



**Islamic Republic of Afghanistan  
Inter-Ministerial Commission for  
Energy (ICE) Secretariat**

**Outline for MEW and DABM  
Operations and Maintenance  
Technical Assistance and Training**

**Revision 2**



**February 2008**

## **ACKNOWLEDGMENTS**

At the ICE Meeting on 25 October 2007, the Ministry of Energy and Water representatives and the *Da Afghanistan Breshna Mossessa* (DABM) representatives requested O&M Technical Assistance and Training support from the donor organizations for the 220 kV transmission lines and 220 kV substations that are a part of the North East Power System (NEPS). The NEPS transmission lines and selected 220 kV substations are expected to be commissioned into service by the end of 2008.

Accordingly, HE Dr. Shams, the Minister of Economy and ICE Chairman directed the ICE Secretariat staff to compile a comprehensive training plan or outline for MEW / DABM generation, transmission and distribution technical assistance and training. This technical assistance and training plan outline meets the objectives directed to the ICE Secretariat staff.

Special thanks is given to the leadership and staff of the Afghanistan Ministry of Energy and Water (MEW) and the Kabul Electricity Department (KED) of the *Da Afghanistan Breshna Mossessa* (DABM), the country's main government organization in charge of electricity power generation, transmission and distribution for providing the information that made this assessment of MEW and DABM Operations and Maintenance Technical Assistance and Training Requirements possible.

The approvals and support provided by HE Minister of Energy and Water Ismail Kahn, HE Dr. J. P. Shams, Chairman of ICE, and DABM President Director Mr. Rabbani allowed the effort to proceed.

The study was conducted by Engineer Wakil Nasery of the Afghanistan Energy information Center (AEIC) and Chris Marlatt, T&D Construction Manager of the LBG/B&V Afghanistan Infrastructure Rehabilitation Program (AIRP), with valuable input from Bob Mengel, Diesel Operations and Maintenance Manager, of the LBG/B&V Afghanistan Infrastructure Rehabilitation Program (AIRP).

## **Outline for MEW and DABM Operations and Maintenance Technical Assistance and Training**

### **1. Summary:**

MEW and DABM have requested through the Inter-Ministerial Commission for Energy (ICE) on 25 October 2007 that technical assistance and training be provided to them in the operations and maintenance of power sector assets, particularly transmission lines and substations, but including generating stations, step-up transformers, MV and LV distribution systems, load control and dispatch, relay and protection systems, energy planning, and specialty areas such as reactive power compensation and transformer maintenance. The maintenance technical assistance and training should cover corrective and preventative maintenance, but may also need to include predictive or reliability centered maintenance at some point.

The technical assistance and training should include training and material for operations and maintenance of the following, with special emphasis on personnel and equipment safety:

- a. Generating stations including hydro power plants and thermal power plants (diesel gensets and gas turbine units).
- b. 500 kV Transmission Lines and Substations including towers, insulators, ACSR conductors, switch yard, transformers, circuit breakers, instrumentation, relays and protection equipment.
- c. 220 kV Transmission Lines and Substations including towers, insulators, ACSR conductors, switch yard, transformers, circuit breakers, instrumentation, relays and protection equipment.
- d. 132 kV Transmission Lines and Substations including towers, insulators, ACSR conductors, switch yard, transformers, circuit breakers, instrumentation, relays and protection equipment.
- e. 110 kV Transmission Lines and Substations including towers, insulators, ACSR conductors, switch yard, transformers, circuit breakers, instrumentation, relays and protection equipment.
- f. 44 kV / 35 kV / 20 kV / 6 kV Medium Voltage Transmission / Distribution Lines and Substations including towers, poles, insulators, ACSR conductors, switch yard, transformers, circuit breakers, instrumentation, relays and protection equipment.
- g. HV / MV Substations including feeder panels, switch yard, transformers, circuit breakers, instrumentation, relays and protection equipment.
- h. MV Junction Stations including feeder panels, circuit breakers, instrumentation, relays and protection equipment.
- i. MV (15 kV – 20 kV) Distribution Systems including poles, ACSR or ABC conductors, insulators and appurtenances, underground cable, and distribution transformers.
- j. LV (400 V) Distribution Systems including poles, ABC conductors, insulators and appurtenances, underground cable, feeder pillars, and meter boxes.
- k. Reactive Power Compensation (Capacitor and Inductor Banks) Systems to maintain power factor as close to unity as practicable in order to minimize transmission lines losses and allow stable operations, especially when connected with other grids.
- l. Load Control and Dispatch Center including current / potential transformers, instrumentation, communications systems, software, and system operations.

## **2. Emphasis:**

The emphasis on the technical assistance and training support for MEW and DABM will be on personnel and equipment, and to a lesser extent on spare parts. All spare parts requirements for generation, transmission and distribution systems (including substations and junction stations) are provided by DABM to MEW for budgeting and procurement activities.

All technical assistance and training should be coordinated with the MEW Vocational Training Center, Capacity Building Department. The scope of technical assistance and training will include the following:

- a. Determine how many MEW, DABM or KED positions are required for each operation and maintenance function described above.
- b. Determine the Knowledge, Skills and Abilities (KSAs) required for each position, separated by (1) operations, (2) maintenance and (3) procurement of tools and supplies, including spare parts.
- c. Determine the number of people at MEW, DABM and KED that have the skill sets required for each position.
- d. Identify the number of positions that are required to be filled by MEW, DABM or KED to operate and maintain the Afghanistan electricity generators, transmission and distribution systems and networks including substations and junction stations.
- e. Ascertain the tools and equipment needed by each position to effectively and safely perform their jobs.
- f. Schedule class room and on-the-job (OJT) technical assistance and training for skilled operations, maintenance, testing and calibration, instrumentation, planning and dispatch personnel. Identify the location of training for each position, number of people to be trained, and the duration of training (classroom or OJT).
- g. Identify and procure job training materials and equipment (including safety equipment) for each position to be assisted or trained.

## **3. DABM Requirements for Capacity Building:**

Over the last several years DABM has initiated some capacity building programs in the different aspects of electricity generation, transmission and distribution, but some of the capacity building programs were for short duration and not highly effective, for example, at rehabilitated junction stations. However, recently DABM has been improving training of operators and repair technicians through technical assistance and on-the-job training by having the DABM staff work alongside contract engineers to learn how to operate and maintain new or rehabilitated systems and components. For example, at the Kajakai, Mahipar and Surobi hydro power plants (HPP) and in the transmission and distribution systems in places like the Faryab transmission and distribution project, many DABM engineers and technicians had been going through on-the-job training and receiving technical assistance from the rehabilitation contractor. However, there are other projects such as the Naghlu East double circuit transmission line project where no job training for DABM staff was done.

Further, some past projects such as the Breshna Kot and East Substation rehabilitation also had some problems concerning training of DABM staff because the protection system is digital (electronics), DABM engineers do not have sufficient experience with this level of technology, and the amount of training was insufficient to enable the engineers, operators and repair technicians to competently operate and maintain the substations.

DABM is concerned about the operation and maintenance of existing substations of all sizes and the MV junction stations, because most of their operators are not engineers or technicians, but rather are skilled or unskilled workers with little formal training. The same problem exists in the power plants (hydro and thermal). By arranging a capacity building program, DABM can improve the technical knowledge of the existing staff, hire and train personnel with the requisite skills, and thereby improve the operations and maintenance of the various power sector assets and improving capacity factor (by minimizing downtime), reducing costs of corrective maintenance, and improving worker safety.

### **How we can arrange this program?**

The first step is to understand the DABM organization, the workload and responsibilities of the various departments, and determine the number of engineers and technicians needed to operate and maintain the Afghanistan generating stations, transmission and distribution systems, repair and calibration facilities (for instruments and controls), load control and dispatch center(s), and also energy sector planning (such as planning for scheduled maintenance and repair outages).

The next step is to prepare Knowledge, Skills and Ability (KSA) requirements for each position to determine the skill sets needed for each position.

After the KSAs are determined, the DABM organization should inventory its engineers and technicians to determine if they have sufficient skilled personnel, and if the personnel are placed in the appropriate positions. A part of this activity is to determine how many of the existing personnel had been trained and for how long, as well as assess the quality of the training provided.

