SECTION 40800 ELEVATOR

40801 General

This Section shall cover all elevator work installed in the Port Administration Building including equipment, material, required accessories to be provided, installation, testing and commissioning, and maintenance training and maintenance tools. The Contractor shall propose elevator manufacture who has capability to carry out maintenance in the Project Site..

This System shall be complying with Contractor Design of Section 10400.

40802 Contractor Responsibility

40802.1 Submission

a) The Elevator described on this specification are guide line and indicate the minimum requirements for achieving the desired performance.

b) In order to develop these requirements into comprehensive systems the Contractor shall

i) Development the design and submit fully detailed shop drawings all aspects of the system

ii) Submit full details of all materials and equipment to be used.

iii) Provide all other necessary information

c) The submission shall supplement the information contained in the Specification and subject to the Engineer's approval ensure that overall design criteria, intent and cost parameters are being adhered to.

d) In all aspect of this work the responsibility will rest with the Contractor whether or not the details are provided by his subcontractor.

E) In addition, the Contractor in the execution of the Works, shall supply and install all auxiliary materials and equipment incidental to the work to ensure complete, functioning installations and systems.

40803 Technical Requirement

40803.1 Quantity
One elevator installed in the Port Administration Building

40803.2 Speed
1.60 meter/second

40803.3 Capacity
13 Passengers (2,200 pounds)

40803.4 Path
20.40 meters.

40803.5 Stops
Six (6) all the ones at the front of the cube.

40803.6 Car
The booth is formed by lateral panels and front in brushing stainless .

40804 Steel Brushing

Door shall be of brushing stainless steel for 1.10 meter of wide and 2.10 meter of high of lateral opening with automatic operation.

Roof shall be of mirrored stainless steel with profiles of transparent acrylic projected in diagonal form with fluorescent illumination.

Modern designed Panel of push buttons with panel of mirrored stainless steel shall be incorporated in a lateral panel including:

a) Concave Call Buttons silver plating of micro tact with illuminated ring of red color when pushing them. Switch with key next to each button for private call.

b) Indicative of digital position of two digits and 16 segments. Digits in red color.

c) Alarm Buttons, to open up and to close door.

d) Numeration with inserts Luxury plated in refined finish.

e) Symbols (Capacity)

f) Intercom of two points.

Internal dimensions shall be of 1.10 meters of front and 2.10 meters of wide. Height shall be of 2.31 meters.

40805 Doors Protection

Device of security shall be of three-dimensional consisting of 56 infrared rays creating a curtain covering all the height of the door. Completely electronic monitor the entrance and the smallest interference in the rays shall make the door to be reopened immediately without physical contact with the passenger. An electronic and soft audible sign indicates the interference shall be of rays.

40806 Doors Operation

Electric automatic to open up and to close the door of the car shall be controlled electronically.

40807 Doors of Floors

Size shall be of 1.10 meters wide and 2.10 meters high for free entrance, with lateral and totally automatic opening.

Doors Finishes and marks shall be of brushed stainless steel in all the floors and walls.

40808 Signal in the Floors

Digital of high yield with cover in brushing stainless steel. In level 1 and 6: indicator of digital position of two digits and 16 segments. Address indicators (digital arrows). Digits and arrows in red color.

In the other floors with direction indicators (digital arrows). Arrows in red color.

40809 Operation

Operations shall be of simplex and collective in both directions. All the functions shall be controlled by the computer located in control processor for the direction and speed of the booth. Control information shall be from both corridor buttons and car booth. All control system shall be applied the most advanced technology of manufacture recommendation.

40810 Car

Free interiors Measures of 1.67 meters of front for 2.55 meters of bottom. Grave of 1.40 meters. Surpass of 3.70 meters.

40811 Machine Room

Located inside the cube below the pottery of the roof with dimensions, loads and requirements indicated in the assembly planes.

40812 Control

Control system shall be of micro processors and designed to integrated circuits system and all the operations of the elevator. The motor and control shall be operated electronically.

Voltage and variable frequency (VF) shall be obtained movement of great comfort with a saving average of 40% of electric power compared with the two speeds system.

40813 Traction

Plane tapes with a polyurethane layer shall be wrapped on the steel cables.

40814 Electricity

In the machine room the following electric supply shall be provided by the Electrical works:

Motors: 220 volts, 3-phases, 60 Hz.

Illumination: 110 volts, 1-phase, 60 Hz for the booth.

SECTION 40900 OVERHEAD CRANE

40901 Scope of Works

This Section covers all Overhead Crane for Maintenance and Repair Shop work including equipment, required accessories, installation, maintenance training and maintenance tools.

The Overhead Crane shall comprise supporting structure, the electrical powered crane, the push-buttons panel, the electrical control panel and the linkage system connecting those component units and wiring on electrical supply thereof.

40902 Contractor's Design Responsibility

a) The description of the Overhead Crane noted on this specification is a guideline and indicates the minimum requirements for achieving the desired performance.

b) In order to develop these requirements into comprehensive systems the Contractor shall:

- Develop the detailed design and submit fully detailed shop drawings showing all aspects of the system

- Submit full details of all materials and equipment to be used.

- Provide all other necessary information

c) The submission shall supplement the information contained in the Specifications and be subject for the Engineer's approval to ensure that overall design criteria, intent and cost parameters are being adhered to.

d) In all aspect of this work the responsibility will rest on the Contractor whether or not the details are provided by his subcontractor.

e) In addition, the Contractor in the execution of the Works shall supply and install all auxiliary materials and equipment incidental to the work to ensure complete, functioning installations and systems.

40903 General Design Conditions

Overhead Crane shall be designed, constructed and installed considering the following:

a) Crane Lifting Capacity: 5 ton

b) Lifting Height: 5.8 m

c) Longitudinal displacement: 39.0 m

d) Transversal Displacement: 24.0 m

e) Maximum Wheel Weight: 6 ton

f) Translation velocity: 18m/min

40904 Overhead Crane Components

40904.1 Supporting Structure

Supporting structure of overhead crane shall be steel and shall consist of:

a) Rail Beams, one on each longitudinal side of the Maintenance and Repair Shop. Adequate supports shall be provided for these beams to be fixed on the shed's structural columns. These beams shall support the steel rails for the longitudinal movement of the Crane Beam.

b) Crane Beam, which shall be provided with rods for the longitudinal translation along the rails.

40904.2 Crane

Crane shall consist of the following components, all bearing a lifting weight of 5 ton:

a) Translating Carriage

b) Pulley and steel cables

c) Protection Cabinet

40904.3 Electrical Components

Overhead crane shall be electrical powered, 460 V, 3-phase, 60 Hz, and shall be provided with the following electrical components:

a) Power Lift, which shall be 460 V, 3-phase, 60 Hz

b) Push-buttons panel, for operation control

c) Starter

d) Flat flexible cable, to allow smooth translation of the carriage longitudinally and transversally.

e) Control Panel

f) All system linking connectors among all electrical components and between the push-button panel and the control panel.

SECTION 41000 WEIGHING BRIDGE

41001 General

This Section covers all weighing bridge work including equipment, required accessories, installation, maintenance training and maintenance tools.

The weighing bridge shall comprise platforms, with weighing mechanism, junction box, load cell unit, indicators, printers and the linkage system connecting those component units and wiring on electrical supply thereof. The surface of loading platform shall be none-slip type.

41002 Contractor Responsibility

a) The weighing bridge system described on this specification are guide line and indicate the minimum requirements for achieving the desired performance.

b) In order to develop these requirements into comprehensive systems the Contractor shall

i) Development the design and submit fully detailed shop drawings all aspects of the system

ii) Submit full details of all materials and equipment to be used.

i) Provide all other necessary information

c) The submission shall supplement the information contained in the Specification and subject to the Engineer's approval ensure that overall design criteria, intent and cost parameters are being adhered to.

d) In all aspect of this work the responsibility will rest with the Contractor whether or not the details are provided by his subcontractor.

In addition, the Contractor in the execution of the Works, shall supply and install all auxiliary materials and equipment incidental to the work to ensure complete, functioning installations and systems.

The Contractor should supply 10,000 tickets of the form instructed by the Engineer, ten copies of operation and maintenance manuals, two years supply of spare parts.

The weighing bridge shall, upon installation, go through experimental weighing test and obtain a certificate issued by a competent authority starting that the said weighing bridge complies with all the specified requirements stipulated herein.

41003 General Specification

Quantity	: 4 sets, 2 sets for the container gate and 2 sets for the cargo gate
Type	: Pitless
Capacity	: 50,000 kg
Minimum graduation	: 10 kg
Accuracy	: 1 / 5000
Platform size	: 3.5 m x 15 m
Weighing mode	: Static
Power Supply	; 120 volts, single phase, 60 Hz.

41004 Accessories

41004.1 Indicator

The indicator should be possessed the indication of a weight measured, the number of weighing times, a truck number, a code, a registered name, guidance, condition of

weighing, and some other items.

41004.2 Printer

The printer should be composed of card-based printer and sprocket-fed printer.

SECTION 41100 WEIGH SCALE

41101 General

This section shall cover weigh scale to be installed in the Container Freight Station. Weigh scale work shall include equipment, material, accessories to be complete system, labor, testing and commissioning.

The weigh scale system consists of four (4) scale sensors, scale platform and digital indicator, and required accessories. The Contractor shall have responsibility to installed required conduit, cabling to comply with proper function of weigh scale between weighing scale and indicator.

This system shall comply with the Contractor Design Section 10400 of General Requirement of Specification.

41102 Weighing Sensor

Four (4) sensors of compression class III 5000 divisions with 5000 pounds of capacity shall be installed on each corner of pit prepared by the Architectural Works. Weighing scale shall be of sensibility 2 mv/v with 25 feet of incorporate cable for interconnection to box of union. Box of union for 4 sensors shall be with lid completely sealed safety against humidity.

41103 Digital Indicator

Digital indicator shall be covered with stainless steel approves of humidity seal category 4. Indication shall be of LED brilliant green color. Digital indicator panel shall be equipped with 20 keys with range of functions metrological and 14 luminous indicators that shall identify the function of operations. Programmable capacity shall be of 8,000 x 0.5 kg with conversion function to pounds. Digital indicator shall equipped function to connect printer and/or computer. Electrical direct connection shall be of 115 VAC.

41104 Platform

Size of platform shall be of approximately 3 meters x 2 meters of structural steel of local construction. Chariots type I 8 and voyages of 6"; covered with sheet of 3/8 bolted with screw head alens, angle for grave border, planes with you detail for construction grave.

