

SECTION – VIII

TECHNICAL SPECIFICATIONS: 33 kV SWITCHYARD EQUIPMENT/WORKS

8.1 SCOPE

Design, detailed engineering, manufacture of equipment, shop testing, packing, transportation, loading & unloading, delivery, storage at site handling, erection, pre-commissioning tests and commissioning of the following equipment/system including preliminary acceptance test and performance guarantee for the following 33 kV switchyard equipment of the powerhouse.

1. Isolators
2. Circuit Breakers
3. Lightning Arrestors
4. Potential Transformers
5. Current Transformers
6. Bus Bars & Bus Connections
7. Grounding/Earthing
8. Lighting of switchyard
9. Lightning Protection System for power house and switchyard
10. Structures
11. Fencing
12. Any other equipment necessary to complete the job

8.2 CODES OF PRACTICE

List of Codes of Practice and Standards is given in Annexure–8/1. All Codes of Practices and Standards shall be the latest editions including all applicable official Amendments & Revision as on date of opening of bid.

8.3 ISOLATORS

8.3.1 Application

These are to be used for:

- i. Breaker isolation/connection on no load
- ii. Line connection/isolation/ on no load

8.3.2 Type And Construction

- i. Triple pole gang operated suitable for outdoor installation in open yard under the specified site conditions.
- ii. Common actuating mechanism for all three poles.
- iii. Motor operated from Remote/local and also manually operable.
- iv. Interchangeable single pole units
- v. Switch blades shall be of copper and of one solid piece construction.
- vi. Adequate Inter-phase clearance and mounting height.

E. E. (E-M),
0/0 the CE, DHPD, Itanagar.

- vii. Speed of operation during opening or closing shall ensure minimum arcing.
- viii. 33 kV isolator shall be horizontal double break type mounted on structure.

8.3.3 TECHNICAL PARTICULARS

- | | | | |
|-------|--|---|---|
| i. | Nominal system voltage | : | 33 kV |
| ii. | Highest system voltage | : | 36 kV |
| iii. | Rated frequency | : | 50 Hz |
| iv. | Type | : | Outdoor station type, double break, triple pole double throw with turn and twist mechanism, with earth switch (on feeder isolator only) |
| v. | Continuous current rating | : | 630 A |
| vi. | Short time rating 1 sec | : | 750 MVA |
| vii. | Rated peak withstand current | : | 17.5 kA Peak |
| viii. | Insulation level of | | |
| | a. Impulse withstand voltage (1.2/50 micro sec.) | : | 170 kV |
| | b. Between poles to earth Across Isolating distance | : | 195 kV |
| | c. One min. power freq. Withstand voltage (both dry & wet) | : | 70 kV |
| | d. Between poles to earth Across Isolating distance | : | 80 kV |
| ix. | Min. creepage distance | : | 2.54 cm/kV |
| x. | Operating mechanism | : | Gang operated, Auto and manual/motorized |
| xi. | Termination | : | ACSR conductor both sides |
| xii. | Earthing switch | : | Mechanically inter-locked with isolator. Rating of earthing Switch same as that of isolator |
| xiii. | Auxiliary contacts | : | 3 NO + 3 NC |
| xiv. | Installation | : | Pole structure with padlocking facility |
| xv. | Interlocks | : | i. With upstream circuit breaker/isolator
ii. Mechanical interlock with earthing switch for correct sequence of operation |
| xvi. | Control voltage | : | 48 V DC/230 V AC |
| xvii. | Temperature rise above 45° ambient | : | 50°C |
- a. Disconnecting blades shall be capable of carrying rated current continuously as well as specified short circuit current for the duration indicated above without causing mechanical damage to any part or temperature rise which may damage the insulation.
 - b. The switches shall be capable of making on to faults specified and withstanding the dynamic stress involved.

- c. The isolator shall be suitable for interrupting small inductive and capacitive currents such as those occurring while disconnecting lines at no load, bus bars or voltage transformers under energized condition.

8.3.4 CONTACTS

- i. High pressure self-aligning adjustable type.
- ii. Contacts shall be well protected all round by a metal cover to provide not only electrostatic screening but also to prevent coarse dust from entering between the contacts.
- iii. Contacts shall be of high grade high conductivity heat resisting copper and silver plated.

8.3.5 OPERATING MECHANISM

- i. It shall be suitable for motorized and also manual operation.
- ii. Operating mechanism and its controls shall be so designed that under no circumstances the travel of the switch blades is interrupted before it reaches the fully closed or open position.
- iii. Provision for padlocking the mechanisms in either the open or closed position shall be provided.
- iv. Housing for the operating mechanism and its control shall be of sheet steel, weather and dust proof construction, with rubber gaskets conforming to enclosure protection class IP-55.