According to our evaluation the previous programs of DABM capacity building were not appropriate because training time was short and people were selected for the training without adequate testing for requisite skills and knowledge. Accordingly, DABM did not achieve expected results and the trainees were not happy.

The training programs also need to consider providing food and refreshments that were not available in past programs. Further, training (class room and OJT) needs to consider the situation of DABM employees that often work multiple jobs in order to provide for some quality of life for themselves and their families.

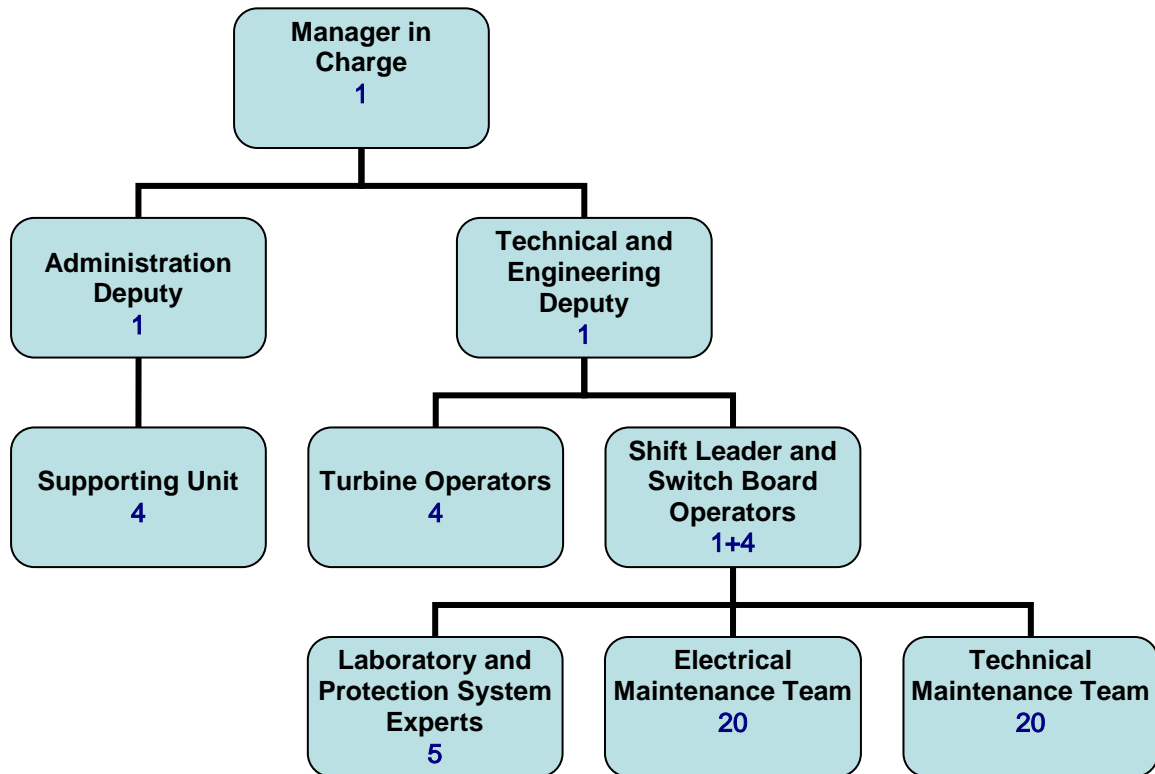
It should be noted that capacity building is not just required for people in the technical field, but DABM needs training in procurement, energy planning, finance and administration, although technical assistance and training of personnel (engineers and technicians) to operate and maintain generation stations, substations, transmission lines, and MV and LV distribution systems (including junction stations) is the higher priority.

It should be noted that DABM has a number of experienced and capable engineers that can be trained in various jobs, and then become trainers themselves to leverage the technical assistance and training investment to cover as many competent people as possible throughout the country at generating stations, substations, junction stations and the like. The "Train the Trainer" concept is being applied now to some of the 220 kV substations with funding from ADB, by Safreco.

The initial technical assistance and training assessment should focus on the generating stations as the source of electricity, and requiring a number of skilled personnel to operate and maintain the generating stations (hydro and thermal). For example, the Naghlu hydro power plant has 110 employees, but all these employees may not be necessary to work in the plant, but the essential personnel necessary to operate and maintain the plant is

indicated in the chart below. The staffing requirements assume three major operations and maintenance (O&M) functions at the plant; the Turbine (or Engine), Generator, and Protection System. Skilled engineers and technicians are needed for proper, accurate and safe operation and maintenance of a power generating station. There is 12+12 people needed for operation, in each 4+4 shift, four people that have responsibility for operation in the control room and the other four are responsible for machinery works such as the turbine, compressor, and water pump and other balance of plant equipment, in the power house.

**Organization Chart of a Typical Hydro Power Plant:**



For the power plants (generating stations), most concerns are in the maintenance area, due to a lack of skilled, trained engineers and technicians. Most power plants cannot properly maintain or renovate the plants due to lack of experience, expertise and training. For major power generating station components such as repairing of turbines, engines and generators, DABM must rely on external skills, although this process is not unusual in any government or investor owned utility.

Still, DABM urgently needs a capacity building program for the generating stations in order to perform routine operations, including preventative and corrective maintenance, to ensure safe and reliable plant operations. If the personnel for the three hydro power plants in Kabul are properly trained to operate and maintain the larger units, as are the personnel at Kajakai, then these operators, engineers and technicians can repair the small hydro power plants that are managed by DABM throughout the country. There will, however, need to be adequate tools, equipment and parts that are needed to perform routine calibration, maintenance and repair activities.

A listing of the current DABM generation stations, power substations, and length of transmission lines is attached herein.

#### 4. Personnel and Positions to be Trained:

The following is an assessment of the numbers of people (and positions) at DABM facilities that need technical assistance and training:

##### Power Generating Stations:

Function	Number of People at Generating Stations
Operation of Power Plant (Control Room)	50
Turbine / Engine Operation	30
Turbine / Engine Maintenance and Repairs	10
Generator Maintenance and Repairs	10
Calibration and Repair of Protection Relays	20
Total	120

##### Transmission Lines:

For transmission line operation and maintenance, DABM has trained engineers and technicians. Not including the 220 kV lineman and substation training sponsored by an ADB Project, DABM needs the following personnel for survey, design and erection work, stringing of conductors, and repairing insulators.

Function	Number of People at DABM
Survey of High, Medium and Low Voltage Lines	40
Transmission Line Design	20
Erection of Towers and Stringing of Line	90
Total	150

##### Substations

For substations only operators should be trained because the DABM Commissioning, Test and Technical Inspection, Maintenance and Relay Protection Departments have responsibility for maintenance of substations.

Function	Number of People at DABM
Substation Operators	252

##### Junction Stations:

DABM has a limited number of junction stations (or load centers). Most of the junction stations are located in Kabul City. There are a total of 15 junction stations, and 12 are located in Kabul City (15 kV – 20 kV) operated and maintained by the Kabul Electric Department (KED) of DABM, and 3 are located in the Mazar-e-Sharif 6 kV distribution network. The number of trained operators and required are:

Function	Number of People at DABM
Operators for 6 kV, 15 kV and 20 kV Junction Stations	30

### **Medium and Low Voltage Distribution Network:**

There are about 1,500 electricians in DABM throughout Afghanistan. The training of the electricians can be done by the junction station operators.

### **Overhead Line (MV & LV):**

Engineers and technicians are needed for installing, repairing and maintaining Medium Voltage (MV) and Low Voltage (LV) overhead lines (including poles, ACSR and ABC conductors, insulators, guy wires and appurtenances). DABM needs an urgent program for technical assistance and training. Technical Assistance can be done with the current and planned activities to rehabilitate the Kabul City MV and LV Distribution System. This technical assistance and training requirement affects all DABM Departments that have linemen.

<b>Function</b>	<b>Number of People at DABM</b>
Linemen for Installation, Repair and Maintenance of Overhead Lines	220

Note: Most of the Linemen belong to the Kabul, Herat, Mazar-e-Sharif, Kandahar and Jalalabad Departments of DABM.

