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Final Report

Technical Assistance to the National Electricity Corporation, Sudan

Rehabilitation of the Blue Nile Grid Project Specification Phase

U.S. AID Contract DAN 5724-C-00-1085-00

Bechtel National, Inc.
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CONTENTS

Section 1

SUMMARY

1.1 BACKGROUND

Since the Blue Nile Grid (BNG) of the National Electricity Corporation (NEC) supplies approximately 80 percent of the electrical energy demand in Sudan, improving the availability of power plants supplying the grid and improving the reliability of the transmission and distribution system are of major concern to NEC management and the Government of Sudan. The Burri Power Station diesel generating units require major overhaul, steam boilers and turbines are in need of major rehabilitation, and plant telecommunications are in a state of disrepair. The Kilo X Gas-turbine Power Station requires a significant restoration of spare parts inventory, and both the Roseires and Sennar Hydro Stations are threatened with outages due to a serious lack of spare parts.

In 1981, there were twenty (20) major outages in the BNG transmission system. Thirteen (13) of these power failures were due to outages in the 220 kv transmission line from Roseires to the Kilo X Station and four (4) were as a result of faults in the 33 kv subtransmission system. The lack of proper communications equipment contributes heavily to the duration of power outages, and coordinating effective load-shedding has been inhibited by lack of timely communications during overload periods.

At present, the mobile equipment available and in use by NEC forces for construction and maintenance is inadequate in quantity. Consequently, preventive maintenance and scheduled repair programs are curtailed because of emergency work demand. Also, in many instances the mobile equipment is in a poor state of repair due to a lack of spare parts. These conditions have been a major factor contributing to the lack of reliability of the power system, particularly with respect to the length of outages when they occur.

In response to the pressing need to improve the reliability of the Blue Nile Grid (BNG), USAID requested that Bechtel send a four-man Team to inspect the BNG and, with NEC management, to develop a priority commodity list including critically needed power system equipment, telecommunications equipment and mobile maintenance and construction equipment. The equipment, together with technical services including specifications, design, procurement, inspection and installation which would lead to the rehabilitation of the BNG, were to be defined. Preliminary estimates of cost and schedule were also to be supplied.

The USAID Mission had hoped that commodity identification, specification, procurement and installation for a large number of the critical commodities could be completed by the late summer of 1982 to alleviate power shortage conditions. However, in the course of discussions in Sudan it became apparent to the Team that the Commodity Import Program (CIP) funding arrangements, USAID and Government of Sudan procurement procedures, and commodity lead-time from purchase to delivery would not permit operation of the first of the critical commodities before November 1982, based on bid requests initiated in April 1982. Furthermore, since the commodities do not include additions to generation capacity, load-shedding will still be required even with an improved transmission and distribution system. It is imperative, however, that the BNG transmission and distribution systems be rehabilitated as soon as possible to reduce frequency and duration of system outages.

1.2 TECHNICAL ASSISTANCE ACTIVITIES

This Specification Phase (Phase 0) of the Blue Nile Grid Rehabilitation Program initially was to have consisted of seven tasks as follows:

Task 1: BNG System Inspection
Task 2: Preparation of Rehabilitation Commodity Lists
Task 3: Specification of Commodities
Task 4: Bid Requests and Evaluations

Task 5: Commodity Selection and Maintenance Program Rationale

Task 6: Organization Planning Counseling Service

Task 7: Summary Document

However, AID/S&T/EY and the USAID Mission, Khartoum, later decided that Phase 0 would include only Tasks 1,2,3,5 and 6. Task 4 was to be included in a subsequent Implementation Phase (Phase I) and would be funded under the CIP Program. Task 6 was completed in Sudan in February 1982, and a copy of the interview notes and an Organization Planning and Management Services Stage of Work was left with the Program Officer, USAID Mission, Khartoum and accepted as fulfillment of Task 6 requirements.

1.3 OBJECTIVES AND BENEFITS

The objectives of the rehabilitation program set out in the Work Plan, dated May 1982, were approved by both AID/S&T/EY and the USAID Mission, Khartoum. The objectives were as follows:

- Improve the reliability of the Blue Nile Grid (BNG) by replacing faulty power system equipment and providing an adequate inventory of spare parts.
- Reduce the duration of power system outages by improving the telecommunications systems and replacing and augmenting mobile construction and maintenance equipment for lines and substations.
- Define the rationale used to determine the selection of replacement of power equipment, the extent of spare parts inventory, the augmentation of mobile maintenance equipment and replacement and additions to telecommunications equipment.

The benefits to be derived from the rehabilitation program were expected to be:

- A level of system reliability which will provide satisfactory service to NEC customers within the BNG generating capacity.
- Improved level of power system equipment availability.
- Improved preventive maintenance, reducing the frequency of outage and equipment failure.
- Increased revenue to NEC due to greatly foreshortened duration of outages when they occur.

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By improving the reliability of the public power system, a number of additional benefits would be forthcoming to the national economy as a whole:

- Reduce dependence upon small emergency diesel generators by private individuals, manufacturing companies, etc.
- Consequent reduction in the consumption of imported oil and refined products as a greater reliance upon hydroelectric power was achieved.
- The improvement of the supporting public infrastructure, which this project represents, is an essential first step towards attracting foreign investment to Sudan.

The Phase 0, Specification Phase, was successfully completed in August 1982, with the submission of specifications for priority equipment for the immediate rehabilitation of the BNG. The specifications appeared in the original edition of this report.

1.4 PHASE I, BLUE NILE GRID REHABILITATION PROGRAM

As a continuation of the BNG rehabilitation program, in July 1982, Bechtel entered into a contract, known as Phase I BNG Rehabilitation Program, with the USAID Mission, Khartoum, to provide NEC with procurement, installation, start-up and initial operation services for the commodities selected by NEC and approved by USAID Mission, Khartoum in Phase 0. Bechtel completed its Phase I services in Khartoum in mid-July 1984. A final report of these activities was submitted to the Energy Officer, USAID Mission, Khartoum, on October 18, 1984.

The specific objectives for Phase I, as listed in the final report, were to provide:

- Engineering services,
- Procurement services,
- Delivery services, and
- Field installation services

to the National Electricity Corporation for all equipment to be installed

under Rehabilitation Program. These services included: detailed specification writing; preparation of lists of recommended vendors and suppliers; issuance of invitations for bid or requests for quotation; review and evaluation of bids or quotations; making contract or purchase order award recommendations to NEC; inspecting and expediting deliveries; coordinating transportation to Sudan; related engineering services; and assistance during installation.

The program achievements and benefits realized by the conclusion of Phase I were summarized in the October 18, 1984 Final Report and are included in this Final Report in Appendix A, Phase I Achievements and Benefits.

1.5 PROCUREMENT ADVISORY SERVICES

Concurrently with Phase I BNG Rehabilitation Program, Procurement Advisory Services were provided under this contract (DAN 5724-C-00-1085-00). The advisory services were directed toward achieving effective NEC operation and management in the areas of purchasing, stores, inventory control and dispensing functions. Also, extensive effort was applied to on-the-job training of clerical and supervisory personnel. The Bechtel Advisor's activities supported two major tasks:

- Strengthening of NEC Purchasing and Inventory Management Capabilities through;
  - Function Reorganization
  - Stock Identification System
  - Inventory Control
  - Facilities Improvement
- Stock and Procedures Standardization through;
  - Stock Classification and Consolidation
  - Inventory Procedure Revision
  - Economic Ordering System Installation
  - Obsolete Item Disposal System Revision

The final report for the Procurement Advisory Services effort was submitted to Mr. Charles Bliss, United States International Development Cooperation Agency, Agency for International Development, Washington, D.C. on September 18, 1984.

Section 2

SUDAN FIELD TRIP

2.1 INITIAL NATIONAL ELECTRICITY CORPORATION DISCUSSIONS

On Sunday, February 7, 1982, the Bechtel Team met with Mohammed Nasar Abu Bakr, Director of Electricity, National Electricity Corporation (NEC), and his senior managers to discuss NEC's immediate interests in the rehabilitation of the Blue Nile Grid (BNG) and assistance in the reorganization of NEC in anticipation of the separation of the electricity supply and water supply functions into two separate government corporations on July 1, 1982. Each member of the Bechtel Team was introduced to his counterpart manager in NEC and working relationships were discussed.

2.1.1 BNG Rehabilitation

Director Abu Bakr presented a list of commodities which had been prepared jointly by NEC and Energy Development International (ED/I), under USAID contract, including the total electric supply industry in Sudan. He stated that only commodities for the BNG were to be considered in the initial rehabilitation effort. He understood that up to $20 million would be available from USAID for commodities and associated technical services under the CIP Program. He requested that, by means of a careful inspection of the BNG and consultation with NEC counterpart managers, the Bechtel Team prepare a prioritized commodity list for his review and approval. It was agreed that the list would include three general groupings (1) Power System Equipment (2) Telecommunications Equipment and (3) Mobile Line Construction and Maintenance Equipment.

2.1.2 Management Assistance

Director Abu Bakr requested that the Bechtel Team prepare a functional organization chart for the proposed new National Electricity Corporation recognizing the Government of Sudan's (GOS) recent decision to regionalize the country. He asked also that the Bechtel Team develop an abbreviated Work Plan and schedule for a management assistance program consisting of four phases: (1) Development of a preliminary organization with a Work Plan for the remaining three phases (to be done in Khartoum before Team departure), (2) Management audit, organization structure, function descriptions and position descriptions, (3) Systems and procedures definitions, automated system definitions with implementation schedules, and (4) System and procedures installation together with a Management Development Program.

2.2 INITIAL USAID/KHARTOUM DISCUSSIONS

On Monday, February 8, 1982, the Bechtel Team met with Arthur Mudge, Mission Director; Keith Sherper, Deputy Director; James Beebe, Program Officer; and Stephen Mintz, Projects Officer, to discuss the Mission's goals in the short-term rehabilitation program for the BNG. The Director emphasized that a reliable electric power supply in the BNG was politically important to the GOS and the hope was that improvement could be achieved by the 1982 system peak (July, August). The Team emphasized to Director Mudge that there was very little that could be done to improve system reliability by the 1982 peak, since equipment procurement and installation lead-times would, on the average, be six months.

The Director stated that financing would be available under the Commodity Import Program (CIP) and that as much as $20 million could be designated to BNG rehabilitation. This was established as the target in developing a prioritized commodity list. He instructed the Team to work with Ted LaFrance, USAID Procurement, in developing the commodity list and procurement procedures.

Director Mudge emphasized that the GOS was seriously undertaking the decentralization of government into nine regions. Infrastructure, such as electric power supply, would also be decentralized. Therefore, any work the Team would do in reorganization of NEC must recognize a decentralized power supply industry.

Later in the day, the Team met with Ted LaFrance to discuss the overall procedure of commodity funding, specification, procurement, shipment and installation. NEC, USAID (Khartoum) and USAID (Washington) work closely throughout the entire process. The Team emphasized that a company like Bechtel should undertake the entire program, but LaFrance said this woul be difficult under present USAID procurement regulations. Exceptions have been granted rarely.

2.3 BLUE NILE GRID INSPECTION

In the period February 9 through February 23, 1982, the Team visited the major generating stations (hydro and thermal) and major substations, and examined 220 kV, 110 kV and 33 kV transmission and subtransmission lines. The Khartoum Load Dispatch Center was inspected, telecommunications at each plant and substation were examined, warehouses and repair shops were visited, and the condition of mobile construction and maintenance equipment was determined. Inspection trips extended from Khartoum North to Sennar and Rosieres in the south and Kosti in the west. During all of these trips extensive discussions were held with area, plant and substation managers on the subjects of operation, maintenance, communications and spare parts problems.

Upon returning from each of the several field trips, the information on operation, maintenance, telecommunications and spare parts was discussed with appropriate managers at NEC headquarters to corroborate commodity and technical assistance needs throughout the BNG.

2.4 BNG POWER SYSTEM EQUIPMENT REQUIREMENTS

The conditions observed in the BNG which relate to its reliability and rehabilitation requirements are summarized below under the categories of generation, transmission, distribution, system losses, system protection, and computer system analysis.

2.4.1 Generation

Steam Stations. The existing Burri Steam Station has 30 MW (10-10-5-5 MW) nameplate capacity. A 10 MW steam turbine was down for repair. Two boilers are being rebuilt and should be ready for the summer peak. These steam units are low pressure and temperature, inefficient units with heat rates between 17,000-21,000 Btu/kWh. They have had twenty-five years of abusive service and, except for the emergency, would not justify the extensive boiler repair now being undertaken.

Diesels. The 13 MW of newer diesel capacity should be reliable power for the summer peak. The 6 MW of old Merlees Diesels that are in service are of questionable reliability if called upon for sustained emergency operation.

Hydro. The Roseires turbines and generators are in reasonable condition, but total capacity available to Khartoum will be effected by total water flow, relative head and the 220 kV transmission system availability. Considering the hydro turbine-generators themselves, the effective head has been the principal output restriction. The Sennar Hydro Units are in good condition but several service water pump runners are in poor repair and must be replaced, or serviced soon, to assure reliable output.

New, Immediate Generation. The Bechtel Team restricted itself to the investigation of two 5 MW mobile trailer-mounted gas-turbine generators and a 30-35 MW skid-mounted gas-turbine generator.

The 5 MW mobile units are low efficiency units. If off-the-shelf units are available, they could possibly be installed before the 1982 summer peak. However, no off-the-shelf units could be located in the course of the study.

The 35 MW unit appeared to be an attractive possibility since General Electric had a unit which could have been available for shipment in June, arriving in Khartoum mid-September with installation in 5 months for a possible start-up in mid-February 1983. The unit would be derated to 27.5 MW for elevation and temperature conditions at Khartoum. The unit has an excellent heat rate (12,000 Btu Full Load to 15,000 Btu 1/2 load) and could be used as a baseload unit. It also could be combined later with a similar gas-turbine to fire a waste-heat boiler to supply a 30 MW steam-turbine unit. The heat rate of the combined cycle would be in the order of 9,000 Btu per kWh, far superior to most 500-1000 MW steam-turbine units.

2.4.2 Transmission

Although the 220 kV transmission system is basically a well-built, lightly loaded, low loss system (even at peak loading) it has the following weaknesses:

- Single, radial 305 mile line from Damazin supplying the principal power to Khartoum
- Sixty percent of the line from Kilo X to Sennar Junction is at present operated as a tapped line with only 2nd and 3rd zone, relatively slow speed relay protection. The one 220 kV line breaker at Meringan has a ground on the protection circuit so it is out of service.
- Several components such as CT's and compressors (for air blast breakers) have had a high failure rate (also one 220/110 kV transformer failure).
- NEC has the following reasonable System Operation Rule: No matter how a 220 kV line breaker is opened, if the station is out of direct communication with the system, the breaker may not be reclosed and the Khartoum System is effectively down until communications are restored. This could be a period as long as 8-10 hours.

- The 220 kV line when operated at peak load is only loaded to 74% of surge impedance capacity (100 vs 135 MW). The excess MVAR are absorbed by 11 kV reactors and the Khartoum load.

- Due to long dry periods, the 220 kV line is subject to some insulator flash-overs. This does not seem to be a serious problem, as is common with systems slightly exposed to coastal areas. Due to the long period required for a flash-over path to deionize, reclosing has been discontinued.

- 11 kV Reactor Switching Breakers used for the 220 kV system have had problems in opening the reactor current. These breakers may be operated several times a day in normal operation.

2.4.3 Distribution

33 kV Distribution. Six Polish, double-loop fed 5 MVA transformer, 33/11 kV substations are seriously over-loaded. There are no loop breakers, so a complete feeder is lost for any 33 kV transmission or cable fault. To alleviate these problems, twelve 10 MVA 33/11 kV transformers are required with six 35 kV class breakers.

33 kV cables and overhead lines are overloaded to the point that the 33 kV system requires additional feeders and resizing of other feeders. Also, 33 kV is too low a voltage for the loads and distances involved, therefore requiring larger cables and conductors and a larger number of substations.

The 110/11 kV, 15 MVA transformer at El Rahad has been moved to a new load center and temporarily replaced by a 7.5 MVA transformer which is too small. A 15 MVA transformer will be needed to return El Rahad Substation to its original size.

