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DIVISION 9 ELECTRICAL WORKS

SECTION 9000 GENERAL TECHNICAL SPECIFICATION

9001 General Requirements

This specification covers the general and specific requirements for the design, manufacture, supply, installation, testing, site work and construction work for Electrical Works for the El Salaam No. 7 (Bir El Abd) Pumping Station.

Any items not described herein shall also be considered part of the work if they are shown on the drawings or are considered necessary for the proper operation of the pumping station or the described equipment.

This Section shall cover the general design, manufacture, supply, installation and testing for all electrical equipment to be supplied by the Contractor. The indicated ratings and features shall govern the specific ratings and requirements for all equipment. The particular specifications and associated drawings shall govern in case of any conflict with this Specification. Any deviations from this specification or the particular specifications shall be clearly state with reasons for the deviations.

The Contractor who supplies electrical equipment with civil contractor shall coordinate timing of delivery of equipment with all civil contractor and equipment manufacturers. All equipment shall be installed in strict accordance with manufacturer's recommendations. The Contractor shall purchase, receive, unload, transport, store, install and commission all material required for complete the electrical and mechanical systems.

9002 Design Works

The Contractor shall furnish a complete design for mechanical and electrical system in accordance with this specification and drawings. The design work shall include, but is not limited to, technical calculations, preparation of drawings and bills of materials, and specifying equipment not specified in this specification, particular specification and drawings but necessary to provide a complete operable pumping station. The technical calculations and design drawings prepared by the Contractor shall be submitted to the Engineer for approval.

9003 Equipment and Material

The word "material" and "materials" as used in these specifications to denote items furnished by the Contractor shall mean equipment, machinery, product (s), component (s), or other item(s) procured under these specifications. All equipment/materials to be furnished by the Contractor shall be new and of the most suitable grade for the purpose intended considering strength, ductility, durability, and best engineering practice. All equipment/material shall be capable of withstanding long time use and shall satisfy all requirements of this specification,

all applicable standards and all requirements, which a complete product should generally meet, even if such requirements are not expressly provided in the particular specifications.

All equipment/material supplied under this contract shall meet all requirements as specified in the particular specifications and attached drawings. All equipment shall be of a construction convenient for disassembly, inspection, erection, maintenance and operation. All equipment shall have markings, such as the center line mark, march mark, etc., in order to facilitate the installation works at the site.

All materials used to be supplied equipment shall be selected with high quality performance. Furnished materials and manufacturing procedures shall be in accordance with pertinent provisions of the applicable standards specified herein, unless otherwise specified. The overall equipment and materials to be supplied is described in the section on the particular specification, drawings and bill of quantities.

9004 Workmanship

All work shall be performed and completed in a thorough workmanlike manner and shall follow the best modern practice in the manufacture of high-grade machinery, notwithstanding any omissions from these specifications. All works shall be performed by mechanics skilled in their various trades.

All bolts, nuts, screws, rivets, threads, pipe, gauges, gears, and measurements or dimensions shown on the drawings shall conform to ISO standards. For internal connections only, the Contractor will be permitted to deviate from the ISO standards.

9005 Scope of Works

The work required for entired electrical equipment comprises the following items and procedure.

- Design, manufacture, testing, supply, insurance, clearing the goods at customs, inland transportation, storing and guarding at site.
- Erection works, testing at site, maintenance during the guarantee period of contracted.
- Handing over to the Engineer the machinery, equipment material and spare parts for the No. 7 Pumping Station.

In the paragraphs of the specifications when references to the pumping units, motors etc. is in singular form, they shall apply equally to all pumping units, motors etc., to be supplied except where specifically stated otherwise.

9006 Works by Other Contractors

(1) Site Preparation

Grading and filling works are executed by the civil contractor of this contract, as shown on the contract drawings.

(2) Building Works

The pumping station building construction is executed by the civil contractors as shown on the contract drawings.

(3) Mechanical Works

Mechanical Works related to No. 7 Pumping Station are conducted by the pumping plant supply contractor in the same contract.

(4) Demarcation between this Contract and the Main Power Substation Contract

The Main Power Substation and 11 kV power receiving circuit breakers in the Auxiliary Substation will be executed by the Main Power Substation Contract, thus are not included in the present Contract.

9007 Service Conditions

All equipment shall be installed and operated under the following conditions.

- Max. Ambient air temperature: 45°C
- Min. ambient air temperature: 5°C
- Max. Relative humidity: 90 % for equipment installed inside of the pump house
  100 % for equipment installed outside
- Average water temperature: 30°C (to be used in pump design)
- Altitude: Less than 1000 m above sea level
- Rain: Rain is rather scarce and occurs during winter.
- Wind velocity and storms: The max. wind velocity is about 120 km/h and may blow from any direction
  The storms may occur in a few days in the year.

All parts of the plant and machinery shall be rated for 24 hours continuous running all year round.

9008 Applicable Standards

All equipment, fabrication and testing thereof shall conform to the latest applicable standards contained in the following list.

a. IEC: International Electro-technical Commission
b. ISO: International Organization for Standardization
c. The Contractor may propose alternative standards or equipment, which shall be at least equal to the standards or equipment specified.
d. If for any reason the Contractor proposes alternatives to or deviations from the specification, or desires to use alternative equipment, he shall submit these standard to be applied to the Engineer for approval, the proposed alternatives or deviations, reason(s) for making the alternative plans, and relevant specifications of the equipment in the English language.
e. The followings have to be acceptable an equivalent.
   - NEMA: National Electrical Manufacturers Association
   - NFPA: National Fire Protection Association
   - EEE: The Institute of Electrical and Electronics Engineers, Inc.
   - ANSI: American National Standards Institute
   - JIS: Japanese Industrial Standard
   - JEM: Standards of the Japan Electrical Manufacturers' Association
   - JEC: Standard of the Japanese Electrotechnical Committee

9009 Unit of Measurements

Units of measurements shall be in the metric system and Celsius for temperature.