### **Power and Distribution Transformers Repairing Workshop:**

DABM has Power and Distribution Transformer repair work shops in Kabul (KED), Negara, Mazar-e-Sharif, Ghorri and Kandahar Power Departments. Three transformer repair electricians at each repair facility are considered adequate for the work load.

<b>Function</b>	<b>Number of People at DABM</b>
Transformer Repair Electricians	15

### **Repairing and Maintenance Department:**

This department is responsible for repairing of all circuit breakers, isolating switches, testing and control of transformers, distribution panels, and low voltage circuit breakers. DABM needs significant help with technical assistance and training for the technicians and electricians in this field. There are 12 Repairing and Maintenance Departments throughout Afghanistan. Each Repairing and Maintenance Department needs 10 people.

<b>Function</b>	<b>Number of People at DABM</b>
Repair and Maintenance Department Engineers and Technicians	120

### **Under Ground and Relay Repairing Department:**

Engineers and technicians of this department are responsible for checking and repairing of all under ground cable and protection relays in junction stations. DABM doesn't have this Department in the entire country, but only in population zones such as Kabul, Nangarhar, Kunduz, Mazar-e-Sharif and Kandahar. These Departments have recurring problems, especially for electronic relays, in substations or junction stations. For example, during the current year some parts of three substations (such as the East, North West and Mazar-e-

Sharif substations) burned down because of faulty workmanship, and were without power for a long time.

Function	Number of People at DABM
Detection and Repair of Faulty Underground Cable	25
Repair of Protection Relays and Circuit Breakers at MV Substations and Junction Stations	50

#### **Relay Department in the Center of DABM:**

The engineers of this Department are responsible for repairing of all relays at DABM HV substations, power plants and high voltage transmission lines. Generally, the engineers and technicians have satisfactory experience in analog system components, but they have critical problems with the modern technology, for example electronic or solid state relays. Some of the Relay Department engineers were trained for short time in the Breshna Kot substation by Siemens engineers, but that was only an introduction. Therefore, the engineers and technicians cannot properly work because of the lack of knowledge, training and experience with modern equipment and systems. This lack of knowledge, skills and experience has caused critical problems in substations and power plants, especially in the North West gas turbine units and the rehabilitated substations.

Function	Number of People at DABM
Relay Repair and Calibration Technicians	12

#### **Dispatching Center:**

DABM currently has only a simple dispatching center, although there are plans to build a more substantial load control and dispatch center in Kabul. Currently, all operations are conducted via telephone, but this situation is expected to improve in the months and years to come.

It should be noted that currently, the operation of hydro power plants is controlled by the plant manager and also by the plants operators, and not by dispatching operators. Commands are sent by radio to substations or power plants, but not by direct action.

Training is necessary to inspire leadership and confidence only not direct action, so for new and complicate systems, such training is considered essential.

Function	Number of People at DABM
Dispatch and Control Center Operators	12

#### **Survey and Planning Department:**

In support of all of the branches of DABM, the Survey and Planning Department has responsibility for survey and design activities for all generation, transmission and distribution system and rights of way. However, personnel in this department have not had the training to use modern technology, such as computers. Training required is basic computer skills plus training in CAD and GIS Programs, and in GPS measurements.

Function	Number of People at DABM
Survey and Planning Engineers	30

### **Procurement Department:**

Each DABM Department has authorization to purchase materials and supplies from the local bazaar, but for larger purchases, the Procurement Department is responsible for procurement of all important or high value material and equipment for power plants, transmission and distribution systems. Accordingly, Procurement Department personnel should be trained in procurement activities using appropriate government standards and specifications.

<b>Function</b>	<b>Number of People at DABM</b>
DABM Center Procurement Department	5
Population Center Procurement Department	20

Training of procurement experts for this Department is very important, especially in the preparation of tender documents. Personnel in this Department also need training in basic computing (internet), and in learning how to prepare tender and bid documents.

The staff of this department doesn't have the ability for internet use, so training in computer usage and in using the internet for procurement and pricing information would be necessary.

### **Diesel Generators Maintenance Department:**

DABM has about 65 Gen Sets throughout Afghanistan, with capacities ranging from 500 to 2,200 KW at this time. Generally, the operations and maintenance of the Gen Sets is lacking. DABM pays a lot of money for private companies to perform maintenance and repairs.

DABM also has a Department in the Center of DABM that repaired Gen Sets in Kabul. However, this Diesel Generator Repair Shop was totally destroyed during the wars and has not been rebuilt.

<b>Function</b>	<b>Number of People at DABM</b>
Kabul City Diesel Repair Department	14
Afghanistan Diesel Repair Department	90

### **Billing and Meter Reading Department:**

The DABM Billing and Meter Reading Departments have problems with an old system of meter readings and collections. Some part of this organization started the computerization work for registration of customers, but that is not enough because it does not cover all commercial, governmental or residential customers. In a short time, with proper training, the Herat Power Department, and a small portion of the Kabul Electric Department became able to use and share code data in computers. Therefore, it is very important to endorse this program and train a minimum of 100 people for DABM units in proper methods of meter reading, billing and collections.

<b>Function</b>	<b>Number of People at DABM</b>
Billing and Meter Reading Clerks	100

**Total Staffing Requirements (People): 1,265**

**5. Required Equipment and Tools:**

The following is a preliminary assessment of the equipment and tools necessary to operate and maintain the DABM facilities:

**Power Generating Stations:**

<b>Equipment and Tools</b>	<b>Quantity Required</b>	<b>Unit Cost (\$USD)</b>	<b>Total Cost (\$USD)</b>
Heavy 4x4 Flatbed Crew Cab Trucks (F350 or Equivalent)	4	40,000.	160,000.
Heavy 4x4 Pick-Up Trucks (F250 or Equivalent)	4	30,000.	120,000.
D4 Cat with Twin Winches and Tilt Blade	1	45,000.	45,000.
Fork Lift Truck (Snorkel)	2	40,000.	80,000.
Under Ground Cable Puller and Tensioner	2	30,000.	60,000.
Backhoe and Trailer	2	65,000.	130,000.
4x4 Flatbed Truck (5 Ton Capacity)	4	20,000.	80,000.
Tractor with Low Boy and Float Trailer	1	150,000.	150,000.
Production Digger (with Auger)	1	125,000.	125,000.
Reel Trailer and Stands	1	15,000.	15,000.
Cable Reel Stands	8	2,000.	16,000.
Miscellaneous Rigging and Tools	See List 1B	399,600.	399,600.
Safety Gear (Hard Hats, Safety Glasses, Safety Boots, Rubber Gloves, Safety Harness, Hearing Protection)	120	800.	96,000.
Employee Tool Bag with Tools and Supplies	120 Sets	1,000.	120,000.
<b>Total ROM Cost per Operational Generation Station</b>			<b>1,380,000.</b>
<b>Total ROM Cost for 15 Operational Generation Stations</b>			<b>20,709,000.</b>
<b>Total ROM Cost Including Employee Tool Bags and Safety Gear</b>			<b>20,925,000.</b>

**Transmission Lines:**

The following equipment and tools should be considered at a transmission system staging area spaced every 100 – 200 km or as otherwise directed by DABM:

<b>Equipment and Tools</b>	<b>Quantity Required</b>	<b>Unit Cost (\$USD)</b>	<b>Total Cost (\$USD)</b>
Heavy 4x4 Flatbed Crew Cab Trucks (F350 or Equivalent)	6	40,000.	240,000.
Heavy 4x4 Service Trucks (F350 or Equivalent)	6	25,000.	150,000.

