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SUMMARY REPORT

SYSTEM REHABILITATION ASSESSMENT AND MANAGEMENT AUDIT OF THE ENTE NAZIONALE ENERGIA ELETTRICA (ENEE) MOGADISHU, SOMALIA

prepared for

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System Rehabilitation Assessment
and Management Audit of the
Ente Nazionale Energia Elettrica (ENEE)

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Section 1

INTRODUCTION

1.1 BACKGROUND

The Somali Power Company (ENEE) operates the national electric utility system in the Somali Democratic Republic. The total installed capacity in Mogadishu in 1985 was approximately 56 megawatts, 12.5 MW of which was diesel-generator capacity located at the Centrale Power Station and 43.5 MW located at the Gezira Power Station. Included in the Gezira capacity, is 15 MW of steam turbine-generator capacity, installed in April, 1985. The total system generation was 110 Gwh in 1985 and the forecasted 1986 generation is 125 Gwh.

The USAID Mission in Mogadishu (USAID) received a request from the Government of the Somali Democratic Republic (GSDR) for technical assistance in connection with the operation of ENEE. Outages were reported to be nearing 50 percent of capacity with no evidence that the causes were being addressed and eliminated. The situation was expected to worsen in the light of the lack of foreign exchange (hard currency) with which to purchase spare parts to restore system equipment to normal operation.

Furthermore, ENEE had been unable to expand and improve its organization as the system had grown. The conditions which contributed to this inability to expand and improve the organizational functions were the increasing technical complexity of operation, growing financing needs, unavailability of adequate foreign exchange and lack of sufficiently trained staff.

1.2 TECHNICAL ASSISTANCE

In response to GSDR's request, the USAID commissioned Bechtel to conduct a study to determine (a) required ENEE system rehabilitation, (b) improvements in the current operation and performance of the system, (c) revisions to the accounting system, (d) customer collection system and, (e) manpower needs and training requirements. To achieve the objectives, the following tasks were performed:

1. Review power demand forecasting and system planning

2. Determination of the required rehabilitation of the generation, transmission and distribution systems

3 Evaluation of the electrical system and billing losses

4. Assessment of the procurement process, inventory control of equipment and spare parts availability

5. Review of financial management procedures, accounting system and billing and collection procedures

6. Review of existing manpower training programs and assessment of manpower needs.

The purpose of this report is to summarize the Bechtel Team findings assembled under the six tasks and to provide recommendations for system rehabilitation, operating improvements, organization changes, accounting and financing systems and procedures revisions.

1.3 REPORT CONTENT

In addition to Section 1, Introduction, the report contains the following sections and appendices:

Section 2	Summary of Recommendations
Section 3	Field Trip Findings
Section 4	Detailed Recommendations
Appendix A	Materials and Equipment Required for Rehabilitation
Appendix B	Proposed Manpower Training and Development Program Outlines
Appendix C	Cost Summaries for Recommended Programs

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Section 2

SUMMARY OF RECOMMENDATIONS

The physical rehabilitation of the ENEE generation, transmission and distribution system, modification of the accounting and billing systems, restructuring of the ENEE organization and the initiation of effective manpower training programs will require formidable effort. The recommended actions required to achieve these ends are briefly summarized in this section. They are developed at considerable length in Section 4.

2.1 GENERATION SYSTEM

2.1.1 Rehabilitation

- Rehabilitate two diesel units (Nos. 6 & 7) at Centrale, Machine Shop, Spare Parts (2 years supply)
- Rehabilitate two diesel units (Nos. 2 & 3) at Gezira, Machine Shop, Spare Parts (2 years supply)
- Provide chemicals for Gezira Steam Unit (2 years supply)

2.1.2 Staffing

- At Gezira Steam Plant add (1) shift charge engineer, (1) instrumentation engineer, (1) results engineer, (2) instrumentation technicians, and (6) apprentices.
- At Gezira Diesel Plant add (2) shift operators, (2) control room operators, (1) shop engineer, (2) machinists, (1) draftsman, (5) maintenance technicians, (1) storekeeper and (6) apprentices.
- At the Centrale Plant add (2) machinists (3) shift operators (3) maintenance technicians, and (1) motor winder.

2.2 TRANSMISSION AND DISTRIBUTION SYSTEM

2.2.1 Rehabilitation

2.2.1.1 Primary Distribution System (3 kV and 15 kV):

- Replace 35 km or existing 3 kV primary system with 15 kV within Mogadishu

- Apply power factor correction (shunt capacitors) to existing and new 15 kV systems

- Apply lightning arrestors at 15 kV overhead line terminations

- Add heavy duty surge arrestors at the Gezira generator busbar and at underground line terminations

- Repair and reactivate the pilot wire differential protection system for Gezira - Centrale - 21 October feeders

- Initiate a program of pole barrier installations at high vehicle traffic location

- Reuse 3 kV/380 V distribution transformers in smaller cities, where feasible

- Replace all 3 kV indoor substations in the center city by 15 kV/380 V pole-mounted transformers

- Establish program of insulator washing and silicon greasing

2.2.1.2 Secondary Distribution System (380/220V)

- Replace 380/220 V secondary distribution, 120 km, in the center six square-kilometers of the city

- Replace the service drops to customers on the replaced secondary in the center city

- Re-examine conductor sizing for 380 V secondary circuits

- Install power factor correction capacitors on the 380/220 V side of 15 kV/380 V transformers

2.2.2 Staffing

- Expand Primary Distribution (15 kV) line crews to five

- Expand Secondary Distribution (380/220 V) line crews to eleven

- Form Distribution Planning Section in Technical Department

2.2.3 Mobile Equipment

- Secure 17 utility vehicles with crew cabs

- Secure 5 utility trucks with boring machines, and 2 utility trucks with cranes
- Secure 2, 15-ton mobile cranes and 2, 5-ton forklift trucks
- Secure 8 jeeps
- Secure 8 pieces of cable pulling equipment
- Secure one cable trencher
- Secure vehicle maintenance equipment

2.3 POWER SYSTEM PLANNING

2.3.1 Demand Forecast

- Establish immediately a Planning Section as an initial step towards power system planning capability in the Planning and Projects Department
- Adopt Bechtel Team demand forecasts for the near-term planning (1986-1988)
- Develop trend forecasting and macroeconomic forecasting methods

2.3.2 System Planning

- Develop system expansion plan, 1986-1995
- Formulate expansion plan development procedures
- Develop three-year expansion plan (1986-88) based on five-year plan using operating and financial department inputs
- Develop implementing Action Plans for involved ENEE Departments

2.3.3 Capital Expenditure Prediction

- Develop capital expenditure prediction, 1986-1995
- Formulate capital expenditure prediction procedures
- Develop three-year capital expenditure prediction (1986-88) using planning and financial departments
- Develop implementing Action Plans for involved ENEE Departments

2.4 PROCUREMENT AND INVENTORY CONTROL

2.4.1 Commercial (Procurement) Function

- Simplify purchase requisition approval procedure for foreign purchases
- Simplify the procedure for approval of foreign exchange (hard currency) for purchase of foreign equipment and services

2.4.2 Commercial Accounting Function

- Define interfaces between the Commercial (Procurement) Accounting Section and the Accounting Services Section of the Finance and Administration Department
- Establish classification policies and practices for either expensing or booking plant equipment replacement

2.4.3 Stores Function

- Develop improved storage methods and facilities and orderly yard marshalling practices for consumable materials and equipment
- Modify and update the stock control system differentiating between planned maintenance stock and unscheduled outage spares.

2.5 ACCOUNTING AND FINANCIAL MANAGEMENT SYSTEMS

2.5.1 Customer Billing, Collections and Accounting

- Change all manuscript customer records to typewritten form
- Automate bill computation and preparation to reduce bill preparation time
- Initiate a two-shift operation with improved work flow
- Formulate and implement a disconnect policy for delinquent bills
- Separate the jobs of meter reader and bill collector
- Eventually, pay all customer bills at ENEE local offices
- Government agencies and corporations should prepare annual electric energy budgets and develop system to pay bills promptly when received.

2.5.2 Plant Accounting and Property Records

- Develop detailed plant account records
- Prepare plant accounting manual identifying interfaces between procurement accounting and plant accounting
- Develop property record instruction manual and conduct a system-wide plant inventory

2.5.3 Income Statements and Balance Sheets

- Re-format and footnote Income Statements and Balance Sheets
- Reduce unpaid bill accounts receivable to 90-days of revenue
- Modernize depreciation accounting system
- Prepare annual financial reports which respond to lending and donor institution requirements
- Establish ENEE internal auditing function

2.5.4 Financial Management Procedures

- Install and document a system for capital requirements forecasting
- Install cash-flow forecasting system
- Document financial policies
- Develop comprehensive Financial Planning program
- Create both a controller function and a financial planning function

2.6 ORGANIZATIONAL REVIEW AND ANALYSIS

2.6.1 Organization Audit

- Engage a management consulting firm to perform a thorough organization audit
- Implement organization changes shown in Figure 4-2, Section 4

2.6.2 Organization Analysis

- Prepare and document corporate objectives, departmental functions, general orders and routine operating instructions

- Transfer all management of ENEE generating stations to the Technical Department

- Staff Planning and Projects Department with personnel to perform long-range system planning and project management

- Create a Distribution System Planning Section in the Technical Department

- Enlarge Accounting Services Section in Finance and Administration Department

- Perform procedures analysis of the Billing Services Section and implement changes

- Implement improved operating interface between the Commercial Accounting Section of the Commercial Department and the Accounting Services Section of the Finance and Administration Department

- Establish personnel planning and organization planning functions in Personnel Department

- Reorganize the Regional and Districts Department functions to parallel the department functions at ENEE headquarters

2.7 MANPOWER AND TRAINING

2.7.1 Manpower

- Conduct a manpower needs assessment stipulating manpower required over a reasonable time period

- Analyze required job skills and prepare job descriptions by labor classification for entire organization

- Prepare job performance standards and skills qualifications tests for vocational jobs.

- Implement an employee performance evaluation program

2.7.2 Training Programs

- Prepare and implement vocational, technical and engineering training programs for generating system personnel

- Prepare and implement vocational, technical and engineering training programs for transmission and distribution system personnel

- Prepare and implement middle-manager and senior manager development programs

- Establish a permanent ENEE vocational and technical training organization.

2.8 MANAGEMENT ADVISORY SERVICES

- Engage a management consulting firm to provide advisory services in organization planning, financial management, accounting systems and personnel management. This should be a two-year program, minimally.

2.9 ESTIMATED COSTS OF PROGRAM RECOMMENDATIONS

- The estimated cost of the ENEE power system rehabilitation program is $12,372,000

- The estimated cost of the vocational training program is $1,271,200 for a period of two years

- The estimated cost of the management advisory services program is $1,398,600 for a period of two years

Section 3

FIELD TRIP FINDINGS

In response to the pressing need (a) to improve the reliability of the ENEE power system, (b) to increase the efficiency of the customer billing and collection systems, (c) to increase the effectiveness of the accounting and financial management systems, (d) to restructure the organization functions, and (e) to train additional utility manpower, AID requested that Bechtel send a team to audit the ENEE organization and the power system operations. Based on this field inspection and audit, the Bechtel team developed a series of findings in the areas enumerated above.

3.1 GENERATION SYSTEM

The ENEE generation system, serving Mogadishu, consists of two thermal power plants, the Centrale Plant and the Gezira Plant.

3.1.1 Plant Operation

The present operating status of the Centrale and Gezira diesel sets and the Gezira steam unit is shown on Table 3-1.

3.1.1.1 Centrale Station. Centrale diesel sets Nos. 1 through 4, installed between 1959 and 1964, have exceeded their design life of 20 years and show signs of significant wear. The sets use light diesel oil and their present generation capacity is approximately 66% of their rated installed capacity. Moreover, two older sets (No. 2 and No. 3) have been out of operation for several years. Because of their higher fuel cost and lower generation capacity, these sets are operated only during serious emergencies.

The Centrale diesel sets, No. 5 through No. 8, are comparatively new, being installed between 1968 and 1977. Because of both their intensive use and problems with auxiliaries, these sets are capable of generating only 83% of their installed capacity. Originally these sets used light diesel fuel. However, since 1983 they have been operating on heavy fuel, except during

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Table 3-1

CENTRALE AND GEZIRA DIESEL SET AND STEAM UNIT INFORMATION

CENTRALE STATION

Set No.	Make & Model	Type of Fuel Used	Year of Initial Operation	Installed Capacity (kW)	Maximum Output (kW)	House Load (kW)	Number of Hours Operated up to 2-25-86	Remarks
1	Duetz 6 cylinder inline	Light diesel	1964	960	650		108,506	
2	diesel, 273 rpm, model	Light diesel	1959	960	650		128,144	Not operable(2)
3	BV6M366 alternator manu-	Light diesel	1959	960	650		132,809	Not operable(2)
4	factured by Pellizari	Light diesel	1963	960	650	600	123,666	
5(1)	Deutz 12 cyliner 'V' diesel, 375 rpm, model	Heavy oil & light diesel	1977	2,160	1,800		35,308	
6(1)	BV 12M350 alternator manufactured by Pellizari	Heavy oil & light diesel	1968	2,160	1,800		66,892	Not operable(2)
7(1)		Heavy oil & light diesel	1974	2,160	1,800		41,948	No operable(2)
8(1)		Heavy oil &	1974	2,160	1,800		44,426	
	Total			12,480	9,800(3)	600		

Notes:
(1) Uses light diesel only during set start up, and shut down and problem with heavy fuel system.
(2) Not operable due to major breakdown, and requires rehabilitation.
(3) Net generation capacity of Centrale Station = 9,200 MW.
(4) Not operable due to major breakdown and requires rehabilitation.
(5) Net generation capacity of Gezira diesel = 23,200 MW.

GEZIRA STATION

Set No.	Make & Model	Type of Fuel Used	Year of Initial Operation	Installed Capacity (kW)	Maximum Output (kW)	House Load (kW)	Number of Hours Operated up to 2-25-86	Remarks
1(1)	Mirrlees-Blackstone 16 cylinder diesel,	Light diesel & heavy oil	April 1979	5,500	5,000		29,182	Will be ready for operation by April 1986
2(1)	500 rpm, model KV16 major manufactured by	Light diesel & heavy oil	February 1979	5,500	5,000		23,642	Not operable(4)
3(1)	Brush.	Light diesel & heavy oil	December 1978	5,500	5,000	1,500	30,880	Not operable(4)
4(1)		Light diesel & heavy oil	December 1978	5,500	4,700		20,655	
5(1)		Light diesel &	April 1984	5,500	5,500		4,871	
Steam Turbine	BBC steam turbine Lentjeb boiler	Heavy oil	April 25, 1985	16,000	16,000	1,000	7,486	Lost hours = 146 (from April 25, 1985 to March 7, 1986) availability - 98%
	Total diesel			27,500	24,700(5)			
	Total steam			16,000	16,000			

start up and shut-down when light diesel oil is used. Again, because of lack of spare parts only sets No. 5 and No. 8 are now operating. Sets No. 6 and No. 7 are not operable because of alternator problems. Some of the auxiliary systems also have operating problems such as the retarded flow of heavy fuel oil from storage tanks at lower tank level. However, these problems have not resulted in engine shut down.

The Centrale Station has a number of small and medium-size shops for the maintenance and repair of engines and electrical components. These shops are equipped primarily with antiquated equipment. Only a few newer pieces of equipment have been installed in some of the shops, such as a fuel pump testing unit. A list of the major equipment is shown on Table 3-2. Due to lack of proper tools, equipment and materials, it is not possible to manufacture engine components in these shops. Only minor machining, equipment maintenance, and small motor winding are possible.

The Stores Department is under ENEE Technical Department administration but has only a marginally acceptable manual material control system. It carries all the parts for Centrale Station and some of the parts of Gezira Station. Because of foreign currency shortage, i.e. no funds available to replenish failed parts, the stores inventory for equipment maintenance and repairs is dangerously low. As a result, some of the parts from currently immobilized engines are being used to maintain the remaining operating engines.

3.1.1.2 Gezira Station. Gezira Station, consisting of a 27.5 MW diesel plant and a 16 MW steam turbine plant is in better operating condition than the Centrale station.

The five diesel engines, Nos. 1 through 5, 5.5 MW each, are larger than the Centrale units and were installed between 1979 and 1984. These engines, were designed for heavy fuel oil and are generating at approximately 87% to 90% of their rated capability. These engines use light diesel fuel oil during start up and shut-down. Inherent problems have developed during the operation of these engines. Two such problems are:

- Shorting of the alternator windings, and

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Table 3-2

MACHINE SHOP EQUIPMENT STATUS - CENTRALE STATION

MACHINE TOOLS

Item No.	Description	Quantity	Equipment Status
1	Turning lathe	4	Working condition but very old; mostly line shaft operated
2	Shaping machine	1	Working condition but very old; mostly line shaft operated
3	Horizontal milling machine	1	Working condition but very old; mostly line shaft operated
4	Reciprocating power saw	1	Working condition but very old; mostly line shaft operated
6	Circular saw	1	Working condition
7	Pedestal drills	2	Not working
8	Portable air compressors	2	Working condition
9	Fuel pump test machine	1	Working condition
10	Small motor winding machine	1	Working condition
11	Small baking chamber	1	Working condition
12	Electric welding machine	1	Working condition

EQUIPMENT

Item No.	Description	Quantity	Equipment Status
1	EOT crane 10 ton capacity for small diesel engines	1	Working condition (installed in 1959)
2	EOT crane, 22 ton capacity for large diesel engines	1	Working condition
3	Manually operated 5 ton crane crane for old engine shop	1	Not working
4	Manually operated 5 ton crane for loading and unloading transformers (for repair)	1	Not working
5	Engine operated 6 ton capacity mobile crane	1	Working condition

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- Failure of the intermediate gear drive brackets.

Both problems have been referred to the manufacturer who, in turn, has suggested that the alternator coil burning may have been caused by lightning strikes. In accordance with the manufacturer's recommendation, lightning arrestors were added to the generator buses. The intermediate gear bracket failures are still under investigation. It is ENEE's opinion that the Brush Co. 15 kV alternators were a first-time design for this application. Regarding the bracket failure, ENEE thinks that inferior materials were used. These diesel engines have developed a history of frequent emergency shut-down and high spare part consumption rates, as well. A typical example of the failure rate is shown on Table 3-3, Emergency Shut Down and Lost Generation Hours, Gezira Diesel Engine No. 1. As a result of frequent shutdown and repair most of the stock of spare parts have been consumed. Only two out of the five engines are now in operating condition; however, engine No. 1, which is being overhauled, should be ready for operation by April, 1986. Engines No. 2 and No. 3 will require extensive rehabilitation before restoration to service.

The 16 MW steam turbine plant at Gezira was commissioned in May, 1985 and is operating as a base load unit. Under the terms of the contract with Brown Boveri Corp. (BBC), all spare parts required for two year's operation of the plant will be provided by the contractor. All chemicals required for water treatment, chemical laboratory, etc. are provided by BBC, but for only one year operation. With the exception of a few minor short-time emergency shut downs, the unit is operating successfully. However, during an early Team plant visit it was noticed that one of two, full capacity cooling water pumps was out of service due to impeller and journal bearing damage, and the other pump was experiencing vibration and shaft water seal problems.

The machine tools in the Gezira diesel plant maintenance shop are more modern than at the Centrale Plant. However, they are not fully utilized because of the lack of cutting tools and miscellaneous steel materials required to manufacture diesel engine components. A list of the machine shop equipment is shown on Table 3-4.

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Table 3-3

EMERGENCY SHUT DOWNS AND LOST GENERATION HOURS - GEZIRA DIESEL ENGINE NO. 1, FROM JULY 2, 1984 THROUGH JUNE 14, 1985 (SHOWS TYPICAL PROBLEMS WITH GEZIRA DIESEL STATION)

Date	Description	Lost Generation Hours
July 2, 1984	Stopped engine for bearing lube oil pressure check, also changed valves.	2.5
August 10, 1984	Engine shut down for cylinder head crack. Replaced cylinder head.	6
August 12, 1984	Changed another cracked cylinder head. Engine shut down.	6
August 21, 1984	Changed one cylinder head and exhaust valves.	6
September 9, 1984	Changed lube oil system.	12
September 22, 1984	Cracked intermediate gear bracket. Engine shut down to change bracket and gear.	144
October 14, 1984	Changed exhaust valves of B4 cylinder head.	2
October 16, 1984	Changed one cracked cylinder head and changed exhaust valve under fuel injector.	8
November 12, 1984	Changed complete lube oil system and changed lube oil.	12
November 14, 1984	Stopped engine for lube oil low pressure. Checked large end clearnances of A and B banks cylinders B1 and B2 large and end clearance lower than normal.	96
November 18, 1984	Changed lube oil pump.	4
December 21, 1984	Pressure test of B1 cylinder fuel injector	1
December 26, 1984	Changed A4 cylinder exhaust valve	2
January 7, 1985	Changed cracked head of A4 cylinder	6
January 8, 1985	Investigation of large end clearance	2
January 28, 1985	Changed exhaust valves of B6 cylinder head	2
January 30, 1985	Changed cracked sheve of B6 cylinder fuel injection valve	2
February 8, 1985	Changed B2 cylinder exhaust valves	2
February 23, 1985	Changed A1 cylinder head ring	0.5
March 4, 1985	Changed A2 cylinder exhaust valves	2
March 16, 1985	Changed rubber rings, top chrome rings, compression and oil rings of B2, B3 and B5 lines	24

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Table 3-3 (Continued)

Date	Description	Lost Generation Hours
March 30, 1985	Changed exhaust valves of A6 cylinder	2
April 7, 1985	Changed exhaust valves of A6 cylinder	2
April 28, 1985	Changed cracked cylinder head, exhaust valves, push rod and rocker of B2 cylinder . Same problem noticed after start up and parts were changed again. Noticed broken studs between piston crown and skirt and damaged cylinder liner of B2 cylinder. Changed B bank turbo charger.	48
May 16, 1985	Engine stopped by itself due to damaged overspeed governor.	2
May 18, 1985	Changed shuttle valve in the control panel.	0.5
May 26, 1985	Changed A5 cylinder exhaust valves.	2
June 14, 1985	Studs between piston skirt and crown of A3 cylinder were broken. This damaged piston liner. On June 15, 1985, decision was taken to overhaul engine #1.	2

(3170H)

Table 3-4

EXISTING MACHINE TOOLS AND EQUIPMENT FOR DIESEL PLANT MAINTENANCE
GEZIRA STATION

MACHINE TOOLS

Item No.	Description	Quantity	Equipment Status
1	Turning lathe	2	Working condition
2	Reciprocating power saw	1	Working condition
3	Pedestal grinder	1	Working condition
4	Pedestal drills	2	Working condition
5	Air compressor (30 bar)	1	Working condition
6	Fuel injector pressure testing machine	1	Working condition
7	Valve grinder	1	Working condition
8	Electric welding machine (portable)	2	Working condition
9	Baking oven	1	Note: This oven has not been operated by plant maintenance personnel.

EQUIPMENT

Item No.	Description	Quantity	Equipment Status
1	Diesel engine maintenance EOT crane, 25/5 ton capacity	1	Working condition
2	Monorail with 1 ton capacity hand chain block and trolley for machine shop.	1	Working condition
3	2 ton capacity battery	2	Not working due to out of order battery. Also battery charger is out of order. Note: Hand carts from steam plant are now being used to move parts from engine shop to machine shop and vice versa.

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3.1.1.3 Plant and Equipment Maintenance and General Cleanliness at Both Stations. Because of the overall shortage of generation capacity and spare parts, a systematic preventive maintenance of the engines, as recommended by the manufacturers, has not been performed. In addition, the following major operating deficiencies were observed:

- While there are record systems to log engine breakdown and maintenance, the details available were not fully explicit for future review and usage and were incomplete.
- Due to lack of funds, adequate stocks have not been maintained except at Centrale Station main stores. Equipment and spares were not stored in an orderly manner.
- During emergency and preventive maintenance, dismantled engine parts were not stored and handled properly.
- Damaged and broken parts were not disposed of, and were scattered over the plant operating floor.
- Equipment which is readily corroded by the salty atmosphere is not properly cleaned and coated to prevent further deterioration.

3.1.2 Manpower

The present organizations and manpower for the maintenance and operation of Gezira and Centrale stations are shown on Figures 3-1 and 3-2 respectively.

3.1.2.1 Gezira Plant. Reporting to the plant superintendent at Gezira station, are two separate groups, one for the operation and maintenance of the diesel plant and the other for the steam plant. Most of the supervisory personnel for the steam and diesel plants are college educated. Almost all of the steam plant personnel were trained by the plant design consultant, either overseas or during construction and commissioning of the plant. Most of the steam plant maintenance and operating personnel are from technical schools. During the first years of operation of the steam plant, seven out of sixty trained technicians left the company. The diesel plant, on the other hand, is maintained and operated by a group consisting of only a few skilled technicians and a large staff of unskilled labor. To assist in the maintenance of the diesel engines, Mirrlees, the manufacturer of the engines, has seconded two of its maintenance technicians to ENEE for two years. Two

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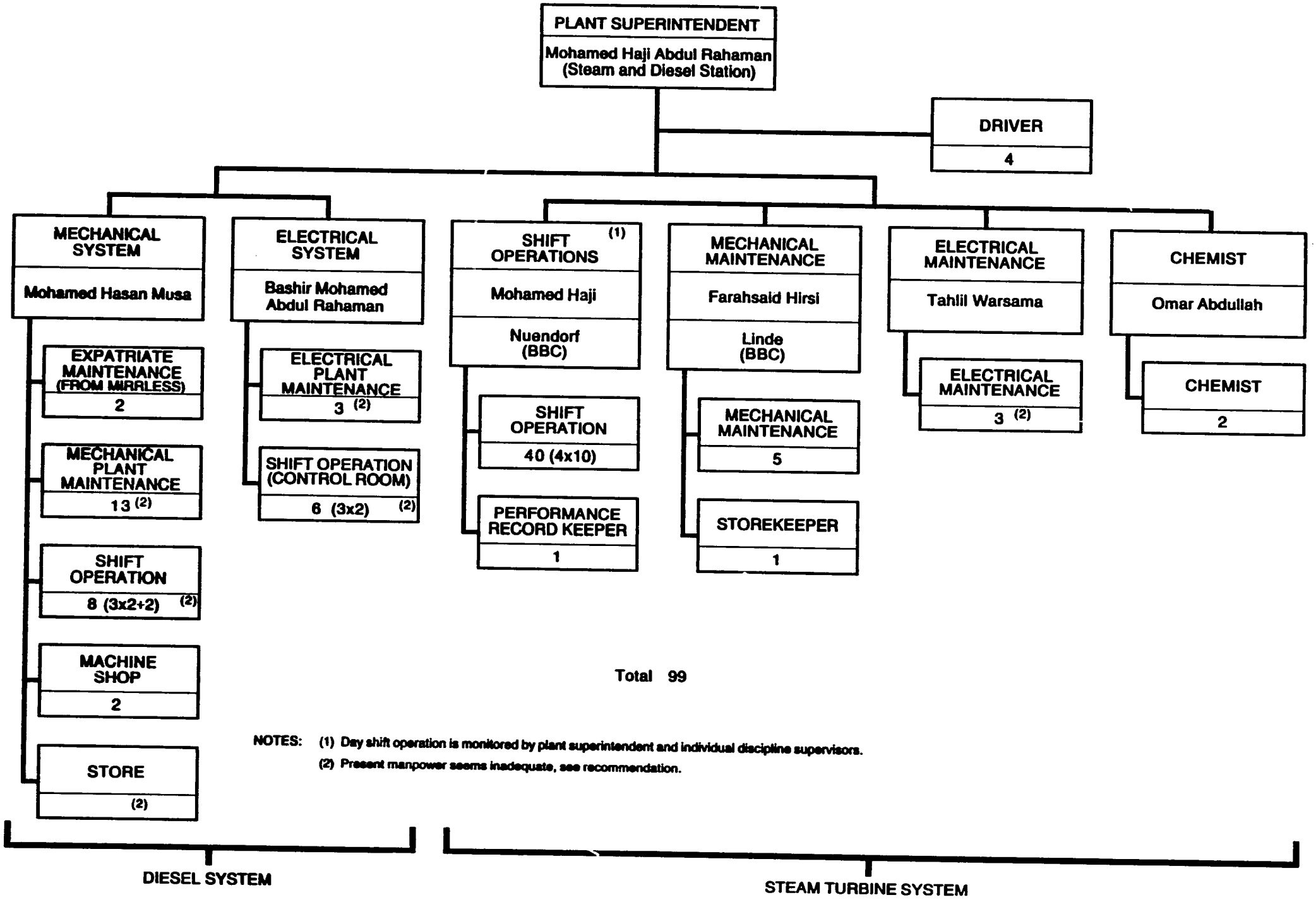

Figure 3-1 Gezira Power Station Operation and Maintenance Organization

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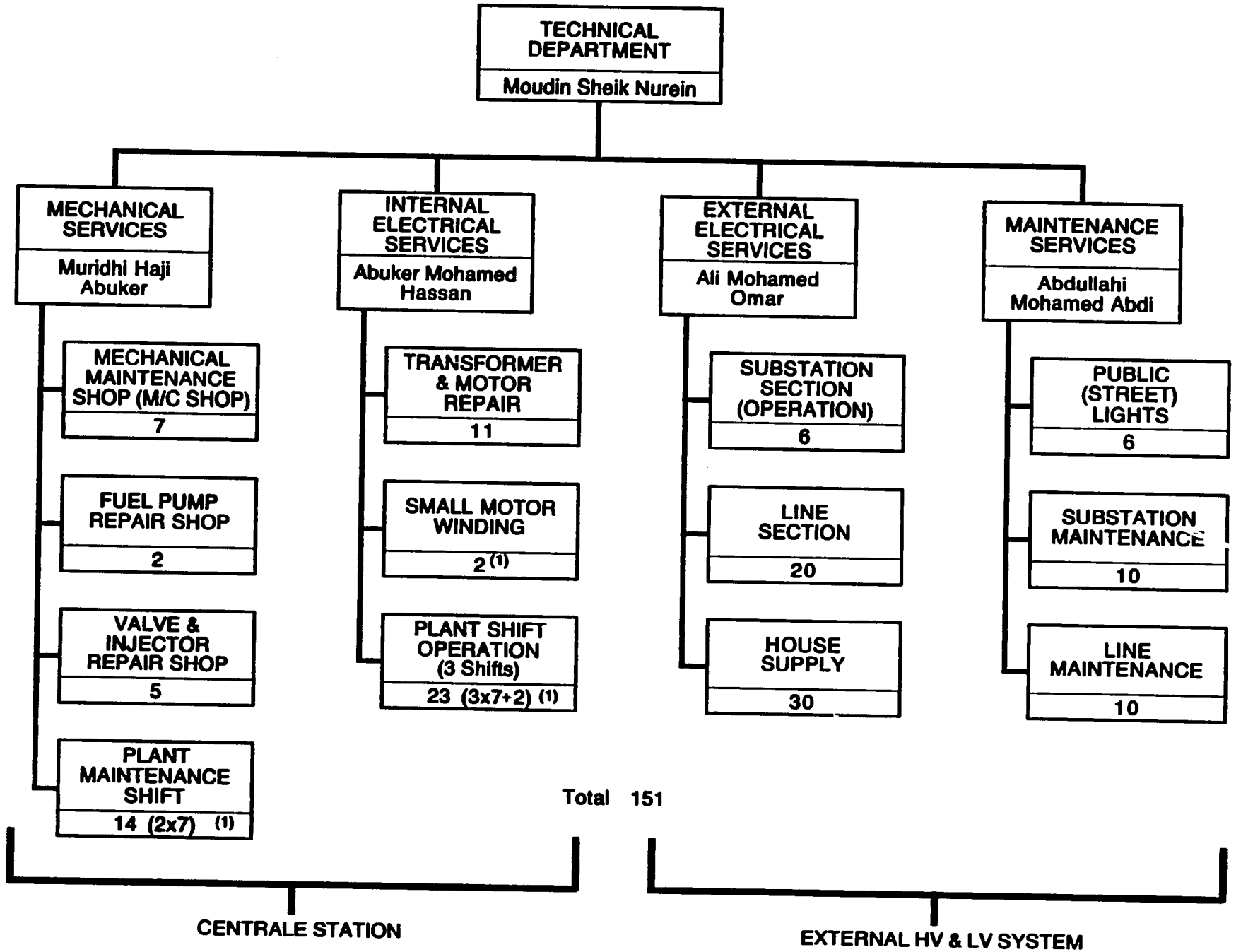

NOTES: (1) Present Manpower Seems Inadequate, See Recommendations

Figure 3-2 Centrale Power Station Operation and Maintenance Organization

engineers have been seconded to ENEE by BBC of Germany for the maintenance and operation of the steam plant. A walk through the steam plant gave a satisfactory impression of the operation and housekeeping. The diesel plant, on the other hand, gave an impression of unsatisfactory housekeeping. However, the difference is largely due to the inherent nature of each plant.

