

## SECTION – VII

### 11 kV BAY EQUIPMENT

#### 7.0 SCOPE

These specifications covers the design, manufacture, supply, erection, testing and commissioning of the following equipment to be installed in the switchyard for 11 kV feeder

- (i) 11 kV Vacuum Circuit Breaker
- (ii) 11 kV Lightning Arrestors
- (iii) 11 kV Isolator
- (iv) 11 KV DO Fuse unit complete with all accessories like barrels with metal parts, fuse elements, hooke stick etc.
- (v) 11 kV current Transformers
- (vi) 11 kV potential transformer
- (vii) Switch Yard Structures as required.
- (viii) Busbar & Busbar connections
- (ix) Insulators & hardware etc. as required.
- (x) grounding and earthing of switchyard and power equipments
- (xi) lightning protection
- (xii) Any other item required in the switchyard to make it complete.

#### 7.1 11 KV VACCUUM CIRCUIT BREAKER : PREFERRED MAKE : KIRLOSKAR ELECTRIC / BHEL / ALSTOM / CROMPTON GREAVES.

##### 7.1.1 SCOPE OF SUPPLY AND DESIGN CRITERIA

These specifications cover the design, manufacture, supply, erection, testing and commissioning of one number 11 kV circuit breaker vacuum type suitable for installation in out door switch yard. The breakers shall be complete in all respect including supporting structures, control kiosk mounted there on, bushings, terminal connectors suitable for ACSR conductor, operating mechanism, earthing terminals etc. as per relevant IS specifications. Scope of work also includes design, manufacture supplying, erection, testing and commissioning of indoor cubical type breaker control panel for remote operation of the breaker from control room with necessary protection relays, over current, earth fault reverse power relay, and any other relay required to make the system safe measuring and metering, indication equipments suitably housed along with the necessary accessories and properly wired. This control panel should be compatible in size and dimension with the LT control and relay panels for the generating units described in Section - VI

##### 7.1.2 APPLICABLE STANDARDS

Unless otherwise modified in this specification, the vacuum circuit breakers shall comply with the following Indian Standards as amended from time to time:

- IS - 13118 : Circuit breakers  
IS - 3156 : Voltage transformers

IS - 2702 : Current transformers

### **7.1.3 RATED VOLTAGE**

The rated voltage for the circuit breaker shall be 12 kV. This represents the highest system voltage corresponding to the nominal system voltage of 11 kV.

### **7.1.4 RATED CURRENT**

The Standard rated normal current shall be 400A.

### **7.1.5 RATED SHORT-CIRCUIT BREAKING CURRENT**

The rms value of the a.c. component of the rated short-circuit breaking current shall be 12.5 kA.

The value of d.c. component shall be calculated in accordance with recommendations contained in IS : 13118.

### **7.1.6 RATED SHORT-CIRCUIT MAKING CURRENT**

The rated short-circuit making current of the circuit breakers shall be taken as 2.5 times the rms value of the a.c. component of the rated short-circuit breaking current.

### **7.1.7 RATED VOLTAGE OF OPERATING DEVICES**

The standard DC voltage for the operating devices shall be 24 V.

### **7.1.8 METERING AND PROTECTION**

- (i) Meters/instruments like KW meter, voltmeter, Ampere meter on the circuit breaker control panel shall be provided in accordance with the relevant ISI standards.
- (ii) A triple-pole IDMTL type protection relay having two elements for over-current protection and one element for earth fault protection shall be provided on 11 kV outgoing circuit breaker control panel. The current setting range of the over-current elements shall be from 50% to 200% in steps of 25% and that of the earth fault element from 20% to 80% in steps of 10%.
- (iii) Trivector electronic energy meter (microprocessor based , digital) on control panel for metering of energy on outgoing feeder.
- (iv) Provision of relays shall be kept in the panel for protection of transformers from high winding temperature, high oil level temperature and low oil level.

### **7.1.9 CONSTRUCTIONAL FEATURES – VACUUM CIRCUIT BREAKER**

#### **Out door Application:**

Vacuum circuit breakers for outdoor application shall be fixed type of construction and the vacuum interrupter units together with the HV connections shall be enclosed in a sealed housing (preferably of porcelain) conforming to IP-65 protection (IS:2147). The operating mechanism, links, etc. shall be housed in a suitable cubicle and should be accessible for maintenance. The indicators and operating handle etc. shall be provided on the front side with a hinged door and locking device. The door shall open upwards (with hinge at the top) for protection against rain (when in open position) .

No isolator shall be provided in outdoor breakers.

### **7.1.10 CLOSING/TRIPPING MECHANISM**

- i. Electrically and Manually operated mechanism. Breaker shall be provided with trip free mechanism.
- ii. It shall be suitable for remote control from the control room.
- iii. The operating mechanism shall be of spring charging type by electrical control under normal conditions. The mechanism shall be trip free electrically and mechanically.
- iv. The motor for spring charging shall be suitable for operation on 230 V AC supply and shall have overload protection.
- v. A local control switch with locking arrangement shall be provided for each breaker for local operating i.e. tripping and closing during maintenance, test etc.
- vi. Local/remote selector switch and Trip/Normal/Close control switch shall be provided in the mechanism cabinet.
- vii. An operation counter for each breaker shall be provided.
- viii. Cabinet for operating mechanism and its accessories shall be as per relevant standards with padlocking facility. Cabinet shall be simplex type, all equipment mounted on front side and wiring on back in proper wire ways.
- ix. Panel illumination and anti-condensation heater shall be provided in the local and remote control panel with MCB and thermostat.
- x. Closing circuit to operate satisfactorily from 85% to 110% of the rated control voltage and tripping from 50% to 110% of the rated voltage.

