

**9.5            GENERAL SPECIFICATIONS  
                  – ELECTRICAL WORKS**

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## **9.5 GENERAL SPECIFICATIONS - ELECTRICAL WORKS**

### **9.5.1 GENERAL**

#### **9.5.1.1 SCOPE OF WORK**

The Contractor shall include the designing, manufacturing, supplying, factory testing, finishing, painting, export packing, insuring, shipping, delivering to the site storage yard designated by the Employer, supervision for installation and erection, field testing and co-operation in the commissioning (the trial running). The operating service to the Employer's local staff at the Site shall be included.

In order to avoid any defects under interface between this Contract work and other Contract work under other Contract package, and to establish effective Site work progress, the Contractor shall make good co-operation with the other Contractor whenever the Engineer confirms such requirements.

The Contractor shall provide all labour, materials, equipment and incidentals to furnish and install the complete electrical system as shown on the drawings and/or specified herein.

It is the intent of these specifications, that when completed, the electrical systems shall be suitable in every respect for the service intended, and the Contractor shall, at no extra cost, supply all the materials and do all the work which may be reasonably implied as being incidental to the work.

The Contractor shall be responsible for all wiring and connections, testing and placing in satisfactory operation the complete electrical system to the approval of the Engineer.

#### **9.5.1.2 RULES AND REGULATIONS**

All equipment and work under this Contract shall be installed in accordance with the requirements of local jurisdiction. The Contractor shall file the required notice with any Municipal Department having jurisdiction over such permits and obtain and pay for all permits required.

#### **9.5.1.3 STANDARDS**

All electrical equipment, design, materials, manufacture, testing, inspection and performance shall, unless otherwise specifically mentioned in this Specification, conform to the authorized latest Standards by International Electrotechnical Commission (IEC).

Other internationally acceptable national standards equivalent to IEC may be considered. In case that IEC Recommendations do not exist, the other national standards may be applied.

If offers, materials or equipment which conform to standards other than the IEC and those stipulated in this Specification, full details including copies in the English language of such standards, grade and class, shall be submitted for approval. Such standards, if approved, shall be incorporated in the Contract, otherwise the IEC and the specified standards shall be applied.

#### **9.5.1.4 UNITS OF MEASUREMENT**

In all correspondence, technical schedules and drawings, Metric Units of measurement shall be employed. On drawings where other units have been used, the metric equivalent shall be marked in addition.

#### **9.5.1.5 WORKMANSHIP**

All Plant and components shall be new and shall be designed and manufactured in the most sound manner, using materials most suited to the particular services. All materials shall comply with the latest relevant authorized standards for testing materials unless otherwise specified or permitted by the Engineer. For the design of all equipment, it shall be considered to enable to make ease of their maintenance work.

All workmanship shall be of the highest class throughout to ensure smooth and vibration free operation under all possible operating conditions, and the design, dimensions and materials of all parts shall be such that the stresses to which they may be subjected shall not render them liable to distortion, undue wear, or damage under the most severe conditions encountered in service.

All parts shall conform to the dimensions shown on and shall be built in accordance with approved drawings. All joints, datum surfaces, and mating components shall be machined and all castings shall be spot faced for nuts. All machined finishes shall be shown on the approved drawings. All screws, bolts, studs & nuts and threads for pipe shall conform to the latest standards of the International Organization for standardization covering these components and shall either all conform to the standards for metric sizes.

The design, materials, manufacture and testing of all pressure vessels, and all slings and lifting equipment shall comply with the relevant statutory regulations of the country in which the Plant is to be installed.

The method of rectification of manufacturing errors, material defects and performance shortcomings shall be subject to the approval of the Engineer.

Suitable structural steel bases or frames shall be provided where necessary to transmit to the concrete foundations all loads imposed by the various parts of the equipment.

Such bases or frames shall be supplied complete with suitable anchor bolts and shall be so proportioned that the bearing loads imposed on the concrete foundations will not exceed 45 kg per square centimeter, unless otherwise specified.

#### **9.5.1.6 PHOTOGRAPHS**

The Contractor shall keep photographic records of the equipment manufacturing, the factory testing and the progress of the Site work.

Upon completion of the Works, the Contractor shall submit three (3) sets of recorded photographs adequately edited in a book with explanations to the Engineer's satisfaction. The Contractor shall provide himself necessary access to the Work and temporary facilities to photograph any parts of the Work at any stage of installation or manufacture.

### **9.5.1.7 INTERPRETATION OF DRAWINGS**

All three-phase circuits shall be run in the conduits unless otherwise shown on the drawings.

The Contractor shall verify with the Engineer the exact locations and mounting heights of lighting fixtures, switches, and receptacles prior to installation.

Any work installed contrary to or without approval by the Engineer shall be subject to change as directed by the Engineer, and no extra compensation will be allowed the contractor for making these changes.

The locations of equipment, fixtures, outlets and similar devices shown on the drawings are approximate only. Exact locations shall be as approved during construction. The Contractor shall obtain in the field all information relevant to the placing of electrical work and in case of any interference with other work, shall proceed as instructed by the Engineer, and shall furnish all labour and materials necessary to complete the work in an approved manner.

Surface mounted panels, boxes, junction boxes, conduit, etc., shall be supported by spacers to provide a clearance between walls and equipment.

The drawings are diagrammatic and functional only and are not intended to show exact circuit layouts, number of fittings, or other installation details. The Contractor shall furnish all labour and materials necessary to install and place in satisfactory operation all power, lighting, and other electrical systems shown. Additional circuits shall be installed by the Contractor wherever needed to conform to the specific requirements of the equipment.

The ratings of motors and other electrically operated devices, together with the size shown for their branch circuit conductors and conduits, are approximate only and are indicative of the probable power requirements insofar as they can be determined in advance of the purchase of equipment. The ratings shown for motor branch circuit protective devices are the maximum ratings permitted. Lower ratings may be used where approved as being proper for the dynamic characteristics of the motor and its connected load.

Unless otherwise specified, all conduits, wires, cables and the support systems for the conduits and cables that are required to make the electrical connections to equipment shall be furnished and installed by the Contractor. All connections to equipment shall be made as shown, specified, and directed and in accordance with the approved shop drawings.

### **9.5.1.8 SIZE OF EQUIPMENT**

The Contractor shall investigate each space in the building through which equipment must pass to reach its final location. If necessary, the manufacturer shall be required to ship his material in sections sized to permit passing through such restricted areas in the building.

### **9.5.1.9 MATERIALS**

The materials used in all systems shall be new, unused, and as hereinafter specified. All materials where not specified shall be of the best of their respective kinds. Samples of materials or manufacturer's specifications shall be submitted for approval.

Electrical equipment shall at all times during construction be adequately protected against mechanical injury or damage by water. If any apparatus has been damaged, such damage shall be repaired by the Contractor at his own cost and expenses.



### 9.5.1.10 ENCLOSED TYPE

Unless otherwise specified in the Schedule of the Special Specification, all equipment enclosures are to be designed and manufactured in accordance with the following protection degrees classified in IEC 529.

(a).	Outdoor Control Cubicle	..	..	IP54
(b).	Outdoor / (Indoor) Instruments	..	..	IP65 / (IP60)
(c).	Outdoor / (Indoor) Motor	..	..	IP54 / (IP50)
(d).	indoor Control Cubicles / Panels	..	..	IP40

Minimum thickness of steel plate for the panel shall be 2.6 mm. Panels shall be bolted at the bottom to suitable steel channel sill.

### 9.5.1.11 SHOP DRAWINGS

Shop drawings shall be submitted in the required number of copies for approval of all materials, equipment, installation and wiring.

All shop drawings shall be checked by the Contractor for accuracy and Contract requirements before submittal. Shop drawings, not so checked and noted by the Contractor shall be returned to him without approval.

The Engineer's check shall be only for conformity with the design concept of the project and compliance with the specifications and Contract drawings. Should any modification is required, the Engineer may instruct the Contractor to do so, and the drawings so modified shall be resubmitted for approval.

It shall be understood, however, that approval of the drawings by the Engineer shall not exonerate the Contractor from any of his liabilities under the Contract.

All drawings submitted for approval to the Employer and the Engineer for any other reasons shall be sent by registered mail with quickest possible mean.

All drawings or documents submitted to the Employer and the Engineer shall bear the Contractor's stamp of approval and the date of submission.

After approval of drawings by the Engineer, the Contractor shall supply the approved drawings to the Employer and the Engineer within one (1) month of the receipt.

The title of the drawing, the signature of the Contractor's responsible Engineer, the date prepared, the number of the drawing, etc., shall appear in the bottom right-hand corner of the drawing. The size of drawings shall be as follows:

A1	(594 mm x 841 mm)
A2	(420 mm x 594 mm)
A3	(297 mm x 420 mm)
A4	(210 mm x 297 mm)

The Contractor shall be responsible for all dimensions to be confirmed and correlated to the job site and for co-ordination of his work with the work of all other trades.

No material shall be ordered or shop work started until the Engineer's approval of shop drawings has been given.

After all items of the Plant have been manufactured and erected, bound prints and Negatives of drawings as-built in each station shall be submitted to the Employer and the Engineer within three (3) months after the date of Taking-Over.

Prototype negatives of all as-built drawings to be submitted to the Employer shall be of "Mylar film" or other approved permanent transparent materials.

Microfilms of all as-built drawings to be submitted to the Engineer shall be of 35 mm size and hold in album with contents, address, number, and title for easy searching.

<b>After Completion of the Works</b>	<b>To the Employer</b>	<b>To the Engineer</b>
Complete sets of bound prints	4 sets	2 sets
Complete set of negatives	1 set for Prototype	1 set for Microfilm

Further copies of particular drawings during the course of the Works are to be provided, if required.

#### **9.5.1.12 PAINTING**

All outside panel surfaces shall be primed, filed where necessary, and given not less than two coats of synthetic undercoat. The finishing coat for the outdoor installations shall be a gloss paint and for the indoor installations shall be a semi-gloss paint.

The inside surface of the enclosures shall have two prime coats and one finishing coat of light cream colour. (5Y 7/1) unless otherwise specified.

The colour scheme for the finishing coats of all equipment, frames for meters and relays, and switch handle shall be proposed by the Contractor with presentation of colour samples or colour chips and shall be subject to the Engineer's approval.

The humid and tropical conditions shall be taken into account on selection of the paints and painting procedure.

#### **9.5.1.13 WIRING**

##### *(1) General*

All wiring shall be done with PVC insulated wire not less than 2.5 sq.mm except for electronics devices. A suitable wiring duct system shall be installed for all inter panel. As far as possible all wiring shall be installed in wiring ducts.

All wiring from hinged door panels to the fixed panels shall be done with flexible conductor of equivalent size.

Wiring between terminals of the various devices shall be point to point. Splices or tee connection will not be acceptable. Wire runs shall be neatly trunked or clamped.

Exposed wiring shall be kept to a minimum, but where used shall be formed into compact groups suitably bound together and properly supported.

Instrument transformer secondary circuits shall be grounded only at the first panel entered, and not be grounded at any point of outside of the enclosures.

Cable supports and clamp type terminal lugs shall be provided for all incoming power wiring terminating at each cubicle. All wire shall be marked near each terminal end with circuit or wire designation. These markers shall be of an approved type and permanently attached to the conductor insulation.

(2) *Terminal Blocks*

Terminal Blocks for control wiring shall be rated not less than 600-volt with cover and be of the molded type with barriers.

White or other light-coloured marking strips, fastened by screws to the molded sections at each block, shall be provided for circuit designation.

Each connected terminal of each block shall have the circuit designation placed on the marking strip with permanent marking fluid. The terminal arrangement, including the terminal blocks for VT and CT circuit connections, shall be subject to the Engineer's approval. Spare marking strips shall be furnished with each block.

(3) *Phase Arrangement*

The standard phase arrangement when facing the front of the panel shall be R-S-R-N, and R-N-S from left to right, from top to bottom, and front to back for A.C three-phase and single-phase circuits and N-P from left to right, P-N from top to bottom and front to back for D.C polarity. All relays, instruments, other devices, buses and equipment involving three-phase circuit shall be arranged and connected in accordance with the standard phase arrangement where possible.

(4) *Wiring Colour Code*

All wires shall be coloured as follows, unless otherwise specified:

<u>Circuit</u>	<u>Colour</u>
Voltage transformers	Red
Current transformers	Black
A.C circuit	Yellow
D.C circuit	Blue
Grounding circuit	Green with yellow stripe

(5) *Phase and Polarity Colour Code*

Following coloured ferrules shall be provided on each wire in order to identify phase and polarity, unless otherwise specified.

<u>Phase and Polarity</u>	<u>Colour</u>
A.C., three-phase, First Phase	Red
Second Phase	Yellow
Third Phase	Black
A.C., single-phase, First Line	Red
Second Line	Yellow
Neutral	Blue

Grounded  
D.C., positive  
Negative

Green with Yellow stripe  
Red  
Blue

#### 9.5.1.14 LABELS AND NAME PLATE

All inscriptions for name plates, rating and instruction plates, labels on all apparatus, cubicles, panels and equipment supplied under the Contract shall be in English.

Name plates shall be provided to identify the services of all items of Plant supplied. The inscriptions shall be approved by the Engineer.