11 kV Distribution. The 11 kV Distribution System is in the poorest condition of all of the components of the Blue Nile Grid. This is caused principally by the following conditions:

- Too small cables and conductors have been installed
- Feeders are over-extended

Little power factor correction has been installed on either the primary feeders or large secondary loads.

2.4.4 System Losses

The Blue Nile Grid System has total losses of about 15-17% with the largest single component of loss occuring in the 11 kV and secondary distribution systems.

With the high cost of generating capacity and fuel in Sudan, total syste losses (from net generated kWh to total metered kWh) should be about 9-12%. System losses should be reduced by 6% which would effectively increase capacity 10-12 MW (at the load, as the largest gain would be in the distribution system). The distribution system losses will be significantly reduced by larger cable and overhead conductor sizes.

It is difficult to locate precisely the capacitors required to improve the poor system power factor without a thorough study, but it is felt th largest proportion should be installed at 11 kV level (100 MVAR - 1/2 switched and 1/2 unswitched) and 20 MVAR at the 33 kV level. A thorough study should be made to determine the optimum location for the capacitor banks to improve both voltage regulation and distribution system losses.

The use of larger-than-normal conductor sizes (because of high fuel cost for losses) plus judicious placement of switched and unswitched capacito banks should significantly raise effective system generating capacity an reduce voltage regulation.

There are at present few if any sectionalizing switches in either the 11 kV or 33 kV systems. These switches are essential for trouble-shooting, emergency service and normal maintenance.

2.4.5 System Protection

NEC has no relay test, application and repair facility. Such a facility with trained personnel is very necessary to proper application and coordination of relays for transmission and distribution system protection. Although the fault records are not detailed enough to pinpoint actual false relay trips, the records do indicate that there is some lack of coordination of relay settings.

To alleviate this situation, two sets of semi-portable relay equipment were placed on the Priority Equipment List. One set would be for a permanent installation and one set to be used at remote stations, although a relay application group is often a separate group from the test and maintenance group. One engineer in the combined group could handle relay application work as part of the protection group.

In the radial system with any 220 kV breaker opening, the system is often lost for extended periods of time regardless of how fast a fault may be cleared. This may have led to a tendency to accept improper relay settings and to make some system changes long-term instead of immediate and also not to correct relay and supervisory circuit faults quickly. Relay setting and maintenance should be on a regularly scheduled basis with adequate spare parts to properly maintain the equipment. The difficulty in getting replacement parts has been a serious problem for NEC relay maintenance personnel.

Transmission Relaying. There is some indication that the XCG Zones could be over-reaching.

Distribution Relaying. The definite-time relays cannot be coordinated and should be replaced. This should eliminate some unnecessary tripping of distribution feeders.

Metering and Lighting Control. The kWh meters presently used are of poor quality. The tendancy for these meters is to be erratic and also to develop friction, reducing the kWh readings. However, it is not possible to replace these meters even though it might be desirable. The demand meters requested will make possible the placing of a proper charge for poor load factor, reducing load and increasing revenues.

Street lights, automatically controled, should reduce the total kWh used, but should not appreciably effect system demand. Normally, street lights are controled by a photoelectric control circuit. Considerable maintenance may be involved in servicing the light controls but the controls are necessary.

2.4.6 System Analysis Computer and Software

System and machine constants must be organized in an accurate and systematic manner to properly apply system data for computer application in any system analysis.

The changes in computers are so rapid at this time that a thorough study must be made so that a reliable, flexible computer and software is selected.

2.5 BNG TELECOMMUNICATIONS EQUIPMENT REQUIREMENTS

2.5.1 Power Line Carrier Network

After visiting the major BNG sites, and following discusions with NEC managers, it became evident that the lack of communications contributes heavily to the duration of power outages and, to a lesser extent, is directly responsible for them. This results when operations personnel cannot coordinate activities, such as load shedding, during periods of overloading.

After reviewing the existing Power Line Carrier (PLC) Network it was deemed reliable except for those instances when the transmission lines suffer catastrophic damage. In view of this, no action was recommended at this time to provide additional PLC equipment except for spare modules and critical components. Any effort to expand the PLC system capability, other than the provision of spares, would be outside of the time frame of this project. It was felt that the best approach to near-term improvement in communications would be the establishment of a parallel route totally independent of the transmission lines. It was recommended that this be accomplished by installing an HF-Radio network with the command control center located at the Khartoum Load Dispatch Center (KLDC).

2.5.2 HF System

The data required for a feasibility study of an HF System was gathered and transmitted to the Bechtel Telecom Group in San Francisco for computer analysis. This analysis determined the availability and reliability index for twenty-four hour coverage throughout the BNG based on frequencies allocated to NEC. This in turn determined the viability of this approach.

In the event that an HF System does not prove to be feasible, then an alternative would be a very extensive and expensive VHF Repeater Network. This would involve a considerable amount of time, field studies, site selection, frequency coordination and engineering. It is not anticipated that this alternative will be required.

It should be noted that the establishment of an HF network is not as desirable as a microwave system paralleling the transmission system. It is not intended that the HF system serve in place of microwave links which have been proposed in long-range studies and recommendations by others. The HF system will not offer the many advantages found in a comprehensive microwave system and its use is looked upon only as an interim solution to immediate telecom problems.

2.5.3 VHF System

In conjunction with the installation of an HF system, it is recommended that a new VHF system be installed at those sites which are listed in the Priority List. The HF system would be used only for contact between KLDC and key control points throughout the BNG while the VHF system would serve the mobile communications required to dispatch and control maintenance crews within specific maintenance areas. It is recommended that the existing Telefunken VHF radios operating on 86 MHz frequency be phased out. They could be reassigned to other use in rural areas which have no mobile radio service. The recommended VHF system would operate in the 157-158.4 MHz band. These frequencies are currently licensed to NEC.

2.5.4 DC Power Supply

The existing 24 VDC power supply used to serve the PLC system is in poor condition and is operating in most cases from single rectifiers. The VHF radios operate from a low output 12 VDC trickle charger and a single car battery of standard capacity. It is recommended that this situation be corrected under the present task by installing new dual 24 VDC rectifiers with a higher rated output and new 24 volt lead-antimony batteries designed to carry the station load during power failures for a minimum of 8 hours. The 24 volt battery would power the PLC directly and would provide 12 VDC for the VHF radio through the use of DC-DC converters or CEMF cells. Less critical stations do not warrant new DC power plants but do need higher ampere capacity. This could be solved by relocating the low-rated rectifiers, which are being replaced, to these less critical stations and operating them in parallel with the existing units.

2.5.5 Voice Frequency Cable

The voice frequency cable which now provides the communications link between KLDC and Burri Power Plant is in poor condition with frequent interruptions due to physical damage. It is recommended that a subscriber radio be installed to serve as the primary system for this

link. The system would operate in the 1.5 GHz band and will require that NEC obtain a license from the Ministry of Communications before any action can be taken. This matter will require the asistance of NEC authorities at high level and should be given immediate attention. The subscriber radio would provide telephone service between KLDC and Burri on an automatic basis. It could also provide a remote control link between KLDC and the HF radio transceiver site which should be located outside of town near the Khartoum North Station. To provide better HF communications, it is recommended that the antennas (due to their size) and the transceiver be located in an area such as that adjacent to the new Khartoum North KLDC site. This would reduce radio frequency and electro-magnetic interference found in an urban area. Locating the HF site near Khartoum North KLDC will also require NEC to obtain land use permits for an area approximately 80 by 100 meters. The frequency approval for 1.5 GHz band and land use permits will have to be resolved before final specifications for the HF system can be released.

2.5.6 Burri Power Plant Communications

At this time, the Burri Power Plant is operating without internal communications. It is planned that a low-line (30 line maximum) electronic Private Branch Exchange (EPBX) be installed. The installation would include all internal wiring in the plant; it would also include new telephone sets with Klaxon horns and light annunicators for signaling at most locations to overcome high ambient noise levels.

2.5.7 Administrative Headquarters

The internal telephone system in the Khartoum administrative and engineering offices is virtually nonexistent. At one time there was an operational step-by-step exchange in the building but it is now in a state of total disrepair. It is planned that a new EPBX, including all building wiring and telephone sets, be installed. The existing telephone room will have to be completely rehabilitated and the old exchange removed. This work should be accomplished by NEC personnel and can be

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started immediately. A new EPBX can not be installed in the room in its present condition. The new system would allow calls to be placed directly to Burri over the proposed subscriber radio link referred to above.

2.5.8 Technical Development

After review of the NEC Telecommunications Maintenance Department, it is evident that there are several areas requiring immediate attention. The most critical of these is in staffing. In a work force of 14,000, there are less than 10 engineering - trainees assigned to the telecommunications section. The technical staff should be expanded with technicians who are dedicated solely to communications. With the installation of new types of radio equipment, electronic PBX's and telex facilities, it will become extremely important that NEC exercise every means possible to improve the level of skill in this area.

It is recommended that the telecom maintenance organization be allocated a new vehicle dedicated to its use. In conjunction with this, duplicate sets of test equipment should be specified; one set should be permanently assigned to a centrally located station in the south while the other would remain in the KLDC Maintenance Center.

2.6 MOBILE CONSTRUCTION AND MAINTENANCE EQUIPMENT REQUIREMENTS

2.6.1 Mobile Equipment

At present, the mobile equipment available and in use by NEC forces for construction and maintenance is inadequate in quantity. Also, in many instances the mobile equipment is in a poor state of repair due to a lack of spare parts or because work demand prevents release of the mobile equipment for preventative maintenance and repair. This situation is a major factor contributing to lack of reliability in the power system, particularly with respect to the length of outages when they occur. For example, a break in a major transmission line may require moving equipment several hundred kilometers in order to make repairs. Also, lack of equipment contributes to reduced efficiency causing higher costs, less productivity and delays in completing needed work.

Providing the needed equipment for construction and maintenance should be one of the fastest ways of improving the reliability of the power system, and equally important, reducing the duration of outages when they do occur.

2.6.2 Repair Centers

The work shops and repair centers at NEC headquarters, area centers and power plants are under-equipped, and existing equipment is in a serious state of deterioration. The "housekeeping" in the repair centers is very poor and maintenance records on vehicles are either non-existent or poorly maintained.

Upon completion of field investigations, the NEC Technical Services Manager and the Assistant Director for Transport, with input from their subordinates in Khartoum and the areas, reviewed the existing equipment and the need for additional equipment for construction and maintenance of the system. From this review, a list of required equipment was prepared which included:

- Mobile cranes and fork-lifts
- Utility trucks with cranes, augers, aerial baskets
- Transporter trucks - tankers, trailers
- Utility vehicles and tractors
- Cable reel carriers
- Line conductor tensioners
- Trenchers
- Dielectric filter machine and test sets
- Buildings for service centers
- Service center equipment.

2.7 DETAILED COMMODITY LISTS FOR BNG REHABILITATION

Detailed Commodity Lists for Power System Equipment, Telecommunications Equipment and Mobile Construction and Maintenance Equipment for BNG Rehabilitation were completed and reviewed with NEC management on February 25, 1982. The approved list was submitted to James Beebe, Program Officer, USAID/Khartoum on February 26, 1982 and to Charles Bliss, Energy Office, USAID/Washington on March 5, 1982. The Commodity Lists are included in Appendix A.

Section 3

CRITERIA FOR EQUIPMENT SELECTION FOR EFFECTIVE BNG REHABILITATION

3.1 INTRODUCTION

Since the Blue Nile Grid is in immediate need of rehabilitation in order to improve the grid reliability and grid component availability, the equipment which will provide the most significant and immediate improvement in reliability and availability must be identified. The entire grid including generation, transmission and distribution is in dire need of replacement equipment and spare parts. The program to be supported by USAID, however, has been limited to the transmission and distribution systems rehabilitation. Fuel supply systems and generation plant are being investigated by other donors. The limits defined for the transmission and distribution systems extend from the high-voltage side of the power plant generator transformer to the distribution system primary voltage. Consideration is to be given to (a) direct replacement of inoperative or failing transmission and distribution equipment and (b) spare parts both for repair of malfunctioning equipment and for future wear and tear of power system equipment. NEC has developed extensive lists of urgent rehabilitation requirements for both the transmission and distribution systems.

3.2 BLUE NILE GRID SUPPORT SYSTEMS

3.2.1 Telecommunication System Requirements

Conditions which have led to frequent and protracted outage of the BNG have been both the inability to communicate at the moment of a system fault in order to take corrective action and the impediments to continuous communication during repair periods and restoration of operations subsequent to the fault. The existing telecommunication system is completely inadequate and unreliable. The telecommunication system, being vital to the satisfactory operation of the BNG, must be rejuvenated and expanded.

3.2.2 Mobile Maintenance Equipment Requirements

Mobile equipment required to maintain the transmission and distribution systems is inadequate in amount, and equipment which is available is subject to regular breakdown, greatly extending the outage periods precipitated by system faults. Furthermore, existing mobile maintenance equipment is frequently inadequately sized and lacking in rugged construction. The few maintenance workshops which do exist are ill-equipped. These problems of inadequate supply of mobile maintenance equipment have resulted in the permanent disability of certain power system equipment and interminable delays in the repair of other equipment. Mobile maintenance equipment in adequate quantities is absolutely essential to the continuous, satisfactory operation of the BNG.

3.2.3 Preventative and Emergency Maintenance Systems

Well managed preventative and emergency maintenance systems and procedures are a basic requirement for well-functioning transmission and distribution systems. Careful records of power system equipment operation must be maintained and outage events adequately documented. Corrective efforts, maintenance work, replacement parts and restoration actions must also be carefully documented. A timely system of inventory control and re-ordering procedures must be maintained to provide adequate spare parts availability. In addition, adequate maintenance procedures, work performance routines, quality control and maintenance technician training are essential to satisfactory and minimal cost maintenance of transmission and distribution systems.

3.3 CRITERIA FOR PRIORITY EQUIPMENT IDENTIFICATION FOR BNG REHABILITATION

In order to identify the equipment which would be most effective in restoring BNG transmission and distribution system reliability, a number of selection criteria were established at the start of the investigation. This priority identificaton requirement was necessitated by the fact that rehabilitation equipment requested earlier by NEC far

exceeded the $20 million available under the USAID Commodity Import Program (CIP) for BNG rehabilitation. The criteria developed and applied were as follows:

- Replacement of failed equipment
- Restoration of inoperative equipment
- Correction of erratic operation
- Improvement in maintenance response time
- Improvement in preventative maintenance

3.3.1 Replacement of Failed Equipment

In many locations power system equipment, telecommunications equipment and mobile construction and maintenance equipment have failed and have not been replaced either because the original equipment is obsolete and no longer available from the original manufacturer, or insufficient foreign exchange credit is available to NEC to purchase equipment replacements. The failure to replace the equipment has led to (a) the assembly of make-shift maintenance vehicles which break down regularly, (b) the use of messengers for operating orders within the Burri Power Plant or in the field by couriers using land-rovers to contact working crews or substation operators, and finally (c) a condition where there is no standby substation or line equipment, and the subsequent failure of the remaining equipment will mean a protracted shut-down of electrical service. Where these conditions exist immediate replacement of equipment is obligatory and has been given highest priority.

3.3.2 Restoration of Inoperative Equipment

There are numerous cases where equipment has been standing idle for lack of critical spare parts. The parts are on order, but foreign exchange credit is not available to NEC to complete the purchases. Typical cases are air compressors used with air-blast circuit breakers, mobile cranes and augers, teleprinters, meter testers, relays and transformers. Where these spare parts can be obtained for this equipment from U.S.

manufacturers, or waivers obtained for other country suppliers, they should be purchased immediately. The repaired equipment will provide for the immediate need for back-up power system equipment to reduce the number of outages and for maintenance equipment which will foreshorten repair and restoration time when outages occur. Restoration of inoperative equipment shares equal priority will replacement of failed equipment.