45000 ELECTRICAL WORKS

SECTION 45100 GENERAL

45101 Scope of Work

The scope of works given in this Specification and the Drawings includes for the supply, installation, testing and commissioning of all equipment and materials herein or showed in the Drawings. The Contactor shall provide and supply labor, tools, provision of storage, space, temporary power and lighting, and other temporary works required for completion and commissioning of the works in accordance with the Specifications and the Drawings. The summary of the scope of works is as follows:

- To apply to the relevant local authorities for permissions as required and to design, supply and install 46 kV power supply line from the connection point near the entrance of La Union Port to the Power Supply Station and 46 kV outdoor switchgear equipment including 46/4.16 KV transformer in transformer yard of the Power Supply Station.
- To supply and install stand-by emergency power generating equipment in generator room of the Power Supply Station
- To supply and install power distribution equipment consisting of 4.16 kV, 480 V and 208-120 V switchgear cubicles in switchgear room and distribution transformer consisting of 4.16/0.48 kV and 4.16/0.208-0.12 kV transformers in transformer room of the Power Supply Station.
- To supply and install underground power cables and other necessary items for 4.16 kV, 480 V and 208-120 V main lines.
- To supply and install area lighting and power outlets consisting of flood lights, streetlights and power outlets for reefer and birth service.
- To design, supply and install fire alarm system.
- To design, supply and install telephone/data network consisting of telephone network, data network, mobile phone and VHF communication.
- To supply and install lighting fixture, outlets, distribution panels, wiring, piping, lightning and grounding for Port Administration Building, Container Freight Station, Maintenance and Repair Shop, Container Gate, Cargo Gate and Power Supply Station.
- To prepare "Shop Drawings" for the installation of major equipment and materials
- To prepare "As-Built" drawings and documents for all the works performed.

45102 Works not Included

45102.1
The 46 kV high voltage line connection to the public power line outside the Port fence will be constructed under the responsibility of the Employer.

45102.2
The telephone/data communication optic fiber cable for connection to the public network will be constructed under the responsibility of the Employer.

45102.3
Works indicated with "NIC" in the Drawings are not included in this Contract.

45103 Co-ordination with Electrical Authorities

45103.1 Co-ordination with Electrical Authorities
The Contractor shall co-ordinate with the Electrical Authorities in the area regarding the works of this Contract until the completion and the power is supplied to the Works. The Contractor shall also apply for the installation of the permanent electricity meter in the name of the Employer.

45103.2 Co-ordination with Radio Frequency Department
The Contractor shall co-ordinate applications and permits for UHF and VHF systems with the Radio Frequency Department from Super Intendencia General de Electricidad y Telecomunicaciones, SIGET (General Superintendent of Electricity and Telecommunication of the Republic of El Salvador).

45104 Codes and Standards

45104.1 Standards for Equipment and Materials
All equipment and materials shall be the latest models, new and in good condition. They shall conform to internationally recognized standards (standard rules, regulations and specifications), such as American National Standard Institute (ANSI), National Electrical Manufacturers Association (NEMA), the Institute of Electrical and Electronics Engineers (IEEE), Japanese Industrial Standard (JIS). They shall be made for the electrical system specified for use at that location. They shall be type-approved by internationally accepted testing institutions such as Underwriters Laboratories (UL), Canadian Standard Association (CSA), and also approved by the Engineer. The Engineer and the Electrical Authorities shall approve the electrical equipment and materials to be used.

45104.2 Standards of Works
The Contractor shall perform the Works in accordance with the Drawings and Specifications, which are complementary. In case of conflicting statements in the Drawings and/or the Specifications, the Engineer shall determine the action to be taken by the Contractor. Works shown in the Specifications and/or Drawings shall be performed until completion. Any related works required for the successful completion of the Contract according to the objectives specified by the Engineer in the Specifications and/or Drawings, even though the details are not shown, shall be done without any additional cost. The Contractor shall perform the electrical works in accordance with the codes such as U.S.A. National Electrical Code (NEC), National Fire Protection Association (NFPA), Illuminating Engineering Society of North America (IESNA), or other standards approved by the Engineer. If it is required to revise the Drawings in order to conform to such codes or for any other reasons, the Contractor shall prepare such shop drawings as necessary and submit to the Engineer for approval before proceeding with the works.

45104.3 Cabling
Cabling shall be sufficiently separated, armored, installed in metal conduits or trenching so that the reliability of all systems is not adversely affected by Electromagnetic Interference (EMI). Relevant international standards have to be applied with selection of equipment, equipotential bounding and, where available, Test Certificates shall be submitted.

45105

45105.1 Factory Test and Site Test
Equipment, materials, and completed works shall be subjected to factory tests and

Testing

acceptance site tests to be approved by the Engineer or Electrical Authorities if so required. The Engineer will have the rights to submit the equipment, materials, and works for testing to compare with the requirements of the Specifications and Drawings. The Contractor shall pay the expenses for such tests by the institutions selected by the Engineer.

45105.2 In case of not Meeting the Full Requirements of the Specifications
Should the works not meet the full requirements of the Specifications then the Contractor shall bear the full expense of correction and further tests.

45105.3 Preparation of Tests
The Contractor shall furnish all necessary test equipment, supervision, labor, power, water and fuel at his own expense.

45105.4 Test Record
The Contractor shall furnish a carefully detailed record of the results of the tests.

45105.5 List of Records
The Contractor shall submit to the Engineer a list of records of:

- Test and measurement of 46 kV switchgear equipment
- Test and measurements of the generating plant
- Test and measurement of 4.16 kV, 480 V and 208-120 V switchgear cubicle
- Primary and secondary voltage of the transformers
- Measurement of insulation resistance of all circuits and of the cables insulation resistance of all wiring including cables shall not be less than 500,000 ohms between conductor-conductor and/or conductor and ground
- Test of switching of lighting
- Measurement of lighting levels
- Measurement of grounding resistance
- Test of automatic circuits
- Testing of fire detection zones, slow whoops and control output
- Measurement of telephone and data network cabling
- Testing of PABX and VHF communication system

45106 Drawings and Manuals

45106.1 Shop Drawings
If there are any changes from the Contract Drawings such as the changes of conduit routes or any other changes ordered by the Engineer for which no drawing is issued, the Contractor shall prepare shop drawings as necessary. Other shop drawings necessary or required by the Engineer to show the details of the installation works shall also be prepared as required. Drawings have to be made as CAD-drawings (e.g. Auto CAD). Submitting of drawings for approval shall be made as described in the general Specifications.

45106.2 As-built Drawings

As-built drawings shall be prepared for all works and shall be approved by the Engineer. Drawings have to be made as CAD-drawings (e.g. Auto CAD). All files on Compact Disk, original tracing of the drawings, two sets of reproduced drawings, two sets of all instruction manuals and maintenance manuals, in both Spanish and English, shall be submitted.

45107 Approval of Equipment, Materials and Drawings

45107.1 Equipment

Approval of equipment, materials, and shop drawings submitted by the Contractor shall mean that at the time of submission, the Engineer has no objection to the proposal at that time. The Contractor shall not be relieved from the responsibilities in using the proper equipment and materials and performing the works to the final approval of the Engineer.

45107.2 Samples

Samples required by the Engineer in accordance with these Specifications are to be provided with no delay at the Contractor's expense and are to be in accordance with the relevant standard method of sampling. The samples shall be taken in such a way or by such a method that they can be considered to be representative of the full quantity of materials from which they are taken. The samples, when approved, will be kept by the Engineer who will reject all materials and workmanship not corresponding in quality and character with the approved samples.

45108 Nameplates

The Contractor shall make nameplates for all equipment to show names, functions, and other details as directed by the Engineer. They shall be made of engraved plastic sheet or aluminum at least 1.0 mm thick and shall be attached permanently with a suitable adhesive.

45110 Training

The Contractor shall instruct and train the Employer's engineers and technicians in the exact operation of all systems and maintenance of the equipment and the works in this Contract.

45111 Warranty

The Contractor shall provide warranty in replacing and/or remedying the works and/or equipment and materials that are found to be defective, incorrect, and/or faulty. The warranty shall also include the works and/or provision of additional equipment and materials required to complete the work in accordance with the Drawings, Specifications, and the objectives of the Engineer as stated in the Contract, even though such works or details of which are not stated in the Contractor's cost proposal and/or materials list. The warranty period shall be one (1) year (365 days), from the date of acceptance of the works, or the date from which the Employer commenced regular operation of the works, whichever comes first. If the Contractor does not take appropriate actions to remedy the works promptly after receiving notification, the Engineer reserves the right to proceed with the remedial works and shall charge the Contractor for such works.

45112 Installation Methods

45112.1 Color Codes of Conductors and Busbars

Conductors and busbars shall have the following color codes: light gray for neutral; green or green with yellow stripes for ground; black for phase A; red for phase B; blue for phase C. For single-phase system, any of the three colors for phase conductors may be used. Small conductors up to 6 sq. mm. shall have color insulation as per the specified color codes. Larger conductors shall be black which

paint or color tape applied at the splices and termination's using the specified color codes. Busbars shall be painted with heat resistant paint using the specified color codes except at the joints.

45112.2 Grounding

Grounding shall be in accordance with NEC Art 250 or equivalent code approved by the Engineer. Lightning protection system, surge arresters, neutral conductors, grounding conductors, equipment frames, lighting fixtures and other non current carrying metallic parts shall be properly grounded. Where electrodes are used for the grounding system, electrode rods of copper clad steel or iron at least 15.87 mm in diameter shall be installed such that at least 2,440 mm of length is in contact with the soil. If rod electrodes cannot be used due to soil conditions, plate electrodes of copper clad, galvanized steel or iron plates with at least 6.35 mm in thickness and at least 0.186 sq. m. of surface exposed to the soil may be used. If electrodes of non-ferrous metal plate are used, they shall be at least 5 mm in thickness. Grounding resistance of the system shall be measured and shall not be more than 4 ohms. If the resistance is greater than 4 ohms, the Contractor shall add more grounding electrodes as may be required at no additional cost. Grounding conductors shall be installed in conduit as specified. Flexible metal conduit may be used as the equipment-grounding conductor in accordance with NEC Art. 250-91 Exception No.1 and 2, or equivalent code approved by the Engineer. Test certificates shall be made for all tests carried out and must include the values of earth electrode resistance, continuity of protective and equipotential bounding conductors and the earth loop impedance.

45112.3 Wiring Methods

Wiring methods shall be in accordance with NEC Art. 300 or equivalent code approved by the Engineer. All electrical and communication wiring shall be in conduits except where specified otherwise. Electrical Metal Tubing (EMT) conduits shall be used except where specified otherwise. Conduit used below grade shall be Intermediate Metal Tubing (IMC) conduit coated with at least three coats of approved bituminous materials for corrosion protection. Exposed conduit where it can be damaged and any exposed conduit from a height of 2,500 mm or less shall be IMC conduit except where specified otherwise. Liquid tight flexible conduit shall be used for connections to motors or equipment with vibration, and for connection of luminaries mounted on the ceiling with T-bar to the outlet box in the ceiling. Multi-conductor flexible cable like Phelps Dodge TSJ, National Hi-Flex White or approved equivalent may be used instead of liquid tight flexible conduit in the ceiling plenum or floor plenum. Empty conduits (designated with "CO") shall have pulling wires installed. Conduit without any size designation shall be 12.5 mm trade size. If conduit sizes are changed and/or not clearly specified, the Contractor shall determine the size in accordance with the Electrical Authorities. Conduit without type designation shall be EMT. Designation "I" or "IMC" shall mean intermediate metal conduit. "R" or "RSC" shall mean Rigid Steel Conduit. "P" or "PVC" shall mean PVC non-metallic conduit. "ACP" shall mean asbestos cement conduit or pipe. Non-metallic conduit, except PVC or HDPE conduit, shall not be bent; only elbows with adequate radius and/or junction boxes may be used to change direction.