9010 Execution

All equipment shall be designed, manufactured and tested in accordance with the procedure of the manufacture's standard. Design procedure and test method shall be submitted to the Engineer for approvals. The inspection and tests of the equipment and workmanship shall be performed under the witness of the third party. The third party inspection shall be proceeded in presence of the manufacture's supervisor at the site.

9011 Welding

Welds shall be free from pinholes, cracks and any other noticeable defects. The welding process and operations shall be in accordance with the international standards. Parts of the equipment, which are, required inspection, maintenance, and possible replacement shall be fastened with bolts and nuts instead of welded.

9012 Severity of Vibration and Sound Pressure Level

(1) Vibration

The vibration severity of the machinery offered shall correspond to quality judgement "Good" or better in ISO 1940.

(2) Sound Level

The sound pressure level measured at no load shall be less than 80-dB (A) at a measuring distance of 1 meter, unless otherwise specified.

9013 Supporting Structures

The support structures except in case of the particularly specified shall be galvanized after fabrication, all necessary galvanized bolts, nuts, and washers to complete the erection shall be furnished, including embedded anchor bolts for securing each support structure to the concrete foundation.

9014 Name Plates

Nameplates or rating plates shall be corrosion resistant and shall be engraved in the English language. Instruction plates, Warning signs and all markings on the equipment, parts and accessories thereof shall also be in the English language. The details of the data to be shown on the nameplate or rating plate shall be indicated on drawings and submitted to the Engineer for approval.

9015 Surface Preparation

Un-galvanized surface of the equipment to be painted shall be cleaned to base metal by sand blasting or chemically cleaned and shall be thoroughly dry before application of any paint. Painting of all the equipment shall be done at the manufacturer's shop. The finished surface of the equipment and portions embedded in concrete shall be protected by rust preventive means. The Contractor shall repair and apply touch-up paint to all equipment imperfections and damage. Touch-up paint shall be of the same type, color, shade and gloss as the finish paint applied by the equipment manufacturer.

(1) Painting for Motors

After surface preparation, multi-coat system shall be applied comprising:

(a) Outside surface and external fan

a. Base coat: Lead oxide primer containing rust resisting painting
   — 1(one) time and dried.
   — Thickness approximate 20 microns.(after dried)
b. Final coat: Phthalic acid resin enamel containing rust resisting painting.
   — 1(one) time and dried.
   — Thickness approximate 20 microns.(after dried)
   Total thickness is approximate 40 microns.
c. The exterior of the motors shall be color specified by the purchase and minimum reflection value shall also be specified by the purchase.

(b) Inside surface of frame and bracket

a. Base coat: Lead oxide primer containing rust resisting painting
   — 1(one) time and dried.
   — Thickness approximate 20 microns.(after dried)
b. Final coat: Phthalic acid resin enamel containing rust resisting painting.
   — 1(one) time and dried.
   — Thickness approximate 20 microns.(after dried)
   Total thickness is approximate 40 microns.

Contractor's painting standard that is technically equivalent to the one described above shall be approved.

(2) Painting for Panels

Prior to painting , the panels shall be cleaned under the following procedure.

(a) Cleaning under pressure in tunnel with water solution of phosphorus degreasing additives and rinsed with warm (ambient temperature) water.

(b) Drying in furnace at 120 ℃.

After surface preparation, multi-coat system shall be applied comprising:

(c) All surfaces shall be electrostatically painted by acrylic-epoxy powder paint of 35 microns.

(d) Two finishing coats, each of 40 microns minimum thickness of polyurethane.

(e) The exteriors of the panels shall be RAL 7030 to give a minimum reflection value of 42%.

Contractor's painting standard that is technically equivalent to the one described above shall be approved.

9016 Packing

All the equipment and spare parts shall be carefully packaged so as to withstand long time transport by sea and land. The electrical equipment shall be completely protected against rust, corrosion and moisture during transport and storage in a humid tropical climate. The spare parts shall be packaged separately from other articles. Packages of spare parts shall be labeled in the English language clearly indicating that the contents are spare parts and giving directions for proper storage. Each package shall be accompanied with a list of contents.

9017 Arrangement and Access of Equipment

The general arrangement of equipment within the pumping station is shown on the attached drawings. Minor changes in the arrangement shown on these drawings may be accepted provided that the overall dimensions, the location of incoming and outgoing of accompanying system and the bay spacing are not varied.

The Contractor shall provide and submit to the Engineer for approval a complete set of

drawings showing all details of equipment arrangement, structure designs and foundation requirements for actual equipment being furnished in accordance with related specifications. The Contractor's arrangement of equipment shall permit safe access for operating personnel on foot in any part of the pumping station. The Contractor's arrangement of equipment shall make provision for maintenance access to equipment with small trucks, forklift or cranes as required.

9018 Installation Supervision

The Contractor shall, at his expense, provide the services of experienced and qualified personnel to supervise the installation of equipment herein defined and of equipment for which the manufacturer recommends installation supervision. Each installation supervisor shall have the following qualifications:

- Be a representative of the manufacturer of the equipment for which the installation supervision shall be provided.
- Have a minimum of 3 years experience in the installation of the manufacturer's equipment similar to that being installed.
- Be reasonably proficient in the use, both oral and written, of the English language.

Each installation supervisor shall supervise and be responsible for the installation, erection, adjustment, and site testing and commissioning of the equipment for which his services are engaged. Each installation supervisor shall be present at the job site at all times during the performance of work for which he has supervision responsibility. Absence of the installation supervisor from the job site during such periods shall not be permitted except with the express authorization of the engineer.

9019 Equipment for which Supervision is required

The installation supervision shall be required, but is not limited to, for the following equipment.