Name plates or labels shall be manufactured of corrosion resistant materials with engraving of a contrasting colour or, alternatively, for indoor use of transparent plastic material with lettering engraved on the back and filled with suitable colour. The materials used shall be non-fading, non-aging and suitable for tropical conditions.

All labels and plates for outdoor use shall be of stainless steel or other approved uncorrodible material and shall be fixed with stainless steel screws.

A rating plate of uncorrodible material shall be attached to each major and auxiliary item of equipment supplied. This plate shall be permanently engraved with the designed full load ratings, serial number, type number, date of manufacture and other identification which are deemed necessary.

Where necessary or required by the Engineer, instruction plates, diagram plates, and other plates showing unit number, circuit number, device number, etc., for clear identification shall be also provided.

#### 9.5.1.15 TESTS

All equipment shall be completely assembled at the factory. They shall be subject, unless otherwise noted, to each test as specified in the SUBSECTION 9.5 GENERAL SPECIFICATIONS-ELECTRICAL WORKS and /or SUB-SECTION 9.6 PARTICULAR SPECIFICATIONS-ELECTRICAL WORKS by the Contractor.

The Contractor shall notify the Engineer at least thirty (30) calendar days prior to the manufacturer's factory tests and the field test, and shall submit the test procedure for approval of the Engineer. The inspector reserved the right to witness all tests.

The Contractor shall furnish the service of the manufacturer's serviceman, all special tools, temporary materials, electricity, fuel, assistance, labour, apparatus and instruments as may be requisite and as may reasonably demanded to carry out such shop and field tests efficiently.

The Contractor shall provide a safe working environment for shop and field test.

Sufficient data shall be obtained during shop and field tests to permit the inspection and to plot characteristic curves for various specified operation conditions.

The tests can be made at either 50 Hz or 60 Hz. If the tests are made at 60 Hz, the manufacturer shall submit six (6) certified sets of calculations showing the equivalent 50 Hz test parameters together with the 60 Hz test data.

The Contractor shall furnish six (6) certified copies of reports of the results of tests, curves and standard application data.

#### **9.5.1.16 REPLACE AND REMEDY**

It shall be the duty of the Contractor to apply such tests, replace, or remedy all defective work, and adjust such systems as and within such time as the Engineer shall require. He shall also instruct in the use of the systems or apparatus such persons as the Engineer shall designate.

#### **9.5.1.17 ACCESSORIES, SPARE PARTS AND TOOLS**

(1) *Accessories*

For all equipment and panels, all essential and desirable accessories for an installation, operation and maintenance shall be furnished and installed, which shall include but not be limited to the each item specified in the GENERAL and /or PARTICULAR SPECIFICATIONS.

(2) *Spare Parts*

A list of spare parts shall be furnished as specified in Section 9.3.1.22.

(3) *Tools*

The Contractor shall furnish all standard and special tools that may be required for the installation, testing, maintenance and servicing of the equipment. These tools shall be properly packed in a suitable steel box with the contents listed on the outside in neat lettering in contrasting colour, in the English language. Each tool box shall be provided with a lock and keys. Hinges for the tool box shall be of the continuous hinge type.

#### **9.5.1.18 ELECTRICAL REQUIREMENTS**

(1) *Protection Co-ordination*

For protection between the primary power receiving scheme to be provided under this Contract and the power supply scheme (the Commercial Power Company side) on the incoming line, the Contractor shall take good co-ordination for selection of the protection system and setting of the protective relays.

(2) *System Connection*

Unless otherwise specified, the following will be applied:

33 kV	: 3-phase, 3-wire, wye-connected system with effectively grounded neutral.
22 kV	: 3-phase, 3-wire, wye-connected system with effectively grounded neutral.
6.6 kV	: 3-phase, 3-wire, delta-connected with non-grounded.
3.3 kV	: 3-phase, 3-wire, delta-connected with non-grounded.
415 V/240 V	: 3-phase, 4-wire, wye-connected system with effective grounded neutral.
110 V D.C System	: Mid-point will be grounded through earth fault detector.

(3) *Particulars of each System*

Unless otherwise specified, the following will be applied:

	<u>33 kV</u>	<u>22 kV</u>	<u>6.6 kV</u>	<u>3.3 kV</u>
- Nominal System Voltage (kV)	33	22	6.6	3.3
- Maximum System Voltage (kV)	36	24	7.2	3.6
- Lightning impulse withstand Voltage (1.2 x 50 micro-sec) (kV peak)	170	125	60	40
- Power – frequency withstand voltage (kV r.m.s.)	70	50	20	10
- Nominal 3-phase symmetrical Interrupting Capacity (kA r.m.s.)	25	25	25	25

(4) *System Frequency*

Rated frequency shall be 50 Hz.

(5) *Interlock*

For maintaining safe operation of the power circuit, necessary electrical or mechanical interlocks shall be provided for switching of circuit breakers and disconnecting switches and other operation.

The interlock shall be fail-safe type for preventing any accident or damage for persons and equipment.

(6) *Counter-measures against Ground-fault on the High Voltage System*

In consideration of possible voltage rise resulting from ground fault in the high voltage system, provisions shall be made to prevent damage to the equipment and human-being.

In order to avoid electrical trouble due to grounding fault of the system, the control circuits, lighting facilities, overhead ground wires, piping, etc., shall be protected by serving electrical insulation, by providing high dielectric strength or by any other counter-measures.

(7) *Consideration of High Temperature and Chlorine Gas*

In the designing and manufacturing all the equipment and facilities under the Contract, due consideration shall be given so as not to affect the life under high average temperature and chlorine gas including in the treated water at the Site.

(8) *Adiabatic Effect and Moisture Prevention*

Provision shall be made for protecting outdoor equipment from harmful effects of heat resulting from direct sunshine. Panels, control boxes shall be provided with adequate space heaters for the prevention of moisture condensation.

(9) *Insulation Co-ordination*

For insulation at the high voltage electrical system, the Contractor shall take good co-ordination for selection of insulation level against external and internal lightning phenomena.

(10) *Auxiliary Electricity Supplies*

The electrical equipment shall be designed to operate and function on the following auxiliary electric power supply system, unless otherwise specified.

(i) Alternating Current

1-phase, 2-wire, 50 Hz	
Voltage	: 240 Volts
Voltage Variation (Bypass output circuit of UPS)	: +10% - 15%
Frequency Variation	: $\pm 5\%$
(Bypass output circuit of UPS)	: (52.5 to 47.5 Hz)

The AC auxiliary power supply shall be used for the instrumentation system and the CPU system, etc.

The power shall be supplied through UPS having the function which can supply continuously stable power even if the main normal power supply system will occur in any failure.

(ii) Direct Current

110 Volts, 2-wire for the instrumentation system, essential controls, indication, alarm, emergency lighting, circuit breaker tripping and closing supplies. The direct current power will be supplied from the DC distribution panel in the control building. All equipment and apparatus shall be capable of operating satisfactorily at +10 /-15% of DC 110 V. DC power supply shall be made by the battery system composing of the storage battery, the silicon dropper and the battery charger, etc.

(11) *Protective Relay Settings*

For protection system the Contractor shall take good co-ordination for selection of the protection system and setting of the protective relays.

Recommendable settings with its calculation sheet for the protective relays and calculation sheets to determine expected fault currents and voltages on the whole electrical system shall be submitted to the Engineer for approval.

#### **9.5.1.19 METERS AND INSTRUMENTS**

All indicating instruments shall be of flush-mounted back-connected, dust-proof and heavy duty switchboard type (if any). Each indicating meter and instrument shall have a removable cover, either transparent or with a transparent window. Each meter and instrument shall be suitable for operation with the instrument transformers shown on the drawings under both normal and short-circuit conditions.

Scale plates shall be of a permanent white circular or rectangular finish with black pointer and markings. The scale range shall be determined from the current transformer and voltage transformer ratios.

All indicating instruments shall be approximately 110 mm square enclosures and shall be provided with clearly readable long scale, approximately 240 degrees. The maximum error shall be not more than one and a half (1.5) percent of full scale range.

All meters shall be marked with red line at the rated value of the scale.

Wattmeter and watthour meter for 3 phase 3 wire system shall be of two (2) elements.

For 3 phase 4 wire system, three (3) elements shall be applied.

Accuracy of watthour meter shall be of 1.0.

Watthour meter shall be of solid-state type.

#### **9.5.1.20 ANNUNCIATION SYSTEM**

The group annunciator system shall provide automatic visual and audible alarms to indicate abnormal conditions. Each annunciator shall have white name plate showing device number of the corresponding relay with black letter. Resetting of the annunciators after operation shall be conducted manually by the push button provided on the associated section on the panel. All annunciator equipment shall be suitable for operation on 110 volt DC ungrounded circuits and operate satisfactorily within a range of 70 – 130 volts DC.

Annunciator relay for the equipment shall be of solid-state type.

The annunciator and its associated equipment shall be located in the place on the panel, where operator can easily confirm the information by it.

##### *(1) Design Requirements and Ratings*

- (i) The audible alarm buzzer for annunciation shall be provided to two kinds of failure.
  - Trip
  - WarningAbove audible alarm shall have function to be able to adjust sound volume and shall be of continuous rating.
- (ii) Window block unit consisted of several windows shall be arranged on the relevant section on the panel, which is associated with its annunciation items.
- (iii) The visual indicating portion of the annunciation system is in rows of windows of each approximately 5 cm square. They shall be individually removable and suitable for painting and/or engraving of the designations.
- (iv) Window illumination shall be brightly lighted to permit easy reading under the room lighting available in the room.
- (v) Annunciator shall be provided for the future stage and be supplied, fully equipped for all windows. "Furthermore, at least 25% spare annunciators shall be provided"
- (vi) Windows for each alarm shall be distinguished with a different colour plate as below:
  - Trip ..... Red
  - Warning ..... White



- (vii) Each window shall be illuminated by LED lamp.
- (viii) The pushbutton switches for annunciation system mentioned below shall be provided:
  - Annunciator lamp test to be located on the panel.
  - Annunciator acknowledge to be located on the panel. By pressing of the pushbutton, audible alarm will be stopped and indicating lamp window will be changed from flashing to lighting.
  - Annunciator reset to be located on the panel. By pressing of the pushbutton, indicating lamp window will be extinguished if the fault or the failure will be cleared. Under still fault or failure, the lamp will be lighting continuously even if the pushbutton is pressed.

These pushbuttons shall be momentary type with latching relay, not alternative type.

ANN system operation sequence is shown on the drawing.

- (ix) Operation of the flasher circuit for flickering associated with the annunciator shall be silent.
- (x) Initiating contact for all annunciations shall close for a sufficient time for proper operation of the annunciator.
- (xi) Annunciation relay to be used to keep instantaneous failure signals shall be solid state with non-mechanical contact.
- (xii) DC 110 Volt ungrounded circuit is applied for annunciation scheme, and it shall be divided into fused sections. The fuses shall be of the type which can give an alarm on blowing.
- (xiii) The failure for all window lamps shall be checked by pressing the “Annunciator Lamp Test” switch.

## 9.5.2 HIGH VOLTAGE SWITCHGEAR

### 9.5.2.1 GENERAL

(1) *General*

The Contractor shall furnish and install all high voltage switchgear and metal enclosed bus duct as hereinafter specified and as shown on the drawings.

(2) *Reference*

The following standards are referred to:

IEC 298	High-voltage metal-enclosed switchgear and control gear
IEC 60	High-Voltage Test Techniques
IEC 71	Insulation Co-ordination
IEC 289	Reactors
IEC 470	High-Voltage alternating current contractors
IEC 694	Common specification for high voltage switchgear and controlgear standards
IEC 529	Classification of degrees of protection provided by enclosures.

### 9.5.2.2 SCHEDULE

The high-voltage switchgears will be specified in SCHEDULE of the SUB-SECTION 9.6 PARTICULAR SPECIFICATIONS-ELECTRICAL WORKS, for their components and others, if required.

### 9.5.2.3 TYPE

(1) *High Voltage Switchgear*

The Switchgear shall be of self-supporting, outdoor or indoor installation, metal-clad type conforming to IEC 298 (1981) and of robust construction.

The degree of protection for the enclosures and partitions, conforming to IEC 529 (1976), shall be as follows:

1) Indoor Metal-clad Switchgear

- Enclosure IP50
- Partitions IP3X

2) Outdoor Metal-clad Switchgear

- Enclosure IP54
- Partitions IP3X

(2) *Metal Enclosed Bus Duct*

The bus duct shall be of metal enclosed, outdoor or indoor installation, non-ventilation and robust construction.