45112.4 Wiring Methods Without Conduit

Installation using non-metallic-sheathed cable shall be in accordance with NEC Art. 336 or equivalent code approved by the Engineer. In the case of small cables, aluminum straps may be used to secure the cables at distances not exceeding 150 mm. For large cables exceeding 10 mm in diameter, plastic saddles shall be used to secure the cables. Cables shall be securely fastened so that they cannot become loose. For open wiring on insulators, using insulated single conductors, NEC Art. 320 or equivalent code approved by the Engineer shall be followed. Splicing of non

metallic-sheathed cable shall be done only in non-metallic junction boxes with covers or grounded metallic boxes with covers or hand holes or manholes.

45112.5 Splicing of Electrical Conductors

Splicing shall be done only in the junction box, lighting fixture, hand hole, or manhole. Splicing is not allowed in the outlet box and conduit. Splicing of copper conductors of size up to 10 sq. mm. shall be done by using insulated crimp-type connectors insulated twist-on connectors (wire nut), and/or self-stripping electrical pigtail and tap connectors. Crimp-type terminals shall be used for connection to the terminals of the equipment using screw terminals. For larger conductors, plated compression connectors and lugs shall be used. For aluminum conductors, copper/aluminum connectors and lugs with oxide-inhibiting compound shall be used. Other types of connectors may be used only upon approval by the Engineer. All connectors, terminals, and lugs shall be type-approved by UL or other equivalent institution approved by the Engineer. Un-isolated connectors shall be insulated with at least three layers but not less than the insulation thickness of the conductor using approved electrical insulating tape rated for temperatures up to 105 degrees C, such as 3M Scotch 33+ vinyl plastic electrical tape, or equivalent approved by the Engineer. Splices in moist locations and underground shall be casted with approved insulating and sealing resin such as 3M Scotchcast, Siemens Protolin or equal approved.

45112.6 Splicing of Signal Cables, Control Cables.

Splicing of low voltage signal cables and control cables shall be done by using self-stripping connectors with protective sealant such as 3M Scotchlok U Series Communication Connectors or equal approved. For indoor cables, enclosures, junction boxes or pull boxes shall be used to protect the splice. For underground and outdoor cables, re-entering splicing enclosures with re-entering electrical insulating and sealing compound shall be used to protect the splice.

45112.7 Installation of Panel Board and Load Center

Panel boards and load centers shall be installed in accordance with NEC Art. 384 or equivalent code. Panel boards and load centers shall be securely surface mounted or flush mounted at a height of 1300 mm to the centerline or as specified. If mounted on brick or concrete walls, expansion bolts and anchors shall be used for mounting. For surface mounted panel boards or load centers with exposed conduits, painted metal covers of the same dimensions as the panel board or load center shall be used to cover the conduits installed above and below to the floor and ceiling. For each flush mounted panel boards or load centers, at least one spare conduit of 25 mm size or larger shall be installed to the ceiling space and to the under floor or junction box near the floor.

45112.8 Installation of Switches

Switches shall be installed in accordance with NEC Art. 380 or equivalent code approved by the Engineer. Galvanized steel switch boxes shall be used for flush mounted switches. For surface mounted switches, die-cast aluminum switch boxes for surface mounting shall be used. Other type of surface mounted switches shall be used only as directed. The switches shall be mounted at a height of 1,250 mm.

45112.9 Installation of Receptacles

Electrical receptacles shall be installed in accordance with NEC Art. 410-L in the same manner as the switch. The receptacles shall be installed at a height of 300 mm or as specified.

45112.10 Installation of Lighting Fixtures

Lighting fixtures shall be installed in accordance with NEC Art. 410. Pendant mounted lighting fixtures supported by tubing or chains shall be mounted at a height of 2,700 mm above finished floor level or as directed or specified on the Drawing. Wall mounted lighting fixtures shall be mounted at a height of 2,200 mm or as directed or specified on the Drawing. Lighting fixtures flush mounted on the ceiling shall be installed so that they can be easily removed from below.

Adjustable chains shall support lighting fixtures mounted on the suspended ceilings or rods or tubing's attached to the floor slab above. The suspended ceiling shall not support its weight. Flexible metallic conduit with sufficient length for moving the lighting fixture by at least one ceiling module on each side shall be used for connection to the outlet boxes. If wiring without conduit is used, sheathed flexible cable with grounding conductor of sufficient length shall be used for connection to the branch circuit. At the lighting fixture, a cable connector shall be used to secure the cable to the body. All lighting fixtures shall be mounted securely so that they cannot become loose, but they can be removed for maintenance. Ballast and capacitors, which are installed separately, shall be installed in painted metal enclosures with removable covers at location, which is easily accessible for maintenance.

45112.11 Mounting of Conduits and Lighting Fixtures

Mounting of conduits and lighting fixtures shall be made by using galvanized or cadmium plate rods, clamps or chains. They shall be sized to support the weight of the equipment. Expansion bolts and anchors of adequate sizes shall be used for mountings on bricks or concrete.

45113 Special Requirements

45113.1 General

The previous Clauses of this section of the specification shall be modified by the following special requirements relating to specific items of the Works. Other statements on the Drawings are complementary to these special requirements.

45113.2 Safety

The Contractor shall be responsible for the electrical safety of all equipment supplied and installed. Whilst any equipment is being installed or tested, the contractor shall ensure that all necessary precautions are taken to safeguard personnel working on site. If necessary, this shall include erecting of warning notices and fencing off areas, which are considered to pose a risk. Operation and environmental impacts shall be considered with the selection and installation of equipment.

The Contractor shall be responsible for ensuring that competent personnel carry out the electrical installation and that the work is carried out in accordance with standard procedures and test requirements. Before any piece of apparatus is energized, it shall be thoroughly examined for the presence of dirt, water or other foreign bodies.

45113.3 Storage

The Contractor shall prepare the storage for all his materials.

45113.4 Protection

The Contractor shall cover and protect his materials and his work from damages and corrosion to the approval of the Engineer's Representative.

SECTION 45200 TRANSMISSION LINE AND SUBSTATION

45201 General

45201.1 Electrical Power Source

Electrical power will be supplied by the 46 kV network of EEO, to witch the port is fed from the Line 1 supply line along the road, transmitted from the San Miguel Substation to the CORSAIN substation.

45201.2 Equipment Location

The electricity power of the port is fed to 46 kV outdoor switchgear in the transformer yard of the power supply station with 46 kV overhead line through the pole mounted section switch and meter with current transformer and potential transformer, and afterwards connected the 46/4.16 kV transformer.

45201.3 Scope of Work

This Section covers the design, manufacture, testing before shipment, transportation to site, installation/erection, commissioning and performance test at the Site of the following:

- 46 kV transmission line
- 46 kV switchgear
- Outdoor structure
- 46/4.16 kV transformer

45202 46 kV Sub-Transmission Line

45202.1 General

The 46 kV line shall be overhead, single circuit, one conductor per phase, mounted on 12 meters high concrete poles, and shall conform to Standard SIGET Acuerdo No. 66-E-2001 (Standard for Aerial Electric Energy Distribution Lines Construction).

The 46 kV line design shall comply the clearances indicated in international standards IEC, ANSI, SCA CAN3-C108.3.1-M84, in order to prevent electromagnetic interference in other systems.

45202.2 Clearances

Minimum clearances shall be as follows:

Conductor to center of pole	1.45 m
Conductor to ground	10 m

45202.3 Conductor

Power conductor shall be Aluminum Conductor Steel Reinforced (ACSR). They shall comply with the following requirement and characteristics

Code	"Penguin" ACSR
Standard	ASTM-B232M
Aluminum area	107.23 mm^2
Steel area	17.87 mm^2
Total conductor area	125.10 mm^2
Number and diameter of aluminum	6 x 4.770 mm
Number and diameter of steel	1 x 4.770 mm

Ultimate strength not less than	3787 kg
Resistance at 20°C	0.2620 Ohm/kg

The power conductor shall be wound on a stout wooden drum. The length of conductor and ground wire shall be 1,000 m per drum.

45202.4 Joints and connectors

Cable joints shall be of compression type and shall be free from slipping off, damage to or failure of the conductor or any parts thereof at a load less than 95% of the ultimate strength of the power conductor.

The electrical conductivity and current carrying capacity of joints for power conductor shall not be less than those of equivalent length of the conductor.

Connectors for conductor shall be of bolted type, with grooves and alloy bolts, complete with compound for connectors to prevent breaking out of oxide film on the conductor's surface.

Insulator Type	Line Post Insulator	Tension (Disc)
ANSI Class	ANSI 56-4 ANSI B57-3	ANSI 52-4
Diameter	161 mm	273 mm
Rated Voltage	45 kV	23 kV
Test voltage RMS to ground	30 kV	10 kV
Cantilever strength	12.5 kN	
Tension strength		67 kN

45202.5 Insulator

Insulators shall be brown or gray colored porcelain (ANSI 70), and both line post and tension insulator sets of disc for 46 KV line. Insulators disc shall be of ball-socket type and dimension of socket and pins shall comply with ANSI standard C29.7-1996, JIS standard C-3817 "pin and socket", or equivalent.

Their size and characteristics shall be as follows:

45202.6 Fitting for insulators

The line post insulator shall have a suitable support for the power conductor on the top of the insulator. Insulator set for tension support shall consist of four insulator discs and tension string assembly including a tension clamp. All bolts, nuts and cotter pins shall be not less than 16 mm in diameter, and shall meet ASTM A394 type O and ASTM A563 grade A. The tension clamp shall be of wedge type and made of bronze casting or malleable iron and be free from slipping off, damage to or failure of the complete conductors at a load less than 800 kg

45202.7 Supports

Supports shall be local made, centrifugal concrete poles, complete with galvanized steel cross arms, step bolts, anchor logs and guy wire sets where necessary. Concrete poles shall be of round section. The diameter of top section shall be not less than 165 mm. Line conductors shall be arranged in horizontal on one cross arm.

The standard of types of supports are as follows:

- Type-A: Straight line and light angle support up to 5 degrees with line post insulators on a single cross arm.
- Type-B: Heavy angle support up to 30 degrees with double line post insulators on a double cross arm.
- Type-C: Terminal and heavy angle support up to 60 degrees with tension insulator sets and jumper line posts on a double cross arm.
- Type-D: Heavy angle support up to 90 degrees with tension insulator sets and jumper line posts on two double cross arms fitted right-angled.

Type A support shall be design to be used without guy wires. Other types shall be reinforced with necessary guy wires. Type A support shall not be used for more than 10 continuous sections. The standard design span shall be 50 meters.

The height of the lowest arm from the ground level, spacing of conductors and other dimensions shall be submitted by the Contractor.

45202.8 Design Conditions of Poles

All supports and arms shall withstand the following load:

1) Vertical loads
   - Weight of supports, conductors, road lighting fixtures and cables, communication cable, insulators, etc. The weight span shall be taken as 150% of the standard span.
   - Vertical load caused by installation of the guy wires

- Weight of worker 200 kg.