- Main pump motors
- Main motor starting panels
- Auto transformer panels
- Exciter panels
- Main pump unit control panel
- Auxiliary substation
- Emergency generator unit

9020 Equipment Problems

When the Contractor encounters a problem, which is unable to solve, the Contractor shall, at his expense, provide the services of qualified and experienced representative of the manufacture at the job site within a reasonable time.

9021 Unloading and Storage

The Contractor shall thoroughly check all equipment received based on the list itemized. The list shall show any damaged or missing parts or equipment. Containers, boxes and crates each shall include a memorandum from the manufacturer, indicating a list of equipment included in the shipment with sufficient description so that equipment and material can be easily identified. The memorandum accompanying each item shall be furnished in an external weatherproof packet.

Equipment shall be unloaded and suitably stored as soon as possible after arrival. The Contractor is responsible for finding proper storage facilities for all equipment and material. All storage facilities shall be of approved by the Engineer. Each item shall be stored with proper identification so that it can be easily located and can be identified. The Contractor shall supply the power source for all electrical requirements of the storage facilities. The Contractor shall store, protect and maintain materials and equipment after receipt until when the Engineer accepting installation of the equipment.

Such storage and maintenance shall be in strict accordance with recommendation of the manufacturer and the requirements of this Specification. The Contractor shall provide all materials, equipment, storage areas and labor required for such storage and maintenance. The Contractor shall be responsible for any damage and deterioration of materials or equipment resulting from improper storage, maintenance or handling. The Contractor shall at his expense subject to the Engineer for approval to recondition, repair or replace to the satisfaction of the Engineer, all materials and equipment so damaged or deteriorated.

All proposed methods of reconditioning or repair shall be submitted to and approved by the Engineer prior to commencing reconditioning or repair work. The Contractor assumes all risks for reconditioning or repair work performed without approval by the Engineer. Equipment stored outdoors shall be supported at least 20 centimeters above the ground. All internal parts shall be kept free of dust, dirt, moisture and contamination of any kind. All spare parts shall be stored at a location and under conditions to be specified by the Engineer.

9022 Installation Requirements

The Contractor shall install all equipment as indicated on the attached drawings and as approved by the Engineer. The Contractor shall provide all tools required for installation, including any special tools, and all the tools specified. All special tools and appliances, as defined in the specifications, shall be furnished also, and become the property of, MED after installation.

Where it is specified that the equipment shall be erected on walls or columns, the Contractor shall install adequate structural steel supports and adequate expansion bolts for anchorage. The steel supports to be installed on foundations shall be leveled with precision to avoid distortion and misalignment among sections or adjacent compartments of equipment. The

quantity, size, arrangement and other details of the equipment erected on the supports shall be subject to the Engineer for approval.

The equipment shall be leveled to ensure that the vertical sides are perfectly vertical and aligned, and that doors, panels and sliding frames operate freely. All electrical equipment and associated accessories shall be assembled, installed, connected and tested as required to make the equipment installation complete and ready for operation. The Contractor shall be responsible for all assembly and disassembly required in the handling and erection of the equipment.

Before assembly or erection, equipment shall be thoroughly cleaned of all protective coatings and foreign material. After the erection of equipment, all external surfaces shall be cleaned of oil, grease, dirt and other foreign material. All marred or damaged spots on equipment and material shall be refinished to match the original finish.

9023 Testing and Trial

(1) Condition and Procedure for Testing

The basic condition and procedure for testing shall be described in the respective sub-section of this Specification. The factory tests for the equipment specified hereinafter shall be carried out in the presence and subject to the control of Employer's Representatives or the Engineer. They have to be informed of the dates when the materials shall be ready for inspection at least 30 days before any materials is ready for inspection to avoid the possibility of delay. The equipment required the above mentioned inspection test as follows.

- Main Pump Motors
- Main Pump Motor Operating Panels
- Central Control System
- Auxiliary Substation

When the observers fail to attend the inspection test, the Contractor may be given discretion either grant a reasonable extension to carry out such tests in the presence of them or the Engineer waive inspection against submission of test certificates and guarantee certificates by the Contractor, which the equipment are tested in accordance with the specifications.

Inspection tests shall be carried out in conforming to prevailing international standards or standards of a competent department in the country of manufacture. Such tests shall be stated briefly in the offer supported by brief abstract in English for it and will be given by the Contractor in full details after concluding the Contract.

The Engineer will issue the certificate of the test results for every test carried out with his comments as to whether tests are successful or rejected. The decision of the Engineer will be final and binding to the Contractor, however test and acceptance certificates issued by

the Engineer do not relieve the Contractor from his obligations under this contract. All tests at site shall be carried out under the control of the Engineer and in the presence of the Contractor (or his representative), or in his absence if he fail to attend at the fixed times, after having been duly notified in that behalf.

The Contractor shall not be entitled to any payment whatsoever or to any extension for the time of completion by reason of, or in respect of such tests, or the failure of any tests, or the rejection of any part of material or equipment as result of any test. All the apparatus and equipment supplied under this contract shall pass their specified tests to the satisfaction of the Engineer both at factory and at site.

(2) Expenses of Tests

All tests shall be carried out by and at the expense of the Contractor who shall supply all test pieces and specimens as well as all apparatus, instruments and equipment even if they are not mentioned in the Contract, staff and labor required for effective carrying out the prescribed tests. All site tests shall be carried out by and at the expense of the Contractor, including in case the Contractor requires repeat the tests before settling any penalties, in which case these tests will be at the Contractor expense. Any repeated tests for the penalty purposes shall be final and binding to all parties.

(3) Calibration of Instruments

The instruments used for the testing shall be of calibrated by the official laboratory recognized by the Engineer. Particulars of the calibration shall be given on test certificates. The Engineer before or after testing will check the calibration of all instruments, even if it has been previously approved.