3.1.2.2 Centrale Plant. The Centrale station is a diesel plant which evolved from an old steam engine plant. Its configuration includes four small (960 kW) and four large (2.2 MW) diesel engines. Discussions with the plant supervisors proved that they are "old hands" and competent and most of the workers are semi-skilled. Earlier the staff had a turnover of 30% per annum, but has now stabilized. A walk through the shops revealed unsatisfactory housekeeping and poor record keeping. Management personnel of both plants (Centrale and Gezira) complained about the shortage of skilled and responsible personnel for the maintenance of the diesel plants.

3.1.3 Conclusions

3.1.3.1 Plant Operations. It is clear that system maximum demand is limited by generation capacity. Because of the existing capacity limitation, any unplanned outage of the operating generators will require load shedding. However, if funds are made available to rehabilitate the two newer engines at Centrale and the two engines at Gezira, the power supply situation will improve through 1989 provided that maximum demand does not exceed the predicted demand and unplanned outages of the steam turbine unit are kept to a minimum. The rehabilitation will also provide an opportunity to conduct preventive maintenance on the diesel engines and the steam turbine. The expected peak demand by the year 1990 will require additional units (see Section 3.3). Considering present diesel and steam turbine operating experience, a 15 MW steam turbine will be more effective than one or two large diesel engines. By the time the second steam unit is installed, ENEE engineers and operators should have gained adequate experience in steam plant operation.

A one-time rehabilitation of the diesel engines will obviously not solve the power supply problem. Considering the high outage rate and maintenance requirements of the diesel engines, an adequate supply of spare parts will be required to keep these units running. Also machine tools and maintenance equipment, not presently available for preventive and emergency maintenance, are required.

Housekeeping, data collection, preventative maintenance, improved plant performance with proper planning and utilization of modern technical know-how to meet future growth and development are very important and requirements must be implemented.

At present, it is true that the performance and availability of the steam plant is much greater than the diesel-engine plant. In due course, however, the outage rate of the steam plant may increase. If proper maintenance of the much more sophisticated equipment in the steam plant is not performed, the outage rate of steam plant (failure of boiler tubes and erosion and corrosion of turbine blades, etc.) can be expected to exceed that of the diesel plant.

Chemical supplies required for steam plant operation and the chemical laboratory are running alarmingly low. A steam plant is not only a mechanical and thermal system but also a chemical system and requires large quantities of chemicals to maintain water quality. It is, therefore, essential for ENEE management to understand the importance of the chemicals to steam plant operation and take the necessary action to replenish chemical supplies.

3.1.3.2 Manpower. From the Gezira steam plant organization chart and from the discussions it is generally concluded that the steam plant has a group of trained supervisors, operators and technicians. However, weaknesses have been observed in the following staffing:

> Both an instrumentation and control engineer and a technician are needed. It is understood that only one instrumentation technician is now available for the steam plant which with its large number of instruments and controls is beyond the capability of the technician to service.

- Results engineer is needed. The steam station requires monitoring of plant and equipment efficiency and plant betterment which is the function of a Results Engineer.

- Station now operated by only two shift-charge engineers.

- No apprenticeship program for technician training and no provision for backup technicians available

The Gezira diesel plant, which has a record of many emergency outages needs skilled technicians and operators. Furthermore, an apprenticeship program is needed to train technicians. The Stores Department is now totally disorganized and needs trained storekeepers.

The conditions at Centrale Station are similar to those at the Gezira plant. It needs a large number of skilled technicians and operators.

3.2 TRANSMISSION AND DISTRIBUTION SYSTEMS

Currently the ENEE transmission system consists of two, 33 kV lines connecting the Gezira steam and diesel plants, a 33kV line connecting the Gezira power station with the West End substation, a 33 kV line (operating at 15 kV) connecting the West End substation with the 21st October substation and a series of 15 kV lines connecting the Gezira Station with the Centrale Station and the 21st October substation. There are 15 kV feeders connecting the refinery and the urea plant to the 15 kV bus as the Gezira power station. A one-line diagram of the ENEE transmission system is shown on Figure 3-3.

The distribution system consists of both 3 kV and 15 kV primary lines throughout Mogadishu and its environs. Presently the 3 kV system is being converted to 15 kV. The secondary system consists of a 3-phase, 380/220 V system with a grounded neutral. The distribution transformers are both pole-mounted (newer installation) and pad-mounted (older installation). The primary and secondary circuits are carried on a variety of wood, metal and concrete (newest) poles. Transformers are fused and service drops are fused (however, many of the fuse-holders have been "hard-wired" to replace fuses).

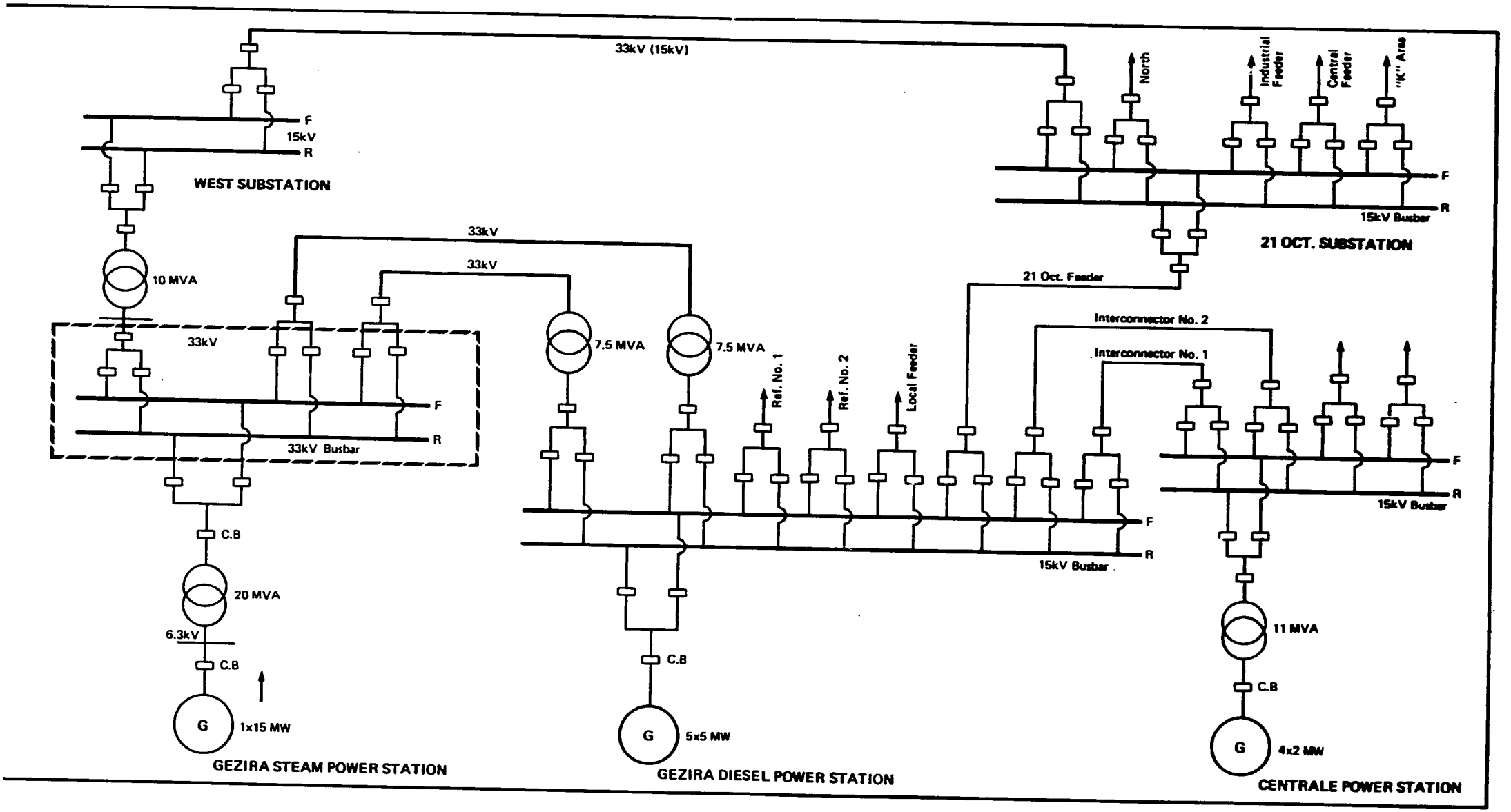

Figure 3-3 One-Line Diagram ENEE Power System

3.2.1 System Conditions

3.2.1.1 Primary Distribution System (3 kV and 15 kV). In general the condition of the primary 3 kV lines is better than that of the secondary (380/220 V) lines; however their condition is not completely satisfactory. In fact, the 3 kV lines show all the corrosion problems of the secondary lines but to a lesser extent. The steel poles of the 3 kV lines are often in a poor state due to vehicle impact damage. Approximately 70 percent of the poles show some damage and 30 percent show damage to the extent that the pole's mechanical strength is impaired.

The 15 kV lines are erected on steel reinforced concrete poles with the conductors, in horizontal formation on upright insulators. Some of these are already showing signs of impact damage. Some protection of line poles situated along roads should be provided.

The environment is salty and very dusty, consequently overhead line insulators, even on new lines, accumulate thick deposits of dust and salt, which leads to numerous flashovers in damp conditions. Until insulator washing can be employed on these lines, some other means such as deep skirt insulators or washing and silicon greasing should be employed.

In the 3 kV system, the conductors are undersized, insulation is poor and the circuits are overloaded. This system is no longer adequate and is being progressively replaced by the 15 kV primary.

Few of the 3 kV or 15 kV primary lines are protected by lightning arresters. Lightning surges on the 15 kV lines can cause Gezira generator winding damage via the 15 kV busbars. The only protection provided is the cable between the lines and the busbars.

The 15 kV lines carry an aerial ground wire which is grounded at every third pole. This ground wire is hung below the phase conductors and cannot, therefore, provide any circuit protection against lightning. The ground wire's purpose is to ground the crossarm and the pole's reinforcing steel.

The 15 kV/380 V pole-mounted transformers are in reasonably good condition. In Mogadishu the 3 kV/380 V transformers are housed in small buildings, or postes and the condition of these buildings range from fair to very poor. The housekeeping at a number of these buildings visited was very poor and are depositories for old and broken equipment and hardware. None of the transformers, at either 3 kV or 15 kV, were adequately screened and live conductors were dangerously within reach.

At many transformers both the primary and secondary fuses are missing from one phase due to a shortage of fuses. Where this occurs the fuse carriers have been bypassed with wire, creating a real possibility of distribution transformer damage at the time of a fault.

The system protection is generally conventional. Although the lines between the Gezira and Centrale stations and between Gezira and 21 October substation have balanced differential, timed overcurrent, and sensitive earth fault protection, the pilot wire cables have been damaged so these feeders are relying upon timed backup protection only. Other 15 kV lines are protected by either relays or by fuses.

The lack of lightning arresters on the 15 kV system is of grave concern. This is a particular problem at Gezira where the diesel-generators are connected directly into the 15 kV busbar to which overhead lines are connected. As mentioned earlier the ground wire on the 15 kV lines, because of its location does not provide lightning protection.

3.2.1.2 Secondary System (380/220 V). There are some secondary lines of new modern construction, however most of the older secondary lines are in a very poor physical state, seriously overloaded and improperly mounted. Replacement rather than rehabilitation is required.

The general state of secondary circuits can be characterized by:

- Line lengths tend to be long because of use of large distribution transformers (200 kVA average) and extensions to match the distribution transformer capacity. We have estimated, from discussion with ENEE people and observation, that secondaries are in the order of 2 km per distribution

transformer and much longer in many cases. Conductor sizes are small and result in unacceptable voltage regulation for the users. This is particularly so in the "old city" area.

- The line hardware shows exteme corrosion to the extent that some crossarms and insulator pins have either failed or are failing.

- The lines use inadequate glass or porcelain insulators, many of these are broken.

- The poles are of two types, tubular steel or wood, and the steel poles near the ocean are so badly corroded that they are in danger of collapsing. Many poles show severe vehicle impact damage. About one in ten wood poles show signs of termite attack and many require steel plate supports driven into the ground.

- Line ground clearance in some cases is as little as 2-3 m due to sagging poles.

- Overloading of conductors has led to annealing and embrittlement resulting in conductor failures.

- The service drops from the secondary are frequently in poor condition and will require replacement.

3.2.1.3 Transmission System. Presently the Gezira station, in addition to 15 kV lines, is tied into the 21 October substation and the West End substation by 33 kV transmission lines. These are lines of modern design using concrete steel-reinforced poles with properly sized conductors and insulators. As in the case of the 15 kV primary, however, the grounding wire does not provide for shield protection and there are no lightning arrestors on the 33 kV lines. The 15 kV lines from Gezira to Centrale have been constructed and insulated for 33 kV operation once the second 16 MW steam unit is completed. There are no current rehabilitation needs for the 33 kV lines.

Extension of the 33 kV system to a new East End substation, the completion of the 33 kV line to Afgoi and the construction of the 45 km 33 kV line to Balad is beyond the scope of this rehabilitation program. However, the installed cost of these lines together with substation and distribution system are shown in Appendix C.

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3.2.1.4 Mobile Construction and Maintenance Equipment. The inventory of currently operating ENEE mobile construction and maintenance is completely inadequate. At present both maintenance work and new lines construction is greatly curtailed. In many instances, existing mobile equipment is in a poor state of repair due to a lack of spare parts or because work demand prevents a release of the mobile equipment for preventative maintenance and repair. The lack of equipment contributes to reduced efficiency causing higher costs, less productivity and delays in completing needed work. The provision of needed mobile equipment for lines construction and maintenance should be one of the fastest ways to improve the reliability of the system, and equally important, reduce the duration of outages. Currently, there are only 15 pieces of mobile equipment (see Table 3-5) to service the Mogadishu area with its 40,000 customers.

3.2.1.5 Workshop. The workshop at 21 October substation for mobile equipment repair is essentially nonexistent and what maintenance equipment is available is in a serious state of deterioration.

3.2.1.6 Pole Manufacturing Plant. The plant presently manufacturers 10 poles every two (2) days, six 12 meter poles and four 8.5 meter poles. Presently, the bridge crane, concrete mixer and bar shears are in need of major repair. Furthermore, a two-year supply of spare parts will be needed for the bridge crane, concrete mixer and bar shears. Additional pole moulds and a second shift operation will be required if the demand for poles for primary and secondary distribution lines is to be met in the Mogadishu area. Furthermore, it was observed that the plant requires a works manager with an engineering background if efficient operation of the plant is to be achieved.

Table 3-5

EXISTING LINE MAINTENANCE AND CONSTRUCTION MOBILE EQUIPMENT

Vechicle	Age (years)
Diesel Land Rover	1
Diesel Land Rover	1
Diesel Land Rover	1
Diesel Land Rover	5
Diesel Land Rover	5
Toyota Land Cruiser	10
Fiat Lorry at Central PS	1
Fiat Lorry at 21 Oct S/S	1
Bedford Earth Boring Machine	1
Fiat Trailer 110NC for pole transportation	9
Fiat Lorry with 1-2 tonne crane	9
Birdelli Mobile Workshop	11
Van	4
Jones 6 Tonne Crane	8
Coles 25 Tonne Crane	2

Six old Land Rovers are out of service and are irrepairable.

3.2.2 Manpower

ENEE is greatly restricted in the number of operating line crews for primary (15 kV) and secondary (380/220 V) line construction and maintenance. The number of crews and staffing as of March 1986 are shown in Table 3-6. The projection of needs for replacement and rehabilitation construction of the existing secondary system in the central city (6 sq. km), the timely completion of the primary 3 kV to 15 kV conversion and the expansion of the system together with system maintenance will require approximately 16 crews, totaling 104 men. There is no formal lineman training program being used in ENEE. What training is achieved is "on-the-job training" with no classroom training.

Table 3-6

ENEE LINE CREWS AND STAFFING
MARCH, 1986

Crew Type	Number of Crews	Number of Persons
15 kV/3 kV Primary Crews (HV)	4	25
380/220 V Secondary Crews (LV)	7	33
Station Crews	2	8
Substation Crews	1	8
Street Lighting Crew	1	4
Estimating Group	1	6
Total	16	84

(3170H)

The line crews are poorly equipped with insufficient handtools to keep the crews fully occupied. Furthermore, due to a serious lack of utility crew vehicles and mobile equipment, crews experience considerable idle time.

3.2.3 Electrical System Losses, Voltage Regulation and Faults

A review of apparent gross system losses, by comparing kWh generated with kWh billed, indicates a range of 20 to 30 percent losses, which is unacceptably high by modern utility operating standards. It was not possible to determine whether losses were primarily technical, i.e., system I^2R, or nontechnical, i.e., not billed or unmetered. It is apparent that both are major, and that by proper attention to billing practices and improvement, particularly of the secondary system, these can be reduced reasonably to possibly 15 percent of annual generation.

Primary distribution losses can be reduced considerably by application of shunt capacitors at strategic locations in the system. It appears that by application of about 5000 kVar of capacitors, system power factor and voltage regulation can be improved to the level of modern distribution system standards.

Voltage regulation is significant which results in excessive, premature motor failures, e.g., air conditioners and refrigerators. System voltage regulation is almost entirely uncontrolled and subject to line loading. No intentional applications of shunt capacitors, i.e., improving power factor, or regulating transformers, has been provided thus far.

As reported by others, distribution transformers are not loaded with due consideration given to transformer capacity. Because of recording deficiencies, as noted before, it is expected that these previous observations are true and that more attention needs to be paid to balancing loads.

Because of environmental conditions such as high levels of dust and humidity, there is a frequent incidence of faults, such as flashovers in all exposed O.H. systems. Many of the faults in the primary and secondary distribution

lines are caused by insulation failure. It is reported that, on the average, 150 primary circuit fuses are blown every month. This is five to seven times the normal rate of fuse replacement in primary distribution circuits. Neither faults nor fault repair times have been recorded.

3.2.4 Distribution Planning

Early in the investigation it became obvious that recordkeeping for any purpose was lacking. There were no system single line diagrams. Distribution maps prepared by Kennedy and Donkin in 1985 were not being updated, nor were copies available. Inventories of installed equipment or spares were not available.

It is necessary to have a system of records for the purpose of establishing plant investment status as well as maintenance requirements. We suggest that a pole numbering system be adopted and property maps be prepared showing location of all poles, distribution transformers and secondaries. Equipment record cards should be prepared for all poles, transformers, sectionalizing equipment and meters in the systems. There is no Distribution Planning Section in ENEE undertaking this essential work.

3.3 POWER SYSTEM PLANNING

Although a Planning and Projects Department, including a Planning Services Section, is identified on the ENEE Organization Chart, the Planning Services Section has not been established. Consequently, no power system planning is currently being undertaken by ENEE. ENEE management is depending upon the system planning, load forecasting and capital expenditure predictions prepared by the Societi Generale Pour L'Industrie (SGI), August 1985. The forecasts, plans and capital estimates prepared in the SGI report now require up-dating.

3.3.1 Demand Forecasting

The only attempt at demand forecasting has been a one-year forecast for a tariff adjustment study in late 1985. Historical data for demand and sales trends have not been compiled either in total or by customer class, and no attempt has been made to assemble future large customer demand and energy requirements. Presently, in ENEE no department has been assigned the

responsibility for demand forecasting; nor, is it within ENEE's immediate plans to develop a disciplined load forecasting program. Much of the disinterest in forecasting stems from the knowledge that funds will not be available to invest in system expansion, therefore the effort spent in planning is, in a sense, futile.

For purposes of developing a 10-year system expansion plan, the Bechtel team developed two trend forecasts, one using a "realistic" growth rate and another an "optimistic" growth rate. These forecasts are shown in Table 3-7. Both forecasts are based on a supply-driven philosophy, since Somalia will not have a positive balance of payments position in the foreseeable future. The realistic scenario is based on the condition that all donors and lenders will respond very cautiously to Somalia's requests for hard currency grants and development loans in light of Somalia's recent default on servicing the debt at the Gezira steam plant. The optimistic scenario is based on implementing a policy, as yet undefined by the Somali government, to make debt service in the power sector a high priority item in order to secure further donor credits and development bank loans for the power sector. It should be emphasized that these are trend forecasts and are not based on macroeconomic data or known customer class growth. In the light of the fact that basic data are not available, and the short period available for this investigation, the trend forecast technique, based on the assumed economic environment, offered the only practical approach to tentative forecasts.

3.3.2 System Planning

As stated earlier, there is no system planning being currently undertaken in ENEE. The last system expansion plan was prepared by SGI and up-dated in August 1983. This plan is now outdated in the light of delayed installation of generating, transmission and distribution plant. Based on a review of the 1983 Expansion Plan and the Bechtel team demand forecasts, simple expansion plans were developed over the period 1986 through 1995. The plant additions are defined in Table 3-8. The expansion plan based on the realistic demand forecast, will require an improvement in financial practices, construction productivity and operation and maintenance efficiency. The expansion plan based on the optimistic scenario, as defined in Table 3-9, will require significant improvements in the aforementioned areas as well as external

Table 3-7

POWER DEMAND FORECASTS - 1986 to 1995
MW

Scenario	Year: 1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Realistic Scenario 1986-1990: Growth at 10% per annum. 1991-1995: Growth at 6 per annum.	27.8	30.6	33.7	37.0	40.7	43.2	45.0	48.5	51.4	54.5
Optimistic Scenario 1986-1990: Growth at 10% per annum. 1991-1995: Growth at 12% per annum.	27.8	30.6	33.7	37.0	40.7	45.6	51.0	7.0	64.0	71.7

Notes:
Both the Optimistic Scenario and the Realistic Scenario are constrained to 10% per annum growth rate in the period 1986 through 1990 due to the rate at which rehabilitation is possible and the earliest installation of the second 15 MW steam turbine unit at Gezira.

The Realistic Scenario assumes that in the period 1991 through 1995 ENEE will be able to install only two additional 15 MW steam units at Gezira due to Somalia's limited foreign exchange.

The Optimstic Scenario assumes that in the period 1991 through 1995 ENEE will be able to install four additional 15 MW steam units at Gezira, as a result of Somalia's improvement in balance of trade and debt service.

Table 3-8

GENERATING PLANT EXPANSION PLAN
REALISTIC SCENARIO

	Capacity (MW)	No. of Sets	Remarks	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Maximum Demand (MW)				23.0	25.3	27.8	30.6	33.7	37.0	40.7	43.2	45.8	48.5	51.4	54.5
CENTRALE STATION															
Old diesel operating	0.65	2	#2 shut down		1.3	1.3	1.3	1.3	1.3	(1)	(1)	(1)	(1)	(1)	(1)
Old diesel rehabilitated	0.65	2	mid-'85		0	0	0	0	0	0	0	0	0	0	0
New diesel operating	1.8	2	#3 shut down 1983		3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
New diesel rehabilitated	1.8	2	#6 shut down January '86 #7 shut down April '85		0	0	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
GEZIRA STATION															
Diesel operating	4.7	3	#1 shut down June '85		9.4 (2x4.7)	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1
Diesel rehabilitated	4.7	2	#2 shut down		0	0	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4
Steam turbine	15.0	1	Oct. '85		15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
Future steam turbines															
No. 2	15.0	1								15.0	15.0	15.0	15.0	15.0	15.0
No. 3	15.0	1											15.0	15.0	15.0
Total available capacity					29.3	34.0	47.0	47.0	47.0	60.7	60.7	60.7	75.7	75.7	75.7
FIRM CAPACITY															
One unit outage (steam)					14.3	19.0	32.0	32.0	32.0	45.7	45.7	45.7	60.7	60.7	60.7
Two unit outage (steam & diesel)					9.6	14.3	27.3	27.3	27.3	41.0	41.0	41.0	56.0	56.0	56.0
SURPLUS (DEFICIT) OF CAPACITY															
One unit outage (steam)					(11.0)	(8.8)	1.4	(1.7)	(5.0)	5.0	2.5	(0.1)	12.2	9.3	6.2
Two unit outage (steam & diesel)					(15.7)	13.5)	(3.3)	(6.4)	(9.7)	0.3	(2.2)	(4.8)	7.5	4.1	1.5

Note
(1) Standby and emergency duty only.

(3172H)

Table 3-9

GENERATING PLANT EXPANSION PLAN
OPTIMISTIC SCENARIO

	Capacity (MW)	No. of Sets	Remarks	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Maximum Demand (MW) Based on UNDP Report of Dec. '85 Action Oriented Scenario)				23.0	25.3	27.8	30.6	33.7	37.0	40.7	45.6	51.0	57.0	64.0	71.7
CENTRALE STATION															
Old diesel operating	0.65	2	#2 shut down		1.3	1.3	1.3	1.3	1.3	(1)	(1)	(1)	(1)	(1)	(1)
Old diesel rehabilitated	0.65	2	mid-'85		0	0	0	0	0	0	0	0	0	0	0
New diesel operating	1.8	2	#3 shut down 1983		3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
New diesel rehabilitated	1.8	2	#6 shut down January '86 #7 shut down April '85		0	0	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
GEZIRA STATION															
Diesel operating	4.7	3	#1 shut down June '85		9.4 (2x4.7)	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1
Diesel rehabilitated	4.7	2	#2 shut down		0	0	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4
Steam turbine	15.0	1	Oct. '85		15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
Future steam turbines															
No. 2	15.0	1							15.0	15.0	15.0	15.0	15.0	15.0	15.0
No. 3	15.0	1									15.0	15.0	15.0	15.0	15.0
No. 4	15.0	1											15.0	15.0	15.0
No. 5	15.0	1													15.0
Total available capacity					29.3	34.0	47.0	47.0	62.0	60.7	75.7	75.7	90.7	90.7	105.7
FIRM CAPACITY															
One unit outage (steam)					14.3	19.0	32.0	32.0	47.0	45.7	60.7	60.7	75.7	75.7	90.7
Two unit outage (steam & diesel)					9.6	14.3	27.3	27.3	42.3	41.0	56.0	56.0	71.0	71.0	86.0
SURPLUS (DEFICIT) OF CAPACITY															
One unit outage (steam)					(11.0)	(8.8)	1.4	(1.7)	10.0	5.0	15.1	9.7	18.7	11.7	19.0
Two unit outage (steam & diesel)					(15.7)	(13.5)	(3.3)	(6.4)	5.3	0.3	10.4	5.0	14.0	7.0	14.3

Note
(1) Standby and emergency duty only.

(3172H)

confidence in the Somali government and ENEE by donor and lending institutions. Any expansion at all in the system seems improbable until considerable investment is made in the rehabilitation of the existing system. The estimated rehabilitation costs begin to approach what would normally be required in capital investment for a two-year expansion period.

3.3.3 Capital Expenditure Prediction

Capital requirements for system expansion were last updated in the SGI 1983 report. In the meantime, although world prices for heavy utility equipment have stabilized, the Somali Shilling has suffered serious devaluation ($1 equal to 16 SoSh in 1983 to $1 equal to 57 SoSh in March 1986). The Bechtel team has prepared a straightforward capital expenditure prediction for each of the two system expansion scenarios using updated costs. The foreign capital requirements will place a great burden on the already over-allocated Somali foreign exchange credits. It is the power system's intensive foreign capital requirements which make any implementation plan, whether realistic or optimistic, most formidable. The capital expenditure predictions for the two expansion scenarios are given in Table 3-10.

3.4 PROCUREMENT AND INVENTORY CONTROL

3.4.1 Commercial Services

The Commercial (Procurement) Department in ENEE consists of a Commercial Services Section, a Stores Section and a Commercial Accounting Section. The Commercial Services Section performs the purchasing function for ENEE and the districts; the traffic function (domestic and overseas transport; customs clearance, insurance and licenses). Presently the section is staffed by five (5) persons, reasonably experienced. However, the section is inadequately staffed and poorly equipped.