The degree of protection for the enclosure, conforming to IEC 529 (1976), shall be as follows:

- a. Indoor Type IP50
- b. Outdoor Type IP54

**9.5.2.4 RATING**

		<b>Nominal System Voltage <u>33 KV</u></b>	<b>Nominal System Voltage <u>22 KV</u></b>	<b>Nominal System Voltage <u>6.6 KV</u></b>	<b>Nominal System Voltage <u>3.3 KV</u></b>
Number of Phases		Three (3) Phase			
Rated Frequency		50 Hz			
Rated Voltage	kV(r.m.s)	36	24	7.2	3.6
Lightning Impulse withstand Voltage					
- To earth	kV (Peak)	170	125	60	40
- Across the isolating distance	kV (Peak)	195	145	70	46
Power frequency withstand voltage					
- To earth	kV (r.m.s)	70	50	20	10
- Across the isolating distance	kV (r.m.s)	80	60	23	12
- Control Circuit	kV (r.m.s)	2.0 (IEC 694 Clause 6.2.10)			
Rated Operating and Control Voltage					
- DC	V	110V + 10 % (IEC 255) - 20 %			
- AC	V (r.m.s)	Single Phase, 240V + 10 % (IEC 694 Clause 4.8) - 15 %			

**9.5.2.5 CONSTRUCTION**

(1) *High Voltage Switchgear*

The draw-out type equipment compartment shall be provided with an automatic shutter to prevent exposure of stationary live contacts when the equipment is in the disconnected, test or removed position.

The enclosures shall be provided with access doors to facilitate inspections of the equipment. The position indicating lamps and inspection windows for the circuit breakers shall be provided on the front doors. The door shall be provided with suitable handles with locks.

At request (as described on the Special Specification), major components such as the bus bar and the connection conductor etc. may be installed with suitable insulation cover.

The enclosures shall be provided with suitable cable terminal compartments for the crosslinked polyethylene (XLPE) insulated power cables having conductor sectional area as shown on the single line diagram. Suitable means shall be provided for supporting the terminal and cable.

A copper ground busbar of 3 x 25 mm or more size shall be provided at the bottom of the enclosure. Clamp type grounding terminals shall be provided for connecting the ground busbar to the lead wire of the station grounding system.

Space heater for 240 volts or 415 volts AC shall be provided with manual/automatic (by thermostat) control switch in each enclosure.

Fluorescent lamp fixtures and receptacles shall also be provided inside each enclosure with manual tumbler switch where applicable.

For the other construction detailed requirement excepted above, IEC 298 and IEC 694 shall be referred.

Minimum thickness of steel for each part of the switchgear shall be:

Side and Rear Plate	..	2.3 mm
Bottom Plate	..	1.6 mm
Ceiling Plate	..	1.6 mm
Roof Plate	..	2.3 mm
Partition Plate	..	1.6 mm
Front Door Plate	..	3.2 mm

The following items shall be provided for the enclosures, as their accessories:

- 1) Name plates for the equipment to be housed
- 2) Channel bases
- 3) Foundation bolts and nuts
- 4) Grounding pads
- 5) Test terminal block and test plug
- 6) Other necessary accessories.

(2) *Metal-enclosed Bus Duct*

Metal-enclosed bus duct shall be fabricated from steel sheet. For the outdoor type, shall finish with hot-dip galvanized and painted.

The connecting parts of the metal-enclosed bus duct shall ensure complete mechanical and electrical connection and shall have openings with covers to inspect the inside of the connected parts.

The metal-enclosed bus duct shall have expansion joint parts where deemed necessary and at points as shown on the Drawing.

#### **9.5.2.6 BUS BAR AND CONNECTION**

The busbars and electrical connections shall be of electrolytic copper or aluminium alloy, air insulated, and shall be sufficiently insulated from ground and from each other.

At request, they may be insulated by suitable insulation cover directly.

Oil or compound filled bus will not be acceptable.

The busbars, connections and their insulated supports shall be of mechanically strong, and shall withstand all the stresses which shall be imposed upon them in ordinary working due to fixing, vibration, fluctuation in temperature, short-circuit or other causes.

All busbars connections shall be silver plated and contacted securely.

The busbars shall be designed to carry their full rated normal current without exceeding a temperature rise of 50°C at an ambient temperature not exceeding 40°C.

In consideration of the protection co-ordination between bus bar and respective connecting circuit breaker, the rated short-time withstand current for bus bar shall be at least not less than the circuit breaker's breaking capacity, as shown on the single line diagram.

Withstand duration shall be more than 1.0 sec, conforming to IEC 298.

#### **9.5.2.7 TESTS**

##### *(1) Factory Test*

The high-voltage switchgear shall be completely assembled at the factory. The switchgear shall be subject, unless otherwise noted, to the following tests by the Contractor

- (i) Verification of construction and wiring
- (ii) Mechanical operation tests
- (iii) Electrical operation tests
- (iv) Temperature rise tests (Type test may be acceptable)
- (v) Withstand voltage tests
- (vi) Short-time current tests (Type test may be acceptable)
- (vii) Short circuit current tests (Type test may be acceptable)
- (viii) Weather-proofing tests (Type test may be acceptable)
- (ix) Accessories and spare parts test
- (x) Measurement of the resistance of the main circuits
- (xi) Tests of auxiliary electrical, pneumatic and hydraulic devices.

##### *(2) Field Test*

After installation, the following tests shall be executed before energizing:

- (i) Verification of construction
- (ii) Mechanical operation tests
- (iii) Electrical operation tests (include remote)
- (iv) High voltage tests.
- (v) Other necessary tests requested by the Employer and the Engineer.
- (vi) Co-operation with other Contractors as may be required, to do total system performance test.

#### **9.5.2.8 EQUIPMENT INCLUDED**

The high voltage switchgear shall include necessary equipment as presented herein.

(1) *Instrument and Relays*

Voltmeters, wattmeters, power factor meters, zero-phase voltmeter and ammeters shall be not less than 110 mm square, 240 degrees from zero to full scale,  $\pm 1.5\%$  of full scale accuracy, panel mounted type and shall be provided with external zero adjustment. The scale ranges shall be determined from the potential transformer and current transformer ratios.

Watt-hour meters shall be 3-phase 3-wire system of 2 element draw-out type, rated voltage 110 V and rated current 5A, panel flush mounted type with pulse contact for remote counter and shall be provided with pulse composed device. Their accuracy class shall be 1.0.

Protection relays shall be draw-out, panel flush mounted, dust proof, static type.

Each protection relay shall be equipped with an operation indicator, using LED lamp, etc., front operated resetting device and contacts for operation on 110 volt D.C.

Each protection relays shall be housed in the case having removable type transparent cover on the front surface of the protective relay panel.

The relay elements associated with the R, S and T Phases shall be mounted and arranged on the left, middle and right respectively in horizontal, and on the top, middle and bottom respectively in vertical, when viewed from the front of the panel. Suitable phase colour shall be marked on both the transparent front cover and the rear side of the case for each phase relay.

Instrument transformer secondary circuit shall be grounded only at the first panel entered, and not be grounded at any point outside the panel.

For each VT and each CT circuit, the test terminal shall be provided and be of plug-in and flush mounting type to insert the test plug in place of the regular plug. When the test plug is inserted, CT circuit shall be closed and VT circuit shall be opened automatically. These test terminals shall be covered with the proper covers.

Each relay shall be suitable type for operation with instrument transformer ratios and connections as shown on single line diagrams under both normal and short circuit conditions.

(i) AC Undervoltage Relay

AC Undervoltage relay shall be three (3)-phase type, plug-in insert type.

(ii) Over Current Relays

Over current relays shall have inverse definite minimum time (IDMT) characteristics with an instantaneous element.

(iii) Ratio Differential Relays

For short circuit fault protection including turn-to-turn-fault on the power transformer, ratio differential relay of most popular type shall be applied.

The followings shall be required:

- Static relay of plug-in insert type
- Three sets of single phase construction
- High speed variable percentage differential type

- With second harmonics restraint element to avoid undesired tripping due to inrush current
- With auxiliary current transformer to compensate miss-matching between primary CT ratios for respective windings and to be built in the relay
- With an instantaneous relay unit.

(iv) Directional Ground Fault Relay

Directional ground fault relay shall be static type and three (3)-phase construction. In consideration that this relay shall be operated under too small fault current, therefore, it is required to avoid its maloperation or undesirable tripping.

Protection relays shall be drawn-out, panel flush mounted, dust proof, static type.

(2) *Phase and Sequence Selector Switches*

Phase and selector switches shall be heavy-duty, rotary type. The phase and sequence selector switches shall be high resistance and arc-proof type, and with dust cover.

(3) *Control Switches*

Control switches shall be spring-return with pistol grip or push button switch type. The control switches shall be wear-proof and arc-proof type, and with dust cover.

Their contactor shall have ample current capacity.

(4) *Signal Lights*

Red signal lights shall be used for "ON" position and green lights for "OFF" position, by using LED lamp.

### 9.5.2.9 INSTALLATION

The high voltage switchgear shall be mounted on steel channels which are installed on the concrete floor. The channels shall cover the full length of the switchgear and shall be installed at level in all directions.

It may be required to install the channels (base) at the time of flooring work, prior to panel (switchgear) installation, depend on site work schedule.

Installation work shall be made so as to maintain the panels in an upright position, and required their shifting shall also be done by means of their lifting or rolling of suitable roll bars inserted under them. Lifting eye bolts shall be mounted on the top of the panel.

### 9.5.2.10 SPARE PARTS

The list of spare parts to be furnished by the Contractor as specified in Section 9.3.1.22 shall include but not be limited to the following:

- (i) 300 percent of indicating lamps of each type on the switchgear
- (ii) 300 percent of fuses of each type and rating used
- (iii) 1 pc of complete assembly of each type of switch
- (iv) 1 set of complete assembly of each type of auxiliary relay
- (v) 300 percent of interior illumination fluorescent lamp of each switchgear
- (vi) 1 set of complete assembly of each type of meter
- (vii) Other spare parts recommended by the manufacturer \*

## 9.5.3 POWER TRANSFORMERS

### 9.5.3.1 GENERAL

#### (1) *General*

The Contractor shall furnish and install all power transformers as hereinafter specified and as shown on the drawings.

#### (2) *References*

The following standards are referred to:

IEC 76	Power Transformer
IEC 726	Dry Type Transformer
IEC 60	High-voltage Test Techniques
IEC 71	Insulation Co-ordination
IEC 137	Bushings for Alternative Voltage above 1000 V
IEC 156	Method for the determination of the electric strength of insulating oils
IEC 214	On-load tap-changers
IEC 270	Partial discharge measurement
IEC 354	Loading guide for oil-immersed transformer
IEC 542	Application guide for on-load tap changers
IEC 551	Measurement of transformer and reactor sound levels
IEC 606	Application guide power transformers
IEC 616	Terminal and tapping markings for power transformer.

### 9.5.3.2 SCHEDULE

The power transformers schedule will be specified in SCHEDULE of the SUB-SECTION 9.6 PARTICULAR SPECIFICATIONS-ELECTRICAL WORKS.



### 9.5.3.3 TYPE, RATING AND CHARACTERISTICS

(1) *Oil Immersed Type*

The type, ratings and characteristics of power transformers and bushings shall be as follows:

	Nominal Voltage 66 kV	Nominal Voltage 33 kV	Nominal Voltage 22 kV	Nominal Voltage 6.6 kV	Nominal Voltage 3.3 kV
Type	Indoor or outdoor, Oil-immersed type, Class A				
Type of cooling:	ONAN				
Number of phase:	Three (3) Phase				
Rate frequency:	50 Hz				
Rating	Continuous				
Lightning impulse withstand voltage (peak)					
- primary (kV)	325	170	125	60	40
- secondary					
6.6 (kV)	60	60	60	-	-
3.3 (kV)	40	40	40	-	-
415 V	-	-	5	5	5
Power frequency withstand voltage					
- Primary (kV)	140	70	50	20	10
- Secondary					
6.6 (kV)	20	20	20	-	-
3.3 (kV)	10	10	10	-	-
415 V	-	-	2	2	2
Vector Group :	Yd5	Yd5	Dy5	Dy5	Dy5
Off circuit tap changer :	4 taps (including rated tap) under full capacity, (max) rated voltage x 1.15/1.1 ~ (min) rated voltage x 1.0/1.1				
Impedance voltage at rated current % :	7.5	5.5	5.0	4.5	4.5
Temperature rise *					
- winding (resistance method) :	Not exceed 55 degree C				
- Oil (thermometer method) Top Oil	Not exceed 55 degree C				
Audio sound level :	Not exceed 70 dB				

\* For only temperature rise, JEC 204 not IEC 76 is to be applied to expect more long life.

(2) *Dry Molded Type*

The type, ratings and characteristics shall be as follows:

	<b>Nominal Voltage 22 kV</b> -----	<b>Nominal Voltage 6.6 kV</b> -----	<b>Nominal Voltage 3.3 kV</b> -----
Type	Indoor, epoxy resin molded type, Class H		
Type of cooling:	Natural Air-cooled		
Number of phase:	Three (3) Phase		
Rate frequency:	50 Hz.		
Rating	Continuous		
Lightning impulse withstand voltage (peak)			
- primary (kV)	95	40	20
- secondary			
6.6 (kV)	40	-	-
3.3 (kV)	20	-	-
415 V	5	5	5
Power frequency withstand voltage			
- Primary (kV)	50	20	10
- Secondary			
6.6 (kV)	20	-	-
3.3 (kV)	10	16	-
415 V	2	2	2
Vector Group :	Dy5	Dy5	Dy5
Off circuit tap changer :	4 taps (including rated tap) under full capacity, (max) rated voltage x 1.15/1.1 ~ (min) rated voltage x 1.0/1.1		
Impedance voltage at rated current % :	5.0	4.5	4.5
Winding temperature rise (resistance method)	Not exceed 120 degree C		
Audio sound level :	Not exceed 70 dB		

#### 9.5.3.4 66 kV TO 22 kV CLASS CONSTRUCTION

(1) *Tanks*

The transformer shall be provided with a steel case of substantial construction, which shall be absolutely water and hot oil-tight.