Heavy 4x4 Pick-Up Trucks (F250 or Equivalent)	4	30,000.	120,000.
Snow Cat	1	30,000.	30,000.
D6 Cat with Twin Winches and Tilt Blade	1	75,000.	75,000.
25 Ton Rough Terrain Crane	1	120,000.	120,000.
150' High Reach Ladder Truck	1	250,000.	250,000.
Hotstick Trailer (Complete)	1	80,000.	80,000.
40 K Puller / Tensioner (Complete)	1	300,000.	300,000.
Excavator (Trackhoe) and Trailer	1	80,000.	80,000.
Backhoe and Trailer	1	65,000.	65,000.
4x4 Flatbed Truck (5 Ton Capacity)	2	20,000.	40,000.
Tractor with Low Boy and Float Trailer	1	150,000.	150,000.
Anchoring Machine	1	50,000.	50,000.
Reel Trailer and Stands	2	15,000.	30,000.
Bundle Blocks	40	1,000.	40,000.
Single Blocks	40	400.	16,000.
Cable Reel Stands	8	2,000.	16,000.
Miscellaneous Rigging and Tools	See List 1A	323,760.	323,760.
Safety Gear (Hard Hats, Safety Glasses, Safety Boots, Rubber Gloves, Safety Harness, Hearing Protection)	150 Sets	800.	120,000.
Employee Tool Bag with Tools and Supplies	150 Sets	1,000.	150,000.
<b>Total ROM Cost per Camp</b>			<b>2,175,760.</b>
<b>Total ROM Cost for 3,717/200 = 19 Camps (Use 20 Camps)</b>			<b>43,515,200.</b>
<b>Total ROM Cost Including Employee Tool Bags and Safety Gear</b>			<b>43,785,200.</b>

#### Substations:

The following equipment and tools should be considered at each substation maintenance and repair crew base in Afghanistan. It is anticipated that substation repair crew bases would exist in Herat, Kabul, Kandahar (for Kandahar and Qalat), Lashkar-Gah / Kajakai, Mazar-e-Sharif, Pul-i-Khumri, and other locations as determined by DABM:

Equipment and Tools	Quantity Required	Unit Cost (\$USD)	Total Cost (\$USD)
Heavy 4x4 Flatbed Crew Cab Trucks (F350 or Equivalent)	4	40,000.	160,000.
Heavy 4x4 Service Trucks (F350 or Equivalent)	6	25,000.	150,000.
Heavy 4x4 Pick-Up Trucks (F250 or Equivalent)	6	30,000.	180,000.
Snow Cat	2	30,000.	60,000.
Bob Cat	4	10,000.	40,000.

D4 Cat with Twin Winches and Angle Blade	2	45,000.	90,000.
D6 Cat with Twin Winches and Angle Blade	1	75,000.	75,000.
15 Ton Rough Terrain Crane	4	90,000.	360,000.
150 Ton Truck Crane	1	350,000.	350,000.
Hotstick Trailer (Complete)	1	80,000.	80,000.
Oil Filter and Vacuum Equipment (Sets)	2	20,000.	40,000.
Excavator (Trackhoe) and Trailer	1	80,000.	80,000.
Backhoe and Trailer	4	65,000.	260,000.
Low Profile Track Backhoe and Trailer	2	15,000.	30,000.
4x4 Flatbed Truck (5 Ton Capacity)	2	20,000.	40,000.
Tractor with Low Boy and Float Trailer	4	100,000.	400,000.
40' Hydraulic Bucket Trucks 4x4	2	60,000.	120,000.
75' Hydraulic Bucket Trucks 4x4	2	125,000.	250,000.
Cable Reel Stands	8	2,000.	16,000.
Fork Lift Truck	4	30,000.	120,000.
Under Ground Cable Puller and Tensioner	2	10,000.	20,000.
Miscellaneous Rigging and Tools	See List 1A	323,760.	323,760.
Safety Gear (Hard Hats, Safety Glasses, Safety Boots, Rubber Gloves, Safety Harness, Hearing Protection)	252	800.	201,600.
Employee Tool Bag with Tools and Supplies	252 Sets	1,000.	252,000.
<b>Total ROM Cost per Substation Repair Base</b>			<b>3,244,760.</b>
<b>Total ROM Cost for 6 Substation Repair Bases</b>			<b>19,468,560.</b>
<b>Total ROM Cost Including Employee Tool Bags and Safety Gear</b>			<b>19,922,160.</b>

### Junction Stations:

Note: Junction Stations tools and equipment is covered by other departments (MV and LV Distribution, Repairing and Maintenance, and Relay Departments).

### Medium and Low Voltage Distribution Networks:

#### Overhead Line (MV & LV):

The following equipment and tools should be considered at each distribution system in Afghanistan where repair of MV and LV overhead lines, poles, insulators, supports and distribution transformers is required. The equipment and tools, and quantities indicated are for each repair crew. For example, it is assumed that Kabul would have 4 MV / LV Maintenance Crews.

<b>Equipment and Tools</b>	<b>Quantity Required</b>	<b>Unit Cost (\$USD)</b>	<b>Total Cost (\$USD)</b>
Heavy 4x4 Flatbed Crew Cab Trucks (F350 or Equivalent)	6	40,000.	240,000.
Heavy 4x4 Pick-Up Trucks (F250 or Equivalent)	6	20,000.	120,000.
40' Hydraulic Bucket Trucks 4x4	5	60,000.	300,000.
75' Hydraulic Bucket Trucks 4x4	1	125,000.	125,000.
D4 Cat with Twin Winches and Tilt Blade	1	45,000.	45,000.
25 Ton Rough Terrain Crane	1	120,000.	120,000.
Fork Lift Truck	1	30,000.	30,000.
MV Hotstick Trailer (Complete)	1	50,000.	50,000.
MV Puller / Tensioner (Complete)	1	150,000.	150,000.
Backhoe and Trailer	2	65,000.	130,000.
4x4 Flatbed Truck (5 Ton Capacity)	4	20,000.	80,000.
Tractor with Low Boy and Float Trailer	1	150,000.	150,000.
Production Digger (with Auger)	1	125,000.	125,000.
Reel Trailer and Stands	1	15,000.	15,000.
MV Blocks and Bases	200	150.	30,000.
Cable Reel Stands	8	2,000.	16,000.
Miscellaneous Rigging and Tools	See List 1B	399,600.	399,600.
Safety Gear (Hard Hats, Safety Glasses, Safety Boots, Rubber Gloves, Safety Harness, Hearing Protection)	220	800.	176,000.
Employee Tool Bag with Tools and Supplies	220 Sets	1,000.	220,000.
<b>Total ROM Cost per Substation Repair Base</b>			<b>2,125,600.</b>
<b>Total ROM Cost for 6 Substation Repair Bases</b>			<b>12,753,600..</b>
<b>Total ROM Cost Including Employee Tool Bags and Safety Gear</b>			<b>13,149,600.</b>

### **Power and Distribution Transformers Repairing Workshop:**

The following tools and equipment would be needed at each Transformer Repair Shop. DABM has Power and Distribution Transformer repair work shops in Kabul (KED), Negara, Mazar-e-Sharif, Ghori and Kandahar Power Departments. Costs would include a winding machine and oven, copper wire and insulation materials, and needed tools and instruments.

<b>Equipment and Tools</b>	<b>Quantity Required</b>	<b>Unit Cost (\$USD)</b>	<b>Total Cost (\$USD)</b>
Heavy 4x4 Service Trucks (F350 or Equivalent)	1	40,000.	40,000.
Heavy 4x4 Pick-Up Trucks (F250 or Equivalent)	1	30,000.	30,000.

Fork Lift Truck	1	30,000.	30,000.
150 Ton Truck Crane	1	350,000.	350,000.
4x4 Flatbed Truck (5 Ton Capacity)	1	20,000.	20,000.
Rewinding Machine with Oven	1	10,000.	10,000.
Miscellaneous Rigging and Tools	See List 1B	399,600.	399,600.
Safety Gear (Hard Hats, Safety Glasses, Safety Boots, Rubber Gloves, Safety Harness, Hearing Protection)	15	800.	12,000.
Employee Tool Bag with Tools and Supplies	15 Sets	1,000.	15,000.
<b>Total ROM Cost per Transformer Repair Shop</b>			<b>879,600.</b>
<b>Total ROM Cost for 5 Transformer Repair Shops</b>			<b>4,398,000.</b>
<b>Total ROM Cost Including Employee Tool Bags and Safety Gear</b>			<b>4,425,000.</b>

#### Repairing and Maintenance Department:

The following equipment and tools should be considered at each location at DABM where repair and testing of meters and relays are conducted. There are 12 Repairing and Maintenance Departments throughout Afghanistan.

