

Clause No.	TECHNICAL SPECIFICATION ELECTRICAL
33 KV Switchgear	
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## 1.00 33 KV SWITCHGEAR CUBICLE

33 KV switchgear indoor system comprises of protection / interlocking / annunciation / inter-tripping / automatic / manual operation schemes for the purpose of satisfactory and efficient operation of the equipment covered under this scope. The specification also includes cable terminations, foundation channels with hardware etc, It is not the intent of this specification to specify herein complete details of design and construction of equipment. However, the equipment offered shall conform to latest standards of engineering, design and workmanship in all respects and be capable of performing in commercial operation in a manner acceptable to the owner. Details of aux. supply for operation/control, protection, alarm, indication etc.

- i) DC supply 48 Volts + 10% / - 15%
- ii) AC supply 415 Volts +/- 10% Three phase 4 wire system

### 1.01 DESIGN & CONSTRUCTIONAL FEATURES

All switchgear panels and circuit breakers shall have the following features.

- i) Conductor: High conductivity aluminum alloy or copper for the horizontal busbars, vertical droppers and connectors to the fixed end of isolating contacts.
- ii) Height of the Switchgear Panel: shall not exceed 2700 mm.
- iii) Insulators shall be of high strength, non-hygroscopic, non-combustible type and suitable to withstand stresses due to over-voltages and short circuit current. Interpole barrier of inflammable material like hylam are not acceptable.
- iv) Sealing: Bushing or other sealing arrangement shall be provided between breaker and busbar / cable compartments to avoid air communication around isolating contacts in the safety shutter area with truck in service position.

### 1.02 CONSTRUCTION

- i) The switchgear assembly shall be rodent, vermin and dust proof.
- ii) In switchgear design where the breaker front itself serves as a door suitable blanking covers one for each size of panel per switch board shall be included.
- iii) The switchgear enclosure shall be constructed with rolled steel section of rolled sheet steel of at least 2.0 mm thickness.

- iv) Pressure relief device shall be provided in each high voltage compartment to vent out safely the gases produced in case of a fault.
- v) Contractor shall furnish calculation during detailed- engineering stage to establish the adequacy of support insulator and bus bar sizes for the declared continuous & short time current ratings.
- vi) Breaker trucks shall have a secure locking in SERVICE position so that they are not displaced during a short circuit.
- vii) Current ratings of all switchgears, circuit breakers, CT's etc. shall be sufficient for carrying the connected load currents without exceeding the permissible temperature limits or reduction in service life. Use of two breakers in parallel to meet the required rating shall not be acceptable.
- viii) Suitable trolley arrangement, if required, shall be provided. One trolley per switchgear room suitable for each type and rating.
- ix) Earthing Arrangement
  - x) Internal earth bus shall be provided which has a capacity to withstand short circuit currents for one second and all enclosures shall be connected to this bus.
  - xi) Earthing arrangement through an integral earth switch or through separate earthing truck shall be provided. Suitable mechanical interlocks shall be provided to prevent the closing of earth switch on live circuit. In case of later arrangement one set of different types of earthing trucks per switch board shall be provided.
  - xii) Earthing switch shall be short time (One second) current withstand capability equal to the breaker.
  - xiii) Cable Entry: The switchgear panel shall be suitable for bottom entry and provided with removable gland plates.
  - xiv) Instrument transformers: The CTs and VTs shall be provided for protection and metering and shall be cast-resin encapsulated type with insulation class 'F' or better. VTs shall have suitable HRC current limiting fuses on both primary and secondary sides, under voltage relays, remote annunciation on supply failure. Each switchgear section shall have a three phase VT. The incomers shall be provided with VT to indicate the incoming voltage before closing the breaker. The complete design including that of selection of proper CT's// PT's/instruments with proper ratings shall be the responsibility of the vendor only.
  - xv) Relays: Selection of all types 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, draw out construction for easy replacement from the front. The auxiliary relays and timers may be in non-draw out cases. Relay shall have port for interphasing with SCADA