### **7.1.11 TESTS**

The circuit breakers, voltage transformers and current transformers shall be subjected to the following routine and type test in accordance with the details specified in the relevant Indian Standards, as amended from time to time.

Circuit Breaker - IS : 13118-1991

**(i) Routine Tests**

- ii)** Power frequency voltage dry test on the main circuit
- iii)** Voltage test on control and auxiliary circuits.
- iv)** Measurement of resistance of the main circuit
- v)** Mechanical operating test

**(ii) Type Tests**

- a) Tests to prove mechanical performance
- b) Tests to prove mechanical operation
- c) Tests to prove that temperature rise of any part does not exceed specified limits
- d) Tests to prove that insulation complies with specified limits
- e) Tests to prove short-circuit making and breaking performance.
- f) Tests to prove sort-time current performance.
- g) Tests to prove performance when breaking line charging current
- h) Test to prove performance when breaking cable charging current
- i) Tests to prove the performance when breaking single capacitor bank currents
- j) Tests to prove the performance when breaking small inductive currents.

**7.1.12 TECHNICAL REQUIREMENTS OF BREAKERS**

<b>SL. NO.</b>	<b>PARTICULARS</b>	<b>11 KV BREAKER</b>
1.	Name of manufacturer/ (Word equivalent not acceptable)	
2.	Manufacturers type designation	Vaccum Type
3.	Rated Voltage	11 KV
4.	Maximum (continuous service rated voltage)	12 KV
5.	Short current rating: 1 second rms (kA) 3 second rms (kA)	16.0 KA
6.	Normal current rating: Under normal conditions Under site conditions	400 Amp. 400 Amp.
7.	Maximum temperature rise ambient	
8.	Breaking capacity a) Symmetrical b) Symmetrical at rated service voltage c) Asymmetrical	12.5 KA 750 MVA
9.	Making capacity	40 KA
10.	Total break time at 10% rated interrupting capacity at rated interrupting capacity	Less than 100 ms Less than 100 ms
11.	Arcing time	Less than 50 ms
12.	Make time	Less than 100 ms

<b>SL. NO.</b>	<b>PARTICULARS</b>	<b>11 KV BREAKER</b>
13.	Minimum reclosing time from the instant of trip coil energisation	--
14.	Minimum dead time for 3 phase reclosing	--
15.	Data on transient recovery voltage	
	i) Amplitude factor	50% of rated capacity
	ii) Natural frequency	--
	iii) Phase factor	--
	iv) R.R.R. volts in micro second	--
16.	Dry 1 minute power frequency withstand test voltage	
	a) Between line terminal and ground objects:	75 kV
		75 kV
	b) Between terminal with breaker contacts open	
17.	1.2 / 50 full wave impulse withstand test voltage for the two cases given below:	
		170 kVP
	Between terminal with breaker contacts open	170 kVP
18.	Bushing of insulators	
	ii) Type of bushing	
	iii) Dry 1 min. power frequency withstand test voltage kV (rms)	Hollow porcelain
	iv) Dry flash over value kV (rms)	--
	v) Wet flash over value kV (rms)	--
	vi) 1.2/50 impulse withstand kV (speak)	--
	vii) Creepage distance	--
19.	Minimum clearance in air	
	ii) Between phases	435 mm
	iii) Live parts to earth	435 mm
	iv) Live parts to ground level	2930 mm
20.	Number of poles of circuit breaker	3
21.	Number of breaks per phase	1
22.	Total length of break per phase	30 mm
23.	Type of main contacts	Butt
24.	Type of arcing contacts	Spiral
25.	Material of arcing contacts	Copper alloy
26.	Contacts silver plated or not	Yes
27.	Thickness of silver plating	20 micros
28.	Contact pressure	139 kgs. area of contacts 94 cms.

SL. NO.	PARTICULARS	11 KV BREAKER
29.	Number of auxiliary contacts provided	
	Those closed when breaker is closed	6
	Those open when breaker is closed	6
30.	Type of operating mechanism	motor
	ii) Opening	spring charging
	iii) Closing	mechanism
31.	Control circuit voltage	24 V DC
36.	Maximum over voltage on switching transformer on no load and the charging current	Less than 4 per unit
41.	Kilometric fault level (MVA)	750 MVA

### 7.1.13 CIRCUIT BREAKERS

- (i) The breakers shall be of vacuum type. They shall be restrike free, stored energy operated, trip free, and with electrical anti-pumping feature. Only motor wound closing spring charging arrangement shall be accepted. Operating cycle shall be 'O-3 min.-CO-3min.-CO'.
- (ii) The breaker shall be controlled locally and/or remotely as required. The closing and tripping coils shall operate under extreme conditions of control voltage variation. Supervision relays shall be provided for trip coil monitoring. Facilities shall be provided for mechanical tripping of breaker and manual charging of closing spring.