(4) Penalties and Rejections

All equipment and materials are rejected, if they do not satisfactory pass the specified tests at factory or any additional tests of current practice, which the Engineer may consider necessary in order to satisfy himself regarding workmanship and quality of material. Besides, if results obtained by the tests made on any equipment or materials, with consideration of the tolerances given in the specifications do not correspond to the specified figures, thus proving that the equipment or material supplied is of a standard lower than that required or guaranteed, the equipment or material will be reject. Due penalties shall be applied on completion of each corresponding test result, and will be subjected to settlement if decided later by the Engineer.

9024 Training

(1) Factory Training

The Contractor shall provide training for MED personnel in the country of the equipment

manufacture as follows.

	Number of Personnel	Period of Training
Senior Electrical Engineer	4	1 month
Junior Electrical Engineer	4	1 month
PLC Engineer	1	1 month

For PLC (Programmable Logic Control) Engineer must be done at the time of design stage and maintenance period on the PLC program.

If possible part of the training should take place at sites in the Contractor's country where equipment similar to that supplied under the contract is being installed. All expenses (Cost of training, accommodations, food, medical treatment, international and local travelling) shall be included in the contract prices.

(2) On the Job Training

The Contractor shall dispatch specialists of operation and maintenance of the electrical system for training by MED personnel in the No. 7 Pumping Station as follows.

- Personnel of the Specialist: by the recommendation of the Contractor
- Period of the training: 3 month.

All expenses (Cost of training, accommodations, medical treatment, international and local travelling of the specialists) shall be included in the contract prices.

SECTION 9100 MAIN MOTORS

9101 General

(1) General

- All Sub-Sections under Section 9000, General Technical Specification shall be applied to this section.
- This Section shall covers the technical requirements for the main pump motors installed in the El Salaam No. 7 Pumping Station.

(2) Scope of Works

The works shall include the designing and furnishing, testing, transport to the site, erection and site tests of the main pump motor completes. The Contractor shall completely coordinate all equipment for the unit, including pump, motor, and exciter, so that all components are compatible with each other. The motor shall satisfy the requirements of the main pump operation and the power supply system such that proper operation of the unit will be obtained during the starting and the operation.

9102 Equipment Requirements

(1) General

The electric motors for the main pumps shall be of a vertical shaft brushless synchronous type. The motor shall run at fixed speed to secure the proper performance of the pump. The pump impeller shall be lifted up through the motor stator hole for the maintenance. The Contractor shall provide the tools to ensure the motor rotor smooth removal for the maintenance.

Devices shall be provided on the motor frame and rotor for lifting with a crane. The motor rating shall be not less than 1.1 of the maximum power transmitted to the pump under all operation conditions rated output 13 MW. The motor shall be designed for indoor service and the enclosure shall be Totally Enclosed Water - Air Cooled (TEWAC) type. The motor shall be cooled by circulating the internal air through one or more air-to-water heat exchangers. The motor shall have the synchronous speed suitable for direct drive of the pump. The noise level shall be less than 85 dB at no load at one meter from the motor surface.

(2) Performance of the Main Motors

- Required quantity: 4 unit
- Type: Synchronous motor
- Rated voltage: AC 11 kV, 3-Phase
- Rated Frequency: 50 Hz
- Rated output capacity: 13,000 kW

The motor shall be provided with the operation characteristics, which the motor is able to start on the full loads. The motor shall be designed for reduced voltage starting system by a suitable means to reduce the starting current. The main pumps shall start under the conditions of that the discharge valve closed and the pump is filled with water. The locked rotor current at rated voltage and frequency shall not exceed 600 percent of rated current.

The motor shall be capable of delivering torque sufficient to meet all pump hydraulic, electrical, and operating conditions specified, and also meet the minimum torque requirements of the standards. In addition, due to abnormal conditions such as protective device trip or power failure, the motor shall be capable of one hot start (motor initially at rated load temperature) or two successive cold starts (motor initially at ambient temperature) without exceeding a temperature rise that will cause injurious heating to any of the motor parts.

The motor is operated in ambient air temperature of 45℃ and at an altitude of about 15 meter above sea level. The maximum temperature rise of the armature and field windings, when the motor is delivering nameplate rated output continuously at rated voltage, rated frequency, and rated power factor, shall not exceed 75℃ over 45℃ by resistance. The temperature rise of other parts of the motor shall be in accordance with the standards for class B insulation systems.

(3) Design and Construction

(a) Structural and Miscellaneous

The motor shall be designed and constructed to rotate in the reverse direction of rotation at the maximum speed obtainable with the valves open and the connected pump acting as a hydraulic turbine. The enclosure of the motor shall have removable sections, covers, or plates for equipment requiring inspection or maintenance, such as the bearings, heat exchangers, indicating and protective devices, and excitation system components.

The motor shall be provided with suitable ladders, stairways, platforms, removable catwalks and any other facilities necessary to provide access to electrical or mechanical devices, which will require inspection, adjustments, and maintenance. The motor shall be supported on the concrete foundation. The motor shall be designed and constructed so that it can be assembled and disassembled with the pumping plant crane in the space provided in the pumping station. The stator inner diameter of the motor shall be designed larger than the outer diameter of the pump impeller.

The motor shall have two grounding lugs, each capable of accepting No. 4/0 cable equipment grounding connection. The ground connection shall be located to minimize exposure of the connecting ground cable to be physically damaged. One high-voltage terminal box and one low -voltage terminal box shall be furnished and mounted on the

motor. Also, a neutral terminal box shall be mounted on the motor. The Contractor shall bring all leads from the motor to these boxes for external connections. Conduits for high-voltage circuit external to the unit will enter the high-voltage terminal box from the bottom and this box shall be designed for these connections.