The procurement cycle for foreign purchases is illustrated in Figure 3-4. The procedure is reasonably straightforward, however, the purchase requisition approval cycle needs to be modified to permit lower level approval to hasten the purchasing cycle for a larger number of less costly commodities. Following the release of purchase order to overseas firms and the receipt of tenders, the evaluation of tenders and award recommendation is made by the

Table 3-10

EWEE GENERATING PLANT CAPITAL EXPENDITURE PREDICTION
($1000)

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Total 10-Year Expenditure
REHABILITATION AND SPARE PARTS											
Gezira Power Station											
Rehabilitation, diesel-generator		910									
Spare parts, diesel-generator		1,720									
Rehabilitation, steam turbine-generator		270									
Spare parts, steam turbine-generator		650									
Centrale Power Station											
Rehabilitation, diesel-generators		1,250									
Spare parts, diesel-generators		1,000									
Subtotal		5,800									5,800
NEW CONSTRUCTION											
REALISTIC EXPANSION SCENARIO											
Gezira Power Station											
Unit No. 2, 15 MW		1,390	6,770	12,900							
Unit No. 3, 15 MW					1,390	6,770	12,900				
Unit No. 4, 15 MW								1,390	6,770	12,900	
Subtotal		1,390	6,770	12,900	1,390	6,770	12,900	1,390	6,770	12,900	64,180
OPTIMISTIC EXPANSION SCENARIO											
Gezira Power Station											
Unit No. 2, 15 MW	1,390	6,770	12,900								
Unit No. 3, 15 MW			1,390	6,770	12,900						
Unit No. 4, 15 MW					1,390	6,770	12,900				
Unit No. 5, 15 MW							1,390	6,770	12,900		
Unit No. 6, 15 MW									1,390	6,770	
Subtotal	1,390	6,770	14,290	6,770	14,290	6,770	14,290	6,770	14,290	6,770	92,400
TOTAL CAPITAL REQUIREMENTS											
Realistic Expansion Scenario	-	7,190	6,770	12,900	1,390	6,770	12,900	1,390	6,770	12,900	68,980
Optimistic Expansion Scenario	1,390	12,570	14,290	6,770	14,290	6,770	14,290	6,770	14,290	6,770	98,200

(3178H)

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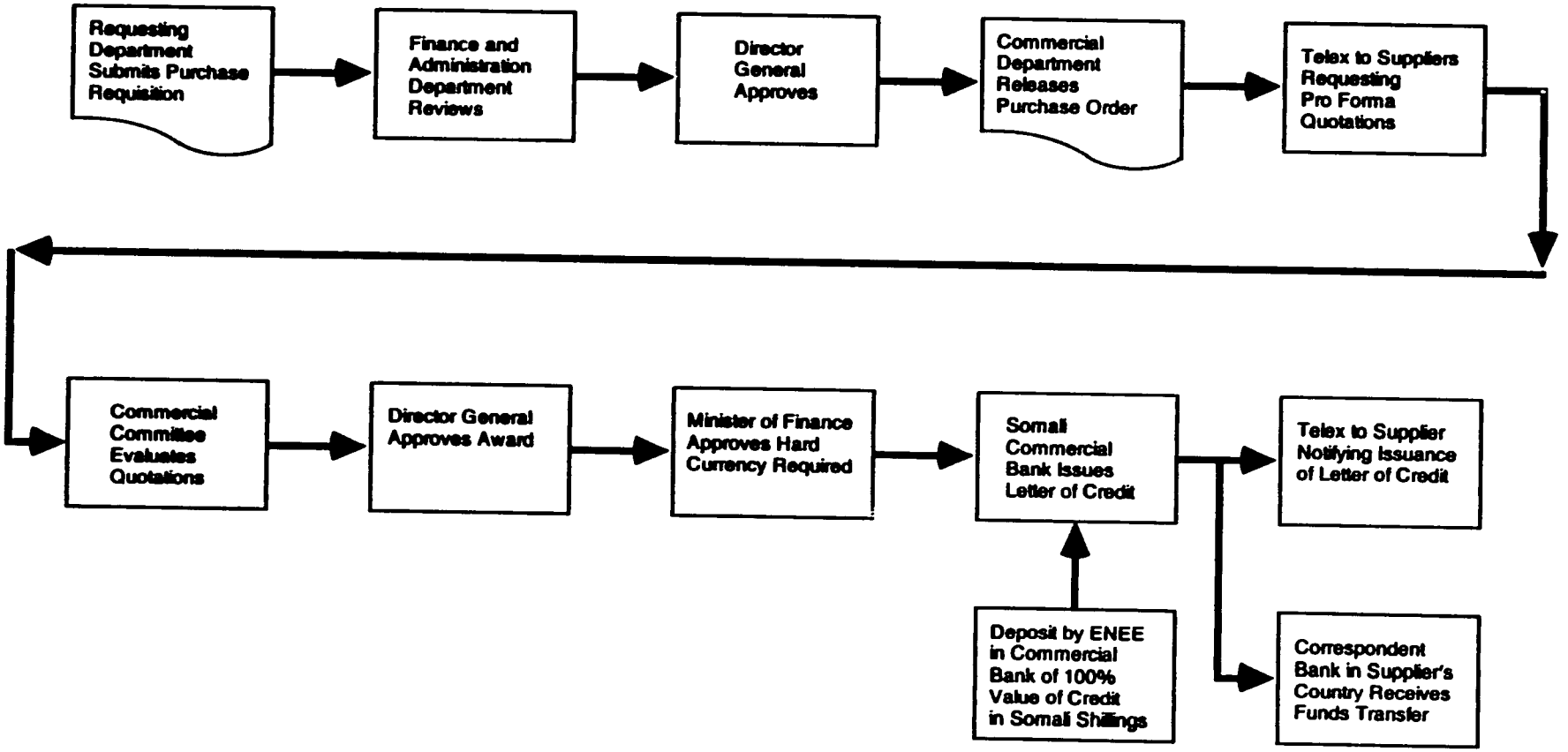

Figure 3-4 Foreign Purchase Procurement Cycle

Internal Commission on Purchases. This Commission consists of five members, one each from the Projects and Planning Department, the Commercial Department, the Administration Department, the Technical Department, and the Public Works Department. In addition, a representative from the Labor Union and an Italian Consultant serve as advisors to the Commission. It was observed that this Commission reviews commodity purchases which are much too low (15,000 SoSh or $3000) in value. A more logical minimum value would be 50,000 SoSh.

The securing of hard currency for purchase of foreign equipment is an arduous process. Each foreign purchase, regardless of purchase value, requires Ministry of Finance approval and a protracted procedure for obtaining a letter of credit from the Somali Commercial Bank. Furthermore, ENEE must deposit Somali Shillings with the Commercial Bank equivalent to 100 percent of the value of the hard currency requirement prior to the release of the letter of credit. This works a serious hardship on ENEE's cash position for purchases above $50,000.

3.4.2 Commercial Accounting

The Commercial Accounting Section is responsible for the records of all banking operations from letter of credit application through final payment of supplier by Somali correspondent banks in the country of the supplier. The records for all invoiced purchase orders, both local and foreign purchases, are kept by this Section. Local purchases, as well, are the responsibility of the Commercial Accounting Section, including the purchase transaction, banking transactions and transaction records. This section has a staff of twelve (12) persons who are working at a reasonable efficiency level. The transfer of completed purchase records to the Accounting Service Section in the Finance and Administration Department is not clearly defined. Also, rules as to what purchases are to be expensed and what purchases are to be booked in plant account records were not clearly defined, apparently leading to over expensing of purchases.

3.4.3 Stores

Inspection of the stores warehouses at both the Centrale station and the 21st October substation disclosed both an inadequate stores record system and poor

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storage and marshalling of materials and equipment. A study by Ewbank Consulting Engineers in October 1976 had set out a complete stock control system, but evidence, from the inspections made, was that only a few of the recommendations of that study were implemented. There needs to be extensive updating in the stock coding system to improve the effectiveness of stores ordering and handling. Furthermore, the maintenance of stock levels is an extremely important task, requiring skillful handling of control systems, and stock and spares forecasts. There also needs to be a differentiation between spares, or stock, used in planned maintenance operations and spares used as replacement resulting from possible unscheduled outages, or breakdown. Maintenance spares have a substantial consumption rate and a reasonably predictable pattern of consumption. Therefore, a well planned and managed level of stock must be maintained which encompasses at least the concepts of maximum inventory, reorder point and minimum level inventory. Such a system was not observed to be in place in the course of the field inspections. For the unscheduled outages, or breakdown, the required spares are more difficult to assess. The decision here requires a weighing of the lost income to ENEE over the period of the unscheduled outage due to the time it takes to secure a major replacement part from the manufacturer as over against the working capital costs of purchasing the major replacement in anticipation of an unscheduled outage resulting from the failure of the major part. It was evident from discussions with ENEE engineering and procurement managers that there is no established policy on the stocking of spare parts for unscheduled outages.

3.5 ACCOUNTING AND FINANCIAL MANAGEMENT SYSTEMS

The USAID Mission/Somalia had specifically requested that the customer billing, collections and accounting systems be audited and that the current billing losses be analyzed. Recommended revisions to the customer billing, collection and accounting systems were to be made including feasible automation. In compliance with these instructions, an in-depth audit was made of the Billings Services Section and Collections Section of the Finance and Administration Department. The findings of the audit are set out in this section.

As a result of this initial audit, it became apparent that a careful examination, as well, should be made of the plant accounting and property records system, income statements and balance sheets and the financial management procedures used currently. Findings in these areas are also presented in this section.

3.5.1 Customer Billing, Collections and Accounting

The customer bill preparation procedure is documented in Figure 3-5. Private accounts for ENEE customers are 35,000, of which 33,500 are lighting accounts and 1,500 are small power (F.M.) accounts. As shown in Figure 3-5, meter reading record sheets are received from the Collections Department and readings are entered into a customer record book manually. The customer bill is prepared by first making a separate calculating machine computation of the energy billing, transferring this calculation into a bill typing machine and typing a two-part bill, one part a receipt and the other part to be left as a notice if the customer does not pay the bill when delivered to his residence. In addition, a bill summary sheet is prepared for each billing unit and one copy delivered to the Collections Section and the other to file. A typical bill is shown in Figure 3-6. The staffing of the Customer Billing Section is as follows:

Private Accounts Staff and Equipment	
Billing Machine and Calculator Operator	6
Clerks	4
Subtotal	10
Supervisor	1
Total	11
Public Accounts Staff and Equipment	
Billing Machine and Calculator Operator	1
Clerks	3
Subtotal	4
Supervisor	1
Total	5

The Public Accounts Billing Machine operator assists the Private Accounts Group regularly. The electric accounting machines are very simple, 10-year

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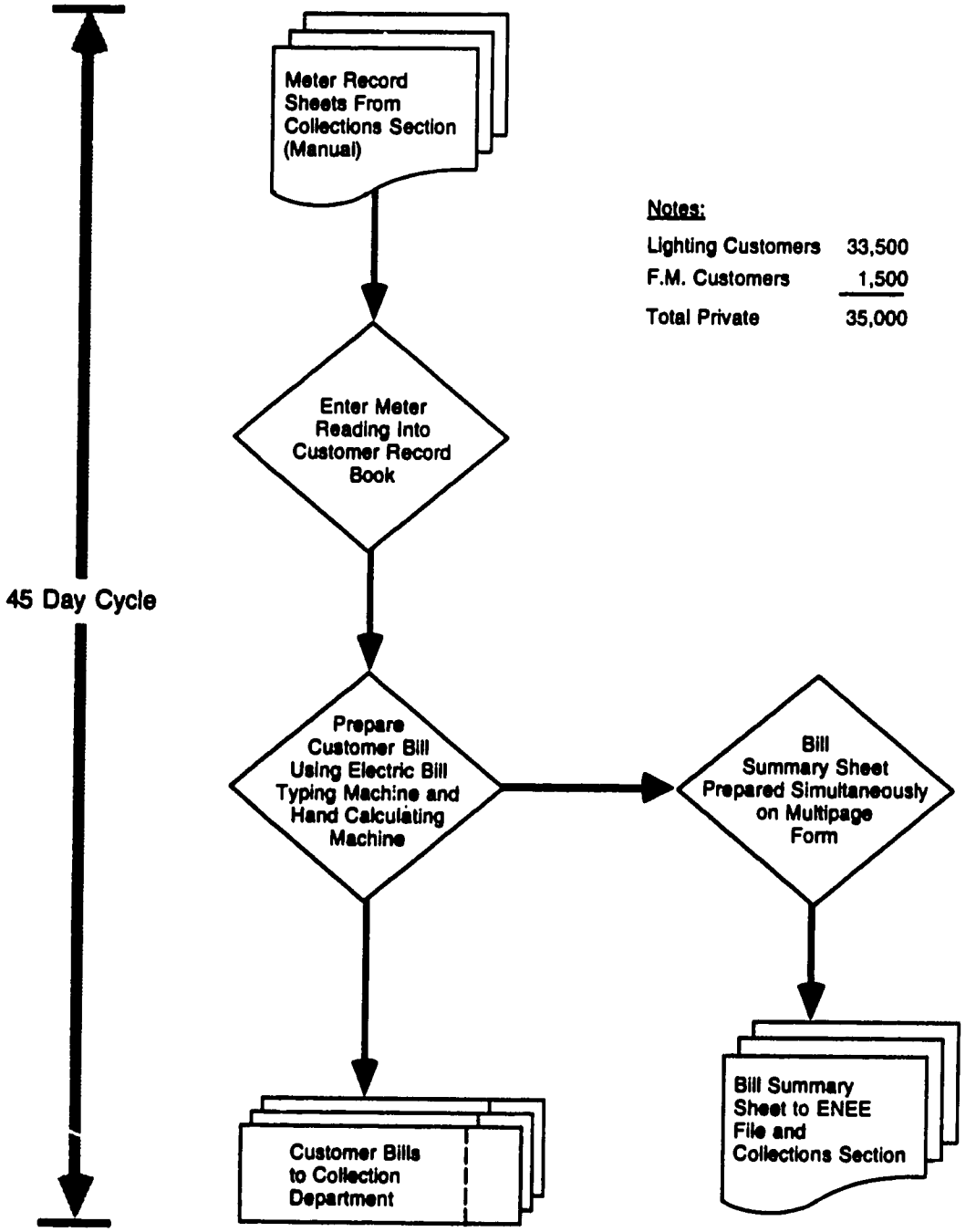

Note: Bill preparation similar for public accounts.
4,000 public meters billed quarterly.

Figure 3-5 Customer Bill Preparation Procedure Private Accounts

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Account No. Meter No.

UT LUCE N°. 31768 1585

Jaalle

CALI AXMED NUUR (Name)

MUQ. (Mogadishu)

W. X. K. U.
WAKAALADDA XOOGGA KORONTADA UMMADDA
MUQDISHO

- OTT. 1985

BOLLO IN ABBONAMENTO
Aut. Min. Prot.
N. 4188 del 28 / 10 / 72

La presente Bolletta si riferisce al consumo di ILLUMINAZIONE del mese di

Lettura attuale final Kwh.	Lettura precedente Initial Kwh.	Consumo Kwh.	Importo Shs. So.	Nolo Cont.	Addizionale Comunale	Servizio	Bollo	Importo da Shs. So.	N. utente
273	252	21	89.25	30.00	2.10	4.00	4.00	129.35	31768

Data 30 DIC. 1985 *

Mora per ritardo pagam.
Totale Sh. So.

La presente bolletta deve essere conservata per esibirla, su richiesta, ai Funzionari dell'WXKU.

4.25 SoSh/Kwhr. Average Cost.

PER QUIETANZA
(con riserva di esigere qualsiasi arretrato)

43,86 AA

(data) (firma)

*Billed 60 days after end of month.

PAID March 4, 1986

Figure 3-6. Typical ENEE Customer Bill

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old, Olivetti machines. The machines only add, and are programmed to insert fixed Somali Shilling costs and total the bill. The machines print both bill and bill summary sheet on multi-page form. The Billing Group does not work overtime to maintain schedule.

Both Public and Private customers are considerably in arrears. The Income Statement for 1984 shows Accounts Receivable (Unpaid Bills) equal to an entire year's revenue, 290 million SoSh. There is no formalized procedure for penalty payments on overdue bills and it is understood that there is a haphazard procedure on cutting power to delinquent customers. The greatest amount of unpaid bills lie in the public sector, government ministries and embassies.

The condition of the customer records file is very poor with the manuscript entries, being many times illegible. The housekeeping in the bill computation section is very poor and conducive to losing records and bills. The bill preparation machines are archaic and a study of electric accounting machines (EAM) versus microcomputer (PCs) and printer needs to be made. Simple improvements in work flow and procedures should lead to a considerable reduction in bill preparation cycle time. With such improvements and extensive automation, it should be possible to forshorten the bill preparation cycle from 45 to 15 days. This is equivalent to reducing accounts receivable by 24 million SoSh which should result in an interest savings of 2.4 million SoSh annually.

The bill delivery and collection cycle is shown in Figure 3-7. Bill delivery is made by the meter reader who also attempts to collect the bill when presented. Since Somalia has no postal service directly to homes, it is necessary that bills be hand-delivered by ENEE personnel. From the day the meter reader receives the bill, a 10-day grace period is allowed for payment. However, payment is seldom made within the 10-day period, since the customer may not be on the premise to receive the bill, or, although on the premise, does not have cash for payment. This will invariably lead to a 15 to 30 day delay in bill payment. The customer must go to the local ENEE office to make payment if he does not pay the bill collector directly. There is no fixed policy or practice on disconnect for delinquent bills. When finally

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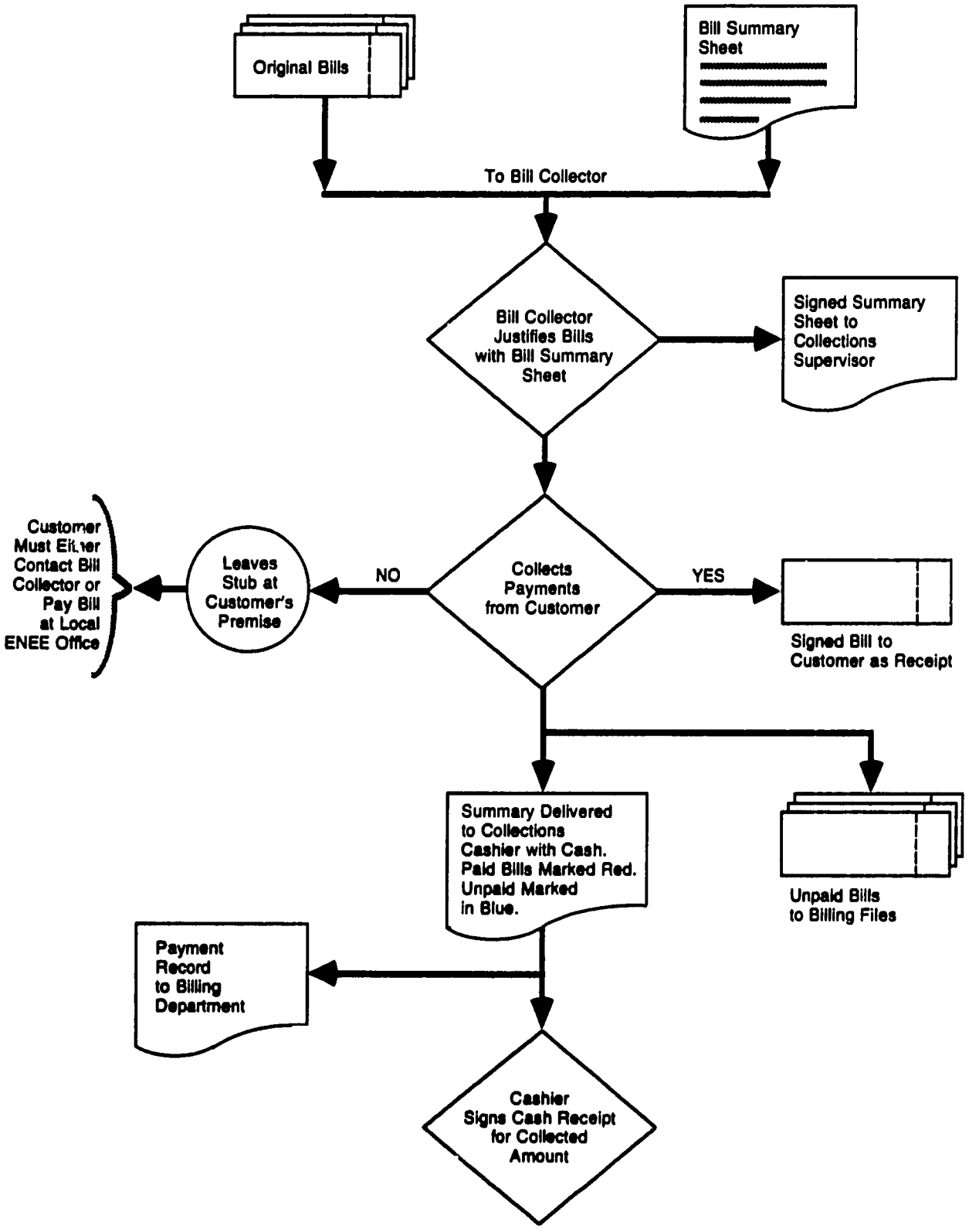

Figure 3-7 Bill Delivery and Collection Cycle

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disconnected the customer is required to pay a 200 SoSh connection charge. At times, private customers may have as much as six month's billing outstanding before a payment is made.

Under the present system, meter readers are required to carry meter reading sheets, bills and large amounts of cash. Each meter reader returns daily to the ENEE headquarters office in the center city with his cash and either deposits in a personal safe or delivers it to the Collections Cashier who receipts it to the meter reader who keeps his receipts. A separate payment record is prepared by the Cashier who delivers it to the Customer Record Group of the Billing Section.

At the same time the bills in each billing unit are delivered to the meter reader/bill collectors, copies of the bills and bill summary sheets are delivered to local ENEE offices to accommodate bill payments at the local offices (see Figure 3-8). Each day each office delivers cash received to the Collections Cashier at ENEE headquarters together with a bill payment record. Cash receipts are made to the local office. Bill summary sheets and unpaid bills are retained until the next billing unit printing is received.

Since the meter reader is required to both read and record meter readings and deliver and collect the bills, he is seriously overloaded. He has seven days in which to collect bills. There are approximately 30 Bill Collectors for Private Accounts and 10 Bill Collectors for Public Accounts with each Private Customer Bill Collector having 6 zones and 200 meters per zone (1,200 meters read per month). Each Public Sector Bill Collector handles about 400 accounts per month.

It appears that both the Private and Public Billing requires a 75 to 90 day meter reading - billing and collection cycle:

Meter reading	Every 30 days
Up-date customer record, bill preparation, and bill delivery	45 days
Payment grace period	10 days
Total cycle	85 days

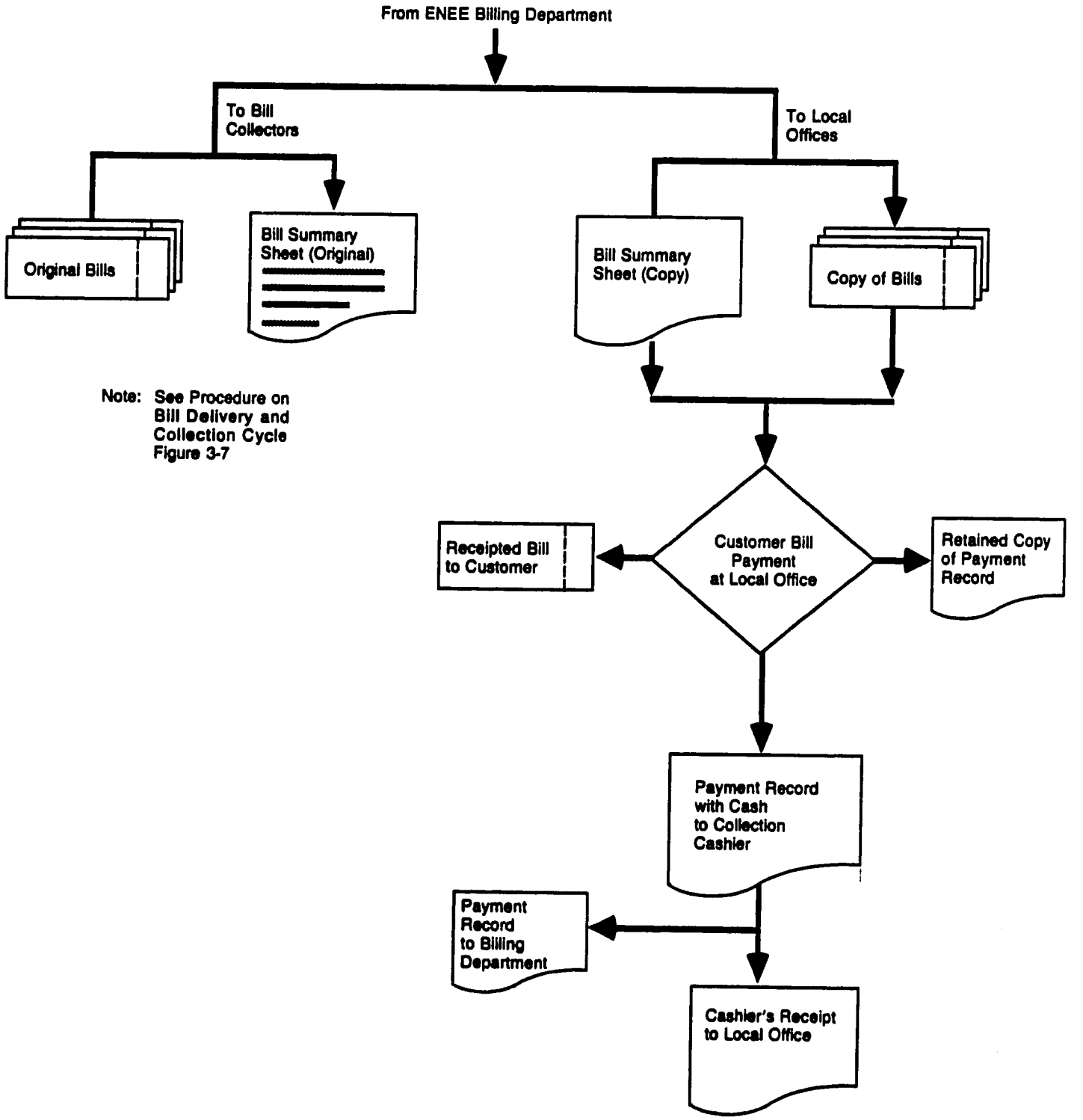

Figure 3-8 Distribution of Bills and Bill Summary Sheets

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The bill collection cycle can be significantly forshortened by separating the meter reading and bill collection functions. This means doubling the staff, but significant improvement in bill collection would result, greatly improving the accounts receivable picture. Interest savings made possible by reduced accounts receivable would cover a considerable portion of the increased labor cost. The bill collector would both deliver and collect bills. As a further step in the bill collection cycle the bill collector (deliverer) would only deliver the bill and the customer would pay his bill at the local office. The bill collector could also be given the responsibility of disconnecting a delinquent customer after proper notification. This would greatly improve prompt payment of bills.

A serious condition exists in the non-payment of electric bills by large government institutions. No amount of improvement in the billing cycle will correct this situation. Rather a new policy for disconnecting service must be defined and implemented without respect to whom the delinquent customer is. A directive, prepared by the Director General of ENEE, should be sent by the Minister of Finance to every public institution requiring that they include electric power expense in their annual budgets and create a monthly cash disbursement schedule for the payment of ENEE electric bills.

3.5.2 Plant Accounting and Property Records

Although the USAID Mission/Somalia had not specifically requested that the ENEE plant accounting and property records be examined, it became obvious in the course of the review of the procurement accounting procedures and the customer accounting system that both of these systems should be audited carefully.

The plant accounting records and processing system are of a very simple form. The plant account system itself consists of only 50 account numbers covering both plant type and plant location. The units of plant are rather large for modern utility plant accounting practice. For example, the turbine-generator at the Gezira Power Station is shown as one plant unit rather than a more detailed listing of units such as turbine rotor, turbine casing, generator field, generator stator, exciter and turning gear. The concept of component pieces of large equipment being considered as replacement units and booked as

such in a plant account was completely foreign to ENEE accounting personnel. As a result it is suspected that major part replacements, such as circulating water pump shaft and impeller, or diesel engine cam shaft gear boxes, were expensed in the year of their failure rather than written off against the plant account with the replacements at current cost added to plant account. This concept was discussed with ENEE plant account personnel suggesting they begin immediately to include smaller units of plant in their accounting.

The plant accounting system appeared to lack discipline. Information in the form of paid invoices for equipment and parts did not provide indication as to whether the invoices should be expensed or booked against the plant account. It also appeared that updating of the plant account record was not a regular procedure, either additions or deletions. A plant accounting instruction manual must be prepared in order to insure a proper registration of investment in active plant. This is very important to the computation of proper capital recovery requirements in the tariff structure. The U.S.A. Uniform System of Accounts for Electric Utilities could serve as a helpful plant account guideline.

There is no property record by location in the ENEE plant record system. In fact, a property record was a new concept to ENEE accounting personnel. Considerable time was spent describing the format and content of such a record using the 21st October substation as an example. The descriptive detail that was required for transformers, circuit breakers, condensers, lightning arrestors, station busing, relays, control panels, cable, etc., was outlined. The procedures required for a major, systemwide property inventory exercise were also described. It was emphasized that, until there was an accurate property record systemwide, it would not be possible to maintain an accurate and up-to-date plant account which is needed for proper plant investment records. It was suggested that a property inventory be undertaken as soon as possible.

3.5.3 Income Statements and Balance Sheets

The Income Statements and Balance Sheets for 1983 and 1984 were analyzed. The Income Statements itemized the income categories and expense categories in reasonable detail. However, the ENEE system of operating accounts should be

expanded to provide better detail in expense recording and backup for Income Statement preparation. The method by which the Income Statements were prepared from the expense accounts was not clearly described and the impression conveyed was that the preparation process seems to lack fiscal rigor. A comparison of annual revenue shown in the Income Statement with accounts receivable entry for unpaid customer bills in the Balance Sheet indicates that accounts receivable are equivalent one year's revenue. This is an entirely unsatisfactory condition. Even for a developing country utility, accounts receivable for unpaid bills should not exceed 90 days' revenue.

The Income Statement is not adequately foot-noted to explain exceptions which have occurred in the year of reporting. A case in point was the doubling in depreciation expense from 1983 to 1984 without explanation. Similarly, the General Expenses doubled and no explanation was given. A reformating of the Income Statement is required to correspond to the definition and arrangement of income and expense items used regularly by international banking and and auditing institutions. Typical footnoting and reference formats should be employed. An instruction manual on Income Statement preparation and submission frequency should be prepared.