### 7.1.14 RELAYS AND PROTECTION

Relay and protection shall generally be as shown in metering and relaying scheme

- (i) Selection of all types of relays shall be subject to Owner's approval. All relays and timers shall be flush mounted with connections from inside. They shall have transparent & dust tight cover, removable from front, drawout construction for easy replacement from the front. They shall have built-in test facilities, or can be provided with necessary test blocks and test switches. One testing plug shall be provided. The auxiliary relays and timers may be in non-drawout cases.
- (ii) The relays and timers shall operate under extreme conditions of control voltage variation. They shall not have any in-build batteries, and shall operate on available dc supply. They shall be provided with hand-reset operation indicators (flags) or LEDs with push buttons for resetting for analyzing the cause of breaker operation.

## **7.2 TECHNICAL SPECIFICATIONS FOR LIGHTNING ARRESTORS**

### **7.2.1 SCOPE**

This specification covers Station class, 10 kA, heavy duty, non-linear resistance, metal oxide type gapless lightning arrester for 11 kV system.

### **7.2.2 APPLICABLE STANDARDS**

As the Indian Standard on metal oxide lightning arresters is under finalization, the lightning arresters shall generally conform to stipulations made in IEC document TC-37.

### **7.2.3 RATED VOLTAGE**

The rated voltage of arresters shall be 9 KV (rms). These ratings are applicable for effectively earthed systems with the transformer neutral effectively earthed.

### **7.2.4 NOMINAL DISCHARGE CURRENT RATING**

The nominal discharge current rating of arresters shall be 5 KA for 11 KV system

### **7.2.5 CURRENT IMPULSE WITHSTAND LEVELS**

The 9 kV arresters shall withstand 18 impulses of long duration current with a peak level of 75 Amps. And duration 1000 micro-secs.

### **7.2.6 PROTECTIVE LEVELS**

These arresters shall meet the following maximum protective levels:

	9KV
Maximum residual voltage at nominal discharge current 11 KV (Peak)	32
Maximum steep current impulse residual voltage at nominal discharge current KV (Peak)	38
Maximum switching impulse residual voltage at 500 Amps.	Not applicable

### **7.2.7 TERMINAL ARRANGEMENT**

The top metal cap and the base of the lightning arresters shall be galvanized. The line terminal shall have a built-in-clamping device which can be adjusted for both horizontal and vertical take off to suit ACSR (Conductor size to be specified by the purchaser). The base of the lightning arresters shall be provided with two separate terminals distinctly marked for connection to earth.

### **7.2.8 SEALING**

The arresters shall be hermetically sealed to avoid ingress of moisture. Suitable rubber gaskets with effective sealing system should be used. Manufacturers should devise a suitable routing production testing to verify the efficacy of sealing.

### **7.2.9 DISCONNECTING DEVICE**

The arrester for 11 kV system may be provided with a suitable disconnecting device. This shall be connected in series with the ground lead and should not affect the sealing system of the arresters. The disconnecting device shall conform to the requirements specified in IS : 3070 (Part-2) 1985.

### **7.2.10 PRESSURE RELIEF DEVICE**

The arresters for 11 kV system should have a suitable pressure relief system in order to avoid damage to its porcelain housing.

### **7.2.11 TESTS**

#### **(1) Type Tests**

- (a) Insulation withstand test
- (b) Residual voltage test
- (c) Current impulse test
- (d) Operating duty test
- (e) Test for arrester disconnectors
- (f) Temperature cycle test on porcelain housing
- (g) Porosity test for porcelain components
- (h) Galvanizing test on exposed steel metal parts
- (i) Visual examination

#### **(2) Acceptance Tests**

The following tests shall be done on the lower whole number of the cube root of the number of arresters to be supplied:

- (a) Power frequency reference voltage test at reference current on complete arresters
- (b) Lightning impulse residual voltage test at nominal discharge current on complete arresters
- (c) Galvanizing test on exposed steel parts
- (d) Visual examination

#### **(3) ROUTINE TESTS**

- (a) Measurement of the reference voltage on the complete arresters
- (b) Residual voltage test at nominal discharge current on the complete arresters of sections.
- (c) Test to verify the efficacy of sealing

#### **(4) INSPECTION**

All tests and inspection shall be made at the place of manufacture unless otherwise specially agreed upon by the manufacturer and the purchaser. The manufacture shall afford the inspector (representing the purchaser) all reasonable facilities without charge to satisfy him that the material is supplied in accordance with this specification.

The purchaser has the right to have the tests carried out at his own cost by an independent agency, whenever there is dispute regarding the quality of supply.

### **7.3 TECHNICAL SPECIFICATION FOR ISOLATOR:**

#### **7.3.1 SCOPE**

This specification covers 11 KV, 50 Hz Air Break Switches for outdoor installation. The switches are suitable for operation under off-load conditions only and are intended for use on feeder circuit at project and Distribution sub-station for 11 KV lines.

#### **7.3.2 APPLICABLE STANDARDS**

Unless otherwise stipulated in this specification, the AB switches shall conform to IS: 9920 (Pt.I to IV)

#### **7.3.3 RATED VOLTAGE**

The rated voltage shall be 11 KV.