<b>Equipment and Tools</b>	<b>Quantity Required</b>	<b>Unit Cost (\$USD)</b>	<b>Total Cost (\$USD)</b>
Heavy 4x4 Service Trucks (F350 or Equivalent)	4	40,000.	160,000.
Heavy 4x4 Pick-Up Trucks (F250 or Equivalent)	4	30,000.	120,000.
40' Hydraulic Bucket Trucks 4x4	4	60,000.	240,000.
Miscellaneous Rigging and Tools	See List 1B	399,600.	399,600.
Safety Gear (Hard Hats, Safety Glasses, Safety Boots, Rubber Gloves, Safety Harness, Hearing Protection)	120	800	96,000.
Employee Tool Bag with Tools and Supplies	120 Sets	1,000.	120,000.
<b>Total ROM Cost per Repairing and Maintenance Department</b>			<b>919,600.</b>
<b>Total ROM Cost for 12 Repairing and Maintenance Departments</b>			<b>11,035,200.</b>
<b>Total ROM Cost Including Employee Tool Bags and Safety Gear</b>			<b>11,251,200.</b>

#### Under Ground and Relay Repairing Department:

Engineers and technicians of this department are responsible for checking and repairing of all under ground cable and protection relays in junction stations. DABM doesn't have this Department in the entire country, but only in population zones such as Kabul, Nangarhar, Kunduz, Mazar-e-Sharif and Kandahar.

<b>Equipment and Tools</b>	<b>Quantity Required</b>	<b>Unit Cost (\$USD)</b>	<b>Total Cost (\$USD)</b>
Heavy 4x4 Flatbed Crew Cab Trucks (F350 or Equivalent)	4	40,000.	160,000.
Heavy 4x4 Pick-Up Trucks (F250 or Equivalent)	4	30,000.	120,000.
D4 Cat with Twin Winches and Tilt Blade	1	45,000.	45,000.
Fork Lift Truck (Snorkel)	2	40,000.	80,000.
Under Ground Cable Puller and Tensioner	2	30,000.	60,000.
Backhoe and Trailer	2	65,000.	130,000.
4x4 Flatbed Truck (5 Ton Capacity)	4	20,000.	80,000.
Tractor with Low Boy and Float Trailer	1	150,000.	150,000.
Production Digger (with Auger)	1	125,000.	125,000.
Reel Trailer and Stands	1	15,000.	15,000.
Cable Reel Stands	8	2,000.	16,000.
Miscellaneous Rigging and Tools	See List 1B	399,600.	399,600.
Safety Gear (Hard Hats, Safety Glasses, Safety Boots, Rubber Gloves, Safety Harness, Hearing Protection)	75	800.	60,000.
Employee Tool Bag with Tools and Supplies	75 Sets	1,000.	75,000.
<b>Total ROM Cost per Underground and Relaying Repair Department</b>			<b>981,000.</b>
<b>Total ROM Cost for 5 Underground and Relaying Repair Departments</b>			<b>4,905,000.</b>
<b>Total ROM Cost Including Employee Tool Bags and Safety Gear</b>			<b>5,040,000.</b>

**Relay Department in the Center of DABM:**

<b>Equipment and Tools</b>	<b>Quantity Required</b>	<b>Unit Cost (\$USD)</b>	<b>Total Cost (\$USD)</b>
Heavy 4x4 Pick-Up Trucks (F250 or Equivalent)	2	30,000.	60,000.
Safety Gear (Hard Hats, Safety Glasses, Safety Boots, Rubber Gloves, Safety Harness, Hearing Protection)	12	800.	9,600.
Employee Tool Bag with Tools and Supplies	12 Sets	1,000.	12,000.
<b>Total ROM Cost for Relay Department in the Center of DABM</b>			<b>60,000.</b>
<b>Total ROM Cost Including Employee Tool Bags and Safety Gear</b>			<b>81,600.</b>

**Dispatching Center:**

NA

**Survey and Planning Department:**

In support of all of the branches of DABM, the Survey and Planning Department has responsibility for survey and design activities for all generation, transmission and distribution system and rights of way.

<b>Equipment and Tools</b>	<b>Quantity Required</b>	<b>Unit Cost (\$USD)</b>	<b>Total Cost (\$USD)</b>
Heavy 4x4 Pick-Up Trucks (F250 or Equivalent)	10	30,000.	300,000.
Safety Gear (Hard Hats, Safety Glasses, Safety Boots, Rubber Gloves, Safety Harness)	30	800.	24,000.
Employee Tool Bag with Tools and Supplies	30 Sets	1,000.	30,000.
<b>Total ROM Cost for Survey and Planning Department</b>			<b>300,000.</b>
<b>Total ROM Cost Including Employee Tool Bags and Safety Gear</b>			<b>354,000.</b>

**Procurement Department:**

NA

**Diesel Generators Maintenance Department:**

<b>Equipment and Tools</b>	<b>Quantity Required</b>	<b>Unit Cost (\$USD)</b>	<b>Total Cost (\$USD)</b>
Heavy 4x4 Pick-Up Trucks (F250 or Equivalent)	25	30,000.	750,000.
Conex Cabin	1	10,000.	10,000.
Karcher Pressure Cleaner	1	2,000.	2,000.
Air Compressor	1	600.	600.
Wet/Dry Vacuum	1	400.	400.
Mechanical Tool Set	1	1,500.	1,500.
Heavy Duty Socket Set	2	1,400.	2,800.
Complete Set Torque Wrenches	1	1,400.	1,400.
Arc Welding Transformer/Helmet and Assorted Welding Electrodes	1	800.	800.
Oxy-Acetelyne Bottles/Torch Set/Goggles and Brazing Rods/Flux	1	1,000.	1,000.
Metal Top Bench complete with Heavy Duty Engineering Vises	1	1,600.	1,600.
Heavy Duty Trolley	1	400.	400.
Assortment Of Nuts/Bolts/Washers	1	1,800.	1,800.
Electrical Tool Set	1	1,800.	1,800.
Digital Clamp-On Ammeter	1	600.	600.
Digital Multimeter	1	1,000.	1,000.

Cable Insulation Tester (Megger)	1	600.	600.
9" Electrical Angle Grinder	1	400.	400.
25 mm Variable Speed Electric Drilling Machine	1	600.	600.
Heavy Duty Cordless Electrical Drilling Machine	1	800.	800.
Set High Strength Steel Twist Drill Bits	2	300.	600.
Electric Soft Solder Iron	1	100.	100.
Insulated Lug Crimping Tool	1	200.	200.
Electrical Extension Reels	2	200.	400.
8" Engineers Electrical Bench Grinder	1	400.	400.
24 V DC Heavy Duty Battery Charger	1	500.	500.
Eye Wash Stand	1	1,000.	1,000.
First Aid Kit	2	500.	1,000.
Safety Gear (Hard Hats, Safety Glasses, Safety Boots, Rubber Gloves, Safety Harness, Hearing Protection)	104	800.	83,200.
Employee Tool Bag with Tools and Supplies	104 Sets	1,000.	104,000.
<b>Total ROM Cost for Diesel Generators Maintenance Department</b>			<b>900,000.</b>
<b>Total ROM Cost Including Employee Tool Bags and Safety Gear</b>			<b>1,080,000.</b>

**Billing and Meter Reading Department:**

<b>Equipment and Tools</b>	<b>Quantity Required</b>	<b>Unit Cost (\$USD)</b>	<b>Total Cost (\$USD)</b>
Heavy 4x4 Pick-Up Trucks (F250 or Equivalent)	30	30,000.	900,000.
Safety Gear (Hard Hats, Safety Glasses, Safety Boots, Rubber Gloves, Safety Harness, Hearing Protection)	100	800.	80,000.
Employee Tool Bag with Tools and Supplies	100 Sets	1,000.	100,000.
<b>Total ROM Cost for Survey and Planning Department</b>			<b>900,000.</b>
<b>Total ROM Cost Including Employee Tool Bags and Safety Gear</b>			<b>1,080,000.</b>