The tanks shall be suitable for filling in the field under 1 kilogram per square centimeter vacuum. Vacuum pumps and any other necessary equipment shall be furnished by the Contractor to permit evacuation of the tanks preparatory to filling with oil if necessary. This equipment will remain the property of the Contractor.

The tanks shall also have suitable jacking boss, lifting eyes and pulling lugs. The transformer tank shall be provided with a fabricated or structural steel base. The base shall be designed and built so as to allow skidding or moving on rollers in either direction. Flat base plates are not acceptable.

The tank shall be provided with oil sampling valve, oil drain valve, oil fill valve, air vent plug and explosion vent. The valves shall have fittings suitable for connecting the oil purifier.

A pressure relief device with alarm contact shall be provided on the explosion vent and shall be connected to a discharge pipe to lead the oil to the ground surface.

The tank shall also be provided with jacking bosses or recesses to permit the use of jacks and shall be provided with pulling lugs to facilitate transferring it in the longitudinal and transverse directions.

Necessary lugs and shackles shall be provided to enable each tank to be lifted by a crane or other means, and shall be so located that safe clearance is obtained between the slings and transformer bushing without use of a spreader.

The tank cover shall be designed so that the bushings can be easily removed and connections to the windings can be easily made.

The inside of the tank and all steel connections shall be sand or shot blasted. The tank internal surface and the metallic part of the core and winding assembly shall be coated with white paint so as to observe dust accumulation.

One or more manholes or handholes shall be provided to permit easy access to the lower end of bushings and the terminals.

Two suitable grounding pads, each for two 95 mm<sup>2</sup> stranded copper conductors, shall be welded to the bottom of each tank.

(2) *Cores*

The transformer cores shall be built up of thin laminations of the best quality non-aging cold rolled grain oriented silicon steel sheet. Lamination shall be coated with an insulating material.

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 will be built up of structural steel members.

To ensure efficient cooling, each core shall be provided with oil ducts.

Suitable means shall be adopted to prevent circulating current being set up within the core.

The core and windings shall be so located within the tank as to prevent movement.

The core shall be electrically connected to the transformer tank to make appropriate grounding.

(3) *Tripping and Closing*

Tripping and closing shall be controlled by DC.110V power from DC power supply equipment.

(4) *Windings*

The windings shall be of high conductivity copper.

The amount of insulation shall be determined not only by normal voltage per turn, but also by due consideration of the line voltage and the service conditions, including impulse phenomena caused by lightning strokes on the transmission line and surges during switching operation of circuit breakers and other associated fault conditions.

In case of graded insulation winding, the insulation of the turns shall be reinforced between turns or provided with suitable means to protect the winding against surges and transients on the basis of result of study for voltage distribution in coil against impulse injection.

The primary and secondary windings shall be so placed 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 subjected on short circuit.

Provision shall be made for taking up any contraction of windings due to shrinkage of insulation materials in order 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 construction of the transformers shall be dried under vacuum, and be impregnated with purified and degassed oil under vacuum.

Adequate provision shall be made for the circulation of the oil around and between the windings, so that a very low temperature gradient between the conductors and the oil is assured and any danger of excessive local heating is eliminated. Spacing blocks shall be provided between section of the windings to ensure 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 a result of the dead short circuit on any side of the transformer. The transformer shall withstand, without injury, the dead short circuit for a duration of at least two (2) seconds.

For the dry type transformer, the windings shall be of cast resin molded type filled heat resistant epoxy under vacuum.

(5) *Off Circuit Tap Changers*

The Tap-changer shall be capable of operating under no-voltage condition from the outside of the transformer at ground level for easy operation. The position must be clearly indicated. All taps shall be rated for full output. Suitable locking mechanism to avoid operation for tap changing during transformer energizing or to avoid charging on incomplete tap position shall be provided by utilization of transformer disconnecting switch auxiliary contact, etc.

(6) *Bushings*

The bushings shall conform to the applied standard.

All porcelain parts shall be one piece. Porcelain parts constructed of assembled segments will not be acceptable. Threaded studs shall be furnished on all bushings.

The bushings for the terminals including neutral shall be of oil filled type or solid single-piece porcelain type.

The porcelain of each busing shall be brown-glazed and the glaze shall be uniform throughout the surface.

The neutral terminal shall be connected with a copper conductor of bar or rod or pipe, which shall run down to ground, supported by insulators on the transformer tank. The neutral conductor shall be fitted with a terminal for the grounding wires of two 95 sq.mm stranded copper.

(7) *Terminal Connectors*

Expansion-type terminal connectors shall be furnished and equipped with an alignment guide.

The size of conductor and method of take-off will be furnished when shop drawings are submitted by the Contractor for approval.

(8) *Insulating Oil*

The insulating oil furnished for use in the power transformers shall be pure mineral oil prepared and refined especially for use in transformers and shall be compatible with the oil remaining on the core and coils after factory testing of the transformers.

Insulating oil shall be non-sludging and of medium viscosity. The characteristics of oil shall comply with IEC 296 Class I.

Each transformer shall be supplied with the first filling of oil and one (1) percent extra oil for one transformer in sealed non-returnable drums.

The manufacturer's name and characteristic of oil shall be stated in the tender.

(9) *Oil Preservation System*

The transformer shall be provided with an oil preservation system in which the transformer oil cannot come in contact with the outside air.

The system may be either the diaphragm-sealed constant pressure type conservator or expansion tank type.

The diaphragm type shall be provided with a dehydrating breather having suitable size for preventing moisture condensation of air in the air cell of conservator. The breather shall be possible to inspect the extent of moisture absorption of the moisture absorbent from outside through a transparent window of the container.

An oil level gauge shall be provided and located in easily visible position from the ground level.

*(10) Cooling Equipment*

The transformers shall be designed with a sufficient number of radiators or cooling units to operate as natural air-cooled units.

Radiators shall be connected to the transformer tank by machined-steel-flanges with the flanges welded to the radiator and to the tank, and the flanges shall be provided with gaskets. Radiators shall be of panel type using seam welded tube.

The radiators for each transformer bank shall be divided into several units including one stand-by unit and fitted directly to the tank of the transformer, and shall be arranged so as to provide uniform and effective circulation of the oil through the transformer windings. Each radiator unit shall be provided with radiator valves at the oil inlet and outlet connections so as to permit its removal without draining the oil from the tank. Each radiator unit shall be equipped with suitable lifting lugs or shackles to facilitate handling.

The radiators shall be designed for safe operation at an oil pressure of at least 2.0 Kg/cm<sup>2</sup>.

*(11) Terminal Cabinet, Duct and Wiring*

The Contractor shall furnish and install where practicable, metal conduit and duct for wiring the accessories. The conduit duct shall be suitably connected to the transformer accessories and shall be connected to a terminal cabinet upon the transformer tank.

The terminal cabinet shall mount a terminal board to facilitate completing the wiring to external circuits.

The Contractor shall furnish and install, where practicable, cable and wire required for connecting the accessories and terminal board. The bottom of the terminal cabinet shall be equipped with removable blank cover plates.

*(12) Protection of Transformer*

The following protection shall be provided on each transformer:

- (i) Buchholtz relay (first stage and second stage)
  - for alarm at the first stage
  - for trip and fire protection at the second stage.
- (ii) High temperatures for top-oil
  - for alarm
- (iii) Low oil levels
  - for alarm and fire protection.
- (iv) Pressure relief device operated:
  - for alarm and fire protection.
- (v) High temperature for winding only for Dry type transformer
  - for alarm

A Buchholtz relay shall be fitted on connecting pipe between the conservator and the tank with alarm and trip contacts suitable for 110 V D.C., and isolating valves shall be inserted on both

sides of the Buchholtz relay. The Buchholtz relay shall be equipped with a testing cock and a gas release cock.

The dial type indicating thermometers with maximum temperature pointer, calibrated in centigrade, and equipped with alarm contacts suitable for 110-volt DC, shall be provided and mounted on the tank to indicate the temperature of the top oil. The thermometer is of vapour pressure type or mercury filled type and variation of the volume or pressure arising from temperature change is transmitted to a Bourdon tube fitted to the indicator through the capillary tube of the flexible interconnecting pipe. The sensing bulb of the thermometer shall be installed at the hottest oil near the top of the tank.

For the dry type transformer, the dial type winding thermometer shall be provided with a resistance type temperature detector of 100 ohm at 0° C platinum element. The temperature detector shall be embedded together, in the resin molded coil preferably.

(13) *Base*

The transformer shall be provided with skid base of fabricated structural steel to be embedded in the concrete foundation for mounting the transformer bank appropriately.

Setting of the base shall be done by the Contractor.

(14) *Bushing Type Current Transformers*

Bushing type current transformer may be furnished for differential protection and metering.

Current transformer shall have double-ratio winding and mounted on bushings of circuit breaker, for above case.

(15) *Accessories*

All accessories shall be furnished with each power transformer. The accessories shall include but not be limited to the following:

(i) Oil immersed Type (for each Transformer)

- Dial-type thermometers with alarm contacts.
- Oil-level gauge, with low-level alarm contacts
- Rating plate and connection diagram with full details of rating in English.
- Pressure relief device with alarm contacts and provision to prevent any ruptured parts from falling into the transformer oil.
- Oil drain and exhaust valves,
- Oil sampling device
- Upper and lower filter-press connections
- Buchholtz relay with one (1) alarm contact and one (1) trip contact.
- Oil inlet-outlet valves
- Oil strainers, if required.
- A ladder on the side of the tank to provide access for safe inspection while the transformer is energized. A barrier and locking device shall be equipped on the lower section of the ladder.
- Suitable handholes or manholes for servicing.

- Clamp type grounding pad, two for each lower transformer tank.
- Terminal box
- Skid base and foundation bolts.
- Dehydrating breather (silicagel)
- Bus duct and Cable duct
- Primary and secondary connection terminals.
- Other necessary accessories

Special tools for erection and maintenance including jacking device for the transformers shall be provided for whole transformers.

(2) Dry – molded Type (for each transformer)

- Dial type winding thermometers with alarm contacts.
- Rating plate and connection diagrams with full details of rating in English.
- Wheeled base to remove the transformer
- Clamp type grounding pad, two for each lower side of transformer frame
- Other necessary accessories.

### 9.5.3.5 TESTS

(1) *Factory Tests*

The following tests shall be carried out at the manufacturer's plant in the presence of the Employer and the Engineer, in compliance with IEC recommendations unless otherwise specified herein.

For the purpose of evaluation whether the Tenderer has capability to perform specified all shop test items including special test without any problem, for his owning testing facilities relating to all undermentioned test items, the Tenderer shall submit the list showing detailed rating of test equipment and photograph to certify them.

- (i). Appearance check
- (ii). Measurement of winding resistance at each tap
- (iii). Measurement of voltage ratio on all taps
- (iv). Check of phase vector relationship and polarity
- (v). Measurement of impedance voltage on each tap
- (vi). Measurement of load loss at rated current
- (vii). Measurement of no-load loss and current
- (viii). Induced overvoltage withstand test
- (ix). Power-frequency voltage withstand test
- (x). Lightning impulse test (full wave and chopped wave)
- (xi). Temperature rise test, only for the first manufactured transformer of each type.
- (xii). Bushing current transformer test including measurement of current ratio and check of relative polarities (if applicable)
- (xiii). Oil pressure test for coolers
- (xiv). Test for instruments
- (xv). Calculation of efficiency and voltage regulation
- (xvi). Mechanical test for tank



- Oil tightness check
  - Vacuum test
  - (xvii). Measurement of acoustic sound level
  - (xviii). Short circuit test (calculation sheet may be acceptable)
  - (xix). Particle discharge (type test may be acceptable)
  - (xx). Inrush current (type test may be acceptable).
- (2) *Field Tests*

After installation, the following tests shall be executed before energizing:

Power Transformer

- (i). Verification of construction
- (ii). Mechanical operation tests
- (iii). Electrical operation tests
- (iv). Measurement of winding resistance
- (v). Voltage ratio and vector relationship checks
- (vi). Insulation oil check
- (vii). High voltage test
- (viii). Other necessary tests requested by the Employer and the Engineer
- (ix). Co-operation with other Contractors as may be required to check the operation and matching of equipment supplied under other contracts.
- (x). Accessories and spare parts tests.