#### **7.3.4 RATED NOMINAL CURRENT**

The rated normal current shall be 400 Amps.

#### **7.3.5 RATED LIGHTNING IMPULSE WITHSTAND VOLTAGE kV (PEAK)**

i)	To earth and between poles	75 KV
ii)	Across the terminals of open Switch	85 KV

#### **7.3.6 RATED ONE-MINUTES POWER FREQUENCY WITHSTAND VOLTAGE kV (rms)**

i)	To earth and between poles	28 KV
ii)	Across the terminals of open Switch	32 KV

**Note:** The withstand values in clauses 5 & 6 shall apply at the standard reference atmosphere (temperature, pressure and humidity) Specified in IS: 2071 (Part-I) 1974.

### 7.3.7 TEMPERATURE RISE

The temperature rise shall not exceed the maximum limits specified below:

Temperature rise limit at ambient temperature not exceeding	40°C
Copper contacts (Silverfaced) in air	65°C
Terminals of the switch intended to be connected to external conductors by bolts	50°C

### 7.3.8 RATED SHORT TIME CURRENT

The rated short time current shall be 16 kA.

### 7.3.9 CONSTRUCTIONAL FEATURES-ISOLATORS

The Air Break Switch shall have triple-pole construction and shall be suitable for horizontal or vertical mounting as required by the purchaser. The switch shall have two 11 kV post insulators per phase suitably mounted on angle irons to enable easy movement of insulators. The angle supports shall be mounted on a 70 mm hollow beam suitable for fixing on the double pole structure. Alternatively, the angles shall be mounted on a steel frame made of two angle/ channel supports. The switch shall be manually operated with a rocking type arrangement through a 30 mm<sup>2</sup> G.I coupling rod.

All current carrying parts shall be made of silver or nickel-plated 90% electrolytic copper. The arcing horns shall be made of phosphor bronze and shall have spring –assisted operation. The switch shall have a spring mechanism so as to ensure that the speed of opening of contacts is independent of the speed of manual operation.

The spacing between the phases shall be adjustable between 600 mm to 760 mm. Total length of the square beam/ base frame shall be kept as 2650 mm. The switch assembly shall be suitable for mounting on a H-pole structure with centre –to –centre distance between poles upto 244 mm.

The vertical operating rod shall comprise of 25 mm (Nominal bore) Galvanized steel tube (medium class) as per IS: 1161-1979. Length of the operating tube shall vary from 580 mm to 6000 mm depending upon the mounting position of the switch on the structure (Exact length to be specified by the purchaser).

Suitable arrangement shall be provided to pad –lock the operating handle in ‘ON’ and ‘OFF’ positions.

The switch shall be provided with bimetallic connectors on the incoming side to accommodate ACSR of sizes 20, 30 and 50 mm<sup>2</sup>. On the outgoing side, about ½ meter long flexible coil type cable jumper of not less than 50 mm aluminum section shall be provided.

All iron parts shall be hot dip galvanized. The tubes shall be galvanized in accordance with IS: 4736-1968.

### **Isolator and Earth Switch Operation**

The isolating switch shall be equipped with local manual operating device intended for operation. It shall be possible to padlock the manual-operating handle both in the open and closed positions of the switches. Additional electromagnetic type interlock shall be provided on the manual operating handle and control cubicle for motor operation so as to prevent the operation of isolator manually and locally when the corresponding circuit breaker is 'ON'. Earth switches shall also be local manual operated by separate operating mechanism.

## **7.4 SPECIFICATIONS FOR 11 kV CTs**

### **9.4.1 Scope**

The specification provides for design, manufacture, testing at manufacturers works and delivery in accordance with the detailed requirements of these specifications of the current transformers as specified in "Schedule of requirements and prices". The terminal connectors, fixing clamps shield rings (if required), hardwares to fix the equipment on structures are included in the scope of this specification.

### **7.4.2 Standards**

The current transformers shall comply with the latest editions of ISS No. 2705 (part – I, II, III & IV) or any other recognised International standard except in so far as modified by these specifications. Where standards adopted are other than ISS, copies of the relevant standard specification be attached with the tender. The tenderer shall state the standard specification to which the equipment conforms.

### **7.4.3 Type and Rating**

The current transformers shall be of ring type, single phase, cast resin, self cooled and suitable for operation in 3 phase solidly grounded system with following particulars:-

i)	Nominal system voltage	11 kV
ii)	Highest system voltage	12 kV
iii)	Frequency	50 Hz
iv)	Ratio	40-20/1
v)	Accuracy protection/ metering	5P15/class 0.2
vi)	Burden	20 VA

### **7.4.4 Temperature Rise**

The maximum temperature attained by any part of the equipment in service at site under continuous overload capacity conditions as per section II and exposed continuously to the direct rays of sun shall not exceed the permissible limit fixed

by the applicable standard, when corrected for the difference between the ambient temperature at site and the ambient temperature specified by the standard.

#### **7.4.5 Drawings**

In addition to any other drawings and literature which the tenderer may enclose to show merits of his equipment, the following drawings shall be supplied.