**Total ROM Equipment and Tool Costs: \$121,093,760**

**List 1A**

**110 kV through 500 kV Maintenance Tool List for each of the Transmission and Substation Service Crew**

<b>Equipment and Tools</b>	<b>ROM Total Cost (\$USD)</b>
Folding or Telescoping Type Universal Hot Sticks = Two 8' and Two 14'	800.
Grounding Sets with Hot Stick High Amp Clamps, Ground Rods and Mid Point Saddles = 4 Sets for 500KV, 4 Sets for 220KV, 4 Sets for 110KV; Minimum Size = #2 Cu (Larger Amp Capacity Required Near Substations)	1,500.
Tower Clamp Type Ground Stingers with Insulated Stick Attached = 12	1,800.
Variety of Cold End / Hot End High Amp Ground Clamps to Modify Sets as Needed = 24 of Each Type	1,200.
High Voltage Tester = 2 (that will fit Universal and Tie Type Hot Sticks)	2,000.
Multi Amp Meter = 2	400.
Megger (Complete) = 1 (for Measuring Insulation Resistance to Ground)	500.
Clamp On Type Ohm Tester and Amp Meter = 1	1,500.
Micro Amp Meter for Stick Leakage Testing = 1	1,000.
Phasing Test Sets with Resistors for All Voltages Being Tested = 2	5,000.
Hot Area Barriers and Crane House Rotation Perimeter / Netting / Barrier Tape = As Required	200.
NOMEX Coveralls and Winter Gear for Flash / Arc Protection = 12 Sets	600.
40 Meter Doubled 5/8" Poly Plus Hand Lines with Blocks, Hooks, Snaps and Rings = 10	2,000.
1/4" X 200' IPS, Seven Strand Whip Lines with Eyes = 10	2,000.
1/2" X 200' IPS, Seven Strand Whip Lines with Eyes = 10	4,000.
5/8" X 200' IPS, Seven Strand Whip Lines with Eyes = 10	5,000.
3/4" X 1000' Samson Braid Rope with Braided Eyes = 1	2,000.
3/8" Poly Three Strand = 6000'	1,000.
1/2" Poly Plus Three Strand = 500'	200.
5/8" Poly Plus Three Strand = 1000'	500.

<b>Equipment and Tools (Continued)</b>	<b>ROM Total Cost (\$USD)</b>
3/4" Poly Plus Three Strand = 1000'	800.
1 Ton, 2 Ton and 5 Ton Aluminum Butt / Rigging Rope Blocks with Hooks = 12 of Each Size	2,400.
Three Skirt, Glacial Soil Screw Anchors with Multiple Extensions and Heads = 50	300.
Screw Anchor Torque Indicator or Shear Pin Adaptor = 2	2,000.
Rock Socket and Washer Type Rock Anchors = 50 Each	100.
Wagon Drill Complete with Swirl Drill Stem Magazine and Variety of Bit Types and Sizes = 1	25,000.
Portable Rock Anchor / Embedded Rebar, Hydraulic Test Machine (Complete with All Sizes of Wedge Grips) = 1	3,000.
Large Assortment Of 3/8", 1/2", 5/8" and 3/4" IPS Seven Strand, Tested Slings = Various Lengths with Eyes	200.
1/2" Through 1" Tested Screw Pin Working Shackles = 30 of Each Size	600.
3/8" X 4" Through 3/4" X 10" V Groove High Speed, Tested Skookum Cable Blocks = 8 of Each Size	6,400.
3/8" X 25' High Test Four Way Lift Chain Assemblies with Rings and Hooks = 2	500.
1/2" X 25' High Test Four Way Lift Chain Assemblies with Rings and Hooks = 2	800.
3/8" X 30' High Test Log Chains with Two High Test Boomers Each = 20	150.
3/8" X 6' and 8' High Test Butt Chains with Rings and Open Hooks = 12 of Each Length	360.
Large Assortment of Kevlar Endless Slings of Various Lengths and Capacities	200.
Hydraulic Jacks, 7 Ton through 50 Ton = 4 of Each Size	4,000.
30 Ton House Jacks, Screw Type = 4	400.
Screw Type Arm Jacks = 4	200.
High Lift Wagon Jacks = One Per Vehicle (16)	800.
High Capacity, Well Built, Lockable Gang Boxes = Two Per Unit	400.
High Strength Kellum Grips, Joint Socks and Swivels = Eight for Each Size Conductor in the Area	800.
Lockable Side Boxes for Flatbed Crew Cabs = 2 Per Crew Cab	300.

<b>Equipment and Tools (Continued)</b>	<b>ROM Total Cost (\$USD)</b>
Sag Guns, Tower / Pole Mounts, Sag Watches and Conductor Thermometers = Three Each	2,100.
Banding Tool and Bulk 5/8" SS Banding = Four with Five Boxes Each Extra Banding and Buckles	1,200.
Kellum Grip Banding Tool with 3/8 Preformed Bands = Two with Five Boxes Each Extra Bands	300.
Hold Down / Uplift Blocks with 5/8" Y Balls = 4	1,200.
X-100 Aluminum Wide Mouth 6" Blocks with 5/8" Y Balls = 50	150.
Shovels, Picks, Axes, Sledges, Frost Bars, Limb Saws, Boomer Bars = 12 Each	250.
Large and Medium Canvas, Leather Bottomed Grunt Bags with Rope Bale and Snap = 24	1,200.
Heavy Duty Chain Saw = Three, One with 32" Bar and Two with 24" Bars	1,600.
Kevlar Saw Chaps, Gloves and Hardhat Chip Shields = 3 Sets	600.
Shop Welder, Compressor, Drill Press and Complete Set of Tools	8,000.
C Channel Heavy Equipment Rollers / Skates = 8	2,400.
Floor Base Reel Rollers	1,000.
Large Truck Mounted Collapsible Reel Roll Up / Rewind Machine with Banding and Tools = 1	15,000.
Three Drum Rope Puller with 5000' of 1/2" Samson Per Drum Mounted On Trailer = 1	30,000.
OPGW 5000 Pound Capacity Double Bull Wheel Tensioner = 1	10,000.
OPGW Anti-Rotation Device = 2	400.
OPGW 18" Center Drop Groove Blocks = 30	15,000.
Motorized, Two Wire Bundle Spacer Buggies that can be Adapted to 3 or 4 Bundle Conductor = 7	5,250.
Bosuns Chairs with All Required Rigging for Helicopter and Conductor Work = 2	1,000.
First Aid Kits and Fire Extinguishers for All Vehicles and Equipment (16)	1,600.
1000 Kg Tested Aluminum Gin Poles with All Accessories, Guying and Attachments = 4	20,000.
Extendable Type Aluminum DE Platforms with Inverted Hangers, Safety Rails and All Accessories = 3	6,000.

<b>Equipment and Tools (Continued)</b>	<b>ROM Total Cost (\$USD)</b>
Pole Mount Kick Pivot DE Platforms with Various Saddles and All Accessories = 3	3,000.
Portable Donkey Engine Winch Rig for Tower Work (Complete) = 2	4,000.
Pole Gin with All Saddles and Extensions = 4	12,000.
Gas Power Capstan for Cable and Rope = 4	8,000.
14', 20' and 24' Fiberglass Clipping Ladders with All Accessories = 6 Each	3,000.
40' and 30' Fiberglass Extension Ladder = 4 Each	600.
High Capacity Chicago Conductor Grips for All Sizes of Conductor In The Area = 30 Each for Two Wire Bundle Construction and 18 Each for Single Conductor Lines	24,000.
High Capacity Bulldog and Flat / V Jaw Grips for All Sizes of Guy Wire and Static In The Area = 8 Per Wire Size	4,000.
Pocket Book Grips for OPGW = 10	2,000.
Pre-Formed DE to be used as OPGW Grips = 2 Boxes	1,000.
Heavy Duty 4X4 Mechanics Truck Complete with Welder, Compressor, Hoist / Boom and All Electric Tools / Air Tools / Hand Tools / Materials and Parts to Repair All Equipment. This Includes Bulk Oil / Fuel Tanks and Complete Filter Service Kits for Each Piece of Equipment.	55,000.
200,000 BTU/HR Salamander / Torpedo Type Heaters, Diesel Fueled = 4	2,000.
<b>ROM Costs for 110 kV through 500 kV Maintenance Tool List for each of the Transmission and Substation Service Crews</b>	<b>325,760</b>