(b) Cooling System

The motor shall be provided with a cooling system completed with air to water heat exchanger (s) surface coolers. The cooling system shall be designed to circulate motor cooling air within the cooling system housing. The cooling system shall be designed such that the temperature in the enclosure does not exceed 40℃ at rated output when using 30℃ of cooling water. Each surface cooler shall be provided with flanges suitable for connecting to the cooling water piping and with lifting eyes to facilitate handling. A drain valve and drain piping shall be provided for draining each cooler. Circulation of cooling air within the motor enclosure shall be accomplished by means of fans on the motor rotor. The cooling-air system shall be arranged to prevent the oil vapor entering.

The surface coolers shall be of the straight-tube type with copper radiating fins continuously soldered or continuously mechanically bonded to the tubes so as to provide adequate thermal conductivity and maintain the efficiency of such conductivity during the life of surface coolers. The radiating fins shall have a suitable thickness. The tube shall have suitable diameter and wall thickness to give mechanical strength and reduce vibration. The design of the coolers shall be that the water velocity in the cooler tubes will not exceed 2 meter per second when the motor is delivering rated output with all coolers in service.

The headers or water boxes shall be of copper alloy and shall be constructed with removable cover plates to permit access to all tubes for cleaning and inspection purposes without disturbing the water pipe connections. A threaded connection shall be provided at the top of each surface cooler for the air - release valves. The Contractor shall furnish and install an air - release valve on each surface cooler. The valves shall be sized for the coolers furnished to continually release entrapped air, shall have cast iron bodies with threaded inlet and outlet connections, and shall be suitable for the working pressure of the cooler.

(c) Rotor

The field winding shall be insulated class F insulation. The entire winding of each pole shall be void free and encapsulated with impervious resin that forms a completely solid integrated insulation structure. The insulation for the field winding shall be moisture tight, abrasion resistant, mechanically stable, and sufficiently resilient to withstand the forces of thermocycling throughout the life of the motor. Electrical connections between field coils shall be of a flexible type and shall be supported sufficiently to eliminate mechanical failure due to vibration, thermal expansion and contraction or stresses from centrifugal forces throughout the speed range of the motor including maximum over speed.

The armature winding shall be adequate for starting the motor under the starting operation conditions indicated herein. The armature windings shall be sufficiently supported to eliminate mechanical failure due to vibration, thermal expansion and contraction, or stresses from centrifugal forces throughout the speed range of the motor including maximum over speed. The run out of shafts shall not exceed the tolerances prescribed in the latest edition of ANSI/IEEE Standard 810 "IEEE Standard for Hydraulic Turbine and Generator Integrally Forged Shaft Coupling and Shaft Run out Tolerances.

(d) Shaft

The motor shall be complete in accordance with the following:

The shaft diameter at the couplings shall be coordinated with the brushless exciter shaft and the pump shaft. The shaft shall be of sufficient size to operate at any speed up to full - reverse runaway speed without vibration or objectionable distortion. The size of the shaft shall be such that the first critical speed will be not less than 125 percent of the maximum runaway speed. The shaft shall be machined accurately and shall be polished where it passes through the guide bearings. To ensure the accurate alignment of the pump and motor shafts, the shafts shall be fitted together and checked for alignment while the shafts are rotating.

(e) Bearing

The motor shall be equipped with an oil-lubricated thrust bearing above the rotor. It shall be equipped with one guide bearing above the rotor and one below the rotor. Guide bearings shall be self-lubricated using oil. The thrust bearing shall have ample capacity to support the combined weight of the rotating parts of the motor and the pump including the maximum steady state hydraulic thrust of the pump impeller and shall be capable of operating under this load at any speed up to the maximum reverse runaway speed of the pump for 30 minutes. Starting at normal operating temperature, the bearing shall be capable of operating at normal speed and rated load without cooling water for at least 15 minutes.

The thrust bearing shall be of the Michel type and capable of operating under the same pressure of oil lubrication while the unit is coasting to a stop. After stopping the unit for more than 24 hours, the thrust bearing should be secured and should be reads for restarting after allowing the oil to enter between the pad and the mirror. The guide bearings shall be capable of with standing all stresses incident to the operation of the unit and to the maximum reverse runaway speed. Starting at normal operating temperature, the bearings shall be capable of operating at normal speed and rated load without cooling water for at least 15 minutes. Provision shall be made for preventing the bearing oil or oil vapor form entering the motor cooling air system. Each guide bearing shall be designed and constructed so that it can be dismantled and removed without disturbing the thrust bearing. The guide bearings shall be so constructed that correct guide bearing clearances can be easily obtained.

For upper and lower guide bearings, it is forbidden to use normal sealing on the shaft to prevent leakage from the housing. Cup type housing should be used. Where self-cooling of lubricating oil is inadequate, cooling coils employing the oil-to-water method of cooling shall be furnished. The cooling coils shall be located in the oil reservoirs. Cooling coils shall be copper alloy No. 706 (90-10 copper nickel) in accordance with ASTM BⅢ or the latest revisions or standards. Suitable fittings shall be provided for easy removal of the bearing cooling water lines outside of the oil reservoir housing. A sampling valve shall be provided on each oil reservoir and shall be placed in a convenient location to facilitate taking oil samples. The bearing oil drain piping shall be sized and sloped to drain the bearing oil reservoirs in less then 45 minutes. Bearing insulation shall be provided at the thrust and guide bearings to prevent harmful circulating current from passing through these bearing surfaces.