3.3.3 Correction of Erratic Operation

There are cases in which equipment has not yet failed, but where operation is erratic calling for excessive operator attention and maintenance service. Typical situations are 220 kV line insulator flashovers preventing rapid reclosure, reactor switching breakers required to operate excessively, overloaded distribution cables, power line carrier network malfunctioning, voice frequency cable interruptions due to careless physical damage, and cable pulling and splicing devices. NEC has placed purchase requisitions for much of the equipment which would provide for normal maintenance, but again the foreign exchange credit is not available for purchase. Equipment which will reduce erratic operation is a high priority requirement.

3.3.4 Improvement in Maintenance Response Time

Outages in the BNG are protracted because of the inability to rapidly determine the nature and location of faults and then to respond quickly with the required manpower and equipment to correct the conditions causing the fault. Outages which should be corrected in a few hours extend to many hours, even to days, due to lack of proper mobile communications systems and adequate mobile maintenance equipment. In each BNG service area visited, it was established that the dispatching and control of maintenance crews required repeated trips between the area headquarters and the site of the outage. Also, the maintenance vehicles in each area were frequently either incapacitated or inadequate to service the maintenance effort required to restore the system. VHF

munications systems and adequate mobile equipment with trained maintenance crews are required immediately to improve maintenance response time.

3.3.5 Improvement in Preventative Maintenance

Equipment testing in the field and machine tools at area repair shops are either non-existent or in disrepair. Testing equipment and machine tools are essential to carrying out planned inspection and repair programs which will prevent the breakdown of equipment and, therefore, avoid outages which now occur due to the lack of preventative maintenance work. Cable test equipment, transformer oil filter and dielectric test equipment, and meter test equipment are examples of equipment required for an effective preventative maintenance program. These are currently either inoperative or not available to NEC. Machine tools to manufacture small replacement parts or repair larger worn parts are limited in number as well. A large inventory of portable tools are also required for line and substation preventative maintenance work. Procurement of equipment to support preventative maintenance work should be of high priority.

Section 4

COMFORMANCE OF EQUIPMENT SELECTION TO PRIOR EQUIPMENT IDENTIFICATION CRITERIA

The identification of priority equipment for the immediate rehabilitation of the BNG was based on the following procedure:

- Review of preliminary equipment lists developed by NEC with NEC functional managers
- Site inspection of power plants, transmission and subtransmission stations and lines, control center and workshops by the Bechtel Team
- Rationalization of a priority equipment list with NEC functional managers using equipment selection criteria
- Final compilation of a priority equipment list and approval by NEC senior management
- Review and approval of the priority equipment list by USAID/Khartoum Mission.

4.1 REVIEW OF PRELIMINARY EQUIPMENT AND TECHNICAL SERVICES LISTS PREPARED BY NEC

An extensive equipment list had been prepared jointly by NEC and the staff of Energy Development International, Inc. (ED/I). The list was compiled from existing NEC material requisitions and procurement documents together with more recently identified equipment needs resulting from very recent equipment failures and outages. The scope of the list included equipment and spare parts for generating, transmission, distribution, telecommunications, mobile maintenance equipment, computer hardware and software, and technical services for the Blue Nile Grid and other isolated urban electric power supply systems in Sudan. The total estimated cost of this equipment and services exceeded $30 million.

Since the grant funds from the USAID Commodity Import Program (CIP) were to be limited to $20 million, a decision was made to limit the USAID-supported rehabilitation commodities to selected transmission power system equipment, telecommunications equipment, mobile maintenance equipment and supporting facilities, and certain testing equipment within the Blue Nile Grid. The distribution system transformers, cable, and conductor replacements were consigned to other donors. Generating plant replacements, major overhauls, and major plant improvements were also to be funded by other programs. Finally, the matters of system feasibility studies, review of NEC's rate structure, and management training were not considered to fall within the scope of the USAID-sponsored BNG rehabilitation program. It was agreed that the equipment selection criteria developed by the Bechtel Team (see Section 3) were to be applied to three major commodity categories:

- Power System Equipment Requirements
- Telecommunications Equipment Requirements
- Mobile Construction and Maintenance Equipment Requirements

In addition, it was agreed that the Bechtel Team was to make a field inspection of (a) major generating plants (steam, gas-turbine, diesel and hydro), (b) major transmission and subtransmission stations, (c) transmission and subtransmission lines, (d) control and communications centers, and (e) maintenance shops and warehouses within the Blue Nile Grid. Following the field inspection, the Bechtel Team was to meet with the NEC headquarters functional managers for an initial compilation of the commodity lists. The final compilation of the commodity lists was to be prepared by the Bechtel Team in conference with the Director of Electricity and the functional managers of NEC. The final compilation was then to be reviewed by the USAID/Khartoum Mission Director, Program Officer, and Procurement Officer for conformance to CIP conditions precedent and USAID procurement regulations.

4.2 SITE INSPECTION OF POWER PLANTS, TRANSMISSION AND SUBTRANSMISSION STATIONS AND LINES, CONTROL CENTERS, AND MAINTENANCE WORKSHOPS

The site inspection of generating plants, transmission plants, telecommunications and control centers, maintenance workshops, and mobile maintenance equipment has been outlined in Section 2. Extensive discussions were held with plant maintenance and operations supervisors and area managers to establish what pieces of equipment and services were critical to the electrical system rehabilitation based on the five criteria for priority equipment identification. Regularly, it was discovered that the preliminary commodity lists developed by NEC were incomplete, particularly in the categories of telecommunications and mobile maintenance equipment. The lack of spare parts, the absence of well-supervised maintenance procedures, and the poor state of "housekeeping" in operating plants, maintenance facilities, and storerooms was observed repeatedly from area to area throughout the BNG. The area managers and supervisors stressed the need for mobile communications equipment and an adequate number of vehicles and tools for effective operation and maintenance. Each site visit was concluded by developing a summary of high-priority commodities in the categories of power systems, telecommunications, and mobile maintenance equipment.

4.3 RATIONALIZATION OF A PRIORITY EQUIPMENT LIST WITH NEC FUNCTIONAL MANAGERS

Following the plant site visits throughout the BNG, the Bechtel Team developed a composite priority equipment list from the equipment identified in the discussions with area managers and supervisors. Each Bechtel Team Specialist responsible for the commodity categories — Power System Equipment, Telecommunications Equipment, and Mobile Maintenance Equipment and Support Facilities — met with a counterpart NEC functional manager to discuss the commodity lists. Numerous adjustments were made to the original NEC commodity list. In order to remain within the $20 million CIP fund limitation, it was necessary to delete some equipment from each category. Some equipment items were left on the priority commodity list assuming that it would be possible to provide U.S. manufactured equipment for failed or inoperative equipment

of a foreign manufacture. The priority commodity lists were then assembled for submission to the Director of Electricity for his review and approval.

4.4 FINAL COMPILATION OF PRIORITY EQUIPMENT LIST AND APPROVAL BY NEC SENIOR MANAGEMENT

The Director of Electricity, NEC funtional managers, and the Bechtel Team met in a final conference to review each commodity category. Further deletions were made to the power system commodity list, namely distribution system equipment which had been placed on the priority commodity list by the functional managers and earlier specified walkie-talkie sets. Added to the priority list were maintenance building and equipment facilities, telecommunications maintenance facilities, and a number of testing devices. The commodity lists approved on Thursday, February 24, 1982, by the Director of Electricity of NEC are included in Appendix A.

4.5 REVIEW AND APPROVAL OF PRIORITY EQUIPMENT LIST BY USAID/KHARTOUM MISSION

The priority commodity list was submitted to Mr. James Beebe, Program Officer, USAID/Khartoum Mission for his review and approval on Friday, February 25, 1982. He reviewed the list and stated that it would be reviewed by the Mission Director, Mr. Arthur Mudge, and forwarded to USAID/Washington for final acceptance. Mr. D.E. Hart met with Messrs. Allan Jacobs, Charles Bliss and Ms. Pat Kochell on Friday, March 5, 1982, in the USAID offices in Washington, D.C. to review the Priority Equipment List. The List was accepted on the condition that the final costs for equipment and associated technical services would not exceed $20 million.

Section 5

EQUIPMENT SPECIFICATIONS AND BID REQUESTS

5.1 DEVELOPMENT OF EQUIPMENT SPECIFICATIONS

Equipment specifications were developed for those commodities appearing in the approved Commodity Lists (see Appendix A). The application requirements for the equipment were based on the site operating requirements determined for each equipment type during the BNG Inspection Trip and discussion with headquarters technical staff and NEC Functional Managers. The detailed engineering specifications were developed by the Bechtel Team Specialists, Design Engineers and Procurement Specialists.

5.1.1 Equipment Identified in Commodity Lists

The power system equipment, telecommunications equipment and mobile maintenance equipment in the approved Commodity List were defined in detail using nameplate data, operation and maintenance manuals, technical and operating reports obtained during the Inspection Trip, and discussions with managers at NEC headquarters. The country of manufacture and current availability of replacement were determined for each piece of equipment. Furthermore, since the equipment to be supplied under the USAID CIP program must be of U.S. manufacture, or select third world countries, equivalent U.S. equipment was identified.

5.1.2 Equipment Application Requirements

Characteristic load cycles, ambient conditions, realistic maintenance frequency, and durability of critical equipment parts were used in the assessment of the adequacy of equipment in use or recently failed. Where it was judged that the equipment applications were inadequate, alternative U.S. equipment was identified as the proper replacement. Where spare equipment was required for back-up, the U.S.-manufactured equivalent was identified with its design and operating characteristics.

5.1.3 Equipment Specification Format

An equipment specification format was developed which carefully defined:

- Scope of services required
- Quality standards for services and materials, using applicable codes and standards
- Content and nature of submittals
- Description of electrical and environmental conditions of site
- Design requirements: ratings and conditions of service for each item of equipment
- Drawings for approval by buyer
- Spare Parts
- Price scope, conditions and warranty
- Shipment and field installation supervision
- Training requirements (where applicable)

The detailed specification document corresponds to that used by Bechtel in its procurement procedures for major electric power projects, both domestic and overseas. The specifications for the equipment were prepared by engineering specialists and designers from Bechtel's power and communication divisions, assisted by Bechtel procurement specialists.

5.2 REVIEW AND APPROVAL OF EQUIPMENT SPECIFICATIONS

The detailed equipment specifications were reviewed by the Bechtel Team Specialists, Bechtel Procurement Specialists, and the Project Manager for technical content and completeness of format. The Specifications were then sent to the Energy Office, USAID (Washington), for transmittal to the USAID Mission and the National Electricity Corporation in Khartoum for their review and approval. On May 17, and 18, 1982, Mr. M. Nasar Abu Bakr, Director of Electricity, NEC, and a party of four NEC managers reviewed the specification with Bechtel engineers in its Los Angeles

Power Division Offices. The specifications were approved with minor revisions and additions. Complete specifications for all commodity categories were compiled and approved by NEC Management on July 20, 1982, and will be submitted as part of the Summary Report for the Specification Phase, to be published in August, 1982.

5.3 PUBLICATION OF SPECIFICATIONS IN BID REQUESTS

Bechtel has been nominated as the Procurement Consultant for the Implementation Phase, and bid-request documentation preparation, publication of bid requests and bid evaluation began July 5, 1982 under the Specification Phase.

Bid request documentation will consist of:

- Instruction and Information to Bidders
- General Conditions
- Special Conditions
- Terms of Compensation
- Technical Specifications

The technical specifications used in the bid request documentation are those that have been prepared and approved in the Specification Phase and published as "Commodity Specifications" in two volumes.

5.4 EVALUATION OF BIDS

The Bechtel Project Team will conduct a coordinated evaluation of bids received. A detailed bid tabulation is prepared recording each bid comparison.

The technical content of the bid will be evaluated by Project Team engineering personnel to determine the bidder's response to the technical

specifications. An analysis of the quality aspects of each bid will also be made. Only those bids which are responsive to the bid request will be considered further.

The commercial content will also be evaluated by Bechtel Contracts and Purchases personnel with emphasis on acceptance of terms and conditions, delivery schedule, price and price adjustments, terms of payment and financial capability.

The final result of the bid evaluation will be the determination of the evaluated lowest technically and commercially accepted bid which meets schedule. The evaluation is not merely a cursory comparison of data but a process geared to evaluating bids on an auditable basis against common criteria to select the most advantageous bid for the client.

Section 6

RECOMMENDATIONS FOR THE DEVELOPMENT OF AN ONGOING BNG MAINTENANCE PROGRAM

6.1 BACKGROUND

In the course of the field inspection trip of the Blue Nile Grid, it became evident that tne maintenance methods and procedures used for generation, transmission, and distribution plant would be in need of considerable improvement if the Grid reliability was to be maintained at an acceptable level following the rehabilitation of the Grid. In addition the materials supply, control and inventory procedures were in need of careful formulation, including the revision of current procedures and the addition of requisite material control and inventory procedures. There is also a need to establish uniform equipment maintenance practices throughout the district electrical systems which make up the Grid.

6.2 OBJECTIVES OF THE MAINTENANCE PROGRAM STUDY

The objectives of the Maintenance Program Study should be (a) to define a maintenance program, applicable thoughout the Blue Nile Grid, to maintain generation, transmission and distribution plant at an acceptable level of Grid operating reliability, (b) to define a materials supply, control and inventory system, (c) to develop a maintenance training program and (d) to install the maintenance program including the materials supply, control and inventory system and the maintenance training program.

6.3 MAINTENANCE PROGRAM WORK PLAN

The Maintenance Program Work Plan should include five tasks:

- Conduct a Maintenance Operations Audit
- Develop a Revised Maintenance Program
- Develop a Materials Supply, Control and Inventory System

- Develop a Maintenance Training Program
- Implement a Revised Maintenance Program including a Materials Supply, Control and Inventory System and Training Program

6.3.1 Conduct a Maintenance Operations Audit

A maintenance audit should be made of all maintenance operations throughout the Blue Nile Grid identifying current practice, materials inventory control and quality control systems, staffing, training programs, maintenance equipment, and facility utilization. The completed audit will recommend changes to maintenance practices, scheduling, quality control, materials supply and inventory procedures, organization, personnel and facilities requirements.

6.3.2 Develop a Revised Maintenance Program

Based on the audit of maintenance functions, a revised maintenance program should be developed. The program should encompass the maintenance of generation, transmission and distribution facilities.

Where currently procedures and practices required to maintain adequate Grid reliabiity are missing, these elements will be defined and included in the overall maintenance program. The organization and facilities required to implement the improved maintenance program will also be defined. The maintenance program developed will be intended for uniform application throughout the operating districts comprising the Blue Nile Grid.

6.3.3 Develop a Materials Supply, Control and Inventory System

A maintenance materials supply, control and inventory system should be designed to interface properly with the National Electricity Corporation's general procurement, work order and general plant accounting systems. Although the system will be centralized in the headquarters office, the system will be designed to utilize, monitor and

complete transactions in the district offices of the Grid. Both manual procedures and automated systems will be thoroughly documented and assembled in Maintenance System Manuals.

6.3.4 Develop a Maintenance Training Program

A basic maintenance training program should be developed for operation, transmission and distribution plant maintenance staff. The training program will encompass the range of technician jobs required in maintenance shops and mobile crews to adequately service the Grid. Courses designed to develop administrative skills will also be developed for maintenance foremen and management personnel. The training program will be based on proven electric utility practices modified to suit the Blue Nile Grid operating environment. The objective of the training programs will be to develop maintenance personnel who can operate maintenance equipment and to supply skilled tradesmen in such a manner as to achieve the levels of Grid reliability required by acceptable utility operating practice.

6.3.5 Implement Revised Maintenance Program Including Materials Supply, Control and Inventory System and Training Program

An implementation of the revised maintenance program will require a period of at least one year in which the Consultant will provide on-the-job training and program implementation assistance through Resident Advisors. The Resident Advisors will work directly with NEC middle management personnel. An implementation schedule will be developed which will effectively upgrade the skills of the maintenance staff and satisfactorily interface new maintenance materials supply systems with other procurement systems to arrest, as soon as practicable, the present deterioration of the operating Grid.

The Resident Advisors will work with NEC counterpart managers in the establishment and execution of the maintenance program and its systems and procedures, until a reasonable level of management skill has been

achieved and improvements in equipment availability are evident. Subsequently, the Resident Advisors will be engaged in monitoring and reviewing the progress of the maintenance program and to further its implementation.