Bushing Current Transformer:

- (i). Verification of terminal markings
- (ii). Power-frequency tests on secondary windings
- (iii). Over-voltage inter-turn tests
- (iv). Determination of errors
- (v). Measurement of knee-point e.m.f. (for only current transformer for high impedance differential relay)
- (vi). Measurement of exiting current at the knee-point e.m.f. (for only current transformer for high impedance type differential relay)
- (vii). Measurement of secondary winding resistance (for only current transformer for high impedance type differential relay).
- (viii) Short-time current tests (The certificate of type test with test report is acceptable)
- (ix) Temperature-rise test. (The certificate of type test with test report is acceptable)

**9.5.3.6 SPARE PARTS**

The list of spare parts to be furnished by the Contractor as specified in Section 7.1.22 shall include but not be limited to the following:

- (i) Each type of Oil immersed type transformers
  - One (1) bushing of each type with conductor and terminal
  - One (1) complete set of gaskets for one bank of transformer
  - Six (6) sets of bursting plates with gaskets

- One (1) set of dial type thermometers with gaskets
- One (1) set of oil level gauge with gaskets
- 100% moisture absorbent
- Other spare parts recommended by the manufacturer \*

(ii) Each type of dry type transformers

- One (1) bushing of each type with conductor and terminal
- One (1) complete set of gaskets for one bank of transformer, if any
- One (1) set of dial type winding thermometers with necessary associated parts
- Other spare parts recommended by the manufacturer \*



## 9.5.4 HIGH VOLTAGE DISCONNECTING SWITCHES

### 9.5.4.1 GENERAL

(1) *General*

The Contractor shall furnish and install all high voltage disconnecting switches as hereinafter specified and as shown on the drawings

(2) *References*

The following standards are referred to:

- IEC 129      Isolators and earthing switches
- IEC 60        High-voltage test techniques

### 9.5.4.2 SCHEDULE

The high-voltage disconnecting switches schedule will be specified in SCHEDULE of the SUB-SECTION 9.6 PARTICULAR SPECIFICATIONS-ELECTRICAL WORKS.

### 9.5.4.3 TYPE

The disconnecting switch shall be of outdoor or indoor use, pole or steel frame-work mounted, three (3) pole, single throw, vertical or horizontal break, gang operated type, manual or remote controlled electrical motor-driven type.

### 9.5.4.4 RATING

	Nominal System Voltage 66 kV	Nominal System Voltage 33 kV	Nominal System Voltage 22 kV	Nominal System Voltage 6.6 kV	Nominal System Voltage 3.3 kV
Number of phases	Three (3) Phase				
Rated frequency	50 Hz.				
Rated Voltage					
kV(rms)	72.5	36	24	7.2	3.6
Lightning impulse withstand voltage					
kV(Peak)	325	170	125	60	40
Power frequency withstand voltage					
kV (rms)	140	70	50	20	10
Rated operating and control voltage					
- DC			110 + 10% - 20%	(IEC 255)	
- AC      (rms)	Three (3) Phase,		415 / 240 V	+ 10% (IEC 694 Clause 4.8) - 15%	

#### 9.5.4.5 CONSTRUCTION

The main high voltage disconnecting switch shall be complete with bases, insulators, contacts, and terminal blades. Operating mechanism shall include motor or pneumatic driving device, operating pipes, interphase shafts, pipe couplings, guide bearings, ground braids, mounting brackets, mounting bolts, operating handle and auxiliary switches required for operating from the ground.

The operating mechanism shall be so designed and fabricated that it will not cause excessive deflections in the members to which it is attached.

All operating rods and levers shall be cut to length and all machining operations and threading shall be completed in the factory.

The operating mechanism shall have provisions for grounding and for padlocking in the open and closed positions.

All switch bases, operating mechanisms, operating rods and other steel parts shall be hot-dip galvanized after all machining and threading operations have been completed.

All breaker disconnect switches shall be suitable for mounting in a horizontal, vertical break position. Switch base shall be drilled to match the drilling of the switch support stands.

The switch terminal pads shall be machined flat and tin plated to assure a low resistance current transfer and to prevent formation of aluminium oxide. Each terminal shall be furnished with a bolted type connector.

Electrical interlock mechanism which any disconnecting switch cannot be operated under relevant circuit breaker closing shall be provided.

Necessary accessories shall be furnished with high voltage disconnecting switches. The accessories shall include but not be limited to the following:

- (i) Motor driven device, or pneumatic driven with the air-compressor and air-tank device,
- (ii) Auxiliary switch
- (iii) Position indicator (lamp and mechanical indicator)
- (iv) Key mechanical interlock
- (v) Supporting structures made of galvanized steel.
- (vi) Two (2) handles (common type for all the same type switches)
- (vii) Hand-operated set with locking device.
- (viii) Operating panel with wiring to complete to terminal blocks for remote control.

#### 9.5.4.6 TESTS

##### (1) *Factory Tests*

The high-voltage disconnecting switches shall be completely assembled at the factory. The disconnecting switches shall be subject, unless otherwise noted, to the following tests by the Contractor:

- (i) Verification of construction
- (ii) Mechanical operation tests

- (iii) Electrical operation tests
- (iv) Measurement of the resistance of the main circuit
- (v) Temperature rise tests (Certificate of type test with test report may be acceptable)
- (vi) Short-time current tests (Certificate of type test with test report may be acceptable)
- (vii) Power frequency withstand voltage dry test
- (viii) Power frequency withstand voltage wet test (certificate of type test with test report may be acceptable)
- (ix) Impulse test (Certificate of type test with test report may be acceptable)
- (x) Operating and mechanical endurance test (Certificate of type test with test report may be acceptable)

(2) *Field Tests*

After installation, the following tests shall be executed before energizing:

- (i) Verification of construction
- (ii) Mechanical operation tests
- (iii) Electrical operation tests
- (iv) Resistance measuring tests
- (v) High voltage test
- (vi) Other necessary tests
- (vii) Other necessary tests requested by the Employer and the Engineer
- (viii) Co-operation with other contractors as may be required to check the operation and matching of equipment supplied under other contracts.
- (ix) Accessories and spare parts tests.



## 9.5.5 HIGH VOLTAGE CIRCUIT BREAKERS AND CONTACTORS

### 9.5.5.1 GENERAL

(1) *General*

The Contractor shall furnish and install all high voltage circuit breakers as hereinafter specified and as shown on the drawings.

(2) *References*

The following standards are referred to:  
 IEC 56 High Voltage Circuit Breaker  
 IEC 60 High-Voltage Test Techniques

### 9.5.5.2 SCHEDULE

Schedule for the high-voltage circuit breakers and contractors will be specified in SCHEDULE of the SUB-SECTION 9.6 PARTICULAR SPECIFICATIONS-ELECTRICAL WORKS.

### 9.5.5.3 TYPE, RATING AND CHARACTERISTICS

The type, ratings and characteristics of high-voltage circuit breakers and contractors shall be as follows:

	Nominal System Voltage 33 kV -----	Nominal System Voltage 11 kV -----	Nominal System Voltage 3.3 kV -----	Nominal System Voltage LV -----
		Three (3) Phase		
		50Hz		
Rated Voltage kV (rms)	36	12	3.6	0.4
Lightning impulse withstand voltage				
- To earth (kV Peak)	170	75	40	2.0
- Across Isolating - Distance (kV Peak)	195	85	46	2.0
Power frequency withstand voltage				
- To earth (kV Peak)	70	28	10	2.0
- Across Isolating - Distance (kV rms)	80	32	12	2.0
Rated operating and control voltage				
DC(V) :		110V + 10% /-20% (IEC 255)		
AC :		Single Phase, 240V (+ 10% -15%)(IEC 694, Clause 4, 8)		



#### 9.5.5.4 CONSTRUCTION

##### (1) *Operating Mechanism*

###### (i) 72.5 kV Class (SF6 Gas) 55

The circuit breaker shall be provided with an operating mechanism of remote electrical and local manual control to be driven by pressure oil, compressed air or motor.

Each circuit breaker shall be provided with an individual pressure oil supply system or an individual compressed air supply system. The hydraulic accumulator or air reservoir of the system shall have sufficient capacity for satisfactory performance of the rated operating sequence at the minimum operating pressure, without oil or air supply.

The output of the oil pump or air compressor shall be sufficient to raise the pressure in the system within 20 minutes from the minimum operating pressure to the maximum operating pressure.

Each operating mechanism shall have an ample capacity for at least two times CO operations from normal operating pressure to minimum operating pressure, without pressure air supply from air compressor or pressure oil supply from oil pump.

The mechanism shall have a trip free function in any position, and shall include the auxiliary switches, operation counter and other required devices.

The power source for the oil pump and air compressor shall be three-phase or single-phase AC.

###### (ii) Less than 36 kV Class (Vacuum)

For the vacuum circuit breaker and the vacuum contractor, the operating mechanism shall be 110 V DC motor driven spring charged operation.

The operation mechanism shall also be capable of both remote and manual operation.

Test operation at draw-out position shall also be available.

The mechanism shall have trip free function in any position with anti-pumping feature and shall include auxiliary contacts, operation counter, position indicator and other required devices.

The mechanism shall be provided with suitable interlock scheme as follows:

- Cannot be closed under any conditions unless the spring is fully charged.

For the vacuum circuit breaker to be applied to the motor circuit feeder, the suitable protection against its undesirable switching surge shall be provided.

The protection shall be made with the surge absorber consisting of capacitor and lightning arrester.

##### (2) *Tripping and Closing*

Tripping and closing control power shall be obtained from DC supply equipment (DC 110 V).

Interposing relays shall be provided in the close and trip circuits for remote control of the circuit breakers.

Local test switch shall be provided for electrically testing the closing and tripping operations of the circuit breaker.

Test operation shall be available at only drawn-out position.

A separate manually operated cutout device to disconnect the circuits from remote closing and tripping devices shall be provided on each circuit breaker. This cutout device shall be mechanically interlocked with the test switch to prevent operation of the breaker from remote closing, re-closing or tripping devices during test operation of the breaker.

(3) *Auxiliary Power and Control Circuits*

All auxiliary power, control and alarm circuits requiring connection to external circuits shall be brought to suitable terminal blocks marked with circuit identification in accordance with the manufacturer's wiring diagram as approved by the Engineer. These terminal blocks shall be located in a common weatherproof housing.

The circuit breaker shall be provided with 110 V DC auxiliary power circuit and AC 415/240V, 3-phase, 4-wire, 50Hz, auxiliary power circuit. For the circuits, suitable molded case circuit breaker shall be installed.

(4) *Accessories*

(i). 72.5 kV Class SF6 circuit breaker (for each)

- Rating plates for circuit breakers and current transformers
- Position indicating lamps: red and green
- Auxiliary switches
- Air or oil valves, pressure gauges and piping
- Pressure switches for oil pump or air compressor control, low pressure alarm, etc.
- SF6 gas pressure gauges, pressure switches, valves and piping
- Space heater
- Operation counter
- Line terminal connectors of compression type
- Grounding terminals
- Supporting structures of hot-dipped galvanized steel, which shall withstand against mechanical impact due to earthquake and wind load specified.
- Despatching number plate holder
- Mounting bolts and nuts
- Other necessary accessories.

(ii) 72.5 kV Class SF6 circuit breaker (for all)

- One set of maintenance tool
- One set of SF6 gas charging device
- One set of SF6 gas leakage detector

(iii) Less than 36 kV Class Vacuum circuit breaker or contractor (for each)

- Rating plates
- Position indicating lamps: red and green
- 10-stage auxiliary switches
- Operation counter
- Closing spring condition indicator
- Draw-out unit with handle and guide
- Necessary terminal connections
- Local control box with push buttons of "ON" and "OFF"
- Other necessary accessories.

(iv) Less than 36 kV Class vacuum circuit breaker or contractor (for all)

- One (1) set of maintenance tools
- One (1) manual charging handle
- One (1) moving cart with lifter
- One (1) vacuum checker tester.

(5) *Spare Parts*

The list of spare parts to be furnished by the Contractor as specified in Section 7.1.22 shall include but not be limited to the following:

(i) For 72.5 kV Class (SF6 Gas) circuit breaker:

- One (1) complete phase (excluding supporting structure)
- Three (3) closing coils
- Three (3) tripping coils
- Two (2) complete sets of gaskets
- 500% of actual set of indicating lamps and fuses
- One (1) set of indicating lamp covers: red and green
- One (1) set consisting of contacts, coils, relays, small components, etc., for control gear recommended by the manufacturer.
- One (1) oil pump or air compressor replacement kit including all moving parts, springs, seals, unloader, pressure regulator and other control valve, gauge components, starter, contractors, etc. and all other recommended parts by the manufacturer.
- SF6 cylinder with gas and accessories which can be replaced the whole gas of one set of circuit breaker.
- Other spare parts recommended by the manufacturer. \*

(ii) For less than 33 kV Class (vacuum type) Circuit Breakers and Contractors:

- Three (3) closing coils
- Three (3) tripping coils
- Three (3) spring charging motors
- One (1) bushing of each type
- One (1) set of indicating lamp covers: red and green
- One (1) set of contacts, coils, relays, valves and other small components.
- Other spare parts recommended by the manufacturer. \*

### 9.5.5.5 TESTS

#### (1) *Factory Tests*

The following tests shall be carried out at the manufacturer's plant before shipment, in compliance with IEC 56-4 (1972), IEC 694 (1980) and IEC 185, unless otherwise specified.

Tests for the vacuum contractors shall be in accordance with IEC 470.

- (i). Appearance check
- (ii). Power-frequency voltage dry test on the main circuit
- (iii). Voltage withstand tests on control and auxiliary circuits
- (iv). Measurement of the resistance of the main circuit
- (v). Mechanical operating test
- (vi). Measurement of making and breaking time
- (vii). SF6 gas leakage test (for 72.5 kV Class)

The certificates of the following type test items shall be submitted with the test report:

- (i). Mechanical test
- (ii). Temperature rise test
- (iii). Impulse voltage test
- (iv). Power-frequency voltage wet test
- (v). Short-circuit making and breaking test
- (vi). Short-time current test
- (vii). Hydrostatic test for tank
- (viii). Test of pressure switches.

