

BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION PROJECTS ENGINEERING MANAGEMENT



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TYPE OF DOC.	TECHNICAL SPECIFICATION			NAME	DS	JK	SKS
TITLE 765kV/400kV/220kV CIRCUIT BREAKER & CSD				SIGN			
				DATE			25/07
				GROUP	TBEM	W.O. No	
CUSTOMER	POWER GRID CORPORATION OF INDIA LTD.						
PROJECT	Extension of following substation under Western Region System Strengthening Scheme (WRSS)-20.						

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SCOPE, SPECIFIC TECHNICAL REQUIREMENTS AND QUANTITIES.

1.0 SCOPE

This technical specification covers the requirements of design, manufacture, inspection and testing at manufacturer's works, proper packing and delivery to project sites and supervision of erection, testing & commissioning of 765kV, 400kV, 220kV Circuit Breaker & CSD complete in all respect for efficient & trouble free operation mentioned under this specification.

The specification comprises of following sections

- Section-1 Scope, project specific technical requirements & bill of quantities.
- Section-2 Standard Technical Specification for Circuit Breaker
- Section-3 Project details & general technical Specifications for all the equipments under the project.
- Section-4 Annexures

In case of any discrepancies between the requirements mentioned under different Sections, order of precedence shall be as follows:

section-1 shall precede section-2, section-2 shall precede section-3

In general, no deviation from the requirements specified in various clauses of this specification shall be allowed and hence, a certificate to this effect shall have to be furnished along with the offer, however bidder shall furnish list of conflicts/ ambiguities/ deviations (if any) in *Schedule of Technical Deviations*. Any conflicts/ ambiguities/ deviations mentioned elsewhere in technical offer shall not be reviewed. In case the deviations mentioned in the *Schedule of Technical Deviations* are not technically acceptable, the offer of the bidder will be liable to rejection.

1.1 The Circuit Breakers & CSD are required for the following Project

Customer: Power Grid Corporation of India Ltd.

Project: Extension of following substation under Western Region System Strengthening Scheme (WRSS)-20.

- (i) 765kV Solapur Substation
- (ii) 765kV Aurangabad Substation
- (iii) 765kV Wardha Substation
- (iv) 400kV Khandwa Substation
- (v) 400kV Rajgarh Substation
- (vi) 400kV Champa Substation
- (vii) 400/220kV Jabalpur Substation

The scope of supplies shall be as per commercial terms and conditions enclosed separately with the enquiry.

2.0 SPECIFIC TECHNICAL REQUIREMENTS

2.1 System Fault Level

SL	Name of Substation	Fault level
1	765kV Solapur	40kA for 1sec
2	765kV Aurangabad	40kA for 1sec
3	765kV Wardha	40kA for 1sec
4	400kV Khandwa	40kA for 1sec
5	400kV Rajgarh	40kA for 1sec
6	400kV Champa	50kA for 1sec
7	400/220kV Jabalpur	40kA for 1sec

- 2.2** The proposed 765kV Circuit Breakers are to be used in 765kV three phase Bus Reactor Bank (New) with an existing spare Reactor and existing 1ph Circuit breaker. The proposed 765kV CB should be interfaced with existing single phase CB for spare reactor switching. Preparation of drawing/schematic for interface with existing 1Ph CB shall be in bidder's scope. Any additional item like contact multiplier relay, Terminal blocks etc for incorporating the interface in all respect shall be in bidder's scope. Any special cable/screened cable other than LT Power & Control Cables shall be in bidder's scope.
- 2.3** Minimum Number of auxiliary contacts on each Circuit Breaker - Besides requirement of technical specification, the manufacturer shall wire up 10 NO + 10 NC contacts of each phase/ pole exclusively for purchaser's use and shall be wired up to common marshalling box of 765, 400 & 220kV CB.
- 2.4** All contacts & control circuits to be wired out upto common control cabinet plus **24 spare terminals** exclusively for Owner's use
- 2.5** All cables within & between circuit breaker poles and its marshalling box and up to the controlled switching device shall be in bidder's scope of supply. Bidder to provide detailed "**Bill of Quantity**" during detailed engineering stage.
- 2.6** Cabling & termination schedule for the same shall be provided by successful bidder along with AS BUILT drawing during contract stage.
- 2.7** TB's for (for incoming AC Power Cables) shall be suitable for size (minimum) **4Cx16** Sqmm Al.
- 2.8** LED luminaries / light is to be provided as per technical requirement (minimum 7 watt).
- 2.9** Following accessories are clarified as bidder's scope of supply
- **Structure** for Equipment support, Ladder & Platform etc.
 - **Foundation bolts** for Circuit Breaker, CB Ladder, CB Platform, common control cubical.
 - **Cable tray** arrangement to be mounted on Breaker structure
 - Breaker **Terminal Pad**

2.10 Followings are not in bidder's scope of supply (BHEL supplied items)

- Terminal Connectors

3.0 SPECIFIC TECHNICAL REQUIREMENTS FOR CSD

3.1 CSD shall be deployed for optimization of switching behavior of bidder supplied circuit Breaker (under present scope).

3.2 Where Control switching device is being provided for Circuit breaker, it is the bidders responsibility to ensure compatibility with CB. Complete interfacing with CB and offered CSD shall be in bidder's scope. Any additional item like transducer, contact multiplication relay, switches, special/screened cables, modification hardwired, modification in schematics (if any) required for interfacing and for complying to the technical specification requirement shall be in bidder's scope and shall be included in quoted price. Preparation of final as built schematics/ interface drawing due to modifications in existing CB schematics for incorporation of CSD/CSD bypass/Alarms etc as per Technical specification is in bidder's scope.

3.3 All wiring necessary for interface of existing CB/CRP with bidder supplied CSD is also deemed to be included in the scope of bidder. Cables, lugs, ties etc required for connection of CSD in existing relay panel is deemed to be included in bidder's scope.

3.4 Supervision of Erection, testing & Commissioning of CSD shall be in bidder's scope.

3.5 Available data for CSD interfacing shall be provided to successful bidder however successful bidder may need to visit respective sites for collection of data as per requirement.

3.6 The CSD should have display facility at the front for the display of settings and measured values. In case where CSD does not have complete display facility for settings and measured values, bidder to supply one number laptop PC with pre-installed, licensed software for each site. Cost of the same shall be deemed included in offer.

- 3.7** Special cables (i.e. screened/FO cable) other than 1100V LT Power & Control Cables required for CB / CSD / Relay Panel interfacing shall be in bidder's scope. Mode of measurement for special cable shall be **cable-trench running length** from Circuit Breaker to Relay panel. **Total requirement special cable qty. is to be estimated & supplied by bidder based on no. of runs etc.**

4.0 OTHER TECHNICAL REQUIREMENT

- 4.1** All equipments shall perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation.
- 4.2** All equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, ice & snow, (wherever applicable) short circuit etc. for the equipment.
- 4.3** The equipment shall also comply with the following:
- To facilitate erection of equipment, all items to be assembled at site shall be "match marked".
 - All piping, if any between equipment control cabinet/operating mechanism to marshalling box of the equipment, shall bear proper identification to facilitate the connection at site
- 4.4** Bidder to submit detailed "guaranteed and technical particulars" and "detailed drawings" for Circuit Breakers during contract stage for approval. Bidder may need to visit to BHEL / Powergrid corporate engineering office for drawing / document approval if standard approval is not available.

5.0 BILL OF QUANTITIES: Please refer Annexure_BOQ

Note:

- 5.1** Total contract value may vary upto $\pm 30\%$ at contract stage.
- 5.2** Prices for all applicable accessories of Circuit Breakers shall be included in the equipment prices.

5.3 Respective dates for the commencement of erection, testing and commissioning activities of Circuit Breakers shall be communicated to manufacturers from time to time as per the readiness of respective sites.

6.0 TECHNICAL QUALIFYING REQUIREMENTS: Please refer the followings

6.1 Annexure_765TQR - applicable for 765kV CB

6.2 Annexure_400TQR - applicable for 400kV & 220kV CB

7.0 SUPERVISION OF ERECTION COMMISSIONING AND TESTING:

Supervision of Erection, testing and commissioning of all the supplied Circuit Breakers are in the bidder's scope. Bidder shall quote lump-sum price for supervision of installation, testing and commissioning of all offered breakers. Supplier's testing engineer shall bring SF6 gas leak detector, SF6 gas filling adopter, timing kit and Transducer for operational analyser (as per requirement).

Required unskilled man power / Labor, tools (other than special tools and tackles which shall be in bidder's scope) shall be provided by BHEL.

The measurement at site shall be carried out as per Powergrid Standard Pre-commissioning procedures as indicated in Section-2 Technical Specification. The commissioning report shall be prepared and signed by the manufacturer's representative.

Following Instruments shall be made available by BHEL to testing engineer

- a) DCRM (Operational analyser) Kit
- b) 5kV Insulation tester
- c) 1kV Insulation tester
- d) Single phase variac
- e) Dew Point meter
- f) Capacitance and Tan Delta Kit

- g) Contact Resistance measurement kit
- h) Multimeter

Any **other instrument(s), if required for Testing/commissioning of Circuit Breaker shall be arranged by bidder.** Cost of the same shall be deemed inclusive in the offer.

The respective dates of commencement of erection, testing and commissioning activities by BHEL will be intimated to the equipment supplier from time to time, so that arrangements for supervising the activity can be made accordingly by the manufacturer.

8.0 TYPE TESTING, INSPECTION, TESTING & INSPECTION CERTIFICATE

All equipment being supplied shall conform to type tests as per technical specification and shall be subject to routine tests in accordance with requirements stipulated under respective sections.

The reports for all type tests as per technical specification shall be furnished by the bidder along with equipment / material drawings. However, type test reports of similar equipments/ material already accepted in POWERGRID shall be applicable for all projects with similar requirement. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited based on ISO / IEC Guide 25 / 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by POWERGRID or representative authorized by POWERGRID or Utility or representative of accredited test lab.

Unless otherwise specified elsewhere, the type test reports submitted shall be of the tests conducted within last 10 (ten) years from the date of NOA. In case the test reports are of the test conducted earlier than 10 (ten) years from the date of NOA, the contractor shall repeat these test(s) at no extra cost to the BHEL / Powergrid.

The Bidder shall intimate the BHEL / Powergrid the detailed program about the type tests at least two (2) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies.

NOTE –

- (a.) NOA stands for Notification of Award issued by Powergrid to BHEL for reference project. Date of NOA is 29th July 2019.
- (b.) Type test report shall be reviewed for approval in detailed engineering stage only.

9.0 SPECIAL TOOLS AND TACKLES:

Bidder shall supply all special tools and tackle (other than maintenance tools as if mentioned in BOQ) which are specifically required for Circuit Breakers and are proprietary in nature. Cost of the same shall be deemed inclusive in the offer for main item. List of such special tools and tackle should be clearly listed along with the technical offer. Any special tool which is not listed in the technical spec / bid but required during the erection/commissioning of Circuit Breakers shall also be supplied by the bidder without time / cost implication.

In case, special tools and tackles which is proprietary in nature is not required for Erection/testing/commissioning or for smooth operation of Circuit Breaker, supplier has to submit a certificate mentioning that no special tools and tackles is required for Circuit Breakers.

10.0 QUALITY PLAN

Bidder to follow valid Powergrid approved Quality Plan as per Powergrid procedure. In case the bidder don't have Powergrid approved Quality Plan, it will be the bidder's responsibility to get its Quality Plan approved directly from the ultimate customer M/s Powergrid Corporation of India Limited.

11.0 TECHNICAL DEVIATIONS:

The bidder shall list all the deviation from the specification separately. Offers without specific deviation will be deemed to be totally in compliance with the specification and NO DEVIATION on any account will be entertained at a later date.

12.0 SPECIAL WARRANTY REQUIREMENT:

Replaced/ Repaired/ Refurbished Equipment (or part of equipment) shall **have 2 years' warranty without prejudice to contractual warranty period.**

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ANNEXURE-BOQ (CIRCUIT BREAKER)

S.No.	DESCRIPTION	UNIT	QUANTITY	REMARKS
1. 765kV SOLAPUR SUBSTATION				
A.	Main Quantity			
1	SUPPLY- CIRCUIT BREAKER : 765KV 40KA FOR 1S 25MM/KV CREEPAGE 3150A, 3 PHASE CIRCUIT BREAKER WITHOUT PIR, WITH CONTROL SWITCHING CAPABILITY, ALONGWITH SUPPORT STRUCTURE, INTERPOLE CABLES, OPERATING MECHANISM, CONTROL BOXES AND ALL ACCESSORIES COMPLETE IN ALL RESPECT	Nos.	1	
2	SUPPLY- CIRCUIT BREAKER : CONTROLLED SWITCHING DEVICE FOR 3-PH CIRCUIT BREAKER	Nos.	1	
3	SUPPLY- CIRCUIT BREAKER : 765KV, FOUNDATION BOLTS FOR CIRCUIT BREAKER, PLATFORM AND LADDER	Lot	1	
4	SUPPLY- CIRCUIT BREAKER : SPECIAL CABLES FOR CB / CSD / RP INTERFACING. MODE OF MEASUREMENT SHALL BE CABLE-TRENCH RUNNING LENGTH FROM CIRCUIT BREAKER TO CSD/ RELAY PANEL	m	100	
5	SUPPLY- CIRCUIT BREAKER : TRANSDUCERS / FIXTURES REQUIRED FOR TRAVEL MEASUREMENT OF COMPLETE 3-PHASE CB	Lot	1	
6	SUPPLY- CIRCUIT BREAKER : SF6 GAS FILLING ADOPTER, INCLUDING COUPLING, REGULATOR, CONNECTING HOSE PIPE UP TO GROUND LEVEL	Nos.	1	
7	SERVICES- CIRCUIT BREAKER : 765KV, SUPERVISION OF ERECTION, TESTING AND COMMISSIONING OF CIRCUIT BREAKER	Nos.	1	
8	SERVICES- CIRCUIT BREAKER : 765KV, SUPERVISION OF ERECTION TESTING AND COMMISSIONING OF CONTROLLED SWITCHING DEVICE	Nos.	1	
B.	Mandatory Spares			
B.1	765kV, 3150A, 40kA for 1-sec 3-Phase Circuit Breaker			
1	SPARES- CIRCUIT BREAKER : 765KV 40KA FOR 1S 25MM/KV CREEPAGE ONE COMPLETE POLE OF 3150A CB WITHOUT PIR, WITH POLE COLUMN INTERRUPTER, DRIVING MECHANISM AND MARSHALING BOX EXCLUDING SUPPORT STRUCTURE	Nos.	1	
2	SPARES- CIRCUIT BREAKER : 765KV, GRADING CAPACITORS	Nos.	1	For each type and rating, as applicable
3	SPARES- CIRCUIT BREAKER : 765KV, O" RINGS, GASKETS & SEALS FOR OPERATING MECHANISM	Set	1	For Complete replacement for one phase of Circuit Breaker
4	SPARES- CIRCUIT BREAKER : 765KV, TRIP COILS WITH RESISTOR	Nos.	3	Set of one no. of each type & rating
5	SPARES- CIRCUIT BREAKER : 765KV, CLOSING COILS WITH RESISTOR	Nos.	3	Set of one no. of each type & rating
6	SPARES- CIRCUIT BREAKER : 765KV, TERMINAL PAD	Nos.	2	
7	SPARES- CIRCUIT BREAKER : 765KV, MOLECULAR FILTER	Nos.	2	For Complete replacement for one phase of Circuit Breaker
8	SPARES- CIRCUIT BREAKER : 765KV, CORONA RINGS	Nos.	1	Set of one no. of each type & rating, as applicable
9	SPARES- CIRCUIT BREAKER : 765KV, RELAY POWER CONTACTORS, SWITCH FUSE UNITS, LIMIT SWITCHES, PUSH BUTTON, TIMERS & MCB ETC	Set	1	set of one no. of each type & rating
10	SPARES- CIRCUIT BREAKER : 765KV, PRESSURE SWITCH OF EACH TYPE/DENSITY MONITOR	Set	1	Set of one no. of each type & rating

ANNEXURE-BOQ (CIRCUIT BREAKER)

S.No.	DESCRIPTION	UNIT	QUANTITY	REMARKS
11	SPARES- CIRCUIT BREAKER : 765KV, AUXILIARY SWITCH ASSEMBLY	Set	1	For one Phase of Circuit Breaker
2. 765kV AURANGABAD SUBSTATION				
A.	Main Quantity			
1	SUPPLY- CIRCUIT BREAKER : 765KV 40KA FOR 1S 25MM/KV CREEPAGE 3150A, 3 PHASE CIRCUIT BREAKER WITHOUT PIR, WITH CONTROL SWITCHING CAPABILITY, ALONGWITH SUPPORT STRUCTURE, INTERPOLE CABLES, OPERATING MECHANISM, CONTROL BOXES AND ALL ACCESSORIES COMPLETE IN ALL RESPECT	Nos.	1	
2	SUPPLY- CIRCUIT BREAKER : CONTROLLED SWITCHING DEVICE FOR 3-PH CIRCUIT BREAKER	Nos.	1	
3	SUPPLY- CIRCUIT BREAKER : 765KV, FOUNDATION BOLTS FOR CIRCUIT BREAKER, PLATFORM AND LADDER	Lot	1	
4	SUPPLY- CIRCUIT BREAKER : SPECIAL CABLES FOR CB / CSD / RP INTERFACING. MODE OF MEASUREMENT SHALL BE CABLE-TRENCH RUNNING LENGTH FROM CIRCUIT BREAKER TO CSD/ RELAY PANEL	m	100	
5	SUPPLY- CIRCUIT BREAKER : TRANSDUCERS / FIXTURES REQUIRED FOR TRAVEL MEASUREMENT OF COMPLETE 3-PHASE CB	Lot	1	
6	SUPPLY- CIRCUIT BREAKER : SF6 GAS FILLING ADOPTER, INCLUDING COUPLING, REGULATOR, CONNECTING HOSE PIPE UP TO GROUND LEVEL	Nos.	1	
7	SERVICES- CIRCUIT BREAKER : 765KV, SUPERVISION OF ERECTION, TESTING AND COMMISSIONING OF CIRCUIT BREAKER	Nos.	1	
8	SERVICES- CIRCUIT BREAKER : 765KV, SUPERVISION OF ERECTION TESTING AND COMMISSIONING OF CONTROLLED SWITCHING DEVICE	Nos.	1	
B.	Mandatory Spares			
B.1	765kV, 3150A, 40kA for 1-sec 3-Phase Circuit Breaker			
1	SPARES- CIRCUIT BREAKER : 765KV 40KA FOR 1S 25MM/KV CREEPAGE ONE COMPLETE POLE OF 3150A CB WITHOUT PIR, WITH POLE COLUMN INTERRUPTER, DRIVING MECHANISM AND MARSHALING BOX EXCLUDING SUPPORT STRUCTURE	Nos.	1	
2	SPARES- CIRCUIT BREAKER : 765KV, GRADING CAPACITORS	Nos.	1	For each type and rating, as applicable
3	SPARES- CIRCUIT BREAKER : 765KV, O" RINGS, GASKETS & SEALS FOR OPERATING MECHANISM	Set	1	For Complete replacement for one phase of Circuit Breaker
4	SPARES- CIRCUIT BREAKER : 765KV, TRIP COILS WITH RESISTOR	Nos.	3	Set of one no. of each type & rating
5	SPARES- CIRCUIT BREAKER : 765KV, CLOSING COILS WITH RESISTOR	Nos.	3	Set of one no. of each type & rating
6	SPARES- CIRCUIT BREAKER : 765KV, TERMINAL PAD	Nos.	2	
7	SPARES- CIRCUIT BREAKER : 765KV, MOLECULAR FILTER	Nos	2	For Complete replacement for one phase of Circuit Breaker

ANNEXURE-BOQ (CIRCUIT BREAKER)