- xvi) Identification plates: Each panel has to be identified on front as well as back side by a large engraved plate giving detailed feeder description on the fixed portion of the panel. Identification labels/painted (Not stickers) plates to be provided inside each panel.
- xvii) Safety Requirements: The switchgears shall be designed to offer adequate level of safety to operating / maintenance personnel. Means shall be provided to prevent access to the live part to avoid accidents during service as well as maintenance period. Bidder shall bring out the safety means provided to achieve above. A detailed instruction plate suitable for wall mounting shall be provided for each switch gear room describing various safe operating procedure / safety precautions for safe operation and maintenance of switchgear. Rubber mats shall be provided in front of each panel. A clearly visible warning label "Isolate elsewhere before earthing "shall be provided on shutters of incoming and other connections which could be energised from other end.
- xviii) Power cable Terminations: Suitable arrangement for power cable termination shall be provided, as required, for switchgear panels and shall be suitable for cable entry from the bottom. The bottom cable entry shall be fitted with removable gland plates of adequate size for fixing the cable glands.
- xix) The Incomer and all outgoing feeder panels shall be suitable for terminating XLPE cables. Panels shall have adequate space inside, to accommodate the heat shrinkable type cable terminations or Cold type cable terminations. Each power cable shall be terminated independently.
- xx) Trip circuit supervision scheme shall be provided for each circuit breaker. The scheme shall be such that it will be possible to test the healthiness of the trip circuit irrespective of whether the breaker is in the closed or open condition.
- xxi) In case of tripping of 33kV incomer feeder of transformer inter tripping with LT circuit breaker shall be provided.

#### 1.03 BAYS & EQUIPMENTS TO BE PROVIDED IN 33KV SWITCHGEAR CUBICLE.

##### 1.03.01 INCOMING BAYS

4 (four) nos. of Incoming bays (minimum) with 1 (one) no. spare bay of 1600 Amps each consisting of following features

- i) 1 No. – electrically operated draw out type SF<sub>6</sub> / VACUUM circuit breaker rated for 1600Amps with shunt trip release, suitable rupturing capacity 40 KA for 1 sec (symmetrical r.m.s.) and complete with standard accessories such as operating handle, auxiliary switch with 4 NO+4NC contacts and the required number of sliding disconnects (minimum 3 sets of 6way disconnects) etc.
- ii) 3 Nos. Indicating LEDs for ON/OFF/Discrepancy indications.

- iii) 3 Nos.- Push buttons for ON/OFF/RESET and 1 Nos. Break control switch (spring return type)
- iv) 3 Nos. Current transformers of 50/1/1/1A ratio, for metering and protection.
- v) 3 Nos. 1 Ph. Current transducers of dual output type interfacing with SCADA
- vi) 1 No. Ammeter with suitable scale along with selector switch for indicating the incomer current
- vii) 1 No.- Microprocessor based Kwh meter suitable for 3 Phase, 4 wire.
- viii) 1 No. Voltmeter of suitable range along with selector switch
- ix) 3 Nos single phase PTs of Ratio  $33kV/\sqrt{3}/110V/\sqrt{3}/110V/\sqrt{3}$ .
- x) 3 Phase, numerical Non-directional over current relay with inverse characteristics. The range of adjustment of the relay should be between 20 to 200% and rated current 1A for over current protection of income.
- xi) Non-directional single pole numerical earth fault relay, with the setting range 5 to 80% of current rating.
- xii) 3 Nos. - Under voltage relays of reputed make to monitor 3 phase voltages with setting of pick-up voltage at 90% and drop off voltage at 70% of the supply AC Voltage with suitable timer to initiate tripping of Breaker.
- xiii) One number numerical integrated multifunctional transformer protection relay as described in section – VII (Clause No 2.02)
- xiv) 3 Nos. 1 phases – voltage transducers of dual output type giving an output of 4 – 20 mA is to be mounted inside the panel at a convenient location for monitoring Bus voltage to be interfaced with SCADA.
- xv) Set of static auxiliary relays of required range for inter tripping and interlocking as required
- xvi) 1 No. – Switch for auto / manual selection.
- xvii) 1 No. – Switch for local / remote selection.
- xviii) 1 No. – Trip / normal / close Switch.
- xix) 1 No. timer for incomer only.
- xx) Necessary test blocks for Energy Meter.
- xxi) 1 No. DC supply on/off control switch.
- xxii) Necessary auxiliary relays, protective relays etc., complete in all respects shall be provided.