Inquiries made, during discussion of the Income Statements and Balance Sheets, and also while discussing the organization of the Finance and Administration Department, did not indicate that an internal auditing section existed within ENEE. However, in a later discussion it was discovered that the Somali Auditor General's Office does perform audits, although not with annual frequency nor with in-depth examination of ENEE's books of account. A separate auditing function should be created with ENEE and its manager should report directly to the Director General.

An attempt was made to review the procedures by which the annual depreciation expense was determined. A summary statement for 1984 was obtained which used three categories of depreciable plant (1) equipment (2) major machinery and (3) buildings. The categories were again divided into a total of twenty-three (23) subcategories. The subcategories, themselves, however were much too broad for a realistic computation of depreciation expenses. Furthermore, the depreciation rates were much too general and there was no evidence that the

rates included any normal distribution of early retirements in each category. Nor was there an indication of net salvage value for the equipment and major machinery categories. Considerable work needs to be done by the plant accounting section in cooperation with the general accounting section in the setting up of a modern depreciation accounting system based on appropriate units of plant, plant life with dispersion of retirements and reasonable net salvage value for equipment.

ENEE does not prepare an annual financial report for the Minister of Public Works or Finance, nor was it possible to determine whether an annual report was prepared for lending or donor institutions. Steps should be taken immediately to prepare an annual report for 1985 operation using a format similar to that used by U.S. Utilities in reports to their stockholders and bondholders.

3.5.4 Financial Management Procedures

From a review of the activities of the Finance and Administrative Department, it was ascertained that there were no documented systems and procedures for forecasting financial requirements for capital, nor were there systems and techniques for forecasting cash-flow requirements and implementing a comprehensive financial planning program. No statements of financial policies were documented. Inquiries were made in an effort to determine if forecasts of plant and equipment requirements were available as well as work plans and budgets. None were found. Balance sheets, operating statements, sources and applications of funds statements are not used as management tools. Techniques for analyzing financial and operating statements and using cash and accrual concepts are unknown to ENEE management personnel.

In particular there was no organized, integrated system for capital planning which employed load and energy forecasting techniques, a master plan for electrical system expansion, a capital expenditure prediction and a current year system construction cost budget.

Within the Finance and Administrative Department there exists no controller's function, planning function or internal auditor's function. The Department consists only of general accounting, customer accounting and bill collection

functions. It also appears that no attempt has been made to implement these missing functions.

3.6 ORGANIZATION REVIEW AND ANALYSIS

3.6.1 Organization Audit

The ENEE organization was audited by means of interviews with the Director General and the Department Managers. There was no current organization chart so it was necessary to develop a chart in the course of the interviews. The chart which was developed is given in Figure 3-9. There are seven (7) functional departments reporting to the Director General, requiring a broad and ineffective span of control. During the six weeks at ENEE it became obvious that the Director General was confronted with too many daily operating problems and was too accessible to customers, both large and small.

Currently, there does not exist a document which defines the ENEE corporate objectives, department functions, general orders and routine operating instructions. The Manager of Personnel stated that the Director General had called for departmental function statements from his department heads in mid-year 1985, but none of the statements of function had been prepared to date.

By means of interviews with each of the department managers, it was possible to identify the sections within each department and to understand section functions. Efforts were also made to interview section supervisors, but this was only effective for the sections in the Technical Department, Planning and Projects Department and Finance and Administration Department.

A complete organization audit of ENEE was made by Russell, Ewbank and Partners in July of 1975. Recommendations were made for reorganization, departmental functions were defined and position descriptions written for all positions in the new organization. Recommendations were also made for personnel to fill the departmental managers positions. It was not possible to determine, through interrogation of the ENEE managers, as to how many of the Ewbank recommendations were implemented. However, by means of the audit of the

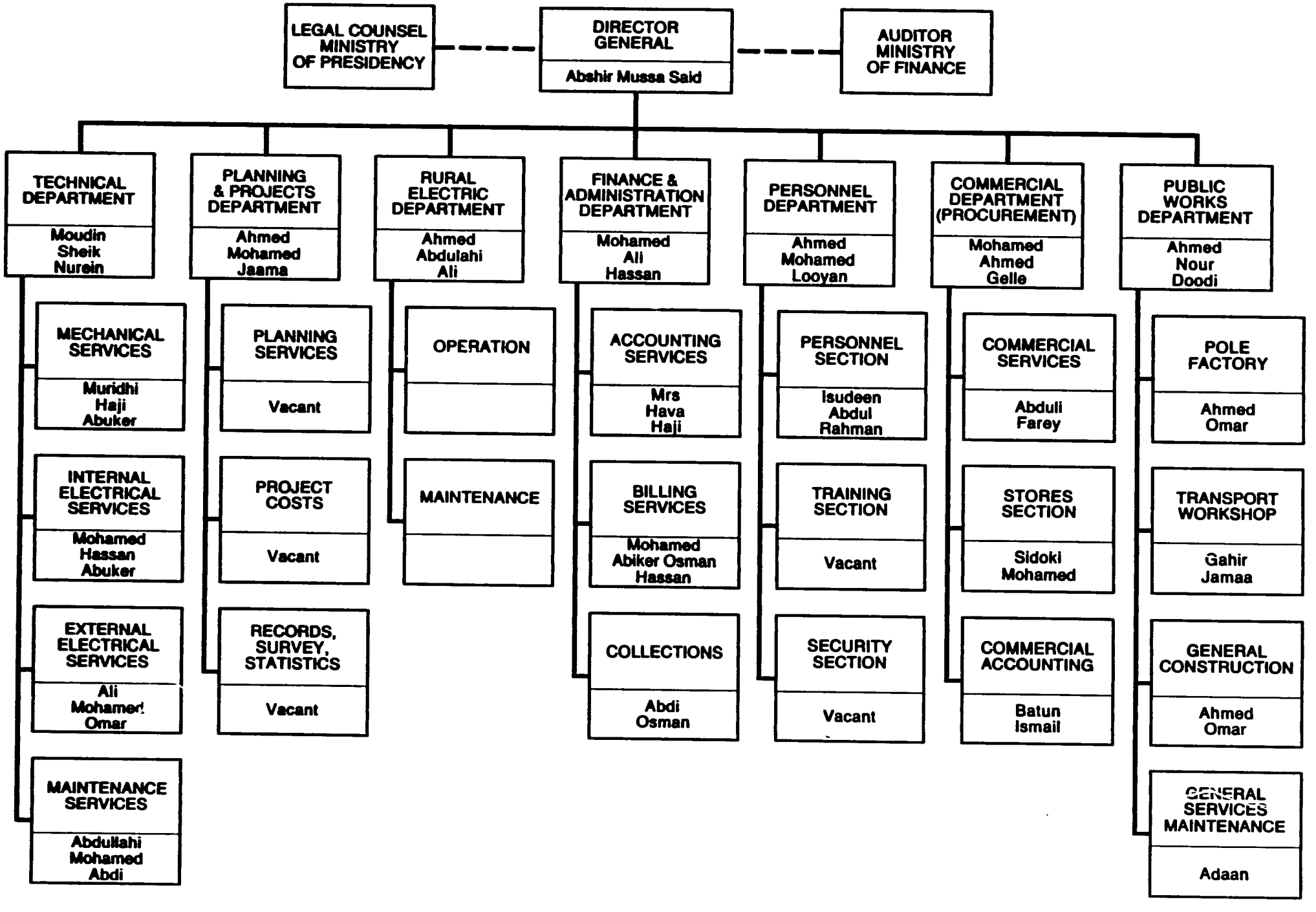

Figure 3-9 ENEE Organization

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existing organization, it was determined that little was done with the recommendations other than to implement the placement of some of the recommended managers.

The Director General referred the Bechtel team chairman to the Manager of Finance and Administration for assistance in the audit and for background in the evolution of the organization. The manager was helpful, but it became evident that no one in ENEE was completely familiar with the Ewbank audit or with any organized attempt to implement its recommendations. Because of the great pressures that are placed upon ENEE managers by day-to-day management problems, very little time is available for organization planning and operating efficiency improvement. As a result, senior management has little understanding of the current performance of either ENEE management personnel or the effectiveness of departments and sections in meeting the poorly-defined objectives of the organization.

3.6.2 Organization Analysis

3.6.2.1 Technical Department. Discussions were held with the Manager of the Technical Services Department during which the department was defined as consisting of five sections: Mechanical Services, Internal Electrical Services, External Electrical Services and Maintenance Services (see Figure 3-9). In effect this department encompasses the operation and maintenance of generating plants, transmission and distribution systems. The total manpower complement is 155 persons, including 17 engineers and technicians. Although the new Gezira Power Station superintendent presently reports to the Manager of the Planning and Projects Department, the intention is to shift the reporting responsibility to the Technical Department Manager once the new steam section of the plant is operating routinely. In time, the department organization should be changed to four sections; namely generation operations, generation maintenance, transmission and distribution systems operations and transmission and distribution systems maintenance. Both the generation plant and the transmission and distribution system construction functions should be transferred to the Planning and Projects Department. The current External Electrical Service Section (including substation operations, transmission line crews, and primary and secondary distribution system line

crews) is understaffed with respect to current maintenance work, 3 kV to 15 kV conversion work and new lines construction. This condition will be discussed further under Section 3.7, Manpower and Training.

As stated earlier, in Subsection 3.2.4, a Distribution Planning Section should be established in this department. There are no up-to-date system single-line diagrams, distribution maps are out of date and equipment performance and maintenance records are mostly nonexistent. The actual planning of transmission and distribution expansion comes from consultant reports which are soon out-dated.

3.6.2.2 Planning and Projects Department. This department consists of three sections; Planning Services, Project Costs and Records, and Survey and Statistics. At present, none of these sections has an appointed supervisor and the department manager is managing all three sections. The department has also assumed the management of the Gezira plant operating and maintenance functions since the initiation of the new steam plant in April 1985. The department is listed as having 192 employees, of which 11 are engineers and 59 are technicians. The large number of technicians and the size of the department is due to the inclusion of the Gezira Power Plant staff in the department roster. The actual functions of planning, project management, project costs and records are grossly understaffed. In fact, the efforts of the department are directed almost solely to the Gezira plant operation with any planning and costing being done through consulting services.

The function of power system planning as described in Section 3.3 requires a Power System Planning Section dedicated to demand forecasting, generation and transmission system planning, capital expenditure prediction preparation and capital budget preparation. Some of this work is being done in the current Planning Services Section, but not in the depth and scope required for effective system planning.

3.6.2.3 Finance and Administration Department. The Finance and Administration Department is comprised of three sections, Accounting Services, Billing Services and Bill Collections. Total employment in this department is 137 persons consisting primarily of accounting clerks. The Accounting

Services Section performs the general accounting and plant accounting services. Annual Income Statements, Balance Sheets, Depreciation Reserve Records are prepared by this section under the direction of the department manager. Work with the supervisor and her assistant in this section disclosed rather limited accounting practices and procedures, particularly in accounts supporting income statements, balance sheets and depreciation expense preparation. There appeared to be no division of the Accounting Services Section into subsections whose responsibilities were distinctly general accounting, plant accounting, depreciation accounting, and accounting reports and records. There were no functional definitions available in writing.

The Billing Services Section functions include customer accounting as well as bill preparation and has been described elsewhere in Subsection 3.5. The Billing Services section is greatly understaffed leading to significant delays in bill preparation. A procedures analysis needs to be made to simplify the work procedures and clarify organization within the section. The division of the section into private billing and public institution billing is an appropriate one and the supervision is effective.

The Bill Collection Section is responsible for customer meter reading and bill collection, private and public. As discussed previously in Section 3.5, meter reading and bill collection should be undertaken by separate staff in order to reduce the total billing and collections cycle time. This will require the reorganization of the Bill Collections Section into two subsections, Meter Reading and Collections, respectively.

3.6.2.4 Commercial Department. The Commercial Department consists of three sections, Commercial Services, Commercial Accounting and Stores. The functions of these three sections have been described in some detail in Section 3.5. The department staff consists of 19 persons, and in terms of the workload is understaffed. Although the department manager is well informed concerning functioning of the three sections, a description of each section's functions and operating responsibilities was not available. Organizational interfacing between the Commercial Accounting Section and the Accounting Services Section of the Finance and Administration Department needs to be more

thoroughly defined. Also, more effective liaison between the Commercial Accounting Section and the Project Costs Section of the Planning and Projects Department is required in order to update regularly project cost records and budgets.

3.6.2.5 Personnel Department. The Personnel Department consists of three sections, Personnel Services, Training and Security. This department consists of 38 persons, 28 of whom are guards. Presently, the Training Section and the Security Section are without supervision. Furthermore, the Training Section is not currently functioning and any training in ENEE is performed as unscheduled on-the-job training in the power plants and electrical system. There is no planned or classroom training being offered to engineers, accountants, and technicians. Eight months ago, the Director General requested that each department manager prepare a description of his departmental functions and a position description for both his position and for those managers immediately reporting to him. This effort was to be implemented by the Personnel Section. To date, this has not been achieved, primarily as a result of a lack of staff trained in the techniques for preparing functional descriptions and position descriptions. Furthermore, the Personnel Department in conjunction with the Finance and Administration Department has not prepared a statement of ENEE objectives, policies, general orders and routine instructions. There were no manuals evident, containing this information. There is no personnel and organization planning function within the department. Also, in discussion with the department manager, it was determined that, although he was familiar with employee performance evaluation systems, no formal program of employee evaluation is currently used. The manager was aware of the recommendations made in the area of performance evaluation by Russell and Ewbank (July 1975), but he stated that no effort had been undertaken to implement the recommendations.

3.6.2.6 Public Works Department. This department consists of four sections, Workshops and Transport, General Construction, General Services Maintenance and the Utility Pole Manufacturing Plant. The department consists of 91 persons, 54 of whom are skilled tradesmen. Each section is capably supervised but somewhat understaffed. However, better liaison needs to be developed

between the General Construction Section and the Internal and External Electrical Services Sections of the Technical Department. Also, in time, the Pole Manufacturing Section should be transferred to the External Electrical Services Section, Technical Service Department.

3.6.2.7 Regional and District Department. It was difficult to ascertain the nature of the organization of the Regional and Districts Department. It appears that there are operations, construction and administration sections, although these were not clearly defined. This department serves as liaison between the regional and district operating companies and ENEE using each of the other six ENEE departments as required. In a reorganization of ENEE, careful consideration should be given to the organization of this department, its reporting relationships to the Director General, and liaison with the other departments in ENEE.

3.7 MANPOWER AND TRAINING

3.7.1 Manpower

As described in Section 3.6, ENEE is organized into seven departments. The total employment, including the regions and districts was 882 persons as of March 1986. The allocation of manpower by department and by job title is given in Table 3-11 Personnel shown under the Regional and District Department are distributed throughout Somalia in its major towns. In discussion with the Manager of Personnel, it was determined that there are no manpower forecasts for future system expansion. It was also determined that there was no management plan for the evaluation and promotion of qualified personnel.

A limited manpower needs assessment was undertaken for the Technical Department, the Projects and Planning Department, the Finance and Administration Department and the Personnel Department. The employment in these departments represents 83 percent of the employees in ENEE in Mogadishu. Taking into account the possible 60 percent growth of the Mogadishu electrical system in the next five years and the need to provide for additional functions in some departments, the projected manpower requirements

Table 3-11

ENEE EMPLOYMENT SUMMARY

Department	Engineers	Accountants	Skilled Technicians	Clerks	Tradesmen	Drivers	Guards	Service Persons	Total
Finance & Administration		1		136					137
Personnel				6			25	7	38
Regions and Districts			9	67	151	4	14	2	250
Commercial		2		8	8			1	19
Technical	5	1	12		137				155
Projects & Planning	11		59	5	74	18	15	9	192
Public Works	—	—	2	6	54	18	5	6	91
	20	4	83	228	426	40	59	25	882

(3153H)

by the year 1991 are shown in Table 3-12. The projected total increase in staff is 240, or a 27 percent increase in the five-year period. An additional 45 engineers and skilled technicians will be required. Tradesmen will increase by 117 persons or 27 percent. This significant increase in staff will require a major recruiting program followed by an extensive training program throughout the corporation.

3.7.2 Manpower Training

3.7.2.1 Training Program for Generation Personnel. With exception of a short term training program initiated and implemented during the construction, start-up and commissioning of the Gezira steam plant, and subsequent on-the-job training (OJT), no other formal training program has been used by ENEE for the training of its plant managers, supervisors and operators. There is still a shortage of skilled and competent staff in the present plant operating force. No formal apprenticeship programs are operative and only a few operator-trainees are receiving OJT at the Centrale Station. It was noted that turnover rates among skilled and semi-skilled technicians were high. Proper on-the-job and class room training, if provided, would make the work more challenging, reducing the turnover rate.

During several discussions with middle management and plant supervisory personnel, a keen interest for further improvement of plant operational knowledge and up-to-date power plant operation was expressed. The present plant managers are almost fully occupied with resolving day-to-day problems and were not able to spend time in planning and manpower development.

Since ENEE is now entering an era of more complicated power generation systems, requiring high skill, precision workmanship, proper planning, and quick and effective decision making, it is essential and critical that training programs be immediately implemented for management, supervisors and technicians.

3.7.2.2 Training Program for Transmission and Distribution Personnel. Extensive training is required in the transmission and distribution operations, maintenance and construction functions. Currently, there is no

Table 3-12

EHEE PROJECTED MANPOWER REQUIREMENTS
1986-1991

Department	Engineers		Accountants		Service Technicians		Clerks		Tradesmens		Drivers		Guards		Service Persons		Total	
	1986	1991	1986	1991	1986	1991	1986	1991	1986	1991	1986	1991	1986	1991	1986	1991	1986	1991
Finance & Administration		2	1	4			136	150									137	156
Personnel		2		2			6	8					25	25	7	8	38	45
Regional & Districts	3	6		4	9	15	67	80	151	190	4	4	14	20	2	10	250	329
Commercial			2	3		8	12	8	12						1	1	19	28
Technical	5	8	1	3	12	24			137	177							155	212
Projects & Planning	12	15		2	59	69	5	10	74	94	18	18	15	15	9	10	192	233
Public Works	—	2	—	2	2	4	6	10	54	70	18	18	5	5	6	6	91	117
	20	35	4	28	83	112	228	270	426	543	40	40	59	65	25	35	882	1120

(3155M)

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formal class training nor an organized apprentice program. ENEE is suffering from a lack of trained substation operators, electrical technicians, linemen and craftsmen.

3.7.2.3 Training Program for Accountants and Administrators. As is the case in the ENEE operating departments, no formalized training is being offered in the finance and administration, personnel and commercial departments. In addition, there appear to be no published instruction manuals for ENEE accounting, personnel and procurement procedures and systems. Training in these areas is most critical in the light of the expected growth of the ENEE organization and the requirements of the international financial community that ENEE is improve its fiscal policies and financial management systems.

Section 4

DETAILED RECOMMENDATIONS

In this section detailed recommendations are presented which, through physical rehabilitation of power system plant, modification of accounting and billing systems, restructuring of organization and initiation of manpower training programs will:

- Improve the availability and reliability of the generation, transmission and distribution systems
- Increase revenue and reduce the customer billing cycle time
- Provide an accurate record of both property and investment providing an accurate base for tariff formulation
- Strengthen both organizational and financial management functions
- Provide adequately trained manpower to support an expanding business with increasingly complex operating systems and procedures.

4.1 GENERATION SYSTEM

The following actions are recommended to improve the Centrale and Gezira Station operating availability and reliability.

4.1.1 Plant Operations

- Rehabilitate diesel engines Nos. 6 and 7 at the Centrale Station and provide mechanical and electrical spare parts for a 2 year operating period for engines Nos. 5 through 8, including spares for lubricating oil centrifuges.
- Provide mechanical and electrical spare parts for a 2 years operating period for engines Nos. 1 and 4 in the Centrale Station.
- Rehabilitate existing machine shop at the Centrale Station and provide machine tools, hand tools, materials, etc. to manufacture diesel engine spares for the Centrale and Gezira Stations.

- Rehabilitate diesel engines Nos. 2 and 3 at the Gezira Station and provide mechanical and electrical spare parts for 2 year operating period of engines Nos. 1 through 5 including spares for fuel oil and lube oil centrifuges.

- Rehabilitate existing machine shop at the Gezira Station and provide tools and materials to manufacture diesel engine spares.

- Provide plant and laboratory chemicals for a 2 year operating period at the Gezira steam plant.

- Provide services of an expatriate instrumentation engineer to train ENEE engineers and technicians for the existing and future steam plants.

The above recommendations are summarized on Tables 4-1 and 4-2. The detailed list of parts, equipment, chemicals, etc. required for the rehabilitation and two years operation for Centrale and Gezira Stations are shown on the following tables in Appendix A:

- Consumable chemicals required for 2 years operation at Gezira steam plant - Table A-1.

- Consumable chemicals and equipment required for chemical laboratory at Gezira - Table A-2.

- Parts for rehabilitation and spares for 2 years operation of Gezira heavy fuel oil separators - Table A-3.

- Electrical parts required for Gezira engine rehabilitation - Table A-4.

- Mechanical parts required for rehabilitation of Gezira diesel units - Table A-5.

- Additional spare equipment requirement for 2 years Gezira Diesel plant operation - Table A-6.

- Handling equipment, tools and miscellaneous equipment for Gezira - Table A-7.

- Spare parts list for Gezira lube oil separators - Table A-8.

- Electrical spare parts for 2 years operation at Gezira diesel engines - Table A-9.

- Handling equipment and tools for Centrale - Table A-10.

- Electrical spares for 2 years operation at Centrale - Table A-11.

(3157H)

SUMMARY OF CENTRALE DIESEL REHABILITATION AND SPARE PARTS REQUIREMENTS

Unit No./ Equipment	Rehabilitation Work			Spare Parts for 2 Years Operation		
	Description	Estimated Cost $	Source or Supply	Description	Estimated Cost $	Source or Supply
#1 Diesel	Engine operating. No rehabilitation work required.	0	N/A	See Table A-14.	$100,000	Manufacturer, Italy
#2 Diesel	Engine not operating. However, considering the age of the engine and operating costs no rehabilitation work is recommended.	0	N/A	This machine will not be operated. Therefore, no spare parts required.	0	N/A
#3	Engine not operating. However, considering the age of the engine and operating costs no rehabilitation work is recommended.	0	N/A	This machine will not be operated. Therefore, no spare parts required.	0	N/A
#4 Diesel	Engine operating. No rehabilitation work required.	0	N/A	See Table A-14.	$100,000	Manufacturer, Italy & Germany
#5 Diesel	Engine operating. However, the switchboard needs changing. List of parts recommended for engine rehabilitation is shown on Table A-12.	$135,000	Manufacturer, Italy & Germany	See Table A-13 for mechanical and Table A-11 for electrical spare parts.	$200,000	Manufacturer, Italy & Germany
#6 Diesel (1)	Engine not operating. Alternator is burnt and switchboard needs replacement. List of parts recommended for engine rehabilitation is shown on Table A-12.	$490,000	Manufacturer, Italy & Germany	See Table A-13 for mechanical and Table A-11 for electrical spare parts.	$200,000	Manufacturer, Italy & Germany
#7 Diesel (1)	Engine not operating. Needs new alternator. List of parts recommended for engine rehabilitation. is shown on Table A-12.	$375,000	Manufacturer, Italy & Germany	See Table A-13 for mechanical and Table A-11 for electrical spare parts.	$200,000	Manufacturer, Italy & Germany
#8 Diesel	Engine operating. No rehabilitation work required.	0	N/A	See Table A-13 for mechanical and Table A-11 for electrical spare parts.	$200,000	Manufacturer, Italy & Germany
Machine Shop & miscellaneous	Machines in existing machine shop are very old. Needs new machines, tools, portable tools for rehabilitation. See Sheet No. 22 for rehabilitation of machine shop.	$250,000	U.S.	None required	0	N/A

Notes:
(1) Will require services of alternator manufacturer's service representative during installaton and testing.

(3174H)

Table 4-2

SUMMARY OF GEZIRA DIESEL AND STEAM TURBINE REHABILITATION AND SPARE PARTS REQUIREMENTS

Unit No./ Equipment	Rehabilitation Work			Spare Parts for 2 Years Operation		
	Description	Estimated Cost $	Source or Supply	Description	Estimated Cost $	Source or Supply
#1 Diesel	Engine will operate from 4-1-86. No No rehabilitation work required.	0	N/A	See Table A-5 for mechanical parts and Table A-9 for electrical parts.	$380,000	Manufacturer, U.K.
#2 Diesel (1)	Crank shaft has surface crack which is being repaired. Alternator rotor is O.K. Some of the stator coils are burnt. Some of the mechanical components have been used for other engines. See Table A-5 for mechanical parts and Table A-4 for electrical	$550,000	Manufacturer, U.K.	See Table A-5 for mechanical parts and Table A-9 for electrical parts.	$380,000	Manufacturer, U.K.
#3 Diesel	Large number or mechanical components have been used to overhaul engine #1. Alternator is O.K. However, needs mostly mechanical parts and few electrical miscellaneous items. See Table A-5 for mechanical parts and Table A-4 for electrical parts.	$550,000	Manufacturer, U.K.	See Table A-5 for mechanical parts and Table A-9 for electrical parts.	$380,000	Manufacturer, U.K.
#4 Diesel	Engine operating. No rehabilitation work required.	0	N/A	See Table A-5 for mechanical parts and Table A-9 for electrical parts.	$380,000	Manufacturer, U.K.
#5 Diesel	Engine operating. No rehabilitation work required.	0	N/A	See Table A-5 for mechanical parts and Table A-9 for electrical parts.	$380,000	Manufacturer, U.K.
Heavy fuel oil separator	One of the heavy fuel centrifuge needs rehabilitation. See Table A-3 for mechanical parts.	$50,000	Alfa-Laval separators are manufactured in U.S. Parts may be available from U.S.	See Table A-3 for spare parts.	$50,000	Alfa-Laval separators are manufactured in U.S. Parts may be available from U.S.

Table 4-2 (Continued)

Unit No./ Equipment	Rehabilitat'. Work			Spare Parts for 2 Years Operation		
	Description	Estimated Cost $	Source or Supply	Description	Estimated Cost $	Source or Supply
Lube oil centrifuge	All five lube oil centrifuges are working. No rehabilitation work required.	0	N/A	See Table A-8 for spare parts.	$30,000	Alfa-Laval separators are manufactured in U.S. Parts may be available from U.S.
Auxiliary equipment	None required.	0	N/A	Additional spare pumps and air compressor required for diesel engine fuel system. See Table A-7.	$400,000	Manufacturer, U.K.
Machine shop and miscellaneous tools	Existing machine shop and diesel plant requires tools, hand tools, etc. For rehabilitation, see Table A-7 for detail requirements.	$60,000	U.S. and Italy (for forklift battery only)	None required	0	N/A
Steam turbine	Steam turbine plant requires no rehabilitation, except the service of an expert instrumentation engineer for 2 years to train steam plant engineer and technicans.	$270,000	U.S.	Spares for 2 years plant operation will be provided by BBC. However, it needs chemicals for plant operation and laboratory. See Tables A-1 and A-2.	$650,000	U.S.

- Electrical parts required for Centrale rehabilitation - Table A-12.

- Mechanical parts required for Centrale diesel engine operation - Tables A-13 and A-14.

Since the diesel engine and generator manufacturers are from the United Kingdom, Germany, and Italy, components for the rehabilitation and spare parts may not be available from U.S. or other approved countries under USAID program. A waiver of "U.S. Source" policy may be necessary to obtain the equipment and parts.

4.1.2 Manpower

4.1.2.1 Gezira Steam Plant. Based on the field survey and review with ENEE Management, it is apparent that there are four categories of plant maintenance and operation personnel which require immediate staffing:

- Instrumentation engineer
- Results engineer
- Shift operators in charge
- Trainees (for future shift operation and maintenance)

Manpower in these categories will also support future steam plant expansion. The requirements are as follows:

1 - Shift-charge engineer (at present there are only two shift engineers)

1 - An expatriate instrumentation engineer to train ENEE engineers and technicians for two years

1 - Instrumentation engineer

2 - Instrumentation technicians

1 - Results engineer

6 - Apprentices (from technical schools) - 2 for shift operation, 2 for mechanical maintenance, 2 for electrical maintenance

12 - Total

(3157H)

4.1.2.2 Gezira Diesel Plant. While ENEE has accumulated extensive experience in diesel plant operation, there are three operating areas at the Gezira diesel plant which require improvement:

- Stores operation
- Machine shop operation
- Skilled plant maintenance and operation technicians

Since it will be beneficial to design and manufacture most spare part components in the machine shop, an engineer supervising the machine shop with two machine operator foremen will be required. This machine shop can be coordinated with the Centrale machine shop, and the machine shop engineer, with a drawing office facility to design spare part components, can supervise both machine shops. In summary, the following additional manpower is recommended for the Gezira diesel plant:

2 - Shift operators for fourth shift

2 - Control room shift operators for fourth shift

1 - Machine shop engineer in charge to Centrale and Gezira machine shops

1 - Draftsman for design and drawing of space parts (for Centrale and Gezira machine shops)

2 - Skilled machine shop operators

1 - Storekeeper

1 - Skilled electrical plant maintenance technician

4 - Skilled mechanical plant maintenance technician

6 - Apprentices (from technical school) - 2 for shift operation, 2 for mechanical maintenance, 2 for electrical maintenance(1)

21 Total

Note: (1) Apprenticeship training benefits can be shared by both Gezira and Centrale.

(3157H)

4.1.2.3 Centrale Diesel Plant. The following additional manpower is recommended for the Centrale diesel plant:

2 - Skilled machine shop operators

3 - Skilled plant shift operators for fourth shift

3 - Skilled plant maintenance technicians for third shift

1 - Skilled technician for small motor winding

9 Total

4.2 TRANSMISSION AND DISTRIBUTION

4.2.1 Primary Distribution System (3 kV and 15 kV)

The following recommendations are made to implement the rehabilitation and improve operation of the primary distribution system:

- Replace 35 km of existing 3 kV primary system with 15 kV within Mogadishu
- Apply power factor correction (shunt capacitors) to existing and new 15 kV systems
- Apply lightning arrestors at 15 kV overhead line terminations
- Add heavy duty surge arrestors at the Gezira generator busbar and underground line terminations
- Repair and reactivate the pilot wire differential protection system for Gezira - Centrale - 21 October feeders
- Initiate a program of pole barrier installations at high vehicle traffic location
- Form an ENEE Planning Section
- Reuse 3 kV/380 V distribution transformers in smaller cities, where feasible
- Replace all 3 kV indoor substations in the center city by 15 kV/380 V pole-mounted transformers
- Establish program of insulator washing and silicon greasing

4.2.2 Secondary Distribution System (380/220 V)

In order to improve the operation of the secondary distribution system, it is recommended that the following be undertaken:

- Replace 380/220 V secondary distribution, 120 km, in the center six square-kilometers of the city (this is included as immediate rehabilitation)
- Replace the service drops to customers on the replaced secondary in the center city
- Re-examine conductor sizing for 380 V secondary circuits
- Install power factor correction capacitor on the 380/220 V side of 15 kV/380 V transformers.