S.No.	DESCRIPTION	UNIT	QUANTITY	REMARKS
8	SPARES- CIRCUIT BREAKER : 765KV, CORONA RINGS	Nos	1	Set of one no. of each type & rating, as applicable
9	SPARES- CIRCUIT BREAKER : 765KV, RELAY POWER CONTACTORS, SWITCH FUSE UNITS, LIMIT SWITCHES, PUSH BUTTON, TIMERS & MCB ETC	Set	1	set of one no. of each type & rating
10	SPARES- CIRCUIT BREAKER : 765KV, PRESSURE SWITCH OF EACH TYPE/DENSITY MONITOR	Set	1	Set of one no. of each type & rating
11	SPARES- CIRCUIT BREAKER : 765KV, AUXILIARY SWITCH ASSEMBLY	Set	1	For one Phase of Circuit Breaker
3. 765kV WARDHA SUBSTATION				
A.	Main Quantity			
1	SUPPLY- CIRCUIT BREAKER : 765KV 40KA FOR 1S 25MM/KV CREEPAGE 3150A, 3 PHASE CIRCUIT BREAKER WITHOUT PIR, WITH CONTROL SWITCHING CAPABILITY, ALONGWITH SUPPORT STRUCTURE, INTERPOLE CABLES, OPERATING MECHANISM, CONTROL BOXES AND ALL ACCESSORIES COMPLETE IN ALL RESPECT	Nos.	1	
2	SUPPLY- CIRCUIT BREAKER : CONTROLLED SWITCHING DEVICE FOR 3-PH CIRCUIT BREAKER	Nos.	1	
3	SUPPLY- CIRCUIT BREAKER : 765KV, FOUNDATION BOLTS FOR CIRCUIT BREAKER, PLATFORM AND LADDER	Lot	1	
4	SUPPLY- CIRCUIT BREAKER : SPECIAL CABLES FOR CB / CSD / RP INTERFACING. MODE OF MEASUREMENT SHALL BE CABLE-TRENCH RUNNING LENGTH FROM CIRCUIT BREAKER TO CSD/ RELAY PANEL	m	100	
5	SUPPLY- CIRCUIT BREAKER : TRANSDUCERS / FIXTURES REQUIRED FOR TRAVEL MEASUREMENT OF COMPLETE 3-PHASE CB	Lot	1	
6	SUPPLY- CIRCUIT BREAKER : SF6 GAS FILLING ADOPTER, INCLUDING COUPLING, REGULATOR, CONNECTING HOSE PIPE UP TO GROUND LEVEL	Nos.	1	
7	SERVICES- CIRCUIT BREAKER : 765KV, SUPERVISION OF ERECTION, TESTING AND COMMISSIONING OF CIRCUIT BREAKER	Nos.	1	
8	SERVICES- CIRCUIT BREAKER : 765KV, SUPERVISION OF ERECTION TESTING AND COMMISSIONING OF CONTROLLED SWITCHING DEVICE	Nos.	1	
B.	Mandatory Spares			
B.1	765kV, 3150A, 40kA for 1-sec 3-Phase Circuit Breaker			
1	SPARES- CIRCUIT BREAKER : 765KV 40KA FOR 1S 25MM/KV CREEPAGE ONE COMPLETE POLE OF 3150A CB WITHOUT PIR, WITH POLE COLUMN INTERRUPTER, DRIVING MECHANISM AND MARSHALING BOX EXCLUDING SUPPORT STRUCTURE	Nos.	1	
2	SPARES- CIRCUIT BREAKER : 765KV, GRADING CAPACITORS	Nos.	1	For each type and rating, as applicable
3	SPARES- CIRCUIT BREAKER : 765KV, O" RINGS, GASKETS & SEALS FOR OPERATING MECHANISM	Set	1	For Complete replacement for one phase of Circuit Breaker
4	SPARES- CIRCUIT BREAKER : 765KV, TRIP COILS WITH RESISTOR	Nos.	3	Set of one no. of each type & rating
5	SPARES- CIRCUIT BREAKER : 765KV, CLOSING COILS WITH RESISTOR	Nos.	3	Set of one no. of each type & rating

ANNEXURE-BOQ (CIRCUIT BREAKER)

S.No.	DESCRIPTION	UNIT	QUANTITY	REMARKS
6	SPARES- CIRCUIT BREAKER : 765KV, TERMINAL PAD	Nos.	2	
7	SPARES- CIRCUIT BREAKER : 765KV, MOLECULAR FILTER	Nos	2	For Complete replacement for one phase of Circuit Breaker
8	SPARES- CIRCUIT BREAKER : 765KV, CORONA RINGS	Nos	1	Set of one no. of each type & rating, as applicable
9	SPARES- CIRCUIT BREAKER : 765KV, RELAY POWER CONTACTORS, SWITCH FUSE UNITS, LIMIT SWITCHES, PUSH BUTTON, TIMERS & MCB ETC	Set	1	set of one no. of each type & rating
10	SPARES- CIRCUIT BREAKER : 765KV, PRESSURE SWITCH OF EACH TYPE/DENSITY MONITOR	Set	1	Set of one no. of each type & rating
11	SPARES- CIRCUIT BREAKER : 765KV, AUXILIARY SWITCH ASSEMBLY	Set	1	For one Phase of Circuit Breaker
4. 400kV KHANDWA SUBSTATION				
A.	Main Quantity			
1	SUPPLY- CIRCUIT BREAKER : 420KV 40KA FOR 1S 25MM/KV CREEPAGE 3150A, 3 PHASE CIRCUIT BREAKER WITHOUT PIR, WITH CONTROL SWITCHING CAPABILITY, ALONGWITH SUPPORT STRUCTURE, INTERPOLE CABLES, OPERATING MECHANISM, CONTROL BOXES AND ALL ACCESSORIES COMPLETE IN ALL RESPECT	Nos.	1	
2	SUPPLY- CIRCUIT BREAKER : CONTROLLED SWITCHING DEVICE FOR 3-PH CIRCUIT BREAKER	Nos.	1	
3	SUPPLY- CIRCUIT BREAKER : 400KV, FOUNDATION BOLTS FOR CIRCUIT BREAKER, PLATFORM AND LADDER	Lot	1	
4	SUPPLY- CIRCUIT BREAKER : SPECIAL CABLES FOR CB / CSD / RP INTERFACING. MODE OF MEASUREMENT SHALL BE CABLE-TRENCH RUNNING LENGTH FROM CIRCUIT BREAKER TO CSD/ RELAY PANEL	m	50	
5	SUPPLY- CIRCUIT BREAKER : TRANSDUCERS / FIXTURES REQUIRED FOR TRAVEL MEASUREMENT OF COMPLETE 3-PHASE CB	Lot	1	
6	SUPPLY- CIRCUIT BREAKER : SF6 GAS FILLING ADOPTER, INCLUDING COUPLING, REGULATOR, CONNECTING HOSE PIPE UP TO GROUND LEVEL	Set	1	
7	SERVICES- CIRCUIT BREAKER : 400KV, SUPERVISION OF ERECTION, TESTING AND COMMISSIONING OF CIRCUIT BREAKER	Nos.	1	
8	SERVICES- CIRCUIT BREAKER : 400KV, SUPERVISION OF ERECTION TESTING AND COMMISSIONING OF CONTROLLED SWITCHING DEVICE	Nos.	1	
B.	Mandatory Spares			
B.1	400kV, 3150A, 40kA for 1-sec 3-Phase Circuit Breaker			
1	SPARES- CIRCUIT BREAKER : 420KV 40KA FOR 1S 25MM/KV CREEPAGE ONE COMPLETE POLE OF 3150A CB WITHOUT PIR, WITH POLE COLUMN INTERRUPTER, DRIVING MECHANISM AND MARSHALING BOX EXCLUDING SUPPORT STRUCTURE	Nos.	1	
2	SPARES- CIRCUIT BREAKER : 400KV, GRADING CAPACITORS	No	1	For each type and rating, as applicable
3	SPARES- CIRCUIT BREAKER : 400KV, O" RINGS, GASKETS & SEALS FOR OPERATING MECHANISM	Set	1	For Complete replacement for one phase of Circuit Breaker

ANNEXURE-BOQ (CIRCUIT BREAKER)

S.No.	DESCRIPTION	UNIT	QUANTITY	REMARKS
4	SPARES- CIRCUIT BREAKER : 400KV, TRIP COILS WITH RESISTOR	Nos.	3	Set of one no. of each type & rating
5	SPARES- CIRCUIT BREAKER : 400KV, CLOSING COILS WITH RESISTOR	Nos.	3	Set of one no. of each type & rating
6	SPARES- CIRCUIT BREAKER : 400KV, TERMINAL PAD	Nos.	2	
7	SPARES- CIRCUIT BREAKER : 400KV, MOLECULAR FILTER	Nos	2	For Complete replacement for one phase of Circuit Breaker
8	SPARES- CIRCUIT BREAKER : 400KV, CORONA RINGS	Nos	1	Set of one no. of each type & rating, as applicable
9	SPARES- CIRCUIT BREAKER : 400KV, RELAY POWER CONTACTORS, SWITCH FUSE UNITS, LIMIT SWITCHES, PUSH BUTTON, TIMERS & MCB ETC	Set	1	set of one no. of each type & rating
10	SPARES- CIRCUIT BREAKER : 400KV, PRESSURE SWITCH OF EACH TYPE/DENSITY MONITOR	Set	1	Set of one no. of each type & rating
11	SPARES- CIRCUIT BREAKER : 400KV, AUXILIARY SWITCH ASSEMBLY	Set	1	For one Phase of Circuit Breaker
5. 400kV RAJGHAH SUBSTATION				
A.	Main Quantity			
1	SUPPLY- CIRCUIT BREAKER : 420KV 40KA FOR 1S 25MM/KV CREEPAGE 3150A, 3 PHASE CIRCUIT BREAKER WITHOUT PIR, WITH CONTROL SWITCHING CAPABILITY, ALONGWITH SUPPORT STRUCTURE, INTERPOLE CABLES, OPERATING MECHANISM, CONTROL BOXES AND ALL ACCESSORIES COMPLETE IN ALL RESPECT	Nos.	1	
2	SUPPLY- CIRCUIT BREAKER : CONTROLLED SWITCHING DEVICE FOR 3-PH CIRCUIT BREAKER	Nos.	1	
3	SUPPLY- CIRCUIT BREAKER : 400KV, FOUNDATION BOLTS FOR CIRCUIT BREAKER, PLATFORM AND LADDER	Lot	1	
4	SUPPLY- CIRCUIT BREAKER : SPECIAL CABLES FOR CB / CSD / RP INTERFACING. MODE OF MEASUREMENT SHALL BE CABLE-TRENCH RUNNING LENGTH FROM CIRCUIT BREAKER TO CSD/ RELAY PANEL	m	50	
5	SUPPLY- CIRCUIT BREAKER : TRANSDUCERS / FIXTURES REQUIRED FOR TRAVEL MEASUREMENT OF COMPLETE 3-PHASE CB	Lot	1	
6	SUPPLY- CIRCUIT BREAKER : SF6 GAS FILLING ADOPTER, INCLUDING COUPLING, REGULATOR, CONNECTING HOSE PIPE UP TO GROUND LEVEL	Set	1	
7	SERVICES- CIRCUIT BREAKER : 400KV, SUPERVISION OF ERECTION, TESTING AND COMMISSIONING OF CIRCUIT BREAKER	Nos.	1	
8	SERVICES- CIRCUIT BREAKER : 400KV, SUPERVISION OF ERECTION TESTING AND COMMISSIONING OF CONTROLLED SWITCHING DEVICE	Nos.	1	
B.	Mandatory Spares			
B.1	400kV, 3150A, 40kA for 1-sec 3-Phase Circuit Breaker			
1	SPARES- CIRCUIT BREAKER : 420KV 40KA FOR 1S 25MM/KV CREEPAGE ONE COMPLETE POLE OF 3150A CB WITHOUT PIR, WITH POLE COLUMN INTERRUPTER, DRIVING MECHANISM AND MARSHALING BOX EXCLUDING SUPPORT STRUCTURE	Nos.	1	

ANNEXURE-BOQ (CIRCUIT BREAKER)

S.No.	DESCRIPTION	UNIT	QUANTITY	REMARKS
2	SPARES- CIRCUIT BREAKER : 400KV, GRADING CAPACITORS	No	1	For each type and rating, as applicable
3	SPARES- CIRCUIT BREAKER : 400KV, O" RINGS, GASKETS & SEALS FOR OPERATING MECHANISM	Set	1	For Complete replacement for one phase of Circuit Breaker
4	SPARES- CIRCUIT BREAKER : 400KV, TRIP COILS WITH RESISTOR	Nos.	3	Set of one no. of each type & rating
5	SPARES- CIRCUIT BREAKER : 400KV, CLOSING COILS WITH RESISTOR	Nos.	3	Set of one no. of each type & rating
6	SPARES- CIRCUIT BREAKER : 400KV, TERMINAL PAD	Nos.	2	
7	SPARES- CIRCUIT BREAKER : 400KV, MOLECULAR FILTER	Nos	2	For Complete replacement for one phase of Circuit Breaker
8	SPARES- CIRCUIT BREAKER : 400KV, CORONA RINGS	Nos	1	Set of one no. of each type & rating, as applicable
9	SPARES- CIRCUIT BREAKER : 400KV, RELAY POWER CONTACTORS, SWITCH FUSE UNITS, LIMIT SWITCHES, PUSH BUTTON, TIMERS & MCB ETC	Set	1	set of one no. of each type & rating
10	SPARES- CIRCUIT BREAKER : 400KV, PRESSURE SWITCH OF EACH TYPE/DENSITY MONITOR	Set	1	Set of one no. of each type & rating
11	SPARES- CIRCUIT BREAKER : 400KV, AUXILIARY SWITCH ASSEMBLY	Set	1	For one Phase of Circuit Breaker
6. 400kV CHAMPA SUBSTATION				
A.	Main Quantity			
1	SUPPLY- CIRCUIT BREAKER : 420KV 50KA FOR 1S 25MM/KV CREEPAGE 3150A, 3 PHASE CIRCUIT BREAKER WITHOUT PIR, WITH CONTROL SWITCHING CAPABILITY, ALONGWITH SUPPORT STRUCTURE, INTERPOLE CABLES, OPERATING MECHANISM, CONTROL BOXES AND ALL ACCESSORIES COMPLETE IN ALL RESPECT	Nos.	1	
2	SUPPLY- CIRCUIT BREAKER : CONTROLLED SWITCHING DEVICE FOR 3-PH CIRCUIT BREAKER	Nos.	1	
3	SUPPLY- CIRCUIT BREAKER : 400KV, FOUNDATION BOLTS FOR CIRCUIT BREAKER, PLATFORM AND LADDER	Lot	1	
4	SUPPLY- CIRCUIT BREAKER : SPECIAL CABLES FOR CB / CSD / RP INTERFACING. MODE OF MEASUREMENT SHALL BE CABLE-TRENCH RUNNING LENGTH FROM CIRCUIT BREAKER TO CSD/ RELAY PANEL	m	50	
5	SUPPLY- CIRCUIT BREAKER : TRANSDUCERS / FIXTURES REQUIRED FOR TRAVEL MEASUREMENT OF COMPLETE 3-PHASE CB	Lot	1	
6	SUPPLY- CIRCUIT BREAKER : SF6 GAS FILLING ADAPTER, INCLUDING COUPLING, REGULATOR, CONNECTING HOSE PIPE UP TO GROUND LEVEL	Set	1	
7	SERVICES- CIRCUIT BREAKER : 400KV, SUPERVISION OF ERECTION, TESTING AND COMMISSIONING OF CIRCUIT BREAKER	Nos.	1	
8	SERVICES- CIRCUIT BREAKER : 400KV, SUPERVISION OF ERECTION TESTING AND COMMISSIONING OF CONTROLLED SWITCHING DEVICE	Nos.	1	

ANNEXURE-BOQ (CIRCUIT BREAKER)

S.No.	DESCRIPTION	UNIT	QUANTITY	REMARKS
B.	Mandatory Spares			
B.1	400kV, 3150A, 50kA for 1-sec 3-Phase Circuit Breaker			
1	SPARES- CIRCUIT BREAKER : 420KV 50KA FOR 1S 25MM/KV CREEPAGE ONE COMPLETE POLE OF 3150A CB WITHOUT PIR, WITH POLE COLUMN INTERRUPTER, DRIVING MECHANISM AND MARSHALING BOX EXCLUDING SUPPORT STRUCTURE	Nos.	1	
2	SPARES- CIRCUIT BREAKER : 400KV, GRADING CAPACITORS	No	1	For each type and rating, as applicable
3	SPARES- CIRCUIT BREAKER : 400KV, O" RINGS, GASKETS & SEALS FOR OPERATING MECHANISM	Set	1	For Complete replacement for one phase of Circuit Breaker
4	SPARES- CIRCUIT BREAKER : 400KV, TRIP COILS WITH RESISTOR	Nos.	3	Set of one no. of each type & rating
5	SPARES- CIRCUIT BREAKER : 400KV, CLOSING COILS WITH RESISTOR	Nos.	3	Set of one no. of each type & rating
6	SPARES- CIRCUIT BREAKER : 400KV, TERMINAL PAD	Nos.	2	
7	SPARES- CIRCUIT BREAKER : 400KV, MOLECULAR FILTER	Nos	2	For Complete replacement for one phase of Circuit Breaker
8	SPARES- CIRCUIT BREAKER : 400KV, CORONA RINGS	Nos	1	Set of one no. of each type & rating, as applicable
9	SPARES- CIRCUIT BREAKER : 400KV, RELAY POWER CONTACTORS, SWITCH FUSE UNITS, LIMIT SWITCHES, PUSH BUTTON, TIMERS & MCB ETC	Set	1	set of one no. of each type & rating
10	SPARES- CIRCUIT BREAKER : 400KV, PRESSURE SWITCH OF EACH TYPE/DENSITY MONITOR	Set	1	Set of one no. of each type & rating
11	SPARES- CIRCUIT BREAKER : 400KV, AUXILIARY SWITCH ASSEMBLY	Set	1	For one Phase of Circuit Breaker
7. 400/220 kV JABALPUR SUBSTATION				
A.	Main Quantity			
1	SUPPLY- CIRCUIT BREAKER : 420KV 40KA FOR 1S 25MM/KV CREEPAGE 3150A, 3 PHASE CIRCUIT BREAKER WITHOUT PIR, WITH CONTROL SWITCHING CAPABILITY, ALONGWITH SUPPORT STRUCTURE, INTERPOLE CABLES, OPERATING MECHANISM, CONTROL BOXES AND ALL ACCESSORIES COMPLETE IN ALL RESPECT	Nos.	2	
2	SUPPLY- CIRCUIT BREAKER : 220KV 40KA FOR 1S 25MM/KV CREEPAGE 1600A, 3 PHASE CIRCUIT BREAKER, ALONGWITH SUPPORT STRUCTURE, INTERPOLE CABLES, OPERATING MECHANISM, CONTROL BOXES AND ALL ACCESSORIES COMPLETE IN ALL RESPECT	Nos.	1	
3	SUPPLY- CIRCUIT BREAKER : CONTROLLED SWITCHING DEVICE FOR 3-PH CIRCUIT BREAKER	Nos.	2	
4	SUPPLY- CIRCUIT BREAKER : 400KV, FOUNDATION BOLTS FOR CIRCUIT BREAKER, PLATFORM AND LADDER	Lot	1	
5	SUPPLY- CIRCUIT BREAKER : 220KV, FOUNDATION BOLTS FOR CIRCUIT BREAKER, PLATFORM AND LADDER	Lot	1	

ANNEXURE-BOQ (CIRCUIT BREAKER)