**1.03.02 OUTGOING BAY**

2 Nos. of Outgoing bays (for outgoing feeders) consisting of following features:

- i) 2 No. – electrically operated draw out type SF<sub>6</sub> / VACUUM circuit breaker rated for 1600 Amps with shunt trip release, rupturing capacity of 40kA for 1 sec (symmetrical r.m.s.) and complete with standard accessories such as operating handle, auxiliary switch with 4 NO+4NC contacts and the required number of sliding disconnects (minimum 3 sets of 6way disconnects) etc.
- ii) 3 Nos. Indicating LEDs for ON/OFF/Discrepancy indications.
- iii) 3 Nos.- Push buttons for ON/OFF/RESET and 1 Nos. Break control switch (spring return type)
- iv) 3 Nos. Current transformers of 150/1/1/1A ratio, for metering & protection.
- v) 3 Nos. 1 Ph. Current transducers of dual output type interfacing with SCADA
- vi) 1 No. Ammeter with suitable scale along with selector switch for indicating the incomer current
- vii) 1 No.- Microprocessor based Kwh meter suitable for 3 Phase, 4 wire
- viii) 1 No. Voltmeter of suitable range along with selector switch
- ix) 3 Nos single phase PTs of Ratio 33kV/ $\sqrt{3}$ /110V/ $\sqrt{3}$ /110V/ $\sqrt{3}$ .
- x) 3 Phase, numerical Non-directional over current relay with inverse characteristics. The range of adjustment of the relay should be between 20 to 200% and rated current 1A for over current protection of incomer.
- xi) Non-directional numerical relay based single pole earth fault relay, with the setting range 5 to 80% of current rating.
- xii) Back up protection for line feeder as described in section VII (Clause 2.02) shall be provided.
- xiii) KW meter suitable for three phase four wire system .
- xiv) Necessary auxiliary relays, protective relays etc., complete in all respects shall be provided.

**1.03.03 Station Transformer bay**

1 Nos. of station service bay consisting of following features:

- i) 1 No. – electrically operated draw out type SF<sub>6</sub> / VACUUM circuit breaker rated for 1600 Amps with shunt trip release, rupturing capacity of 40kA for 1 sec (symmetrical r.m.s.) and complete with standard accessories such as operating

handle, auxiliary switch with 4 NO+4NC contacts and the required number of sliding disconnects (minimum 3 sets of 6way disconnects) etc.

- i) 3 Nos. Indicating LEDs for ON/OFF/Discrepancy indications.
- ii) 3 Nos.- Push buttons for ON/OFF/RESET and 1 Nos. Break control switch (spring return type)
- iii) 3 Nos. Current transformers of 25/1/1/1A ratio, for metering and protection respectively.
- iv) 3 Nos. 1 Ph. Current transducers of dual output type interfacing with SCADA
- v) 1 No. Ammeter with suitable scale along with selector switch for indicating the incomer current
- vi) 1 No.- Microprocessor based Kwh meter suitable for 3 Phase, 4 wire
- vii) 1 No. Voltmeter of suitable range along with selector switch
- viii) 3 Nos single phase PTs of Ratio  $33\text{kV}/\sqrt{3}/110\text{V}/\sqrt{3}/110\text{V}/\sqrt{3}$ .
- ix) 3 Phase, numerical Non-directional over current relay with inverse characteristics. The range of adjustment of the relay should be between 20 to 200% and rated current 1A for over current protection of incomer.
- x) Non-directional numerical single pole earth fault relay, with the setting range 5 to 80% of current rating.
- xi) KW meter suitable for three phase four wire system of 75/1-1 CT ratio.
- xii) One number numerical integrated multifunctional transformer protection relay as described in section – VII (Clause No 2.02).

#### 1.04 Control, Relay, Protection and Metering.

- i) All relays shall be draw out type conforming to all requirements as per IS: 3231 and shall be suitable for operation from CT and VT secondary as required.
- ii) The protective relays, except for lock-out relays shall have self - reset contacts, and shall be suitable for efficient and reliable operation of the protective schemes
- iii) Protective relays shall be of numerical communicable technology with self monitoring features. A combination of electromechanical & numerical communicable type relays for main protections is not acceptable.
- iv) All relays & timers shall be designed for satisfactory performance under specified tropical and humid conditions.
- v) The relays and timer shall operate under extreme conditions of control voltage variation.