Resident Advisors would also be used at the outset of the program to train NEC instructors who will be responsible for the conduct of maintenance tradesmen training courses. The instructors will be selected on the basis of demonstrated aptitude and will undergo an intensive course of training in the use of maintenance tools and techniques employed in servicing generation, transmission and distribution facilities.

Managers and staff who will perform the maintenance material supply, control and inventory functions will receive specific training in the new supply systems. Resident Advisors will work closely with the materials supply management personnel during the planned implementation of the new systems. Documented manual procedures and automated systems will be implemented under the direction of the Resident Advisors. However, as soon as a full cycle of the materials supply system has been achieved, the Resident Advisors will retire to a role of systems operation monitoring and advising.

As required, the Resident Advisors will work with managers and staff in major district centers in the course of the implementation period. However, it is expected that headquarters staff, trained by the Resident Advisors, would assume the responsibility of training district personnel as soon as possible.

The implementation task for the Maintenance Program would be considered complete when the headquarters maintenance organization has been trained and is functioning independently of the Resident Advisors and the maintenance shops and crews in the Khartoum Area of the Grid have reached a satisfactory level of maintenance program effectiveness. It is expected that this might be accomplished within a year of the initiation of the implementation effort.

COMMODITY LISTS FOR THE IMMEDIATE REHABILITATION OF THE BLUE NILE GRID

(As approved February 24, 1982)

APPENDIX A

Table 1

POWER SYSTEM EQUIPMENT

Replacement Air Compressor for Air-blast Breakers (5)*

Outdoor Freestanding 15 kV Vacuum Breaker (1)

11 kV Distribution Capacitor Units (80,000 kVAC)

Switching control for 11 kV Distribution Pole Mounted Capacitor

Relay Test Sets (2) and Variable Frequency Generator (1)

220 kV System Surge Arresters (1)

110 kV System Surge Arresters (6)

220 kV Power Systems Pedestal Type Multi-ratio Bushing CTs (6)

110-11 kV Substation Transformer (1)

115 kV SF6 Outdoor Power Circuit Breakers (6)

El Bager 110-33-11 kV/17.5-10-10 MVA Substation, including

- 115 kV SF6 Outdoor Power Circuit Breakers
- 110-33-11 kV Substation Transformer
- 34.5 kV SF6 or Vacuum Outdoor Power Circuit Breakers
- Metal-clad Air or Vaccuum Breaker Switchgear
- Station Service - Neutral Grounding Zigzag Transformer, Neutral Resistor and Disconnect Switch

Computer System (1)

Computer System Software (1)

* Numbers in parentheses indicate number of units

Table 2

TELECOMMUNICATION EQUIPMENT

100 Line and 16 Line Electronic Private Branch Exchanges

HF-SSB Radio System (14 sites)

VHF Land Mobile Radio System (28 sites)

Subscriber Radio System (3 sites)

DC Power Plants (11 sites)

Steel Towers

Telephones Sets, Cable, Wiring, and Ancillary Equipment

Table 3

CONSTRUCTION AND MAINTENANCE EQUIPMENT

Cranes and Loaders

4 Mobile Cranes, Rough Terrain, 15-50 Tons

5 Forklift Trucks, Diesel, 2.5-5 Tons

Trucks

- 4 Utility Trucks with Derrick-Crane, 8 tons
- 10 Utility Trucks with Derrick-Auger, 8 tons
- 10 Utility Trucks with Aerial Basket, 2-Man
- 6 Utility Truck/Fuel Tanker, 2000 gallon
- Transport Trucks with Trailer, 40 tons
- Transport Trailer, Lo-Boy, 50 tons

Miscellaneous Vehicles

- 4 Utility Vehicles 4-Wheel Drive P/U Body, 1.5 tons
- 2 Utility Vehicles 4 Wheel Drive Crew Cab, P/U Body, 1.5 Tons, 6-Passenger
- 2 Utility Vehicles 4 Wheel Drive Suburban Body, 9-Passenger
- 1 Utility Vehicle 4 Wheel Drive Suburban Body, 3-Passenger (Communication Test Vehicle)
- 1 Utility Vehicle 4 Wheel Drive Van Body, 2-Passenger (Cable Test Vehicle)
- 4 Utility Tractors, 2 Wheel Drive with Trailer, 8 tons
- 4 Utility Tractors, 4 Wheel Drive with Trailer, 8 tons

Miscellaneous Equipment

- 2 Excavators (Cable Trenchers), 50 cm wide x 2 m deep

3 Air Compressors, Electric Powered, 50 cfm, 175 psig

Table 3 (Continued)

- 2 Air Compressors, Diesel Powered, 150 cfm, 100 psig
- 6 Cable Reel Carriers, Single-reel, 72 x 44 inches
- 3 Cable Reel Carriers with Tensioner, Single-reel, 72 x 44 inches
- 6 Cable Reel Carriers with Tensioners, Single-reel 96 x 56 inches
- 3 Line Conductor Tensioners, Bullwheel type, 42 inch x 1.8 inch diameter
- 4 Line Conductor Puller, Drum Type, 4000 lb, 65 hp

Maintenance Center Equipment

- Horizontal Milling Machine, 1000 x 300 mm
- Plate Bending Machine, 2500 mm width
- Power Hacksaw Machine, 600 mm blade
- Metal-turning Lathe, 2000 mm centres
- Metal-threading Machine, 1/4 to 2 1/2 inches
- Welding Machine (Spot), 80-300 mm
- Gear Shaping Machine, 20-125 mm
- 2 Drill Presses, Floor Model
- 2 Air Compressors, 40 cfm, 175 psig
- Miscellaneous Equipment

Buildings

- 1 Prefabricated Building, Metal Type, 210 x 70 x 19 ft.
- 9 Prefabricated Buildings, Metal Type, 180 x 70 x 19 ft.

Appendix B

PHASE I PROGRAM ACHIEVEMENTS AND BENEFITS

As stated in Section 1, the overall objectives of the BNG Rehabilitation Program were to:

- Improve the reliability of the BNG transmission and distribution systems
- Reduce the duration of power system outages

The benefits expected from the rehabilitation program were:

- Improved level of system reliability
- Improved level of power system equipment availability
- Improved preventative maintenance program reducing the frequency of power system equipment outages
- Increased revenue to NEC due to greatly foreshortened duration of power system outages.

Both the achievements in improved power system operations and the benefits realized from the installation of equipment provided by the Commodity Import Program (CIP) for the BNG Rehabilitation will be discussed in this Section.

2.1 POWER SYSTEM OPERATION IMPROVEMENT

The inspection of the 220 KV, 110 KV and 33 KV stations and lines in the Blue Nile Grid by a Bechtel Inspection Team under an earlier contract (USAID DAN-5724-C-00-1085-00) indicated that extensive replacement of faulty circuit breakers was required; surge arrestors were needed; multi-ratio Bushing Current Transformers were required; a larger 110/11KV substation transformer for load growth was needed; a new substation, El Bagier, was required in a growing industrial area; and, several air compressors used by air-blast circuit breakers were to be replaced. Cable test equipment, relay test sets and transformer oil filtration equipment were also seriously needed.

The 11 KV distribution system is in the poorest condition of all the components of the Blue Nile Grid. This is caused principally by improperly sized cables and conductors, over-extended feeders and very poor power factor correction. Therefore, approximately 64,000 KVAC of capacitors are needed as an initial step to power factor correction in the Khartoum distribution system.

2.1.1 Improvement Achievements

Early in the program, May 1983, a large 220 KV air-blast circuit breaker, was replaced at Damazine Power Station. At the time, the 220 KV line circuit breakers were by-passed at the Damazine Substation, with only the generator transformer circuit breakers protecting the south end of a 250 Km double circuit transmission line. The line therefore was placed at great hazard as were the power station generators. Through the expediting of procurement on Bechtel's part, two, 220 KV SF6 circuit breakers were found in the United States and shipped to Sudan within three months - 12 months ahead of program schedule. The second breaker could have been installed at Damazine immediately had not Ramadan interfered with its installation.

Reactor switching breakers (15 KV, vacuum type) were in Khartoum in January, 1984 for installation at the Kilo X, Meringan and Sennar Junction Substations. Foundation modifications were underway in late July and it was expected that all breakers would be operating by the end of September, 1984. Bechtel's field services were concluded July 15, but Westinghouse Field Engineers and NEC installation crews were to complete the work. Bechtel provided all of the foundation modification drawings in a timely manner coinciding with the arrival of the breakers in Khartoun.

All of the power system SF6 circuit breakers and surge arrestors for 220 KV, 110 KV and 33 KV substation applications arrived in Sudan between April and July, 1984. It is expected that these circuit breakers will be installed at the Damazine, Sennar Junction, Meringan, Hasha Heisa and Kuku substations in the period September through November, 1984. Westinghouse Field Engineers will supervise installation and NEC will provide the installation crews.

The new 15 MVA, 110/33/11 KV station transformer arrived in April, 1984. Bechtel provided foundation modification drawings for installation at the Gadarif Substation in April. NEC should begin installation at Gadarif in September, 1984, under Westinghouse Field Engineer supervision.

All of the equipment for the New El Bagier Substation (40 Km south of Khartoum) arrived in Sudan between April and July, 1984. The substation civil works drawings were supplied by Westinghouse in April, and NEC let the contract for civil works construction in August, after considerable delay resulting from NEC management indecision. It is expected that civil works construction will begin in late August, with Westinghouse Field Engineers beginning their work in late September. The substation should be operating in February, 1985.

Relay test sets, cable test equipment and transformer oil filtration

equipment were placed in operation between February and April, 1984. This equipment was then assigned to locations throughout the BNG.

The 11 KV Distribution Capacitor units and switching controls arrived in Khartoum in May, 1984. NEC began installing the pole-mounted capacitors and switches in June in selected sections of the Khartoun District 11 KV distribution network. The capacitors should be installed over a period of six months.

2.1.2 Benefits to System Operations

The early installation of circuit breakers at the 220 KV Damazine Substation resulted in a number of benefits to transmission line operation and protection. First, it was possible to take either of the two circuits down for maintenance without interrupting service on the Damazine to Meringan segment of the 220 KV line. Secondly, reclosing problems of the replaced air-blast circuit breakers were completely eliminated. Thirdly, the faulty air compressor and drying systems were retired since they were no longer required. Fourthly, the very hazardous "hard-wired" by-pass around the former inoperative circuit breakers was eliminated and generating equipment and lines were removed from the possibility of damage from a very serious and destructive fault.

Since NEC had no relay test, applications and repair facility, the utilization of the two semi-portable relay equipment test sets will result in proper relay settings so as to correct relay and supervisory circuit faults quickly. Relay setting and maintenance should now proceed on a regularly scheduled basis with adequate spare parts to properly maintain the equipment. The immediate benefit of proper relay setting and maintenance will be the rapid clearance of system faults, circuit reclosing and the prevention of damage to equipment from prolonged faults. These conditions have plagued BNG operation for years.

The 15 KV vacuum breakers used for reactor switching at the Kilo X,

Meringan and Sennar Junction Substations will greatly improve the load carrying capacity of the 220 KV transmission line, possibly by as much as 35 MW at peak load time. This is as much as 30 % of the peak load in the Khartoum area.

The 110 KV and 33 KV SF6 circuit breakers installed in the BNG from Kilo X to Sennar Junction substations will greatly improve fault clearance and equipment protection. System down time currently caused by extended faults and damaged equipment will be greatly reduced by these breaker applications.

The installation of the 15 MVA transformer at Gadarif [illegible] doubling in served load from 6 MW to 12 MW with a doubling in revenue from this segment of the Gadarif system.

The El Bagier substation will permit the opening up of a long-needed industrial park between Kilo X and Wad Medani substations. An additional load of 14 MW can be served with significant voltage improvement in the 33 KV subtransmission and 11 KV distribution systems in the area. The revenue increase to NEC will be sizeable.

The Khartoum District has already experienced improvement in voltage and line carrying capacity of the 11 KV distribution lines due to the early installation of switched and unswitched, pole-mounted 11 KV capacitors. The improvement in voltage has led to much improved quality of service to small commercial and residential customers with a simultaneous increase in revenue from increased energy consumption.

2.2 MOBILE EQUIPMENT ENHANCEMENT

Inspection of mobile equipment and repair centers under the earlier contract underscored the fact that the mobile equipment available and in use by NEC forces for construction and maintenance was inadequate both in quantity and state of repair. This situation has been a major

contributor to the poor availability of the power system. Particularly, when outages occur, they are greatly protracted in time because of the limited mobile equipment which must be moved great distances. Furthermore, the workshops and repair centers at KLDC, area centers and power plants are under-equipped, and existing equipment is in a serious state of disrepair. Vehicles urgently required were; cranes and loaders; trucks with cranes, augers, trailers and tanks; and aerial baskets. Miscellaneous vehicles included crew cabs, communications vehicles, vans, buses, pick-up trucks and jeeps. Miscellaneous equipment consisted of air compressors, excavators, cable reel carriers and tensioners and line conductor pullers. An array of vehicle maintenance center and general workshop equipment ranging from drilling machines and welding machines to a gear shaping machine and an engine dynometer was also required. Pre-fabricated buildings were also included for a vehicle maintenance center, general workshop and combination warehouse and repair shops at area centers.

2.2.1 Mobile Equipment Enhancement Achievements

Mobile equipment in the truck classification, among the first of the CIP commodities to arrive in Khartoum, was the 14 trucks with augers and derricks. These trucks were immediately pressed into service in late September, 1983 to meet a pent-up need for distribution pole setting and pole-mounted transformer installations in the Khartoum District. Within a matter of days every truck was in operation, and within a few months the backlog for pole setting had been greatly reduced. The trucks with tankers and aerial baskets were placed in service in October, 1983. The tankers immediately began to alleviate gasoline and diesel fuel hauling problems within the BNG. The aerial baskets were used to increase the efficiency of street lighting maintenance and 11 KV distribution hot-line work.

The 15, 30 and 50 ton cranes were operating by January, 1984, being used for circuit breaker and transformer setting, communications tower

erection and Central Stores heavy yard lifting. Up until January, NEC had to make all lifts in excess of 30 tons by means of cranes rented from the Armed Forces. This meant days and sometimes weeks of delay for heavy lifts.

Vans and buses became available for use in November 1983 and were used to alleviate the serious transportation problems for employees to and from work and on the job. Within a few days of arrival in Khartoum, all vans and buses had been assigned and were in use. Crew cabs, pick-up trucks and jeeps were the next to arrive in Khartoum and these were all assigned in November and December, 1983.

The fork lift trucks, cable trenchers and cable reel carriers arrived in Khartoum in September, 1983. The fork lift trucks and excavators were being used in the Khartoum system by October. A number of the cable reel carriers and cable pullers were damaged in shipment from Port Sudan to Khartoum as a result of mishandling at both Port Sudan and NEC Central Stores. As of June, 1984, about 50 percent of the cable reel, puller and tensioner equipment was not in operation due to the initial damage. Insurance claims had been made.

2.2.2 Benefits to System Operation

The use of the trucks with augers and derricks improved the distribution pole and pole-mounted equipment installation efficiency and schedule significantly. In the entire Khartoum province there were approximately five augers which were operable prior to the receipt of the augers and derricks under this program. In effect, the use of the new augers and derricks more than doubled the rate of installation of distribution system poles and hardware in the Khartoum District. These trucks, together with mobile radios installed about 9 months later, were also able to provide maintenance to damaged poles and equipment at a rate never before achieved in the Khartoum District. The impact made by the new augers and derricks was so significant that the Director General

requested 10 additional augers and derricks be purchased for other areas (Wad Medani, Sennar Junction, Damazine) under the LOCOM-2.

The nine, 50 ft. and 70 ft. aerial baskets are being used throughout the Khartoum District for street lighting maintenance, installation of pole-mounted hardware in the 11 KV distribution system. The aerial baskets have been most useful in 11 KV hot-line maintenance work and the clearance of line obstructions such as trees and other debris. Previously, this work was done by hand ladder and rather large labor crews which were costly and inefficient.