#### (2) *Field Tests*

After installation, the following tests shall be executed before energizing:

- (i). Verification of construction
- (ii). Mechanical operation tests
- (iii). Electrical operation tests
- (iv). Measurement of insulation resistance
- (v). Tests for pressure, oil or compressed air supply
- (vi). High voltage test
- (vii). Other necessary tests requested by the Employer and the Engineer
- (viii). Co-operation with other Contractors as may be required to check the operation and matching of equipment supplied under other contracts.
- (ix). *Accessories and spare parts tests.*



## 9.5.6 LIGHTNING ARRESTERS

### 9.5.6.1 GENERAL

(1) *General*

The Contractor shall furnish and install all lightning arresters as hereinafter specified and as shown on the drawings.

(2) *References*

The following standard is referred to:

IEC 99          Lightning Arresters

### 9.5.6.2 SCHEDULE

The lightning arresters schedule will be specified in SCHEDULE of the SUB-SECTION 9.6 PARTICULAR SPECIFICATIONS-ELECTRICAL WORKS.

### 9.5.6.3 TYPE RATING AND CHARACTERISTICS

The type, ratings and characteristics of lightning arresters shall be as follows:

	Nominal Voltage 66 kV (effective neutral grounded) -----	Nominal Voltage 33 kV (effective neutral grounded) -----	Nominal Voltage 22 kV (Non- grounded) -----	Nominal Voltage 6.6 kV (Non- grounded) -----	Nominal Voltage 3.3kV (Non- grounded) -----
Type	Indoor or Outdoor, Single-pole, Gapless, Explosion-proof type				
Number of phase:	Three (3) Phase				
Rated frequency:	50 Hz				
Rated Voltage(kV)	60	30	28	8.4	4.2
Lightning impulse withstand voltage (kV)	325	170	125	60	40
Power frequency withstand voltage(kV)	140	70	50	20	10
Max. continuous Operating voltage (line to ground) (kV peak)	76.3	38.2	39.6	14.3	7.1
Max. residual Voltage at lightning Impulse current of 8 x 20 μS					

- 10 kA (kV crest)      Less than 70% of Lightning impulse withstand voltage

#### 9.5.6.4 ACCESSORIES

All accessories shall be furnished with each lightning arrester. The accessories shall include but not be limited to the following:

- (i) Discharge counter four (4) digit, non-reset type
- (ii) Supporting structures made of galvanized steel (if necessary)
- (iii) Detector for leakage current
- (iv) Discharge current recorder

#### 9.5.6.5 TESTS

##### (1) *Factory Tests*

The lightning arresters shall be completely assembled at the factory. The lightning arresters shall be subject, unless otherwise noted, to the following tests by dry condition.

- (i) Verification of construction
- (ii) Power frequency starting voltage test
- (iii) Measurement of leakage current
- (iv) Power frequency withstand voltage dry test
- (v) Discharge counter operation test

The certificates of the following type test items shall be submitted with the test report:

- (i) Residual voltage test
- (ii) Power frequency voltage wet test
- (iii) Impulse voltage test
- (iv) Pressure-relief device test (if any).

##### (2) *Field Tests*

After installation, the following tests shall be executed before energizing:

- (i) Verification of construction
- (ii) Insulation resistance measuring
- (iii) High voltage test

## 9.5.7 INSTRUMENT TRANSFORMERS

### 9.5.7.1 GENERAL

(1) *General*

The Contractor shall furnish and install all instrument transformers as hereinafter specified and as shown on the drawings.

(2) *References*

The following standards are referred to:

IEC 185	Current Transformers
IEC 186	Voltage Transformers
IEC 358	Coupling Capacitors and capacitor dividers

### 9.5.7.2 SCHEDULE

The instrument transformers schedule will be specified in SCHEDULE of the SUB-SECTION 9.6 PARTICULAR SPECIFICATIONS-ELECTRICAL WORKS.

### 9.5.7.3 TYPE, RATING AND CHARACTERISTICS

The type, ratings and characteristics of instrument transformers shall be as follows:



(1) *Potential Transformer*

	Nominal Voltage 66 kV -----	Nominal Voltage 22 kV -----	Nominal Voltage 6.6 kV -----	Nominal Voltage 3.3 kV -----	Nominal Voltage 415V -----
Type					
- Outdoor					
- Indoor					
Number of phase			Three (3) Phase		
Rated frequency			50 Hz		
Primary Voltage (kV)	66	22	6.6	3.3	0.415
Secondary voltage (V)			110		
Accuracy class					
- General			1.0 Class		
- Tariff metering			0.5 Class		
Lightning impulse withstand voltage (kV)	325	125	60	40	5
Power frequency withstand voltage					
- Primary winding (kV)	325	125	60	410	5
- Secondary winding (kV)	2	2	2	2	2
Rated burden			200 VA more than		
Polarity			Subtractive		

(2) *Grounding Potential Transformer*

	<b>Nominal Voltage 66 kV</b>	<b>Nominal Voltage 22 kV</b>	<b>Nominal Voltage 6.6 kV</b>	<b>Nominal Voltage 3.3 kV</b>
Type				
- Outdoor			Oil filled completely sealed type	
- Indoor			Dry epoxy resin molded, built-in type	
Number of phase:		Three (3) Phase		
Rated frequency:		50 Hz		
Primary Voltage (kV)	66	22	6.6	3.3
Secondary voltage (V)			110 or 190	
Tertiary voltage (V)			110/3 or 190/3	
Accuracy class				
- Secondary			1.0 Class	
- Tertiary			3G Class	
Lightning impulse withstand voltage				
(kV)	325	125	60	40
Power frequency withstand voltage				
- Primary Winding (kV)	140	50	20	10
- Secondary Winding (kV)	2	2	2	2
Rated burden				
- Secondary			200 VA more	
- Tertiary			200 VA more	
Polarity			Subtractive	

(3) *Current Transformer*

	Nominal Voltage 66 kV -----	Nominal Voltage 22 kV -----	Nominal Voltage 6.6 kV -----	Nominal Voltage 3.3 kV -----	Nominal Voltage 415V -----
Type					
- Outdoor					Oil filled completely sealed type
- Indoor					Dry epoxy resin molded, built-in type
Number of phase			Single	Phase	
Rated frequency				50 Hz	
Primary Voltage(kV)	66	22	6.6	3.3	0.415
Rated current ratio			As shown on the Single Line Diagram		
Accuracy class					
- General metering					1.0 Class
- Tariff metering					0.5 Class
- Protection					5P10
Short term current for one (1) second		100% X Normal Interrupting Capacity			
Lightning impulse withstand voltage (kV)	325	125	60	40	5
Power frequency withstand voltage					
- Primary winding (kV)	140	50	20	10	2
- Secondary winding (kV)	2	2	2	2	2
Rated burden			30 VA more		
Polarity			Subtractive		

(4) *Zero Phase Sequence Current Transformer*

	Nominal Voltage 22 kV	Nominal Voltage 6.6 kV	Nominal Voltage 3.3 kV	Nominal Voltage 415V
Type	Indoor, dry epoxy resin molded type			
Number of phase	Single Phase			
Rated frequency	50 Hz			
Primary Voltage (kV)	22	6.6	3.3	0.415
Zero phase current ratio	200/1.5 mA			
Accuracy class	H class			
Short-time current for One (1) second	100% x Nominal interrupting capacity			
Lightning impulse withstand voltage (kV)	125	60	40	5
Power frequency withstand voltage				
- Primary winding (kV)	50	20	10	2
- Secondary winding (kV)	2	2	2	2
Rated burden	100 VA			
Polarity	Subtractive			

(5) *Rated Burden*

Rated burden of each instrument transformer shall be confirmed by the Contractor in accordance with the total necessary burden of the proposed meters, relays and cables and be responsible for modification of burden if the above mentioned burden is insufficient.

**9.5.7.4 CONSTRUCTION**

Current transformer shall be rated to withstand the thermal and magnetic stresses from currents equal to the short time rating of the circuit breakers.

The case shall be welded and weatherproof, finished for outdoor service. If made of ordinary steel it shall be galvanized and painted.

Polarity marks shall be permanent; shall be the integral parts of the transformer; and shall not be obliterated.

The terminal box shall be weatherproof design. The cover of the compartment shall be held by non-corrosive fasteners which are drilled to accommodate the seal wire.

Ground terminals shall be welded to the base plate and be provided with a clamp type connector.

On the terminal board in the terminal box, connection by using of insufficient wiring terminal such as Y (fork type) type, etc., shall not be acceptable to avoid possibility of undesirable high voltage occurrence in case of the current transformer especially.

#### **9.5.7.5 TESTS**

##### *(1) Factory Tests*

The instrument transformers shall be completely assembled at the factory. The instrument transformers shall be completely subject, unless otherwise noted, to the following tests by the Contractor.

- a. Potential and Ground Potential Transformers
  - (i) Verification of construction
  - (ii) Polarity tests
  - (iii) Temperature rise tests
  - (iv) Lightning impulse withstand voltage tests
  - (v) Power frequency withstand voltage tests
  - (vi) Voltage ratio error tests
  - (vii) Residual voltage tests
- b. Current and Zero-Phase Sequence Transformers
  - (i) Verification of construction
  - (ii) Polarity tests
  - (iii) Power frequency withstand voltage tests
  - (iv) Current ratio error tests
  - (v) Residual current tests
- c. The certificate of the following type test items shall be submitted with the test report:
  - (i) Short time current test for CT
  - (ii) Temperature rise test for CT
  - (iii) Secondary circuit open test for CT
  - (iv) Lightning impulse withstand voltage test for CT and PT
  - (v) Accuracy test for CT and PT.

##### *(2) Field Tests*

After installations, the following tests shall be executed before energized.

- (i) Verification of construction
- (ii) Polarity check
- (iii) High voltage test
- (iv) Measurement of current ratio and voltage ratio
- (v) Measurement of insulation resistance
- (vi) Other necessary tests requested by the Employer and the Engineer

## 9.5.8 POWER CAPACITORS

### 9.5.8.1 GENERAL

(1) *General*

The Contractor shall furnish and install all power capacitors as hereinafter specified and as shown on the drawings.

(2) *References*

The Following standard is referred to:

IEC 70            Power Capacitors

### 9.5.8.2 SCHEDULE

The power capacitors schedule will be specified in SCHEDULE of the SUB-SECTION 9.6 PARTICULAR SPECIFICATIONS-ELECTRICAL WORKS.

### 9.5.8.3 TYPE, RATING AND CHARACTERISTICS

The type, ratings and characteristics of power capacitors shall be as follows:

(1) *Power Capacitor*

		<b>Nominal Voltage 6.6 kV</b>	<b>Nominal Voltage 3.3 kV</b>
		-----	-----
(i)	Type :	Indoor, oil-filled completely sealed type	
(ii)	Number of phases :	Three (3) Phase	
(iii)	Rated frequency :	50 Hz	
(iv)	Rated voltage (kV) :	6.6	3.3
(v)	Maximum voltage :	110% x Rated voltage	
(vi)	Maximum current :	135% x Rated current	
(vii)	Lightning impulse withstand Voltage (kV) :	60	45
(viii)	Power frequency withstand Voltage (kV) :	20	10
(ix)	Accessories :	Discharge device (coil or resistor)	
(x)	Maximum temperature rise at nominal operating voltage :	30° C at the maximum ambient temperature of 35°C	

(2) *Series Reactor*

		<b>Nominal Voltage 6.6 kV</b>	<b>Nominal Voltage 3.3 kV</b>
		-----	-----
(i)	Type :	Indoor, oil-immersed or dry molded, hermetically sealed, self-cooled type	
(ii)	Number of phases :	Three (3) Phase	
(iii)	Rated frequency :	50 Hz	
(iv)	Circuit voltage (kV) :	6.6	3.3
(v)	Rated capacity :	6% x power capacitors	
(vi)	Maximum current :	135% x Rated current	
(vii)	Lightning impulse withstand Voltage (kV) :	60	45
(viii)	Power frequency withstand Voltage (kV) :	20	10

#### 9.5.8.4 CONSTRUCTION

The internal elements of the capacitor unit shall be made of synthetic films or kraft paper sandwiched between synthetic films as an insulator and aluminium foil as an electrode.

After congregating several numbers of these elements, the capacitor unit shall thoroughly dried under high temperature and vacuum condition, and impregnated with synthetic insulation oil of high purity which has been beforehand completely degassed of harmful impurities not to leave any gas in the container which may cause deterioration of the dielectrics.

The container shall be metal case having an ample strength and flexibility, and shall be capable of adjusting the volume in the container against expansion and contraction of the impregnating oil due to change of temperature.

The power capacitor shall have suitable mechanical fault detector to protect the capacitor from internal faults.

The detector shall be provided with the capacitor.

Upon detection, the faulted capacitor shall be removed from the circuit to prevent container rupturing.

Discharge device shall have function which the discharge of residual electric charge can be reduce to 50V or less within five (5) seconds at the capacitor terminal.