8.3.6 EARTHING SWITCHES FOR LINE ISOLATORS

- i. Disconnecting switches shall be provided with earthing switches on the line side forming integral part.
- ii. Rating of earthing switch shall be same as that of the main isolator/disconnecting switch with respect to rated short time current and dynamic peak withstand current.
- iii. Earthing blade shall be operated by a separate mechanism on manual and motorized mode but interlocked so that it can be closed only when the main disconnecting switch is open and vice-versa.

8.3.7 INTERLOCKS

- i. To be interlocked with associated isolators and circuit breakers through castle key and electrical interlock arrangement.
- ii. Earthing switch and isolator interlocking.
- iii. For closing of isolators main blades, associated earthing switches shall have to open and it is also to ensure that isolators are not used for on load closing.
- iv. Final wiring or contact multiplication relay, blocking solenoid etc. shall be provided as per approved logic diagram.
- v. Breaker can be closed if associated earthing switches are open and isolators are in closed position.

8.3.8 TERMINAL CONNECTION

Shall be provided with high conductivity terminal connecting suitable for ACSR conductors.

8.4 33 kV CIRCUIT BREAKERS

8.4.1 TYPE

- i. Outdoor type Vacuum Circuit Breaker suitable for installation in open yard.
- ii. Three identical single pole units linked together for simultaneous operation, complete with supporting frames and tie-rods.
- iii. Capable of interrupting small inductive currents caused by switching of unloaded transformers and low capacitive current without causing undue over-voltage.
- iv. The circuit breakers are to be supplied complete with their control and relay panels.

8.4.2 TECHNICAL PARTICULARS

i.	Nominal system voltage	:	33 kV
ii.	Highest system voltage	:	36 kV
iii.	BIL	:	170 kV
iv.	Power Frequency withstand voltage	:	70 kV
v.	Rated frequency	:	50 Hz
vi.	Rated continuous current	:	1250 A
vii.	Closing mechanism	:	Electrical spring charging with 230 V AC motor and local manual closing.
	a. Closing coil/tripping coil (2 nos.)	:	48 V DC
	b. No. of Poles	:	3
viii.	Symmetrical short circuit withstand capacity	:	750 MVA for 1 sec.
ix.	Temperature rise	:	Not to exceed 50°C above ambient temp. of 45°C.
x.	Operating duty	:	0-3 min. CO-3 min.-CO.
xi.	Dead time of breaker	:	Adjustable between 0.3 sec. to 15 sec.
xii.	System neutral	:	Solidly Earthed
xiii.	Min. creeping distance	:	900 mm
xiv.	Control supply voltage	:	48 V DC
xv.	Auxiliary, contacts with each circuit breaker	:	6NO+6NC Interchangeable at site
xvi.	Accessories		
	a. ON/OFF/TRIP	:	Mechanical as well as Electrical
	b. Emergency tripping mechanism	:	Mechanical
	c. Termination suitable with connectors	:	ACSR Conductor
	d. Anti-pumping operation	:	To be provided
	e. Spring charge indicator	:	To be provided

8.4.3 OPERATING MECHANISM

- i. Electrically / 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.

8.5 33 kV LIGHTNING ARRESTORS

8.5.1 TYPE

- i. Station class, 10 kA, heavy duty, non-linear resistance, metal oxide type gapless lightning arrester for 33 kV system.
- ii. Self-supporting type in single pole assembly.
- iii. Suitable for pedestal mounting.
- iv. Outdoor type suitable for installation in open yard.
- v. Shall be designed to provide maximum protection against lightning and switching surges.

8.5.2 TECHNICAL PARTICULARS

i.	Nominal system voltage	:	33 kV
ii.	Highest system voltage (rms)	:	36 kV
iii.	Rated arrester voltage (rms)	:	30 kV
iv.	Continuous operating voltage (rms)	:	24 kV
v.	Frequency	:	50 Hz
vi.	Power frequency with stand test voltage	:	70 kV
vii.	Impulse voltage (peak)	:	170 kV
viii.	System neutral connection	:	Solidly earthed
ix.	Nominal discharge current for 8/20 micro sec.	:	10 kA (peak)
x.	Long duration discharge class as per IEC-99-4	:	3/2
xi.	Maximum residual voltage at nominal discharge current of 8/20 micro sec wave	:	100 kVP (peak)
xii.	Maximum steep current impulse (1/20 micro sec.) residual voltage at nominal discharge current	:	110 kV (peak)

xiii.	Arrester Housing		
	a.	One minute power frequency withstand voltage (rms)	: 70 kV
	b.	Lighting impulse withstand voltage	: 170 kV (peak)
xiv.	Prospective Symm. Fault current for pressure relief test (rms)		: 40 kA
xv.	Disconnecting device		: Disconnecting devices as per IS: 3070 (Part-II) shall be connected in series with ground lead.
xv.	Minimum creepage distance of porcelain housing (mm)		: 900