**List 1B**

**Maintenance Tool List for each of the MV and LV Distribution System Crews, Repair and Maintenance Department Crews and Survey / Planning Crews**

<b>Equipment and Tools</b>	<b>ROM Total Cost (\$USD)</b>
Cable Cutters for Copper and AAA Conductors = 2	500.
Cable Cutters for ACSR Conductors = 2	500.
Cable Cutters for EHS Guy Wire = 2	500.
Hand Operated Hydraulic Cable Cutters = 2	12,000.
Hand Operated Hydraulic ACSR Cable Cutters = 2	12,000.
Hand Operated Hydraulic Press with Dies for Main and Service ABC Cable (4.5 Tons Minimum Capacity) = 2	6,000.
Hand Operated Hydraulic Press with Dies for MV Overhead Lines (12 Tons Minimum Capacity) = 2	7,400.
Electro-Hydraulic Pump with Accessories (Dies and Hoses) for Overhead Conductors and Copper Cables	35,000.
Stripping Tool for XLPE Cable = 2	500.
Micro-Ohm Meter = 2	7,000.
Electronic Voltage Detector for Bare Conductors = 2	4,000.
Electronic Voltage Detector for Separable Connector Capacitive Dividers = 2	4,000.
Phase Tester for MV Overhead Distribution Network = 2	10,000.
Insulator Puncture Detector = 2	14,000.
Line Fault Locator = 2	8,000.
Portable Multimeter = 4	1,600.
Three Phase Portable Grounding Kit = 4	8,000.
Non-Contact Phase Sequence Indicator = 2	3,000.
Portable Infrared Thermometer = 2	2,000.
Heavy Duty Rotary Hammer with Accessories = 2 Sets	2,200.
Heavy Duty Drill (12 mm) = 2	1,000.

<b>Equipment and Tools (Continued)</b>	<b>ROM Total Cost (\$USD)</b>
Ratchet Hoist = 4	6,000.
Insulating Ladders = 4	6,000.
Drill Set for Metal Work = 2 Sets	1,500.
Drill Set for Concrete Work = 2 Sets	1,400.
Portable Generator, 400 VAC, 3.5 KVA, 3 Phase (Petrol Operated) = 2	8,000.
Portable Halogen Lamps (500 W) = 4	400.
Allen Wrench Sets = 2	6,000.
Assorted Chisels (Small, Medium and Large) = 4 Sets	400.
Adjustable Wrenches (150 mm – 450 mm) = 4 Sets	1,600.
Open End / Box End Wrench Set (Small) = 8 Sets	400.
Open End / Box End Wrench Set (Large) = 8 Sets	800.
Socket Wrench Set (Small) = 8 Sets	400.
Socket Wrench Set (Large) = 8 Sets	800.
Torque Wrench (0 – 60 NM) = 4 Sets	2,000.
Side Cutting Pliers = 4	100.
Propane Torch with Hose Pipe and Torches = 4	3,000.
Rubber Gloves – Pair (1000 V), Industrial Gloves – Pair and Dust Masks = 20	2,000.
Line Man's Safety Belt with Toll Bag, Tool Bag Holder and Safety Line = 4	2,000.
9 M Portable Ladder, FRP, Telescoping = 2	7,000.
Tirfor Tackle 2,500 kg, 20 M Wire Length = 2	7,000.
Frog Clamps for Stay Wire, ACSR Conductors, and ABC Cable (Various Sizes)	8,000.
Cable Pulling Grips with Swivels for ACSR and ABC Conductors (Various Sizes)	12,000.

<b>Equipment and Tools</b>	<b>ROM Total Cost (\$USD)</b>
Cable Rollers for ACSR and ABC Conductors (Various Sizes)	40,000.
Bicycle Type Measuring Wheel (Meters) = 2	2,000.
Lifting Devices for Transformers = 2	140,000.
200,000 BTU/HR Salamander / Torpedo Type Heaters, Diesel Fueled = 4	2,000.
<b>ROM Costs for MV and LV Distribution System Crews, Repair and Maintenance Department Crews and Survey / Planning Crews</b>	<b>399,600.</b>

1. Note: Tool Bag for Each Employee Contains:

- a. One Pair of Rubber Gloves (1,000 V)
- b. One Pair of Industrial Work Gloves
- c. Dust Mask (10)
- d. One Pair Ear (Hearing) Protection
- e. One Pair Safety Glasses
- f. Cross Link Socket Set
- g. Cutting Tools (Jack Type)
- h. Open End / Ring End Spanner Wrenches (13 mm – 22 mm)
- i. Ratchet Wrench (13 mm – 22 mm")
- j. Side Cutting Pliers
- k. Socket Wrenches (13 mm – 22 mm)
- l. Screw Driver
- m. Nut Driver (10 mm, 13 mm, and 17 mm)
- n. Cable Knife

## Sample Training Outline for Thermal Power Plants

1. Operations:
  - a. Monitoring Control Room Operations
  - b. Engine Starting and Stopping Procedures
  - c. Fuel Supply and Filtration Monitoring
  - d. Intake Air and Exhaust Systems Monitoring
  - e. Coolant Systems Monitoring
  - f. Engine Faults and Protective Devices
  - g. Hourly Preventative Maintenance Checks
  - h. Keeping of Control Room Hourly Logs
  - i. O&M for Generators and Motors
  - j. Use of Personnel Protective Equipment
  
2. Mechanical Maintenance:
  - a. Safe Use of Tools
  - b. Hourly Preventative Maintenance Checks
  - c. Daily Preventative Maintenance Checks
  - d. Weekly Pump and Motor Checks
  - e. Static / Dynamic Starters
  - f. Lubrication and Inspection of Auxiliary Equipment
  - g. Maintenance of Coolant Systems
  - h. Maintenance of Lubrication (Oil) and Oil Filtration Systems
  - i. Maintenance of Fueling and Fuel Injection Systems
  - j. Maintenance of Air Intake and Exhaust Systems
  - k. Maintenance of Aftercoolers
  - l. Camshaft and Cam Follower Inspections (Gen Sets Only)
  - m. Tappet and Injector Settings (Gen Sets Only)
  - n. Hot Gas Casing Changeout and "B" Inspections (GT Only)
  - o. Turbo Charger Maintenance
  - p. Engine Dismantling and Assembly
  - q. Repair and Maintenance of Large Extraction Fans and Space Fans
  - r. Use of Hytorc Wrenches and Accessories
  - s. Coupling and Alignment Procedures
  - t. Use of Personnel Protective Equipment
  
3. Electrical Maintenance:
  - a. Electrical Principles
  - b. Reading and Comprehending Electrical Drawings
  - c. Maintenance of Generators and Motors
  - d. Maintenance of Static and Dynamic Starters
  - e. Electrical Systems Control and Fault Finding
  - f. Hourly Preventative Maintenance Checks
  - g. Daily Preventative Maintenance Checks
  - h. Operation and Maintenance of Main Circuit Breakers

- i. Maintenance of DC Systems (Batteries and Chargers)
  - j. Maintenance of Starting and Charging Circuits
  - k. Maintenance of AC and DC Lighting Circuits
  - l. Use of Electrical Tools
  - m. Use of Electrical Testing and Measuring Instruments
  - n. Auxiliary Equipment Checks and Maintenance
  - o. Transformer Checks and Maintenance
  - p. Cable and Wiring Connections
  - q. Use of Personnel Protective Equipment
4. Fuel Handling:
- a. Fuel Quantity Measurements (Fuel Meter and Dip Stick Methods)
  - b. Fuel Testing for Quality, Density, Flash Point, Total Suspended Solids and water Content per Fuel Specifications
  - c. Fuel Transfer from Tanker to Bulk Storage Tanks including Valve Lineup, Sequence and Operations
  - d. Fuel Download Meter Reading and Recording
  - e. Daily Fuel Usage and Electronic Reporting (Liters and Liters per MWH)
5. Materials Handling:
- a. Materials (Stores) Receipt and Identification Against Purchase Orders
  - b. Material (Stores) Receipt Inspection
  - c. Electronic Materials (Stores) Receipt Reporting
  - d. Material (Stores) Handling and Storage
  - e. Materials (Stores) Requisition and Issuance
  - f. Daily Consumable Materials (Stores) Usage and Reporting
  - g. Consumable (Stores) Requirements Forecasting