#### 9.5.8.5 TESTS

(1) *Factory Tests*

The power capacitors shall be completely assembled at the factory. The power capacitors shall be subject, unless otherwise noted, to the following tests by the Contractor:

- (i) Verification of construction
- (ii) Capacity tests

- (iii) Power frequency withstand voltage tests
- (iv) Capacitor loss tests
- (v) Temperature rise tests (Certificate of the type test with test report may be acceptable)
- (vi) Oil tightness tests
- (vii) Lightning impulse test (Certificate of the type test with test report may be acceptable)
- (viii) Capacitor loss test at elevated temperature (Certificate of the type with test report test may be acceptable)
- (ix) Measurement of insulation resistance

(2) *Field Tests*

After installation, the following tests shall be executed before energizing.

- (i) Verification of construction
- (ii) High voltage test
- (iii) Measurement of insulation resistance.

#### **9.5.8.6 ACCESSORIES**

The following accessories shall be provided :

- (i) For each capacitor bank
  - Rating plate and connection diagrams with full details
  - Two (2) grounding terminals
  - Other necessary accessories.
- (ii) For each reactor
  - Rating plate
  - Oil level gauge (if applicable)
  - Dial type thermometer (if applicable)
  - Two (2) grounding terminals
  - Other necessary accessories.





## 9.5.9 BATTERY AND CHARGER PANEL

### 9.5.9.1 GENERAL

#### (1) General

The Contractor shall furnish and install all battery and charger panels as hereinafter specified and as shown on the drawings.

#### (2) References

The following standards are referred to:

IEC 896	Pb battery
IEC 623	Ni – Cd Battery
SBA 6001	Determining the capacity of stationary batteries
JIS C8707	Stationary sealed lead-acid battery.

### 9.5.9.2 SCHEDULE

The battery and charger panel schedule will be specified in SCHEDULE of the SUB-SECTION 9.6 PARTICULAR SPECIFICATIONS-ELECTRICAL WORKS

### 9.5.9.3 TYPE, RATING AND CHARACTERISTICS

The type, ratings and characteristics of battery and charger panel shall be as follows:

(i) Type	:	Self-supported, metal-enclosed, indoor, battery built-in type
(ii) Rated insulation voltage	:	
- Main circuit	:	600V AC r.m.s.
- Control circuit	:	250V AC r.m.s
(iii) Rated operation voltage	:	
- Input	:	415V AC Three (3) Phase or 240V AC Single (1) Phase
- Output	:	110V DC
(iv) Input rated frequency	:	50 Hz
(v) Power frequency withstand Voltage	:	
- Main circuit	:	2000V AC .
- Control circuit	:	1500V AC
(vi) Rated operating and control voltage	:	
- DC	:	110V + 10% - 15%
- AC	:	220V + 10% - 20%

#### 9.5.9.4 CONSTRUCTION

The battery and charger panel shall be fabricated from flat rolled steel panel, reinforced where necessary in such a manner that the complete structure shall be rigid and free from twist and weave during handling and after installation.

The front shall be fabricated not less than 3.2 mm thick steel and other parts shall be fabricated not less than 2.3 mm thick steel.

The complete battery and charger panel including circuit breakers, transformer, thyristor and reactor shall be capable of withstanding without damage the electro-magnetic and thermal stresses resulting from the maximum asymmetrical value of the short-circuit current.

The panel shall be provided with lockable hinged front door and removable panels of adequate thickness on rear and bottom.

Provisions shall be made for bottom plate for bottom entry of power and control cable.

For safety of operating personnel, it is essential that should an arc develop in any one of the compartments, it shall be confined to that compartment without affecting the other compartments.

The panel shall be equipped with a space heater, a lamp and consent.

The panel shall be furnished as a completely factory-assembled unit where transportation facilities and installation requirements permit.

#### 9.5.9.5 EQUIPMENT INCLUDED

##### (1) Battery

Battery shall be of the nickel-cadmium type or the lead-acid type having cells contained in heat resistant, transparent, high impact plastic containers.

Cell containers shall be clearly marked to show the maximum and minimum levels of electrolyte, and shall be provided with vented filler plugs.

Cells shall be numbered consecutively. Cell terminals shall be of robust construction and shall be permanently marked to show their polarity.

Battery trays shall be factory treated with an electrolyte corrosion resistant finish, plastic coatings.

The battery shall have 5 hours discharge rate for the nickel-cadmium type and 10 hours discharge rate for the lead-acid type respectively, and have ample capacity as shown on the single line diagram.

Battery shall be of the following ratings:

- |                                |   |                                                                |
|--------------------------------|---|----------------------------------------------------------------|
| (i) Number of cells            | : | 92 cells (for Ni-Cd type)<br>55 cells (for lead-acid type)     |
| (ii) Floating charging voltage | : | 1.45V/cell (for Ni-Cd type)<br>2.15V/cell (for lead-acid type) |

- |                                         |   |                                                              |
|-----------------------------------------|---|--------------------------------------------------------------|
| (iii) Boost/Equalizing charging voltage | : | 1.6V/cell (for Ni-Cd type)<br>2.3V/cell (for lead-acid type) |
| (iv) Nominal voltage                    | : | 110V                                                         |
| (V) Allowable minimum voltage           | : | 1.1V/cell (for Ni-Cd type)<br>1.8V/cell (for lead-acid type) |

(2) *Battery Charger*

Battery charger shall be of the solid state constant voltage type incorporating a self-protecting current limiting feature for protection against low battery volts and short circuits. Battery charger shall be capable of initial charging, floating operation and equalizing charging.

Battery charger shall be suitable for continuous operation in an ambient temperature of 40 degrees C. Their output voltage regulation shall be not less than  $\pm 2\%$  irrespective of AC main input variations of  $\pm 10\%$  for load variation from 0% to 100% by using of a load voltage compensating device.

Battery charger shall have the following type and ratings:

- |                                       |   |                                                                                                    |
|---------------------------------------|---|----------------------------------------------------------------------------------------------------|
| (i) Type                              | : | Thyristor rectified switching type automatic boost/equalizing charge and load voltage compensator. |
| (ii) Rated                            | : | Continuous                                                                                         |
| (iii) Temperature rise of components: |   |                                                                                                    |
| - Transformer winding                 | : | less than 50 deg. C                                                                                |
| - Silicon diode                       | : | less than 85 deg. C                                                                                |
| - Thyristor                           | : | less than 65 deg. C                                                                                |
| - Resistor                            | : | less than 200 deg. C                                                                               |

Battery charger shall be fitted with an "ON" / "OFF" switch, AC-ammeter, DC-ammeter, DC-voltmeter with selector switch, indicating lamps for "AUTOMATIC CHARGE", "CHARGE OUTPUT FAILED" and others, and AC undervoltage relay, DC undervoltage relay and DC ground detecting relay, etc.as shown on the single line diagram.

(3) *DC Panel*

DC panel shall be self-supporting, indoor installation, metal enclosed cubicle type of robust construction. The degree of protection for enclosure shall be IP50 conforming to IEC 144 (1963).

The panel shall include the molded case circuit breakers as shown on the single line diagram.

The panel shall be provided with transparent front door consisting of transparent plate (glass plate, etc.) and suitable steel frame in order to avoid undesirable operation of the molded case circuit breakers by personnel touch, etc., and to make easy watch for the breakers' switching status.

The door shall be provided with suitable lockable handle.

(4) *Accessories*

The following accessories shall be supplied:

(i)	Maintenance tools	1 set
(ii)	Portable DC voltmeter (1.0 class)	1 set
(iii)	Syringe hydrometer	1 set
(iv)	Vent mounted thermometer (0-100 deg.C)	3 sets
(v)	Mixing tanks	1 set
(vi)	Funnel (made of synthetic resin)	3 sets
(vii)	Bottle (made of synthetic resin)	3 sets
(viii)	Requisite quantity of potassium hydroxide with 10% extra	1 set
(ix)	Sufficient quantity of distilled water first filling up	1 set
(x)	Steel locker for containing accessories	1 set

(5) *Spare Parts*

The list of spare parts to be furnished by the Contractor as specified in Section 7.1.22 shall include but not be limited to the following :

- (i) 30% of diluted potassium (For Ni-CD type)
- (ii) 30% of diluted sulfuric acid (For lead-acid type)
- (iii) Two (2) cells in seal
- (iv) 500% of actual use of indicating lamps and fuses
- (v) Other spare parts recommended by the manufacturer \*

**9.5.9.6 TESTS**

(1) *Factory Tests*

The battery and charge panels shall be completely assembled at the factory. The panels shall be subject, unless otherwise noted, to the following tests by the Contractor:

Battery Charger Panel

- (i) Construction check
- (ii) Power frequency voltage withstand test
- (iii) Measurement of insulation resistance
- (iv) Calibration test for meters
- (v) Operation tests including sequence check
- (vi) Characteristic test for relays.

Storage Battery

- (i) Construction check
- (ii) Electrolyte purity measurement
- (iii) Efficiency test (Certificate of the type test with test report may be acceptable).

(2) *Field Tests*

After installation, the following tests shall be executed before energizing:

- (i) Verification of construction
- (ii) Mechanical operation tests
- (iii) Electrical operation tests
- (iv) Measurement of insulation resistance.

#### 9.5.9.7 INSTALLATION

The battery and charger panel shall be mounted on steel channels which are installed on the concrete floor. The channels shall cover full length of the panel and shall be installed at level in all directions.

It may be required to install the channels (base) at the time of flooring work, prior to panel installation, depend on site work schedule.

Installation work shall be made so as to maintain the panels in an upright position, and *required their shifting shall also be done by means of their lifting or rolling of suitable roll bars inserted under them.* Lifting eye bolts shall be mounted on the top of the panel.

The panel shall be protected against any damage during its installation. Any damage for the paint shall be carefully repaired using touch-up paint furnished by the panel manufacturer.



## 9.5.10 HIGH VOLTAGE MOTOR CONTROL PANELS

### 9.5.10.1 GENERAL

#### (1) General

The Contractor shall furnish and install all high voltage motor control panels as hereinafter specified and as shown on the drawings.

The high voltage motor control panels shall be composed of the high-voltage motor panels and auxiliary relay panels.

Except for specification mentioned below, SUB-SECTION 9.5.2 HIGH VOLTAGE SWITCHGEAR, shall be complied with, where applicable.

#### (2) References

The following standards are referred to:

IEC 70	Power capacitors
IEC 144	Degrees of protection of enclosures for low switchgear and controlgear
IEC 158	Contractors
IEC 185	Current transformers
IEC 186	Voltage transformers
IEC 289	Reactors
IEC 292	AC general-purpose motor control center
IEC 298	High-voltage metal-enclosed switchgear
IEC 470	High voltage alternating current contractors.
IEC 726	Dry type transformer

### 9.5.10.2 SCHEDULE

The high-voltage motor control panel schedule will be specified in SCHEDULE of the SUB-SECTION 9.6 PARTICULAR SPECIFICATIONS-ELECTRICAL WORKS.



### 9.5.10.3 TYPE, RATING AND CHARACTERISTICS

The type, ratings and characteristics of the high-voltage motor control panels shall be as follows:

	NOMINAL VOLTAGE 6.6 kV -----	NOMINAL VOLTAGE 3.3 kV -----
Type	Indoor, self-supported metal-clad type	
Number of phases	Three (3) Phase	
Rated frequency	50 Hz	
Lightning impulse		
- withstand voltage		
- to earth (kV)	60	40
- across the isolating distance (kV)	70	46
Power frequency withstand voltage		
- to earth (kV)	20	10
- across the isolating distance (kV)	23	12
- control circuit (kV)	2	2
Rating operating and control voltage		
DC	110V + 10% (IEC 255) - 20%	
AC (r.m.s)	Three Phase, 415/240V + 10% (IEC 694 Clause 4.8) - 15%	

### 9.5.10.4 CONSTRUCTION

#### (1) High-voltage Motor Control Panels

The high-voltage motor control panels shall be an assembly which is enclosed in an earthed metal-enclosure.

The degree of protection for the enclosures and partitions, conforming to IEC 529 (1976), shall be as follows:

- Enclosure IP50
- Partitions IP3X

Minimum thickness of steel for each part of the high-voltage motor control panels shall be:

Side and rear plate	2.3 mm
Bottom plate	1.6 mm
Ceiling plate	1.6 mm
Roof plate	2.3 mm
Partition plate	1.6 mm
Front door plate	3.2 mm

Space heater fluorescent lamp fixtures and receptacle shall be provided inside each switchgear with thermostat and lighting switch.

(2) *Auxiliary Panels*

The auxiliary relay panels shall include auxiliary relays, sequence controllers, timers, annunciators and other devices for automatic controls, link-up controls and manual controls of each high-voltage motor.

Space heater fluorescent lamp fixtures and receptacles shall be provided inside each relay panel with thermostat and lighting switch.

#### 9.5.10.5 POWER BUSBAR AND EARTH BUSBAR

All busbars shall be made of copper and shall be totally enclosed with long life and durable insulating material.

Power buses shall be copper having a suitable current rating, and shall be supported by non-hygroscopic insulators designed to withstand forces due to the momentary short circuit current of the system.

Earth bus shall be of copper and size shall be not less than 6 mm x 75 mm.

A tee connection from the main earth-bus shall project into each circuit breaker compartment for the automatic earthing of the circuit breaker when it is inserted into the compartment.