4.2.3 Mobile Construction and Maintenance Equipment

To improve line construction schedules and reduce maintenance outage time the mobile construction and maintenance equipment must be increased to the basic requirements listed in Table 4-3. A vehicle maintenance workshop must be established with the equipment shown in Table 4-4.

4.2.4 Pole Manufacturing Plant

In order to increase the production of the plant, the following actions are recommended:

- Rehabilitate bridge crane, concrete mixer, and bar shear
- Provide additional pole moulds
- Provide two-year supply of spare parts for the crane, concrete mixer and bar shear.

4.2.5 Tools and Equipment

The inventory of tools and hand operated equipment must be significantly restored. The following is recommended:

- Safety equipment
- Testing and measuring meter
- Protection test equipment

Table 4-3

ENEE CONSTRUCTION AND MAINTENANCE MOBILE EQUIPMENT REQUIREMENTS

Utility Vehicles

5 - Vehicles, 4WD, P/U body, 1.5 tons, 6-man crew cab, fully equipped
11 - Vehicles, 4WD, P/U body, 1.5 tons, 4-man crew cab, fully equipped
1 - Vehicle, 4WD, Van body, 4-passenger (Cable test vehicle)

Trucks

5 - Utility trucks with Boring machine and crane
2 - Utility trucks with crane, 8 ton

Cranes and Loaders

2 - Mobile cranes, 15 tons, for rough terrain
2 - Forklift trucks, 5 tons, diesel

Miscellaneous Equipment

1 - Cable trencher
3 - Cable reels with tensioners
3 - Line conductor pullers
2 - Pole trailers with tractors
8 - Jeeps

Table 4-4

VEHICLE MAINTENANCE SHOP EQUIPMENT

- Engine Diagnostic Machine
- Valve grinding machine
- Injector testing equipment
- Tire maintenance equipment
- Drill press, lathe, milling machine
- Air compressor, electric
- Welding machine
- 2 sets of engine mechanics tools

4.2.6 Manpower

The line crews must be expanded to efficiently accomplish the 3 kV to 15 kV primary distribution lines conversion, the replacement of 380/220 V secondary and the expansion of the 15 kV primary and 380/220 V secondary distribution systems. This will require an increase of at least 40 lines personnel and an expansion to 18 line crews. The recommended line crew staffing is shown in Table 4-5.

Table 4-5

RECOMMENDED LINE CREW COMPLEMENT

Activity	Crew Type	Manpower
15 kV Expansion	Two @ 12 men	24
380/220 V Expansion	Five @ 4 men	20
3 kV to 15 kV Conversion	Two @ 12 men	24
380/220 V Replacement	Five @ 4 men	20
15 kV Swing Crew	One @ 12 men	12
380/220 V Swing Crew	One @ 4 men	4
Primary/Secondary Maintenance Crew	Two @ 4 men	8
	Total Linemen	112

A suggested organization for the Lines Department is shown in Figure 4-1 as discussed with Mr. Nurideen, Manager of Technical Department. Currently, about 84 people are employed in Lines/Substation work. Future requirements will be two times that number, or 164.

4.2.7 Distribution Planning Section

A Distribution Planning Section should be formed immediately and staffed by sufficient engineering and planning personnel. To accomplish the initial task of establishing this department with adequate inventory records, property maps and equipment record cards in a reasonable time, an outside consultant should be employed.

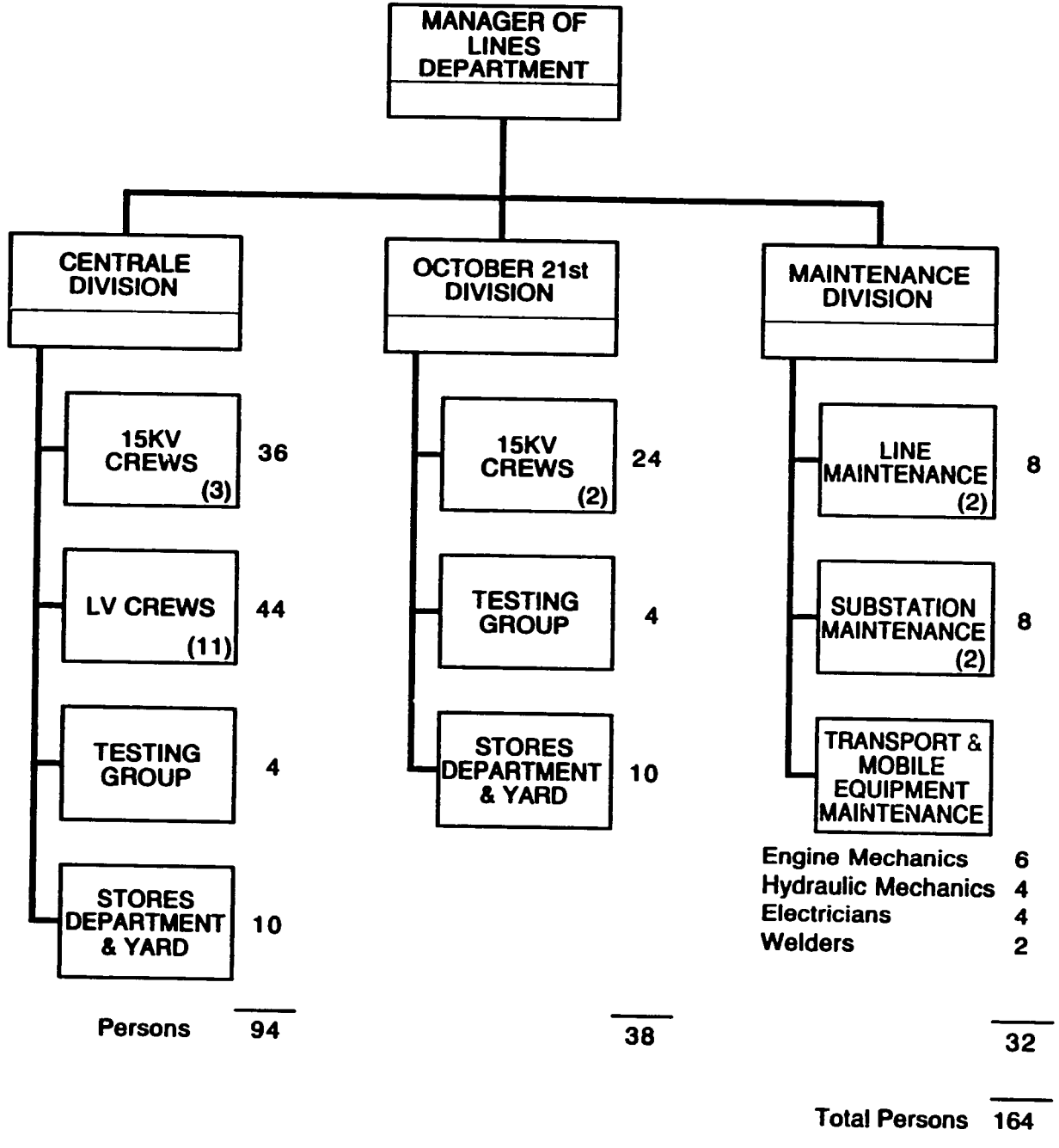

Figure 4-1 Recommended Lines Department Organization

4.3 POWER SYSTEM PLANNING

In light of the nonexistence of a power system planning discipline in ENEE, the following recommendation is made:

- Establish immediately the Planning Services Section in the Planning and Projects Department which will undertake:
  - Demand forecasting
  - System planning
  - Capital expenditure prediction

4.3.1 Demand Forecasting

- Compile historical demand and sales data by customer class
- Prepare market study for large potential utility customers
- Develop both trend forecasting and macroeconomic forecasting methods
- Use the Bechtel team realistic forecast in the near-term (1986-1988)

4.3.2 System Planning

- Develop an expansion plan for the period 1986-1991 using the Bechtel team scenarios
- Formulate expansion plan development procedures, document and prepare forms for the required input information from ENEE operating and financial departments
- Develop a three-year expansion plan modifying the Bechtel team scenario and using input from the operating and financial departments
- Develop an Action Plan for each ENEE Department involved in implementing the three-year expansion plan.

4.3.3 Capital Expenditure Prediction

- Develop a capital expenditure prediction for the period 1986-1991
- Formulate capital expenditure prediction procedures, document and prepare forms for the required input information from ENEE estimating and financial departments

- Prepare capital expenditure prediction for the three-year period using inputs from the estimating and financial departments

- Develop Action Plan for each ENEE Department involved in the implementing and auditing of the three-year capital expenditure prediction.

4.4 PROCUREMENT AND INVENTORY CONTROL

The results of the analysis of the findings related to the ENEE Procurement and Inventory Control provide the basis for the following recommended improvements in the functions of procurement, accounting and stores handling.

4.4.1 Commercial (Procurement) Function

- Simplify purchase requisition approval procedure for foreign purchases and reduce the staffing of the Internal Commission on Purchases to include only the Projects and Planning Department, the Commercial Department, the Technical Department and the Administration Department

- Simplify the procedure for approval of "hard currency" for purchase of foreign equipment by means of a one-time approval of annual hard currency requirements for all forecasted ENEE commodity needs by the Ministry of Finance. Require only 25 percent deposit in local currency equivalent for hard currency at time of approval of letter of credit, the remaining 75 percent to be supplied over some reasonable payment period.

4.4.2 Commercial Accounting Function

- Clearly define the interfaces between the Commercial Accounting Section and the Accounting Services Section of the Administrative Department to ensure proper and timely accounting records and expenditure classification by the Accounting Services Section

- Establish policies and practices whereby commodity purchases are classified either as expenses in a current year or plant replacements to be entered as a capital item in plant account records. Establish "units of plant" which are to be considered as capital when replacing failed equipment.

4.4.3 Stores Function

- Improve storing and orderly yard marshalling of all equipment, spare parts and consumable materials at each warehouse location, particularly the Centrale Station, the Gezira Station and the 21st October Substation and Storage Yard

- Modify and update the stock control system differentiating between planned maintenance stock and unscheduled outage spares. Develop an economic analysis procedure which includes the probability of the forced outage of major part failures, the expense to ENEE resulting from the outage period due to the failure as over against the working capital costs of storing major parts in anticipation of the parts failure.

4.5 ACCOUNTING AND FINANCIAL MANAGEMENT

4.5.1 Customer Billing, Collection and Accounting System

The audit of the customer billing, collections and accounting system suggests that the following procedural changes and equipment applications be used to reduce the billing and collection cycle and to improve the customer accounting system:

- All manuscript meter readings should be transferred to a typewritten record. At the same time, either a punched card or a disk record should be created for each customer bill.

- Bill computation should be completely automated using either a punched card as input to an electric accounting machine system or a disk as input to a PC and printer. A completely printed bill should be the output.

- The time spent in bill preparation should be reduced from 45 days to 15 days by means of workflow improvement, two-shift operation and automation.

- A disconnect policy should be thoroughly defined for delinquent bills and straightforward practices established.

- Government agencies and corporations should be required to budget their energy bills on an annual basis and be prepared to pay billing within the normal grace period.

- The jobs of meter reader and bill collector should be separated to improve work efficiency of both jobs.

- Eventually, customer bill payments should be made at local ENEE offices, eliminating bill collection on customer premises and the handling of cash in the field.

4.5.2 Plant Accounting and Property Records

- Develop a more detailed plant account using smaller units of plant representing the lowest level of plant replacement.

- Create a proper interface between the Procurement Accounting Section and the Plant Accounting Section to insure either proper expensing or booking of equipment invoices. Create a plant accounting instruction manual.

- Initiate a property record systems and conduct first systemwide property inventory.

4.5.3 Income Statements and Balance Sheets

The review of 1983 and 1984 Income Statements and Balance Sheets suggests a number of recommendations which will increase the value of both statements to ENEE management and international lending and donor institutions. Furthermore, a procedures manual needs to be developed to insure accurate preparation of these financial statements. Depreciation accounting procedures need considerable improvement and auditing systems and an internal auditing function are lacking. It is, therefore, recommended that:

- Income Statements and Balance Sheets should be reformatted and properly footnoted to meet international standards required by financial institutions.

- The accounts receivable in unpaid bills should be reduced from approximately one year revenue to 90 day's revenue by a rigorous bill collection and disconnect policy.

- Income Statements should be prepared with quarterly frequency.

- An internal auditing function must be established within ENEE, reporting to the Director General on a continuing basis.

- Depreciation accounting should be modernized including smaller units of plant, and more realistic depreciation rates, including dispersion of retirements.

- An annual financial report should be prepared as a means of documenting ENEE's financial performance for use by lender and donor institutions.

4.5.4 Financial Management Procedures

The audit of the activities of the ENEE Finance and Administrative Department revealed that there is no financial planning program operative in ENEE. Furthermore, capital requirements forecasting and source and application of funds statements are not used. The following, therefore, is recommended:

- Install and document a system and procedures for capital requirements forecasting.
- Install and document a system and procedures for forecasting cash-flow requirements.
- Develop work plans and budgets.
- Document financial policies.
- Develop a comprehensive financial planning program.
- Create a controller's function and financial planning function within the Finance and Administrative Department.

4.6 ORGANIZATION REVIEW AND ANALYSIS

The review of the ENEE organization and its functions disclosed that the span of control imposed on the Director General was too broad. Furthermore, documentation of corporate objectives, departmental functions, general orders and routine operating instructions did not exist. Although audits have been made of the ENEE organization (Russell, Ewbank July 1975), the day-to-day pressures on ENEE department managers has made it most difficult to find the time to engage in organization planning, personnel planning and performance evaluation. Based on the organization analysis made in the course of this field assignment, the following recommendations are made.

4.6.1 Organization Audit

- Engage a management consulting firm to perform a thorough organization audit for the purpose of recommending a revised organization structure.
- In the interim, consider implementing the organization defined in Figure 4-2 which regroups departments under senior directors reducing the span of control of the Director General.

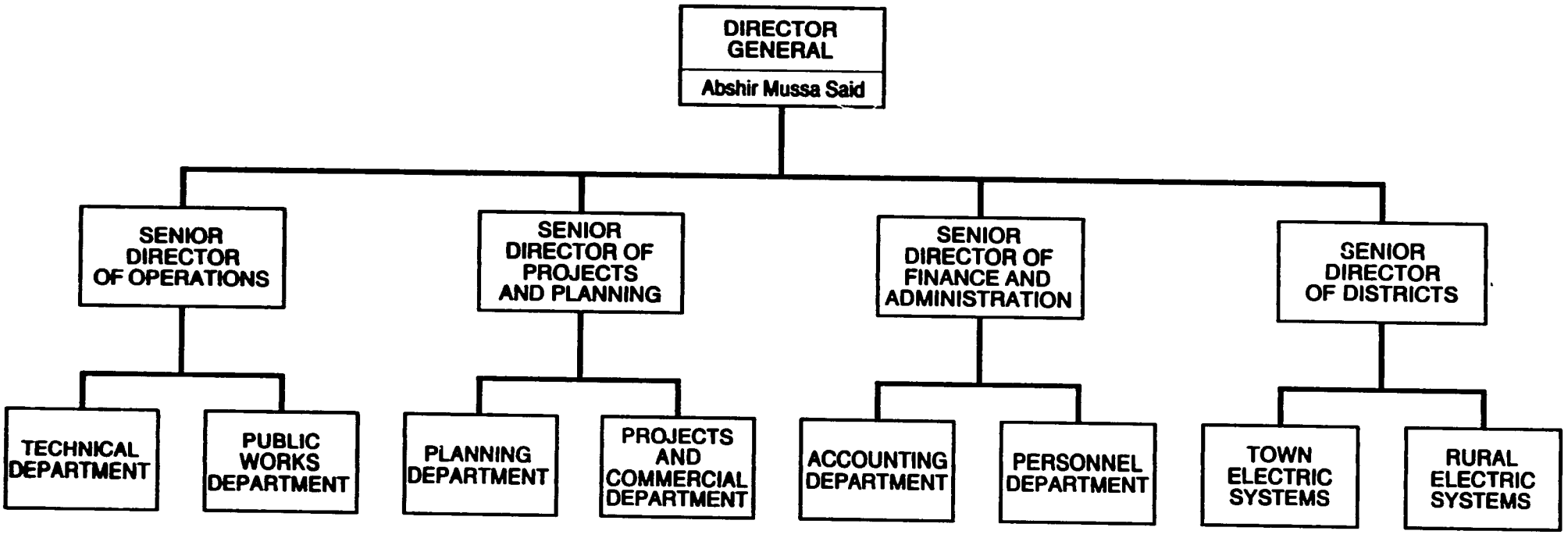

Figure 4-2 Proposed ENEE Organization

4.6.2 Organization Analysis

- Prepare corporate objectives, departmental functions, general orders and routine instructions for ENEE's current operations under the direction of the Personnel Department.

- Implement a program of manager and professional staff employee evaluation.

- Transfer all general management of generation plant operations to the Technical Department.

- Staff immediately the Planning and Projects Department with adequate personnel to perform long range system planning, project management and distribution system planning.

- Enlarge the Accounting Services Section in the Finance and Administration Department to better service financial reports required for effective financial control and planning.

- Perform a procedures analysis of work being done in the Billing Services Section to clarify the organization and identify manpower requirements.

- Define and implement an improved operating interface between the Commercial Accounting Section of the Commercial Department and the Accounting Services Section of the Finance and Administration Department to provide either a more timely expensing of commodities and services or a booking to plant account where appropriate.

- Establish, in the Personnel Department, a personnel and organization planning function.

- Reorganize the Regional and Districts Department, establishing a direct reporting relationship to the Director General and creating operating sections in the department which have a parallel relationship to operating departments at ENEE headquarters.

4.7 MANPOWER AND TRAINING

The manpower review, department by department, indicated that ENEE must carefully plan for the impending expansion in employment required to meet future system growth. Since neither manpower forecasts, recruiting strategy nor performance evaluation programs exist, it is essential that the Personnel Department together with senior management initiate an in-depth manpower needs assessment and an organized employee training and development program.

4.7.1 Manpower

- Conduct a manpower needs assessment, department by department, stipulating the manpower needs over a reasonable time period

- Analyze the skills required to perform jobs and prepare job descriptions by labor classification

- Prepare job skills performance standards and qualifications requirements for vocational jobs.

4.7.2 Training Programs

4.7.2.1 Vocational and Technical Training for Generation System Personnel. A training and manpower development program for pre-technicians, technicians, supervisors and managers should be implemented. Outlines for the training is briefly described in Appendix B.

4.7.2.2 Training Program for Vocational Jobs. The training content for vocational jobs in transmission and distribution system operations, construction and maintenance are given in Appendix B.

4.7.2.3 Training Program for Transmission and Distribution Engineers. Technical training programs for ENEE engineers are given in Appendix B.

4.7.2.4 Development Program for ENEE Managers. Mid-Managers should be given formalized development courses in engineering, accounting and financial planning. These would be released-time, formal courses offered at ENEE headquarters. The training program is defined in Appendix B.

4.7.2.5 Senior Manager Development. The ENEE senior managers, department managers and above, should audit the middle-manager development courses offered by ENEE in Mogadishu. However, additionally they should be offered advanced overseas courses (in the United States) consisting of training modules and on-the-job exposure to management requirements in each manager's functional area, operations, engineering, accounting, or procurement, etc. Flexibility in programming should be uppermost in the learning requirements of each ENEE manager. Also included in the overseas development experience would

be construction in financial and managerial accounting, cost management and planning, organizational planning and evaluation and human resources development.

4.7.2.6 Training Organization. Implementation of the vocational training program described in Subsection 4.7.2.2 and in Appendix B will require the formation of a training organization corresponding to that down in Figure 4-3. Initially and for a period of at least two years the services of expatriate training managers and supervisors will be required to define, implement and manage the training program.

4.8 MANAGEMENT ADVISORY SERVICES

In order for ENEE to effectively implement the recommended improvements in organization, financial management and personnel management, a management consulting firm should be retained for a period of two years. The consulting services required together with the schedule required to implement the services is shown in Figure 4-4. The management consulting team required would include the team chairman (would provide the organizational services), an accounting services specialist, a procurement services specialist, a financial planning specialist, a tariff specialist and a personnel services specialist. The total effort would require 92 person-months. The budget for the required management advisory services is given in Appendix C.