1. Drawing showing outlines of each current transformer.
2. Drawing showing inside details viz
  - a) No. of primary turns
  - b) No. of secondary turns
  - c) Core Area
  - d) Cross-sectional area of primary and secondary conductor.
3. Drawing showing details of both primary & secondary terminal connectors.
4. Drawing showing details of mounting flange.
5. Magnetising curves for each of the secondaries of current transformers.
6. Drawing showing the connection and wiring diagrams of primary and secondary windings.
7. Primary and secondary windings.
8. Manuals on maintenance & check/trouble shooters etc.

#### **7.4.6 General Requirements**

Current transformers shall be of robust design, tested quality and reliable in operation. Only pure high grade paper, wound evenly under controlled conditions and impregnated with mineral oil under high vacuum shall be used for the main insulation. The assembly of each CT shall be dried, filled with appropriate quality of insulating oil under high vacuum and hermetically sealed with or without inert gas to eliminate undesirable effect of moisture and oxygen on the internal insulation. No breathers and/or drying chemicals shall be used in the design and construction of CTs.

The shape of the external metal parts shall ensure that rain water runs off and it does not accumulate. All external surfaces shall be resistant to atmospheric corrosion either by the selection of suitable materials or by proper treatment such as hot dip galvanisation, zinc

coating and passivation enamel painted over rust inhibitive coat of zinc chrome primer etc. Likewise, the internal metal surfaces coming in contact with oil shall be given proper treatment unless the material used itself is oil resistant. Bolts, nuts and washers to be used as fasteners shall be heavily hot dip galvanised throughout. The galvanising should conform to IS: 2629-1966. All CTs shall have an oil level gauge marked with the maximum and minimum levels. Although no oil samples may be required to be taken for analysis nor any filter connections made for reconditioning of oil at site but a filling plug at the top and a drain at the bottom of the lower tank shall be provided on each CT for use during initial assembly or any subsequent repair.

The current transformers shall be with dead/live tank design. The current transformers shall be of single phase oil immersed, self cooled and suitable for services indicated, complete in all respects conforming to the latest edition of relevant standard specification. The cores shall be of high grade, non-ageing silicon laminated steel of low hysteresis loss and high permeability to ensure high accuracy at both normal and fault currents. The CTs shall be hermetically sealed with or without inert gas to eliminate breathing and prevent air and moisture from entering into the tank. To take care of volumetric variation of oil due to temperature changes-stainless steel bellows/Nitrogen shall be provided. In case Nitrogen is used the supplier shall ensure that gas is filled at suitable pressure to take care of the expansion & compression of nitrogen gas. The equipment shall be provided with oil level gauge and pressure relieving device capable of releasing abnormal internal pressures. The secondary terminals shall be brought out in a compartment on one side of the equipment for easy access. The secondary taps shall be adequately reinforced to withstand normal handling without damage. Equipment shall be provided with power factor terminals for testing loss angle (Tan delta). The equipment shall also be provided with drain valve, sampling plug to check deterioration of oil characteristics and replacement of oil at site. Means adopted for sealing the CTs hermetically and to absorb the variation in volume of oil due to temperature variation by way of provision of stainless steel volume adjustable bellows or other means shall be clearly brought out in the tender. Rubber or PVC/synthetic bellows for the purpose shall not be accepted. The secondary terminal of CTs shall be provided with short circuiting arrangement.

#### **7.4.7 Terminal Connectors**

All current transformers shall be provided with appropriate number of solderless clamp type primary connectors suitable for ACSR conductor and shall be suitable for horizontal as well as vertical take off with single conductor as per actual requirement to be intimated to the successful tenderer. Suitable terminal earth connectors for earth connection shall also be included in scope of supply of current transformers.

#### **7.4.8 Terminal Box**

All secondary terminals shall be brought out in a compartment on one side of each current transformer for easy access. A terminal board which shall have arrangements for short circuiting of secondary terminals shall be provided. A cable box alongwith necessary glands for receiving control cables suitable for mounting on the bottom plate of the terminal box shall be included in the scope of supply. A door with locking arrangements shall be provided on the front of the terminal box so as to permit easy access to the secondary terminals. The door shall have suitable arrangements to check ingress of moisture into the terminals box. The secondaries of CTs shall be shorted in the terminal box before dispatch from the factory.

#### **7.4.9 Type of Mounting**

The current transformers shall be suitable for mounting in vacuum circuit breaker. The necessary flanged, bolts etc. for the base of CTs shall be within the scope of supply and these shall be galvanized.

#### **7.4.10 System Frequency**

CTs shall be suitable for giving satisfactory service when system frequency varies by 3% from normal value of 50 c/s system frequency.

#### **7.4.11 Tropical Treatment**

The equipment will be subjected during service to extremely severe exposure to atmospheric moisture and long periods of high ambient temperatures. All corrodible parts and surfaces shall be of such material and shall be provided with such protective finishes that no part of the installed equipment shall be injuriously affected by atmospheric conditions. All electrical auxiliary equipment shall be given special treatment for tropical conditions.

#### **7.4.12 Materials & Workmanship**

All materials used in the manufacture of equipment shall be of the best quality obtainable of their respective kinds and the whole of the work shall be of the highest class well finished of approved design and make. Castings shall be free from blow holes, flaws, cracks, and other defects and shall be smooth close grained and of true forms and dimensions. All machined surfaces shall be true and smooth finished.