(f) Stator Winding and Insulation

The armature shall be connected WYE with the three main leads brought out of the stator frame. The armature leads shall be terminated with individual bolted-type solderless connectors. The armature lead insulation shall be completely sealed so that it is equal to the armature coil insulation with regard to moisture resistance and voltage class. The armature leads and coils shall be firmly anchored to withstand short-circuit stresses and stresses from frequent starting. The motor shall be furnished with a vacuum-pressure impregnated insulation system having form wound armature coils. The windings shall be copper and the insulation shall be for the voltage class being furnished and shall be a class F system. The insulation shall be a mica tape for the entire coil and coil connection, except the Contractor has the option of furnishing mica tape or a mica wrapper for the slot portion of the coil. Metallic support rings shall also be insulated. The insulation coil and coil leads shall be overlapped with glass tape or a comparable reinforcing tape.

Prior to impregnation, the insulated coils shall be inserted in the stator and completely connected. The connections shall be insulated and the insulation overtopped with a glass tape or comparable reinforcing tape. The completely wound stator, which includes stator coils, coil supports, blocking tying materials, slot wedges, all connections, and main leads, shall be given a vacuum - pressure impregnation treatment of epoxy resin. The completely wound stator shall be heat cured after vacuum - pressure impregnation treatment. If the stator dimensions are too great to permit immersion in a tank for vacuum - pressure impregnation, the completely insulated coils shall be vacuum-pressure impregnated, and heat cured prior to insertion in the stator.

(g) Anti-condensation Heaters

The motor and exciter shall be provided with suitable heaters to prevent condensation in the windings or oil reservoirs when the motor is shut down for extended periods. The heaters shall be suitable for use on a 3-phase, 380 volt, 50 Hz, alternating - current circuit.

(h) Brush-less Exciter

The exciter shall have continuous capacity (in amperes) at least 10 percent in excess of the actual capacity required for operation of its motor at nameplate rated output. The exciter shall have sufficient capacity to meet the above requirement when the motor field is cold (20℃) and the power supply voltage and frequency at the motor terminals are within the range of NEMA or equivalent standards. The exciter shall be located below the motor rotor to reduce the motor height due to the restriction of Pump House Building. Each brushless, rotating-type exciter shall meet the applicable provisions of NEMA, ANSI, IEEE, and IEC standards or equivalent standards, and shall include the following.

- Direct-connected, 3-phase, alternating current generator with rotating armature and stationary field windings insulated with a sealed winding, class F insulation system
- Silicon bridge rectifier shall have a continuous output rating as specified above, and in addition, an allowance shall be made to cover any loss in capacity as may result from aging.
- Suitable mounting of all rotates equipment to withstand the forces of rotation and vibration.

(i) Indicating and Protective Devices

The Contractor shall furnish devices with the motor for local indication and for producing signals for remote indication and protection of the motor specified in Section 9500 Central Control System. All devices shall be accessible for viewing while the motor is in operation.

a. Devices for central indication
   - Bearing temperature indications. One for each guides and thrust bearing.
   - Bearing temperature alarms. One for each guides and thrust bearing.
   - Armature winding temperature indications. -One per phase.
   - Cooling water outlet temperature alarms. One for each heat exchanger and each bearing cooling coil (if bearings are water-cooled)
   - Cooling water flow alarms. One for each heat exchanger and each bearing cooling coil (if bearings are water-cooled)
   - X-Y Vibration monitor on upper bearing housing

b. Devices for local indication
   - An oil-level sight gauge for each oil reservoir.
   - Industrial thermometers (temperature gauges). One for each guides and thrust bearing.
   - Cooling water flow gauges/switches. One gauge/switch for each heat exchanger and each bearing cooling coil (if bearings are water-cooled) to provide positive indication of cooling water. Each switch shall be vane type.
   - Cooling water outlet temperature gauges/switches. One gauge/switch for each heat exchanger and each bearing cooling coil (if bearings are water-cooled) to provide positive indication of cooling water.
   - Cooling water inlet temperature gauges. One gauge for each heat exchanger and each bearing cooling coil (if bearings are water-cooled) to provide positive

indication of cooling water.

- X-Y Vibration probes on upper bearing housing
- Temperature switches. -One temperature switch for each guide and thrust bearing with two normally close contacts which open for temperatures just below what may damage the bearing. Temperature switches shall be of the vapor - pressure-actuated type and shall be provided with a calibrated dial and external adjustments for setting the operating point and differential.

c. Resistance temperature detectors: One hundred-ohm platinum resistance temperature detectors shall be provided as follows

- Thrust bearing. -Two detectors.
- Guide bearings. - One detector for each guide bearing.
- Armature winding. -Six armature winding detectors, two per phase.

d. The sensing element shall be encapsulated in a flexible, heat-cured compound through the entire slot.

e. The leads shall be encapsulated in the same material or protected with acrylic resin-coated fiberglass sleeve.

f. Devices for central or remote operation shall have electrically independent contacts each rated to interrupt 0.1 ampere, inductive at 220 - 250 volts direct current, and to continuously carry 1 amperes.

g. Two contacts shall be provided on each flow/temperature switch. One contact shall be normally open and the other normally closed.

(j) Current Transformer

Three CTs, one in each phase, for motor differential protection shall be installed in the neutral terminal box. Leads from the CTs shall be brought to the low-voltage terminal box.

(k) Terminal Boxes and Terminal Blocks

Installation of terminal boxes and terminal blocks shall be performed in accordance with the applicable provisions of the National Fire Protection Association. Terminal boxes shall include a high-voltage, a neutral, and a low-voltage terminal box.

- The high voltage terminal boxes shall be designed for armature lead connections. The power cable to the high voltage terminal box will be metallic shielded, rated 15,000 volts and will terminate with stress cones. The terminal box shall be designed for enclosing these stress cones, and grounding the shielding.
- Clamp type ground lug suitable for connecting the conductor shields shall be provided inside the high voltage terminal box.
- The neutral terminal box shall connect all three neutral leads together with the neutrals left ungrounded. Three CTs, one in each phase for motor differential protection shall be installed in the neutral terminal box.
- All indicating and protective device leads, current transformer leads, exciter field leads, and all wiring for external circuits shall be terminated on terminal blocks located in the low voltage terminal box.
- Nameplates shall be furnished and installed adjacent to all electrical devices

mounted on within the terminal box. Each nameplate shall be engraved with sufficient detail to easily identify the specific function and circuit of the devices.