The cranes, 15, 30 and 50 tons (four in all), greatly reduced the "wait-times" for off-loading equipment at Central Stores, loading equipment for site delivery, off-loading at site, removal of failed equipment and setting of new equipment at site. Both the 30 and 50 ton cranes were used for erecting the 120, 140 and 160 ft. telecommunications towers at Burri, KLDC and Khartoum North sites in March and April, 1984. Without these cranes NEC would have been required to rent a crane from one of the expatriate contractors in Khartoum which would have been both costly and schedule delaying. On several occasions NEC was able to rent the 50 ton crane to the Armed Forces and the Ministry of Irrigation.

The jeeps, pick-up trucks, vans and buses, approximately 85 vehicles in all, have resulted in considerable savings in man-hours and in reduced employee travel time to and from job-sites. Prior to the availability of these vehicles, field engineers, supervisors and craftsmen were required to wait for transportation simply because there were so few operating vehicles. A number of the jeeps, pick-up trucks and vans are now equipped with mobile radios which results in great time savings in dispatching and maintenance instruction in the field at the location of repair work.

The two excavator/cable trenchers are used continuously and have greatly

reduced the time required to complete new, distribution cable extensions. Except for down time for regular maintenance these machines have been used continuously. The 5 forklift trucks have greatly facilitated the movement of materials at the Central Stores warehouse and yard. One of the effective uses was the relocating of materials in the warehouse yard to provide a more rational marshalling of similar materials. This was done upon Bechtel recommendation. Many times materials were not properly located and stored simply because the operation had to be done by manual labor. Those cable reel carriers, tensioners and conductor pullers which were not damaged, about 15 in all, are being used in the 11 KV and 33 KV, distribution and subtransmission systems. Their use has expedited installation and protected cable and conductors from damage during installation. In times past there has been regular damage to conductors while being installed.

2.3 TELECOMMUNICATIONS EXPANSION

The Bechtel Inspection Team, under the earlier contract, determined that the existing Power Line Carrier (PLC) Network was reliable but was subject to frequent interruptions due to the repeated transmission line outages. It was, therefore, considered obligatory that a parallel communications route, totally independent of the transmission line, be installed. It was recommended that this be accomplished by installing a HF-radio network with the command control center located at KLDC.

In conjunction with the HF system, it was recommended that a VHF system be installed at key operating centers throughout the Blue Nile Grid. The HF system would be used to communicate with these operating centers and the VHF system would provide the mobile communications to dispatch and control maintenance crews working out of these operating centers.

The existing 24 VDC power supply system, serving the PLC system, was in very poor operating condition. It was recommended that higher rated rectifiers be installed and lead-antimony batteries, designed to carry

operating center communications during a power outage for as long as eight hours, replace the lead-acid batteries.

The voice frequency cable which provided communications between KLDC and Burri Power Plant was in very poor condition and subject to frequent interruptions. A Subscriber Radio System (using a microwave link instead of cable) was recommended to replace the existing cable. It was also designed to handle the HF radio transceiver equipment at the Khartoum North Power Plant site.

Burri Power Plant was operating without internal communications. It was recommended that an electronic (32 line) Private Branch Exchange (EPBX) be installed together with all internal wiring and new telephone sets and communications. The internal telephone system at the Khartoum Headquarters office was virtually non-existent. It was recommended that a 104 line EPBX be installed in the headquarters building together with wiring and telephone sets. This system will permit direct calls to be made to the Burri Power Plant.

2.3.1 Telecommunications Systems Achievements

The HF System was completely installed and operating by the end of June, 1984, with the exception of the Atbara site and the Khartoum North remote control system. However, the 1 KW amplifiers and couplers were tested in the Headquarters shop for all locations. The remote control system for Khartoum North was also tested by means of a back-to-back R.F. test configuration at KLDC. NEC telecommunications technicians are completely familiar with the installation of this equipment which should be completed by the end of July, 1984. As early as October, 1983, Bechtel had provided temporary HF radio links to Wad Medani, Damazine and Port Sudan. This was a service which was not required by contract.

The VHF system installation is dependent upon the construction of 80 ft. towers throughout the BNG system. The towers at Omduruan, Khartoum North

and Khartoum were erected by the end of April and the balance of the towers (18 in all) were to be erected by a thoroughly trained contract team by the end of July, 1984. VHF base stations were operating at KLDC, Khartoum Maintenance, Omduruan Maintenance, Khartoum North Maintenance and Burri Power Plant by Mid-June, 1984. Two qualified NEC teams were formed for the continued commissioning of mobile and fixed station radios. The VHF field engineer was scheduled to return to Khartoum for the microprocessor/VHF radio/EPBX audio interconnect by the end of July, 1984. All VHF base stations throughout the BNG should be operating by the end of August.

The Subscriber Telephone links (microwave) between KLDC and the Burri Power Plant were commissioned in May, 1984 and end-to-end checks were made. A formal seven-day course with hands-on training was given to NEC telecommunications engineers.

DC plant installations were completed at the Burri Power Plant and KLDC sites. Hands-on training courses were given covering all procedures from battery filling to charging methods. DC plants were in the process of being installed at nine other sites by mid-July. It is expected that all DC plants will be operating by the end of August, 1984.

The EPBX systems at both KLDC and Burri Power Plant were installed and operating by mid-June, 1984. Regular telephone communications within KLDC and Burri and between the two locations are now possible. The EPBX/VHF microprocessor/Paging audio interconnect were to be verified in late July, 1984, with the return of the VHF and EPBX field engineers.

2.3.2 Operating Benefits Attributable to Telecommunications Installations

The HF System now provides a reliable, dedicated communications link within the Blue Nile Grid completely independent of the PLC system and public telephone. Operating orders can now be given from KLDC to every operating center in the BNG, Port Sudan Stores, Atbara, and Kashim El

Girba operations. None of these communications links were available nine months ago. Critical field maintenance instructions may now be given to BNG operating centers which in turn can communicate with field crews through VHF base stations at the operating centers. On major power line outages the down time has become one-fourth of what was typical before the telecommunication systems were installed. The telecommunication systems together with mobile equipment have improved maintenance mobilization and performance immeasurably. The impact is now seen in the great decrease in protracted power outages.

The VHF radio system with mobile radios assigned to maintenance vehicles, field maintenance supervisors, operations managers, and senior operating officers has resulted in revolutionary changes in operations and maintenance. It is now possible for senior operating managers to communicate with one another and their field supervisors 24 hours a day. Continuous communications are now possible with Central Stores and Area Stores which have greatly improved logistics in mobilizing equipment both for emergency and planned weekly maintenance. Prior to these radio communications it was actually necessary for field people to return to an operating center phone to communicate with KLDC or Stores (and many times the phone was out of order requiring a 10 to 15 Km trip to Headquarters or Stores). After regular hours it was impossible to communicate with the field, or manager to manager, except by messenger. The mobile radio has proved to be invaluable for on-the-spot emergency repair operations when additional material or crews are required.

The EPBX installations at both Headquarters and Burri Power Plant, together with the Subscriber Radio Link (microwave), have proved invaluable to interoffice and site communications. Supervisors who have never had a phone before are now able to call over a hundred stations within Headquarters. This has saved an untold number of hours. Burri Power Plant supervisors with phones located at important operating stations throughout the plant and the site, are now able to quickly

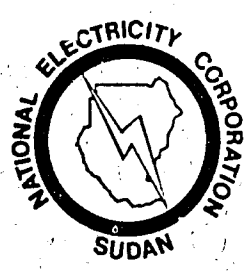
remedy operating problems and give rapid maintenance instructions throughout the plant. Communications between the Plant Superintendent and the Senior Director of Operations at KLDC is now immediate, whereas before only the public telephone system was available and this only 50 percent of the time.

Final Report

USAID PROGRAM FOR TECHNICAL ASSISTANCE IN CONVENTIONAL ENERGY

USAID Contract DAN-5724-C00-1085-00

Procurement Advisory Services
To
The National Electricity Corporation
Khartoum, Sudan



September, 1984

Bechtel National, Inc.,
San Francisco, CA

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Section 1

INTRODUCTION

This is the final report covering the in-country services of the Bechtel Procurement Advisor. The services began February 3, 1983 under USAID Contract DAN-5724-C00-1085-00 and were completed on February 3, 1984.

1.1 BACKGROUND

A provisional order entitled, "The National Electricity Corporation Act," was issued by the President of Sudan in 1982. Implementation of this Act required organizing and staffing the newly created National Electricity Corporation (NEC) in a manner that would provide an efficient and reliable electricity supply system in Sudan.

Prior to execution of the Act, Bechtel National Inc. (BNI) dispatched a Team of experts to Sudan in February, 1982, to survey the needs of the former Public Electric and Water Corporation (PEWC). The Team's main purpose was to review the specific equipment requirements for transmission, mobile equipment and telecommunication equipment which would improve the operating reliability of the electric supply system.

In addition, the Team also identified other operating areas requiring further development. Three areas identified were: (1) maintenance of the entire electric system (2) procurement procedures, systems and functional organization and (3) a tariff study for both PEWC and Regional Companies. Of these, it was determined that the procurement function required the most immediate attention. Improvement in procurement would also provide direct support to the CIP program under USAID Contract No. 650-K602-C-00-2003. which would be implemented in July, 1982.

The procurement advisory services were to assist the Director of Supplies and his staff for a period of one year. The main objectives were to advise the newly formed NEC in the improvement of existing procurement systems and organization and in the development of new systems and organization, where necessary.

1.2 STATEMENT OF WORK

The Scope of Services was directed at achieving efficient and effective operations and management in stores inventory, control and dispensing functions. The Advisor's efforts included:

Task 1: <u>The Strengthening of Purchasing and Inventory Management Capability Including</u>:

- Reorganization of the Purchasing and Stores function.
- Development of a coordinated purchasing/inventory stock identification system.
- Establishment of procurement and inventory control practices and procedures.
- Examination of the feasibility of establishing an automated inventory reporting system.
- Implementation of an economic ordering system capable of reducing procurement costs.
- Examination of existing inventory stock and storage facilities.
- Recommendations for the systematic disposal of obsolete and unusable items.
- Development of a comprehensive facilities utilization plan.

Task 2: <u>Standardization and Establishment of Priorities</u>

- Standards Review
- Establishment of Priorities

1.3 STAFFING

Mr. Johnny W. Mowatt was assigned as the Procurement Advisor on February 3, 1983. He coordinated with Mr. Dick E. Hart, Bechtel Resident Manager in Khartoum and Mr. James D. Malone, Procurement Operations Manager in Los Angeles. He reported to Mr. James F. Houle, Project Director, in San Francisco who directed and managed the USAID Contract No. DAN-5724-C00-1085-00.

Section 2

SUMMARY

The Scope of Work, as originally planned was both too ambitious and premature, considering that NEC was in the process of reorganizing at the beginning of the Procurement Advisory Services Program. The NEC organization was in transition and management staffing was not finalized until July, 1983. Furthermore, it was discovered that most problem areas were related to lack of Senior Management direction and failure to implement existing procedures. These two factors were later to be the greatest obstacles to realizing progress within the Department of Supplies. However as a result of the services provided under this contract many improvements have been realized both by NEC and USAID. During the course of performing the assigned tasks, fundamental deficiencies in procurement procedures and organization were identified and recommendations made. The study led to a recognition of major needs and the realization that problems must be addressed individually and sequentially. Previously, the Department of Supplies had attempted to address too many problem areas simultaneously.

2.1 CONCLUSIONS

NEC must realize it cannot develop the Department of Supplies until its overall corporate organization is defined, objectives for the Department are identified and procedures are written and adopted. A single year of Advisory Services did not allow sufficient time to address all of these areas and to improve operations. Activities which were completed are shown in Appendix A. Most of the recommendations made in this report are remedial and not final. Furthermore, the Advisor had no authority to

implement any of the recommendations set forth. This too, was an obstacle to reaching the Program objectives.

Further discussions in this report on organization, stock identification systems and daily operations demonstrate that the Stores Section of the Department of Supplies has the basic business procedures to operate efficiently. However, apathy of Section personnel has led to poor performance and has either slowed down implementation or inhibited applications of procedures. Unfortunately, this apathy may be self-perpetuating unless brought under control through strong supervision and guidance.

Although the current Procurement Advisory Services Program has been limited in results, some of the objectives were achieved. A new Department Director was appointed; department responsibilities defined; material handling equipment dedicated to Stores; and major problem areas identified. The one factor which prevented more tangible progress was the lack of authority delegated to the Advisor by the NEC Management.

2.2 RECOMMENDATIONS

Based on the Advisor's observations made over the one year study period, the following efforts should be given highest priority in the development of a viable Department of Supplies and the introduction of economic procurement:

1. Stores:

   - Establish a well defined Stores Provisioning Program
     - Identify annual space requirements
     - Identify obsolete items
     - Quantify purchasing funding requests

- Conduct a physical inventory and set up a Stock Control Section
  - Determine the space required
  - Create a central records management area
- Dispose of obsolete/unusable items
  - Determine reduced space requirements
  - Reduce costs of maintaining records and handling material
- Develop a comprehensive facilities utilization plan
- Write formal stock provisioning procedures and enforce them
- Implement the recommended stores organization chart and appoint staff

2. Purchasing:
   - Write formal procedures
   - Add an Expediting Section
   - Define and delegate approval authority

In order to solve the basic operating problems and strengthen the Stores function, consideration should be given to providing a one-year Program of direct expatriate assistance in procurement management. The Scope of Work recommended below would require two expatriate Advisors having line management authority and reporting to the Director of Supplies. The program would be conducted in three phases.

1. Complete all administrative tasks, including procedures definitions.
2. Implement procedures and supervise Supplies Department daily operations.
3. Turn over operation to NEC personnel, monitor performance and present final recommendations/comments.

The work effort should be directed to the following procurement functions:

- Stock Control (one Advisor)
  - Organize the Section
  - Establish formal written procedures
  - Layout work area
  - Organize all records
  - Maintain strict control of inventory
  - Concurrently train personnel for eventual takeover
- Warehousing (one Advisor)
  - Establish formal written procedures
  - Clean out work areas
  - Dispose of obsolete items
  - Identify storage needs
  - Organize warehouse and laydown areas
  - Establish records maintenance and storage areas
  - Concurrently train personnel for eventual takeover

These managers would coordinate their efforts with NEC line supervisors and report directly to the Director of Supplies. If granted this managerial authority, they should be able to greatly increase NEC's ability to improve the Stores function. There is a small cadre of qualified managerial and staff personnel presently working in Stores who are capable of effective performance. It is a matter of managing the function in such a way as to stimulate and motivate the managers and staff.

An example of what may be achieved company-wide is illustrated by NEC's Port Sudan operation. The NEC supplies representative in Port Sudan has well organized files, a clean work area and a good tracking system. Procurement information received from Port Sudan is timely and reliable. The primary goal for the Department should be to achieve the same level of performance in all of its Sections.

It might be argued that this one-year period of expatriate management is not a permanent solution to the Stores problem at NEC. However, it is

felt that the pressing needs of the Stores function necessitates this initial action. It is, of course, recognized that the longer-term training and development of additional support staff must be undertaken. Such long-term assistance should be in the form of practical Procurement applications and on-the-job training. The assistance should be well defined with a scope of work that is manageable and ensures qualified personnel upon Program completion. If given energetic management support, a longer-term approach would provide many on-going benefits.

The Department of Supplies is now in a good position to develop further. But it will require the continued attention of Senior Management and support of the Director of Supplies.

Section 3

ORGANIZATION

NEC's Department of Supplies consists of two basic divisions: Stores and Purchasing. These, in turn, are further divided into operational Sections. Stores is responsible for shipping, receiving, warehousing and stock issues. Purchasing handles buying (domestic and foreign sections), traffic and insurance. All Sections report to the Director of Supplies.

The Provisional Order of 1982 also requires that NEC provide support to the Regional Electric Companies. These Regional Companies are autonomous organizations relying on NEC's access to foreign-financed goods. They do not have, however, a direct line management reporting relationship to NEC. Furthermore, the Regional Companies are not required to submit to operational guidance by NEC.

3.1 ADVISORY SERVICES RENDERED

During the first quarter, the Advisor's efforts consisted of familiarization with NEC's Supplies Department. A review of forms and practices in the Khartoum main office was augmented by visits to Damazin Hydro Station and Port Sudan Stores. These visits provided an overview of Procurement operations and a basis on which to begin the analysis.