#### **7.4.13 Instructions Plate and Marking**

All name plates, Instructions plates, warning signs and any marking whatsoever on the equipment and its parts and accessories shall be in English Language. In order to facilitate sorting and erection at site, every part of the plant and equipment shall be suitably marked.

Each current transformer shall be provided with a non-corrosive and non-rusting rating plate with all particulars marked in accordance with clause 5.1 of IS:2705 part I (amended upto date) together with the following additional particulars:-

Purpose (Measurement or protection), rated output at p.f. lagging and rated class of accuracy of each secondary winding.

Terminal numbering of each secondary winding.

Rated instrument security factor in respect of winding meant for measurement and metering.

Secondary winding resistance at 75°C.

Knee point voltage.

Maximum exciting current at knee point voltage.

Rated thermal current.

Switching impulse withstand voltage.

Class of insulation.

Accuracy limit factor (ALF).

No. of cores

VA burden

#### **7.4.14 Tests**

Each current transformer shall comply with type test including short time current test as stipulated in relevant Indian Standard specification. The short time current test and dynamic current test report must specify the cross section area of primary winding and the number of turns of the primary winding. Test report without this information shall not be accepted. The CTs shall also conform to the additional type test i.e. test to prove the capability of withstanding earthquake forces specified earlier in this specification. Temperature rise test shall be conducted at continuous overload capacity in order to ensure conformity of the CTs to specified requirements. Detailed test reports of insulating oil used shall be supplied and got approved before despatch of the CTs. The reports of all type tests and other tests conducted on similar equipment shall be supplied along with the tender. Additional charges (if any) for conducting impulse test, short time current withstand test and dynamic current withstand test and temperature rise test, at continuous overload capacity as per section II shall be quoted by the tenderer, so as to enable purchaser to decide for the carrying out of these tests on CTs offered. Desired type tests may be got carried out from independent laboratory out of the manufactured lot, which will be accepted on after successful testing.

Each current transformer shall be subjected to routine tests and type tests (if not already done on the same design) as per relevant Indian standards in presence of purchaser's representative, if so desired by the purchaser. All the test reports shall be submitted and got approved from the purchaser before despatch of equipment.

#### **Current Transformers - IS : 2705 (Part-I) - 1992**

##### **(I) Routine Tests:**

- (a) Verification of terminal markings and polarity

**EE (E-M)**

0/0 the CE, DHPD, Itanagar

- (b) High voltage power-frequency test on primary windings
- (c) High voltage power-frequency tests on secondary windings
- (d) Over-voltage inter-turn test
- (e) Determination of errors according to the requirements of the appropriate accuracy class.

## **(II) Type Tests**

- a) Verification of terminal markings and polarity
- b) High voltage power-frequency test on primary windings
- c) High voltage power-frequency tests on secondary windings
- d) Over-voltage inter-turn test
- e) Determination of errors according to the requirements of the appropriate accuracy class.
- f) Short-time current test
- g) Temperature-rise test
- h) Impulse voltage test for current transformers for service in electrically exposed installations.

### **7.4.15 Inspection**

- (a) All tests and inspection shall be made at the place of manufacture unless otherwise especially agreed upon by the manufacturers and purchasers at the time of purchase. The manufacture shall afford the inspector representing the purchaser all reasonable facilities, without charge, to satisfy him that the material is being furnished in accordance with the specifications.
- (b) The purchaser has the right to have the tests carried out at his own cost by an independent agency whenever there is dispute regarding the quality of supply.

### **(c) Insulation Resistance values**

The tenderers should recommend the minimum insulation resistance values of Primary winding to secondary winding earthed with 2500 volts and 5000 volts megger below which CTs should not be energised.

### **(d) Delta Test**

The tenderers should recommend minimum values of tan delta and partial discharge level for the current transformers offered. A suitable procedure to be adopted for their measurement alongwith relevant standard should also be brought. The copy of relevant standard adopted for tan delta and partial discharge measurement should also be supplied with the tender.

### **7.4.16 Completeness of the Equipment**

All fittings, accessories and apparatus which may have not been specifically mentioned in this specification but which are actually necessary for the

completeness of the equipment shall be deemed to have been included in the contract. All equipment shall, therefore, complete in all details whether such details are mentioned in this specification or not.

#### **7.4.17 Windings and Cores**

##### **a) Primary Winding**

The conducting material for the primary winding may comprise of electrolytic high conductivity copper strips or aluminium tube and sufficient area of cross section shall be provided to cater for the guaranteed short time as well as continuous thermal current ratings under site conditions. The winding shall be wound type or hair pin type.

The main insulation shall be paper and oil combination having high mechanical strength, superior electrical withstand properties and good ageing qualities to ensure long trouble free life for the CTs. Strong winding shall be provided as required to ensure high mechanical strength for safety against short circuit stresses.

##### **b) Cores and Secondary Windings**

All the cores may be continuous without any air gap. All the protection cores shall be formed out of high grade, cold rolled, grain – oriented silicon laminated steel, whereas the metering cores in which high accuracy at low amperes turns and low ISF are required, may be of Mu metal or such other ferromagnetic material. The core material shall have low hysteresis loss and high permeability. The area of cross-section of the cores as also the flux densities at rated primary current and rated burden shall be consistent with the required characteristics of the CTs. The cores shall be carefully annealed and bonded after they are wound to relieve the stress during winding.