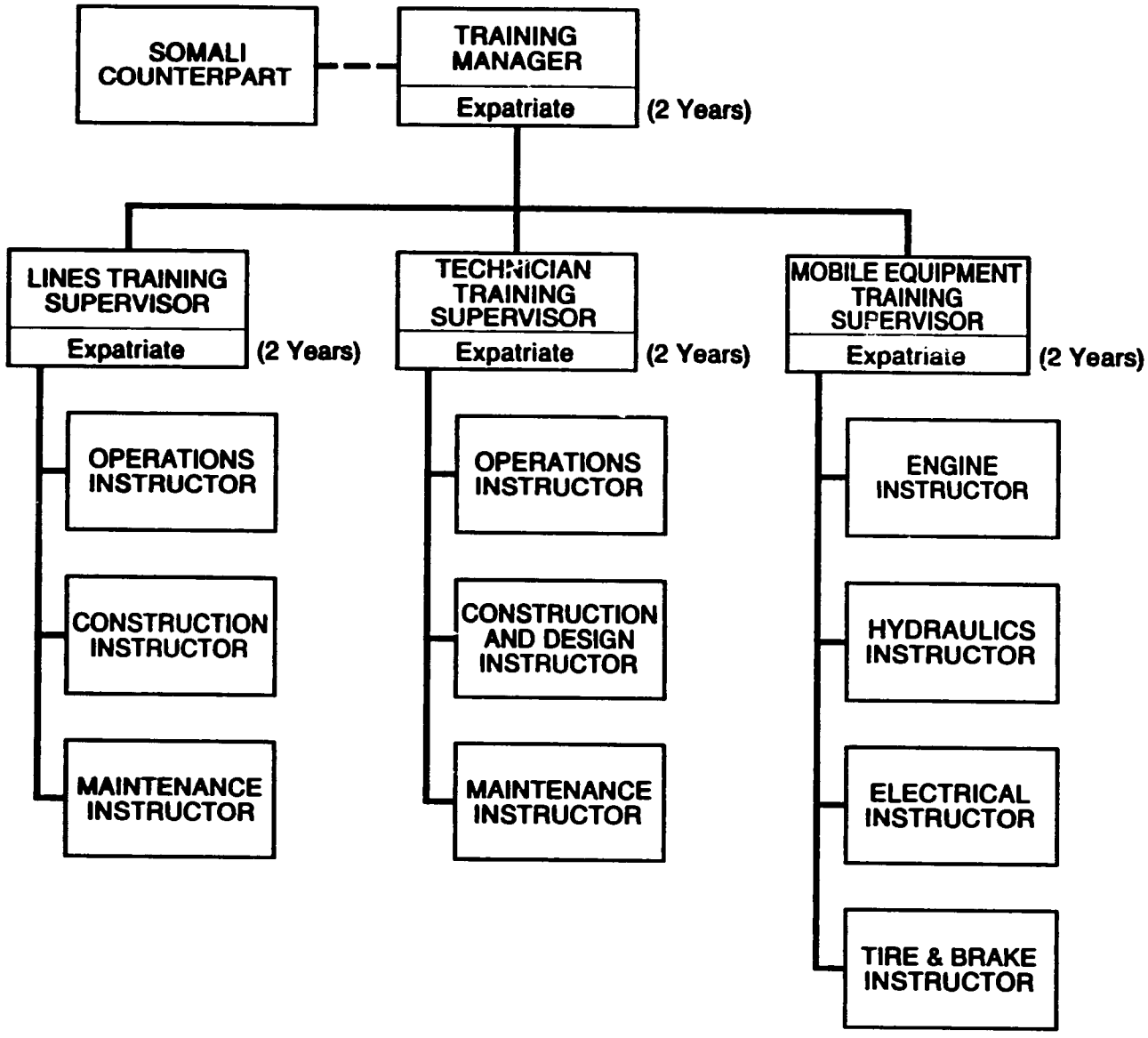

Figure 4-3 Transmission and Distribution Personnel Training Program Organization

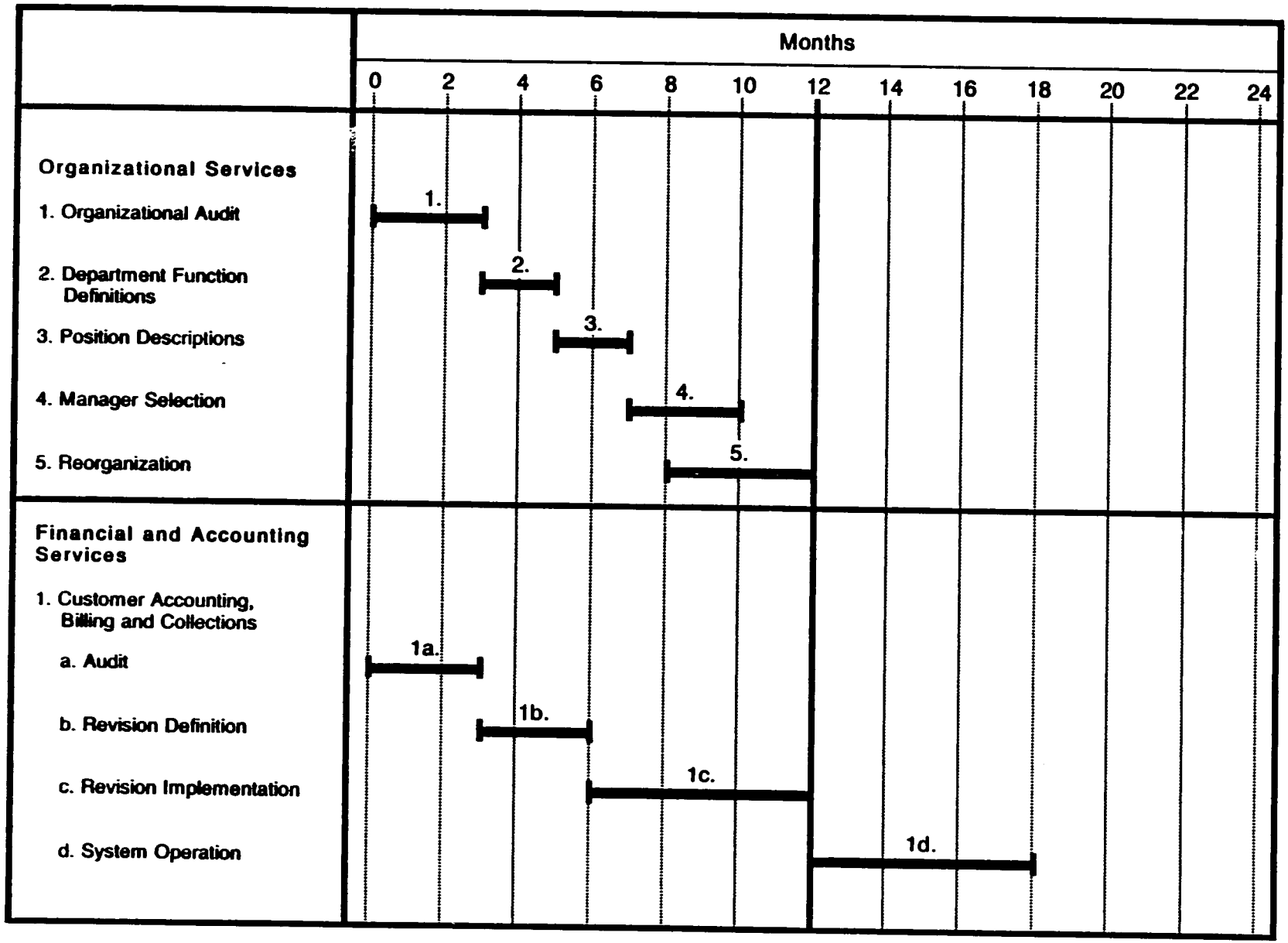

Figure 4-4 Organizational, Financial and Personnel Consulting Services Schedule

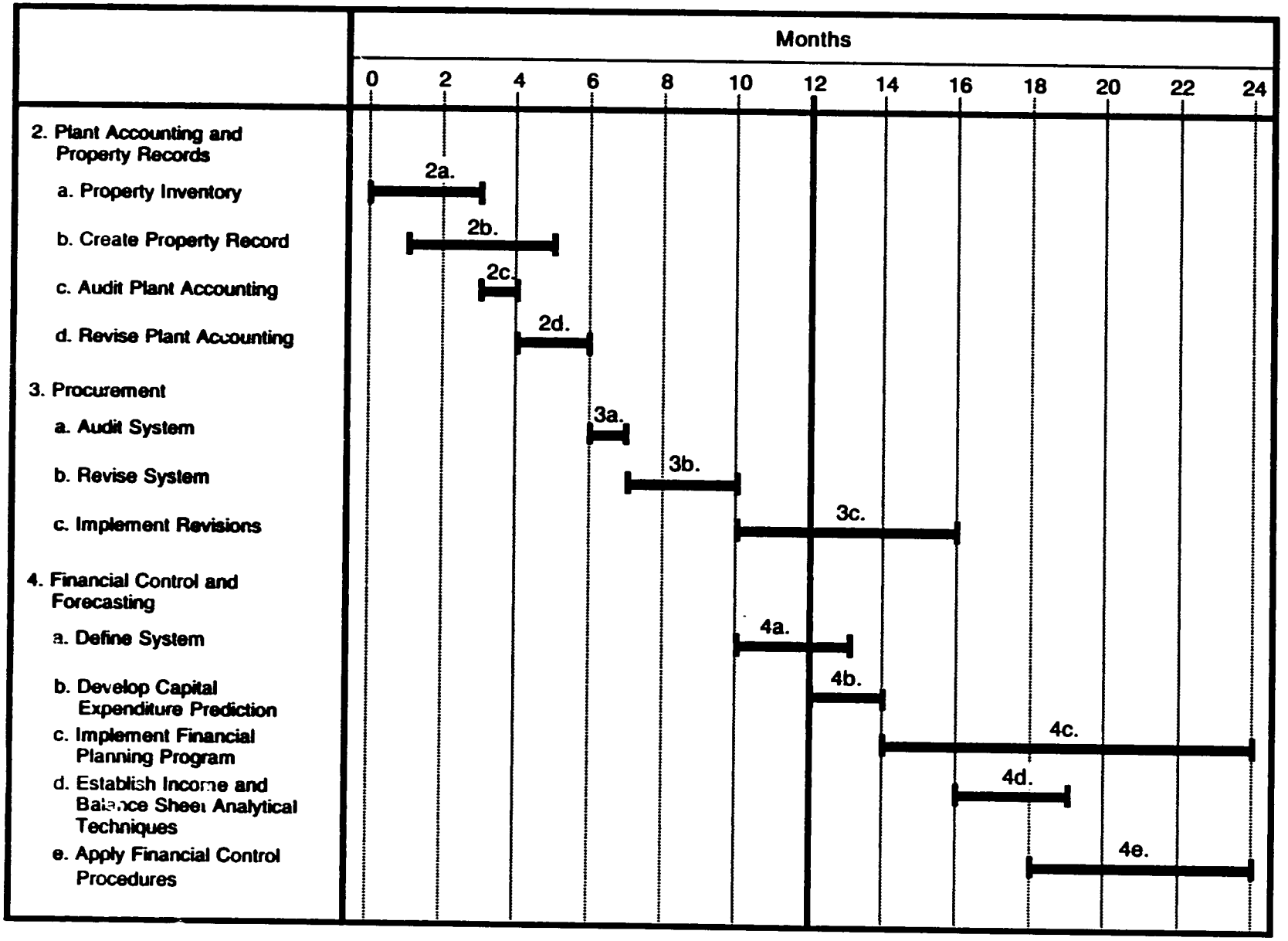

Figure 4-4 Organizational, Financial and Personnel Consulting Services Schedule

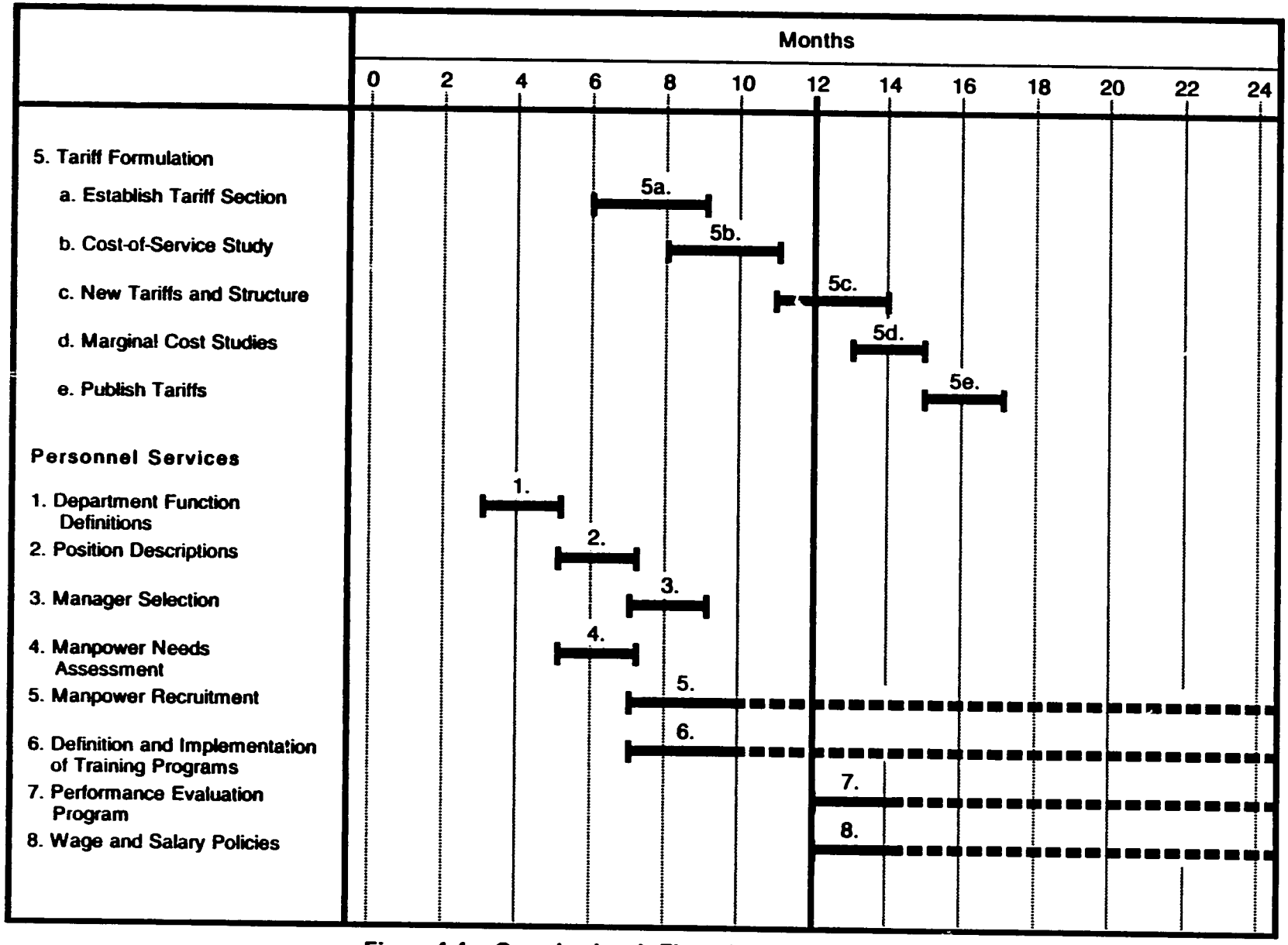

Figure 4-4 Organizational, Financial and Personnel Consulting Services Schedule

4.9 ESTIMATED COSTS OF PROGRAM RECOMMENDATIONS

4.9.1 ENEE System Rehabilitation Costs

The costs to rehabilitate the ENEE power system, including the provision of advisory services providing engineering, procurement and field installation are summarized in Table 4-6 as $11,412,000.

4.9.2 Vocational Training Program Costs

The costs for expatriate management and supervision of a two-year vocational training program are summarized in Table 4-7 as $1,271,200. The expectation is that each of the expatriate staff will develop a Somali counterpart staff to manage and supervise the training program at the completion of the two-year period.

4.9.3 Management Advisory Service Costs

The costs for expatriate management advisory services for a two-year period (92 person-month) are summarized in Table 4-8 as $1,398,600. The expectation is that at the conclusion of the two-year period, the organizational, financial, accounting and personnel programs will have been implemented and ENEE senior and middle-managers will be managing the programs effectively.

Table 4-6

SUMMARY OF REHABILITATION EQUIPMENT AND ADVISORY SERVICES COSTS

REHABILITATION		
GENERATION		
Rehabilitation Equipment	$2,730,000	
Spare Supply Parts, 2-year	4,030,000	
	$6,760,000	$ 6,760,000
TRANSMISSION AND DISTRIBUTION		
Conversion 3 kV to 15 kV	$1,017,000	
Replace Central City Secondary	$2,160,000	
	$3,177,000	
Mobile Equipment, Vehicle Maintenance Shop	$1,420,000	
	400,000	
	$1,820,000	$ 4,997,0000
	Subtotal	$11.757,000
ADVISORY SERVICES		
Engineering Specifications	$ 32,400	
Procurement	129,600	
Field Supervision Chief of Party, Mech. Engr., Electrical Engr.	372,000	
	$ 534,000	
Subsistence, Transport	81,000	
Subtotal	$ 615,000	$ 615,000
Total Cost		$12,372,000

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Table 4-7

SUMMARY OF THE COSTS TO MANAGE AND SUPERVISE A TWO-YEAR ENEE VOCATIONAL TRAINING PROGRAM

SALARIES		
Expatriate Manager	$268,800	
Three, Expatriate Supervisors	$672,000	
	$940,800	$ 940,800
Housing, Transportation and Miscellaneous Costs	$330,400	$ 330,400
		$1,271,200

Table 4-8

SUMMARY OF THE COSTS TO PROVIDE TWO-YEAR ENEE MANAGEMENT ADVISORY SERVICES PROGRAM

SALARIES		
Expatriate Manager	$268,000	
Five, Expatriate Specialists	635,000	
	$903,000	$ 903,000
Housing, Transportation and Miscellaneous Cost	$495,600	$ 495,600
		$1,398,600

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Appendix A

MATERIALS AND EQUIPMENT REQUIRED FOR REHABILITATION

(3815H)

Table A-1

CONSUMABLE CHEMICALS REQUIRED FOR 2-YEAR OPERATION OF GEZIRA STEAM PLANT

Item No.	Description	Quantity	Available From
1	Hydrochloric acid with inhibitor for distillers cleaning	600 litres	USA
2	Evaporat 3000 for distillers chemical dosing	3,600 litres	USA
3	HCL 32%, for chlorination plant cleaning	600 litres	USA
4	NaOH 50%, for chlorination plant neutralization and regeneration of demineralizer mixed beds	13,000 litres	USA
5	Amonia solution 25%, for water treatment chemical dosing	6,600 litres	USA
6	Hydrazine 15% for steam cycle water treatment	2,250 litres	USA
7	Chloride of calcium for potable water chemical dosing	1,650 kg	USA
8	Sodium bicarbonate ($NaHCO_3$) for potable water chemical dosing	1,800 kg	USA
9	Iron sulphate for chemical dosing of cooling water	18,200 kg	USA
10	Sulfuric acid 96%, for regeneration of demineralizer mixed bed	5,400 litres	USA
11	Cation resin (Lewatit 5100 MB)	2x150 litres (for 5 year operation)	USA
12	Anion resin (Lewatit MP 500 MB)	2x300 litres (for 5 year operation)	USA

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Table A-2

CONSUMABLE CHEMICALS AND EQUIPMENT REQUIRED FOR 2 YEARS OPERATION OF GEZIRA STEAM PLANT CHEMICAL LABORATORY

Item No.	Description	Quantity	Available From
1	Aceton C_2H_8O	20 litres	USA
2	Acetic acid $C_2H_4O_2$	6 litres	USA
3	Amonia NH_3 25%	30 litres	USA
4	Thioglycolic acid $C_2H_4O_2S$	6 kg	USA
5	Chloroform CCL_4	30 litres	USA
6	Hydrochloric acid HCL 37%	50 litres	USA
7	Hydrochloric acid fixnal (1 mol & 0.1 mol) (12) (12)	24 pcs	USA
8	IDRANOL A & IDRANOL III (0.1 mol)	24 pcs	USA
9	Methanol CH_3OH	30 litres	USA
10	Nessler reagent	7 litres	USA
11	Potassium hydroxide fixnal (1 mol & 0.1 mol) (12) (12)	24 pcs	USA
12	Sodium hydroxide fixnal (1 mol & 0.1 mol) (12) (12)	24 pcs	USA
13	Sulfuric acid 96% or 97%	30 litres	USA
14	Sulfuric acid fixnal (1 mol & 0.1 mol) (12) (12)	24 pcs	USA
15	Muscasol	20 litres	USA
16	Pyrogalic acid	2.5 kg	USA
17	Amonium acetate	2.5 kg	USA
18	Salicylic acid	500 g	USA
19	Pu meter with temperature compensation suitable for battery electrical operation	1	USA
20	Conductivity meter suitable for battery electrical operation	1	USA

Note: Graded reagent for chemical laboratory.

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Table A-3

PARTS LIST FOR REHABILITATION OF ONE AND 2 YEARS SPARES
FOR TWO HEAVY FUEL SEPARATOR AT GEZIRA STATION - ALFA LAVAL

Type: MAPX 309 BGT-24
Man. No. 2953150
Worm Wheel Shaft 1420-1500 R/M
Rev-Counter 118-125 r/m
Weight ex Motor 1150 Kg

Supply Source: USA

Item	Quantity: Rehabilitation	Quantity: Spares for both Units	Description	Part No.
1	1	2	Lock ring	520359-3
2	1	2	Discharge collar	521880-2
3	2	4	Seal ring	65594
4	1	2	T( ) disc with neck (purifier)	-
5	2	4	Gravity disc	517242-8
6	1	2	Bowl disc	520220-82
7	1	2	Bowl hood	-
8	2	4	Seal ring	71440
9	10	5	Seal ring	67587
10			Disc set (No)	No
11	1	2	Distributor	-
12	2	4	Cap nut	72589
13	2	4	Nave cap	72588
14	1	5	Seal ring	65201
15	1	2	Sliding bowl bottom	69172
16	10	5	Seal ring	67575
17	10	5	Screw (2)	68918
18	1	2	Bowl body	-
19	10	5	Screen plug	62642
20	5	5	Guide sleeve	67572
21	1	2	Spring support	-
22	5	5	Screw (6)	73883
23	5	5	Spring (16)	68657
24	1	2	Operating slide	71435
25	5	2	Valve plug (3)	68899
26	10	5	Seal ring	67566
27	2	2	Valve seat (3)	68565
28	5	5	Packing (3)	69310
29	2	2	Motor adapter	67190
30	6	3	Frame ring	67675
31	20	10	Lining	65228
32	10	10	Seal ring	33259
33	10	10	Seal ring	67566
34	15	10	Seal ring	65396
35	10	10	Seal ring	65395
36	8	4	Protecting glass tube	68076

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Table A-3 (Continued)

Item	Quantity: Rehabilitation	Quantity: Spares for both Units	Description	Part No.
37	4	2	Sight glass	65246
38	4	2	Seal ring	68075
39	4	2	Seal ring	71167
40	4	2	Shear pin	62527
41	4	2	Seal ring	64100
42	4	2	Packing	223316-5
43	4	2	Seal ring	42153

Table A-4

ELECTRICAL PARTS REQUIRED FOR REHABILITATION OF
GEZIRA DIESEL ENGINES 2 AND 3
(Brush Alternator)

Supply Source: Manufacturer (U.K.)

Item No.	Quantity (for Engines 2&3)	Description
1	25	Fixed and moving contacts for u.C.A_3 contactor 45A
2	15	Fixed and moving contacts for u.C.A_1 contactor 30A
3	15	Fixed and moving contacts for u.C.A_7 contactor 85A
4	140	Fuse link 2 amp. type N1T2
5	20	Fuse link 4 amp. type N1T4
6	20	Fuse link 6 amp. type N1T6
7	20	Fuse link 10 amp. type T1A10
8	20	Fuse link 16 amp. type T1A16
9	20	Fuse link 20 amp. type T1A20
10	20	Fuse link 40 amp. type T1S40
11	10	Fuse link 35 amp. type T1S35
12	10	Fuse link 50 amp. type T1S50
13	30	Fuse link 60 amp. type T1S60
14	30	Fuse link 63 amp. type T1A63
15	10	Fuse link 100 amp. type T1S100M
16	60	Coil for contactors u.C.A_{381} 110V AC
17	20	Complete contactors u.C.A_3 45A
18	15	Complete contactors u.C.A_1 30A
19	10	Complete contactors u.C.A_7 85A
20	20	O/L relay type OLRRS
21	10	Change over solenoid type 11W486 400x2 110 V DC
22	10	Thermostat range 0-140°C type Maclaren
23	10	Master thermostat 0-140°C type Maclaren
24	2	Engine speed probe type M_C 25 R CCL6
25	2	Speed control switch (raise-off-low) position
26	15	Heater elements for H.f line heater 380 V 5 kW
27	30	Clipon terminal type Sake 32 8 Sake 35
28	5	A mot controls electronic cards BD_3 BD_2 BD_5 BD_1 BD_6
29	6	Generator 15 kV coils (Rew in ....)

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Table A-4

ELECTRICAL PARTS REQUIRED FOR REHABILITATION OF
GEZIRA DIESEL ENGINES 2 AND 3
(Brush Alternator)

Supply Source: Manufacturer (U.K.)

Item No.	Quantity (for Engines 2&3)	Description
1	25	Fixed and moving contacts for u.C.A_3 contactor 45A
2	15	Fixed and moving contacts for u.C.A_1 contactor 30A
3	15	Fixed and moving contacts for u.C.A_7 contactor 85A
4	140	Fuse link 2 amp. type N1T2
5	20	Fuse link 4 amp. type N1T4
6	20	Fuse link 6 amp. type N1T6
7	20	Fuse link 10 amp. type T1A10
8	20	Fuse link 16 amp. type T1A16
9	20	Fuse link 20 amp. type T1A20
10	20	Fuse link 40 amp. type T1S40
11	10	Fuse link 35 amp. type T1S35
12	10	Fuse link 50 amp. type T1S50
13	30	Fuse link 60 amp. type T1S60
14	30	Fuse link 63 amp. type T1A63
15	10	Fuse link 100 amp. type T1S100M
16	60	Coil for contactors u.C.A_{381} 110V AC
17	20	Complete contactors u.C.A_3 45A
18	15	Complete contactors u.C.A_1 30A
19	10	Complete contactors u.C.A_7 85A
20	20	O/L relay type OLRRS
21	10	Change over solenoid type 11W486 400x2 110 V DC
22	10	Thermostat range 0-140°C type Maclaren
23	10	Master thermostat 0-140°C type Maclaren
24	2	Engine speed probe type M_C 25 R CCL6
25	2	Speed control switch (raise-off-low) position
26	15	Heater elements for H.f line heater 380 V 5 kW
27	30	Clipon terminal type Sake 32 8 Sake 35
28	5	A mot controls electronic cards BD_3 BD_2 BD_5 BD_1 BD_6
29	6	Generator 15 kV coils (Rewind.....)

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Table A-5

MECHANICAL PARTS REQUIRED FOR REHABILITATION OF GEZIRA DIESEL ENGINES 2 AND 3, AND SPARES FOR 2 YEARS OF OPERATION OF DIESEL ENGINES
(MATERIALS TO BE FURNISHED FROM THE MANUFACTURER OF THE ENGINES IN U.K.)

Item No.(1)	Parts Reqd. for Engine #2 Rehabilitation (Quantity)	Parts Reqd. for Engine #3 Rehabilitation (Quantity)	Spare Parts for each Engine (Quantity)	Item No.(1)	Parts Reqd. for Engine #2 Rehabilitation (Quantity)	Rehabilitation for Engine #3 Rehabilitation (Quantity)	Spare Parts for each Engine (Quantity)
1	32	10	24	31	5	-	10
2	32	10	24	32	35 ft	35 ft	35 ft
3	32	3	16	33	10	5	20
4	32	3	16	34	1	-	1
5	10	-	2	35	20	20	40*
6	5	-	10	36	2	-	1
7	10	1	4	37	2	-	1
8	2	-	1*	38	2	-	2
9	1	-	2	30	2	-	2
10	20	10	30	40	2	-	2
11	-	-	1	41	6	-	4
12	6	6	12*	42	12	6	12*
13	-	-	2	43	2	-	2
14	1	-	2*	44	2	1	4
15	20	20	40*	45	5	-	10
16	20	20	40*	46	2	-	2
17	2 tins	2 tins	5 tins	47	1	-	1
18	1	1	2	48	5	-	1
19	1 tin	1 tin	5 tins*	49	16	16	12
20	20	10	30	50	1	-	2
21	18	18	18	51	3	3	4
22	10	5	7	52	16	8	16
23	128	128	100	53	16	8	16
24	100	100	100	54	8	2	8
25	50	50	100	55	8	-	8
26	32	32	16	56	8	-	8
27	16	16	16	57	8	-	8
28	10	5	32	58	8	-	8
29	5	5	20	59	2	1	2*
30	20	5	10	60	2	1	2*

(3181H)

Table A-5 (Continued)

Item No.(1)	Parts Reqd. for Engine #2 Rehabilitation (Quantity)	Parts Reqd. for Engine #3 Rehabilitation (Quantity)	Spare Parts for each Engine (Quantity)	Item No.(1)	Parts Reqd. for Engine #2 Rehabilitation (Quantity)	Rehabilitation for Engine #3 Rehabilitation (Quantity)	Spare Parts for each Engine (Quantity)
61	2	1	2*	95	1	-	1*
62	2	1	2*	96	1	-	1*
63	1	-	1	97	1	-	2*
64	2	1	2*	98	10	4	20*
65	1	-	2	99	10	4	20*
66	1	-	2	100	20	8	40*
67	10 ft	5 ft	10 ft	101	20	8	40*
68	10 ft	5 ft	10 ft	102	64	64	128*
69	2	2	4	103	64	64	128*
70	2	2	4	104	8	2	10
71	1	1	2	105	16	4	40
72	1	1	2	106	8	2	20
73	[illegible]	2	4	107	16	4	40
74	1	1	2	108	16	4	40
75	1	1	2	109	32	8	80
76	1	1	2	110	32	8	80
77	2	2	4	111	32	8	80
78	1	-	1	112	10	10	20
79	16	8	8*	113	10	10	20
80	16	8	8*	114	10	10	20
81	16	8	8*	115	-	-	2*
82	4	-	10	116	-	-	2*
83	4	-	10	117	2	-	4*
84	4	-	10	118	2	-	4*
85	4	-	10	119	10	-	32
86	4	-	10	120	-	-	20
87	4	-	10	121	16	4	20
88	4	-	10	122	-	-	-
89	3 tins	3 tins	9 tins	123	2	2	10*
90	1	-	2*	124	2	2	10*
91	1	-	2*	125	1 set	1 set	1 set
92	1	1	2*	126	-	-	2 sets*
93	1	1	2*	127	-	-	1 set*
94	1	-	1*	128	-	-	2 sets*

Notes:

* Indicates spare for 5 engines

(1) See attached spare parts list

Table A-5 (Continued)

SPARE PARTS LIST FOR:
ENGINE No. 6704/1 and 6901/1
Type: 16kV Major
RPM: 500
Serial No. 76.29.0 and 82.50.01
Spares Order No. 333/85/GPS

Item	Contents	Part No.
1	Air valve	K20859
2	Exhaust valve	K46451
3	Assembly of valve cage (R/H)	K29053
4	Assembly of valve cage (L/H)	K29051
5	Cylinder head (new heads)	K37383
6	Cylinder head (reconditioned heads)	K37383
7	Cylinder liner	K14709
8	Lubricating oil pump (of David Brown, Roloid gear pumps; order No. G88 2080 2-1/2 H Rotor: Max. GPM 230 Pressure: 75 psi RPM 1203	
9	Fuel pump (Bryce Ref. FDDAB 300 B0522)	K38157
10	Half liner intermediate	K44312
11	M.S. half liner wide	K44313
12	Half liner	K44311
13	Thrust half washer	K30289
14	Assembly of crank gear wheel	K31377
15	Split pin	SP6116
16	Split pins	SP7122
17	Jointing compound	SD296/4
18	Jointing	SD119/3
19	Compound	SD296/3
20	'O' ring	K30992
21	Sealing ring	K30942
22	Joint liner to casing	K28424
23	Split pins	SP4/14
24	Locking wire	SD295/10
25	'O' ring	K15330
26	Piston ring	K36462
27	Piston ring	K36463
28	Assy of double-edged scraper ring and spring	K45657
29	Locktite 242e	SD265/10
30	Fuel cams	K36089
31	Cotter pins	K15278
32	Locking wire	SD24512
33	Split pin	SP4112
34	Aeroquip adapter	SD118140
35	Copper washer	CW32/52/2
36	Lubricating oil spray assy "A" bank	K36873
37	Lubricating oil spray assy "B" bank	K36874
38	Equal tee	SD6012
39	Lubricating oil spray "A" bank	K37863

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Table A-5 (Continued)

Item	Contents	Part No.
40	Lubricating oil spray "B" bank	K37864
41	Stud coupling	SD107/13
42	Steel bluck	SD268/10
43	Adapter	K488/31
44	Lockplate for spray	K36868
45	Setscrew	FS104/12
46	Steam coupling	SD63/2
47	Screw assembly comprising	K38888
48	Cooled injector assembly for H Fuel	K42540
49	Nozzle (Bryce Ref. HL 135 II 66 H42 9P6)	K23802
50	Air master valve	K37653
51	Red fibre joint	6HFR1051
52	'O' ring	K35168
53	Joint	K9720
54	Camroller	K21968
55	Manifold to cylinder head	K49363
56	Manifold to cylinder head	K38719
57	Pipe assy	K18769
58	Pipe assy	K18767
59	Pipe assy	K41836
60	Pipe assembly bedplate connection 'A" bank	K34726
61	Pipe assy	K36019
62	Pipe assy to Pratt valve	K47016
63	Pratt shut-off valve	K47018
64	Pipe assembly	K41727
65	Pipe assembly 'A' bank	K49413
66	Pipe assembly 'B' bank	K44412
67	Air pipe	SD1/13
68	Pipe	SD1/11
69	Joint	K31062
70	Joint	K30161
71	Joint	K41125
72	Joint	K30797
73	Joint	K31039
74	Joint	K30244
75	Joint	K30245
76	Joint	K30622
77	Joint	K30794
78	Overspeed governor assembly (500 rpm)	-
79	Pipe assembly	K44288
80	Pipe assembly	K38619
81	Pipe assembly	K39809
82	Assy exh. valve cooling water out pipe - long	K40714
83	Assy exh. valve cooling water out pipe - short	K40712
84	Assy exh. valve cooling water out pipe - long	K36354
85	Assy exh. valve cooling water out pipe - short	K36358
86	Pipe assy	K39811
87	Pipe assy	K32537
88	Pipe assy	K32539
89	PBC grease	-

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Table A-5 (Continued)

Item	Contents	Part No.
	Vavle cage pump: Motor - Brook Crompton Parkinson Frame D1325H motor No. FDD16FZE, KW 7.5, V 380 , RPM 2865, Amps 16, Hz 50 insul Class B Rating MC Pump - Ingersol Rand Imp gal: 67 RPM 2900 Diff head ft 175, serial No. 6083264/1 Model 32-200 M.	
91	Nozzle ring for turbocharger (type VTR 400 spec Z4R 546 II EA 217 AN 3Z) - Brown Boveri	30
92	Bearing assy compend for above turbocharger	32
93	Bearing assy turbend for above turbocharger	38
94	Shaft (complete) for above turbocharger	20
95	Exhaust pipes	K22760
96	Exhaust pipes	K22764
97	Connecting rods assy	K45662
98	L/E bolts	K45499
99	L/E bolts	K45549
100	Nuts	K44131
101	Washers	K44132
102	Piston crown stud	K53595
103	Piston crown nuts	K52579
104	Banjo's	K52538
105	Washers	CW41/68/2
106	Valve adaptor	K16202
107	Washer	CW50/64/2
108	Valve	J10755
109	Bolt	K36853
110	Washer	SW68
111	Specer tube	K36854
112	Washer	K24146
113	Adaptor	K38622
114	Pipe assembly	K38622
115	Intergears "A" bank bracket	K48390
116	Intergears "B" bank bracket	K48391
117	Intermediate gear	K30077
118	Pinion assembly	K31379
119	Tappet assembly	K36763
120	Circlip	K20480
121	Push-rod	K25805
122	Exhaust bellows	
123	Gasket - exhaust outlet from turbocharger	
124	Gasket - air inlet to turbocharger	
125	Crankcase door joint (bulk gasket)	K1498
126	Pneumatic equipment for 16 kV major	
127	Jacket water pump and motor assy (Brook Crompton Parkinson motor frame D180LM, kW 22, 1450 rpm, and pump M125/250/250/ATSER 612307414)	
128	Pump mechanical seal	25171/548/0001'

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Table A-6

ADDITIONAL SPARE EQUIPMENT REQUIRED FOR 2 YEARS OPERATION OF GEZIRA DIESEL PLANT

Supply Source: Manufacturer (U.K.)

Item No.	Quantity (for 5 Engines)	Description
1	2-Assy.	Light fuel pressuring pump assembly, duty 450 gal/hr 20 lb in^2, for engine 6704/1 (Model 10M 1-1/2 T 4R/01)
2	2-Assy.	Heavy fuel pressuring pump assembly, duty 450 gal/hr 20 lb/in^2. For engine 6704/1 (Model 20M 2T 4R/19)
3	2-Assy.	Air compressor size AWMS (Worthington-Simpson), 27.6 BAR, 960 RPM, 43M3/hr for diesel engine system start, stop and control air

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Table A-7

HANDLING EQUIPMENT, TOOLS AND MISCELLANEOUS EQUIPMENT REQUIRED FOR REHABILITATION OF GEZIRA DIESEL PLANT

Supply Source: USA

Item No.	Quantity	Description
1	2-Lots	Miscellaneous cutting, turning, threading, cutting, etc. tools for lathe
2	1-Lot	Miscellaneous steel stock (rods, bars, etc.) for manufacturing diesel engine parts (bolts, nuts, studs, etc.)
3	2	Portable electric drills 3/4" and 1" dia. including miscellaneous drills, reamers, etc. and attachments
4	2-Lots	Miscellaneous grinding wheels for pedestal grinder
5	2	Hand chain pulleys 1 and 2 ton capacity
6	5-Sets	Miscellaneous hand tools
7	10-Sets	Miscellaneous connectors for diesel engine pneumatic system
8	3-Sets	Battery-type 40EL for Electro Carrello forklift type GMF/2000
9	1	Portable air compressors
10	1-Set	Light weight (portable) electric welding machine

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Table A-8

SPARE PARTS LIST FOR 2 YEARS OPERATION OF 4 GEZIRA LUB. OIL SEPARATOR (OIL CENTRIFUGE) ENGINES #1 THRU #4(1)

Type: MAB 204S-20 (4048-1)
ALFA-LAVAL
For Wheel Shaft: 1400-1500 r/m
Tachmeter: XXY
Rev/min Counter: 118-125 r/min

Supply Source: USA

Item	Quantity	Description	Part No.
1	4*	Thermometer	64002
2	8*	Pressure gauge	526306-01
3	4*	Elastic plate	519532-01
4	8*	Seal ring	223402-01
5	8*	Seal ring	73920
6	4*	Seal ring	65901
7	4*	Seal ring	68085
8	8*	Seal ring	223401-30
9	8*	Seal ring	519548-01
10	4*	Seal ring	519550-01
11	4*	Seal ring	517761-01
12	4*	Seal ring	223401-38
13	4*	Seal ring	14238
14	4*	Seal ring	223431-02
15	4*	Seal ring	223401-28
16	4*	Seal ring	223410-09
17	4*	Seal ring	223406-14
18	4*	Seal ring	223408-04
19	4*	Seal ring	33336
20	4*	Seal ring	38411
21	12*	Friction pads	527983-90
22	4*	Seal ring	223406-0
23	8*	Elastic pad	519532-0

* Indicates spares for 4 lube oil centrifuges

Note:
(1) No parts required for Engine #5 lube oil centrifuge.