S.No.	DESCRIPTION	UNIT	QUANTITY	REMARKS
6	SUPPLY- CIRCUIT BREAKER : SPECIAL CABLES FOR CB / CSD / RP INTERFACING. MODE OF MEASUREMENT SHALL BE CABLE-TRENCH RUNNING LENGTH FROM CIRCUIT BREAKER TO CSD/ RELAY PANEL	m	100	
7	SUPPLY- CIRCUIT BREAKER : TRANSDUCERS / FIXTURES REQUIRED FOR TRAVEL MEASUREMENT OF COMPLETE 3-PHASE CB	Lot	1	
8	SUPPLY- CIRCUIT BREAKER : SF6 GAS FILLING ADOPTER, INCLUDING COUPLING, REGULATOR, CONNECTING HOSE PIPE UP TO GROUND LEVEL	Set	1	To be used for all supplied breaker
9	SERVICES- CIRCUIT BREAKER : 400KV, SUPERVISION OF ERECTION, TESTING AND COMMISSIONING OF CIRCUIT BREAKER	Nos.	2	
10	SERVICES- CIRCUIT BREAKER : 220KV, SUPERVISION OF ERECTION, TESTING AND COMMISSIONING OF CIRCUIT BREAKER	Nos.	1	
11	SERVICES- CIRCUIT BREAKER : 400KV, SUPERVISION OF ERECTION TESTING AND COMMISSIONING OF CONTROLLED SWITCHING DEVICE	Nos.	2	
B.	Mandatory Spares			
B.1	400kV, 3150A, 40KA for 1-sec 3-Phase Circuit Breaker			
1	SPARES- CIRCUIT BREAKER : 420KV 40KA FOR 1S 25MM/KV CREEPAGE ONE COMPLETE POLE OF 3150A CB WITHOUT PIR, WITH POLE COLUMN INTERRUPTER, DRIVING MECHANISM AND MARSHALING BOX EXCLUDING SUPPORT STRUCTURE	Nos.	1	
2	SPARES- CIRCUIT BREAKER : 400KV, GRADING CAPACITORS	No	1	For each type and rating, as applicable
3	SPARES- CIRCUIT BREAKER : 400KV, O" RINGS, GASKETS & SEALS FOR OPERATING MECHANISM	Set	1	For Complete replacement for one phase of Circuit Breaker
4	SPARES- CIRCUIT BREAKER : 400KV, TRIP COILS WITH RESISTOR	Nos.	3	Set of one no. of each type & rating
5	SPARES- CIRCUIT BREAKER : 400KV, CLOSING COILS WITH RESISTOR	Nos.	3	Set of one no. of each type & rating
6	SPARES- CIRCUIT BREAKER : 400KV, TERMINAL PAD	Nos.	2	
7	SPARES- CIRCUIT BREAKER : 400KV, MOLECULAR FILTER	Nos	2	For Complete replacement for one phase of Circuit Breaker
8	SPARES- CIRCUIT BREAKER : 400KV, CORONA RINGS	Nos	1	Set of one no. of each type & rating, as applicable
9	SPARES- CIRCUIT BREAKER : 400KV, RELAY POWER CONTACTORS, SWITCH FUSE UNITS, LIMIT SWITCHES, PUSH BUTTON, TIMERS & MCB ETC	Set	1	set of one no. of each type & rating
10	SPARES- CIRCUIT BREAKER : 400KV, PRESSURE SWITCH OF EACH TYPE/DENSITY MONITOR	Set	1	Set of one no. of each type & rating
11	SPARES- CIRCUIT BREAKER : 400KV, AUXILIARY SWITCH ASSEMBLY	Set	1	For one Phase of Circuit Breaker
B.2	220kV, 1600A, 40KA for 1-sec 3-Phase Circuit Breaker			
1	SPARES- CIRCUIT BREAKER : 220KV 40KA FOR 1S 25MM/KV CREEPAGE ONE COMPLETE POLE OF 1600A CB WITH POLE COLUMN INTERRUPTER, DRIVING MECHANISM AND MARSHALING BOX EXCLUDING SUPPORT STRUCTURE	Nos.	1	

ANNEXURE-BOQ (CIRCUIT BREAKER)

S.No.	DESCRIPTION	UNIT	QUANTITY	REMARKS
2	SPARES- CIRCUIT BREAKER : 220KV, O" RINGS, GASKETS & SEALS FOR OPERATING MECHANISM	Set	1	For Complete replacement for one phase of Circuit Breaker
3	SPARES- CIRCUIT BREAKER : 220KV, TRIP COILS WITH RESISTOR	Nos.	3	Set of one no. of each type & rating
4	SPARES- CIRCUIT BREAKER : 220KV, CLOSING COILS WITH RESISTOR	Nos.	3	Set of one no. of each type & rating
5	SPARES- CIRCUIT BREAKER : 220KV, TERMINAL PAD	Nos.	2	
6	SPARES- CIRCUIT BREAKER : 220KV, MOLECULAR FILTER	Nos	2	For Complete replacement for one phase of Circuit Breaker
7	SPARES- CIRCUIT BREAKER : 220KV, CORONA RINGS	Nos	1	Set of one no. of each type & rating, as applicable
8	SPARES- CIRCUIT BREAKER : 220KV, RELAY POWER CONTACTORS, SWITCH FUSE UNITS, LIMIT SWITCHES, PUSH BUTTON, TIMERS & MCB ETC	Set	1	set of one no. of each type & rating
9	SPARES- CIRCUIT BREAKER : 220KV, PRESSURE SWITCH OF EACH TYPE/DENSITY MONITOR	Set	1	Set of one no. of each type & rating
10	SPARES- CIRCUIT BREAKER : 220KV, AUXILIARY SWITCH ASSEMBLY	Set	1	For one Phase of Circuit Breaker
8. 400/220 kV ITARSI SUBSTATION				
A.	Main Quantity			
1	SUPPLY- CIRCUIT BREAKER : 220KV 40KA FOR 1S 25MM/KV CREEPAGE 1600A, 3 PHASE CIRCUIT BREAKER, ALONGWITH SUPPORT STRUCTURE, INTERPOLE CABLES, OPERATING MECHANISM, CONTROL BOXES AND ALL ACCESSORIES COMPLETE IN ALL RESPECT	Nos.	1	
2	SUPPLY- CIRCUIT BREAKER : 220KV, FOUNDATION BOLTS FOR CIRCUIT BREAKER, PLATFORM AND LADDER	Lot	1	
3	SUPPLY- CIRCUIT BREAKER : SF6 GAS FILLING ADOPTER, INCLUDING COUPLING, REGULATOR, CONNECTING HOSE PIPE UP TO GROUND LEVEL	Set	1	
4	SUPPLY- CIRCUIT BREAKER : TRANSDUCERS / FIXTURES REQUIRED FOR TRAVEL MEASUREMENT OF COMPLETE 3-PHASE CB	Lot	1	
5	SERVICES- CIRCUIT BREAKER : 220KV, SUPERVISION OF ERECTION, TESTING AND COMMISSIONING OF CIRCUIT BREAKER	Nos.	1	
B.	Mandatory Spares			
	220kV, 1600A, 40KA for 1-sec 3-Phase Circuit Breaker			
1	SPARES- CIRCUIT BREAKER : 220KV 40KA FOR 1S 25MM/KV CREEPAGE ONE COMPLETE POLE OF 1600A CB WITH POLE COLUMN INTERRUPTER, DRIVING MECHANISM AND MARSHALING BOX EXCLUDING SUPPORT STRUCTURE	Nos.	1	
2	SPARES- CIRCUIT BREAKER : 220KV, O" RINGS, GASKETS & SEALS FOR OPERATING MECHANISM	Set	1	For Complete replacement for one phase of Circuit Breaker

ALS Substation Package-SS19 for extension of (i) 765kV Solapur S/S; (ii) 765kV Aurangabad S/S; (iii) 765kV Wardha S/S; (iv) 400kV Khandwa S/S; (v) 400kV Rajgarh S/S; (vi) 400kV Champa S/S; (vii) 400/220kV Itarsi S/S & (viii) 400/220kV Jabalpur Substation under Western Region System Strengthening Scheme (WRSS)-20.

ANNEXURE-BOQ (CIRCUIT BREAKER)

S.No.	DESCRIPTION	UNIT	QUANTITY	REMARKS
3	SPARES- CIRCUIT BREAKER : 220KV, TRIP COILS WITH RESISTOR	Nos.	3	Set of one no. of each type & rating
4	SPARES- CIRCUIT BREAKER : 220KV, CLOSING COILS WITH RESISTOR	Nos.	3	Set of one no. of each type & rating
5	SPARES- CIRCUIT BREAKER : 220KV, TERMINAL PAD	Nos.	2	
6	SPARES- CIRCUIT BREAKER : 220KV, MOLECULAR FILTER	Nos	2	For Complete replacement for one phase of Circuit Breaker
7	SPARES- CIRCUIT BREAKER : 220KV, CORONA RINGS	Nos	1	Set of one no. of each type & rating, as applicable
8	SPARES- CIRCUIT BREAKER : 220KV, RELAY POWER CONTACTORS, SWITCH FUSE UNITS, LIMIT SWITCHES, PUSH BUTTON, TIMERS & MCB ETC	Set	1	set of one no. of each type & rating
9	SPARES- CIRCUIT BREAKER : 220KV, PRESSURE SWITCH OF EACH TYPE/DENSITY MONITOR	Set	1	Set of one no. of each type & rating
10	SPARES- CIRCUIT BREAKER : 220KV, AUXILIARY SWITCH ASSEMBLY	Set	1	For one Phase of Circuit Breaker

Bidder should be manufacturer of the offered Circuit Breaker. Bidder needs to meets the following technical requirements as stipulated here under:

Technical requirements for 765kV Air Insulated Switchgear (AIS) Equipment (i.e Circuit Breaker) shall be follows:

(i) The manufacturer(s) whose 765kV equipment(s) are offered, must have, manufactured, type tested (as per IEC/IS or equivalent standard) and supplied 715kV or higher voltage class equipment(s), which are in satisfactory operation# for at least two (2) years as on the date of NOA.

OR

(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India for the offered equipment and not meeting the requirement stipulated in (i) above, can also be considered provided that

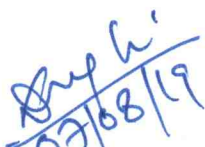
a) 715kV or higher Voltage class equipment(s) must have been manufactured in the above Indian works & type tested (as per IEC/IS standard) and supplied as on the date of NOA.

b) Contractor shall furnish performance guarantee for an amount of 10% of the ex-works cost of the equipments(s) and this performance guarantee shall be in addition to the contract performance guarantee to be submitted by the contractor.

Legend:

: satisfactory operation means certificate issued by the Employer/Utility certifying the operation without any adverse remark.

NOA: Date of NOA for reference project is 29.07.2019.


PREPARED BY


REVIEWED BY


APPROVED BY

Bidder should be manufacturer of the offered Circuit Breaker. Bidder needs to meets the following technical requirements as stipulated here under:

Technical requirements for 400/220kV* Air Insulated Switchgear (AIS) Equipment* (i.e Circuit Breaker) shall be follows:

(i) The manufacturer(s) whose 400/220kV* equipment(s) are offered, must have, manufactured, type tested (as per IEC/IS or equivalent standard) and supplied 345/220kV* or higher voltage class equipment(s), which are in satisfactory operation# for at least two (2) years as on the date of NOA.

OR

(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India for the offered equipment and not meeting the requirement stipulated in (i) above, can also be considered provided that

a) 345/220kV* or higher Voltage class equipment(s) must have been manufactured in the above Indian works & type tested (as per IEC/IS standard) and supplied as on the date of NOA.

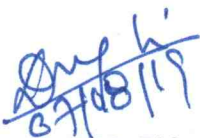
b) Contractor shall furnish performance guarantee for an amount of 10% of the ex-works cost of the equipments(s)* and this performance guarantee shall be in addition to the contract performance guarantee to be submitted by the contractor.

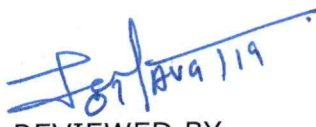
Legend:

* : voltage class of respective equipment as applicable.

: satisfactory operation means certificate issued by the Employer/Utility certifying the operation without any adverse remark.

NOA: Date of NOA for reference project is 29.07.2019.


PREPARED BY


REVIEWED BY


APPROVED BY

Section -2
STANDARD TECHNICAL SPECIFICATION
Doc No. TB-408-316-102, Rev.0

TECHNICAL SPECIFICATION
SECTION: SWITCHGEAR-CB
REVISION-11

Summary of major changes made in this revision w.r.t earlier Technical Specification, Section: Switchgear, Chapter-CB, Rev.10A & Section: Switchgear, Chapter 765kV CB, Rev.02

- 1) Technical specification, Section: Switchgear, Chapter 765kV CB, Rev.02 and Section: Switchgear, Chapter CB, Rev.10A are merged to prepare this combined technical specification section up to 765kV CB.
- 2) All 765kV & 400kV Circuit Breaker control schematics shall be finalized in such a way, that it may operate with or without CSD (refer clause 1.6)
- 3) Some duty requirements parameters added/modified (refer clause 2.0)
- 4) SF6 gas for main CBs shall be supplied in returnable cylinders (refer clause 5.0)
- 5) Insulators for Circuit breakers can be of Porcelain/polymer type (refer clause 6.0)
- 6) Included Indicative platform & ladder drawing for 400kV&765kV CB (refer clause 9.0)
- 7) Included Plug-in type arrangement for termination of inter pole cables (refer clause 11.0)
- 8) Included Technical parameters for 72.5kV CB (refer clause 16.0)
- 9) Some parameters like dielectric, creepage, seismic requirement etc w.r.t CBs are included (refer clause 16.0)
- 10) Included Actions required for defects observed during defect liability period (refer clause 18.0)

Note:

Changes made in this document are shown with bold letters, further major changes are listed above; however for complete details of changes, please refer the complete technical specification, Section: Switchgear-CB, REV.11

REMARK - PLEASE READ TERMINOLOGY OF SECTION-2 OF TECH SPECIFICATION AS FOLLWOS

- 1. Read "GTR" as "Section-3 of technical specification"**
- 2. Read "Powergrid" as "BHEL/Powergrid".**
- 3. Read "Employer" as "Powergrid".**
- 4. Read "Contractor" as bidder**

SECTION: SWITCHGEAR–CB (CIRCUIT BREAKER)

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SECTION: SWITCHGEAR–CB (CIRCUIT BREAKER)

1.0 GENERAL

1.1 The circuit breakers and accessories shall conform to IEC: 62271-100, IEC: 62271-1 and other relevant IEC standards except to the extent explicitly modified in the specification and shall also be in accordance with requirements specified in Section-GTR.

1.2 800/420/245/145/72.5kV circuit breakers offered would be of sulphur hexafluoride (SF6) type and of class C2-M2 as per IEC. The bidder may offer circuit breakers of either live tank type or dead tank type of proven design.

1.3 The circuit breaker shall be complete with operating mechanism, common marshalling box, piping, inter-pole cables, cable accessories like glands, terminal blocks, marking ferrules, lugs, pressure gauges, density monitors (with graduated scale), galvanised support structure, platform with ladder for CB, their foundation bolts and all other accessories required for carrying out all the functions of the CB.

All necessary parts to provide a complete and operable circuit breaker installation such as terminal pads, control parts and other devices shall be provided.

1.4 Painting shall be done in line with Section – GTR. Paint shade RAL-7032 or similar shades can be used for painting. The support structure, platform & ladder of circuit breaker shall be hot dip galvanised. Exposed hardware items shall be hot dip galvanised or Electro-galvanised.

1.5 The circuit breakers shall be designed for use in the geographic and meteorological conditions as given in Section-Project.

1.6 All 765kV & 400kV Circuit Breaker control schematics shall be finalized in such a way, that it may operate with or without CSD by using a suitable selector switch irrespective of whether circuit breakers to be supplied are envisaged along with CSD or not as per bid price schedules.

2.0 DUTY REQUIREMENTS

2.1 The circuit breakers shall be capable of performing their duties without opening resistors.

2.2 The circuit breaker shall meet the duty requirements for any type of fault or fault location and also for line switching when used on effectively grounded system and perform make and break operations as per the stipulated duty cycles satisfactorily.

2.2.1 PRE-INSERTION RESISTER

800kV & 420kV circuit breakers shall be provided with single step pre-insertion closing resistors (wherever the requirement of PIR is explicitly specified in bid price schedules) to limit the switching surges. The resistance value of pre-insertion resistor and the duration of pre-insertion time is given in clause 16.0 of this section. The resistor shall have thermal rating for the following duties:

i) TERMINAL FAULT

Close 1 Min Open Close Open.....2 min Close 1 Min Open Close Open.

ii) RECLOSING AGAINST TRAPPED CHARGES

Duty shall be the same as under (i) above. The first, third and fourth closures are to be on de - energised line while second closing is to be made with lines against trapped charge of 1.2 p.u. of opposite polarity.

iii) OUT OF PHASE CLOSING

One closing operation under phase opposition, that is with twice the voltage across the terminals.

iv) No allowance shall be made for heat dissipation of resistor during time interval between successive closing operations. The resistors and resistor supports shall perform all these duties without deterioration. Test reports of resistors proving thermal rating for duties specified above shall be furnished during detailed engineering. The calculations shall be provided to take care of the effect of tolerances on resistance values and-insertion time.

2.3 The breaker shall be capable of:

i) Interrupting the steady and transient magnetizing current corresponding to Power transformers as follows:

Voltage rating of CB	Type of Transformer	Rating (in MVA)
800kV	765/400kV	250 to 1500
420kV	765/400kV	250 to 1500
	400/220kV	250 to 630
	400/132kV	160 to 315
245kV	400/220kV	200 to 630
	220/132kV	50 to 200

	220/66kV	50 to 200
145kV	220/132kV	50 to 200
	132/33kV	10 to 50

- ii) Interrupting line/cable charging current as per IEC without use of opening resistors. The breaker shall be able to interrupt the rated line charging current as per IEC-62271-100 with test voltage immediately before opening equal to the product of $U/\sqrt{3}$ and 1.4
- iii) Clearing short line fault (kilometric faults) with source impedance behind the bus equivalent to symmetrical fault current specified.
- iii) Breaking 25% of the rated fault current at twice rated voltage under phase opposition condition.
- iv) Withstanding all dielectric stresses imposed on it in open condition at lock out pressure continuously (i.e. shall be designed for 2 p.u. across the breaker continuously, for validation of which a power frequency withstand test conducted for a duration of at least 15 minutes is acceptable).
- v) Circuit breakers shall be able to switch in and out the shunt reactor as detailed below:

Voltage rating of CB	Reactor Rating (in MVAR)	Max. rise of over voltage (in p.u.)
800kV	150 to 330	1.9
420kV	50 to 150	2.3
245kV	25 to 50	2.3

- a. Capability of 400 kV circuit breakers to interrupt inductive current below 100 A without giving rise to overvoltage more than 2.3 p.u. (As specified in IEC-62271-110) shall be validated by carrying out the simulation study/analysis (EMTP/PSCAD) by modeling an equivalent circuit comprising all circuit component i.e. Inductance of Shunt Reactor, Stray capacitance of Shunt Reactor, Circuit Breaker, Stray capacitance of Bus Connection, Capacitance of grading Capacitor, inductance of neutral grounding reactor, Network Thevenin's equivalent, any other series/parallel inductance/capacitance connected to simulate the actual inductive load switching.

- b. Current chopping capability (chopping number) of circuit breaker as per IEC-62271-306 to be figured out from actual Laboratory test and / or field test report and same Current chopping capability (chopping number) shall be used in above said simulation study/analysis.
- c. To validate the results of above said simulation study/analysis report, the same study shall be carried out for capability of tested circuit breaker and the study/analysis results shall be comparable with actual Laboratory test and / or field test reports.
- d. Laboratory test/ field test reports shall be submitted for 400 kV CBs in case there is change in design including change in following:
 - i. Different short circuit current capability
 - ii. Different model/type
- vi) The breakers shall also withstand the voltages specified under clause 16.0 of this section.

2.6 CONTROLLED SWITCHING DEVICE (CSD) :

Circuit Breakers shall be equipped with controlled switching device with consequent optimization of switching behavior, when used in:

- Switching of transformer (from 765kV and 400kV side circuit breakers only)
- Switching of shunt Reactor

The CSD shall be provided in Circuit breaker of switchable line reactor bay and in Main & Tie bay circuit breakers of Transformers, line with non-switchable line reactors and Bus reactors. The CSD shall be supplied as per bid price schedules.