After the first quarter and continuing throughout the Program, it remained the Advisor's opinion that the Supplies Department's major weakness was the Stores Division. This division was not functioning adequately to meet NEC's needs, let alone meeting its additional

responsibility to Regional Companies. Therefore, in this final report, major emphasis is directed toward the Stores functions.

Unlike the Stores Sections, the existing Purchasing Sections are defined and are functioning and following daily routines. Each Section in interfaces with the others and understands specific areas of Purchasing responsibility and authority. The obvious weakness is the lack of an Expediting Section. Currently, expediting is performed only sporadically and is uncoordinated. Ongoing in-house expediting is totally non-existent.

The above observations were discussed with the responsible NEC management personnel and an initial work plan was formulated. Although the contract Statement of Work intended addressing each Section, it was decided that the Advisor's efforts would be directed towards the Stores function only. If time permitted the Advisor would then direct attention to the Purchasing function.

The greatest obstacle to tackling the organizational problems of the Supply Department was that NEC's overall organization continued to be fluid and was not fixed until July 1983. A second obstacle was Stores personnel's inability to concentrate its attention on one problem at a time. These problems, combined with the difficulty inherent in delegating authority and assigning responsible personnel, made Department of Supplies organization planning a difficult and time-consuming task.

The Organization Chart and Job Descriptions (Appendices B and C.) prepared by the Advisor, were initial efforts used to provide NEC with guidelines. It was necessary to formalize, for the first time, a division of responsibility and define job titles. The intent was to start with supervisory personnel who would develop their own job descriptions. Based on their experience, the Supervisors would then

direct subordinates in the development of their position descriptions.

Unfortunately, NEC's overall organization, with defined management positions, was not established until late July, 1983. A new Director of Supplies was assigned at that time, but the remaining positions on the Supplies Department Organization Chart were not permanently filled. This delayed progress in further development of job descriptions, in defining a cohesive department structure and in establishing Area Stores reporting relationships.

3.2 RECOMMENDATIONS

Key positions, below the Department Director level, require assignment of permanent personnel in order to establish continuity and provide management direction. NEC Senior Management needs to continue its development of the Department of Supples by designating personnel for these key positions. This should then lead to writing subordinate Job Descriptions and filling those positions with personnel who meet the position requirements. The Department of Supplies would then have a viable organization with established personnel duties and lines of authority by which to manage.

Section 4

STOCK IDENTIFICATION SYSTEM

NEC Stores has a Bin-Card Stock Identification System. The System is designed to provide identification of all stock, location, back orders, receipts, issues and stock on hand. This information is then transferred to a Stock Review Form to provide an historical recapitulation for management review (see Appendix D).

4.1 ADVISORY SERVICES RENDERED

The Bin-Card System was reviewed and found to be an adequate method for stock identification. It is one, however, which will require daily updating and continuous monitoring. It is the primary source of information for inventory control and ordering.

All stock items are provided with a vocabulary number for identification. These were reviewed and recommendations made. The cards are numerically sequenced and maintained within their respective sections: General; Electrical; Mechanical Spares; or Transit. Each Section Head becomes responsible for the Bin-Card maintenance and accuracy. The Bin-Cards must be accurate in order to fulfill their designed function. However, it is here that Stores' problems occur. The system is established and adequate, but not maintained, as demonstrated by the Advisor's review.

4.2 RECOMMENDATIONS

The Bin-Cards require periodic checking of quantities listed as "on hand". They need to be kept in neat files and updated daily. Although

further elaborated on in Sections 5 and 7, these weaknesses could be reduced by taking physical inventories more frequently and setting up a new Stock Control Group.

Section 5

INVENTORY CONTROL

As stated in Section 4 , Inventory Control begins with a good stock identification system. As was discussed, the Bin-Card System of NEC is adequate, but needs maintenance to provide useful information. For this reason, it is imperative that NEC recognize each Section function as being interrelated to others.

5.1 ADVISORY SERVICES RENDERED

The Advisor recommended that NEC begin with identifying actual inventory. The procedure (included as Appendix E) discussed in this Section, was developed for two reasons: (1) to verify Bin-Card counts and (2) to quantify obsolete items. This procedure should lead to reducing many of the Supplies Department problems in providing warehouse space requirements, performing economic purchases and reducing stock levels.

It was recommended that a physical inventory be the starting point in establishing accurate records and organizing a Stock Control Group to maintain these records. Unfortunately, Stores personnel felt that taking a physical inventory was the responsibility of other Sections and internal conflicts prevented an inventory from being taken during the Advisor's one-year residency.

However, in October, 1983, the USAID Mission Order ADM-12 (Appendix F) and an implementing procedure authc ed by the Advisor (Appendix G) mandated that NEC management establish materials controls for USAID-funded commodities. The application of Mission Order ADM 12,

"Property Accountability of USAID Financed Commodities", uncovered a fundamental weakness within NEC's materials control procedures; namely, lack of good records management and adherence to established procedures. While implementing the requirements of the Mission Order by means of Bechtel/NEC weekly meetings, NEC developed an appreciation for the Advisor's and the Bechtel Resident Manager's insistence on improving record keeping within the Stores function.

The problems NEC encountered in understanding the intent of USAID ADM-12 and its ultimate benefit, were identical to those observed by the Advisor earlier when efforts were made to address the need for adequate records in the Supplies Department. Ultimately, all of the information published and maintained by Stores is used as input to both the Stock Provisioning Program and NEC's capital requirements for financial planning. If the inventory figures are not accurate, the Stock Provisioning Program is of little value and financial planning is impossible.

5.2 RECOMMENDATIONS

A complete company-wide stock inventory needs to be taken in order to update all Bin-Cards and identify obsolete items. This information is also required for input to the Stores Provisioning Program. Upon Completion of an inventory, the Bin-Cards should be consolidated within the Stock Control Section and their updating become one of the Section's primary duties.

Section 6

FACILITIES

NEC's Central Stores function is set up to serve the smaller stores facilities at other locations in support of the entire electric system. The warehouse buildings are laid out in a reasonable manner within an identified grid system with racks numbered numerically and shelves alphabetically. Locations correspond to the Bin-Card notation.

However, yard laydown areas are very poorly identified and maintained. Part of the problem is due to the Water Department not removing all of its supplies over a year ago from Central Stores. Also, there was a severe lack of materials handling equipment. These laydown areas deserve the same attention as the buildings. Equipment marshalling concepts and procedures are seriously needed.

6.1 ADVISORY SERVICES RENDERED

In establishing a comprehensive facility utilization plan, there must be an identification of actual stock levels. As discussed in the Section 5 this has not been done. Likewise, as addressed in Section 7, removal of obsolete, or unusable items, also has not occurred. These factors greatly inhibited progress in formulating a plan.

On the other hand, the Advisor pointed out that many corrective actions could be taken concurrently while accomplishing the Bin-Card and

inventory tasks. The Advisor review indicated that the Warehouses do have adequate staff to perform clean-up and housekeeping. But, housekeeping must be continuous and the yard laydown areas must be continuously inspected with the marshalling of similar equipment in adjacent yard areas.

Also the Advisor brought to NEC's attention the fact that many warehouse shelves were empty, while many items remained on the floor. In discussing this, two points came into focus; (1) most of the empty space was reserved for items carried "on order", and (2) the items on the floor were slow moving.

A fundamental flaw in Stores procedures has led to a large amount of open space for articles "on order". This resulted from Stores previously listing items as "on order" once a request was issued to Purchasing. Due to a lack of financing and/or technical changes to stock items many items were never ordered. The Advisor brought this to the attention of the Assistant Director of Supplies for rectification.

Also, it was pointed out that slow moving articles on the floor should be placed on a back shelf and rotated periodically. Every effort should be made to have all stock located on the shelves and off the ground. This would also aid in reducing damage to goods.

6.2 RECOMMENDATIONS

Although there has been an attempt to layout existing Central Stores facilities, much effort is required to optimize space usage. In particular, the laydown areas (yard) need to be cleaned up and equipment properly marshalled. Moreover, development of a comprehensive plan cannot proceed until realistic storage requirements are identified. Identification of space requirements is only possible by taking

inventory, finalizing the Stores Provisioning Program and disposing of obsolete items.

NEC should perform the above tasks and expedite removal of the Department of Water Supply materials from Central Stores. These actions, combined with a good Stores Provisioning Program, will enable NEC to develop and implement a comprehensive facilities utilization plan.

Section 7

DISPOSAL OF OBSOLETE ITEMS

It became evident that some time had elapsed since NEC last addressed the problem of disposal of obsolete/unusable items. Some items had not been moved from stock for two years or more. To assist NEC, the procedure described in this Section was developed to solve the problem.

7.1 ADVISORY SERVICES RENDERED

It was acknowledged by Stores that this task was difficult and therefore it was easier to rationalize the retention of obsolete items. However, the Advisor pointed out that the amount of work required to maintain Bin-Cards and the unnecessary use of valuable space is more costly to the Corporation than the disposal of obsolete stock.

A preliminary list of obsolete items was prepared in April 1983 under the direction of the Advisor, and further augmented by observations during the Stores Provisioning Program review. These listings, combined with an obsolete item identifications procedure, suggested by the Advisor, would enable NEC to make progress in releasing valuable warehouse space.

It was emphasized by the Advisor that identification of obsolete items requires coordination between Engineering and Stores. Stores should periodically advise Engineering of any items which do not move. Engineering should then review the need to maintain this stock item and projected future requirements. Likewise, Engineering should advise Stores whenever a major design change occurs or the source of supply changes, which will effect the item required in stock. By double checking each other, Management can be made aware of obsolete items. An

Obsolete Items and Disposition Procedure is given in Attachment H.

Similarly, when a damaged, unrepairable part is discovered, Stores should advise Engineering so they can determine the need to reorder. Often unrepairable goods were found in the warehouse and carried as an available spare.

7.2 RECOMMENDATION

The Department of Supplies and the Department of Engineering should immediately undertake the implementation of an obsolete stock identification and disposal system. Disposal of obsolete items will result in significant storekeeping labor savings and space savings.

Section 8

ECONOMIC ORDERING SYSTEM

NEC's Stock Provisioning Program, when implemented as designed, will support an economic purchasing system. The Program has all the data and procedures required to purchase effectively stock items on an annual basis. However the main obstacle to ordering has been the lack of hard currency.

8.1 ADVISOR SERVICES RENDERED

It is the Advisor's opinion that the Stock Provisioning Program must be regularly updated and used as a basis for the periodic requesting of funds. The Stock Provisioning Program should identify specific needs and projected quantities of materials. NEC should then request pricing, extend the cost for quantities required and develop a total projected cost. Based on this analysis, NEC would approach the Ministry of Finance for the required foreign currency credits.

The Program, by definition, is designed to avoid the current poor stock availability. In fact, this Program is the key element in NEC Stores Division's responsibility to provide materials for operation and construction on a timely basis. The requisition procedure in the Stock Provisioning Program is defined in Appendix I.

8.2 RECOMMENDATION

Due to the magnitude of the financial impact of stock inventory, this Program should receive priority management attention. A Task Force of Engineers should be established to identify stock duplication and items

which may be combined, instead of maintaining separate stock items. The emphasis during
the Engineering Review should be on stock item quantity reduction and minimizing redundant stock items.

Secondly, items over two years old should be examined for obsolescence. If obsolete, they should be disposed of. If not, identify economic levels of stock inventory.

Thirdly, all stock vocabulary numbers, for which there is not stock on hand and for which no issues have been made in the last thirty-six months, should be deleted.

Lastly but most importantly, the condensed stock program should be reviewed to establish realistic minimum and maximum levels. The Task Force assigned to this review should include one representative each from Engineering, Stores and Planning. The review should be assigned a specific schedule, but should not extend beyond eight weeks. The Stock Provisioning Program is intended to maintain generation plant replacements and consumable parts, and electric system wire, cable, fuses, bulbs, etc. Spare parts for specific equipment are determined at the time of purchase and are not initially included in the Stock Provisioning Program.