- vi) They shall not have any inbuilt batteries, and shall operate on available DC supply. They shall be provided with hand-reset operation indicators (flags) or LEDs with pushbuttons for resetting for analyzing the cause of breaker operation.
- vii) Shall have built-in test facilities, or can be provided with necessary test blocks and test switches. One testing plug shall be provided for each switch board.
- viii) For other detail please refer section VII (Control & Relay panel for 33 KV switchyard)

**1.05 CONTROL SUPPLY**

- i) Each switchgear shall be provided with necessary arrangement for receiving, isolating, distributing and fusing of 230V AC and 48 V DC supplies for various control, lighting, space heating and spring charging circuits. DC supply for control shall be duplicated for each board which shall run through auxiliary bus wires.
- ii) Necessary hardware shall be provided in the switchgear panel like coupling relays, auxiliary relays, transducers etc. to effect interlocks, exchange of information status and exercise control from remote.
- iii) 48V D.C. supply required for control and protection relays shall be arranged.

**1.06 GENERAL DATA**

Earthquake conditions

Under the seismic conditions, stipulated in this specification, 33KV, 11KV and 415V switchgear panels shall meet the following requirements:

- i) The physical alignment of 33KV, 11KV and 415V switchgear panels along with incoming and outgoing feeder connections, supporting insulators & structures of bus bars should not get disturbed and there should not be any internal flashover and/or electrical fault.
- ii) All relays, transducers, indicating instruments, devices in switchgear panels should not mal-operate.
- iii) Current carrying parts, supporting structure, earth connection etc. should not get dislocated and /or should not break or distort.
- iv) Co-ordination with other systems
- v) It will be the responsibility of the contractor to coordinate the 33KV, 11KV & 415V Switchgear with Computerized Plant Control System (SCADA) of the power house.
- vi) Despatch of equipments and Handling of equipment at site



- vii) Care shall be taken for safe handling of equipments at site during transport, stacking, shifting to erection site, erection at site in order to prevent damages to the equipment.
- viii) The bidder has to unload the panels in a storage place (store sheds) in the project site area as directed by the Engineer and shall load, re-transport and unload the same from storage place to the erection place at appropriate time.

#### 1.07 TESTS OF SWITCHGEARS

The following type test certificates on each type & rating of Switchgear, MCC panel and distribution boards shall be submitted.

- i) Short time withstand test with circuit breaker mounted inside the switchgear panel
- ii) Temperature rise test.
- iii) Type II-Short circuit co-ordination test for any three rating of MCC module as selected by the Employer.
- iv) Test sequence-1 & combined test sequence shall be carried out on each rating of circuit breaker mounted inside the panel.
- v) Degree of protection tests.
- vi) The manufacturer shall carry out all routine tests as specified in relevant IS/IEC Standard on all major components and furnish copies of test certificates for Owner's approval.
- vii) The following tests shall be carried out for panels and its components before despatch at factory in accordance with latest IS/IEC standards and 3(THREE) copies of test certificates shall be supplied. The test certificates shall be approved by the Owner prior to despatch of materials.

##### 1.07.01 ROUTINE TEST

###### **VISUAL CHECK** (as per IS: 8623 Cl. 8.3.1.1, 8.3.1.2)

- i) Visual inspection of mounting and connecting of various parts.
- ii) Checking of all instruments for their positioning and rating.
- iii) Checking of internal wiring according to the approved drawings.
- iv) Checking of connections to ensure adequate contacts.
- v) Clearance and creepage distance between bus bars, risers and also between bus bars, risers and earth.
- vi) Functional checking of all control circuits, closing, tripping, interlock and alarm circuits including proper functioning of component equipment such as ACB, MCCB etc.

**1.07.02 HIGH VOLTAGE TEST –**  
(As per IS: 8623, Cl.8.3.2.1, 8.2.2.4)

- i) Phase to ground - (as per IS)
- ii) Phase to phase - (- do -)
- iii) For auxiliary circuits - (- do -)

**1.07.03 INSULATION RESISTANCE TEST**

- i) For bus bar
- ii) Auxiliary circuits.