2) Transverse loads

- Wind pressure of 69 kg/m^2 (120 km/h) at right angle to the line and support, on whole projected area.
- Transverse component of angle effect due to the maximum working tension of conductors.

3) Longitudinal loads

100 % of the maximum working tension of conductors, road lighting fixture conductors and communication cable.

Wind load shall be assumed as follows:

- On conductor, road lighting fixture conductors and communication cable

  69 kg/m^2 on projected area at + 40°C

- On concrete pole

  69 kg/m^2 on projected area at + 40°C

- On arm, insulator set, etc.

  150 kg/m^2 on projected area at + 18°C

(No wind pressure may be considered for guy wires and jumper conductors)

The temperature shall be assumed to vary within the range, 40°C maximum and 10°C minimum.

The maximum working tension of line conductor shall be 350 kg.

The design calculation and drawings of supports shall be submitted by the Contractor for approval.

45202.9 Guy Wire Assembly

A guy wire assembly shall consist of a steel band with a thimble and performed grips, a guy insulator with perform grips, steel wire and a screw type anchor with a thimble and a performed grip. All items shall be galvanized and the guy wire may be so designed as to withstand the load of the angle effect and conductor tension with a factor of safety of more than 2.5. The design calculation and drawings of guy wires shall be submitted by the Contractor for approval.

Guy wires shall be galvanized steel not less than 8 mm in diameter (50 mm^2).

45202.10 Grounding Materials

Grounding rods shall be made of copper clad steel rods and provided with copper lead wires. The lead wire shall be 8 mm^2 in size of 1.5 m in length. The size of rod shall be 19 mm in diameter and 3 m in length.

Insulated grounding wire of 8 mm^2 copper wire shall also be supplied to connect other metal part to the grounding rods.

45202.11 Cross Arm, Band and Others

Pole band for fixing cross arms, arm ties and pole anchors shall also be supplied. All bands shall be made of galvanized steel, and shall meet standard ASTM AI 23.

45202.12 Foundation

The setting depth shall be so designed that the overturning load may be supported with a factor of safety of no less than 2.0, but in no case shall be less than 1/6 of total length of the pole.

The properties of soil for design of supports shall be assumed as follows:

Ultimate soil bearing capacity : 20 t/m^2

Weight of soil : 1.5 t/m^3

Angle of inverted pyramid of soil acting against uplift force of stay anchor plate:

15 degrees from the direction of anchor.

Where required, support foundations shall be reinforced with concrete logs or by wrapping concrete around the concrete poles. The design calculation and drawings for the foundation shall be submitted by the Contractor to the Engineer for approval.

45203 46 KV Switchgear

45203.1 Circuits and Equipment

The Contractor shall furnish the 46 KV switchgear equipment in accordance with the following requirement:

- One (1) circuit breaker
- One (1) 3 pole disconnecting switch
- Three (3) current transformers
- Three (3) potential transformers
- Three (3) lightning arresters

45203.2 Circuit Breaker

1) Type

Three-pole, single-throw, high speed, outdoor, SF6 gas type, trip-free in any position, 60 Hz, complete with secondary air reservoir, piping, conduit, wiring and any other accessories needed for operation.

2) Rating

Rated voltage	52 kV
Basic impulse level	250 kV
Rated continuous current	400 A
Rated breaking current	25 kA
Breaking time	60 ms
Rated operating sequence	0 – 0.3 s – CO – 3 min – CO
Control circuit voltage	125 V DC

3) Operating mechanism

The circuit breaker shall be provided with a motor charged spring operating mechanism for remote electric controls and local manual controls.

4) Control cabinet

Control cabinet of the circuit breaker shall be moisture-proof and provided with suitable heaters to prevent moisture condensation. The cabinet shall have a blank, accessible steel door with gasket. The lead wires and cables shall enter the cabinet from the bottom.

5) Accessories

The following items shall be provided:

- Name plate
- Position indicating lamps
- 10-stage auxiliary switch
- Counter to record the frequency of operation
- Necessary terminal connections with clamp type terminal
- Grounding terminal
- Supporting structure
- One set of maintenance tools
- Other necessary accessories

6) Spare parts

The following parts shall be supplied:

- One (1) set of closing coil
- One (1) set of tripping coil
- One (1) set of gasket of each type
- 300% of actual use of signal lamp and fuses
- One (1) set of small components consisting of contacts, coils, relay, etc. for control gear recommended by manufacture.

7) Test

The following tests shall be carried out at the Contractor's shop:

- Construction test
- Power frequency withstand voltage test
- Operation test
- Temperature rise test (Certificate of type test may be acceptable)
- Millivolt drop test (Certificate of type test may be acceptable)
- Impulse voltage test
- Rupturing capacity test (Certificate of type test may be acceptable)

45203.3 Three-pole Disconnecting Switch

1) Type

The disconnecting switch shall be of three-pole, single throw, outdoor, gang-operated, horizontal-break, rotating insulator type.

2) Rating

Rated voltage	52 kV
Rated continuous current	400 A

3) Accessories

The following items shall be provided:

- Name plate
- 3-stage auxiliary switch for position indication and interlock
- Hand operating set
- Necessary terminal connection with clamp type terminal
- Grounding terminals
- Other necessary accessories

4) Spare parts

The following item shall be supplied

- 300% actual use of lamps

5) Tests

The following tests shall be carried out at the Contractor's shop:

- Construction test
- Operation test
- Power frequency withstand voltage test
- Measurement of resistance
- Temperature rise test (Certificate of type test may be acceptable)
- Impulse voltage test
- Short-time current test

45203.4 Current Transformer

1) Type

Oil immersed, outdoor double core type for measuring instrument and protective relays.

2) Rating

Highest system voltage	52 kV
Rated burden	40 VA
Current ratio	100/5 A x 2
Accuracy class	1.0 class for measuring, 5P20 for protection
Over current strength	40 times for 1 s

3) Accessories

The following items shall be provided for each current transformer:

- Name plate
- Oil level gauge or window
- Oil valves or plugs
- Necessary terminal connections with clamp type terminals
- Grounding terminal
- Other necessary accessories

4) Tests

The following tests shall be carried out at the Contractor shop:

- Construction test
- Ratio and phase error
- Polarity test
- Power frequency withstand voltage test
- Impulse voltage test
- Opening test of the secondary circuit
- Over voltage inter-turn test
- Short-time current test (Certification of type test may be acceptable)
- Temperature rise test

45203.5 Potential Transformer

1) Type

Single phase, oil-immersed, outdoor type

2) Rating

Primary voltage	46 KV/√3
Secondary voltage	120 V
Rated burden	400 V
Accuracy	1.0 class

3) Accessories

The following items shall be provided for each potential transformer:

- Name plate
- Oil level gauge or window
- Oil valves or plugs
- Necessary terminal connection
- Grounding terminal
- Other necessary accessories

4) Tests

- Construction test

- Ratio and phase
- Polarity test
- Power frequency withstand voltage test
- Impulse voltage test
- Temperature rise test

45203.6 Lighting Surge Arresters

1) Type

Outdoor type, zinc oxide gapless. Standard ANSI C62-2

2) Ratings

Rated voltage	48 kV
Normal discharge current	10 kA
Impulse withstand voltage	250 kV
Maximum discharge voltage	31 kV (peak) at 10 kA

3) Accessories

The following accessories shall be provided for each lightning arrester:

- Name plate
- Operation counter
- Discharge current recorder
- Necessary terminal connections with clamp type terminals
- Other necessary accessories

4) Tests

The following tests shall be carried out at the Contractor's shop:

- Construction test
- Power frequency spark-over voltage test
- Impulse spark-over voltage test
- Insulation resistance measurement
- Leakage current test

45204 46 KV Outdoor Structure

45204.1 General

The Contractor shall finish all structures, and steel framework of switchgear equipment excluding framework of circuit breaker. The erection work at site shall be carried out by the Contractor.

The post structure and frameworks shall be located in accordance with the layout shown on the Drawing. The outline of the post structure and frameworks may be varied slightly in accordance with the specification of the switchgear equipment.

All complete foundation drawings which other contractor can easily perform the foundation works for them shall be submitted for approval of the Engineer.

45204.2 Detail of Design

The steel structures and framework shall be designed in accordance with the

following requirement:

1) Vertical loading

The weight of the conductors, ground wires, insulator strings and structure/framework themselves shall be considered.

2) Wind load

On conductors and ground wires : 69 kg/m^2 on project area

On insulators and all other circular section : 130 kg/m^2 on project area

3) Working tension of conductor and ground wire

Conductors : 600 kg for 46 kV bus and slack spans

4) Seismic coefficient : 0.12

5) Factor of safety

The structures shall be designed so that no failure or permanent distortion shall occur when the load equivalent to 1.5 times the maximum simultaneous working loads are applied.

6) Slenderness Ratio

The slenderness ratio shall not exceed 200 for main and 220 for web member and 250 for nominal members as compression member and 400 for tension member.

7) Member size

No leg members less than 5 mm in thickness and 60 mm in width of flange for main, and 3 mm in thickness and 45 mm in width of flange for web and nominal shall be used.

8) Bolts and nuts

All the members shall be connected by bolts and nuts. The size of the connection bolts shall be more than 16 mm for leg member and 12 mm for web member. The suitable anchor bolts shall be provided. The size of step bolts shall be 16 mm.

The Contractor shall submit full details and drawings for the steel structure and steel frameworks to the Engineer for approval prior to commencing fabrication.

45204.3 Foundation

The concrete foundation for steel structure and steel framework will be placed by the other contractor under the Contractor's supervision, and the Contractor shall submit the necessary design drawings with calculation for foundation for approval.

Safety factor of concrete for uplifting force shall not be less than 2. The allowable bearing strength of earth shall be assumed to be 40 t/m^2 for 46 kV switchyard. The weight of earth shall be assumed to be 1.5 t/m^3 and weight of concrete to be 2.3 t/m^3. The angle of repose will be reckoned as 20 degrees for 40 t/m^2 bearing strength of earth. The seismic coefficient shall be taken as 0.12.

45204.4 Materials
All steel employed for the structures and frames shall have high yield point and high ultimate tensile strength and shall meet ASTM A36 and ASTM A572. All the materials shall be subject to approval of the Engineer.

45204.5 Workmanship
The cutting, drilling, punching and bending of all fabricated steel work shall be in accordance with the best practice for material being used and subject to approval of the Engineer. Diameter of bolt holes shall not be more than 1.5 mm larger than diameter of bolts.

All members shall be hot dip galvanized after fabrication. Bolts and nuts shall also be galvanized. All members shall be stamped or marked in an approved manner with numbers and/or letters corresponding to number and/or letters on drawings or material list approved by the Engineer.

45204.6 Tests
The following tests shall be carried out before shipment:

- Mechanical strength of material
- Galvanizing test
- Shop assembly

45205 46/4.16 KV Transformer

45205.1 Type and Ratio
The transformer shall be of 3-phase, oil immersed, self-cooled, outdoor use type and the no-load ratio of delta-star connection shall be 48.3F-46R-43.7 kA to 4.16 kV.