2.6.1 Technical Requirement for controlled switching device:

- a) The CSD shall be designed to operate correctly and satisfactorily with the excursion of auxiliary A/C & DC voltages and frequency as specified in section - GTR.
- b) The CSD shall meet the requirements of IEC-61000-4-16 class IV for HF disturbance test (for short and long durations both) and fast transient test shall be as per IEC-61000-4-4 level IV and insulation test as per IEC 60255-5.
- c) The CSD shall have functions for switching ON & OFF the circuit breakers.

- d) The CSD shall get command to operate the breakers manually. The controller shall be able to analyze the current and voltage waves available through the signals from secondaries of CTs & CVTs for the purpose of calculation of optimum moment of the switching the circuit breaker and issue command to circuit breaker to operate.
- e) The CSD shall also have an adaptive control feature to consider the next operating time of the breaker in calculation of optimum time of issuing the switching command. In calculation of next operating time of the breaker, the CSD must consider all factors that may affect the operating time of the breaker such as, but not limited to, ambient temperature, control voltage variation, SF6 gas density variations etc. Schematic drawing for this purpose shall be provided by the contractor. The accuracy of the operating time estimation by the controller shall be better than ± 0.5 ms.
- f) The CSD should have display facility at the front for the display of settings and measured values.
- g) The CSD shall be PC compatible for the setting of various parameters and down loading of the settings and measured values, date, time of switching etc. Window based software for this purpose shall be supplied by the contractor to be used on the owner's PC.
- h) The controller shall be suitable for current input of 1 ampere from the secondary of the CTs. and 110 V (Ph to Ph) from the CVTs. The CSD shall withstand transient and dynamic state values of the current from the secondary of the CTs and CVTs.
- i) The CSD shall have time setting resolution of 0.1 ms or better.
- j) The CSD shall have sufficient number of output/input potential free contacts for connecting the monitoring equipment and annunciation system available in the control room. Necessary details shall be worked out during engineering of the scheme.
- k) The CSD shall also record and monitor the switching operations and make adjustments to the switching instants to optimize the switching behavior as necessary. It shall provide self-diagnostic facilities, signaling of alarms and enable downloading of data captured from the switching events.
- l) The provision for bypassing the Controlled switching device shall be provided through BCU and SCADA both so that whenever, the CSD is not healthy due to any reason (including auxiliary supply failure), uncontrolled trip/close command can be extended to the circuit

In case where CSD does not have adequate display facility for settings and measured values, bidder to supply one number laptop PC with pre-installed, licensed software for each site. Cost of the same shall be deemed included in offer.

Breaker. Alternatively, in case of any non-operation of the CSD after receiving a close/trip command after a pre-determined time delay, the CSD should automatically be bypassed so as to ensure that the trip and close commands are extended to the Trip/Close coils through subsequent command.

- m) The CSD shall be provided with a communication port to facilitate online communication of the CSD with Substation automation system directly on IEC 61850 protocols. If the CSD does not meet the protocols of IEC 61850, suitable gateway shall be provided to enable the communication of CSD as per IEC 61850.

3.0 TOTAL BREAK TIME

- 3.1 The total break time as specified under this section shall not be exceeded under any of the following duties:

- i) Test duties T10, T30, T60, T100a, and T100s (with TRV as per IEC: 62271-100)

- ii) Short line fault L75, L90 (with TRV as per IEC: 62271-100)

- 3.2 The total break time of the breaker shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage (70-110%), arc extinguishing medium pressure etc. While furnishing the proof of the total break time of complete circuit breaker, the effect of non-simultaneity between contacts within a pole or between poles shall be brought out to establish guaranteed total break time.

- 3.3 The values guaranteed shall be supported with the type test reports.

4.0 CONSTRUCTIONAL FEATURES

The features and constructional details of circuit breakers shall be in accordance with requirements stated hereunder:

4.1 Contacts

- 4.1.1 The gap between the open contacts shall be such that it can withstand at least the rated phase to ground voltage for 8 hours at zero gauge pressure of SF6 gas due to the leakage. The breaker should be able to withstand all dielectric stresses imposed on it in open condition at lock out pressure continuously (i.e. 2 p.u. across the breaker continuously, for validation of which a power frequency dielectric with stand test conducted for a duration of at least 15 minutes is acceptable).

- 4.2 If multi-break interrupters are used, these shall be so designed and augmented that a uniform voltage distribution is developed across them. Calculations/

test reports in support of the same shall be furnished. The thermal and voltage withstand rating of the grading elements shall be adequate for the service conditions and duty specified.

4.3 The SF6 Circuit Breaker shall meet the following additional requirements:

- a) The circuit breaker shall be single pressure type. The design and construction of the circuit breaker shall be such that there is a minimum possibility of gas leakage and entry of moisture. There should not be any condensation of SF6 gas on the internal insulating surfaces of the circuit breaker.
- b) All gasketed surfaces shall be smooth, straight and reinforced, if necessary, to minimise distortion and to make a tight seal, the operating rod connecting the operating mechanism to the arc chamber (SF6 media) shall have adequate seals. The SF6 gas leakage should not exceed 0.5% per year and the leakage rate shall be guaranteed during the warrantee period. In case the leakage under the specified conditions is found to be greater than 0.5% per year after commissioning of circuit breaker during the warrantee period, the manufacturer will have to supply free of cost, the total gas requirement for subsequent ten (10) years, based on actual leakage observed during the warrantee period.
- c) In the interrupter assembly there shall be an absorbing product box to minimise the effect of SF6 decomposition products and moisture. The material used in the construction of the circuit breakers shall be fully compatible with SF6 gas decomposition products.
- d) Each pole shall form an enclosure filled with SF6 gas independent of two other poles (for 800, 420 & 245 kV CBs) and the SF6 density of each pole shall be monitored individually. For CBs of voltage class of 145 kV or less, a common SF6 scheme/density monitor shall be acceptable.
- e) The dial type SF6 density monitor shall be adequately temperature compensated to model the pressure changes due to variations in ambient temperature within the body of circuit breaker as a whole. Separate density monitor and dial type temperature compensated pressure gauge is also acceptable. The density monitor shall have graduated scale and it shall be possible to dismantle the density monitor for checking/replacement without draining the SF6 gas by providing suitable interlocked non return valve coupling.
- f) Circuit Breaker shall be capable of withstanding a vacuum of minimum 8 millibars without distortion or failure of any part.

- g) Sufficient SF6 gas (including that will be required for gas analysis during filling) shall be provided to fill all the circuit breakers being supplied. Spare gas shall be supplied in separate unused cylinders as per requirement specified in BPS.

4.4 Provisions shall be made for attaching an operational analyser to record contact travel, speed and making measurement of operating timings, pre insertion timings of closing resistors if used, synchronisation of contacts in one pole.

4.5 The CO (Close-open) operation and its timing shall be such as to ensure complete travel/insertion of the contact during closing operation and then follow the opening operation.

5.0 SULPHUR HEXAFLUORIDE GAS (SF6 GAS)

- a) The SF6 gas shall comply with IEC 60376 and shall be suitable in all respects for use in the switchgear under the operating conditions.
- b) The high pressure cylinders in which the SF6 gas is shipped and stored at site shall comply with requirements of the relevant standards and regulations. SF6 gas shall be supplied (in returnable cylinders) for all circuit breakers. However, SF6 gas for spare circuit breakers and mandatory spare quantity of SF6 gas shall be supplied in non-returnable cylinders.
- c) Test: SF6 gas shall be tested for purity, dew point, air, hydro-soluble fluorides and water content as per IEC 60376 and test certificates shall be furnished to Employer indicating all the tests as per IEC 60376 for each lot of SF6 gas and Material safety datasheet shall be provided. Gas bottles should be checked for leakage during receipt at site.

6.0 INSULATORS

- a) The porcelain/polymer of the insulators shall conform to the requirements stipulated under Section-GTR.
- b) The mechanical characteristics of insulators shall match with the requirements specified under this section.
- c) All porcelain & polymer hollow column insulators shall conform to IEC-62155 & IEC-61462 respectively.
- d) Hollow Porcelain/polymer for pressurised columns/chambers should be in one integral piece in green and fired stage.

7.0 SPARE PARTS AND MAINTENANCE EQUIPMENT

The bidder shall include in his proposal, spare parts and maintenance equipment in accordance with BPS. Calibration certificates of each maintenance equipment shall be supplied along with the equipment.

8.0 OPERATING MECHANISM AND CONTROL

8.1 General Requirements

8.1.1 Circuit breaker shall be operated by spring charged mechanism. The mechanism box shall meet the requirements of IP-55.

8.1.2 The operating mechanism box shall be strong, rigid, rebound free and shall be readily accessible for maintenance.

8.1.3 The mechanism shall be anti-pumping and trip free under every method of closing.

8.1.4 The mechanism shall be such that the failure of any auxiliary spring will not prevent tripping and will not cause unwanted trip or closing operation of the Circuit Breaker

8.1.5 A mechanical indicator shall be provided to show open and close position of the breaker. It shall be located in a position where it will be visible to a man standing on the ground level with the mechanism housing closed. An operation counter shall also be provided in the common marshalling box.

8.1.6 Working parts of the mechanism shall be of corrosion resisting material, bearings which require grease shall be equipped with pressure type grease fittings. Bearing pin, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the breaker.

8.1.7 The contractor shall furnish detailed operation and maintenance manual of the mechanism alongwith the operation manual for the circuit breaker. The instruction manuals shall contain exploded diagrams with complete storage, handling, erection, commissioning, troubleshooting, servicing and overhauling instructions.

8.1.8 Size of common marshalling Box shall be such that adequate space is available for working in the panel and all wiring shall be routed through non-inflammable wire troughs with covers.

8.1.9 Space shall be available in 765kV CB common marshalling box to mount monitoring device, of about 300x300x150mm size and of approximately 7kg weight, by the owner in future.

8.1.10 Operating mechanism and Marshalling box should be provided with space heater with thermostat, CFL/LED lamp and AC point /Socket.

- 8.2 Control:
- 8.2.1 The close and trip circuits shall be designed to permit use of momentary contact switches and push buttons.
- 8.2.2 Each breaker shall be provided with two (2) independent tripping circuits, pressure switches and coils each to be fed from separate DC sources.
- 8.2.3 The breaker shall normally be operated by remote electrical control. Electrical tripping shall be performed by shunt trip coils. However, provisions shall be made for local electrical control. For this purpose a local/remote selector switch and close and trip control switch/push buttons shall be provided in the Breaker common marshalling box.
- 8.2.4 The trip coils shall be suitable for trip circuit supervision during both open and close position of breaker.
- 8.2.5 Closing coil and associated circuits shall operate correctly at all values of voltage between 85% and 110% of the rated voltage. Shunt trip coil and associated circuits shall operate correctly under all operating conditions of the circuit breaker up to the rated breaking capacity of the circuit breaker and at all values of supply voltage between 70% and 110% of rated voltage. However, even at 50% of rated voltage the breaker shall be able to open. If additional elements are introduced in the trip coil circuit their successful operation and reliability for similar applications on outdoor circuit breakers shall be clearly brought out during detailed engineering.
- 8.2.6 The 765kV kV, 3-Phase circuit breakers suitable for single phase switching shall be suitable for taking a spare pole into service in case of any operational requirement and their marshalling box shall be suitable for accommodating the additional relays etc. required for changeover arrangement of all contacts, alarms, signals, indications, interlocks and lockouts.
- 8.2.7 In trip and closing circuits, relays/relay contacts shall preferably be used instead of contactors.
- 8.2.8 Controlled switching scheme/device, wherever required shall be considered as integral part of CB and shall be commissioned along with CB.
- 8.2.9 Density Monitor contacts and pressure switch contacts shall be preferably suitable for direct use as permissive in closing and tripping circuits. The devices shall provide continuous & automatic monitoring of the state of the gas as follows:
- a) 'Gas Refill' level

This contact will be used for remote indication/ to annunciate the need for gas refilling.

b) 'SF6 gas density Low' Alarm level - 1

This contact will be used for remote indication/ to annunciate the need for the urgent gas refilling.

c) 'SF6 gas density Low' Alarm level - 2

This contact will be used to annunciate the need for gas refilling under emergency or trip the Circuit Breaker.

d) 'Breaker Block' level

This is the minimum gas density at which the manufacturer will guarantee the rated fault interrupting capability of the breaker. At this level the breaker block contact shall operate & the tripping & closing circuit shall be blocked.

It shall be possible to test all gas monitoring relays/devices without de-energizing the primary equipment & without reducing pressure in the main section. Plugs & sockets shall be used for test purposes. It shall also damp the pressure pulsation while filling the gas in service, so that flickering of the pressure switch contacts does not take place.

The density monitor shall be placed suitably inclined in such a way so that the readings are visible from ground level with or without using binoculars. Separate contacts have to be used for each of tripping and closing circuits. If contacts are not suitably rated and multiplying relays are used then fail safe logic/schemes are to be employed. DC supplies for all auxiliary circuits shall be monitored and provision shall be made for remote annunciations and operation lockout in case of D.C. failures. Density monitors are to be so mounted that the contacts do not change on vibration during operation of circuit Breaker.

8.2.10 The auxiliary switch of the breaker shall be positively driven by the breaker operating rod.

8.3 Spring operated mechanism:

- a) Spring operated mechanism shall be complete with motor as per manufacturer practice. Opening spring and closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit shall also be provided.
- b) As long as power is available to the motor, a continuous sequence of the closing and opening operations shall be possible. The motor shall have adequate thermal rating for this duty.

- c) After failure of power supply to the motor one close open operation shall be possible with the energy contained in the operating mechanism.
- d) Breaker operation shall be independent of the motor which shall be used solely for compressing the closing spring. Facility for manual charging of the closing spring shall also be provided. The motor rating shall be such that it requires not more than 30 seconds for full charging of the closing spring.
- e) Closing action of circuit breaker shall compress the opening spring ready for tripping.
- f) When closing springs are discharged after closing a breaker, closing springs shall be automatically charged for the next operation and an indication of this shall be provided in the local and remote control cabinet.
- g) Provisions shall be made to prevent a closing operation of the breaker when the spring is in the partial charged condition. Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of closing springs when the breaker is already in the closed position.
- h) The spring operating mechanism shall have adequate energy stored in the operating spring to close and latch the circuit breaker against the rated making current and also to provide the required energy for the tripping mechanism in case the tripping energy is derived from the operating mechanism.
- i) The spring charging failure alarm shall be provided with a time delay relay having setting range from 0-1minute.
- j) Separate MCBs shall be provided for each spring charging motor and the rating of MCBs shall be suitably selected to match the starting, running and stalling time.
- k) An overload relay shall be provided for protection of the spring charging motor.

9.0 SUPPORT STRUCTURE

- a) The structure design shall be such that during operation of circuit breaker vibrations are reduced to minimum.
- b) Ladder and Maintenance platform for 400kV and 765kV Circuit breaker:

A suitable ladder with the safety cage and a free standing maintenance platform with railing for each pole of the circuit breaker shall be supplied along with the equipment and its support structure. The platform shall be suitable for maintenance personnel to stand and carry out the activities along with the tools and plant.

The ladder cum maintenance platform shall be designed as a free standing structure without taking any support from the main circuit breaker structure. The ladder having height more than 3.0m shall have at least 15 degree slope and is to be provided with safety guard above 2.0m level. All structural steel for the platform shall be as per IS: 2062 and to be galvanized. An indicative drawing of ladder and platform (Drg.Ref.: C-ENGG-IND.DWG-PLATFORM-CB, Rev.0) is added at page 27 of 27 with this specification for guidance which may be modified to suit the requirement of CB by CB manufacturer. However, the minimum size of the structural members shall be maintained as mentioned in the drawing.

- c) For 220kV, 132kV & 66kV circuit breakers a suitable platform cum ladder shall be provided as per manufacturer design.

10.0 TERMINAL CONNECTOR PAD

The circuit breaker terminal pads shall be made up of high quality electrolytic copper or aluminium and shall be conforming to Australian Standard AS-2935 or equivalent standard for rated current. The terminal pad shall have protective covers which shall be removed before interconnections.

11.0 INTER-POLE CABLING

- 11.1 All cables to be used by contractor shall be armoured and shall be as per IS – 1554/ IEC-60502 (1100 Volts Grade). All cables within & between circuit breaker poles and its marshalling box and up to the controlled switching device is included in the scope of work. Special cables like screened cable if required for Circuit Breaker, temperature Transducer/CB Status Signals for CSD and its associated C&R panel shall be laid in 50mm diameter PVC pipe. Suitable supports for PVC pipe shall be included in the scope of Supply.
- 11.2 Only stranded conductor shall be used. Minimum size of the conductor for inter-pole control wiring shall be 1.5 sq.mm. Copper.
- 11.3 The cables shall be with oxygen index Minimum 29 and temperature index as 250°C as per relevant standards.
- 11.4 Separate cables shall be used for AC, DC-I, DC-II and selected DC.
- 11.5 All inter-pole cabling of Circuit breakers and up to common marshalling box shall be done by plug-in type arrangement. Suitable removable type

encasing cover shall be provided in case plug-in type connection arrangement is provided exterior side of LCC/MB. The plug-in type cable termination shall be conforming to IP-67 as per IEC60529. Cable sealing arrangement shall be provided (as per requirement) to avoid entry of moisture etc.

11.6 Vertical run of cables to the operating mechanism box shall be properly supported by providing the perforated closed type galvanized cable tray (Cable tray also to be supplied along with the Circuit Breaker) to be fixed as an integral part of the structures. The load of the cable shall not be transferred to the mechanism box/plug-in type terminal arrangement in any circumstances. Hanging or loose run of cable is not permitted. The drawing of cable tray including fixing arrangement shall be incorporated in the GA drawing of CB also.

11.7 Wiring shall be done with stud type terminals and ring type lugs. More than two wires shall not be connected on each side of terminal.

12.0 FITTINGS AND ACCESSORIES

12.1 Following is list of some of the major fittings and accessories to be furnished by Contractor in the common marshalling box. Number and exact location of these parts shall be indicated in the drawing.

- i) Cable glands (Double compression type), Lugs, Ferrules etc.
- ii) Local/remote changeover switch.
- iii) Operation counter
- iv) Control switches to cut off control power supply.
- v) Fuses/MCBs as required.
- vi) The number of terminals provided shall be adequate enough to wire out all contacts and control circuits plus 24 terminals spare for future use.
- vii) Anti-pumping relay.
- viii) Pole discrepancy relay (for electrically ganged CBs).
- ix) D.C. Supervision relays.
- x) Rating plate description in accordance with IEC incorporating year of manufacture.
- xi) Controlled switching accessories like sensors, timers, relays etc.(as applicable)

- xii) Transducers/Fixtures required for travel measurement shall be supplied by CB manufacturer. The complete set of Transducers/Fixtures for measurement of complete 3-phase CB shall be supplied for each station. Further, one set of gas filling adopter (Including coupling, regulator, connecting hose pipe up to ground level) shall be supplied as per BPS.

13.0 ADDITIONAL DATA TO BE FURNISHED

- a) Drawing, showing contacts in close, arc initiation, full arcing, arc extinction and open position.
- b) The temperature v/s pressure curves for each setting of density monitor along with details of density monitor.
- c) Method of checking the healthiness of voltage distribution devices (condensers) provided across the breaks at site.
- d) Data on capabilities of circuit breakers in terms of time and number of operations at duties ranging from 100% fault currents to load currents of the lowest possible value without requiring any maintenance or checks.
- e) Maximum non-simultaneity between contacts, between poles and effect of the same on the guaranteed total break time.
- f) Sectional view of non-return couplings used for SF6 pipes.
- g) Details & type of filters used in interrupter assembly and also the operating experience with such filters.
- h) Details of SF6 gas:
 - i) The test methods used in controlling the quality of gas used in the circuit breakers particularly purity and moisture content.
 - ii) Proposed tests to assess the conditions of the SF6 within a circuit breaker after a period of service particularly with regard to moisture contents of the gas.
- j) Shall furnish curves supported by test data indicating the opening time under close open operation with combined variation of trip coil voltage.
- k) Detailed literature and schematic diagrams of switching mechanism for closing resistor showing the duration of insertion shall also be furnished alongwith the calculations in respect of thermal rating of resistors for the duties specified under clause 2.2.1 of this section in case of 420 kV & 800kV circuit breakers.