Power busbar shall be located at upper side of panel. At request (as described on the Special Specifications), major components such as the busbar and the connection conductor, etc., may be provided with suitable insulation cover.

#### 9.5.10.6 TESTS

(1) *Factory Tests*

The high-voltage motor control panels shall be completely assembled at the factory. The switchgear shall be subject, unless otherwise noted, to the following tests by the Contractor:

- (i) Verification of construction
- (ii) Mechanical operation tests
- (iii) Electrical operation tests
- (iv) Temperature rise tests
- (v) Withstand voltage tests
- (vi) Short-time current tests
- (vii) Short circuit current tests
- (viii) Weatherproofing tests
- (ix) Accessories and spare parts test.

(2) *Field Tests*

After installation, the following tests shall be executed before energizing:

- (i) Verification of construction
- (ii) Mechanical operation tests
- (iii) Electrical operation tests (include remote)

(iv) High voltage tests.

### 9.5.10.7 EQUIPMENT INCLUDED

The high-voltage motor control panels shall include necessary equipment presented herein.

(1) *Motor Controller*

The motor controller shall have the following ratings and features:

(i) Full-Voltage Starter Type

	<b>NOMINAL 6.6 kV</b>	<b>NOMINAL 3.3 kV</b>
	-----	-----
(a) Vacuum circuit breaker		
- Type :	Three (3) pole, single-throw, vacuum type, draw out type	
- Rated voltage (kV) :	7.2	3.6
- Rated interrupting current (kA) :	As shown on the single line diagram	
- Rated operating & control voltage		
AC :	3 Phase, 415 / 240 V + 10% - 15%	
DC :	110V + 10% - 20%	
- Number of circuit breakers :	1	1

(ii) Reactor Starter Type

	<b>NOMINAL 6.6 kV</b>	<b>NOMINAL 3.3 kV</b>
	-----	-----
(a) Vacuum Circuit breaker		
- Type :	Three (3) pole, single-throw, vacuum type, drawout type	
- Rated voltage (kV) :	7.2	3.6
- Rated interrupting current (kA) :	As shown on the single line diagram	
- Rated operating & control voltage		
AC :	3 Phase, 415/240V + 10% - 15%	
DC :	110V + 10% - 20%	
- Number of circuit breaker :	1	1

	NOMINAL 6.6 kV	NOMINAL 3.3 kV
	-----	-----
(b) Vacuum switch		
- Type :	Three (3) pole, single-throw, vacuum load break switch, drawout type	
- Number of switches :	1	1
- Rated voltage (kV) :	7.2	3.6
- Rated interrupting current (kA) :	As shown on the single line diagram	
- Switching frequency (times/hour) :	600	
(c) Starting Reactor		
- Type :	Dry built-in type	
- Rated voltage (kV) :	7.2	3.6
- Insulation level :	B Class	
- Reduced voltage tap :	55% - 65% - 80%	
- Rating :	Intermittent periodic duty type with starting.	
- Capacity :	Ample start time duration capacity to be able to start the relevant motor sufficiently.	

(iii) Condorfer (Auto Transformer) Starter Type

	NOMINAL 6.6 kV	NOMINAL 3.3 kV
	-----	-----
(a) Vacuum Circuit breaker		
Type :	Three (3) pole, single-throw, vacuum type, draw-out type	
- Rated interrupting current (KA) :	As shown on the single line diagram	
- Rated operating & control voltage		
AC :	3 Phase, 415/240V + 10% - 15%	
DC :	110V + 10% - 20%	
- Number of circuit breaker :	1	1
(b) Vacuum switch		
- Type :	Three (3) pole, single-throw, vacuum load break switch, drawout type	
- Number of switches :	2	2
- Rated voltage (kV) :	7.2	3.6
- Rated interrupting current (kA) :	As shown on the single line diagram	
- Switching frequency (times/hour) :	600	
- Rated operating & control voltage		
- AC :	3 Phase, 415/240V + 10% - 15%	
- DC :	110V + 10% - 20%	

	NOMINAL 6.6 kV -----	NOMINAL 3.3 kV -----
(c) Auto Transformer		
Type	Dry molded type, indoor use, natural air cooling, built-in type	
- Insulation level	Class B	
- Tap	50%	65% - 80%
- Capacity	Ample short time duration capacity to be able to start the relevant motor sufficiently.	
- Number	1	1

(iv) Construction

AC control power shall be supplied from the each control power transformer in the high-voltage motor control panel.

Controller shall also be mounted in the high voltage motor control panel.

Interlock shall be furnished to prevent operation of the isolating mechanism under load; opening of the high voltage compartment before the controller is isolated and closing the line contractor while the door is open.

All controllers shall have the following equipment:

- (a). Static type overload relays, external hand reset, in all three phases.
- (b). Three (3) phase surge capacitors connected on the load side of the run contractor.
- (c). Protective relays shall be furnished with 2a + 2b, auxiliary contacts for operating alarms.
- (d). All necessary control relays and auxiliary contacts required for proper operation.

(v) Accessories

All accessories shall be furnished with each motor controller. The accessories shall include but not be limited to the following:

- (a). Primary and secondary couplers
- (b). Auxiliary switch
- (c). Position indicator (lights and mechanical)
- (d). Operator counter
- (e). Operation cabinet with wiring complete to terminal block for remote control
- (f). Three (3) phase surge capacitors
- (g). Name plate.

(vi) Spare Parts

The list of spare parts to be furnished by the Contractor as specified in Section 7.1.22 shall include but not be limited to the following. Spares for each motor controller of each starter type.

- (a). Three (3) complete set of vacuum bulbs

- (b). Each one (1) complete set of closing coil and tripping coil
- (c). One (1) complete set of auxiliary switch
- (d). Each type 500% pieces of lamp bulbs
- (e). One (1) complete set of signal lights.

(2) *Instruments and Relays*

Voltmeters, wattmeters and ammeters shall be not less than 110 mm square, 240 degrees from zero to full scale,  $\pm 1.5\%$  of full scale accuracy, panel mounted type and shall be provided with external zero adjustment.

Relays shall be draw-out, panel mounted, static type.

(3) *Phase and Sequence Selector Switches*

Phase and selector switches shall be heavy-duty, rotary type.

(4) *Control Switches*

Control switches shall be spring return type. The control switches shall be wear-proof type and arc-proof type, and with dust cover.

(5) *Annunciator*

Annunciator and signal light shall be back lighted and shall be relay operate. Annunciator operation sequence is shown on the drawing.

(6) *Sequence Controller*

All equipment shall be designed for nominal AC supply at 240 V, 50 Hz, single phase. Automatic voltage regulator shall be furnished to provide a constant voltage source for the sequence controller with the specified input voltage variation. Ambient temperature will be 0 deg. C to 45 deg. C, and all offered equipment must be suitable for operation at these temperatures.

All equipment shall be treated to prevent the growth of fungus or other living organisms and shall be completely solid state, unless otherwise specified.

Unless otherwise specified all active and passive elements shall be manufactured to industrial standard specifications.

Lightning protection shall be provided for all equipment furnished under this section.

Self-checking system and battery for power failure shall be provided.

Two sets of programming loader for programming shall be furnished.

Specifications of sequence controller shall be as follows:

Programme system	:	Stored programme system
Instructions	:	Basic four (Read, and or write)
Computation functions	:	Timer computation, counter computation, step control, shift register and logic control.

Computation system	:	Usually cyclic computation
Input	:	Non-voltage contact
Output	:	Contact

(7) *Auxiliary Relays*

Auxiliary relays shall be general purpose industrial types, and shall be dust cover enclosed plug-in type.

(8) *Signal Lights*

Red signal lights shall be used for "ON" position and green lights for "OFF" position.

Signal light shall be of LED lamp.

(9) *Test Terminals*

Test terminals shall be furnished on the secondary circuit of the potential transformer and the current transformer. All matching test plugs shall be furnished. Test plugs and lead wires for each type of protective relay shall be furnished.

#### 9.5.10.8 INSTALLATION

The high voltage motor control panel shall be mounted on steel channels which are installed on the concrete floor. The channels shall cover the full length of the panel and shall be installed at level in all directions.

It may be required to install the channels (base) at the time of flooring work, prior to panel installation, depend on site work schedule.

Installation work shall be made so as to maintain the panels in an upright position and required their shifting shall also be done by means of their lifting or rolling of suitable roll bars inserted under them. Lifting eye bolts shall be mounted on the top of the panel.

The panel shall be protected against any damage during its installation. Any damage for the paint shall be carefully repaired using touch-up paint furnished by the panel manufacturer.

## 9.5.11 LOCAL CONTROL PANEL

### 9.5.11.1 GENERAL

#### (1) General

The Contractor shall furnish and install all local control panels as hereinafter specified and as shown on the drawings.

#### (2) References

The following standard is referred to:

IEC 492 Factory-built assemblies of low-voltage switchgear and control gear.

### 9.5.11.2 SCHEDULE

The local control panels schedule will be specified in SCHEDULE of the SUB-SECTION 9.6 PARTICULAR SPECIFICATIONS-ELECTRICAL WORKS.

### 9.5.11.3 TYPE, RATINGS AND CHARACTERISTICS

The type, ratings and characteristics of the local control panels, shall be as follows:

Type	:	Indoor, self-standing type or indoor, pipe-stand type or indoor wall-mounted type or indoor, self-standing, explosion proof type or indoor, pipe-stand, explosion proof type or indoor, wall-mounted, explosion proof type or outdoor, self-standing type or outdoor, pipe-stand type or outdoor, wall-mounted type.
Number of phases	:	Three (3) phase, four (4) wire
Rated frequency	:	50 Hz.
Rated insulation voltage	:	
- Main circuit	:	600V AC r.m.s.
- Control circuit	:	250V AC r.m.s.
Rated operation voltage	:	
- Main circuit	:	415V AC.
- Control circuit	:	240V AC and 110V DC
Power frequency withstand voltage	:	
- Main circuit	:	2,000V AC r.m.s.
- Control circuit	:	1,500V AC r.m.s.
Rated operating and control voltage	:	
- DC	:	110V + 10% (IEC 25) - 20%.
- AC	:	Three (3) Phase, 415/240V + 10% - 15% (IEC 694, Clause 4.8)



#### 9.5.11.4 CONSTRUCTION

The local control panel shall be designed and manufactured on the basis of consideration of actual site condition such as moisture, dust, chemicals and explosive gas, etc.

Local control panel shall be fabricated of heavy gauge steel not less than 2.3 mm thick and shall be of rigid construction.

Necessary devices such as ammeters, control switches, pushbuttons, signal lamps, selectors and annunciators shall be panel front mounted and relay, timer and terminals shall be panel inside installed.

Local control panels which will be in outdoor service or in service at basement floor of the building shall be provided with space heater and thermostat.

Door for maintenance shall be provided with key-locking.

All fastening devices shall be stainless steel.

#### 9.5.11.5 TESTS

##### (1) *Factory Tests*

The local control panels shall be completely assembled at the factory. The local control panels shall be subject, unless otherwise noted, to the following tests by the Contractor:

- (i) Verification of construction
- (ii) Mechanical operation tests
- (iii) Electrical operation tests including meter calibration check
- (iv) Temperature rise tests
- (v) Withstanding voltage tests including insulation resistance measurement
- (vi) Weather proofing tests

##### (2) *Field Tests*

After installation, the following tests shall be executed before energizing:

- (i) Verification of construction
- (ii) Electrical operation tests
- (iii) Measurement of insulation resistance.

#### 9.5.11.6 EQUIPMENT INCLUDED

The local control panels shall include necessary equipment as presented herein.

##### (i) Molded Case Circuit Breaker

Circuit breaker shall be of molded case type with auxiliary switch, bolted-in. Circuit breaker shall have ample interrupting current value. If required, circuit breaker shall be furnished with motor operation for interlocking and operating.

(ii) Instruments

Voltmeters and ammeters shall be not less than 110 mm square, 240 degrees from zero to full scale,  $\pm 1.5\%$  of full scale accuracy, panel mounted type and shall be provided with external zero adjustment.

(iii) Phase and Sequence Selector Switches

Phase and selector switches shall be heavy-duty, rotary type.

(iv) Control Switches

Control switches shall be pushbutton type. The control switches shall be wear-proof type and arcproof type, with dust cover.

Lamp indicator, etc., shall have suitable resistor, if required.

(v) Annunciator

Annunciator and signal light shall be back lighted and shall be relay operated. The light shall go out when the alarm condition is removed.

(vi) Auxiliary Relays

Auxiliary relays shall be general purpose industrial types, and shall be dust cover enclosed plug in type.

(vii) Signal Lights

Red signal lights shall be used for "ON" position and green lights for "OFF" position.

Colour caps shall be made of a material which will not be softened by the heat from the lamps.

Each signal light shall be of LED lamp preferably.

(viii) Test Terminals

Test terminals shall be furnished for the secondary circuit of the potential transformer and the current transformer. All matching test plugs shall be furnished. Test plugs and lead wires for each type of protective relay shall be furnished.

#### **9.5.11.7 INSTALLATION**

The local control panels shall be protected against damage at all times. Any damage to the paint shall be carefully repaired using touch-up paint furnished by the panel manufacturer.