- A copper ground bar with suitable length, width, and thickens shall be mounted inside the box near the bottom for grounding the shields of control cables, the neutral of the control transformer secondary and other equipment. The ground bus shall be electrically connected to the box, which shall be suitable for cable entry by conduits from below.
- Terminal blocks shall accommodate ring lugs at the terminal screws. Terminal blocks shall be furnished with binding-or washer-head screws having serrated or grooved contact surfaces or having lock washers.
- Terminal blocks shall be furnished with molded insulating barriers between terminal, brass terminal strips, and removable covers and marking strips with the wire designations marked thereon. Terminal blocks for control wiring shall be suitable for internal cable stand shall be provided with at least 20 percent spare terminal for terminating spare conductors in each control cable and for possible future use.
- The short-circuiting type terminal blocks for the current transformer circuits on the motor shall be equipped in the switch gear board.

(l) Coupling and Flange

The Contractor shall calculate the shaft critical speed for the combined motor and pump. The calculations shall take into account the rigidity of the pump and motor bearings supports as well as their locations, the motor shaft dimensions and the motor rotating mass. The calculated critical speed shall be a minimum of 25 percent above the runaway speed. The Contractor shall submit critical speed calculation sheet.

The motor coupling flange to the pump intermediate shaft shall basically conform to ANSI/IEEE Standard 810. "IEEE standard for Hydraulic Turbine and Generator integrally Forged shaft Couplings and Shaft Run out Tolerances". The elevation of the face of the coupling shall be determined by the Contractor. A female half coupling on the motor shaft shall be connected to a male half coupling of the upper coupling flange of the pump intermediate shaft.

The alignment of the shafts shall be checked individually and combined on the intermediate shaft at the shop by rotating the shafts. The tolerances for the shaft run out shall be in accordance with ANSI/IEEE Standard 810. The aligned shafts shall be matches marked with permanent stamps, using marks sufficiently different for each set of shafts to prevent interchange of shafts during assembly in the field. Each shaft shall also be designated near the coupling with the pumping unit number.

To ensure the accurate alignment of the pump and motor shaft, the intermediate shaft shall be shipped to the motor contractor to be fitted together with the motor shaft and shall be checked carefully for alignment of the assembly while the shafts are rotating. The intermediate shaft shall be shipped to the motor contractor with the boltholes in the coupling flange drilled undersize. The motor contractor shall be responsible for the

following:

- Furnishing for the pump contractor a template or other adequate information for drilling undersize intermediate shaft coupling boltholes and for machining the recess on the coupling flange, if required, to accommodate the nut guard.
- Fitting the intermediate shaft to the motor shaft and reaming the boltholes in the coupling flanges of both shafts.
- Furnishing and fitting all coupling bolts, nuts, and nut guards for the coupling between the two shafts.
- Furnishing a bolt jack for inserting and removing the coupling bolts
- Aligning the pump and motor shafts and checking the alignment of the coupled assembly while rotating to ensure that the tolerances for shaft run out are in accordance with ANSI/IEEE Standard 810.
- Matchmarking the aligned shafts by permanent stamps.
- Storing and protecting the intermediate shafts until shipped to the site.

The Contractor may be omitted shaft or coupling nut covers mounted for both coupling of the pump and intermediate shaft, if coupling face is apart 2.5 m from walkway floor within pump pit and intermediate guide bearing floor.

9103 Tests

(1) Factory Tests

Before shipping, the motors shall be tested for the following items according to IEC 34 and IEC 85 or equivalent standards.

- Visual inspection of the motor
- Winding resistance measurement
- No load saturation test and phase sequence check
- Three phase short circuit test
- Temperature rise test
  Temperature rise test may be carried out by IEEE 112 the equivalent heat run method or equivalent standards.
- Starting current and starting toque measurement (by reduced voltage)
- Vibration measurement
- Efficiency calculation
  Efficiency calculation may be carried out by IEEE 112 the equivalent heat run method or equivalent standards.
- Insulation resistance measurement
- Dielectric strength Test
- Noise measurements

(2) Site Tests

Any main motor will be subjected to the following test items at the site.

(a) Before running (After installation) Tests
- Visual inspection
- Insulation resistance measurement
  (Meg-ohm test for the stator winding of the motor.)
- Dielectric test (for the stator of the motor.)

(b) Running Tests
- Motor individual running test
  (Vibration measurement and temperature test)
- Motor running test coupled with pump
  (Vibration measurement and temperature test)

(3) Test Reports

The Contractor shall submit to the Engineer for approval four certified copies of all reports of the tests. The reports shall include any analyses of these tests.

9104 Spare Parts

The Contractor shall submit spare parts list, which are considered to be necessary during the 2 years normal operation. The spare parts as described in below shall be included in the list.

For Main Motor	Quantity
- Set of bearing for all sizes	1
- Tools for pull out the motor parts and bearing	1

9105 Appliances and Tools

The Contractor shall submit the list of recommendable appliance and tools.

9106 Data, Descriptive Documents and Drawings

(1) Drawings and Data Submission

The Contractor shall submit following drawings and documents to the Engineer.
- Catalog
- Motor data sheet
- Motor outline drawing
- Deviation lists
- Starting torque curve
- Spare parts list
- Special tool list

(2) Drawings for Manufacture

The Contractor shall submit the following documents after issuance of purchase order or letter of intent to the Engineer.