- l) All duty requirements as applicable to 800 kV, 420 kV, 245 kV, 145 kV & 72.5kV CBs specified under Clause 2.0 of this section shall be provided with the support of adequate test reports.

14.0 DEAD TANK TYPE CIRCUIT BREAKER

14.1 In case dead tank type circuit breaker is offered, the Bidder shall offer bushing type CTs (whose secondary parameters are given in under Section: Switchgear-Instrument Transformer and in case of 765kV and 400kV these secondaries shall be provided in sets of 3 cores, i.e., 2 cores of PX class and one core of metering, on both sides of dead tank circuit breaker instead of conventional outdoor CTs.

14.2 The enclosure shall be made of either Al/Al Alloy or mild steel (suitably hot dip galvanized). The enclosure shall be designed for the mechanical and thermal loads to which it is subjected in service. The enclosure shall be manufactured and tested according to the pressure vessel codes {i.e., latest edition of the ASME code for pressure vessel - Section VIII of BS-5179, IS4379, IS-7311 (as applicable) and also shall meet Indian Boiler Regulations}.

The maximum temperature of enclosure with CB breaker carrying full load current shall not exceed the ambient by more than 20 deg C.

14.3 The enclosure has to be tested as a routine test at 1.5 times the design pressure for one minute. A bursting pressure test shall be carried out at 5 times the design pressure as type test on the enclosure.

15.0 TESTS

15.1 In accordance with the requirements stipulated under Section-GTR the circuit breaker alongwith its operating mechanism shall conform to the type tests as per IEC: 62271-100.

15.2 The type test reports as per IEC and the following additional type test reports shall also be submitted for purchaser's/employer's review:

- i) Corona extinction voltage test (procedure as per Annexure-A of Section-GTR).
- ii) Out of phase closing test as per IEC: 62271-100.
- iii) Line charging interrupting current for proving parameters as per clause no. 16.0 of this section.
- iv) Test to demonstrate the Power Frequency withstand capability of breaker in open condition at Zero Gauge pressure and at lockout pressure (Ref. Clause 4.1.1).

- v) Seismic withstand test (procedure as per Annexure-B of Section-GTR) in unpressurised condition.
- vi) Verification of the degree of protection.
- vii) Low temperature test (applicable only for minimum ambient temperatures of less than (-) 10 deg.C application purpose) and High temperature test. Contractor can also submit the field performance report in line with IEC stipulations.
- viii) Static Terminal Load test.
- ix) Critical Currents test (if applicable).
- x) Switching of Shunt Reactors. Test reports shall be submitted as per IEC. Calculations shall be submitted for meeting the requirements of clause 2.3(v) of this section.
- xi) Circuit breakers meant for controlled switching shall conform to requirements of IEC/TR-62271 – 302. The contractor shall submit test reports to demonstrate that the offered CB conforms to the requirements of performance verification tests and parameter definition tests as per IEC/TR 62271-302. The contractor shall also furnish the report for the re-ignition free arcing window for switching 3-phase shunt reactor as demonstrated in the shunt reactor switching test.

15.3 Routine Tests

Routine tests as per IEC:62271-100 shall be performed on all circuit breakers.

In addition to the mechanical and electrical tests specified by IEC, the following tests shall also be performed.

- i) Speed curves for each breaker shall be obtained with the help of a suitable operation analyzer to determine the breaker contact movement during opening, closing, auto reclosing and trip free operation under normal as well as limiting operating control voltage conditions. The tests shall show the speed of contacts directly at various stages of operation, travel of contacts, opening time, closing time, shortest time between separation and meeting of contacts at break make operation etc. This test shall also be performed at site for which the necessary operation analyzer along with necessary transducers, cables, console etc. shall be arranged by the contractor at his own cost.
- ii) During testing of CB, dynamic contact resistance measurement (DCRM) shall be carried out for close-open (CO) operations with delay of 300ms between close and trip operations. Minimum 100A

current shall be injected for DCRM test. Travel characteristics, injected current, trip/close coil current shall also be recorded along with DCRM test.

- iii) Routine tests on Circuit breakers with Controlled switching device as per IEC/TR 62271-302.
- iv) Tan delta and Capacitance measurement for grading capacitors at rated voltage and also at 10kV (for reference).

16.0 TECHNICAL PARAMETERS FOR CIRCUIT BREAKER

(In addition to those indicated in section-GTR)

Sl. no.	Parameter	765kV system	400kV system	220kV system	132 kV system	66 kV system
1.	Rated voltage (U _{max}) kV (rms)	800	420	245	145	72.5
2.	Rated frequency (Hz)	50	50	50	50	50
3.	No. of poles	3	3	3	3	3
4.	Type of circuit breaker	SF6 gas insulated	SF6 gas insulated	SF6 gas insulated	SF6 gas insulated	SF6 gas insulated
5.	Rated continuous current (A) at an ambient temperature of 50°C	3150/4000	2000/3150/4000 (as applicable)	1600/2500 (as applicable)	1250	1250
6.	Rated short circuit capacity with percentage of DC component as per IEC-62271-100 corresponding to minimum opening time under operating conditions specified.	50kA (As applicable)	40/50/63kA (As applicable)	40/50 kA (As applicable)	31.5kA	25kA
7.	Symmetrical interrupting capability kA (rms)	50	40/50/63 (As applicable)	40/50 (As applicable)	31.5	25
8.	Rated short circuit making current kAp	125	100/125/157.5 (As applicable)	100/125 (As applicable)	80	63
9.	Short time current carrying capability kA (rms)	50 for one second	40/50/63 As applicable for one second	40/50 As applicable for one second	31.5 for one second	25 for three second
10.	Out of phase breaking current carrying capability kA (rms)	12.5	10/12.5/15.75 (As applicable)	As per IEC	As per IEC	As per IEC
11.	Rated line charging interrupting current at 90 deg. Leading power factor angle (A rms) (The breaker shall be able to interrupt the rated line charging current with test voltage immediately before	900	600	As per IEC	As per IEC	As per IEC

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	opening equal to the product of $U/\sqrt{3}$ and 1.4 as per IEC-62271-100					
12.	First pole to clear factor	1.3	1.3	1.3	1.3	1.5
13.	Temperature rise over an ambient temperature of 50°C	As per IEC: 62271-100	As per IEC: 62271-100	As per IEC: 62271-100	As per IEC: 62271-100	As per IEC: 62271-100
14.	Rated break time as IEC (ms)	40	40	60	60	Less than 75
15.	Total break time (ms)	45	45	65	65	Less than 80
16.	Total closing time (ms)	Not more than 150	Not more than 150	Not more than 150	Not more than 150	Not more than 150
17.	Operating mechanism or a combination of these	Spring	Spring	Spring	Spring	Spring
18.	Rated operating duty cycle	O-0.3s-CO-3 min-CO	O-0.3s-CO-3 min-CO	O-0.3s-CO-3 min-CO	O-0.3s-CO-3 min-CO	O-0.3s-CO-3 min-CO
19.	Reclosing	Single phase & Three phase auto reclosing.	Single phase & Three phase auto reclosing.	Single phase & Three phase auto reclosing.	Three phase auto reclosing. (Single phase auto reclosing if specified in section-project)	Three phase auto reclosing.
20.	Pre-insertion resistor requirement	As per BPS	As per BPS	NA	NA	NA
i)	Rating (ohms)	450(max.) with tolerance as applicable	400(max.) with tolerance as applicable	NA	NA	NA
ii)	Minimum electrical (mechanical insertion time + pre-arcing time) pre-insertion time (ms)	9	8	NA	NA	NA
iii)	Opening of PIR contacts	PIR contacts should open immediately after closing of main contacts OR At least 5 ms prior to opening of main contacts at rated air/gas pressure where the	PIR contacts should open immediately after closing of main contacts OR At least 5 ms prior to opening of main contacts at rated air/gas pressure where the	NA	NA	NA

[SECTION-2]

		PIR contacts remain closed	PIR contacts remain closed			
21.	Max. difference in the instants of closing/opening of contacts (ms) between poles at rated control voltage and rated operating & quenching media pressures	2.5(within a pole) 3.3(opening) 5.0(closing)	2.5(within a pole) 3.3(opening) 5.0(closing)	3.3(opening) 5.0(closing)	3.3(opening) 3.3(closing)	As per IEC
22.	Maximum allowable switching over voltage under any switching condition	1.9 p.u.	2.3 p.u.	As per IEC	As per IEC	As per IEC
23.	Trip coil and closing coil voltage with variation as specified	220V DC	220V DC	220V DC	220V DC or 110V DC	220V DC or 110V DC
24.	Noise level at base and up to 50 m distance from base of circuit breaker	As per IEC	140dB (max.)	140dB (max.)	140dB (max.)	140dB (max.)
25.	Rating of Auxiliary contacts	10A at 220V DC	10A at 220V DC	10A at 220V DC	10A at 220V DC	10A at 220V DC
26.	Breaking capacity of Aux. Contacts	2A DC with circuit time constant not less than 20ms	2A DC with circuit time constant not less than 20ms	2A DC with circuit time constant not less than 20ms	2A DC with circuit time constant not less than 20ms	2A DC with circuit time constant not less than 20ms
27.	Rated insulation levels					
i)	Full wave impulse withstand (1.2 /50 s) between line terminals and ground	±2100kVp	±1425 kVp	±1050 kVp	±650 kVp	±325 kVp
ii)	Full wave impulse withstand (1.2 /50 s) between terminals with circuit breaker open	2100kVp impulse on one terminal & 455 kVp power frequency voltage of opposite polarity on the other terminal	1425 kVp impulse on one terminal & 240 kVp power frequency voltage of opposite polarity on the other terminal	±1050 kVp	+ 650kVp	±325 kVp
iii)	Rated switching impulse withstand voltage (250/2500 s) Dry & wet between line terminals and ground	+ 1550kVp	+1050 kVp	NA	NA	NA
iv)	Rated switching impulse withstand voltage (250/2500 s) Dry & wet Between terminals with circuit breaker open	1175kVp impulse on one terminal & 650 kVp power frequency	900 kVp impulse on one terminal & 345 kVp power frequency	NA	NA	NA

		voltage of opposite polarity on the other terminal	voltage of opposite polarity on the other terminal			
v)	One minute power frequency dry withstand voltage between line terminals and ground	830kV rms	520 kV rms.	460 kV rms.	275 kV rms	140 kV rms
vi)	One minute power frequency dry withstand voltage between terminals with circuit breaker open	1150kV rms	610 kV rms.	460 kV rms.	275 kV rms	160 kV rms
28.	Minimum corona extinction voltage with CB in all positions	508 kV rms	320kV rms	156 kV rms	92 kV rms	NA
29.	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz (Micro volts)	2500 V (at 508kV rms)	1000 V (at 266kV rms)	1000 V (at 156kV rms)	500 V (at 92kV rms)	NA
30.	Minimum Creepage distance*					
i)	Phase to ground (25mm/kV)	20000mm	10500mm	6125mm	3625mm	1813mm
ii)	Between CB terminals	18000mm	10500mm	6125mm	3625mm	1813mm
31.	System neutral earthing	Effectively earthed				
32.	Rated terminal load	As per IEC or as per the value calculated based on specific switchyard layout requirement, whichever is higher.				
33.	Auxiliary contacts	Besides requirement of technical specification, the manufacturer/contractor shall wire up 10 NO + 10 NC contacts exclusively for purchaser's use and wired up to common marshalling box.				
34.	No. of terminals in common marshalling box	All contacts & control circuits to be wired out up to common marshalling box + minimum 24 terminals exclusively for purchaser's future use				
35.	Seismic level	0.5g horizontal for the site location under the Zone-V as per IS-1893 0.3g horizontal for the site location under other than the Zone-V as per IS-1893				

* The values indicated are for specific creepage of 25mm/kV. In case of specific creepage of 31mm/kV specified, the Minimum Creepage distance values shall be considered proportionately.

17.0 PRE-COMMISSIONING TESTS

- 17.1 An indicative list of tests is given below. All routine tests except power frequency voltage dry withstand test on main circuit breaker shall be repeated on the completely assembled breaker at site. For Pre-commissioning tests, procedures and formats for circuit breakers, POWERGRID document no. CF/CB/03/R-4 dated 01/04/2013 of document no. D-2-01-03-01-04 dated 01-04-2013 will be the reference document. This document will be available at respective sites and shall be referred by the contractor. Contractor shall perform any additional test based on specialties of the items as per the field Q.P./instructions of the equipment Supplier or Employer without any extra cost to the Employer. The Contractor

Supervision of Erection, Testing & Commissioning is in the scope of bidder.

shall arrange all instruments required for conducting these tests alongwith calibration certificates and shall furnish the list of instruments to the Employer for approval.

- (a) Insulation resistance of each pole.
- (b) Check adjustments, if any suggested by manufacturer.
- (c) Breaker closing and opening time.
- (d) Slow and Power closing operation and opening.
- (e) Trip free and anti pumping operation.
- (f) Minimum pick-up voltage of coils.
- (g) Dynamic Contact resistance measurement.
- (h) Functional checking of control circuits interlocks, tripping through protective relays and auto reclose operation.
- (i) Insulation resistance of control circuits, motor etc.
- (j) Resistance of closing and tripping coils.
- (k) SF6 gas leakage check.
- (l) Dew Point Measurement
- (m) Operation check of pressure switches and gas density monitor during gas filling.
- (n) Checking of mechanical 'CLOSE' interlock, wherever applicable.
- (o) Testing of grading capacitor.
- (p) Resistance measurement of main circuit.
- (q) Checking of operating mechanisms
- (r) Check for annunciations in control room.
- (s) Point of wave switching test (wherever applicable)

17.2 The contractor shall ensure that erection, testing and commissioning of circuit breaker shall be carried out under the supervision of the circuit breaker manufacturer's representative. The commissioning report shall be signed by the manufacturer's representative.

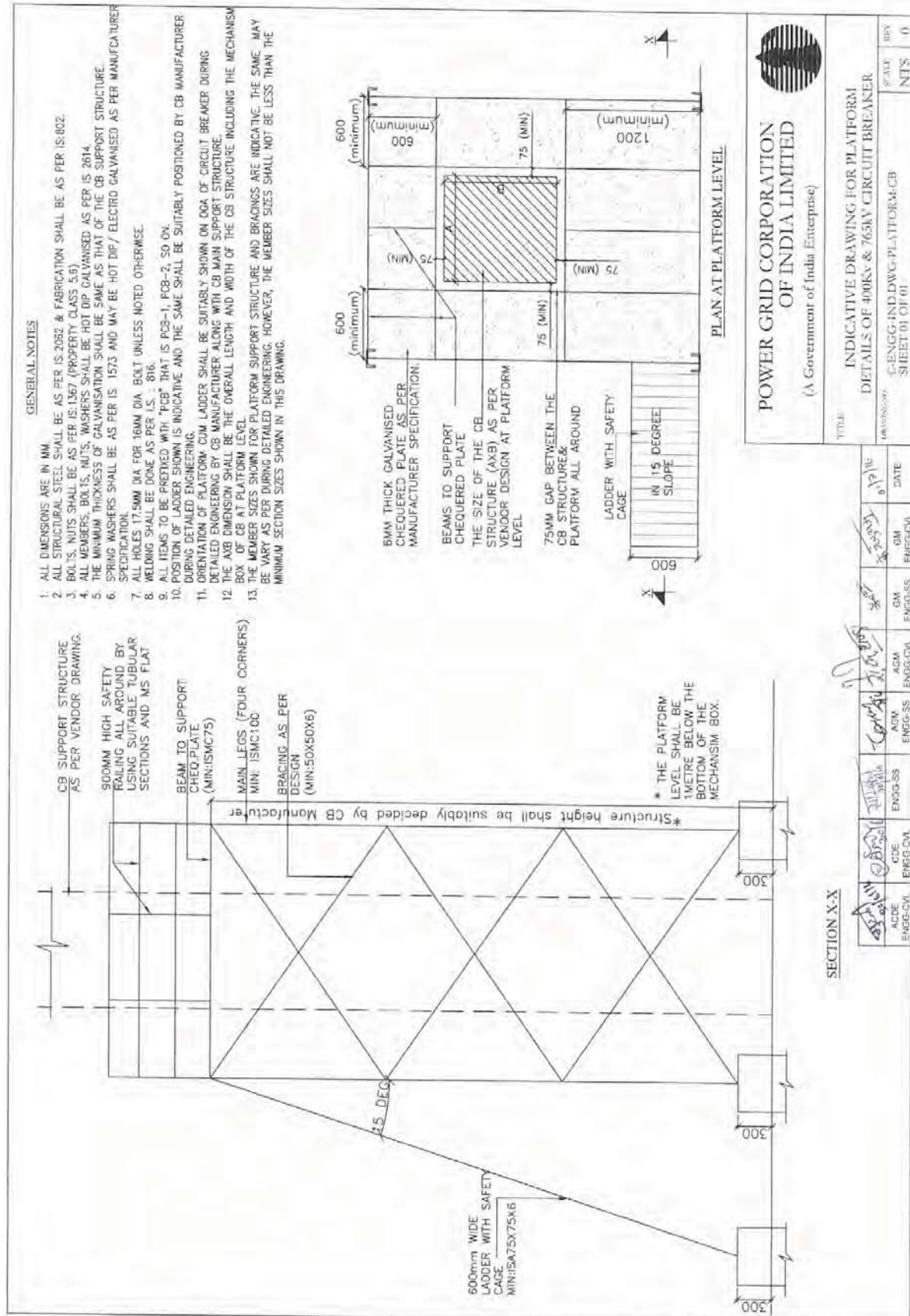
18.0 ACTIONS REQUIRED FOR DEFECTS OBSERVED DURING DEFECT LIABILITY PERIOD

The actions required to be taken by contractor in case of defects observed in AIS type Circuit Breakers of ratings 132kV & above during the warranty period (defect liability period) shall be as per following. Further, the replaced/repaired/ refurbished equipment (or part of equipment) shall have warranty in line with the GCC clause 22 in SCC.

Sl.no.	Nature of problem	Corrective measures to be taken by contractor
1.	Blasting of interrupter, PIR, pole column,	Replacement of complete CB pole Including SF6 gas
	a. Abnormal DCRM and Travel Measurement b. Contact assembly and internal component damage, misalignment not leading to complete failure of interrupter/ PIR	Repair/replacement of affected assembly/ component based on repair procedure approved by QA
2.	Crack in insulator, cementing joint of interrupter , PIR , pole column	Replacement of affected part
3.	SF6 gas leakage from sealing and bolted joints. SF6 gas leakage detectable by any Leakage Detection Method	Rectification by replacement of gasket, O-ring, sealing, Interrupter or affected part to be replaced etc If unable to arrest the leakage in 02 attempts, replacement of interrupter/ column
4.	SF6 gas low dew point: > (-)35 deg C at atmospheric pressure.	Re-conditioning of gas. If does not improve, complete evacuation of CB, replacement filter material and gas
5.	Oil leakage of grading capacitor Change in Capacitance value beyond +/- 5 % w.r.t. to value of Capacitance obtained at site during pre-commissioning test.	Replacement or Refurbishment of grading capacitor
6.	Pole/ break discrepancy (during O&M) Limits: Break to Break (Opening/Closing) : max. 2.5 ms Phase to Phase (Opening) : max. 3.33 ms Phase to Phase (Closing) : max 5 ms	Rectification/replacement of affected parts
7.	Static Contact Resistance: increase >50% from factory/ pre-commissioning value or >75 micro-ohm/ break whichever is lower	Rectification/Replacement of pole
8.	Drive mechanism assembly failure	Rectification/ Replacement of affected part
9.	Trip/ close coil, density monitor, relays and contactors and components of common MB	Replacement of affected part

Note: 1) Replaced/Repaired/Refurbished Equipment (or part of equipment) shall have 2 years warranty without prejudice to contractual warranty period.