The connection shall be arranged in accordance with vector symbol Dy1 of IEC Publication 76, 1967, and neutral of star connection winding shall be grounded through neutral grounding resistor.

45205.2 Frequency
The transformer shall be designed for a frequency of 60 Hz.

45205.3 Output
The continuous rated output of the transformer shall be 4,000 kVA on any taps

45205.4 Temperature Rise
The maximum temperature rise shall not exceed the following value at the rated output:

60°C in oil by thermometer

65°C in winding by resistance thermometer

45205.5 Insulating oil
Insulating oil shall be of non-slugging and of medium viscosity. The characteristics of oil to be used shall conform standard B.S.A. No. 148, as Shell Diala D or equivalent available in El Salvador.

The transformer shall be supplied with the first filling of oil and ten percent of extra oil in sealed non-returnable drums.

45205.6 Insulation Level

1) 46 kV side

Full wave impulse	250 kV for 1.2 x 50 micro-second
Chopped wave impulse	290 kV
Power frequency	95 kV for one minute

2) 4.16 kV side

Full wave impulse	75 kV for 1.2 x 50 micro-second
Chopped wave impulse	88 kV
Power frequency	19 kV for one minute

45205.7 Impedance Voltage

Impedance at the rated KVA shall be more than 6.0 % for the purpose of suppression of short circuit for secondary fault.

45205.8 Core

The transformer core shall be built up of thin laminations of the best quality non-aging silicon steel. Lamination shall be coated with an insulating material and clamped securely with insulated bolts.

The design of core and the method of clamping shall be such as to ensure it free from excessive noise and vibration. The clamping framework shall be built up of structural steel members. The cores shall be provided with lifting eyes or other approved arrangements to permit easy and ready dismantling, and so designed that core and windings can be lifted from the tank with as little dismantling as possible.

To ensure efficient cooling, each core shall be provided with oil ducts. Suitable means shall be adopted to prevent circulating being set up within the core. The cores and windings shall be so located within the tank as to prevent movement. The cores shall be electrically connected to the transformer tank

45205.9 Windings and Insulation

The windings shall be of high conductivity copper. The amount of insulation shall be determined not merely by normal voltage per turn, but also by dueconsideration of the line voltage and the service conditions, including impulse phenomena caused by lightning strokes on transmission line and surges during switching and fault conditions.

The insulation of the end turns of each winding adjacent to the transformer terminals shall be reinforced between turns or provided with suitable means to protect the winding against surges and transients. The primary and secondary windings shall be designed that they remain electrically balanced with their magnetic centers coincident under all conditions of operation. The windings shall be so arranged and so firmly clamped in position that they will withstand the mechanical stresses to which they might be subject on short circuit.

Provision shall be made for taking up any contraction due to shrinkage to eliminate movement of any coil due to short circuit, vibration or other sources of disturbance. All windings, after being wound, and all fibrous and hygroscopic material used in the construct of transformer shall be dried under vacuum and impregnated with hot oil.

Adequate provision shall be made for the circulation of the oil round and the windings, so that a very low temperature gradient between the conductors and the oil shall be assured and any danger of excessive local heating shall be eliminated. Spacing blocks shall be provided between section of the windings to ensure radial

circulation of the oil and to ensure that the windings present a sufficient contact surface to the oil.

The general design and construction of the transformer and the bracing of the windings shall be such that no mechanical movement of the coil is possible as result of the dead short circuit on any side of the transformer. The transformer shall withstand, without injury, the dead short circuit for duration of at least two seconds.

45205.10 Tank

Core and windings shall be enclosed and securely held in a tank made of stout steel plates. The tank shall be of welded construction, suitably stiffened by means of channel or angle section welded to the tank, and shall be absolutely water and hot oil tight and suitable for vacuum drying. It shall be designed to permit convenient handling. Necessary lugs and shackles shall be provided to enable the whole transformer to be lifted bodily by a crane or other means. They shall be so located that safe clearance is obtained between the slings and transformer bushing without use of a spreader.

The base of transformer shall be provided with jack steps or recesses to permit the use of jacks and shall have pulling eyes on all four sides. The tank cover shall be designed so that the bushings can be easily removed and connections to the windings easily made. The inside of the tank and all steel connections shall be sand or shot blasted. All mill scale shall be completely removed from the outside of the tank before painting. Two suitable grounding pads shall be welded to the base of the tank

45205.11 Bushing

The bushings for 46 kV side shall be of oil filled or condenser type and the bushings for 4.16 kV side shall be of solid type. The color of bushing shell shall be brown and the glazed surface shall be free from bulges, hair lines cracks and other defects. The glaze shall be uniform throughout the surface.

The terminal of following bushing shall be bolted with clamp type terminal for the following conductors:

46 kV side	: 100 mm^2 copper stranded wire
4.16 kV side	: 1C 400 mm^2 power cable

45205.12 Cooling System

The transformer cooling system shall consist of radiators. The radiator shall be fitted directly to the tank. These shall be provided with radiator valves, lifting eye and necessary accessories

45205.13 Oil Conservator

The transformer shall be supplied with a conservator of atmosphere sealed type with oil resistant rubber diaphragm fitted with an oil level indicator and a silica gel breather of suitable size or equivalent approved by the Engineer. It must be possible to inspect the silica gel through a glass window or alternately the container shall be made of glass.

45205.14 No-load Tap Changer

No load tap changer shall be set manually, after switching off the transformer. They shall have an indicator window on the gear box for the position of the tap.

45205.15 Neutral Grounding Resistor

Neutral point of the transformer shall be grounded through a grounding resistor. The

neutral grounding resistor shall be rated as follows:

Resistance at 20°C:	12 ohms ±7%
Rating voltage:	2,400 V
Rating current:	200 A
Service time:	10 seconds
Frequency:	60 Hz

45205.16 Protection

The following protection shall be provided:

- Buchholtz relay protection
- Temperature non-trip alarm (top oil and winding)
- Oil level non-trip alarm

Buchholtz relay shall be fitted on between the consevator and the tank with alarm and trip contacts suitable for 125 V DC, and isolating valves shall be inserted on the both side of Buchholtz relay. The relay shall be equipped with a testing cock and a gas release cock.

Dial type indicating thermometer calibrated in centigrade, equipped with alarm contacts suitable for 125 V DC, shall be supplied for indicating the temperature of top oil. The transformer shall be provided with a temperature detector of 100 ohm at 0°C for connection to 46 kV winding temperature indicator in the control room.

45205.17 Skid Base

The transformer shall be provided with skid base, necessary devices for setting, and appropriate devices for locking on the foundation.

45205.18 Other Accessories

The following accessories shall be provided with the transformer:

- Combined type oil drain, filtering and sampling valves with screwed cap
- Explosion vent
- Name plate and connection diagrams with full details of rating in Spanish
- Manhole and handhole
- A ladder on the side of tank to provide access for safe inspection. The lower section of the ladder shall be equipped with a barrier and locking device to prevent its use by unauthorized persons.
- Terminal box mounted on the tank containing the terminals for connections of all alarm contacts and controls. The space below the control housing shall be kept free of obstructions, which would interfere with conduit connections.
- Two clamp type ground connectors
- Other necessary accessories

45205.19 Spare Parts

- One set of gaskets
- Two bursting plates
- One dial type thermometer
- One oil level gauge
- Other necessary spare recommended by the manufacturer

45205.20 Tests

The following tests shall be carried out at the Contractor's shop in compliance with this Specification:

- Ratio (on all tapping)
- Polarity and phase relationship
- Resistance of both windings at each tap
- No-load current and losses
- Load losses at rated current
- Impedance voltages at rated current on the tapping corresponding to the service voltage
- High voltage test
- Impulse tests of full wave and chopped wave
- Temperature rise test

After completely assembling transformer at site, the following commissioning test shall be carried out:

- High voltage test (IEC No. 270 or similar)

  In order to confirm whether the transformer has any troubles or not in erection work, following voltage shall be applied:

46 kV side	59 kV (130%), 30 minutes
4.16 kV side	5.2 kV, (130%), 10 minutes

- Measurement of insulation resistance
- Polarity and phase relationship
- Noise level test (IEC publication No. 551)
- Oil sample test (VDE 0370.10.66)

SECTION 45300 EMERGENCY POWER GENERATING EQUIPMENT

45301 General

45301.1 Number and Capacity

Two 1,000 kVA diesel engine generator unit complete with necessary switchgear and control equipment, accessories and material shall be provided to supply electric power for emergency.

45301.2 Location

The diesel engine generating unit shall be installed in the generator room of the Power Supply Station.

45301.3 Construction

The diesel engine and generator shall be interconnected to form a single unit. The unit shall be mounted on girder frame by using a vibration damping rubber suspension so that the diesel generating unit can be placed directly on the floor and no special foundation work is required.

45301.4 Ambient Condition

The generating unit shall be designed for operation of maximum 40°C ambient temperature, 0 m site altitude above sea level and 90 % humidity.

45301.5 Scope of Supply

The contractor shall supply and install emergency generating unit, consisting of :

1) Diesel engine generator
   - AC generator
   - Diesel engine
   - Cooling and ventilation equipment
   - Exhaust system
   - Daily fuel tank system
   - Starting and supply equipment
   - Generator control panel
   - Engine control panel

2) Switchgear and control cubicle
   - Switchgear and control cubicle
   - Generator control panel

3) Fuel Tank

45302 Diesel Engine Generator

45302.1 Generator

The generator shall be 3-phase, 3-wire, revolting field type with damper winding, self-excited, self-ventilated open type, single bearing synchronous alternator. The rating of the generator shall be 4.16 kV, 60 Hz, 0.8 lagging, 1,000 kVA continuous output and shall be directly connected and flange-mounted to engine. Insulation shall be Class "F".

The excitation current shall be controlled by both voltage and current of the generator through rectifiers to have compound characteristics. The automatic voltage regulator shall be provided for the excitation system, capable of controlling voltage

within ±1.5 % from no load to full load.

The maximum temperature rise of the generator shall not exceed the following:

Stator winding (by thermometer)	: 85°C
Rotor field winding (by thermometer)	: 85°C
Bearing	: 40°C

45302.2 Diesel engine

The diesel engine shall be of the full compression ignition vertical cylinder, single acting, 4-cycle, solid injection, water-cooled type. The cooling water jacket of engine shall be designed for safe operation at maximum water pressure of 5 kg/cm^2. The engine shall not require premium fuel for satisfactory performance.

The diesel engine and generator shall be placed on a common bed plate. Continuous output of diesel engine generator unit shall be guaranteed to be 1,000 kVA at generator terminals, under the climatic condition and at the engine speed of 1,800 rpm. The diesel engine shall be automatically started by a starter motor when the normal electricity supply is cut off and manually stopped. The diesel engine shall be stopped automatically and locked when fault happens. The diesel engine shall be equipped with fuel, lubrication oil, intake air filters, lubrication oil cooler, gear driven fuel transfer pump, fuel priming pump, gear driven cooling water pump, cooling water temperature controls and starting motor.