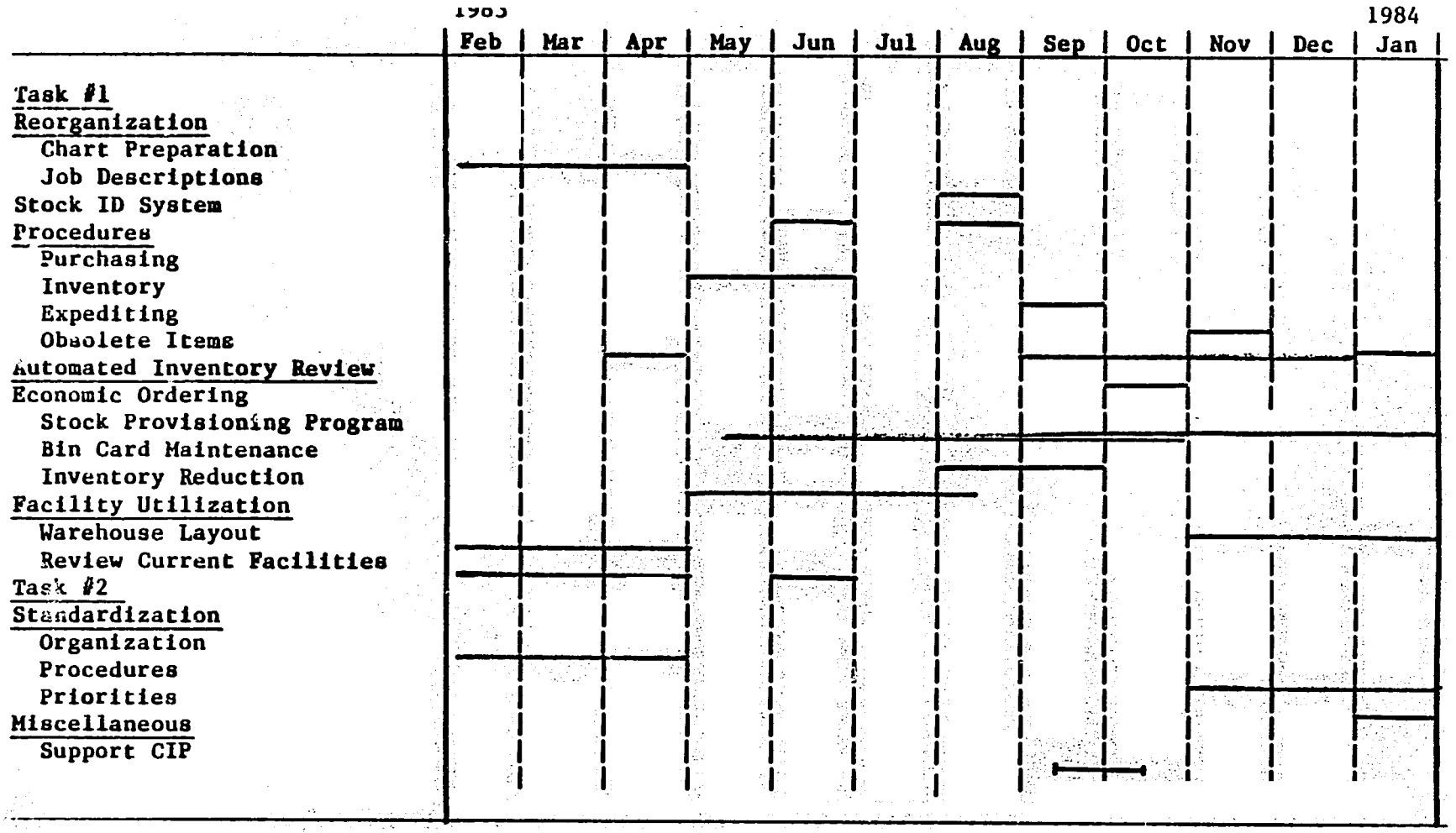
Section 9

STANDARDIZATION

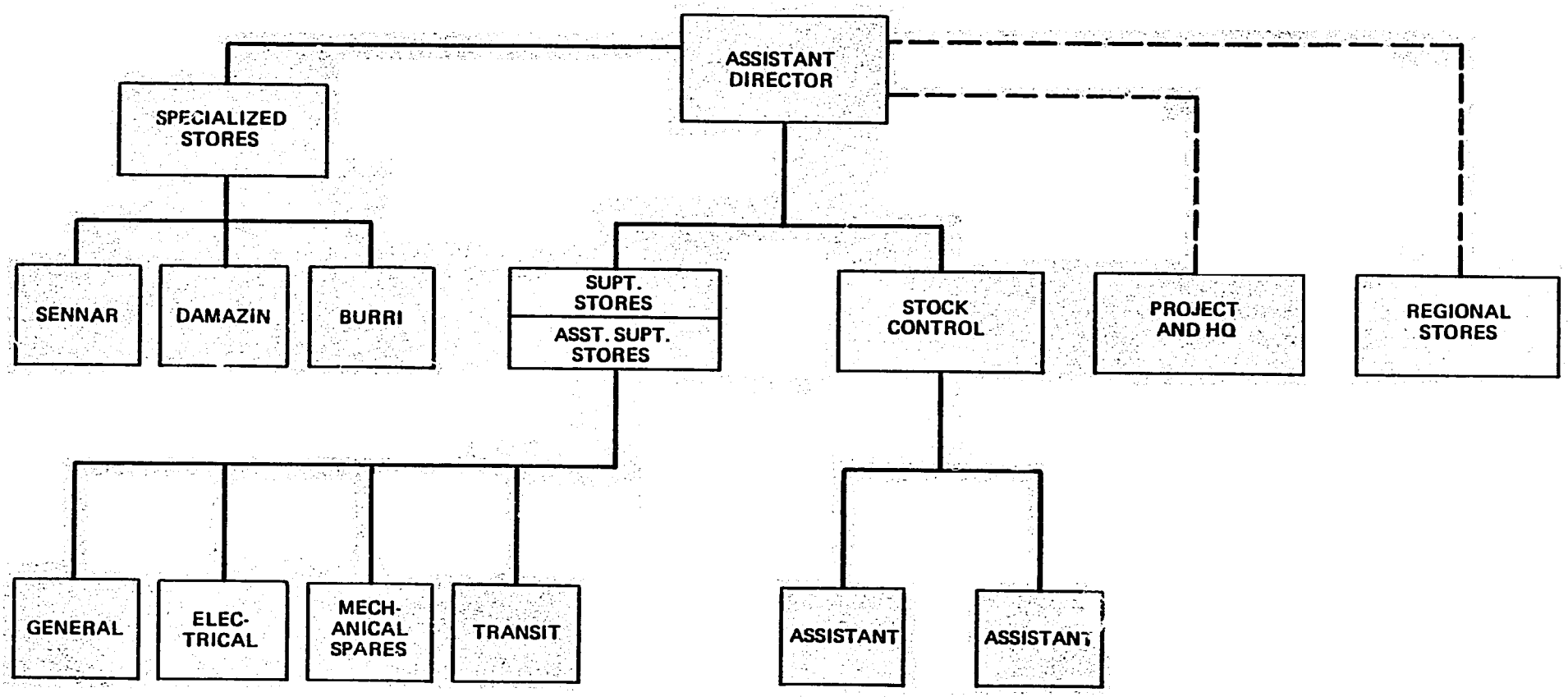
Due to the manner in which NEC obtains funding, most grant assistance requires purchases be made in the granting country. This arrangement greatly limits NEC's ability to standardize their equipment. However, as discussed in the Stores Provisioning Program, NEC should, as much as possible, standardize within their existing system.

9.1 RECOMMENDATION

Engineering should review each requirement and consider what impact any change in equipment has on other equipment. Likewise, attempts should be made to maximize standardization when planning future system expansion. This will have the benefits of (a) significant savings (b) a simplified Stores Provisioning Program and (c) minimum warehouse and yard facilities.



PROGRAM ACTIVITY SCHEDULE



PROPOSED ORGANIZATION CHART
NATIONAL ELECTRICITY CORPORATION
PURCHASING AND STORES

Appendix B

Job Description

Title: Assistant Director - Stores

Reports to: Director of Supplies

Purpose: Management and Supervision of all Warehouse and Stock Control Personnel

Activities/Functions

- Participates on management team for development of Stores Provisioning Program.
- Interfaces with other department representatives to ensure availability of storage space.
- Writes and enforces all procedures.
- Provides guidance to regional, special and Project/Headquarter Stores.
- Directs Superintendent of Stores and Superintendent of Stock Control.
- Develops and maintains training programs.

Job Description

Title: Superintendent of Stock Control

Reports to: Assistant Director of Stores

Purpose: Records Management

Activities/Functions

- Assigns duties to stock control group.
- Maintains Bin Cards and posts entries daily.
- Logs requisitions and issues stock provisioning order (SPO) to stores and/or purchasing, as applicable.
- Advises purchasing and accounting if foreign, when stock levels reach order points.
- After receipt of purchase order and letter of credit, if applicable, post "dues in" on Bin Cards.
- Participates in planning session for the stock provisioning program.

Job Description

Title: Superintendent of Stores

Reports to: Assistant Director of Stores

Purpose: Director Supervision of Receiving, Warehousing and Shipping for Central Stores

Activities/Functions

- Coordination of Head Storekeepers to enture timely distribution of goods.
- Collects daily receipt and delivery records from each section and provides same to stock control.
- Assigns outside laydown areas.
- Monitors pending receipts to ensure proper storage space is available. If not, defines requirements and advises Assistant Director in a timely manner.
- Monitors Central Stores for adherence to procedures and organization.

Job Description

Title: Head Storekeeper (Central Stores)

Reports to: Superintendent of Stores

Purpose: Responsible for Daily Operation of Assigned Section

Activities/Functions

- Direct Supervision of Storekeepers.
- Assigns priorities and daily tasks.
- Ensures proper record entries and transmits daily records to the superintendent of stores.
- Ensures proper storage and space.
- Ensures daily maintenance of equipment assigned to his section.
- Provides recommendations on stock levels and the stores provisioning program.
- Provides training for storekeepers.

BIN CARD

SECTION

Description _____

_____

Maker's Part No. _____

Last supplier

_____

_____

LOCATION

Rack No. _____

Row No. _____

Shelf No. _____

Qty.	RESERVES For Whom	Authority

Vocab. No. _____

Old Bin No. _____

Max. Stock _____

Min. Stock _____

Order Point _____

UNIT _____

ON ORDER			DATE	RECEIPTS			ISSUES			STOCK BALANCE	STORE-KEEPER'S INITIAL FOR ENTRY
Date	Order No.	Qty.		Order Rec'd	Receipt Note No.	Receipt Note Qty.	Req. No.	Job. No.	Qty.		

(G.P.P. 68436) PEWC 715000 9/79

STOCK REVIEW FORM

From _____

Date Requested _____

Date Returned _____

Section _____ Commodity _____

(G.P.P. 3732) S.G. 240 CEWC 715211 300 Bks. 8/71

				A	B	C	D	E	F	G	H	J	K			L	M	BUYER'S ACTION		
Stock Vocab. No.	Location	DESCRIPTION	Unit	Bal. Before Last Receip	LAST RECEIPT			Total D+A	Present Stock	Total Usage E - F	Last 12 Month's Usage	Old		New			Dues In (Qty.)	New Order Quantity	Order No.	Date	Initial
					Date	Order No.	Qty.					Max.	Min.	Max.	Min.	Re-orde					

D-2

Originator _____ Details Provided by _____ Engineer _____ Stock Control _____

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INVENTORY PROCEDURE

I. PREPARATION

A. Store Keepers

1. Ensure items are stored in the location indicated on the Bin Card or each location is listed.
2. Loose articles, where practical, should be repacked in standard bulk lots.
3. Ensure all items are clearly identified and labeled.
4. Place all containers and cartons with labels facing out for easy identification.
5. Check containers with a broken seal and ensure a full count of material is present.
6. Collect all Bin Cards, receipt and issue records and submit to stock control.

B. Stock Control

1. Collect all Bin Cards for each item to be checked.
2. Ensure all posting of receipts and issues is current.
3. Advise all departments and area stores of the dates each section will be inventoried.
4. Mark a red line across each Bin Card for items to be checked and note "Inventory 5/83".
5. Assign checkers to verify random samples of stock.

C. Director of Supplies

1. Assign teams of counters and checkers for each section.
2. Designate dates for inventory, by section.

II. PROCESS

A. Counters

1. Counters will work in two (2) man teams: One will physically count and one will make the entry on the "Count Card", Attachment "A".

2. Ensure each item is identical in a specific location any discrepancy and advise the store keeper.

3. Count every item in each location.

4. If like items are found in multiple locations, a separate count card must be used.

5. Complete the count card information and sign.

B. Store Keepers

1. Move items to provide access to counters, as necessary.

2. Resolve discrepancy if unlike items are found in the same location.

3. Ensure unauthorized personnel are not provided access during the inventory.

4. Ensure no goods are received or issued until the count if complete.

5. Following the completed inventory all receipts and issues must be marked "AI" (After Inventory), until stock control completes reconciliation.

C. Checkers

1. Stock control will assign checkers in two man teams, who will perform as in II.A., only on a random basis.

2. For items checked, Attachment B will be completed.

D. STOCK CONTROL

1. Collect all count cards and verification cards.

2. Post actual inventory on Bin Cards.

3. Immediately advise the chief store keeper of any discrepancy between the Bin Card and stock count.

4. Start a new Bin Card based on the actual stock quantity on hand.

III. CONCLUSION

1. Only stock control will maintain Bin Cards. After the inventory.

2. All posting of receipts and issues will be by authorized stock control personnel.

3. Periodic random inventories will be taken and an annual complete inventory will be taken as a follow up.

USAID Khartoum Sudan

Mission Order

USAID Order Number: ADM-12 Effective Date: October 26, 1983

SUBJECT: Property Accountability for AID Financed Commodities

I. General

Effective utilization of AID assistance requires that commodities financed by AID reach the ultimate user on a timely basis in a usable condition, and are utilized for the purpose intended within a prescribed time period.

II. Utilization

AID project and program assistance agreements specify that the Government of Sudan shall ensure that the commodities financed under such agreements shall be effectively used for the purpose for which the assistance was made available. Agreements also prohibit the reexport of AID-financed commodities without prior approval by AID.

Effective use under program assistance is defined as including:

A. Prompt processing of commodity imports through customs and removal from customs by the importer within 90 calendar days, unless the importer is hindered by force majeure; and

B. Consumption or use by the importer or sale or transfer by the importer for consumption or use within one year from the date of arrival of the commodities at the port of entry, unless a longer period can be justified to the satisfaction of AID by reason of force majeure, special market situations, or other circumstances.

III. Maintenance of Records

AID Regulations require that the Government of Sudan maintain records adequate to document the arrival and disposition in the cooperating country of all commodities financed by AID, and to identify the importer (if the commodity is imported by the borrower/grantee) for a period of 5 years following the date of payment or reimbursement by AID.

IV. Determination of Adequacy of Property Accounting System

A. Project Assistance

In negotiating project assistance agreements, USAID ascertains that project implementation plans include procedures for monitoring progress to

assure that commodity inputs are received and utilized in a timely manner. The Mission is responsible for the review of project progress reports to ascertain that commodities financed by AID are being effectively used in the project--or if not, are transferred for use by other projects or otherwise disposed of as approved by the Mission.

B. Program Assistance

1. Responsibilities

In discharging its responsibilities under Section 201.41 of AID Regulation 1, the Government of Sudan (GOS) may rely upon its overall system applied to all imports in the form of controls or surveillance over import licenses, foreign exchange use and customs release, or it may establish a system specifically for the purpose of discharging its responsibilities regarding AID-financed commodities. In either case, the system must be one which

a) Ascertains whether commodities are received in the quantity and condition for which payment was made by AID.

b) Assures that AID-financed commodities clear customs promptly.

c) Permits determination of the amount, nature and value of AID-financed commodities not cleared from customs and the reasons for their failure to clear.

d) Has the capability of indicating adjustments resulting from importers' claims for loss, shortages, or damage to AID-financed commodities.

e) Assures availability of data for end-use verification, including information needed to monitor AID's prohibition of reexports. (See Section 201.42 of AID Regulationl.)

2. Mission Evaluation of Government of Sudan Accounting Systems

The following factors should be considered by the USAID in determining whether the GOS system accomplishes the objectives set forth above:

a) Import Procedures--Do they provide for early identification of the pending use of AID financing?

b) Financial Procedures--Do the financial procedures followed by the national and commercial banks for the sale of AID foreign exchange provide assurance that the negotiable instruments required to effect the release of private-sector commodities from customs are made available to importers only after they have deposited the full local currency equivalent of the AID dollar purchase?

c) Port Operations--Do they provide reasonable safeguards for the physical handling, storage, and security of imports? Is an adequate storage fee escalation applied to imports following the free storage period to discourage private-sector importers from using the port facilities for warehousing purposes?

d) Customs Procedures--Is a realistic percentage of private-sector imports physically inspected? Is there provision for the confiscation and sale of unclaimed goods at public auction? Do the above procedures and procedures for the collection of import duties and port storage fees ensure that goods are released to the importer of record and in a realistic time period?

e) Insurance Laws or Regulations--Do cooperating country laws or regulations provide reasonable assurance that dollars received by importers as a result of marine insurance or carrier settlements do not merely result in foreign exchange windfalls but are instead (a) used for purposes consistent with the original authority to import, or (b) converted to local currency through official channels?

f) Recordkeeping--Are commodity tally records maintained at the port or elsewhere which reflect short shipments, landings, and releases and are such records available for USAID review and analysis?

3. Possible Need for Mission-Operated System

If USAID/Sudan determines that the GOS system provides reasonable assurance that the requirements above will be met, the Mission will monitor that system as provided in Section V-A. If the GOS system does not provide such assurance, the Mission will establish and maintain its own system to meet these requirements until such time as the GOS system becomes adequate.

V. Project Commodities

A. Adequate GOS System

1. The Project Officer will review all progress reports to ascertain that commodities financed by AID are being effectively utilized in the project or, if not, are transferred for use by other projects or otherwise disposed of as approved by USAID.

2. USAID requires the GOS implementing agency to prepare quarterly reports, which identifies the (1) dollar value and description of commodities shipped; (2) description of commodities and date released from customs, (3) receipt at end use site, (4) date put into service and (5) present condition.

3. A contractor under the guidance of the USAID Controller will be responsible for periodic port checks to assure that AID financed commodities moving through the port smoothly and expeditiously.

4. The Project Officer will be primarily responsible for making end use checks of AID project commodities to assure that all are being used as intended.

B. Inadequate GOS System

In the event that the Mission determines that the GOS implementing agency does not have a property accounting system in place or the existing system will not provide adequate control of project commodities the Project Officer will:

1. Assure that the technical assistance contractor will establish records to accurately account for all project commodities.

2. The system must include:

a) description of quantities and date of commodity ordered

b) date of shipment

c) date of arrival in port

d) date of release from customs

e) date of arrival at project site

f) date that commodity was put in use.

g) physical location of commodity

h) serial number if any

i) cost of commodity

3. The contractor is to include in his periodic reports the status of commodity procurement.

4. The Project Officer will be responsible for end use examinations to assure that all commodities are being used as intended and are being maintained.

VI. Program Assistance

USAID Sudan has determined that at this time the GOS system does not provide reasonable assurance that control over program financial commodities is in place. Therefore, the following USAID system will be used.

Arrival Accounting

To assist the Controller of USAID/Sudan in performing reviews of arrival of commodities at the port of entry, USAID contracted with Arkel-Talab [illegible] to act as a USAID's representative in obtaining information,

as required by USAID, from importers, shipping agents, transit agents and the Government of Sudan. Specifically, the Contractor will perform the following activities:

a) Complete the USAID's Arrival Accounting Form as required. This form shows name of importer, name of supplier, commodity, date of arrival, date and quantity offloaded, date and quantity received by importer and losses.

b) Perform periodic port checks on USAID distressed cargo and complete the USAID's-Unclaimed Cargo Form when needed. This form shows commodity, quantity received by customs, number and date of Out-Turn Receipt (issued by customs), name of vessel and date of arrival.

c) Provide other information and/or assistance to USAID as required.