8.6 POTENTIAL TRANSFORMERS

8.6.1 TYPE

- i. 33 kV outdoor type
- ii. Epoxy moulded dry type for 33 kV sealed type self cooled
- iii. Single phase design
- iv. Independently mounted
- v. Suitable for operation on 33 kV, 3 phase, 50 Hz AC systems

8.6.2 TECHNICAL PARTICULARS

i.	Standard	:	IS-3156 (1992)
ii.	Nominal system voltage	:	33 kV
iii.	Highest system voltage	:	36 kV
iv.	Rated frequency	:	50 Hz
v.	System neutral earthing	:	Solidity earthed
vi.	Number of secondary	:	One
vii.	Voltage ratio	:	$\frac{33kV}{\sqrt{3}} / \frac{110V}{\sqrt{3}}$
viii.	Class of insulation	:	F
ix.	Insulation level	:	
	a.	One minute power Frequency withstand Voltage (wet and dry)	: 70 kV
	b.	Impulse withstand voltage	: 170 kV
x.	For rating/other details	:	Refer single line diagram
xi.	Temperature rise	:	As per IS 3156 Part-I/1992
xii.	Limits of voltage error & phase displacements	:	As per IS 3156 Part-I/1992
xiii.	Accuracy & burden etc.	:	As required and in Annexure 8/2.

8.6.3 WINDING CONNECTION

- i. Any three single phase units shall be suitable for three phase connection in star/star formation on three phase system.
- ii. The positive, negative and zero sequence impedances shall all be equal.
- iii. Secondary winding to be used for metering.

8.6.4 LIMITS OF TEMPERATURE RISE

- i. Limits of temperature rise specified in technical particulars shall correspond to 1.2 times the rated primary voltage applied continuously at rated frequency and at rated burden connected to both the secondary windings simultaneously.
- ii. Temperature rise when 1.5 times the rated primary voltage is applied for 30 seconds after achieving stable thermal conditions followed by application of 1.2 times the rated voltage continuously, shall not exceed by more than 10°C from the values specified above.

8.6.5 TERMINAL ARRANGEMENT

- i. Bi-metallic (Cu/Al) terminal connector shall be suitable for ACSR conductors.
- ii. Suitable earth terminal connector to be supplied for connections to earth.
- iii. Secondary terminals to be housed in weather and dust proof cabinet with provision for terminating PVC insulated, armoured and PVC sheathed control cables.

8.7 CURRENT TRANSFORMERS**8.7.1 TYPE**

33 kV outdoor type

8.7.2 TECHNICAL PARTICULARS

- | | | | |
|-------|--|---|--------------------------------|
| i. | Standard | : | IS-2705 (1992) |
| ii. | Nominal system voltage | : | 33 kV |
| iii. | Highest system voltage | : | 36 kV |
| iv. | CT Ratio | : | As per Annexure-8/2 |
| v. | Rated frequency | : | 50 Hz |
| vi. | System neutral earthing | : | Solidly earthed |
| vii. | Short time thermal current rating for
1 sec. duration | : | 25 kA |
| viii. | Class of insulation | : | F |
| ix. | Insulation level | : | |
| | a. Peak impulse withstand voltage | : | 170 kV |
| | b. Rated one minute power frequency
wet and dry withstand voltage | : | 70 kV |
| x. | Terminal | : | Suitable for ACSR
conductor |
| xi. | Marshalling kisok | : | IP-55 enclosure |

- xii. For rating, ratio, class of accuracy and VA burden etc. : As required and shown in Annexure

8.8 BUSBARS AND BUSBAR CONNECTIONS

8.8.1 TECHNICAL PARTICULARS

- i. Nominal system voltage : 33 kV
 ii. Nominal current rating : 800 A
 iii. Bus conductor : ACSR “DOG”
 iv. Short time rating : 750 MVA (12.5 kA)
 for 3 (three) seconds

8.8.2 CLEARANCE

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

8.8.3 ACSR CONDUCTOR

- i. Construction
- Conforming to IS 398 (Part-III)-1996
 - Aluminum wire made from at least 99.5% pure electrolytic aluminum rods of EC grade with copper content less than 0.04%.
 - Steel wires uniformly coated with electrolytic high grade 99.95% pure zinc.
 - Steel strand hot dip galvanized with minimum coating of 250 gm/sq.m.
 - No joints permitted in the individual aluminum strands and steel core of the conductor.
 - No Joints permitted in bus bar and jumpers conductor.