45302.3 Cooling and ventilation equipment:

The generating set shall be designed with a cooling radiator and an electric motor driven fan for cooling of the diesel engine and the machine room. The water-cooled radiator may be mounted directly to the engine. Protection guards to be installed. The water-cooled radiator shall be fitted with canvas bellows for connection to a galvanized channel. The expansion tank for cooling liquid shall be mounted on the engine and shall be provided with a liquid level-switch and level-indicator.

45302.4 Exhaust system

The exhaust system shall incorporate silencers suitable for use in an industrial area and shall include all necessary supports and other items to make a complete installation.

Exhaust tubing shall be heavy gauge mild steel to the latest standards, and shall include a stainless steel bellows close to the engine to reduce vibration and permit engine movement.

The system shall be suspended from the walls and roof by suitable brackets and angle ties, which shall include mountings to prevent the transmission of vibration and noise to the building.

45302.5 Daily Fuel Tank System

The base frame shall incorporate a fuel tank with a capacity of 1,500 liters, complete with contents indicator, fuel fill up with breather, fuel feed and return lines to engine and drain plug. Tank shall be 100% fill at Take Over moment.

45302.6 Starting and supply equipment

A 24 V DC starting system, comprising axial starter lead-acid batteries of ample capacity supplied dry charged as standard. A charging rectifier for charging shall be included. Capacity of the system shall be for at least 3 restarts.

45302.7 Engine Control Panel

The following meters, gauges and other control equipment shall be mounted on the engine operating panel:

- One tachometer (provided with integrating time meter)
- One oil pressure gauge
- One water temperature gauge
- One oil temperature gauge
- One fuel gauge
- One charging ammeter
- One battery switch
- One starter switch
- One preheat switch
- One preheat lamp
- One stop button
- One throttle handle
- One OK monitor

45303 Switchgear and Control Cubicle

45303.1 Switchgear and Control Cubicle

The control cubicle for two-unit diesel engine generator shall be provided. The cubicle shall be of sheet metal dead front, indoor type, floor mounted and self standing. The panel-mounted equipment and devices shall include, but not be limited to, the following:

- Instruments for measuring of current, voltage, frequency, cooling water temperature, lubricating oil pressure, fuel level and running time
- Selector switch for manual/automatic/test-operation
- Manual starting/stopping equipment
- Automatic change-over control for testing (synchronized parallel operation during a few cycles, without distortion for connected loads).
- Electronic measuring unit for speed which disengages the starting motor, initiates the voltage recovery, blocks the protective system and switches off the stopping coil after a stop
- Protective system for motor and generator and circuits for blocking the plant in

the event of a fault occurring

- The central unit for signaling shall be of the flag relay type with separate outgoing contacts for remote indication and local alarm. The alarm shall be separately cancelled. The signal relays are to be reset with a common push-button
- Fuses for operating, indicating and measuring circuits
- Electronic voltage regulation
- Current transformers connected to the extended neutral of the generator
- Generator contactor
- Terminal blocks for outgoing cables
- Equipment for monitoring the main supply for automatic starting, stopping and manual testing
- Time-lag relays for delayed starts, stops and for idling
- Main contactor

45303.2 Generator Control Panel
The following meters and apparatus shall be mounted on the generator control panel:

- One frequency meter
- One AC voltmeter with selector switch
- One AC ammeter with selector switch
- One voltage regulator
- One circuit breaker (3-phase mold case circuit breaker)
- One pilot lamp
- One panel light
- One light switch

45304 Fuel Tank

45304.1 Capacity
The fuel tank shall be designed to provide the volume of fuel oil consumed for operating both diesel engine generators during 15 hours at 100% load.

45304.2 Location
The fuel tank shall be laid under the ground of outside adjacent the generator room.

45304.3 Piping
The piping shall be complete with fuel feed and return line to engines, drain plug, contents indicators and fuel fill up with breathers. Tank shall be 100% fill at Take Over moment.

45304.4 Foundation Work

The foundations are part of this contract.

SECTION 45400 POWER DISTRIBUTING EQUIPMENT

45401 General

45401.1 General

This Clause covers the design, manufacture, testing before shipment, transportation to site, installation/erection and performance test at the Site of the followings:

- 4.16 kV switchgears
- 4.16/0.48 kV transformers
- 480 V switchgears
- 4.16/0.208-0.12 kV transformer
- 208-120 V switchgear
- Control switchboard
- Storage battery

45401.2 Location

Switchgear shall be installed in the switchgear room, and the transformer shall be installed in the transformer room of the Power Supply Station.

45402 4.16 KV Switchgears

45402.1 Circuits and Equipment

The Contractor shall furnish and install a self-supporting indoor type metal-enclosed cubicle, consist of the following equipment:

- One (1) set of 3-phase buses
- One (1) set of transfer switch
- Eight (8) set of Circuit breakers
  - One for incoming line from 46/4.16 kV transformer
  - Two for incoming line from diesel engine generators
  - Two for gantry crane feeder
  - Two for 4.16/0.48 kV transformers
  - One for 4.16/0.208-120 kV transformer
- Twenty seven (27) current transformers
- Fifteen (15) Zero-phase current transformers
- Three (3) potential transformers
- Other necessary accessories

45402.2 Three-phase Bus

Three-phase, three-wire copper bus shall be of 4,160 volts, 60 Hz and 1,200 A. The bus shall withstand 29 kA current for one second under fault conditions without mechanical and thermal failure. All bolted joints shall be silver-plated. The bus supports shall be non-hygroscopic, flame retardant, track resistant material.

45402.3 Circuit Breaker

1) Type

Three-pole, single throw, draw out, vacuum type. Trip free in any position with anti-pumping feature, 60 Hz, complete with conduit, wiring and any other accessory needed for operation.

2) Rating

Rated voltage	4.76 kV
Basic impulse level	60 kV
Rated continuous current	1200 A
Rated breaking current	29 kA
Breaking time	5 cycles
Operating duty cycle	0 – 1 min – CO – 3 min – CO
Control circuit voltage	125 V DC

3) Operating Mechanism

The circuit breaker shall be provided with remote electric and local manual control and shall be of 125 V DC motor-operated spring charged type.

4) Auxiliary Switches

The breaker auxiliary switches shall have sufficient contacts for all controls and interlocks plus two sets of spare contacts (one normally open and one normally close).

5) Control Supply Protection

Fuses and knife switches or molded case circuit breakers shall be provided in the DC supply to each unit of the switchgear.

6) Wiring

Secondary wiring in high voltage compartments shall be protected as far as practical with grounded metal covers, conduit or sheath.

7) Spares

- One set of moving and fixed contacts for 3-phases of each rating
- One set of closing coil
- One set of tripping coil
- Other necessary spares recommended by the manufacturer

8) Tests

- Construction test
- Power frequency withstand voltage test
- Operation test
- Temperature rise test (Certificate of type test may be acceptable)
- Milivolt drop test (Certificate of type test may be acceptable)

- Rupturing capacity test (Certificate of type test may be acceptable)

45402.4 Current Transformers

1) Type

Dry type for measuring instruments and protective relays

2) Rating

Highest system voltage	4.76 kV
Current ratio	1200/5 A
Accuracy	High accuracy, only for bus side of 46/4.16 kV transformer line
	Standard accuracy for exception of above
Rated burden	40 VA
Over current strength	40 times for 1 s

3) Accessory

The following items shall be provided:

- Name plate
- Necessary terminal connections
- Grounding terminal
- Other necessary accessories

4) Tests

The following test shall be carried out at the Contractor's shop:

- Construction test
- Ratio and phase error
- Polarity test
- Power frequency withstand voltage test

45402.5 Zero-phase Current Transformer

1) Type

Dry mould, penetration type for cable with testing lead wire for protective relay

2) Ratings

Highest system voltage	4.76 kV
Rated primary current	1200 A
Zero phase current ratio	50/5 A
Accuracy	H class
Rated burden	10 ohm

3) Accessories

- Name plate

- Necessary terminal connections
- Grounding terminal
- Other necessary accessories

4) Tests

Same as Sub-section 45402.4

45402.6 Voltage Transformer

1) Type

Three phase, dry mould type.

2) Ratings

Primary voltage	4200 V
Secondary voltage	120 V
Rated burden	40 VA
Accuracy	1.0 class

3) Accessories

- Name plate
- Necessary terminal connections
- Grounding terminal
- Other necessary accessories

4) Tests

- Construction test
- Ratio and phase error test
- Polarity test
- Power frequency withstand voltage test

45403 4.16/0.48 KV Transformer

45403.1 Type and Ratio

The transformer shall be of two 1,000 kVA, oil immersed, self-cooled, indoor use type and the no-load ratio of delta star connection shall be 4.37F-4.16R-3.95 kV to 480 V for three phase, three-wire system of 60 Hz.

45403.2 Output

The continuous rated output of the transformers shall be 1,000 kVA on any taps

45403.3 Impedance

The impedance at the rated kVA shall be more than 4.5 % for the purpose of suppression of short circuit current for the secondary fault.

45403.4 Temperature rise

The maximum temperature rise for winding shall not exceed the following value under the rated output, with resistance measurement:

For class B insulation	80° C
For class F insulation	100° C

For class H insulation 125° C

45403.5 Frequency
The transformer shall be designed for a frequency of 60 Hz.

45403.6 Insulation level
The transformers shall withstand the following power frequency voltages for one minute:

For 4.16 kV side	19 kV
For 480 V side	4 kV

45403.7 Core
The transformer cores shall be built up of thin laminations of the best quality non-aging silicon steel. Lamination shall be coated with an insulating material and clamped securely with suitable method. The design of the core and the method of clamping shall be such as to ensure it free from excessive noise and vibration. The clamping framework shall be built up of structural steel members. To ensure efficient cooling, core shall be provided with air duct. The core shall be electrically connected to the transformer base.

45403.8 Winding and Insulation
Full insulation shall be applied on all windings. The windings shall be of high conductivity copper and shall be insulated with insulation material of Class B, F or H. The amount of insulation shall be determined not merely by normal voltage per turn but also by due consideration of the line voltage and the service conditions including surges during switching and fault conditions. The insulation of the end turns of each winding adjacent to the transformer terminals shall be reinforced between turns or provided with suitable means to protect the winding against surges and transients.

The winding shall be so arranged and so firmly clamped in position that they will withstand the mechanical stresses, to which they might be subject on short circuit. Provision shall be made for taking up any contraction due to shrinkage to eliminate movement of any coil due to short circuit, vibration or other sources of disturbance. Adequate provision shall be made for the circulation of cooling air around and between the windings, so that a very low temperature gradient between the conductors and air be assured, and any danger due to excessive local heating be eliminated.

The general design and construction of the transformer and the bracing of the windings shall be such that no mechanical movement of the coil is possible as result of the dead short circuit on any side of the transformer. The transformer shall withstand, without injury, the dead short circuit for duration of at least two seconds.