- Approval drawings/documents list
- Certified mount, shaft drawing and outline drawing with loading data
- Motor data sheet
- Starting torque curve
- Spare parts list / Special tool list
- Factory test procedures
- Factory test report
- Installation, Operation and Maintenance Manual
- Shipping Documents

(3) Instruction Manuals

The Contractor shall submit the instruction manuals for the motors and auxiliaries to the Engineer.

9107 Measurement and Payment

Separate measurement or payment shall not be made for the work required under this section. Only when, all equipment or devices related to the main motor have been installed, connected and completed it is accepted by the Engineer.

All costs in connection with the work specified herein will be considered to be included with the related item of work in the Bill of Quantities.

SECTION 9200 LOW VOLTAGE MOTORS

9201 General

(1) General

- All Sub-Sections under Section 9000, General Technical Specification shall be applied to this section.
- This Section covers the technical requirements for the low voltage motors installed in the El Salaam No. 7 Pumping Station.

(2) Scope of Works

The works shall include the designing, testing, transport to the site, erection and site tests of the low voltage motors used to auxiliary equipment of the main pump and miscellaneous facilities. The Contractor shall completely coordinate all equipment for the unit, including motor, cable connection, coupling to the facilities, so that all components are compatible with each other.

9202 Equipment Requirements

(1) General

The motors shall be of a vertical or horizontal shaft, squirrel cage induction motor or wound rotor induction motor.

(2) Performance

(a) Low Voltage Motors

- Type: As shown on the equipment list on the drawings.
- Required quantity: As shown on the list
- Rated voltage: AC 380 V, 3-Phase
- Rated Frequency: 50 Hz
- Rated output capacity: As shown on the list
- Pole Numbers: As shown on the list
- Rotor construction: As shown on the list

(3) Design and construction

(a) Squirrel Cage Induction Motors

- Enclosure of low voltage (LV) motors shall be totally enclosed, fan-cooled type or natural cooling types, equivalent to protection grade of IP 54, unless otherwise specified.
- Class of insulation for LV motors shall be of Class F insulation, B temperature rise, unless otherwise specified.

- All motors shall be equipped with terminal boxes, which made of cast iron or steel to contain the connection between motor lead-outs and incoming cables.
- The ball bearings, roller bearings or sleeve bearings shall be equipped as per duty requirement. When, the sleeve bearings is used, oil ring and oil strainer shall be provided to remove foreign particles in case of forced lubricating system.
- Motors shall have lifting attachment for installation, transportation and maintenance.
- At least two grounding terminals, one is for inside the terminal box, and the other for the leg section of the motor body, shall be provided.
- All motors shall be provided with stainless steel rating plates incorporating the appropriate items in accordance with IEC34-1. In addition to those items the following data shall be indicated the following items.
  - Type of enclosure in accordance with IEC34-5.
  - Bearing and lubrication references
  - Purchase order number and year of manufacture
  - Weight
  - Rating

(b) Wound Rotor Induction Motors

- Enclosure of LV motors shall be totally enclosed, fan-cooled type or natural cooling types, equivalent to IP 54, unless otherwise specified.
- Class of insulation for LV motors shall be Class F insulation, B temperature rise, unless otherwise specified.
- All motors shall be equipped with terminal boxes, which made of cast iron or steel to contain the connection between motor lead-outs and incoming cables.
- The ball bearings, roller bearings or sleeve bearings shall be equipped as per duty requirement. When the sleeve bearings are used, oil ring and oil strainer shall be provided to remove foreign particles in case of forced lubricating system.
- Motors shall have lifting attachment for installation, transportation and maintenance.
- At least two grounding terminals, the one is for inside the terminal box, and the other for the leg section of the motor body, shall be provided.
- All motors shall be provided with stainless steel rating plates incorporating the appropriate items in accordance with IEC34-1. In addition to those items the following data shall be indicated:
  - Type of enclosure in accordance with IEC34-5.
  - Bearing and lubrication references
  - Purchase order number and year of manufacture
  - Weight
  - Rating

9203 Tests

(1) Factory Tests

Before shipping, the motors shall be performed the tests according to IEC 34 and IEC 85 or equivalent standards.

- Visual inspection of the motor
- Winding resistance measurement
- No load test (For LV motors less than 55 kW, the type-test data shall be submitted)
- Locked rotor test (For LV motors less than 55 kW, the type-test data shall be submitted)
- Temperature rise test (For LV motors less than 55 kW, the type-test data shall be submitted)
  Temperature rise test may be carried out by IEEE 112 the equivalent heat run method or equivalent standards.
- Starting current and starting toque measurement (For LV motors less than 55 kW, the type-test data shall be submitted)
- Efficiency calculation (For LV motors less than 55 kW, the type-test data shall be submitted)
  Efficiency calculation may be carried out by IEEE 112 the equivalent heat run method or equivalent standards.
- Insulation resistance measurement (For LV motors less than 55 kW, the type-test data shall be submitted)

(2) Site Tests

All LV motors shall be subjected to the following test at site:

(a) Before running (After installation) Tests
- Visual inspection
- Insulation resistance measurement (Meg-ohm test for the stator winding of the motor.)

(b) Running Test
- Motor individual running test (For LV motors over than 55 kW only (Vibration measurement and temperature test)

(3) Test Reports

The Contractor shall submit to the engineer for approvals of four copies of all reports of the tests. The reports shall include any analyses of these tests.

9204 Spare Parts

The Contractor shall submit spare parts list, which are considered to be necessary during the 2 years normal operation. The spare parts as described in below shall be included in the list.

For Low Voltage Motor Quantity	Quantity
- Set of bearing for all sizes	1

9205 Measurement and Payment

Separate measurement or payment shall not be made for the work required under this section. Only when, all equipment or devices related to the LV motor has been installed, connected and completed it is accepted by the Engineer.

All costs in connection with the work specified herein will be considered to be included with the related item of work in the Bill of Quantities.