2) The measurement at site shall be carried out as per POWERGRID standard Pre-commissioning procedures as indicated in Technical Specification.



PRE-COMMISSIONING CHECKS/TESTS FOR OTHER SWITCHYARD EQUIPMENTS

NOTE - PLEASE REFER THE APPLICABLE CLAUSES FOR BIDDER SUPPLIED EQUIPMENT ONLY, OTHER IRRELEVANT CLAUSES MAY PLEASE BE IGNORED.

Once erection is completed, various pre-commissioning checks/ tests are performed to ensure the healthiness of the switchyard equipments prior to their energisation. Various major electrical tests to be performed and their significance are given below:

Sr. No.	Name of Test / Check point	Purpose of test/ check
6.1	Tan δ & Capacitance measurement of CT, each stack of CVT & total capacitance, CB voltage grading capacitor & each stack of Surge Arresters	The purpose of the dissipation factor measurement of high voltage insulation is to detect incipient weaknesses in HV insulation. The most important benefit to be gained from this measurement is to obtain a “benchmark reference reading” on costly and high voltage equipment when the equipment is new and insulation is clean, dry and free from impurities. Tan delta & Capacitance values shall be comparable with factory test results and in no case shall be more than 0.5 %.
6.2	Checks/ Tests applicable for CTs	
6.2.1	Polarity test for CT	To ascertain whether the polarity markings are correct or not as per drawing.
6.2.2	Magnetization characteristics of CT	To prove that the turns of CTs secondary windings are not short circuited and to check healthiness of CT cores. The magnetizing currents at KPV (Knee point voltage) shall be less than the specified value. The ratio of secondary and primary voltage shall also be measured.
6.2.3	Ratio test for CT	The ratio errors of the primary to the secondary currents should within specified ratio errors.
6.2.4	IR measurement of CT (Primary & Secondary windings)	Changes in the normal IR value of CT indicate abnormal conditions such as presence of moisture, dirt, dust, crack in insulator of CT and degradation of insulation.
6.2.5	DGA test of CT oil	This test shall be conducted after 30 days of commissioning. The purpose is to identify evolving faults in the CT and DGA values shall be comparable with factory values (if available)
6.3	Checks/ Tests applicable for Circuit Breakers	
6.3.1	Dew point measurement of SF ₆ gas	Dew point of SF ₆ gas is to measure moisture content in SF ₆ gas which shall indicate whether CB evacuation is done properly or not. This test shall be carried out preferably at rated pressure of SF ₆ gas.
6.3.2	Measurement of Circuit	To measure closing/ tripping/ CO timings. These timings



Sr. No.	Name of Test / Check point	Purpose of test/ check
	Breaker Operating Timings including PIR Timings	should be within permissible limits and shall be comparable with factory values. Pole discrepancies and Break to Break discrepancies shall be less than specified values.
6.3.3	DCRM Contact Travel Measurement / DC injected currents and trip/ close coil currents.	DCRM is the technique for measuring Contact Resistance during operation (Close/ Trip) of a circuit breaker with a delay Tco of 300ms. A DC current of at least 100 Amp is injected through the circuit breaker. The current and voltage drop are measured and resistance is calculated. The resistance and travel versus time data provides useful information on the condition of the circuit breaker contacts and is used as a diagnostic tool. DCRM test signatures shall be approved by Corporate OS.
6.3.4	Operational lockout checking for EHV Circuit Breakers	To ensure various lockout operation of CB by simulating the actual conditions at the specified pressure of oil/ air/ operating medium.
6.3.5	Measurement of static contact resistance	This test is conducted to evaluate healthiness of Main contacts. 100 Amp DC is injected and voltage drop is measured across each CB contact to compute contact resistance.
6.3.6	Checking the Anti-Pumping feature	By giving simultaneous close/ trip commands, CB hunting shall not take place by operation of Mechanical/ Electrical anti pumping feature.
6.3.7	Checking the Anti-Condensation Heaters	To check correct operation of Thermostat provided for anti condensation heaters.
6.3.8	Pole discrepancy relay testing	To test tripping of CB in case of pole discrepancy more than 2.5 seconds or specified value.
6.3.9	Checking the N2 priming pressure	This test is to check healthiness of N2 accumulators provided in Hydraulic drive mechanisms. N2 priming pressure shall be as per the rated pressure.
6.4	Checks/ Tests applicable for CVTs	
6.4.1	CVT polarity, Ratio test	This test is conducted in the same manner as for CT to determine correct CVT polarity, ratio and phasor group.
6.4.2	Insulation resistance measurement of Primary & secondary winding	Changes in the normal IR value of CVT indicate abnormal conditions such as presence of moisture, dirt, dust, crack in insulator of CVT and degradation of insulation.
6.5	Checks/ Tests applicable for Isolators	
6.5.1	MILLIVOLT Drop test	The voltage drop gives a measure of resistance of current carrying part and contacts by injecting minimum 100 A DC current.

Sr. No.	Name of Test / Check point	Purpose of test/ check
6.5.2	50 operation tests	To test operation of contacts etc with jumpers connected and contact resistance to be measured after 50 operations. There shall not be any change from the previous value.
6.6	Checks/ Tests applicable for Surge Arrestors	
6.6.1	Third Harmonic Resistive Current (THRC) for surge arrestors	To monitor healthiness of Surge arrestors by monitoring third harmonic resistive current from the leakage current. This test is to be conducted after charging of Las. The value of THRC shall be less than 30 μ A.
6.6.2	IR measurement of each stack of LA	Changes in the normal IR value of LA indicate abnormal conditions such as presence of moisture, dirt, dust, crack in insulator of LA and degradation of insulation.
6.6.3	Checking of operation of LA counter	This test is done to check the healthiness of LA counter.
6.7	Checks/ Tests for other areas/ equipments	
6.7.1	Earth resistance measurement	To ensure value of earth resistance is below 1 ohm.
6.7.2	Secondary current injection test	Conducted for testing of protecting devices, circuit breakers, trip coils, motor overloads etc.
6.7.3	Contact Tightness check of Bay contacts by Primary injection method	Since complete bay contact resistance measurement is practically not possible because DC current may not be injected in CT primary, hence contact tightness check by primary injection method has been introduced to check overall contact tightness.
6.7.4	Stability check for Bus Bar	This test is performed to check the proper operation of Bus Bar protection by simulating actual conditions. Any problem in CT connection, wrong cabling, relay setting can be detected by this test.



6.1 TAN DELTA & CAPACITANCE MEASUREMENT OF CT, CVT, CB VOLTAGE GRADING CAPACITORS AND LA STACKS

To measure dissipation factor/loss factor (Tan delta) and Capacitance measurement of EHV class CTs, CVTs, CB Voltage Grading Capacitors & LA stacks by applying test voltages up to 10kV.

A) CURRENT TRANSFORMERS

CTs with test taps

1. Tan delta tap to be disconnected from ground.
2. High voltage lead from tan delta kit to be connected to primary(HV) Terminal and LV lead to be connected to the Tan delta test tap.
3. P1 and P2 to be shorted
4. Porcelain surface to be thoroughly cleaned.
5. Measurements have to be taken in UST mode with fully automatic test kit.
6. Standard procedure(as specified by kit supplier) for measuring capacitance and tan delta in charged switchyard/induced voltage conditions should be followed for measurement of capacitance and tan delta values.
7. It is to be ensured to connect the test tap to ground terminal after carrying out the test.

B) CB VOLTAGE GRADING CAPACITOR

1. Connect LV cable to the middle of the double interrupter.
2. Connect HV cable to the other end of the Grading capacitor to be tested.
3. The opposite end of the grading capacitor has to be grounded using earth switch.
4. Measurements have to be taken in UST Mode with fully automatic test kit.
5. Disconnect the HV cable and connect the same to the other grading capacitor and ground the previous grading capacitor. Now the second grading capacitor is ready for testing.
6. Standard procedure (as specified by kit supplier) for measuring capacitance and tan delta in charged switchyard/induced voltage conditions should be followed
7. Measurements are to be carried out at 10 kV/ 12 KV.

C) CAPACITOR VOLTAGE TRANSFORMERS

1. Testing procedure for Top and Middle Stacks:
 - (a) Apply 10 KV between flanges of Top/Middle stacks (whichever is being tested)
 - (b) Carry out measurements in UST mode at 10.0 KV
 - (c) While measuring Middle/ Bottom stacks, Top/ middle stacks to be shorted.
2. Testing procedure for Bottom Stack connected to EMU PT
 - (a) Connect HV of the test kit at the top flange of bottom stack. HF point to be grounded. Earth connection of the neutral of the PT to be opened/ isolated from ground.
 - (b) Top of CVT to be guarded. LV lead of the kit to be connected at the top of the CVT for guarding.

- (c) Carry out measurements in GSTg mode at 10.0 KV
 - (d) Repeat the Test with neutral of PT connected to ground.
 - (e) In case Tan delta value is negative or erratic, only capacitance values are to be monitored.
 - (f) Measurement to be carried out using fully automatic kit.
3. Standard procedure (as specified by kit supplier) for measuring capacitance and tan delta in charged switchyard/ induced voltage conditions should be followed.

D) SURGE ARRESTERS

1. Testing procedure for Top, Middle and Bottom Stacks:
 - (a) Apply 10 KV between flanges of Top/Middle/ Bottom stacks (whichever is being tested)
 - (b) Carry out measurements in UST mode at 10.0 KV with fully automatic test kit.
 - (c) While measuring Middle/ Bottom stacks, the stacks above the HV lead to be shorted.
2. Standard procedure (as specified by kit supplier) for measuring capacitance and tan delta in charged switchyard/ induced voltage conditions should be followed.
3. While doing measurement of bottom stack the earth connection to be removed.

6.2 CHECKS/TESTS APPLICABLE FOR CTs

6.2.1 POLARITY TEST FOR CT

A centre zero voltmeter is connected across CT secondary. A 1.5 Volt battery is touched to primary of CT. The deflection of pointer should be similar in case of each CT core.

At any instant current entering the primary from P1 the current should leave secondary from the terminal marked S1. A setup shown in the Figure 9 can show whether the polarity markings are correct or not.

When the key is pressed, current enters the primary through terminal P1, the voltmeter connected as shown, should read positive. A general arrangement of polarity test setup is indicated in Fig. 10.

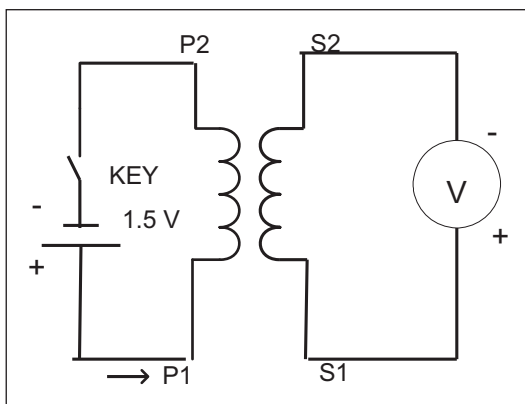


Figure - 9

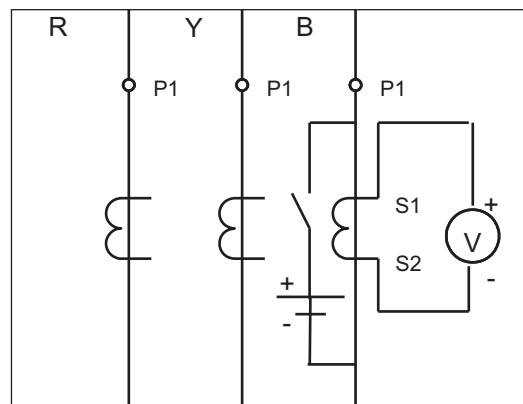


Figure - 10

6.2.2 MAGNETIZATION CHARACTERISTICS OF CTs

PRECAUTIONS

- There should be no joints in testing leads/cables.
- It should be ensured that whole testing equipment along with testing procedures are available at testing site. Testing must be carried out in presence of testing personnel only.

Test Equipment: Voltage source of 5 kV, Voltmeter of range 0 to 5 kV, Ammeter of range 0 to 500 Amps, testing leads/cables etc.

Test Procedure: Make connections as per diagram shown below (Fig- 11). After making proper connections, applied voltage is increased from zero to rated Knee Point Voltage in steps of 25%, 50%, 75% and 100%. Measure the current drawn by the CT secondary core at respective applied voltages and record the test results

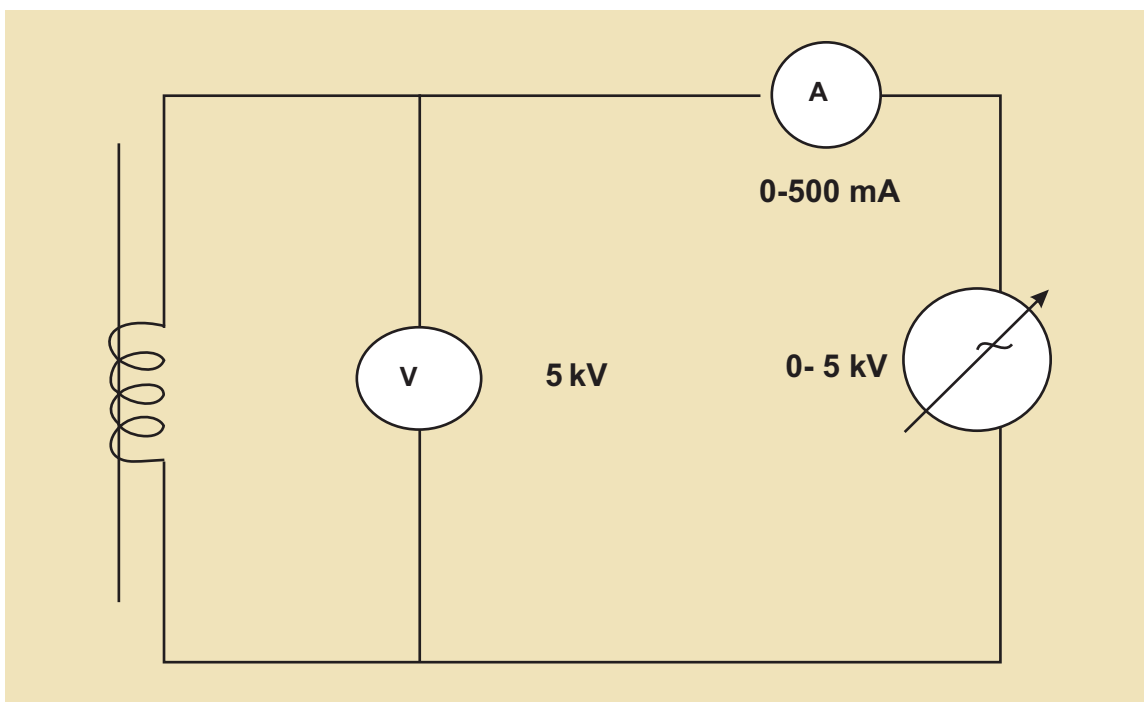


Figure - 11

Knee Point Voltage is normally defined as the voltage at which 10% increase in the applied voltage causes 30 to 50% increase in secondary current. The magnetization current at rated Knee Point Voltage should not be more than the specified/designed value. A curve can be drawn between applied voltage and magnetizing current. Typically, the curve drawn should be like the one given below in Fig.-12.

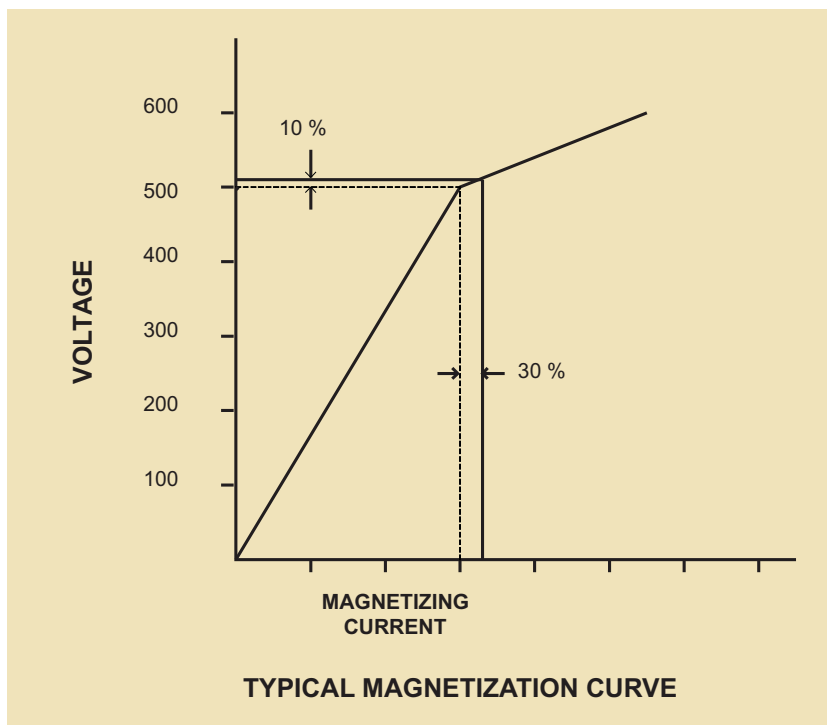


Figure - 12

From the curve it can be implied that up to rated KPV (Knee Point Voltage), the VI curve should be almost a straight line. However, if this line is not linear, this indicates that the magnetizing characteristics are not desirable. If the slope of the curve starts increasing, it indicates that magnetizing induction becomes low and total primary current is utilized in exciting the core alone. Consequently, output of CT secondary disappears.

6.2.3 RATIO TEST FOR CURRENT TRANSFORMER

The ratio check has to be carried out as indicated in Fig-13 below.

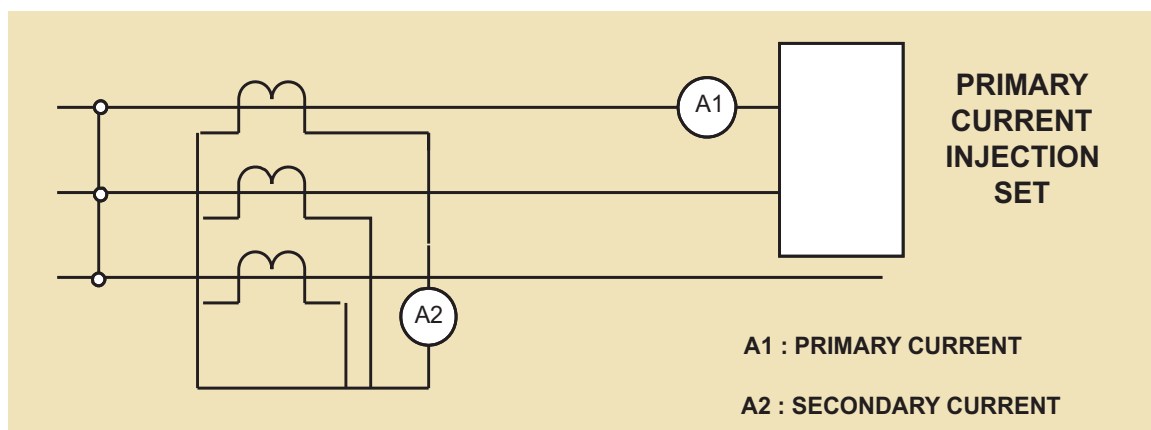


Figure - 13

It is customary to conduct this in conjunction with the primary injection test. Current is passed through the primary circuit with the secondary winding circuit to its normal circuit load. The ratio of the primary to the secondary currents should approximate closely to that stamped under CT identification plate.

Alternatively, ratio test is to be conducted as per the following method (Fig-14).