45403.9 Terminals
Each terminal shall be bolted with compression type terminal for cross linked polyethylene insulted cables (XLPE), as follows:

4.16 kV side : One (1) set of compression type terminals of 60 mm^2, three-core cross linked polyethylene insulated cable

480 V side : 2 x 400 mm^2 single-core for each phase

Suitable compression supporting device shall be provided.

45403.10 Frame and Barrier

Core and windings shall be securely held in stout steel frames. They shall be so designed as to permit convenient handling. Necessary lugs and shackles shall be provided to enable the transformer to be lifted bodily by a crane or other means in a minimum of outage of other remaining two transformers without removing them from the locations as they are. Safe clearance shall be obtained between the slings and terminals without use of a spreader. Two grounding pads for 55 mm^2 copper conductor shall be welded to the base of the frame on each transformer.

45403.11 Tap Changer

The non-voltage tap changer shall be provided on 4.16 kV side with taps at 4.37F kV, 4.16R kV and 3.95F kV. The tap changer shall be capable of operating under non-voltage condition from the outside of the transformer. Tap position must be clearly indicated and means of locking shall be provided. All taps shall be rated for full output.

45403.12 Protection and Alarm

The following protection and alarm shall be provided:

Protection	: Over current protection
Alarm	: Temperature, high

A dial type indicating thermometer calibrated in centigrade and equipped with alarm contacts suitable for 125 V DC operating shall be supplied for indicating the temperature of winging. The transformer shall be provided with a temperature detector of 100 ohm at 0° C platinum for connection to alarm and indicator circuit in the switchgear room.

45403.13 Wheel

Roller wheels of bi-directional type shall be equipped on the transformer base. The transformers shall be locked after positioning on their foundations by means of appropriate devices, which stand against a mechanical impact of 0.12 G.

45403.14 Accessories

The following accessories shall be provided with each transformer:

- Name plate, colored phase marks and connection diagrams with full details of rating in Spanish
- Terminal box mounted on the support containing the terminals for connections of all alarm contacts and controls
- Clamp type ground connectors, two for the transformer
- One set of copper bar with support for grounding bus
- ne lot of cable support
- Other necessary accessories.

45403.15 Spare Parts

The following items shall be finished and quoted as spares:

- One dial type thermometer

- One thermometer

- One set of spares recommended by the manufacture

45403.16 Tests

The following test shall be carried out at the manufacture's shop in the presence of the Engineer, in compliance with this Specification:

- Ratio on all taps

- Polarity and phase relationship

- Resistance of both winding at each tap

- No-load current and losses

- Load losses at rated current

- Impedance voltages on all taps

- Temperature rise test

- High voltage test

After installing the transformers at site, the completion and commissioning test shall be carried out.

45404 480 V Switchgear

45404.1 Circuits and Equipment

The Contractor shall furnish one set of self-supporting type metal-enclosed cubicle assembly for reefer, area lighting, service outlet in each berth and other. The cubicle shall consist of two groups connected with tie circuit breaker.

The following apparatus shall be mounted inside the cubicle for No. 1 Group:

- One (1) set of 3-phase bus

- One (1) air circuit breaker

- Three (3) current transformers

- Three (3) single-phase potential transformers

- Nine (9) molded case circuit breakers

For No.2 Group, the following apparatus shall be mounted, including tie circuit:

- One (1) set of 3-phase bus

- Two (2) air circuit breaker

- Three (3) current transformer

- Three (3) single phase potential transformers

- Seven (7) molded case circuit breaker

45404.2 Three-phase Bus

Three-phase, three-wire copper bus shall be of 600 volts, 60 Hz and 2,000 A. The bus shall withstand 65 kA current for one second under fault conditions without mechanical and thermal failure. Oil or compound filled bus will not be acceptable. All bolted joints shall be silver-plated. The bus supports shall be of non-hygroscopic, flame retardant, track resistant material.

45404.3 Air Circuit Breaker

1) Type

The circuit breaker shall be of three-pole, single throw, draw-out type, trip-free in any position, with anti-pumping feature, complete with controls and wirings and other accessories needed for operation.

2) Ratings

The circuit breaker shall be rated as follows:

Rated voltage	600 V
Rated frequency	60 Hz
Rated continuous current	2000 A
Rated interrupting current	65 kA
Control circuit voltage	125 V DC

3) Operating mechanism

The circuit breaker shall be electrically remote controlled from the control board and locally by manual control. The circuit breaker shall open automatically in cases of over-current and under-voltage. The circuit breakers shall be electrically interlocked each other.

4) Test

The following tests shall be carried out at the manufacturer's shop before shipment:

- Construction Check
- High voltage test
- Operation test

The data for the following tests shall be submitted with the test report:

- Mechanical endurance test
- Impulse voltage test
- Interrupting capacity test

After installing the transformers at site, the completion and commissioning test shall be carried out.

45404.4 Current Transformer

1) Type

The current transformers shall be of dry molded type

2) Ratings

The current transformers shall be rated as follows

Maximum voltage	600 V
Current ratio	2,000/5 A
Rated burden	40 VA
Accuracy	1.0 class
Over-current strength	65 kV for one seconds
Over-current constant	more than 20

3) Accessories, spares and tests

Accessories, spares and tests shall be provided in accordance with Sub-section 45402.5

45404.5 Potential Transformer

1) Type

The potential transformers shall be of single-phase, dry molded type.

2) Ratings

The potential transformers shall be rated as follows:

Insulation class	600 V
Primary voltage	480 V
Secondary voltage	120 V
Rated burden	40 VA
Accuracy	1.0 class

3) Accessories, spares and tests

Accessories, spares and tests shall be provided in accordance with Sub-section 45402.6.

45404.6 Molded Case Circuit Breaker

Molded case circuit breakers shall be of three-pole, 600 volts. The rated frame currents shall be 800 A. The rated interrupting current shall be more than 65 kA.

45404.7 Cubicle and Terminations

1) Construction

The following apparatuses shall be mounted on the front side of each 480 V switchgear cubicle:

- One (1) set of position indicating lamps (red and green)
- One (1) ammeter with selective switch
- One (1) voltmeter with selective switch
- One (1) under-voltage relay
- One (1) over-current relay

The cubicles shall have the suitable cable terminal compartments for cross-linked polyethylene insulated PVC sheathed power cables as stated bellows:

a) For No. 1 Group

- 6 x 400 mm^2 single-core for 1,000 kVA transformer's secondary
- 100 mm^2 three-core for service outlet for crane in Container Berth
- 60 mm^2 three-core for service outlet for ship in Container Berth
- 60 mm^2 three-core for service outlet for crane in Multipurpose Berth
- 60 mm^2 three-core for service outlet for ship in Multi-purpose Berth
- 100 mm^2 three-core for service outlet for ship in Passenger Berth
- 38 mm^2 three-core for flood light (T1, T2, T3, T4)
- 60 mm^2 three-core for flood light (T5, T6, T7, T8)
- 22 mm^2 three-core for flood light (T9, T10, T11, T12)
- 22 mm^2 three-core for flood light (T13, T14, T15, T16)

b) For No. 2 Group

- 6 x 400 mm^2 single-core for 1,000 kVA transformer's secondary
- 100 mm^2 three-core for reefer outlet (R1, R2, R3, R4)
- 100 mm^2 three-core for reefer outlet (R5, R6, R7, R8)
- 22 mm^2 three-core for street light, essential load
- 22 mm^2 three-core for street light, non-essential load
- 100 mm^2 three-core for Port Administration Building
- 100 mm^2 three-core for Container Freight Station

The power cables shall be furnished and connected under Section 45500. Suitable means shall be provided for supporting the terminal and cables.

2) Tests

The following tests shall be carried out at the manufacturer's shop before shipment:

- Construction check
- Operation test
- Sequence test
- Dielectric test

After installing the transformers at site, the completion and commissioning test shall be carried out.

45404.8 Accessories

The following items shall be provided on each equipment as applicable

- Name plate
- Necessary terminal connection
- Grounding terminal
- Other necessary accessories

45404.9 Spare Parts
The following parts shall be furnished:

- One (1) set of fixed and moving contacts of the air circuit breaker
- Three (3) sets of closing coils of the air circuit breaker
- Three (3) sets of tripping coil of the air circuit breaker
- 500 % of actual use of indicating lamps and fuses
- 200 % of control components
- One (1) set of molded case circuit breaker of each type and rating
- One (1) set of other spares recommended by the manufacturer

45405 4.16/0.208-0.12 kV Transformer

45405.1 Type and Ratio
The transformer shall be of one 500 kVA, oil-immersed, self-cooled, indoor use type and no-load ratio of delta star connection shall be 4.37F-4.16R-3.95 kV to 208-120 V for three phase, four-wire system of 60 Hz.

45405.2 Output
The continuous rated output of the transformer shall be 500 kVA on any taps

45405.3 Impedance
The impedance at the rated kVA shall be more than 4.5 % for the purpose of suppression of short circuit current for the secondary fault.

45405.4 Temperature Rise
The maximum temperature rise for windings shall not exceed the following value under the rated output, with resistance measurement:

For class B insulation	80° C
For class F insulation	100° C
For class H insulation	125° C

45405.5 Frequency
The transformer shall be designed for a frequency of 60 Hz.

45405.6 Insulation Level
The transformer shall withstand the following power frequency voltages for one minute:

For 4.16 kV side	19 kV
For 208-120 V side	2 kV

45405.7 Core
The core shall be provided as specified in Sub-section 45403.7.

45405.8 Winding and Insulation
The winding and insulation shall be provided as specified in Sub-section 45403.8.

45405.9 Terminals
Each terminal shall be bolted with compression type terminal for cross linked

polyethylene insulted cables as follows:

4.16 kV side : One (1) set of compression type terminals of 22 mm^2, three-core cross linked polyethylene insulated cable

208-120 V side: 6 x 500 mm^2 single-core for line circuit

250 mm^2 single-core for neutral circuit

Suitable compression supporting device shall be provided.

45405.10 Frame and Barrier
The frame and barrier shall be provided as specified in Sub-section 45403.10.

45405.11 Tap Changer
The tap changer shall be provided as specified in Sub-section 45403.11.

45405.12 Protection and Alarm
The protection and alarm shall be provided as specified in Sub-section 45403.12.

45405.13 Wheel
The wheel shall be provided as specified in Sub-section 45403.13

45405.14 Accessories
The accessories shall be provided as specified in Sub-section 45403.14.

45405.15 Spare Parts
The spare parts shall be provided as specified in Sub-section 45403.15.

45405.16 Tests
The tests shall be applied as specified in Sub-section 45403.16.

45406 208-120 V Switchgear

45406.1 Circuits and Equipment
The Contractor shall furnish a self-supporting type metal-enclosed cubicle assembly for maintenance and repair shop, container gate, cargo gate, power supply station and fuel station.

The following apparatus shall be mounted inside the cubicle:

- One (1) set of 3-phase bus
- One (1) air circuit breaker
- Three (3) current transformers
- Three (3) single-phase transformers
- Five (5) molded case circuit breaker

45406.2 Three-phase Bus
Three-phase, four-wire copper bus shall be of 600 V, 60 Hz and 2,000 A. The bus shall withstand 65 kA current for one second under fault conditions without mechanical and thermal failure. Oil or compound filled bus will not be acceptable. All bolted joints shall be silver-plated. The bus supports shall be of non-hygroscopic, flame retardant, track resistant material.