## Afghanistan's Electricity Generating Stations

Plant Name	Plant Type	Provided By	Year	Design Units and Capacity (KW)	Current Units and Capacity (KW)	Area Served
Naghlu	Hydro	USSR	1967	4 x 25,000	3 x 25000	Kabul
Surobi	Hydro	Germany	1957	2 x 11000	2 x 10000	Kabul
Mahipar	Hydro	Germany	1967	3 x 22000	2 x 16000	Kabul
GT (1+2)	Thermal	Germany	1978	2 x 21800		Kabul
GT (3+4)	Thermal	Germany	1985	21800+23800	21800+23800	Kabul
Darunta	Hydro	USSR	1964	3 x 3850	3 x 2500	Jalalabad
Kajakai	Hydro	USA	1975	2 x 16500	2 x 12000	Kandahar
Filkoh	Hydro	Germany	1950	2 x 320		Kandahar
Babawali	Hydro	Germany	1963	1 x 250		Kandahar
Grishk	Hydro	USA	1961	2 x 1200	1 x 500	Grishk
Puli-Khumri	Hydro	USSR	1962	3 x 3000	2 x 2500	Pu-i-Khumri
Chaki-Wardak	Hydro	Germany	1940	3 x 1100	1 x 600	Chaki-Wardak
Jabul-Seraj	Hydro	USA.UK	1920	2 x 500 and 2 x 770	0+200 and 0+300	Jabul-Seraj
Parwan	Hydro	China	1973	3 x 800	2 x 800	Parwan
Asadabad	Hydro	Germany	1983	2 x 350	1 x 250	Asadabad
Ghorband	Hydro	India	1975	3 x 100	1 x 100	Ghorband
Faizabad	Hydro	India	1984	3 x 85	1 x 85	Faizabad
Baharak	Hydro	India	1986	2 x 100	1 x 100	Baharak
Chalwarcha	Hydro	India	1950	1 x 85		Herat
<b>Total</b>				<b>343,820</b>	<b>212,835</b>	

### Afghanistan Existing Substations

ID	Grid	Name	Transformer	Installed Capacity (MVA)	Voltage KV	Condition	Province
1	Balkh	Mazar-i-Sharif (Old)	T1(4) + T2(4)	8	35/6	Existing	Balkh
2	Balkh	Mazar Sharif (New)	T1(16) + T2(16)	32	110/35/6	Existing	Balkh
3	Balkh	Andkhoy	T1(10)	10	110/6	Existing	Faryab
4	Balkh	Sheberghan (Jarquduq)	T1(16) + T2(16)	32	110/35/6	Existing	Jawzjan
5	Balkh	Fertilizer Co.	T1(10) + T2(10)	20	35/6	Existing	Balkh
6	Balkh	Balkh District	T1(1)	1	35/6	Existing	Balkh
7	Balkh	Maymana	T1(16) + T2(16)	32	110/20	Existing	Faryab
8	Balkh	Shirin Tagab	T1(10) + T2(10)	20	110/20	Existing	Faryab
9	Balkh	Khoja Sabzposh	T1(4) + T2(4)	8	110/20	Existing	Faryab
10	Balkh	Sheberghan	T1(4) + T2(4)	8	35/6	Existing	Jawzjan
11	Balkh	Khoja Gogirdak	T1(1)+T2(1)	2	35/6	Existing	Jawzjan
12	Balkh	Khoja Dokoh	T1(2.5)	2.5	110/6	Existing	Jawzjan
13	Balkh	Said Abad	T1(1)	1	35/6	Existing	Sari Pul
14	Balkh	Sari Pul (Jangulbagh)	T1(16)	16	35/6	Existing	Sari Pul
		<b>Total</b>		<b>192.5</b>			

**Afghanistan Existing Substations (Continued)**

<b>ID</b>	<b>Grid</b>	<b>Name</b>	<b>Transformer</b>	<b>Installed Capacity (MVA)</b>	<b>Voltage KV</b>	<b>Condition</b>	<b>Province</b>
15	Ghori	Pul-i-Khumri (Step Up)	T1(7.5) + T2(7.5)	15	35/6	Rehab.	Baghlan
		<b>Total</b>		<b>15</b>			
16	Jalalabad	Ghouchak	T1(5.6)	5.6	35/6	Rehab.	Nangarhar
17	Jalalabad	Darunta	T1(7.5) + T2(7.5)	15	35/6	Rehab.	Nangarhar
18	Jalalabad	Jalalabad city	T1(4) + T2(4)	8	35/6	Existing	Nangarhar
19	Jalalabad	Form Hada	T1(1.6)	1.6	35/6	Existing	Nangarhar
		<b>Total</b>		<b>30.2</b>			
20	Kabul	Kabul East	T1(25)	25	110/20-15	Existing	Kabul
21	Kabul	Kabul Northwest	T1(25)+T2(25)+T3(20)	70	110/15	Existing	Kabul
22	Kabul	Surobi	<b>T1(5.6)</b>	5.6	110/35/6	Existing	Kabul
23	Kabul	Kabul North	T1(40) + T2(40)	80	110/15	Existing	Kabul
24	Kabul	Breshna Kot	T1(25) + T2(25)	50	110/20-15	Existing	Kabul
25	Kabul	(Pul-e-Charkhi) MW Radio	T1(6.3) + T2(6.3)	12.6	110/10	Existing	Kabul
26	Kabul	Mahipar Substation	T1(26)+T2(26)+T3(26)	78	110/10	Existing	Kabul

**Afghanistan Existing Substations (Continued)**

<b>ID</b>	<b>Grid</b>	<b>Name</b>	<b>Transformer</b>	<b>Installed Capacity (MVA)</b>	<b>Voltage KV</b>	<b>Condition</b>	<b>Province</b>
27	Kabul	Surobi Substation	3[T1(16)] + 3[T2(16)]	32	110/6	Existing	Kabul
28	Kabul	Naghlu Substation	T1(30)+T2(30)+ T3(30)+T4(30)	120	110/10	Existing	Kabul
		<b>Total</b>		<b>473.2</b>			
29	Kunduz	Kunduz (Old)	T1(2.6)+T2(2.6)	5.2	35/6	Existing	Kunduz
30	Kunduz	Kunduz (New)	T1(16)+T2(16)	32	110/35/6	Existing	Kunduz
		<b>Total</b>		<b>37.2</b>			
31	Parwan	Jabul-Seraj City	T1(2.5)	2.5	44/2.3	Rehab.	Parwan
		<b>Total</b>		<b>2.5</b>			
		<b>NEPS Total</b>		<b>750.6</b>			
32	Kandahar	Kandahar	T1(25)	25	110/20	Existing	Kandahar
33	Helmand	Kajaki Switchyard	T1(25) + T2(25)	50	13.5/110	Existing	Helmand
34	Helmand	Pushmool	T1(4)	4	110/20	Existing	Helmand
35	Helmand	Sangin	T1(4)	4	110/20	Existing	Helmand
36	Helmand	Grishk	T1(5)	5	44/3.2	Existing	Helmand
37	Helmand	Lashkar Gah	T1(3.3)+T2(3.3)+T3(3.3)	9.9	110/44	Existing	Helmand

Afghanistan Existing Substations (Continued)

ID	Grid	Name	Transformer	Installed Capacity (MVA)	Voltage KV	Condition	Province
38	Helmand	Lashkar Gah	T1(3) + T2(3.3)	6.3	44/3.2	Existing	Helmand
		<b>SEPS Total</b>		<b>104.2</b>			
39	Herat	Herat (Iran)	T1(30) + T2(30)	60	132/20	Existing	Herat
40	Herat	Herat (Noor Jahad)	T1(40) + T2(40)	80	110/20	Existing	Herat
41	Herat	Rubat Sangi	T1(15)	15	110/20	Existing	Herat
42	Herat	Ghorian	T1(15)	30	132/20	Existing	Herat
		<b>Herat Total</b>		<b>185</b>			
		<b>Grand Total</b>		<b>1,039.8</b>			