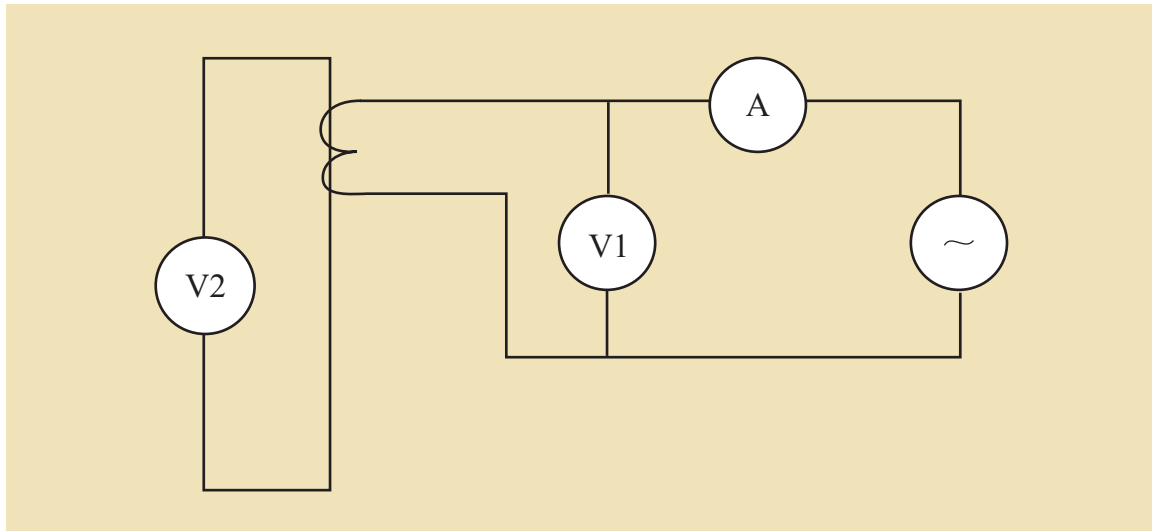


Figure - 14

Apply voltage from secondary of the CT and measure voltage in primary winding. Increase voltage in secondary up to rated KPV/ ISF and by recording Primary Voltage, compute ratio of $V1/V2$. The ratio should match with the specified value.

6.2.4 INSULATION RESISTANCE MEASUREMENT OF CURRENT TRANSFORMER

PRECAUTIONS

- There should be no joints in testing cables.
- Test leads should not touch any live part.
- Megger body should be earthed (if separate terminal is provided).
- Surface/terminals should be cleaned.
- IR measurement should be carried out preferably in dry and sunny weather.
- Never connect the test set to energized equipment.
- The ground terminal must be connected first and removed at last.
- High voltage plugs should be free from moisture during installation and operation.
- If oil traces are found on the surface of CT, the same should be cleaned by Methyl Alcohol only. Petrol or diesel should never be used.
- It should be ensured that whole testing equipment along with testing procedures are available at testing site. Testing must be carried out in presence of testing engineer only.
- After testing with high voltage, test terminals must be grounded before being touched by any personnel.
- Test leads should be properly screened/ shielded.

Connect the Megger as per figure-15 given below. Connect the HV terminal to the Primary terminal of CT by using crocodile clip for firm grip

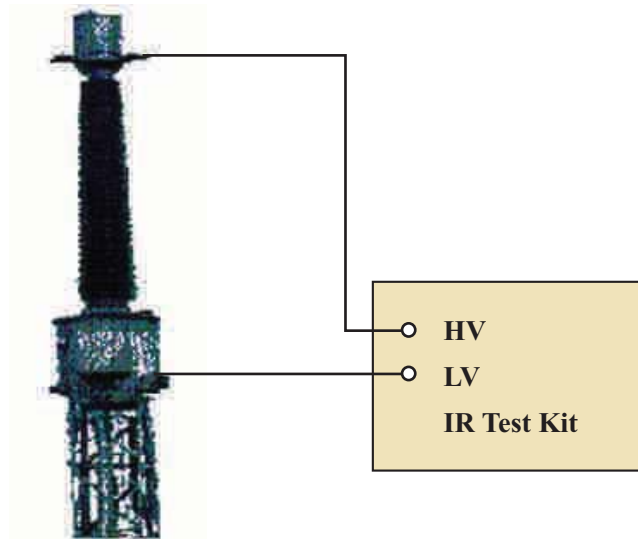


Figure-15 Typical Arrangement for IR measurement

Carry out the measurement as per standard procedure given by the kit supplier.

A test voltage as specified is applied as per the above connections and successive readings are taken. Values of IR should be recorded after 15 seconds, 60 seconds and 600 seconds. Ambient temperature and weather conditions are to be recorded.

6.2.5 DGA Test of CT Oil: Oil samples to be collected in 300ml bottles and to be sent to CIOTL Hyderabad for testing. Test results should be comparable to factory values. In case of any deviation, test results to be forwarded to CC-OS for approval.

6.3 CHECKS/ TESTS APPLICABLE FOR CIRCUIT BREAKERS

6.3.1 DEW POINT MEASUREMENT OF SF₆ GAS FOR CIRCUIT BREAKER

Dew Point is the temperature at which moisture content in SF₆ gas starts condensing.

Dew Point at rated pressure of CB: Dew Point when measured keeping regulating valve in service at the outlet of dew point kit to allow required flow rate of gas, is called at rated pressure of CB. Inlet valve is opened completely.

Dew Point at atmospheric pressure : Dew Point when measured by regulating the gas flow at the inlet of dew point kit and keeping outlet regulating valve (if provided) in fully open condition so that flow rate of gas is maintained as required, is called at atmospheric pressure.

TESTING PROCEDURE

- Make the connections to the kit from CB pole ensuring that regulating valve is fully closed at the time of connections of the Dew Point kit.
- By regulating the flow rate of SF₆ gas (0.2 liter/min to 0.5 liter/min - ref. IEC 60480), the value of dew point is observed till it becomes stable.

- c) If the regulating valve is provided at outlet of the dew point kit then values as given in Doc. no. for rated pressures are to be monitored.

Dew Point of SF₆ gas varies with pressure at which measurement is being carried out. This is due to the fact that Saturation Vapour Pressure decreases with increase in Pressure of the SF₆ gas. Hence, dew point of SF₆ gas at higher pressure is lower than dew point at atmospheric pressure. Therefore, it is to be ensured that if measurement has been done at a pressure other than the atmospheric pressure, same is to be converted to the atmospheric pressure as given in the table below used at the time of commissioning for various CB manufacturers: Method for converting dew point at different gas pressures, is given/described in IEC-60480.

Sl. No.	Make of CB	Dew point at rated pressure	Dew point at Atmospheric Pressure (Limit)
1	BHEL	(-) 15° C	- 36° C
2	M & G	-	- 39° C
3	CGL	(-) 15° C	- 35° C
4	ABB	(-) 15° C	- 35° C
5	NGEF	(-) 15° C	- 36° C

6.3.2 MEASUREMENT OF CIRCUIT BREAKER OPERATING TIMINGS INCLUDING PRE INSERTION RESISTOR TIMINGS

PRECAUTIONS

- There should not be any joint in testing cables.
- Test leads should not touch any live part.
- Never connect the test set to energised equipment.
- The ground cable must be connected first and removed at last.
- High voltage plugs should be free from moisture during installation and operation.
- Circuit Breaker Analyser body should be earthed (if separate earth is provided).
- It should be ensured that whole testing equipment along with testing procedures are available at testing site. Testing must be carried out in presence of testing personnel only.
- Surface/terminals should be cleaned where the connections for testing are to be made.
- Clean earth point with sand paper/wire brush where earth terminal is to be provided.
- Ensure that all the poles trip simultaneously through single close/trip command.

TESTING PROCEDURE

- Make connections as shown in the figure-16 below. It is to be ensured that R, Y, B phase marking cables are connected with the proper place in the CB analyser and colour codes are to be maintained for all the three poles of CB.
- Make connections for recording operating timings of Auxiliary contacts.
- Extend power supply to Circuit Breaker Analyzer.
- Give closing command to closing coil of CB and note down the PIR and main contact closing time. Take the print out from the Analyzer.

- e) Give tripping command to trip coil-I of CB & note down the main contact tripping time.
- f) Give tripping command to trip coil-II of CB & note down the main contact closing time.
- g) Note down the timings for 'CO', and 'OCO' by giving respective commands. CO command to be given without time delay but 300ms time delay to be given between O and CO operation in testing for OCO.
- h) To find out opening time of PIR contacts, PIR assembly has to be electrically isolated from Main contacts and then PIR contacts are to be connected to separate digital channels of the Analyzer.

EVALUATION OF TEST RESULTS

A) CLOSING TIMINGS

Closing timings and Discrepancy in operating times of PIR and main contacts should not exceed the permissible limits as specified in the DOC NO: D-5-02-XX-01-03. In any case, main contacts should not close prior to closing of PIR contacts and PIR contacts should not open prior to closing of main contacts. In case, contact bouncing is observed in operating timings for PIR and main contacts, same should be rectified by tightening the cable connections.

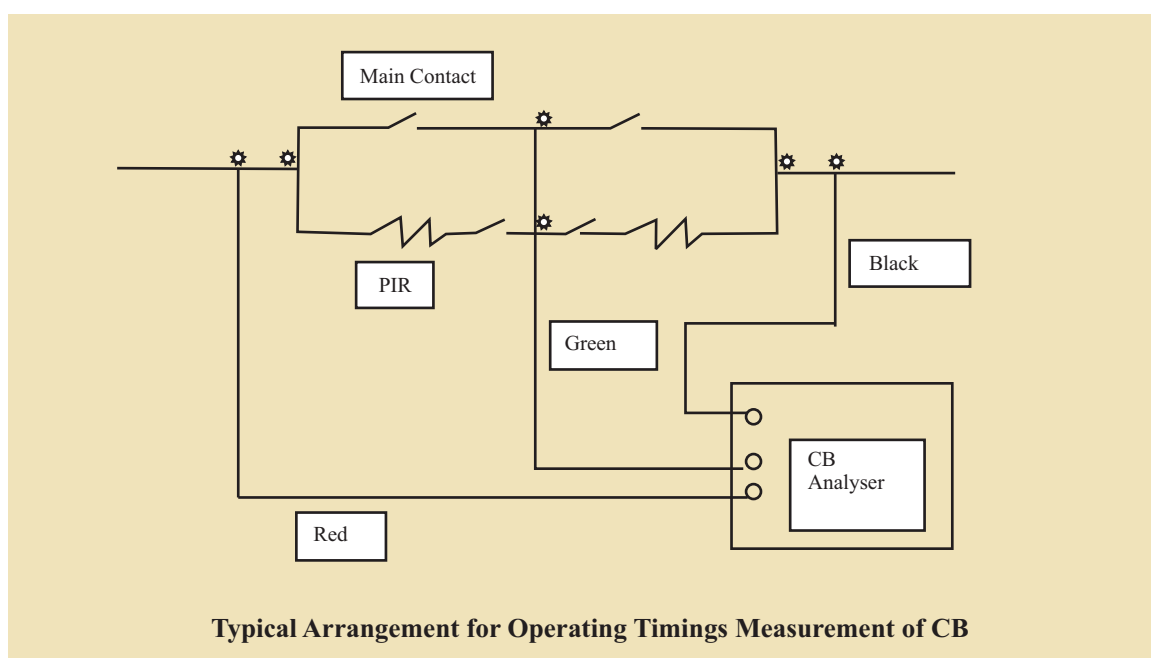


Figure - 16

B) TRIPPING TIMINGS

Trip time and pole discrepancy in operating timings should not exceed beyond permissible value given in Doc. No. D-5-02-XX-01-03. In case of ABB, NGEF and CGL make CBs, while tripping, PIR contacts should not open after opening of main contacts.



C) 'CO' TIMINGS

CO timings should be within permissible limits as specified by different manufacturers. If operating timings of CB poles are not within limits, same may be corrected by:

1. Equalizing the SF6 gas pressure in all the poles
2. Adjusting plunger movement of trip/ close coils
3. Adjustment in operating mechanism
4. Changing of trip/ close coils (if required)

It is also important to measure timings of auxiliary contacts from the point of view of variations w.r.t. the main contacts.

6.3.3 DYNAMIC CONTACT RESISTANCE MEASUREMENT (DCRM) AND CONTACT TRAVEL MEASUREMENT OF EHV CIRCUIT BREAKERS

Test Equipment: 100 Amp. DCRM kit with CB operational analyzer with 10k Hz sampling frequency.

Isolation Required

- a) CB should be in open position.
- b) Isolator of both sides of CB should be in open position.
- c) Earth switch of one side of CB should be in open position.

Precautions

- a) There should be no joints in testing leads/cables.
- b) It should be ensured that whole testing equipment along with testing procedures are available at testing site. Testing must be carried out in presence of testing personnel only.
- c) Current leads should be connected such that voltage leads are not outside area of current flow.

Testing Procedure

1. Follow the standard procedure as given in instruction manual of DCRM kit.
2. The tightness of connections at CB flanges is most important to ensure error free measurement. CB during CO operation generates lot of vibrations and failure of connections during this period can dramatically change the dynamic signature of CB resistance.
3. DCRM signatures should be recorded for CO operation. Open command should be extended after 300 ms from the close command.
4. Clean portions of incoming and outgoing flanges of CB with polish paper to remove paint, oxidation etc, at points where Current clamps are mounted.
5. Select this point of connection, as close as possible to the end of porcelain insulator to ensure that minimum resistance is offered by flanges, bolts, terminal connectors etc.
6. It should be ensured that Travel Transducers are properly fitted.
7. Sampling frequency during measurement should be 10 KHz.
8. Resistance, travel, injected current and Trip/ Close coil currents are to be recorded.

The variations in the measured resistance versus time will be seen as a finger print for the breaker contacts and can be used as a bench mark for comparing with future measurements on the same breaker. This provides information on the condition of the breaker contacts, driving mechanism, operating levers etc.

Dynamic Contact Resistance Measurement for CB healthiness

By application of Dynamic Contact Resistance Measurement, condition of arcing contact, main contact, operating levers, driving mechanism can be predicted. If DCRM signature shows wide variations and also there is change in arcing contact insertion time, it indicates erosion of the arcing contacts to main contacts and subsequent failure.

Contact Travel Measurement

Transducers are attached to the operating rod or interrupting chamber in order to record the contact travel. When CB closes, contact travel is recorded. Contact bounces or any other abnormality is also clearly indicated by the Contact Travel Measurement.

If contact travel, contact speed and contact acceleration signature are compared with the original signatures, then it may indicate problems related with the operating mechanism, operating levers, main/ arcing contacts, alignments etc.

DCRM along with Contact Travel measurement is useful in monitoring length of Arcing contacts. Erosion of Arcing contacts may lead to commutation failures and current may get transferred to Main contacts. Due to heat of arc, main contacts may get damaged.

6.3.4 OPERATIONAL LOCKOUT CHECKING FOR EHV CIRCUIT BREAKERS

6.3.4.1 TESTING PROCEDURE:

A. SF6 GAS PRESSURE LOCKOUT

a) LOW PRESSURE ALARM

Close Isolation Valve between CB Pole(s) and density monitor. Start releasing SF6 gas from density monitor till the low pressure gas alarm contacts are actuated which is detected by Multimeter. Note down the pressure and temperature at which the contacts get actuated.

b) OPERATIONAL LOCKOUT:

Continue releasing SF₆ gas from isolated zone till the operational lockout Alarm Contacts are actuated which are detected by Multimeter. Note down the pressure and temperature at which the contacts get actuated. This is called operational lockout pressure.

B. PNEUMATIC OPERATING SYSTEM LOCKOUT

a) COMPRESSOR START/STOP SWITCH

Close the isolating valve of CB. Release air into atmosphere from the compressor. Note down the value of pressure at which Compressor starts building up air pressure and pressure at which Compressor stops.



b) CBAUTO RECLOSE LOCKOUT

Close isolation valve between pneumatic system and pressure switches. Release air from the isolated zone to atmosphere. Note down pressure at which A/R L/O contacts of pressure switch get actuated which are detected by Multimeter. The leads of the Multimeter should be connected to the contactor where the ARL/O of CB are made.

c) CB CLOSING LOCKOUT

Release air from the isolated zone to atmosphere. Note down pressure at which CB Closing L/O contacts of pressure switch get actuated which are detected by Multimeter.

d) CB OPERATIONAL LOCKOUT

Release air from the isolated zone to atmosphere. Note down pressure at which CB Operational L/O contacts of pressure switch get actuated which are detected by Multimeter.

e) MECHANICAL CLOSING INTERLOCK (FOR ABB & BHEL CBs ONLY)

CB should be in closed position. Release air from pneumatic system of CB to atmosphere and observe whether CB poles start opening, if so, note down the pressure at which tie rod starts coming down. In such case the closing interlock is to be opened for inspection and if required, replace the closing interlock.

C. HYDRAULIC OPERATING SYSTEM LOCKOUT

a) Pump START/STOP

By opening pressure release valve, note down the pressure at which Pump starts building up oil pressure and pressure at which pump stops.

b) CBAUTO RECLOSE LOCKOUT

Close Isolation valve between hydraulic system and pressure switches. Release oil from the isolated zone to oil tank. Note down pressure at which A/R L/O contacts of pressure switch get actuated which are detected by Multimeter.

c) CB CLOSING LOCKOUT

Release oil from the isolated zone to oil tank. Note down pressure at which CB Closing L/O contacts of pressure switch get actuated which are detected by Multimeter.

d) CB OPERATIONAL LOCKOUT

Release oil from the isolated zone to container. Note down pressure at which CB Operational L/O contacts of pressure switch get actuated which are detected by Multimeter.

D. OPERATING PRESSURE DROP TEST:

For Pneumatic/ Hydraulic operating system, operating pressure drop test to be performed during OCO operation of CB, keeping AC supply of Hydraulic pump/ Compressor in off condition. Hydraulic/ Pneumatic pressure drop should be within limits (as recommended by Manufacturer)

6.3.4.2 EVALUATION OF TEST RESULTS

A. SF6 GAS PRESSURE LOCKOUT

All the SF6 gas pressure switches settings should be checked and corrected with ambient temperature. Settings of SF6 gas pressure switches should be within ± 0.1 bar/ Kg/cm² of the set value (after taking into account the temperature correction factor).

B. AIR PRESSURE LOCKOUT

All the air pressure switches settings should be checked and corrected and should be within ± 0.3 bar/ Kg/cm² of the set value.

C. OIL PRESSURE LOCKOUT

All the oil pressure switches settings should be checked and corrected and should be within ± 0.3 bar/ Kg/cm² of the set value.

6.3.5 MEASUREMENT OF STATIC CONTACT RESISTANCE

The Static contact resistance of main circuit of each pole of a circuit breaker is of the order of a few tens of micro ohms. 100 A DC is injected and milli volt drop is measured across each CB contact to compute contact resistance. The values should be within specified limits.

6.3.6 CHECKING THE ANTI-PUMPING FEATURE

When the breaker is in open position and closing and opening commands are given simultaneously the breaker first closes and then opens, but does not reclose even though the closing command is maintained.

6.3.7 CHECKING THE ANTI-CONDENSATION HEATERS

Check the supervisory circuit of the anti-condensation heaters for correct functioning. With the heaters switched ON, measure their current output.

6.3.8 POLE DISCREPANCY RELAY TESTING

Pole Discrepancy is defined as the difference in closing & opening timings of different poles of CB.

A. WHEN CB IN OPEN POSITION

Closing Command is extended to close one pole, say R-Pole, of CB. After closing R-Pole of CB, this Pole should automatically open after 2.5 seconds (as per pole discrepancy timer settings). Repeat the test for remaining two poles of CB.

B. WHEN CB IN CLOSED POSITION

Tripping Command is extended to trip one pole, say R-Pole, of CB. Remaining Y and B- Poles of CB should automatically open after 2.5 seconds. Repeat the same test for remaining two poles of CB.

C. EVALUATION OF TEST RESULTS

Permissible value of pole discrepancy between two poles of CB is 3.33 msec. from system point of view and it should not be confused with the setting of pole discrepancy timer which is generally 1.0 or 2.5 sec. depending on Auto-reclose scheme.