Table A-9

ELECTRICAL SPARE PARTS FOR 2 YEARS OPERATION OF
GEZIRA DIESEL ENGINES #1 THRU 5

Supply Source: Manufacturer (U.K.)

Item No.	Quantity	Description
1	250	Fixed and moving contacts for U.C.A-3 contactor
2	150	Fixed and moving contacts for U.C.A-7 contactor
3	50	110 volt A.C. coil for U.C.A-3 contactor
4	400	Bulbs 130 V; 20 MA
5	150	Fuse link 63 amp. type T1A63
6	150	Fuse link 40 amp. type T1A40
7	40	Fuse link 350 amp. type TTM
8	60	Fuse link 80 amp. type T1A80
9	300	Fuse link 2 amp. type NIT2
10	100	Fuse link 4 amp. type NIT4
11	100	Fuse link 6 amp. type NIT6
12	20	Fuse link 20 amp. type T1A20
13	25	Thermostat range 0-140°C type MacLaren
14	15	Master thermostat range 0-140°C type MacLaren
15	150	Klippon terminal SAK35
16	20	Heavy fuel change over solinoid type 11W486400x02; 110 V DC
17	10 set	Fixed and moving contacts for fuse switch type UFSB40-Watford
18	2	Complete fuse switch type UFSB40
19	24	Heater element for line heater 5 kW; 380 V
20	20	Heater element for bus rail heater 3 kW; 380 V
21	3	Speed control switch (raise-of-low) position
22	6	Mechanical seal for jacket water pump type pumpak model 125-250
23	1	? motor pump complete type pumpak model 125-250
24	6	Mechanical seal for valve case C.W. pump type pumpak Model 32-200M
25	2	Valve cage cooling water motor-pump type pumpak 32-200M 380 V
26	6	Clear span P130L indication controller range 0-600
27	10 sets	Gland packing for light fuel pump model 10M1-1/2T4R/01
28	10 sets	Gland packing for pump model 20M2T4R/19
29	4 sets	Gland packing for heavy fuel transfer pump model 50M10T4R/M01
30	5 sets	Gland packing for lube oil pump model 100ML5T42/M01

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Table A-10

HANDLING EQUIPMENT, TOOLS AND MISCELLANEOUS EQUIPMENT REQUIRED FOR REHABILITATION OF CENTRALE DIESEL PLANT

Supply Source: USA

Item No.	Quantity	Description
1	2-lots	Miscellaneous cutting, turning, thread cutting, etc. tools for lathe
2	1-lot	Miscellaneous steel stoln (rods, bars, etc.) for manufacturing diesel engine parts (bolts, nuts, studs, etc.)
3	2	Portable electric drills 3/4" and 1" dia. including miscellaneous drills, reamers, etc. and attachments
4	2-lots	Miscellaneous grinding wheels for pedestal grinders
5	2	Lathese - 4 ft and 3 ft bed
7	1	Universal milling machine with miscellaneous cutters
8	2	Pedestal drills 1-1/2" and 1" dia. with miscellaneous drills, etc.
9	1	Power saw (reciprocating type)
10	1	Pedestal grinder 12" dia. wheel
11	1	2-ton capacity diesel operated forklift
12	1	6-ton capacity mobile crane diesel operated
13	1	Portable air compressor 40 bar, 400L/min.
14	1	Electric welding machine

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Table A-11

ELECTRICAL SPARE PARTS FOR 2 YEARS OPERATION OF CENTRALE DIESEL ENGINES #5 THROUGH #8

Supply Source: Manufacturer (Italy)

Item No.	Quantity (for all 4 Engines	For Specific Engine Qty.	Engine No.	Description
1	-	2(1)	One each for #7 & #8	Step up transformer 2000 kVA 0.38/15 kV
2	-	2(1)	One each for #5 & #7	Step up transformer 1000 kVA 0.38/15 kV
3	8(1)	-	-	Air circuit breaker, 4500 A
4	4(1)	-	-	Oil circuit breaker, 22 kV, 600 A
5	2(3)	-	-	Insulation test instrument (Megger)
6	10(3)	-	-	Clamp on ammeters and volt meters (testers)

CENTRAL POWER STATION
ELECTRICAL SPARE PARTS NEEDS

Item No.	Quantity	Description
7	(3) 800 of 2 amp. 800 of 4 amp. 800 of 10 amp. 800 of 20 amp. 500 of 25 amp.	Cylindrical Cartridge Fuse Industrial type gl
8	(1) 2	From Electromeccanica Due Stelle S.p.a Castellanza Knife Switch (Sezionatori rotator a dopio sezionamento 3SDR 24 kV 800 amp.)
9	3	Item like above mentioned 3SDR 36 kV 400 amp.

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Table A-11 (Continued)

Item No.	Quantity	Description
10	(2)	From GEC Instrument Britain
	2	Low Frequency Reley type FTG
	3	Differencial Reley type DDGT.31FF2212A5
	3	Sensitive Earth Volt Reley type CTU 15AF2001A5
	2	Pilo Wire Protection Reley type D5F7 mark DSFIRF2115A
	2	Stanteneus Overcurrent Reley CAG11
	4	Overcurrent and Earth Volt Reley type CDG11 & 16
	4	Inverse Time Earth Volt Reley type CDG 12
	2	Definite Time Delav Reley type VTT
	4	Voltage Selection Reley type VAP22
	4	Overcurrent and Earthfault Reley type CDG31FF212385
	4	Tripping Reley type VAJ, MARK VAJY 11BF2044BA
	4	Earthing Overcurrent Reley type CDG, Mark CDG12AF2302G5
	4	Underfrequency Time Delay, VTT Mark VTT11NG2070C
	4	No Voltage Reley, type Van Mark VAU SPEC1RF1096T
	4	Low Voltage Reley, type Var Mark VAR113BF 2002A
	2	Voltage Selection Reley type VAP, Mark VAP22NG2001A
	2	Tripping Reley, type VAA Mark VAA11AF3201AB
	2	Underfrequency Releys type FTG Mark FTG11AF2131A5
11	(1)	Single Pole Voltage Transformers
	9	Type VRS 17B. 15000: 3 Italy

Notes:

(1) Supply Source - Italy
(2) Supply Source - U.K.
(3) Supply Source - U.S.

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Table A-12

ELECTRICAL PARTS REQUIRED FOR REHABILITATION OF CENTRALE DIESEL ENGINES #5, #6 AND #7

Supply Source: Manufacturer Pellizari, Italy

Item No.	Quantity	For Engine No.	Description
1	2	One each for engines 6&7	Alternator 2,700 kVA, 380 Volts
2	2	One each for engines 5&6	Switch Board

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Table A-13

MECHANICAL SPARES REQUIRED FOR 2 YEARS OPERATION
OF CENTRALE DIESEL ENGINES #5 THROUGH #8
BV12N356
Source of Supply: Manufacturer (Germany and Italy)

PEZZI DI RICAMBIO

X DEPURATORI FUEL MOPX 210 N= 2

DESCRIZIONE	QUANTITA (FOR 4 ENGINES)
Guarnisione = 223408 - 04	20
" = 67675	20
" = 223406 - 31	20
" = 190603	20
" = 73212	20
" = 71866	20
Manometro= 526306-01	2
" = 532773-01	2
Termometro=537256-01	5
Manometro Per Olio= 554775-01	5
" " " = 543054-01	5
Guarnisione=71320	20
" =71322	20
" =223408-04	20
Tappi=518549-01	20
Guarnisione=223412-05	6
" =67575	8
" =67587	6
" =71440	15
" =223401-77	9
" =517774 -02	9
Ferodi = 539136 -82	20
Vetro Olio=38685	8

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Table A-13 (Continued)

PEZZI DI RICAMBIO

X DEPRERATORI E IMPIANTI

DESCRIZIONE	QUANTITA (FOR 4 ENGINES)
DEPORATORI ~~XXXX~~ OLIO TIPO MOPX 205	
Guarnisione = 223 4 0 6 - 1 0	20
" = 223 4 0 2 - 1 2	20
" = 223 4 0 6 - 2 9	20
" = 74067	20
" = 42151	20
" = 517774 -0 6	20
" = 223406 -2 8	20
" = 223408 -0 8	20
" = 223404 -0 6	20
" = 89035	20
" = 521931 -0 1	20
" = 521933 -0 1	20
MOLE -226214 -33	36
Guarnisione = 223408 -9	20
" = 223408 -6	20
Tappi-521864-01	20
Ugelli-71433	10
Guarnisione = 521863 -0 1	20
" = 521875 -0 1	25
" = 223401 -2 8	20
" = 223322 -0 2	20
Supporto Lampo Centripedo-540219 -0 2	5
Pompa Centripedo = 521500 -0 1	4
Ferodi-518478-81	16
Vetro Spia Olio = 8859	10

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Table A-13 (Continued)

PEZZI DI RICAMBIO

X IMPIANTO DELLE 6 CENTRIFUGHE

DESCRIZIONE			QUANTITA (FOR 4 ENGINES)
Guarnizione	=	223318-05	20
Tubi Flessi bili	=	534115-80	20
Guarnizione	=	223318-06	30
Tubi Flessibili	=	538270-80	20
Gruppo Formazione a dosco acqua	=	7006802-80	8
Valvola 3 Vie	=	7016051-11	5
" " "	=	7039457-10	5
Bobina	=	7016051-01	8
Elettro Valvola	=	7003493-05	10
Bobina	=	7004671-05	10
Pressostato	=	770360- 05	20
Tiseflex Tipo Unc-42		12	5

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Table A-13 (Continued)

JAMHUURIYADDA DIMOQRAADIGGA SOOMAALIYA
WAKAALADDA XOOGGA KORONTADDA UMMADDAA

KU:- MAAREEYAHA WAAXDA FARSAMADA 8.WXKU 28/12/85
MUQDISHO

UJ:- Ricambio Ocorenti Per I Motori Deuts BV12M.350=N.5.6.7.8.

	QTY. PER ENGINES	
1	8	(Otto) Pompa O'io Con Ingarnaggi di Comando 38 Dent Costr.de B V12M 350 0114 - 3 -C 114 -34 -0114 - 40 - 45
2	4	(Quattro) Valvole Per Mesce.In Marcia (Atarting Marter Valve) Cost.0132
3	4	(Quattro) Regolatore Wood Word (Governer.UG.8-0129)
4	20	(Fonti) Scaricatori di Condensa.G.T.8-1/Model Max-8 Numero 89.. (Imbianta e Ardaya Quadro IML.).
5	20	(Fonti) Scaricatori di Condensa Tipo FT3.Press Per D.88
6	4	(Quattro) Pompe Centerfuge Per Alta Pressione Tipo H.T-40/1-82/1 9865/ 1-101 8 -17 -2900 (Per Vapore).
7	4	(Quattro) Omrom Tipo 61F G Floctess Switch.Rated.Voltage ac 110/220V E ce 8 Voltage.
		OMRON.TATEISI ELECTRNICS CO PER L AQUA.
8	300	Lampadine 24V 1-5 Watt.Bc.73CSRAM.
9	250	Fussibili e Cartuccie 1414 -4A
10	100	" " " " 14106-6A
11	100	" " " " 1232020A
12	100	" " " " 1412525A
13	100	" " " " 1323232A
14	100	" " " " 14144040A
15	100	" " WABER 35 A 500V.
16	100	" DIAS 4A 500V GL/91 Numero 525622,
17	100	" 16A 500V Kenoker Numero 5/5B16
18	100	" 4A 500V Numero 5 SA12
19	100	" " 6A 380V
20	100	" " " a Cartuccie 380V 32V.
21	100	" " " a Ledner 6A 500V GL
22	100	Wairodm.Tipo ULCSV/R22050 VOLT2220 HZ.50 VA12AT E 10 PER Valvola F FRAFALLO DI CALDAIO.
23	8	VAlvola di Frenaiale SAMI D.PTT.250/0450 Omm H20 Tipo Serie Numero C.S.T 706/80.
24	10	(Dieci) Teenova V.Le STEVIO 5 Milano Italia.Modello A [illegible]
25	4	[illegible]

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[illegible]

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Table A-13 (Continued)

BAZAMENTO 350 GURUPPO DI COSTNISIONE BV12M350

DESCRIZIONE				QUANTITA (FOR 4 ENGINES)
0104-1	-	3	Tappo	40
0104	-	4	Anello di Tenuta.e52x60 Din 7603 Cu	96
"	-	5	Tappo Con Protesione di Zinco	48
"	-	6	Prigioniero	384
"	-	7	Rosetta	384
"	-	8	Dada esagonalle	384
"	-	9	Guarnizione Per Fiegia .Ovale	48
"	-	10	Fiegia	48
"	-	11	Vite Testa esagonalle m10x30 Din 933m 8G	96
"	-	13	Anello Tonda di gomma	96
"	-	14	Anello Tonda di gomma	48
"	-	15	Guarnizione Fra testta Cilindrica	48
"	-	16	Spina Cilindrica 16m 6x24 Din 7	20
"	-	17	Spina Cilindrica 16m6x24 Din 7	20
"	-	18	Tappo	48

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Table A-13 (Continued)

GURPO DI CONCHISIONE BV12M350

DESCRIZIONE				QUANTITA (FOR 4 ENGINES)
0106	-	3	Boccolle delle Spinette	48
"	-	4	Tappo Conintayll	24
"	-	5	Spina Cilindrica 16m8x24 Din 7	24
"	-	6	Spina Cilindrica 16mx36 Din 7	24
"	-	7	Spina Cilindrica 16m6x28 Din	24
"	-	8	Prigioniero	96
"	-	9	Rosette	996
"	-	10	Dado da Intagli m30x2 Din 935 89	96
"	-	11	Coppigli CX55 Din 94	196
"	-	12	Spina Cilindrica 8m6x120 Din 7	48
"	-	13	Seminello di raccomento	24
"	-	14	Piastrina di Sicurezza Con nasello	72
"	-	15	Vite stesta esagonalle m8x18 Din 933m 86	120
"	-	16	Seminello di Fissaggio	24
"	-	17	Spina cilindrica 8m6x14 Din 7	48
"	-	18	Piastrina di Sicurezza Con anello M 8.4 Din 93 St.	48
"	-	19	Cuscinetto delle Bielle	24
"	-	20	Cuscinetto della Bance	24

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Table A-13 (Continued)

GURPO DI CONCHISIONE BV12M350

DESCRIZIONE			QUANTITA (FOR 4 ENGINES)
0108	- 5	Testa Cilindro	6
0108	- 7	Coperchio	48
"	- 11	Guarnizione	100
" b	- 12	Vita a Testgas esagonale M10x12 Din 933m 8G	250
"	- 14	Coperchio	24
"	- 15	Guarnizione JT	50
"	- 16	Vite a Testa esagonale M10x20 Din 933m 8 G	150
"	- 17	Anello di Tenutta A60x68 Din 7603 Cu	50
"	- 19	Anello Di Tenutta	50
"	- 20	Cannotto	24
"	- 21	anello di Tenutta	50
"	- 22	Flangia	24
"	- 23	Prigioniero m14x35 Din 939 - 65	50
"	- 26	Guarnizione Gi Deutz 2	50
"	- 27	Guarnizione 56 DIN 7151161 Deutz 2	50
"	- 28	Entrata acqua	50
"	- 29	anello di Tenutta	50
"	- 30	Vitta Testa esagonale m10x40 Din 933m G	100
"	- 31	Vitta testa esagonale m10x28 Din 933m.G	100
"	- 33	Valvola indicatrice	24
"	- 34	Anello di Sicurezza	100
"	- 45	Santella	24
"	-46	Raccordo	24
"	- 47	Anello di Tenutta	100
"	- 50	Guarnizione Gi Deutz 2	[illegible]
"	- 52	Anello di Tenutta e38x44.Din 7603 Cu	100
"	- 53	Guarnizione	100
"	- 54	Raccorda	50

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Table A-13 (Continued)

VALVOLA DI ASPIROZIONE DI SCARICO
GRUPPO COSTRUZIONE

DESCRIZIONE			QUANTITA (FOR 4 ENGINES)
0108	- 71	Valvola di aspirazione Cost da 0108-76 -77	12
		Contaru Capleti di Valvola Diabastiro di Rottozione Deut.	
"	- 72	Valvola Scarico Costda 0108-75-76-78 Contero Completo Fimo 92-95	12
"	- 89	Anello di Tenuta	48
"	- 90	Anello di Tenuta	48
"	- 91	DI Tenuta A30X38 Din 7603 Gu	36
"	- 93	Anello di Tenuta A35X1,5 ec 73102	48

MOTOORE BV 12M 350

RICAMBI ACCORRENTE PER GRUPPPO 350

N.	100 = Ellemento.Filtro A Cartuccio da Nafta	
"	100 = Ellemento Filtro Turbo Compressore Rotongai	
"	4 = Dinamma Tacchictore della.Tippo GR-122	
"	4 = Contigin Elettrica della uana Tippo - Guarnizione Scarico	100
	Guarnizione aspirizione	800
	Rafri Grante Aria	
	e Sovrallimentazione	
	0123-58- 16 -100	

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Table A-13 (Continued)

ORGANI DI DISTRIBUZIONE PER ASPIRAZIONE E SCARICO
GRUPPO DI COSTRUZIONE

DESCRIZIONE				QUANTITA (FOR 4 ENGINES)
0111	-	45	Perno di guida	48
0111	-	46	Anelle di Tenuta	48
"	-	47	Piastre di Sicurezza	48
"	-	48	Vite a Testa esagonale m12X15 Din 933m8 G	48
"	-	49	Angolare	48
"	-	50	Angolare	48
"	-	51	Vite a testa esagonale m6x12 Din 933m 88	12
"	-	52	Guarnizione	48
"	-	53	Fascetta di Fissaggio	48
"	-	54	Staffa di Fissaggio	48
"	-	55	Vite Testa Esagonale m8X25 Din 933m 88	48

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Table A-13 (Continued)

POMPA DI INIEZIONE
GRUPPO DI COSTRUZIONE BV12M350
(Page 1)

	DESCRIZIONE	QUANTITA (FOR 4 ENGINES)
0117 - 143	Boccola di scorrimento 6X16 DIN 1483	12
" - 144	Molla Elicoidale	12
" - 145	Guarnizione 36 DIN 71511 DUTZ DW 20	15
" - 146	Falangia	12
" - 147	Anello tonda di Gomma	24
" - 148	" " " "	24
" - 149	" " " "	24
" - 150	Sfera ø 10111 DI 5401	48
" - 151	Prigioniero di Dilatazione	48
" - 152	Spina Cilindrica	48
" - 153	Piastrina di Fissaggio	12
" - 154	Accordo A13/10 DIN 7612	1
" - 155	" A16/13 " 7612	10
" - 156	Accordo Orientabile A4 DIN 7623	10
" - 157	" " A6 " 7623	10
" - 158	" " A8 " 7623	10
" - 159	" " A13 " 7623	20
" - 160	Doppio Raccordo Orientanile	10
" - 161	Raccordo 6DIN 7624	10
" - 162	Valvola Per Tenere Costante la Pressione	1
" - 163	Ingranaggio	1
" - 164	Pignone di Fornirai con 0117 -14	2
" - 165	Valvola di Sovrapressione Cost da Corpo	1
" - 166	Prigioniero M10X20DIN 835 - 6,8	1
" - 167	Coperchio Cost da 0117-168-173	1
" - 168	Coperchio	1
" - 169	Guarnizione	1
" - 170	Manopola	1
" - 171	Anello di Sicurezza 16x1 471	6
" - 172	Filtro	6
" - 173	Anello di Tenuta,A12x15,5 Din 7603 Cu	1
" - 174	Serbatoio di Compensazione	2
" - 175	Tubazione del Combustibile	6
" - 176	Tubazione di Troppo Pieno	4
" - 178	Raccordo,Orientabile 212 Din 7607	4
" - 180	dado 16x 26x1,5 Din 7607	10

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Table A-13 (Continued)

POMPA DI INIEZIONE
GRUPPO DI COSTRUZIONE BV12M350
(Page 2)

DESCRIZIONE		QUANTITA (FOR 4 ENGINES)
0117 - 181	Leva di Arresto	4
" - 182	Albero di Arresto	4
" - 183	Tubazione dell'Olio	4
" - 184	Tubazione dell'Olio	4
" - 185	Anello	4
" - 186	Chiavetta Calbirata A8X540 DIN 6865	4
" - 187	Coperchio	4
" - 188	Vite attesta esagola M8X25 DIN 933M8G	12
" - 189	Manicotto Filetetto	54
" - 190	Camma	8
" - 191	Anello di tenotta a.10X13-5 DIN 7603 CU	32
" - 192	" " " a.12X15.5 " 7603 CU	30
" - 193	" " " a.14X18. " 7603 CU	30
" - 194	" " " a.16X22 " 7603 CU	18
" - 195	" " " a.18X22 " 7603 CU	20
" - 196	" " " a.18X24 " 7603 CU	28
" - 197	" " " a.20X24 " 7603 CU	8
" - 198	" " " a.24X32 " 7603 CU	8
" - 199	" " " a.26X31 " 7603 CU	20
" - 200	" " " a.30X36 " 7603 CU	30
" - 201	" " " a.22X27 " 7603 CU	8
" - 202	Leva " Rinvio mz	8
" - 203	Perno	8
" - 204	Spina Cilindrica M 6m6X40 DIN 7	8
" - 205	Vita di testa Esagonale m8X30 DIN 933m8G	8
" - 206	Vite Esagonale m8X65 DIN 931m8G	20
" - 207	Rosetta	8
" - 208	Scatole Per comando ausiliario	8
" - 209	Boccola Per Cuscinetto	20
" - 210	Albero	[illegible]
" - 211	Leva	[illegible]
" - 212	Boccola di screggio 6X36 DIN 1461	8
" - 213	Cuscinetto sfere 6082 Rs DIN 625	12

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Table A-13 (Continued)

POMPA DI INIEZIONE
GRUPPO DI COSTRUZIONE I .2M350
(Page 3)

	DESCRIZIONE	QUANTITA (FOR 4 ENGINES)
0117 - 214	Perno 8X6X22X18,5 DIN 1434	12
" - 215	Leva	12
" - 216	Perno 6X6X22X18,5 " 1434	8
" - 217	Rosetta	8
" - 218	Copio Olio 1,5X15 DIN 84	8
" - 219	Anello	20
" - 220	Anello di Sicurezza 22X1,2 DIN 461	20
" - 221	Coperchio	10
" - 222	Guarnizione	8
" - 223	Vite	8
" - 224	Guarnizione	10
" - 225	Rosetta 13 DIN 125	8
" - 226	Vite a testa Esagonale M12X140 DIN 931 10X	24
" - 227	Manicotto	20
" - 228	Prigioniero M8X35 DIN 835-65	18
" - 229	Pompa Dell'Olio	2
" - 230	Corpo della Pompa	1
" - 231	Perno	1
" - 232	Molla Elicoidale	1
" - 233	Pistone	1
" - 234	Rullo della Camma	1
" - 235	Perno	1
" - 236	Anello di Sicurezza 8x0,5 Din 471	2
" - 237	Spina 6x28 Din 1475	1
" - 238	Filtro a rete Metallica	10
" - 239	Anello di Sicurezza 32x1,5 Din 471	10
" - 240	Guarnizione	10
" - 241	Sfera ∅ 10mm,111 Din 5401	10
" - 242	Molla elicoidale	1
" - 243	Raccordo Orientabile A10 Din 7623	10
" - 244	Guarnizione A16x22 Din 7603 Cu	10
" - 245	Anello di Sicurezza 12x1 Din 471	10
" - 247	Anello Tondo di Gomma	[illegible]
" - 248	Leva	4
" - 249	Guarnizione	15
" - 250	Filtro a rete Metallica	410

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Table A-13 (Continued)

POMPA DI INIEZIONE
GRUPPO DI COSTRUZIONE BV12M350
(Page 4)

DESCRIZIONE	QUANTITA (FOR 4 ENGINES)
0117 - 251 Rosetta	4
" - 252 Vite a Testa Esagonale m6X25 DIN933m8G	4
" - 253 Coperchio	1
" - 254 Guarnizione	1
" - 255 Vite a Testa Cilindrica m8X25DIN912G8	4
" - 256 Rosette Elastica 8DIN7980	4
" - 257 Boccola Filetata	1

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Table A-13 (Continued)

INIETTORE TIPO LORANGE RAFFREDDATO
GRUPPO DI COSTRUZIONE BV12M350

DESCRIZIONE				QUANTITA (FOR 4 ENGINES)
0119	-	100	Iniettore ra treddato Costituito da	12
0119	-	105	Corpo dell Iniettore con Spina Filietatata boccolo Spina Cilindrica (Cost da . 0119-103,104,106,131)	12
0119	-	103	Spina Filetatta	100
"	-	104	Spina Filetata	100
"	-	105	Boccola	12
"	-	107	Vite di registazione	12
"	-	108	Raccorda avvitata	24
"	-	109	Anello Tondo di gomma 16x3	100
"	-	114	Dado d testa esagonale	24
"	-	115	Spina Cilindrica 5m6x16 Din 7	12
"	-	116	Piattello sede Mole	12
"	-	117	Perno	12
"	-	118	Raccorda Per Tubazione di mandata	12
"	-	119	Raccordo Per tubazione di Mandada	12
"	-	120	Raccordo di Passaggio	12
"	-	121	Filtro a rete.Metallia	12
"	-	122	Dado del Polvenzzatore	12
"	-	132	Bossolo Tippo Nafta Pesant	50
"	-	124	Anelle di Tenuta A 38x44 Din 7603 Cu	100
"	-	125	Molla Elicoidale.	12
"	-	127	Vite Cava A6 Din 7623	12
"	-	128	Anello di Tenuta a 12x6 Din 7603 Cu	60
"	-	129	Vite di registrazione	12
"	-	130	Anello di Tenuta A10x14 Din 7603 Cu	60
"	-	131	Spina Cilindrica 6x8 Din 1473	24
"	-	145	Cappello del Polvenzzatore Tipo Nafta Pesante 6x0,5 ø x120	12

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Table A-13 (Continued)

VALVOLA DI TROPPO PIENO MOTORE BV12M350

DESCRIZIONE				QUANTITA (FOR 4 ENGINES)
0121	-	1	Valvola Di troppo Pieno Cost da 0121-2 Sino a 0121- 8	4
0121	-	2	Corpo della Valvola	2
"	-	3	Valvola	2
"	-	4	Vite Vegistrazione	2
"	-	5	Perno di Registrazione	2
"	-	6	Molla a Licoidale	2
"	-	7	Dado 16m 26x1,5 Din 7606	2
"	-	8	Anello di Tenuta A18x24 Din 7603 Cu	2

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Table A-13 (Continued)

DISTRIBUTORE STELLA GER AVVIAMENTO AD ARIA COMPRISSA
GRUPPO DI COSTRUZIONE BV12M350

DESCRIZIONE			QUANTITA (FOR 4 ENGINES)
0130	- 3	Scatola	1
0130	- 5	Boccole da Fornirsi insieme	6
"	- 6	Distributore	6
"	- 7	Spina Cilindrica	6
"	- 8	Rosetta Cilindrica	6
"	- 9	Molla elicoidale	6
"	-10	Tappo	5
"	-11-	Anello di Tenuta A14x32 Din 7603 Cu	6
"	-12	Tappo	1
"	-14	Anello di Tenuta A14X32 Din 7603 Cu	12
"	- 15	Vite a Testa esagonale M10X65 Din 931 m8 G	4
"	-15	Vite Cava m8 Din 7623	6
"	-17	Guarnizione Jto	1
"	-18	Cuffia	1
"	-19	Vite a Testa Esagonale m8X70 Din 931m8G	2
"	-20	Spina Cilindrica 6m6X16 Din 7	

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Table A-13 (Continued)

VALVOLE DI AVRIAMENTO
GRUPPO DI COSTRUZIONE BV12M350
(Page 1)

	DESCRIZIONE		QUANTITA (FOR 4 ENGINES)
'0131 - 7	Corpo delle Valvole	12	12
" - 8	Stelle Delle Valvole	12	12
" - 9	Rosette	12	12
" -10	Cilindretto	-	12
" -11	Pistoncino	12	12
" -12	Fascia E lastica Per Pistoncino A70x3 ec Din 73102 in bronzo		72
" -13	Coperchio Per Cilindretto		12
" -14	Pistoncino	-	12
" -15	Fascia E Lastica	-	36
" -16	Molla Elicoidale	12	12
" -17	Prigioniero ec 16x30 Din 939-6-S	48	48
" -18	Prigioniero ec 14x28 Din 939-6-S	-	48
" -19	Dado Esagonale M16 Din 934-6 s	48	48
" -20	Dado Esagonale M14 Din 934-6S S	-	48
" -21	Anello di Tenuta A14x18 Din 7603 Cu36		36
" -22	Ingrassatore Stauffer	12	12
" -23	Dado ad Intagli M20x1,5 Din 935-S S12		12
" -24	Copiglia 4x40 Din 94	12	12
" -25	Tappo	12	12
" -26	Vite di registrazione A75x84 Din 7603 Cu	12	12
" -27	Anello di Tenuta A75x84 Din 7603 Cu		12
" -28	Cilindretto		12
" -29	Anello Tondo di Gomma	12	12
" -52	Prigioniero ec 16x100 Din 939-6 S		44
" -53	anello Di Tenuta A38x44 Din 7603 Cu		48
" -54	Sede Valvole		12
" -55	Corpo delle Valvole		12
" -56	Stella Valvole		12

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Table A-13 (Continued)

VALVOLE DI AVRIAMENTO
GRUPPO DI COSTRUZIONE BV12M350
(Page 2)

DESCRIZIONE		QUANTITA (FOR 4 ENGINES)
0131 - 61	Pistoncino	12
" - 62	Fascia a Lastica A52x2,5 ex DIN 73102 in bronzo	36
" - 66	Coperchio	12
" - 67	Vite Testa Esagonale mÃ 12 Din 85-55	48
" - 68	Rosetta e Lastica 50 Din 127	48
" - 69	Flangia	12
" - 70	Rosetta Sferica 0 17 Din 6319	24
" - 71	Vite a testa esagonale m16 Din 931 55	24
" - 72	Anelle di Tenuta A10x14 Din 7603 Cu	24
" - 73	Vite di registrazione	12
" - 74	dado di Registrazione	12
" - 75	Vite a Testa esagonale mÃ35 Din 931	12
" - 76	Rosetta e Lastica 35 Din 127	12
" - 77	Dado esagonale mÃ Din 934m 5 8	12