The secondary winding shall be high conductivity copper wire of suitable cross-section. The copper wires shall have enamel insulation and paper insulation may also be provided to enhance reliability. The secondary winding shall be uniformly distributed on the total circumference of the core. For obtaining different ratios, the secondary winding may be suitably tapped. The leads of the secondary taps shall be brought out to the terminal box.

#### **7.4.18 Overloading Capacity**

The current transformers shall be suitable to withstand an overload capacity continuously above the normal rating at all taps without exceeding the permissible temperature rise.

#### **7.4.19 Short time Current Rating**

The short time current rating of the current transformer at all taps shall be as per IS. Tenders with short time rating of the equipment less than this value shall be rejected out rightly.

#### 7.4.20 External Insulation

The external insulation shall comprise of a hollow porcelain, which will also serve as a housing for the main insulation or other internal parts of the CTs depending upon the type of arrangement offered by the tenderer. Insulators shall be of high grade and homogeneous porcelain made by the wet process. The porcelain shall have hard glazing and shall comply with the requirements of IS 5621-1970 in all respects. The skirt forms shall be carefully selected to achieve the necessary flashover distance and total / protected creepage distances as specified in this specification.

#### 7.4.21 Fittings and Accessories

Besides any other items recommended by the manufacturers a list of fittings and accessories whether specifically referred in the text of this specification or not but required to be incorporated/supplied with the CTs, is given below for ready reference:-

Primary terminals  
Terminal connectors for connections from line to the CT primary  
Rating and diagram plates  
Earthing terminals

#### 7.4.22 Schedule of Guaranteed and Other Technical Particulars

Tenders shall be accompanied by the Guaranteed and technical particulars as called for in particulars which are subject to guarantee shall be clearly marked.

#### 7.4.23 Experience / Performance

The tenderers shall clearly state their experience / performance resources and engineering organisation to undertake the work. Tenderers shall give in tabulated form, orders executed under execution for similar material by them alongwith the full details and names of electricity boards/undertakings etc. to whom such equipments have been supplied as under:-

S.No.	Name of Organisation from which orders received	Details of CTs for which orders received		Present status
		Qty of CTs (voltage wise)	Short time current rating of the CTs	(Whether supplied or yet to be supplied)

Copies of performance reports from Electricity Boards, utilities shall also be supplied with the tender.

#### 7.4.24 Departure from specification

Should the tenderer wish to depart from the provision of the specification either on account of manufacturing practice or for any other reasons, he shall draw attention to the proposed points of departure in his tender and submit such full information/drawings and specifications so that the merits of his proposal may be fully understood. This specification shall be held binding unless the departures have been fully recorded as required above.

#### 7.5 11 KV POTENTIAL TRANSFORMER

11 kV potential transformer of ratio  $\frac{11kV}{\sqrt{3}} / \frac{110}{\sqrt{3}}$  volts shall be provided suitable to install in outdoor switchyard for metering of power transfer to distribution organization. This potential transformer may be three phase or three single phase type as per relevant Indian Standard and of burden and accuracy as follows':

**Voltage Ratio:** The voltage ratio shall be 11000/110 volts. The transformer shall be star/star connected and one of the secondary shall be earthed

**Rated output:** The standard rated output of the potential transformer shall be 100 VA per phase.

**Accuracy Class:-** The standard accuracy class shall be 0.5.

#### Standard : IS - 3156 (Part-I)-1992

**Tests:** The transformer shall be subjected to the following tests as per relevant IS

##### (i) Routine Tests

- ii) Verification of terminal markings and polarity
- iii) Power-frequency dry withstand tests on primary windings
- iv) Power-frequency dry withstand tests on secondary windings
- v) Determination of errors according to the requirements of the appropriate accuracy class.

##### (ii). Type Tests

- (a) Verification of terminal markings and polarity
- (b) Power-frequency dry withstand tests on primary windings
- (c) Power-frequency dry withstand tests on secondary windings
- (d) Determination of errors according to the requirements of the appropriate accuracy class
- (e) Temperature-rise test
- (f) Impulse voltage tests on voltage transformers for service in electrically exposed installations

## 7.6 SWITCHYARD STRUCTURES ETC.

Galvanized main and auxiliary structures for the equipment to be installed in the switchyard shall be provided alongwith other material e.g. conductors, clamp and connectors, insulators and hardware etc. complete as required.

## 7.7 BUSBARS AND BUSBAR CONNECTIONS

### 7.7.1 TECHNICAL PARTICULARS

i.	Nominal system voltage	:	11 kV
ii.	Nominal current rating	:	400 A
iii.	Bus conductor	:	ACSR "DOG"
iv.	Short time rating for 3 (three) seconds	:	750 MVA (12.5 kA)

### 7.7.2 CLEARANCE

The net clearance in air of bus bars, jumpers etc. shall not be less than that given in CBIP manual.

### 7.7.3 Hardware

The bolted tension fittings complete with U-bolts arcing horns etc. shall be provided suitable for 11 kV bus bar. Clamps and connectors for connecting ACSR conductor shall be made of alloy casting.