**1.07.04 CONTINUITY TEST**

A point to point check shall be made to ensure the compliance of the complete wiring as per the approved electrical schematic diagram.

**1.07.05 TEST FOR CIRCUIT BREAKERS.**

- i) Checking alignment of breaker trucks for free movement and for correct operations of shutters.
- ii) Slow closing/ opening operation.
- iii) Manual operation of breaker.
- iv) Power Closing/opening operation manually and electrically.
- v) Breaker closing and tripping time.
- vi) Trip free and anti-pumping operation.
- vii) Contact resistance.
- viii) I R values, resistance & minimum pick up voltage of coils.
- ix) Checking of electrical & mechanical interlocks provided such as:
  - x) Shunt trip release
  - xi) Bimetal release.
  - xii) Under voltage release.
  - xiii) Short circuit release.
- xiv) Checks on spring charging motor for correct operation of limit switches & time of charging.
- xv) Insulation resistance of each pole of breaker.
- xvi) H V test
- xvii) With switch in close position - Phase to ground and phase to phase with switch in open position between fixed and moving contacts.
- xviii) H V tests on auxiliary circuits as per standard.
- xix) Maximum terminal voltage drop between terminals at rated currents.
- xx) Checking of various interlocks.
- xxi) Interchangeability of breakers

**1.07.06 TEST FOR ACBs**

- i) For MCCBs, type test reports shall be furnished. MCCBs have to undergo the following sequence of type tests without any maintenance/adjustment, tests to be conducted as per relevant IS.
- ii) Construction test
- iii) Routine Test
- iv) Operation test
- v) Trip calibration test
- vi) Overload test
- vii) Temperature rise test
- viii) Endurance test
- ix) Insulation resistance test
- x) High voltage withstand test
- xi) Short circuit test

**1.07.07 TESTS ON CURRENT TRANSFORMER**

- i) Meggering between windings and winding terminal to body
- ii) Polarity test
- iii) Ratio test
- iv) Checking of all ratios on all cores by primary injection of current.
- v) Magnetization characteristics, secondary winding resistance.

**1.07.08 TESTS ON RELAYS**

Checking of internal wiring.

- i) Meggering of
  - a) All terminals to body
  - b) A C to DC terminals
- ii) Checking operation characteristics by secondary injection.
- iii) Checking minimum pick up voltage of DC coils.
- iv) Checking operation of electrical/mechanical targets.
- v) Relay setting.

**1.07.08 TYPE TESTS:**

The test certificates for following type tests, which are already performed, on each type of circuit breaker (as per IS 13118/ IEC-62271-100 or latest revision there-of) shall be furnished..

- i) For switchgear assembly and circuit breaker
  - a) Dielectric tests as per IEC 60694
  - b) Temperature rise test as per IEC 60694
  - c) Measurement of the resistance of the main circuit as per IEC60694
  - d) Short time withstand current and peak withstand current tests as per IEC 60694 & IS 13118.
- ii) For circuit breaker only
  - a) Mechanical & environmental tests as per IS 13118 or IEC 62271-100.
  - b) Short circuit current making & breaking tests as per IS 13118 or IEC 62271-100.
- iii) Tests on associated equipment

All bushings, insulators, bus bars, indicating instruments/devices instrument transformers and associated items of switchgear panels shall be tested by the Contractor in accordance with relevant IS or IEC standard. The test reports shall be furnished for approval before the Routine and Acceptance tests at works

#### **1.07.09 SITE TESTS**

After complete erection at the site, the following tests shall be performed on 33kV Switchgear panels :

- i) Measurement of insulation resistance of bus and power circuits.
- ii) Test & checking of control schemes
- iii) Operational tests of breakers-electrical (Local/Remote) & manual
- iv) Testing & checking of interlocking schemes and protection relays.
- v) All testing equipment shall be arranged by the Contractor at his own cost during the testing.

**1.08 Specific technical requirement:**

**33KV SWITCHGEAR CUBICLE**

a)	Normal system voltage	33kV
b)	Corresponding highest system voltage	36 kV
c)	Frequency	50 Hz (+ 3%, - 5%)
d)	Number of phases	3
e)	Class indoor/outdoor	indoor
f)	Rated short circuit withstand of the panels	40kA (Symmetrical r.m.s)
g)	Switchgear	Free standing, Floor mounted, metal clad, fully compartmentalized draw-out type.