2. End Use Monitoring

The Controller of USAID/Sudan is responsible to perform end-use monitoring on sample basis - to ensure that USAID CIP commodities are being used as intended.

Any adverse findings by the Contractor and/or by the Controller will be communicated to the Supply Management Office for followup with the interested importers.

12/20/83
Revision 1

PROPERTY ACCOUNTABILITY
RECEIVING PROCEDURE

PURPOSE: To document and fulfill the requirements of USAID order number ADM-12, dated October 26, 1983.

SCOPE: Accountability for AID financed commodities; from arrival in-country, to installation/operation and maintenance history.

A. Bechtel National Inc. (BNI) Records

1. Receipt of goods and location will be recorded by the company accountant.

2. Maintenance costs will be paid out of petty cash and debit entries made against the respective contract numbers, by the accountant.

3. A seperate file will be kept, chronologically,, ex[illegible]ing:
   a. Receipt, condition, over short and damage (O,S, & D) contract number and location.
   b. Disposition, use and location of spare parts.
   c. Maintenance records and costs.
4. Quarterly, a summary of costs, a statement of condition and an inventory of spare parts will be submitted to USAID mission.

B. National Electricity Corporation (N.E.C.) records for CIP goods received.

1. For all goods received, in-country, a receiving report (attachment 1) is issued.

2. The "Port of Sudan/Airport Receiving Log" is completed daily and formally transmitted to BNI on Saturday, weekly. (Attachment 2).

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a. Ship/Airline Arrival date:
The date goods arrive at the airport or are in the harbor at Port Sudan.

b. Carrier Name:
Name of Ship or Airline and flight number.

c. P.O./P.C. Number:
Purchase Order or Purchase Contract number for commodities delivered.

d. Commodity:
Actual goods included in this shipment. Such should relate to a P.O. or P.C. item number.

e. O, S & D:
Over, Short or Damage ((O, S & D) should be indicated in this column and explained in the comments section

f. Customs Clearance Date:
The date the commodity is released from customs for in-country shipment.

g. Shipping Date/Destination:
The date the commodity leaves the airport or Port and its final destination.

h. Comments:
Any general statements, which may clarify the report. However, this section must specifically address the following:

1. O, S & D:
   State what action is taken to resolve.
2. Customs Clearance Date:
   State reason for any delay.

3. Shipping Date/Destination:
   State reason for delay.

3. The "Insurance Claims Log" is completed as necessary and formally transmitted to BNI on Saturday, weekly. (Attachment 3)

a. The first four columns are completed the same as 2a, 2b, 2c, and 2d above.

b. Value:
The total value of the commodity listed.

c. Date of Claim:
The date the insurance claim was filed.

d. Date of Settlement:
The date the insurance claim was settled.

e. Comments:
1. Disposition of goods will be clearly stated.
2. The comments column will indicate any settlement and accountability of same.

4. The "Stores Receiving Log" is completed daily and transmitted to BNI on Saturday, weekly. (Attachment 4).

a. Date of Arrival:
The date the commodity arrives at stores or end destination, as applicable.

b. P.O./ P.C. Number:
Purchase Order or Purchase Contract number for commodity received.

c. Item Number:
The item number, as listed in the P.O./P.C., for the commodity received.

d. Commodity:
Actual goods included in this shipment and as listed in 4b and 4c above.

e. Value:
The value of this commodity as shown on the invoice and stated in the P.O./P.C.

f. Location:
Physical location of the commodity, as shown on the bin card.

g. Release To User Date:
The date the commodity is released from stores.

h. Comments:
Any general statements which clarify this report or address the condition of the commodity.

5. The "User Records Log" will be published and distributed to BNI monthly. This log is for easy reference and does not fulfill the need for detailed records required by the manufacturer or USAID. Only the location of detailed records will be shown on this log.

a. The first four columns are to be completed the same as 4a, 4b, 4c and 4d above.

b. Date of Installation/Operation:
This is the date equipment is installed or vehicles are released for operation.

c. Location:
The physical location of the commodity and/or the person responsible for the vehicle.

d. Maintenance Required Yes or No:
This column indicates if the manufacturer has provided a recommended maintenance schedule.

e. Comments/Location of Maintenance Records:
This column is for any general comments regarding the commodity at the time of receipt. However, it is specifically intended that this column also list the location of the detailed maintenance records.

c. Records Storage

1. BNI

a. All Records (Logs) will be filed chronologically, by title, for the duration of the contract.

b. Quarterly, a written summary of each log will be issued to USAID. Such will indicate, with the exception of the "User Records Log", completion of all actions.

c. The "User Records Log" will always reflect the current location of goods and maintenance records for auditable purposes.

2. NEC

All records stated herein will be maintained for a minimum of five (5) years. All maintenance records will be kept current and readily available for inspection, upon request.

BLUF NILE GRID REHABILITATION PROJECT

MATERIAL RECEIVING REPORT

PO/PC NO._____ DATE_____

SUPPLIER:_____

PO/PC ITEM NO.

DESCRIPTION:

DELIVERED TO/LOCATION/:

CHECKED AND DECLARED IN SATISFACTORY CONDITION BY NEC:

VERIFIED BY BNI:

_____ _____

INSURANCE CLAIMS LOG

DATE OF ARRIVAL	CARRIER NAME	P.O./P.C. NUMBER	COMMODITY	VALUE	DATE OF CLAIM	DATE OF SETTLEMENT	COMMENTS/ DISPOSITION OF GOODS

USER RECORDING LOG

DATE OF CEIPT	P.O./P.C. NUMBER	ITEM NUMBER	COMMODITY	DATE OF INSTALLATION OPERATION	LOCATION	MAINTENANCE REQUIRED YES OR NO	COMMENTS/LOCATION OF MAINTENANCE RECORDS

STORES RECEIVING LOG

DATE OF ARRIVAL	P.O./ P.C. NUMBER	ITEM NUMBER	COMMODITY	VALUE	LOCATION	RELEASE TO USER/DATE	COMMENTS

PORT OF SUDAN/AIRPORT RECEIVING LOG

SHIP/AIRLINE ARRIVAL DATE	CARRIER NAME	P.O./P.C. NUMBER	COMMODITY	O,S & D	CUSTOMS CLEARANCE DATE	SHIPPING DESTINATION DATE	COMMENTS

PREMINIARY

Obsolete Items and Disposition Procedure

DEFINITION: An obsolete item is one which is no longer required in stock, due to: (1) Equipment and/or system has changed; or (2) usage of the item is on an "As Required" basis and has not had a repetitive draw down in the last thirty-six (36) months.

PROCEDURE

1. DETERMINATION OF OBSOLETE ITEMS

   A) The Assistantr Director of Stores, quarterly, compiles a complete list of obsolete items and submits same to the Director of Supplies.

   B) The Director of Supplies transmits the list to the Area Stores; engineering; planning; and Generation Departments. These sections must concur or comment within two weeks. If no response is received, it shall be interpreted that the section concurs.

2. AUTHORITY FOR DISPOSAL

   A) Following completion of the final list, reflecting input from others, the Director of Supplies will submit same to the Director General for approval.

   B) Only the Director General, or an approved delegate, may approve the obsolete item list for disposal.

3. DISPOSAL OF OBSOLETE ITEMS

   A) After receipt of approval on the list of obsolete items, the Director of Supplies shall instruct Purchasing & Stores to coordinate in completing final disposition of goods.

   B) METHODS OF DISPOSAL

      1) If possible, the goods should be returned to the original supplier. This can be

accomplished if, there is a return clause in the contract or negotiation with the original seller.

2) A negotiated sale to another utility using like or similar equipment, a listing of these utilities may possibly be obtained from the seller.

3) Consignment to a qualified dealer to sell on NEC's behalf. Written bids for consignment sales agreements should be solicited in the newspaper.

4) Direct sales may be offered through the newspaper. However, a realistic appraised value should be established and award should be as follows:

   a) If an offer equals or is greater than the appraised price, it is accepted from the first bidder.

   b) If no offer equals the appraised price it is awarded to the highest bidder.

5) Lastly, the remaining items are determined scrap and open bids are solicited for the total lot.

4. APPROVAL OF SALE

All sales are subject to the same approval levels as a purchase order of comparable value.

5. Notice of sale and release of goods

A) A notice of sale will be sent to the buyer, the accounting department and stores.

B) After the buyer obtains a receipt from accounting, he must take a copy of stores for release of goods.

6. TERMS & CONDITIONS FOR ALL SALES

A) All sales are "As is", FOB location and buyer's transport.

B) All offerings are subject to prior sale or other disposition.

C) No implies warranty of saleability or fitness for purpose shall apply.

D) All sales are final: Cash or other payment acceptable to seller is required prior to release of goods to buyer.

E) Any applicable taxes will be added to the sale price.

F) Sold good must be removed within ten (10) working days from the notice of sale date.

REQUISITION PROCEDURE

The Procedure for issuance of a Purchase Order (P.O.) or Purchase Contract (P.C.) and shipment to the destination.

1.0 CONTROL DOCUMENT

1.1 Stores Requisition

The responsible area completes the store requisition (G.P.P. 62037) and issues to stores for handling in accordance with paragraph 2.0 below.

1.2 Stores Provisioning Program (SPP)

1.2.1 Each area summarizes annual requirements for stock consumables.

1.2.2 The planning manager reviews and approves the final quantities on the SPP summation sheet. The SPP is issued to purchasing and handled in accordance with the procedure discussed in paragraph 3.0 below.

1.3 Technical Letter

1.3.1 A Technical letter, approved by the responsible manager, may be transmitted to purchasing, in lieu of 1.1 and 1.2 above.

1.3.2 The Technical letter will include all information included on the stores requisaition and except for 1.3.3. below, will be for non-stock items and/or urgent needs.

1.3.3 Spares

1.3.3.1 The responsible department prepares a preliminary spare parts list.

1.3.3.2 The list is transmitted to the manufacturer for its concurrence.

1.3.3.3 The manufactuere prepares a proforma invoice and returns same to the responsible technical person.

1.3.3.4 The technical department finalizes the spare parts list and totals the proforma invoice.

1.3.3.4.A Values less than 50,000 LS. are approved by the General Manager

1.3.3.4.B Values greater than 50,000 LS. must be approved by the Minister of Finance in order to obtain an import license.

1.3.3.5 After obtaining proper approval, a technical letter is issued to purchasing.

2.0 STORES

2.1 If available, issue material from stock upon receipt of properly approved stores requisition. If not available,

2.2 The requisition is transmitted to stock control. Stock Control prepares a stores provisioning order (SPO). The SPO is issued to purchasing and handled in accordance with 3.0 below.

3.0 PURCHASING

3.1 Definitions

3.1.1 Purchase Order (P.O.)

For equipment, materials and services (e.g. Technical Service Representative).

3.1.2 Purchase Contents (P.C.)

For equipment, materials and Services (e.g. Technical Service Representative).

3.2 Local (Domestic)

3.2.1 Purchases of items and/or services available in Sudan.

3.2.1.1 Total value less than 1500 LS. may be solicited, evaluated, recommended and approved by the Director of Supply.

3.2.2.2 Total values exceeding 1500 LS. must be open Tender (Public Bid) subject to the procedures outlined in 3.3 below.

3.3 Foreign or total value greater than 1500 LS.

3.3.1 If applicable, obtain complete technical specification and attach to the standard tender package.

3.3.2 Issue tender documents to approved bidders (if foreign) or to interested bidders who have submitted the 2% deposit (if local).

3.3.3 Received all proposals in accordance with tender deadline and request convention of tender Board.

3.3.4 Tender Board consists of the following representatives:

1 Person - Purchasing
2 People - Technical
1 Person - Finance
1 Person - Legal
Minister of Finance, if the value is greater than 1,000,000 LS.

4.0 SHIPPING & INSURANCE (TRAFFIC)

4.1 Obtain import license from Ministry of Trade.

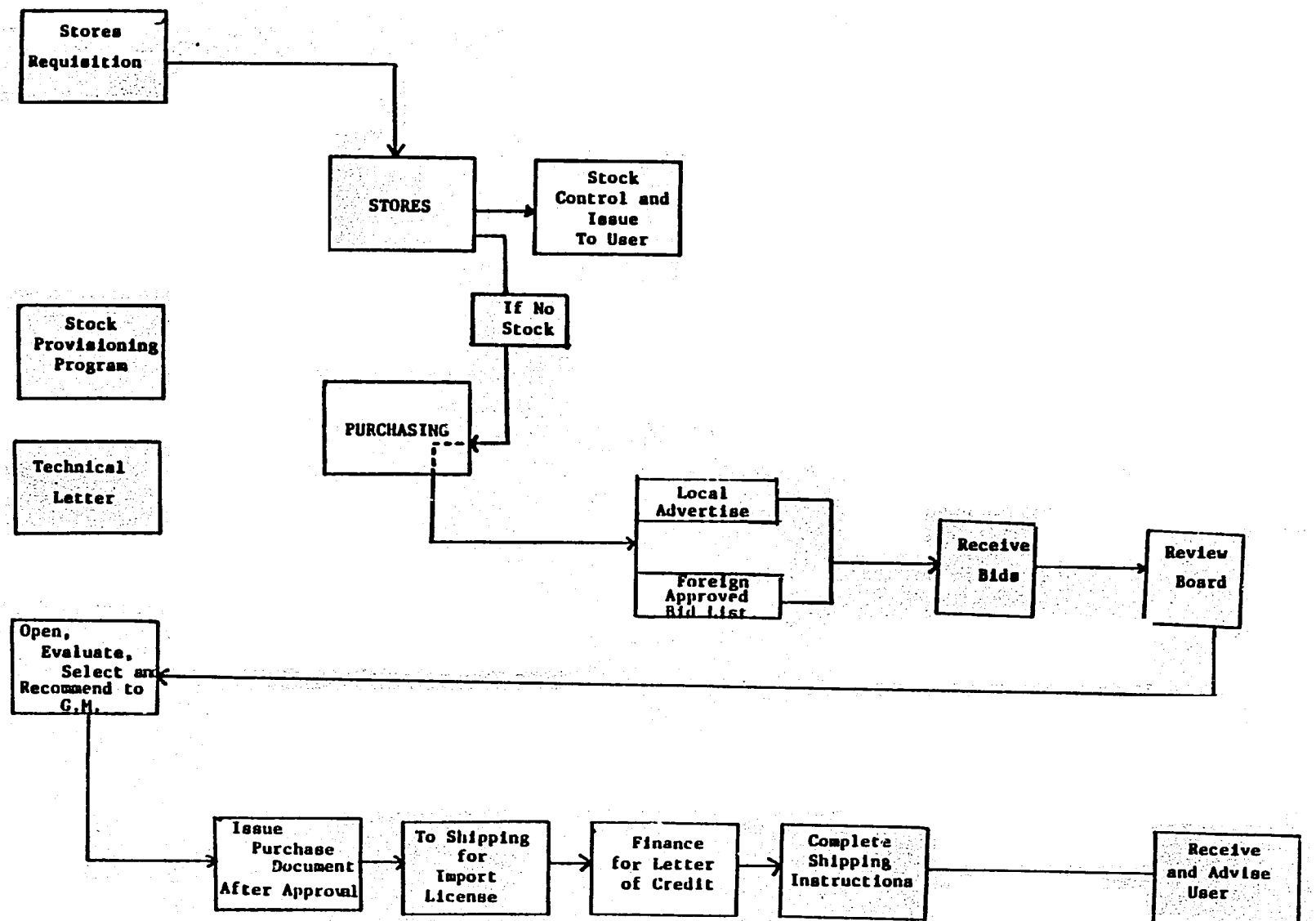
4.2 Submit documentation including PO/PC and import license to the Director of Finance in order for that department to obtain the letter of Credit.

4.3 After receipt of the completed package, including the letter of credit:

4.3.1 Contact Sudan Shipping Lines to provide Instructions to the Supplier.

4.3.2 Ensure Sudan Shipping Lines and the Government Cargo Agent are coordinated for customs clearance.

4.3.3 If time is of the essence, arrange Transportation to the required destination. Rail transportation will be arranged and directed by the responsible government agency.



PURCHASING FLOW CHART