Bi-metallic connectors shall be used for connecting equipment terminals made of copper or brass. Bolts, nuts and washers for connectors shall be made of mild steel and electro-galvanized and passivated to make them corrosion resistant conforming to requirements of BS 1706.

### 7.7.4 INSULATORS

The insulators shall conform to the relevant latest IS standards (IS 2544, 731, 1248) and made of hard porcelain. Creepage distance shall be adequate for polluted outdoor atmosphere. Glazing of the insulator shall be uniform brown color, free from blisters, burns and other similar defects.

The insulators shall have technical particular as detailed below:

i.	Type	Post/Disc/Pin
ii.	Nominal system voltage kV (rms)	11
iii.	Highest system voltage kV (rms)	12
iv.	Wet power frequency one minute withstand voltage kV (rms)	70
v.	Power frequency puncture kV (rms) voltage	1.3 times the actual dry flash over voltage

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vi.	Impulse withstand voltage kV(peak)	170
vii.	Creepage distance in mm (minimum)	580
viii.	Minimum failing load	10 kN
		(45 kN for disc insulators)

### 7.7.5 GROUNDING / EARTHING OF SWITCHYARD AND POWER HOUSE EQUIPMENTS

Earthing system of the S/yard and power station shall be designed as per IS: 3043 and IEEE: 80. Earthing system in addition to individual copper earthings of all equipments shall also have interconnected mesh of mild steel rods buried in ground in the switchyard area and/or earthing electrode type earthing system for the power house area as may be most suited to the existing power house. All off-site areas shall be interconnected together by minimum two parallel conductors. The contractor shall furnish the detailed design and calculations for Owner's approval. Contractor shall obtain all necessary statutory approvals for the system. The grounding resistance of the grounding system for power house and switchyard together shall not be more than 0.5 Ohms. The step and touch potentials shall be within safe limits. The earthing system of the power station and switchyard shall be joined together.

The grounding and lightning protection shall include complete grounding of PH and switchyard area including the equipment, earthing of all steel structures & bodies of all equipment.

The equipment/work shall have following features:

- i. All earthing connections shall be sufficient to carry the fault current of 25 kA for 1 sec.
- ii. Soldered joints shall not be used. All joints shall be made pressure type fitting or welded.
- iii. The earth resistance of yard and Power house shall be not be more than that indicated above.
- iv. Touch and step potential shall be maintained in a safe value by grounding mat in accordance with IEEE-80 for a fault current of 25 kA for 1 sec.
- v. Fencing around the yard shall be earthed separately.
- vi. All earth electrodes shall have facilities for measurements of resistance and watering during dry season.
- vii. Earth mat shall be extended 150 cm beyond fencing.
- viii. All structures and buildings shall be provided with lightning protection and shielding as per IS-2309.
- ix. Individual earthing by copper plate and copper strip of all equipments inside the power house and switchyard like alternators, control panels, LT distribution board, 11 KC VCB, Transformers Lighting arrestors, isolators, is to be done by the contractor. The scope covers providing all materials required for earthing i/c civil works like digging of pits etc.
- x. Any other item/work required for efficient completion of work.
- xi. Earthing should conform to relevant IS specification.

## **7.8 LIGHTNING PROTECTION**

The lightning protection system shall be designed as per IS: 2309. It shall cover all buildings and structures in the plant, and switchyard areas. It shall comprise horizontal/vertical air terminations, down conductors, test links and earth connections to the station earthing grid. All conductors shall be of minimum 25x6 mm size and shall be of galvanised steel only.

The down conductors of lightning protection system shall have a test joint at about 1500 mm above ground level. Each down conductor shall be connected to a 40 mm dia, 3 m long mild steel earth electrode as well as station earthing grid.

The lightning protection system shall not be in direct contact with under ground metallic service ducts and cables, and shall not be connected above ground level to other earthing conductors. All joints in the down conductors shall be of welded type.

Pulser system for lightning shall not be accepted.

Hazardous areas handling inflammable/explosive materials and associated storage areas shall be protected by a system of aerial earths as per IEEE: 142.

## **7.9 PAINTING AND FINISHING**

The painting shall be, as per relevant IS. It shall be ensured that there will be no rusting, no peeling-off of the paint. The painting shall be long lasting type. The contractor shall ensure sufficient spare supply of paint for any touch-up required later on. Colour shades for different equipments inside the Power House and Switchyard shall be approved by purchaser.

**Annexure**

**CODE OF PRACTICE AND STANDARDS**

IS-3231	Electrical relays for power system protections
IS- 1248	Indicating Instruments
IS-722	Energy meters, control switches (LV switching devices for control and Auxiliary Circuits)
IS-2705	Current transformers
IS-3156	Voltage transformers
IS-4237	General requirements for Switchgear and control gear for voltage not exceeding 1 kV
IEC-157	
IS-375	Marking and arrangements for switchgear busbars, main connection and auxiliary wiring
IS-8686	Specification for static protective relays
IS: 1248	Specification for direct acting electrical indicating instruments
IS: 2516	Specification for alternating current circuit breakers (Part I&II)
IEC 529	Classification of degrees of protection provided by enclosure (IP code)