting; distribution system construction, operation and maintenance; meter maintenance and repair; and diesel operation and maintenance.

(2) Future Staff: The training of personnel for the long-range problem is of equally great importance. The competition of the power industry with other fields of endeavor may be such that a special effort must be made to obtain the allocation of the necessary numbers and skills required or it may even be necessary to arrange and finance the training of a number of qualified young students in order to freeze them in certain positions for a definite period of time.

Participants, prior to acceptance, in this group particularly should agree to (a) working in the field in which they are to be trained for a minimum of eight years upon return to Afghanistan; (b) practical application of their training by "working with their hands"; (c) willingness to pass on their knowledge to others by "in-service" training. The RGA and the power company should likewise agree to assignment of personnel in the power business to a position commensurate to their training and ability. The RGA should agree to a minimum requirement for military service by these trainees.

It is recommended that a minimum of four per year for an indefinite period (at least five years) be selected and given a full engineering training through the receipt of a BS degree from a university or college of recognized standing, which should be followed by one year "in-service" training in a foreign private electric utility in the field of their specialty. Many electrical, some mechanical and a few civil engineers are needed. The practical training of these engineers should be performed in one or more of the following specialized fields:

Transmission and distribution system design, operation and maintenance;
Power plant operation and maintenance;
Metering and controls;
Communications and inductive coordination;
Load dispatching;
System operation;
Standards and codes;
Accounting;
Rates.

(3) Language Training: Personnel selected for training in foreign countries should be qualified in the language of the country in which they are to be trained. Such language training, if required, should be started at the earliest possible time.

(4) Foreign Staff: The bringing of foreign experts to assist the power industry is imperative. One of the most satisfactory ways in which to accomplish this would be:

Make a general contract with an engineering firm which has had experience in providing services to electric utilities including management, operations, maintenance and long-range planning. This contract should:

a. specify the permanent staff to be provided;

b. provide that specialists, with a minimum of administrative action, may be brought to Afghanistan or be utilized elsewhere, as required, for solution of special problems or to perform training;

c. generally establish rates of pay and overhead for specialists employed under (2) above;

d. establish funding for work estimated necessary during a 2 or 3 year period. Work may be limited either to the funding available or to a total number of man months.

(The permanent staff might be small and consist of management, financing, accounting and training skills whereas specialists might be brought for the actual time required to accomplish such work and "in-service" training as organization of the power company, special training, business administration, rate study, system planning, standards and codes, regulatory commission, maintenance, feasibility studies, selection of sites, supervision of operations and preparation of loan applications.)

The objective of this approach should be the establishment of a nucleus of experts who, in the beginning, should perform the work, assisted by the Afghan staff. Some skills will be more quickly attained than others. In the case of a new power generating plant, several foreign experts might be required for a few months following its placement in operation but the number should rapidly diminish to one expert who might be required indefinitely. The qualifications of the Afghan staff to perform the duties unaided should be of equal importance to the performance of the specific duties by the foreign experts.

A small amount of commodities such as test instruments, tools, a D. C. calculating board and vehicle commensurate to travel requirements should be provided under the contract.

F. General Statement: The recognition of a problem is the first important step toward its solution. The RGA has recognized the need for the over-all approach herein outlined which is well expressed in the following excerpts from the letter of June 5, 1961 from Royal Afghan Ministry of Mines and Industries to Director USOM/A in regard to contracting for the Arghandab project:

"We wish to call your attention to what could be a serious weakness in contracting this Project, and request all concerned with the Arghandab Contract to seriously consider all implications and any problems the following explanation creates. The point in question is that of training, developing, equipping a competent staff from management down, that can take over and properly operate this over-all Power System, after its physical completion. The Harza report mentions this matter but only briefly with very little detail as to how this over-all training task is to be accomplished.

"We realize the importance, and difficulties, and the possibility that the contractor may not be fully aware of all that is involved."