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Table A-13 (Continued)

DESCRIZIONE	QUANTITA (FOR 4 ENGINES)
2	Pompa Completa Autoklav Dalla Majmar, Tipo CP2-40-Volt 3x380 HZ 50 Pressoere M 4 Ata Cod 540 33-91
50	Teste Meccaniche per pompa Majmar Tipo CP2-40
10	Valvole alusmiare dalla Carraro per Calaiaia Tipo GS 30F attacai Entrata Din 25 (1) Tarata A Kg 8 e Uscita Din 40 (1-½)
2	Valvola Servo Comandata Pneumatica Tipo PL 600 Per blocco entrata Combustibile Motore
4	Filtri Fu nafta para elettrica pneumatica Dala Boll Back-Flushing tipo 6,20,1 N°.32 S,N.113 272,
4	Valvola 37T dalla Jlicker, Termopaletra tR 50 37T DN 20 Pressione Max 16 Bar,
4	Valvola 37T dalla Jucker Per Termoespoletone + R 5037T D N 32 Pressione Max 16 Bar
2	Repaletore di Temperatura X Vapore dalla Carraro Dn25-N58401/83,
4	Repaletore di Temperatura X Vapore dalla Carraro Dn25-N58401/83 Campo di Taratura 70 -115
4	Repaletore di Temperatura X Vapore dalla (Avvaro Din 15A N.58444 Campo di Taratura 50-100,
2	Faraio Tubiro per Vapore dalla Kochiaca-U. Bolla Terbav G.N.B2N. 5466 Neustadt /Wied Fabr.N.7744,15.15.83 Heit 30 -28 tipo DWGX - 6, Pressione Max 6 - 16 Bar temperatura Max 150° -00° K CAL/h 28000,

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Table A-14

MECHANICAL SPARES REQUIRED FOR 2 YEARS OPERATION OF CENTRALE DIESEL ENGINES #1 AND #4

Source of Supply: Manufacturer (Italy)

CATALGO D.7761-1 MOTORE BV.6.M.366

QTY. FOR 2 UNITS	DESCRIZIONE		
12	Valvola Aspirizione e Scarico	Fig	1101.1103-11 6
50	Tappi 25X10 Con Anelli	Fig	1124 -1125-1129
16	Valvole Scarico Con Zede Valvole	Fig	1110 -1117
100	Fasce Elastice	Fig	1131
16	Valvole .Sprizione Con Sede Valvole	Fig	1103 -1110
200	Guarnizione Sprizione E Scarico	Fig	1332
2	Coletore di Scarico Complette	Fig	1334 -1371
	Bilancieri		
24	Bilancieri Sprizione e Scarico	Fig	1207 - 1208
10	Aste Bilancieri Sprizione e Scarico	Fig	1255
80	Filhrunge Bilchse	Fig	1216 -1211
20	Anelli	Fig	12156 - 1215
	VALVOLA DI MARCIA		
1	Valvola.Per la Messa Marcia	Fig	5964C - 5999C
4	Dadi ad Intagli	Fig	5995 C
50	Copigli 4 X35 Din .94.	Fig	5988 .C
4	Pistanuie. Di guide.	Fig	5990.C
4	Valvola	Fig	5984 -C
4	Valvola	Fig	5978 .C
8	Molla cilindrica	Fig	5989 .C
20	Anelli di Tenutta	Fig	5992.C
20	Anelli di Tenuta	Fig	5969.C
	VALVOLA PER LA MESSA IN MARCIA		
20	Vite A Testa esagonale. M-16X45 Din 931	Fig	5967 -C
10	Boccole	Fig	5996 -C
50	Fasce Elastice	Fig	5991 -C
50	Fasce Elastice	Fig	5969 -C
10	Perno	Fig	5980 -C
10	Anello di Sicurezza 20X1,2 Din 471	Fig	5981 -C
80	Anello di Tenuta M.16X45 Din 931	Fig	5970- C
10	Filtri a Vete	Fig	[illegible]

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Table A-14 (Continued)

MOTORE BV6M-366
CATALGE BVm-366.D.7761-1 6.CMLINDRI

QTY. FOR 2 UNITS	DESCRIZIONE		
3	Biella Completa	Fig	700 Composta Fig 701-721
24	Cuscinetti Biella	Fig	721
24	Vite Biella	Fig	714
48	Dadi Biella	Fig	715
24	Cuscinetti Banco	Fig	131-132
4	Cuscinetti Banco	"	149-150
4	Serie Di Pistoni	"	600-601-608
4	Serie di Camicie	"	500-501-503
50	Guarnizione Fra testa e Camicie	"	503
100	Anelli di Gomma Camicie	"	502
100	Anelli	"	511
50	Spugli Rubinetti	"	510
4	Serie Fasce e Lastice 420x390x10	"	608
4	Serie Rasechiechie 300A420	"	607
30	Anelli Seeger 180x4 Din 472	"	605

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Table A-14 (Continued)

RICAMBI PER POMPE INIEZIONE
MOTORE DEUTZ-BV6M366

QTY. FOR 2 UNITS	DESCRIZIONE
N. 2	Pompe Iniezione Complette
N. 4	Pompe Alimentazione Nafta
N. 4	Serie Cuscinetti Per Turbo Compressore Brown Boveri
N. 100	Prigionieri Con Dadi Per Portine
N. 5	Rotoli Gomma Sintetica Per Guarnizione da mm.
N. 100	Termometri a 600 Gradi Per Testate
N. 10	Manometri Per Pressione Turbina
N. 50	Valvole By-Pass Complette Per Pompe
N. 100	Anelli Con Bossolo
N. 100	Diaframmi
N. 10	Sonde Smontigliate (Punte Carborundum)

ORIGINALE -GRANA 500 -COMUNA DA Kg 0.5

N. 30	Valvole Aspiranti E Prementi	Fig	1717 -1718-1720-1721
N. 8	Supporto Bilanceri Pompa Combust	Fig	1746
N. 8	Albero " " "	Fig	1741
N. 16	Anelli di Fissaggio B/4-D.705	Fig	1744
N. 16	Pezzo Conico 4X30 Di Spina	Fig	1745
N. 24	Leve Bilanciere Pompa Comb	Fig	1740
N. 48	Perni " " "	Fig	1738
N. 144	Scaccari Pompe Combust	Fig	1737
N. 24	Valvole Di Tromba Piena	Fig	1766
N. 6	Viti Di Pressione Pompa Comb	Fig	1764

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Table A-14 (Continued)

RICAMBI PER POMPE INIEZIONE
MOTORE DEUTZ-BV6M366

QTY. FOR 2 UNITS	DESCRIZIONE		
N. 6	Forcelle " " "	Fig	1735
N. 6	Dado " " "	Fig	1734
N. 24	Punterie " " "	Fig	1727
N. 6	- Motte Co·vene'è by Pres	Fig	1730
N. 24	Forcelle " " "	Fig	1688
N. 24	Fissaggio Punteri P " "	Fig	1608
N. 24	Perni Punterie " " "	Fig	1680
N. 48	Rondelle (Disco) " "	Fig	1681
N. 48	Coniglie " " "	Fig	1682
N. 16	ASTA BILANCERE " " "	Fig	1673-1675
N. 12	PERNO " " " "	Fig	1684
N. 12	SPINA CILINDRICA " "	Fig	1685
N. 24	PEZZO INTERMEDIO " "	Fig	1686
N. 6	CONTENITORE OLIO " "	Fig	1689
N. 25	PISTONI POMPA BAFTA CON BOCCOLA	Fig	1775
N. 10	MOLLE PER POMPANTE	Fig	1762
N. 6	VITE PRESSENTE PER POMPANTE	Fig	1761
N.100	ANELLI DI TENUTA PER INIETTORI	Fig	904
N. 24	MOLLE PER INIETTORE	Fig	911
N. 30	RICCORDI TUBO INIEZ.POMPA INIETTORE		
N.100	GUARNIZIONE DA TESTATA A TUBO SCARICO		
N.100	GUARNIZIONE DA TESTATA A TUBO SPRAZIONE		
N.100	GUANNIZIONE DA TUBO SCARICO TURBINA.		

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Table A-14 (Continued)

ONE EMERGENCY GENERATOR

MOTORE FIOL 7.14.E.BF12L.714

DESCRIZIONE

N.	0144 - 00 -50		16443MIA		
90	358490A0144-011	IP	00889 Anello di Tenuta	0144-01-222-09	
86	3368750A0154 -01	IP	00887 Anello di tenuta	0154-01-09-05, mA, 79	
35	1160383A8929 -40	IP	00887 Anello di Tenuta	L150-172-18.3.2940-51.S.M.2.A-81	4
	0144-00 ,50 .		16 446 .M2B.		
20	335 .8580.K.0144-20	I	00892. Guarnisiene	0144-02-217.30	4
	0144-00 -50.		16447 -MIC		
37	336.5782.K.0152-08	LO	000 36-Tube Scarico Olio	0152 -08 -47 - 10	4
38	116 5994.E 8929-27	10	03402 Anello di Tenuta.	12 X3. 721	5
	0144- 00.		50.16450. MIE		
16	335.9105.K.0144-15	I	02937.Riferegerente Olio.	0144-15-242-20	1
13	336.9037.E.054-15	1	00892.Guarnisiene Per Refegente del Olio.	0154- 15 -05 .14	4
	0144 - 00.		50 16451 M 2E		
24	116 -8469.E.8941-20	I	01385 Elemente Filtrente	P . 3 . 4120 .	1
	0144 -00 .		50.16454 MIF .		
26	128-8402 -E	IP.	02243 . Pompente	1418-425-006A.Sm6F.	4
25	210-3039.E.015-17	IP.	00887 Guarnisiene	1410-210 001 Sm6. F.23	
24	210.3057.E	IP.	00887 Guarnisiene	1410-210 001.S. .6F23	
23	210.3045.E.0150-17	IP	04413 Molle Per Pomente	0150-17-28-07-S.M.6F22	
46	110.9044.E.8844.50	IP	03277. Cuehinete	6205.Dia 625 S.M6F. 26	
47	116.0648.E.8929.40	IP	00887 Anello di Tenuta	A25X47X10,2940-MI S.M.6.F.29	
65	336.8826.E.0154-01	IP.	03541 Spezeta	0154-01-43-21-S.M. 6.F.34	
	0144 - 00		50 -16455 MIF.		
2	336 -9821-0154 -19	IP	01177 Pieferezetere	0154-19-01-02 S -7 F.2	
3	336-6157-E0152-19	IP	00887 Anello di Tenuta	0152-19-01-04 S .7. 73	
1	336.9523.K.0154-19	IP	01182 Parte Pieferezetere	0154-19-06-20-S -7 F 1	

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Table A-14 (Continued)

RICAMBI OCCORRENTI PER.1 MOTORI
DIESEL DEUTS - F10L - 714 C BF12L 714

ONE PORTABLE GENERATOR

QUANTITY FOR ONE UNIT		DESCRIZIONE				
N.	24	Molle Pompanti Pompa Combust - N.2 CAT - 0144-00 MIF				
N.	24	Guarnie Valvolàme	N=24	"	"	"
No	24	Valvolàme Pompa Combust	N=25	"	"	" "
No	24	Pompanti Pompa Combust	N=25	"	"	" "
No	4	Pompette Nafta a Mano	N= 2	"	"	" "
No	3	Serie Tenselli Gomma Pompa Combust		"	"	" "
No	24	Tolvapizzatori N=2 N12F		"	" "	" "
No	24	Anelli N=8 N2F		"	"	" "
No	12	Pistone Cat 0144-00		"	"	" "
No	12	Testate Complete 1110		"	"	" "
No	12	Cilindri Cat 0144,00				
No	24	Valvole Aspirazione N 1 C				
No	24	Valvole Scarico				
No	24	Sedi Valvole Scarico				
No	24	Sedi Valvole Aspirazione				
No	24	Guide Valvole Scarico				
No	24	Guide Valvole Aspirazione				
No	24	Candelette 24 Volt				
No	24	Serie Guarnizione				
No	4	Serie Di Fasce Elastiche -CAT-0144-00 MID				

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Appendix B

PROPOSED MANPOWER TRAINING AND DEVELOPMENT PROGRAMS

1.0 VOCATIONAL AND TECHNICAL TRAINING FOR GENERATION SYSTEM PERSONNEL

- Pre-technician - A formal full-time apprenticeship program shall be introduced both at Centrale and Gezira stations. In addition to on-the-job training, classroom lectures should be conducted. The classroom lectures can either be conducted by the line supervisor or by technical school teachers. Students from technical schools should be encouraged to work at the power plant for one semester of training per year. This will be mutually helpful as the students will receive practical training and plant management will be supplied with qualified new employees.

- Technicians - Course and classroom lectures should be provided to the operators and technicians. The program should place specific emphasis on plant and auxiliary equipment operations; records and data maintenance; generation control, start-up and shut down; maintenance of plant tools and equipment; housekeeping; and preventive maintenance. Particular instruction should be given in the advanced control and monitoring systems required by modern steam plants.

  Supervisory training should also be given to promising technicians and operators who evidence a willingness to accept responsibility. The classroom lectures can either be taught by ENEE supervisors and management staff or by lecturers from technical schools and colleges.

- Supervisors - The training course should offer participants an introduction to the basic management skills required diesel and steam power system operations. The course content should stress design considerations, generation requirements and expansion planning, materials and equipment standards and specifications, load management techniques, construction supervision and work planning, planned preventive maintenance program, implementation of schedule, record data maintenance and budget preparation.

- Managers - Managers should be scheduled for overseas electric utility system generation, transmission and distribution management courses. This experience will provide exposure to state-of-the-art technology and management techniques. Participants should also be offered short-term courses in system and project planning,

construction, operation and maintenance management in Mogadishu. Each development experience would be adapted to the individual manager's need.

2.0 TRAINING PROGRAM FOR VOCATIONAL JOBS

- Operations

  - Substation Operators

    Electric System Operation Theory (Intermediate Level); Protective Equipment Operation; Relay System Operation; Operating Safety and "Red-Taging"; Daily Operating and Outage Reports; Equipment Inspection Routines; and Operator Qualification Examination

- Construction

  - Technicians

    Electric System Operation Theory (Senior Level); Electric System Equipment Standards; Design Standards and Specifications; Relay System Theory and Design; Safety Standards and Manual Preparation; Equipment Operating and Maintenance Manual Preparation; Inspection Routine Documentation; and Qualification Examination Preparation and Administration

  - Linemen (15 kV) Primary

    Climbing Techniques and Lineman Tool Use; Lineman Tool Maintenance; Circuit Security Procedures; Line Hardware Use and Installation Practice; Transformer Installation and Practice; Protective Equipment Installation and Practice; Line Stringing and Practice; and Lineman Qualification Examination (Written and Field)

  - Linemen (380/220 V) Secondary

    Climbing Techniques and Lineman Tool Use (LV); Lineman Tool Maintenance; Secondary Circuit Security Procedures; Line Hardware Use and Installation Practice; Transformer Fusing, Disconnect and Replacement; Service Drop Installation and Practice; Customer Premise Fuse and Breaker Installation; Safety Standards and Practices; and Lineman Qualification Examination

- Maintenance

  - Technicians

Include all under construction training; Cable Testing Procedures and Field Application; Fault Location and Isolation Procedures; Electric Equipment Failure and Analysis Reports; Line Construction and Maintenance Equipment and Tool Inspection, Repair and Replacement Reports; and Development of New Construction and Maintenance Procedures

- Linemen

  Include all under construction training; Equipment Fault Recognition and Isolation Procedures; Equipment and Line Removal Procedures; and Maintenance Reports and Replacement Requisition Procedures

o Craftsmen

- Engine Mechanics

  Diesel Engine Theory (Intermediate Level); Engine Overhaul "Hands-on" Training, including all systems; Fuel, Cooling, Lubricating, Electrical, Transmission, etc.; Use of Engine Diagnostic Machine; Use of Machine Tools for Spare Parts Manufacture; Welding Instruction and Equipment Use; Use of Mechanics Handtools, including maintenance and storage; and Mechanic Qualification Examination (Written and "Hands-on")

- Hydraulic Systems Mechanics

  Hydraulic Control Systems Theory (intermediate); Controller and Pump Overhauling including servo-mechanisms; pilot valves, pump impellers, lines, strainer, reservoirs; Instrument and gauge repair; Test bench procedures; Use of Machine Tools for Spare Parts Manufacture; Use of Mechanics Hand Tools, including maintenance and storage; and Hydraulic Mechanic Qualification Examination (Written and "Hands-on")

- Electricians

  Electrical Control Systems Theory for Mobile Equipment (Intermediate); Electrical Control Inspection, Replacement and Repair, Theory and "Hands-on"; Use of Electrical Control System Diagnostic Equipment; Use of Machine Tools for Spare Parts Manufacture; Use of Electrician's Hand Tools, including maintenance and storage; and, Electrician's Qualification Examination (Written and "Hands-on")

- Tire and Brake Mechanic

  Tire Treatment, Wear, Repair and Replacement Standards; Tire Inspection Procedures and Frequency; Tire Wear Causes, Recognition and Correction and Records; Tire Removal, Replacement and Proper Inflation; New Tire Storage and Inventory; Used Tire Storage and Salvage; Brake System Operation Instruction; Brake System Inspection and Repair and Records; Brake System Testing and Records; and Mechanics Qualification Examination (Written and "Hands-on").

3.0 TRAINING PROGRAM FOR TRANSMISSIONS AND DISTRIBUTION ENGINEERS

- Distribution Protective Devices

  Principles of protection, fuses, breakers disconnect switches, sectionalizers, transformer protection; arc interruption theory; lightning theory and surge arrestors; basic distribution circuits and systems; and reclosure theory and operation.

- Substation Operation and Maintenance

  Protective devices; primary cable installation, grounding, bus connection; control wiring, meter and test equipment, protective devices, station services transfer switches, batteries; circuit breakers, voltage regulators, station capacitor banks, transformers and switching.

- Line Equipment Maintenance

  Basic theory and principles of maintenance; protective devices; AC distribution systems; three-phase connections; power transformer; control system of regulators; distribution line connections; inductance and capacitance and the functions of capacitors.

- Meter Test and Repair

  Electric terms and the watt-hour meter; introduction to testing of meters; single phase and three-phase meters; indicating demand meters; instrument transformer; recording demand meters; station metering and instruments.

- Construction Supervision

  Design theory; standards and specifications for materials and construction; construction techniques; inspection procedures; job training and safety practices; proper record and accounting controls; work planning and scheduling.

4.0 DEVELOPMENT PROGRAM FOR ENEE MANAGERS

- Distribution System Engineering

  Planning and Design - Subject material would include: short- and long-range system planning; construction standards and specifications; equipment specifications; system design (overhead and underground - single-phase and three-phase); system mapping and circuit diagrams; load forecasting; modern load management technology; service area load requirements; substation design; transformer loading; voltage studies; sectionalizing studies; fault current studies and protection coordination.

  Construction - Subject material would include: construction planning; design and specifications materials control; conformance to construction standards; construction supervision; work order procedures; inspection procedures (pole, line, line equipment, substation); and right-of-way clearing.

  Operations and Maintenance - Subject material would include: planned preventive maintenance programs; work plans; distribution equipment operations and maintenance; maintenance records; outage reports; system load analysis; improving the load factor; identifying peak loads; recent developments in load-management equipment technology and its application; materials management; meter test and repair; sectionalizing; line sagging; pole treatment; transformer loading; substation (configuration, operations, maintenance); distribution transformer and circuit reclosure operations and maintenance; regulator operations and maintenance; job training and safety; departmental budgets and work order procedures.

- Materials Management

  This course would be offered to supervision both in the operating departments and to the procurement and stores departments. The subject material would include: inventory control principles (order point, economic order quantity); procurement procedures; procedures for stocking new items; stock records posting (orders and receipts); stock records positing (issues and returns); stock replenishment procedures for material spot checks; procedures for daily report of issues; stock price changes; stock number and cataloging practices; special stores control practices; physical inventory (physical count procedures, reconciliation methods); warehouse safety and security; methods of material accounting.

- Accounting Procedures

  This course would be offered to accounting supervisors in the operating departments and in the finance and administration department. The subject material would be as follows: time, attendance and payroll records; miscellaneous sales (billing for services, cash sales records); maintaining accounts receivable ledgers; billing and accounts receivable procedures (steps in properly recording meter readings, summarizing bills, recording bills in proper ledgers, the monthly sales journal); service contracts (irrigation, street lighting, industrial services); meter reading cards (understanding meter report information and customer service orders); cash receipts (purchases, official receipts, account numbers, cashiers' daily collection reports, preparation of bank deposits, the cash receipts journal, the daily cash balance sheet); accounts payable records; description, preparation, and disposition of accounts payable vouchers; cash disbursements (accounts payable disbursements, payroll disbursements, petty cash funds; installation or construction work orders (additions to plant, retirement or replacement of assets, transportation time charges); special accounting procedures; description of work orders (purchase of new equipment/special equipment, reimbursement work order numbers, distribution system and retirement work orders); journal vouchers (preparation, assignment, posting); materials accounting.

- Auditing

  This course would be offered to accountants from the finance and administration department who would form an auditing section. The subject material would include: purpose of the audit function; scope of the audit and report format; auditing standards (general, field, reporting); preparing for examination of financial records, auditing, and reporting requirements (general reporting, general working conditions of the utility auditor, specific auditing and reporting procedures); audit working paper guidelines; character of working papers and other support documentation (internal control, accounting procedures, review of legal documents, the working trial balance, utility plant/reserve working papers, cash and investments, receivables, materials and supplies, other assets, equity accounts, long-term debt, current and accrued liabilities, deferred credits and reserves, contingent assets and liabilities, revenues, expenses, payroll, other working papers); preparation and organization of working papers; the auditor's report, including supplemental letters and financial statements (balance sheet, statements of review and changes in financial position, notes to financial statements).

- Financial Planning and Cash Management

  This course would be offered to supervisors in the finance and administration department. The subject material would include: financial policies; measuring financial performance; developing financial objectives; techniques in projecting financial ratio needs; forecasting cash-flow requirements; forecasting plant and equipment requirements; work plans and budgets; the balance sheet structure; operating statements; sources and applications of funds statements; techniques for analyzing financial and operating statements; cash and accrual concepts; implementing a financial planning program.

Appendix C

COST SUMMARIES FOR RECOMMENDED PROGRAMS

M4

Table C-1

SUMMARY OF REHABILITATION EQUIPMENT AND ADVISORY SERVICES COSTS

REHABILITATION		
GENERATION		
Rehabilitation Equipment	$2,730,00	
Spare Supply Parts, 2-year	4,030,000	
	$6,760,000	$ 6,760,000
TRANSMISSION AND DISTRIBUTION		
Conversion 3 kV to 15 kV	$1,017,000	
Replace Central City Secondary	$2,160,000	
	$3,177,000	
Mobile Equipment, Vehicle Maintenance Shop	$1,420,000	
	400,000	
	$1,820,000	$ 4,997,0000
	Subtotal	$11,757,000
ADVISORY SERVICES		
Engineering Specifications	$ 32,400	
Procurement	129,600	
Field Supervision Chief of Party, Mech. Engr., Electrical Engr.	372,000	
	$ 534,000	
Subsistence, Transport	81,000	
Subtotal	$ 615,000	$ 615,000
Total Cost		$12,372,000

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Table C-2

COST OF REHABILITATION EQUIPMENT AND SPARE PARTS
CENTRALE POWER STATION

Rehabilitation	
Diesel-Generator Unit No. 5	$ 135,000
Diesel-Generator Unit No. 6	490,000
Diesel-Generator Unit No. 7	375,000
Machine Shop	250,000
Sub-total	$1,250,000
Spare Parts (2 year supply)	
Diesel-Generators, Units No. 1 & 2	$ 200,000
Diesel-Generators, Units No. 5 through 8	800,000
Total	$2,250,000

Table C-3

COST OF REHABILITATION EQUIPMENT AND SPARE PARTS
GEZIRA POWER STATION

Rehabilitation	
Diesel-Generators, Units No. 2 & 3	$1,100,000
Fuel Oil Separator	50,000
Machine Shop	60,000
Steam Turbine-Generator Plant	270,000
Sub-total	$1,480,000
Spare Parts (2 year supply)	
Diesel-Generator Units, No. 1 through 5	$1,900,000
Fuel Oil Separator	50,000
Lube Oil Centrifuge	30,000
Auxiliary Equipment	400,000
Steam-Turbine Generator Plant	650,000
Sub-total	$3,030,000
Total	$4,510,000

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Table C-4

REHABILITATION AND CONVERSION OF THE MOGADISHU
TRANSMISSION DISTRIBUTION SYSTEM
1986-1990

o 35 km, 15 kV OH line @$8600./kM	$ 301,000
o Replace 12,000 kVA, 3-0.38 kV Distribution Transformers with 15-0.38 kV Transformers @ $33./kVA	$ 396,000
o Replace 120 km of 380/220 V Secondaries in "Old City" @ $18,000/km	$2,160,000
o Addition of 8000 kVAR of Shunt Capacitors for Power Factor Improvement @ $40/kVAR	$ 320,000
Total	$3,177,000

(3183H)

Table C-5

REQUIRED CONSTRUCTION AND MAINTENANCE EQUIPMENT

	Estimate Cost in US$
Utility Vehicles	
5 - Vehicles, 4WD, P/U body, 1.5 tons, 6-man crew cab, fully equipped	$125,000
11 - Vehicles, 4WD, P/U body, 1.5 tons, 4-man crew cab, fully equipped	$264,000
1 - Vehicle, 4WD, Van body, 4-passenger (Cable test vehicle)	$100,000
Trucks	
5 - Utility trucks with Boring machine and crane	$255,000
2 - Utility trucks with crane, 8 ton	$98,000
Cranes and Loaders	
2 - Mobile cranes, 15 tons, for rough terrain	$190,000
2 - Forklift trucks, 5 tons diesel	$64,000
Miscellaneous Equipment	
1 - Cable trencher	$100,000
3 - Cable reels with tensioners	$60,000
3 - Line conductor pullers	$80,000
2 - Pole trailers with tractors	$64,000
8 - Jeeps	$120,000
Vehicle Maintenance Shop (equipment only)	$400,000
- Engine diagnosic machine	
- Valve grinding machine	
- Injector testing equipment - diesel	
- Tire maintenance equipment	
- Drill press, lathe, milling machine	
- Air compressor, electric	
- Welding machine	
- 2 sets of engine mechanics tools	
Total	$1,820,000

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Table C-6

ESTIMATED COST FOR 15 MW STEAM TURBINE PLANT
GEZIRA POWER STATION

FROM SGI REPORT OF AUGUST 1983, TABLE 106
STEAM TURBINE SET NO. 2 COSTS:

	Foreign	Local	Total ($x10^6)
Based on December 31, 1983, SoSh	239.33×10^6	7.90×10^6	247.24
Based on December 31, 1983, $ (@ 15 SoSh = $1.00)	15.96	0.52	16.48
Escalated to middle of 1987 (3.5 yrs. @ 5% = 1.186)	18.93	0.62	19.55

Escalation of Plant Cost @ 5%/yr
From mid-1987 to end 1989

And cash flow @	7%	for first 6 months	= 19.55 x .07 x 1.0125	= 1.39
	33%	for next 12 months	= 19.55 x .33 x 1.05	= 6.77
	60%	for next 12 months	= 19.55 x .6 x 1.1	= 12.90
	100%	30 months		21.06

Escalated to middle of 1991 (4.0 yrs. @ 5%)	23.0	0.76	23.76

Escalation of Plant Cost @ 5%/yr
From mid-1971 to end 1993

And cash flow @	7%	for first 6 months	= 23.76 x .07 x 1.0125	= 1.68
	33%	for next 12 months	= 23.76 x .33 x 1.05	= 8.23
	60%	for next 12 months	= 23.76 x .6 x 1.1	= 15.68
	100%	30 months		25.59

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Table C-7

EXTENSIONS TO T&D SYSTEMS
1990-1995

(Excludes Line Drops, Service Entrances and Meters)

MOGADISHU		
o	10 km - 33 kV OH line from Centrale and 21 Oct. SS to New East S.S. @ $9,000/km	$ 90,000
o	New East S.S., 33-15 kV, 10 MVA @ $1,510,000	$1,450,000
o	Additional Switchgear at Centrale and 21 OCT. S.S.	$ 60,000
o	38 km, 15 kV OH Line @ $8600/km	$ 327,000
o	28 MVA, 15 - 0.38 kV Distribution Transformers @ $33/kVA	$ 924,000
o	28 km, 380/220 V Secondaries @ $18,000/km	$5,040,000
o	4000 kVAR, Shunt Capacitors for Power Factor Improvement @ $40/kVAR	$ 160,000
	Total	$8,051,000
AFGOI		
o	7 km, 33 kV OH Line @$9000/km	$ 973,000
o	3 km, 15 kV OH Line @ $8600/km	$ 26,000
o	3.2 MVA, 15 - 0.38 kV Distribution Transformer @ $33/kVA	$ 106,000
o	32 km, 380/220 V Secondaries @ $18,000/km	$ 576,000
o	1.6 MVA, 33-15 kV Substation	$ 202,000
	Total	$ 973,000
BALAD		
o	45 km, 33 kV OH Line @ $9000/km	$ 405,000
o	3 km, 15 kV OH Line @ $8600/km	$26,000
o	8 MVA, 15 - 0.38 kV Distribution Transformer @ $33/kVA	$ 264,000
o	80 km, 380/220 V Secondaries @ $18,000/km	$1,440,000
o	4 MVA, 33-15 kV Substation	$ 505,000
	Total	$2,640,000

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Table C-8

SUMMARY OF THE COSTS TO MANAGE AND SUPERVISE A TWO-YEAR ENEE VOCATIONAL TRAINING PROGRAM

SALARIES		
Expatriate Manager	$268,800	
Three, Expatriate Supervisors	$672,000	
	$940,800	$ 940,800
Housing, Transportation and Miscellaneous Costs	$330,400	$ 330,400
		$1,271,200

Table C-9

SUMMARY OF THE COST TO PROVIDE TWO-YEAR ENEE MANAGEMENT ADVISORY SERVICES PROGRAM

SALARIES		
Expatriate Manager	$268,000	
Five, Expatriate Specialists	635,000	
	$903,000	$ 903,000
Housing, Transportation and Miscellaneous Cost	$495,600	$ 495,600
		$1,398,600

(3183H)