**33 KV CIRCUIT BREAKER DETAILS**

a)	SF6/Vacuum circuit Breaker re-strike free, trip free, stored energy operated and with electrical anti-pumping features	Draw out type
b)	Number of poles	3
c)	Rated voltage	36 kV
d)	Rated normal current	1600 Amp
e)	Rated frequency	50 Hz (+ 3%, -5%)
f)	Rated short circuit breaking current	40kA (Symmetrical r.m.s)
g)	Rated short time	1 sec
h)	Rated Operating Duty	0-3 min – co – 3 min - co
i)	Rated insulation level rated/min. power frequency withstand voltage (r.m.s value)	70 kV
j)	Rated lightning impulse withstand voltage (peak value)	170 kVp
k)	Rated supply voltage	48 V DC Control supply closing and opening 230 V AC Aux
l)	No. of Auxiliary contacts	4NO+4NC Contacts

**33kV Current Transformer:**

a)	Current transformers rated Insulation level	
	i) Rated/min power	70 kV frequency withstand voltage (rms value)
	ii) Rated lightning	170 kV impulse withstand voltage (peak value)
b)	Minimum creepage	25 mm/kV of highest system voltage
r)	C.T. details	For Incomer    For Outgoing Feeder    For SST

	i) Ratio-	50/1/1/1	150/1/1/1	25/1/1/1
s)	Class of Accuracy			
	i) Core I	0.2S	0.2S	0.2S
	ii) Core II	5P15	5P15	5P15
	iii) Core III	PS	PS	PS
t)	Purpose of each core			
	i) Core I	Metering	Metering	Metering
	ii) Core II	Protection	Protection	Protection
	iii) Core III	Differential Protection	---	Differential Protection
u)	Burden			
	i) Core I	15 VA	15 VA	15 VA
	ii) Core II	15 VA	15 VA	15 VA
	iii) Core III	---	---	---
Note: CT's shall be of reputed make with proven experience. CT parameters shall be finalized during detail engineering as per system requirement.				

### 33 KV POTENTIAL TRANSFORMERS

1.	<b>Rated Insulation level.</b>	
a.	Rated/min power	70 kV frequency withstand voltage(rms value)
b.	Rated lightning	170 kV impulse withstand voltage (peak value)
2.	Class of insulation	
3.	Rated voltage factor	1.2 continuous & 1.9 for 30 seconds
4.	Minimum creepage	25 mm/kV of highest system voltage
5.	Applicable standard	IS: 3156
6.	PT details	
7.	Rating	33KV/ $\sqrt{3}$ / 110V/ $\sqrt{3}$ / 110V/ $\sqrt{3}$
8.	Burden	100 VA
9.	Class of Accuracy	0.2S for winding 1/3P for wining 2
10.	Purpose	Metering & protection
11.	Connection	Star/Star

#### Note :

- i) Potential transformers shall be single phase units. PT's shall be of reputed make.
- ii) Each secondary shall be protected by 3 Amps. HRC fuse.
- iii) PT parameters shall be finalized during detail engineering.

**IX Details of auxiliary supply for operation/control, protection, alarm, indication etc.**

DC supply – Minimum 48 V +10% / - 15%

AC supply 415 Volts + or-10% Three phase 4 wire system

**X Lightning Arrester:**

- |  |                          |
|--|--------------------------|
| i) Type :  | Metal oxide gapless type |
| ii) Installation :   | Indoor                   |
| iii) Rated voltage:  | 30 kV                    |
| iv) Maximum continuous operating voltage:  | 24 kV                    |
| v) Nominal discharge current   | 10 KA (peak)             |
| vi) Maximum residual voltage for 8/20 microsecond discharge.                                       |                          |
| a) At 0.5 times nominal discharge current  | 85 kV (peak)             |
| b) At nominal discharge current  | 90 kV (peak)             |
| c) At twice the nominal discharge current  | 102 kV (peak)            |
| vii) Steep front current residual voltage with 1 Microsecond front time current wave of 10 kA peak | 100 kV (peak)            |
| viii) Switching current 1 KA (peak)  | 73 KV (peak)             |