45406.3 Air Circuit Breaker

1) Type

The circuit breaker shall be of three-pole, single throw, draw-out type, trip-free in any position, with anti-pumping feature, complete with controls and wirings and other accessories needed for operation.

2) Ratings

The circuit breaker shall be rated as follows:

Rated voltage	600 V
Rated frequency	60 Hz
Rated continuous current	2,000 A
Rated interrupting current	65 kA
Control circuit voltage	125 V DC

3) Operating mechanism

Operating mechanism shall be provided in accordance with Sub-section 45404.3 3).

4) Tests

Tests shall be applied in accordance with Sub-section 45404 (4).

45406.4 Current Transformer

1) Type

The current transformers shall be of dry molded type.

2) Ratings

The current transformer shall be rated as follows:

Maximum voltage	600 V
Current ratio	2,000/5 A
Rated burden	40 VA
Accuracy	1.0 class
Over-current strength	10 kV for one second
Over-current constant	more than 20

3) Accessories, spares and tests

Accessories, spares and tests shall be provided in accordance with Sub-section 45402.5.

45406.5 Potential Transformer

1) Type

The potential transformers shall be of single-phase, dry molded type.

2) Ratings

The potential transformers shall be rated as follows:

Insulation class	600 V
Primary voltage	208 V
Secondary voltage	120 V
Rated burden	40 VA
Accuracy	1.0 class

3) Accessories, spares and tests

Accessories, spares and tests shall be provided in accordance with Sub-section 45402.7.

45406.6 Molded Case Circuit Breaker

Molded case circuit breaker shall be of three-pole, 600 volts. The rated frame currents shall be 800 A. The rated interrupting current shall be more than 65 kV.

45406.7 Cubicle and Terminations

1) Construction

The following apparatuses shall be mounted on the front side of the cubicle:

- One (1) set of position indicating lamps (red and green)
- One (1) ammeter with selective switch
- One (1) voltmeter with selective switch
- One (1) under-voltage relay
- One (1) over-current relay

The cubicle shall have the suitable cable terminal compartments for cross-linked polyethylene insulated (XLPE PVC) sheathed cables as stated bellows:

- 6 x 500 mm^2 single-core for 500 kVA transformer secondary
- 250 mm^2 single-core for neutral circuit of 500 kVA transformer
- 150 mm^2 three-core for Maintenance and Repair Shop
- 60 mm^2 three-core for Container Gate
- 38 mm^2 three-core for Cargo Gate
- 38 mm^2 three-core for spare
- 14 mm^2 three-core spare

The power cables shall be furnished and connected under Section 45500. Suitable means shall be provided for supporting the terminal and cables.

2) Tests

The tests shall be applied as specified in Sub-section 45404.7 (2).

45406.8 Accessories

The accessories shall be provided as specified in Sub-section 45404.8

45406.9 Spare Parts

The spare parts shall be provided as specified in Subsection 45404.9.

45407 Control Switchboard

45407.1 General

The major items of control switchboard and appurtenant to be supplied shall be as follows:

- One (1) Main control switchboard
- One (1) AC panel
- One (1) DC panel
- One (1) Battery charger panel

The control switchboard shall be furnished complete with instruments, meters, control switches, annunciators, test blocks, terminal blocks, wiring and other miscellaneous devices as indicated in the specification. The switchboard shall include all required auxiliary and accessory devices, such as auxiliary current and potential transformers, protective devices, fuses, and resistors, whether or not expressly specified. All instrument scales, coils, relay contacts, and similar features shall be suitable for the apparatus controlled or the purpose intended.

45407.2 Main Control Switchboard (Monitor Control Board)

The panel-mounted equipment and devices shall include but not be limited to the followings:

1) Control

Programable logic controller shall be utilized for transfer between normal source and emergency source by diesel generator. The sequence of operation shall be as follows:

Automatic Mode

- Under normal conditions, the main breaker is closed and the tie breaker is open.
- Under phase lose or loss of phase to phase of normal source to between 80% and 100%, and after a time delay, adjustable from 1 to 60 seconds to override momentary dips and outage, the transfer system will open the affected main breaker and close the tie breaker.
- When normal voltage has been restored after a time delay, adjustable from 10 to 600 seconds (to ensure the integrity of the source), the transfer system will open the tie breaker. The transfer system will have an adjustable neutral position timer (0-10 seconds) to allow voltage to decay sufficiently before the affected main breaker is then closed.
- If source b) should fail while carrying the load, transfer to source a) shall be made instantaneously upon restoration of source a) to satisfactory conditions.
- If both sources should fail simultaneously, no action is taken.
- If the main or tie breakers trip due to a fault, transfer system will be reset to manual mode and manual operation of that breaker will be prevented until its over current trip switch is reset.

Manual Mode

Breakers may be opened and closed using pushbuttons on the transfer system display while in manual mode. Interlocking is in place to prevent the closing of both mains

and the tie simultaneously.

2) Metering

Instruments shall be provided to indicate the following.

46 kV transmission line:

- Line current
- kW power received
- 46 kV line voltage
- System frequency
- kWh energy
- kVarh

4.16 kV circuits:

- Main transformer current
- Main transformer kW
- Power factor
- 4.16 kV bus voltage
- 4.16 kV bus ground voltage
- Diesel generator line current
- Diesel generator kW output

480 V circuit

- 4.16/0.48 kV transformer current
- 480 V bus voltage
- Transformer kW output
- Transformer kWh energy

208-120 V circuit

- 4.16/0.208-0.12 kV transformer current
- 208-120 V bus voltage
- 4.16/0.208-0.12 kV transformer kW output
- 4.16/0.208-0.12 kV transformer kWh energy

3) Relaying

Relaying panels shall be provided for each machine and equipment incorporating the following protective and alarm features, but the Contractor shall ensure that the protective and alarm schemes are in every way suitable for machine and method of starting.

Protection for 46 kV transmission line:

For the protection system of the 46 kV transmission line, directional distance relay system shall be provided if required.

Protection for main transformer:

- Differential protection on the main transformer

- Overecurrent protection on the main transformer
- Buchholtz relay operating (2nd stage)
- Other necessary protection

Protection for diesel generator:

- Differential protection on the generator
- Overcurrent protection on the generator
- Ground fault protection on the generator
- Bearing temperature (2nd stage)
- Other necessary protection

Protection for 4.16/0.48 kV transformer:

- Overcurrent protection on the transformer
- Other necessary protection

Protection for 4.16/0.208-0.12 kV transformer

- Overcurrent protection on the transformer
- Other necessary protection

Protection for 4.16 kV circuit:

- Undervoltage protection
- Overvoltage protection
- Overcurrent protection on 4.16 kV bus section

Protection for 480 V circuit:

- Overcurrent protection on the 480 V feeders
- Ground fault protection on the 480 V feeders
- Directional ground fault protection on the 480 V feeders
- Undervoltage protection on the 480 V feeders

Protection for 208-120 V circuit:

- Overcurrent protection on the 208-120 V feeders
- Ground fault protection on the 208-120 V feeder
- Directional ground fault protection on the 208-120 V feeder
- Undervoltage protection on the 208-120 V feeder

Alarm for 46 kV transmission line:

- Air pressure low for circuit breaker and disconnecting switch
- Gas pressure low for circuit breaker
- Unhealthy of disconnecting switch
- Other necessary alarm

Alarm for main transformer:

- Oil temperature high
- Oil level low

- Buchholtz relay operating (1st stage)
- Winding temperature high
- Other necessary alarm

Alarm for 4.16/0.48 kV and 4.16/0.208-0.12 kV transformers:

- Oil temperature high for the transformers
- Other necessary alarm

Alarm for 4.16 kV, 480 V and 208-120 V circuits

- Overvoltage ground
- Other necessary alarm

45407.3 AC Panel

The panel mounted equipment and devices shall be include but not be limited to the followings:

- One AC voltmeter, 0 – 300 V
- One Wattmeter, 300 kW
- One Watthour meter for low tension supply
- Some No fuse-breakers
- One AC voltmeter selector switches
- One AC ammeter selector switches
- One set of test block
- Some Overcurrent relay

45407.4 DC Panel

The panel mounted equipment and device shall include but not be limited to the followings:

- One DC ammeter, 50 - 0 -100 A
- Some No fuse-breakers
- One Magnetic contactor for DC emergency lighting circuits
- Two Lamp indicators with contactor for ground polarity indicator
- One Change over switch for DC voltmeter
- One set of test block

45407.5 Battery Charger Panel

One metal enclosed battery charger, having doors in front to facilitate inspection, shall be supplied. The rectifier element for battery charger shall be of silicon. Fuse protection shall be provided for individual rectifier diodes.

The battery charger shall be capable of initial charging, floating operation and equalizing charging for 100 AH storage battery supplied under Sub-section 45408. The battery charger shall be equipped with an automatic voltage regulator to maintain DC output voltage within ±2% under operating condition.

The battery charger shall be designed for the following requirements:

AC input voltage: 208 V, 3-phase or 120 V, single phase

Rated DC output voltage 125 V

Rated DC output current 30 A

DC voltage regulating range: 102 ~ 159 V

Following instrument shall be mounted on the panel:

One AC ammeter, 0- 30 A

One DC ammeter, 0- 100 A

One DC voltmeter, 0- 200 V

One No fuse-breaker

One DC undervoltage relay

One DC ground detecting relay

The Contractor shall supply all other necessary for the battery charger.

45408 Storage Battery

45408.1 Type and Rating

One set of storage battery consisting of 60 cells each in sealed plastic transparent container shall be provided to supply 125 volts, D.C. power coordinating with battery charger specified in item 45407.5 for the power supply station controls. The battery shall be of lead acid, enclosed type, with gas filter, 125 volts, 100 AH (ampere-hour) at 10-hour discharge rate

45408.2 Construction

The battery shall be of heavy-duty, long life construction and shall be provided with the followings:

- Positive plate of pasted or tudor type and negative plate of pasted type
- Separators
- Cells of enclosed explosion proof and sulfuric acid fume proof type, consisting of chemical resisting materials, with provisions for measuring the specific gravity of electrolyte from outside. The covers shall be fitted with spray proof vent plugs. Sufficient sediment space shall be provided so that the battery will not have to be cleaned out during its normal life.
- Supports for cells
- Base structure of steel construction painted with acid resisting.

45408.3 Accessories

The following items shall be supplied under this Contract:

- Requisite quantity of sulfuric acid with 10% extra.
- Sufficient quantity of distilled water for first filling up
- Mixing tank of adequate capacity
- Voltmeter, hydrometers (Portable and vent mounted) and vent mounted thermometer.
- Intercell connectors between cells and terminal lugs

- Other necessary accessories.

45408.4 Spares

- Diluted sulfuric acid : 30%
- Distilled water : 30%

45408.5 Tests

1) Shop test
   - Construction test
   - Efficiency test (Certificate of type test may be acceptable)
2) Site test

   After initial charging, test of capacity will be carried out at site.