8.8.4 TECHNICAL PARTICULARS

Sl. No.	Description	Type of Conductor
1.	Wire diameter Aluminum (mm) Steel (mm)	6/4.72 7/1.57
2.	Sectional area of aluminum (sq.mm)	103.6
3.	Total sectional area (sq.mm)	118.45
4.	Overall diameter (mm)	14.15
5.	Approximate weight (kg/km)	394
6.	Maximum calculated D.C. resistance at 20°C (ohms/km)	0.2745
7.	Ultimate tensile strength (kN)	32.99
8.	Final modulus of elasticity (Kg/Sq.m)	0.735x10 ⁶ Kg/cm ²
9.	Coefficient of linear expansion x 10 ⁻⁶ per °C	19.53

8.8.5 Hardwares

The bolted tension fittings complete with U-bolts arcing horns etc. shall be provided suitable for 33 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.

8.8.6 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)	33
iii.	Highest system voltage kV (rms)	36
iv.	Wet power frequency one minute withstand voltage kV (rms)	70
v.	Power frequency puncture kV (rms)	1.3 times the actual voltage dry flash over voltage
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)

8.9 GROUNDING / EARTHING OF SWITCHYARD

Earthing system of the S/yard and power station shall be designed as per IS: 3043 and IEEE: 80. Earthing system network/earthmat shall be 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 with in 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 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. 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 as per IS-2309.
- ix. Complete earthing of transformer neutrals, L.A. earthing of all steel structures, earthing of bodies of all equipment etc.
- x. Any other item/work required for efficient completion of work.

8.12 PAINTING AND FINISHING

The colour code for the electrical equipment shall be as follows:

Sl.No.	Item	Colour	Paint Shade No. (as per IS:5,1991)
1.	Transformer	Dark admiralty grey	632
2.	Outdoor equipment	Dark admiralty grey	632
3.	Outdoor structures, bolts, nuts etc.	Galvanised	--
4.	H.T. Switchgear panels	Light gray	631
5.	L.T. board etc.	Light admiralty grey	697
6.	Panels, Dist. Boards etc.	Light admiralty grey	697
7.	Junction Boxes	Light grey	631
8.	Earthing	Bus Greas	--

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.

8.13 FENCING

The 33 kV switchyard shall be secured by surrounding it with 2 meters high M.S. pale fencing consisting of 2.3 m long 50 x 50 x 6 mm M.S. angle upright supports and two numbers 40 x 40 x 5 mm M.S. angle runners. The supports shall be spaced at 3 m interval and 75 mm wide pale strips shall be fixed on runners through G.I. bolts/nuts/washers at a clear spacing of 75 mm. The corner upright shall be supported with similar angle struts. The supports and struts shall be properly grouted.

E. E. (E-M),
0/0 the CE, DHPD, Itanagar.

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	Marking and arrangements for switchgear busbars, main connection and auxiliary wiring
IS-375	
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)

DETAILS OF INSTRUMENT TRANSFORMERS**CURRENT TRANSFORMERS**

Sl. No.	Location	Voltage (kV)	Ratio	Core	Class of Accuracy	VA Burden	Quantity
1.	Generator circuits						
	Neutral side	3.3	400/5	-	PS	30	} 6
	Line side	3.3	400/5	Core 1	PS	30	
				Core 2	0.2	30	
				Core 3	5P 15	30	
			Core 4	0.2	30		
2.	Generator Transformer Circuits						
	L.V. Side	3.3	400/5	Core 1	0.2	30	} 6
	H.V. Side	33	40/5	Core 2	5P 15	30	
				-	5P 15	30	} 6
3.	Station Transformer Circuit						
	L.V. Side	0.415	350/5	Core 1	0.2	15	} 3
				Core 2	5P 15	15	
	H.V. Side	3.3	50/5		5P 15	20	} 3
4.	33 kV Feeder Circuit						
		33	80/5	Core 1	5P 15	30	} 3
			Core 2	0.2	30		

POTENTIAL TRANSFORMERS

Sl. No.	Location	Ratio	Class of Accuracy	VA Burden	Qty.
1.	Generator circuits				
	Protection & metering PT	$\frac{3.3kV}{\sqrt{3}} / \frac{110V}{\sqrt{3}} / \frac{110V}{\sqrt{3}}$	3P for protection core 0.5 for measuring core	100	2 (3-Phase)
	AVR PT	$\frac{3.3kV}{\sqrt{3}} / \frac{110V}{\sqrt{3}}$	0.5		2 (3-Phase)
2.	3.3 kV Switch gear	$\frac{3.3kV}{\sqrt{3}} / \frac{110V}{\sqrt{3}} / \frac{110V}{\sqrt{3}}$	0.5	100	1 (3-Phase)
3.	33 kV Bus Bar	$\frac{33kV}{\sqrt{3}} / \frac{110V}{\sqrt{3}}$	0.5	100	3 (1-Phase)
4.	33 kV Feeder Circuit	$\frac{33kV}{\sqrt{3}} / \frac{110V}{\sqrt{3}}$	0.5	100	3 (1-Phase)