6.3.9 CHECKING THE NITROGEN PRIMING PRESSURE

Close the pressure release valve. Shortly after the oil pump starts, the priming pressure (200 bar at 20 °C) in the accumulator can be read. The relationship between the pressure and temperature is indicated in Fig. 17.

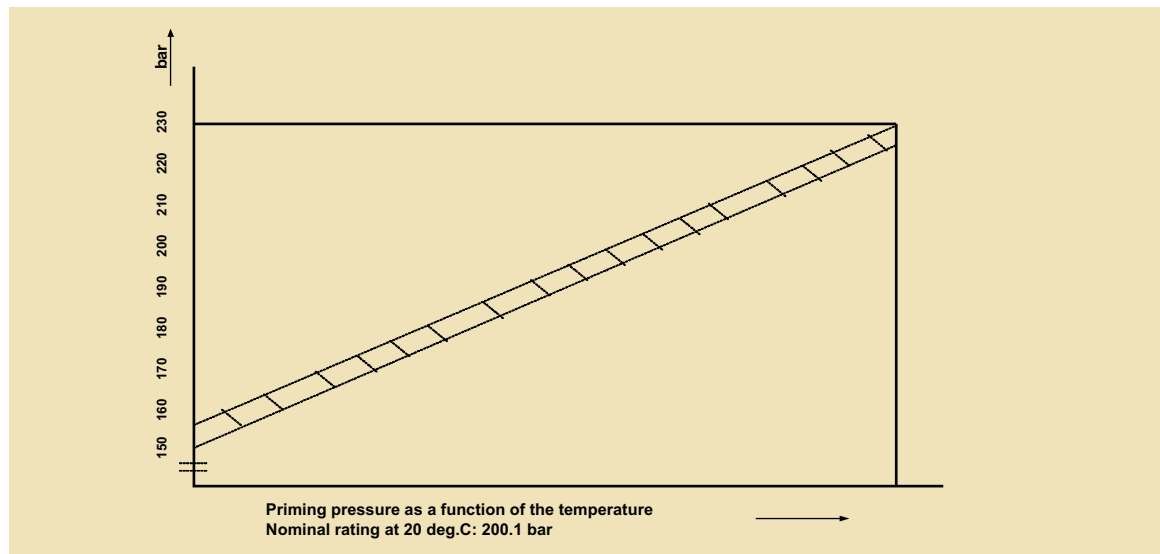


Figure - 17

6.4 CHECKS/ TESTS APPLICABLE FOR CVTs

6.4.1 CVT POLARITY, RATIO TEST

CVT polarity is checked in the same manner as for CT, taking care to ensure that the battery is connected to the primary winding. In case of star/star winding configuration care has to be taken to ensure that the primary and secondary neutral points are not connected together. It is necessary to verify that the phase rotation sequence of the 3 phase CVT is correct. The secondary voltage between phases and neutral are measured and then phase rotation meter is connected across the three phase terminal.

6.4.2 INSULATION RESISTANCE MEASUREMENT OF PRIMARY & SECONDARY WINDING

6.5 CHECKS/TESTS APPLICABLE FOR ISOLATORS

6.5.1 MILLIVOLT DROPTESTS

The milli volt drop across the isolator is measured using DC current. The voltage drop gives a measure of resistance of current carrying part and contacts.

The DC current should be equal to or more than 100 A. The resistance of isolator should be measured at ambient air temperature. The temperature of specimen/environmental temperature should be recorded. The value of measured resistance should be converted to the value of temperature at which factory test results are taken. Temperature corrected value of resistance should be comparable to the factory value.

6.5.2 50 OPERATION TESTS

6.6 CHECKS/TESTS APPLICABLE FOR SURGE ARRESTERS

6.6.1 MEASUREMENT OF THIRD HARMONIC RESISTIVE CURRENT FOR SURGE ARRESTERS

Testing Procedure

- Make the connections as per the diagram given below (Fig.18)
- The kit should be properly earthed.
- Clamp On type CT should be placed above the surge monitor to pick up the total leakage current.
- Carryout the measurements as per standard procedure supplied by the test kit manufacturer.
- Note down the system voltage and ambient temperature along with the test current value.
- Avoid measurement during monsoon.

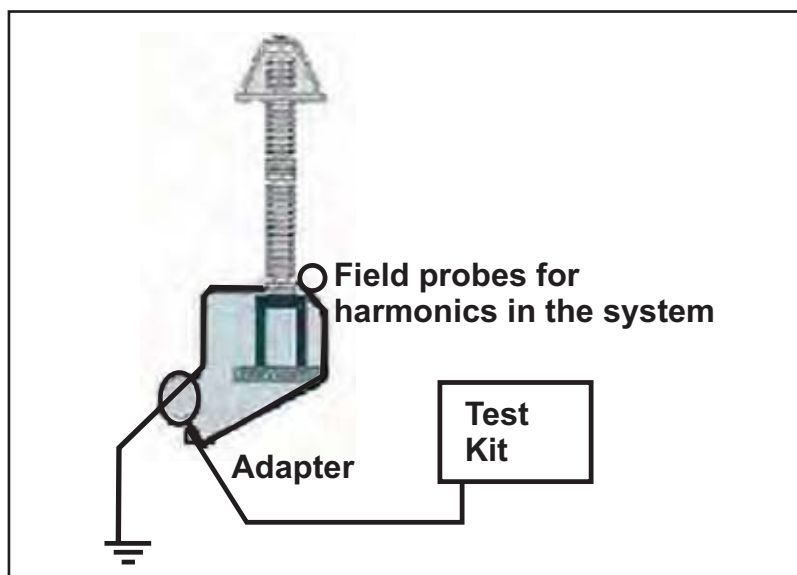


Figure- 18 Typical arrangement for THRCM Test

EVALUATION OF TEST RESULTS

- A. ZnO Surge Arrester continuously conducts a small leakage current (Fig.19). The resistive component of this leakage current may increase with time due to different stresses causing ageing and finally cause arrester failure.
- B. If Harmonics are present in the system voltage, it affects the value of measured third harmonic current. Compensating device provided to be used to nullify the effect. The value of Third Harmonic Resistive current shall be less than 30 μA

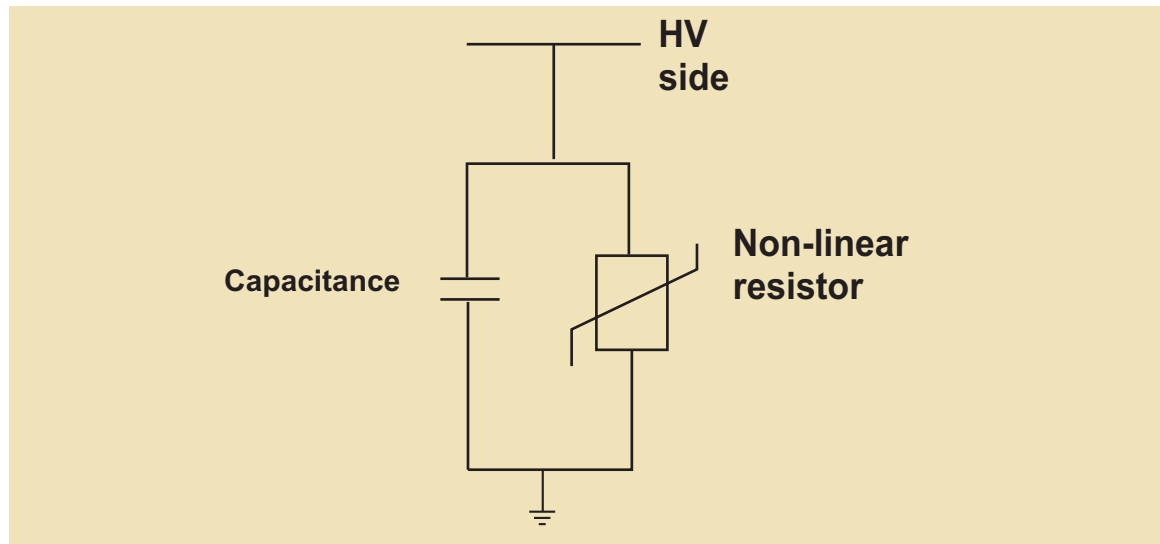


Figure-19 Arrester equivalent circuit

6.7 CHECKS/TESTS FOR OTHER AREAS/EQUIPMENTS

6.7.1 EARTH RESISTANCE MEASUREMENT

Normally Earth tester is used for measuring

- (a) Soil resistivity
 - (b) Earth resistance
- a. Prior to the testing of soil resistivity and earth resistance the operation manual of the testing instrument available at site may be referred for procedures to be adopted for measurement of soil resistivity and earth resistance.
A typical earth tester has 4 terminals. C1, P1, C2, P2 and 4 similar electrodes are driven in the ground at equal distances and connected to the instruments in the order of C1, P1 and P2, C2. Then the handle is rotated or button is pressed and the reading of the resistance is read on the scale of the instrument. If R is the resistance measured then

$$\text{Specific Resistivity} = 2\pi a R$$

Where 'a' is the distance between the electrode

And R is the resistance in ohms measured on the earth tester.

- b. In order to measure earth resistance of the electrode of the substation, it could be connected to C1 and the value of R could be read in the scale with the rotation of the handle of the Insulation tester. This will give the earth resistance. The value as far as possible should be around 1 ohm. To improve the value, water should be spread at the earth pit.

6.7.2 SECONDARY CURRENT INJECTION TEST SETS

The primary test is essential when commissioning and new installation as a test the whole protection system and will detect current transformers connected with incorrect polarity or relays that have been set in the wrong sequence in differential system. Secondary current injection sets are very useful for conducting these tests. The standard secondary current injection test equipment consists of a 1/5 A current injection set, separate wave form filter unit and a digital counter. The equipment is designed in a portable kit for on site testing of protecting devices, circuit breakers, trip coils, motor overloads, and similar apparatus. The filter unit should be used when testing saturating core type relays to ensure that the test current has a substantially sinusoidal waveform. The typical test setup is shown in fig. 20. Details of the testing will be elaborated in the relay testing.

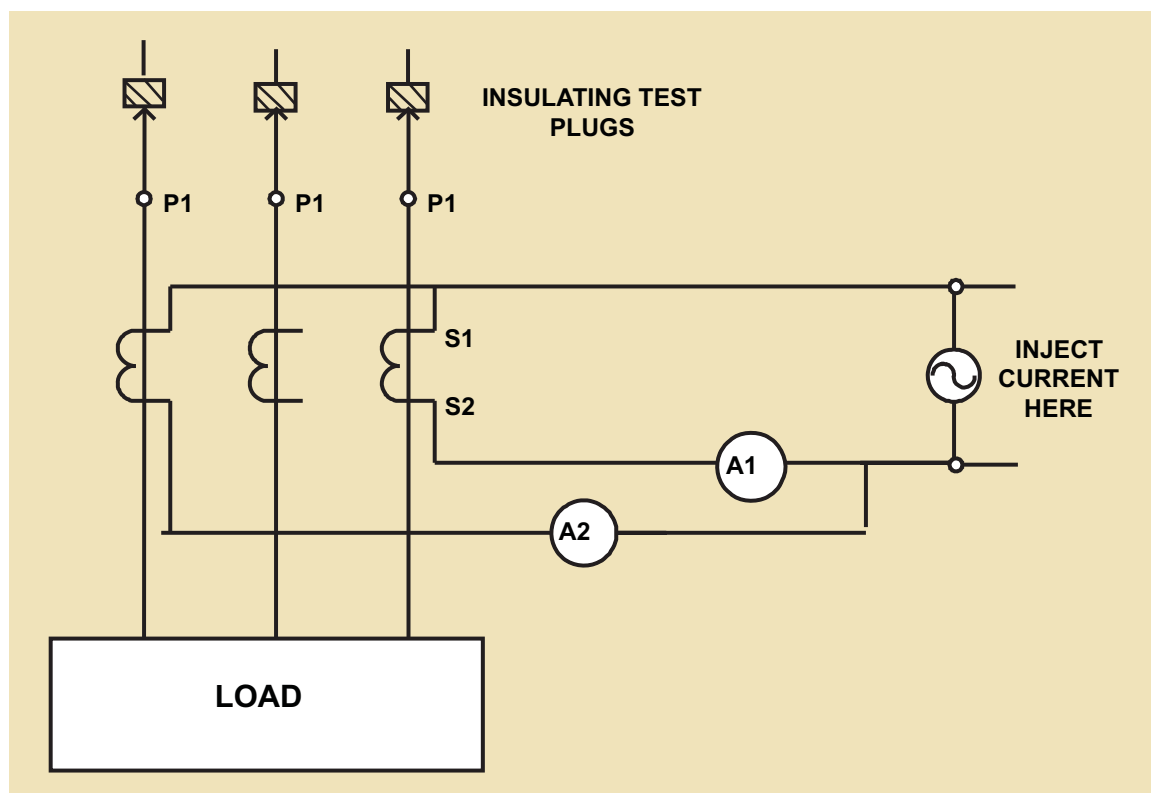


Figure - 20

6.7.3 CONTACT TIGHTNESS TEST OF BAY CONTACTS:

- Isolate the Bay from Bus–Side and line side as shown in Fig.-21.
- Ensure that all the secondary cores are connected or short if not in use.
- Inject the Current at Point 1 (200A) from primary injection kit (w r t earth) and return current via earth point at 2 as shown in Fig.-21.
- Check that we are able to inject current at point 1 and measure the current at point 2.
- Injection of current is the indication of contact tightness.
- Repeat the procedure for point 1 & 3
- Repeat the procedure for point 1 & 4

Note: Above tests can be aborted if individual contact resistances are within satisfactory limit and physical phase checking is satisfactory.

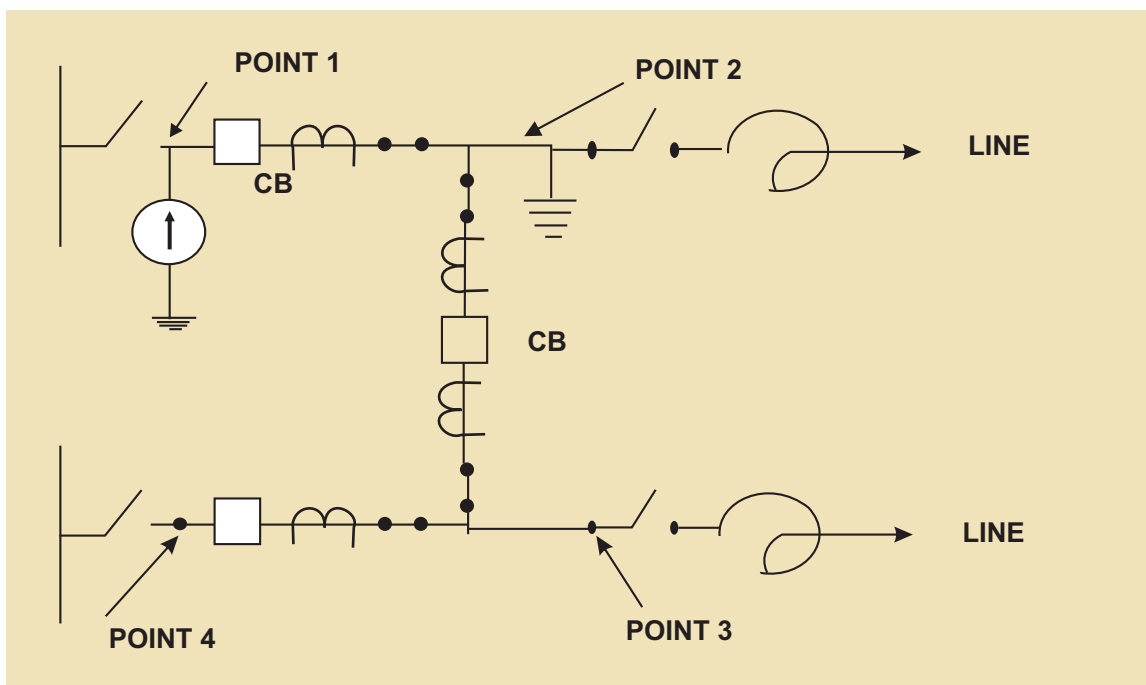


Figure-21 : Primary injection test to check contact tightness of Bay/ feeders



PRE-COMMISSIONING FORMATS FOR CIRCUIT BREAKER

I. General Details

DETAILS	
Region:	Sub-Station:
Feeder Name:	LOA No. :
Make:	Year of Manufacture:
Equipment Designation: Ex: 452	
Sr. No.:	Type:
Rating:	Rated Breaking Capacity(kA):
Operating Voltage:	Control Voltage (DC) :
Date of Receipt at site:	Date of Erection:
Date of energisation:	

II. Pre-Commissioning Checks:

Sl .No	Description	Status		Remarks
		Yes	No	
1	Equipment is free from dirt/dust/rust/ foreign materials etc.			
2	Equipment is free from all visible defects on physical inspection			
3	Support structures, marshalling box has been provided with double earth			
4	All nuts and bolts are tightened correctly as per specified torque			
5	Equipment erection is complete in all respect & erection completion certificate along with list of outstanding activities reviewed (attach remaining activities, if any)			
6	Permanent pole leveling and identification is done			

Sl .No	Description	Status		Remarks
		Yes	No	
7	Leveling and alignment of structure and base frame is checked			
8	Control box / marshalling kiosk is free from any physical defects			
9	Tightness of nuts bolts of terminal connectors are checked			
10	Auxiliary contacts and relays have been cleaned and free from rust / damage			
11	All spare wires to be kept with ferrules but not terminated at the terminal blocks			
12	Check all the valves in the SF6 pipe line are tightened, DILO coupling are tightened.			
13	Slow and power closing operation and opening done (wherever applicable)			

III. Operating System

Closing		Opening	
Hydraulic		Hydraulic	
Pneumatic		Pneumatic	
Spring		Spring	
Others		Others	

A. Hydraulic system

a) Accumulator

	R Ø	Y Ø	B Ø
Make			
Serial number			
Type			
Year of manufacture			

b) Pump details

Make		Volt	
Serial number		Amperes	
Type		Hp/ kW	
Year of manufacturer		O/L setting (Thermal Over load)	

c) Details of relays/contactors used

Schematic drawing no _____

Circuit Reference	Make	Type	No+Nc
Oil Pressure Switch			
Closing Lockout			
Auto Reclosing Lockout			
Operational Lockout			
Anti Pumping Contactor			
Pole Discrepancy Timer			
SF6 Alarm/Lockout			

**d) Operation checks**

Date of Hydraulic Oil filling _____

Type of Hydraulic Oil _____

1. Venting of Hydraulic system

Sl.No	Item Description	Status		REMARKS
		Yes	No	
1	Pump			
2	Pilot Valve			
3	Main Valve			
4	Accumulator			
5	Hydraulic Mechanism			

2. Pressurising hydraulic system

Sl.No	Description	Factory Test Value	Site Test Value	Remark Record Deficiencies, If Any
1	Pre-filling pressure of N ₂ in accumulator (bar / °C)			
2	Pump running time for charging hydraulic system from initial pressure to working pressure			
3	Checking safety valve (open/close)			
4	Hydraulic pressure drop for 1 hr			
	Breaker on position			
	Breaker off position			
5	Oil pressure monitor			
	Pump on / off bar			
	Pump running time			
6	Auto reclosing lockout (oil) Pressure contact _____ make/break			
7	Closing lockout (oil) pressure Contact _____ make/break			
8	General lockout (oil) Pressure contact _____ make/break			
9	Checking loss of nitrogen Pressure contact _____ make/break			

Factory test report ref no: _____

3. Oil pressure drop during operations and pump running time in seconds

Sl.No	Description	Factory Test Value	Site Test Value
(i)	Pressure before operation(Bar)		
	Pressure after closing operation(Bar)		
	Pump running time(Sec)		
(ii)	Pressure before operation(Bar)		
	Pressure after opening operation(Bar)		
	Pump running time(Sec)		
(iii)	Pressure before operation(Bar)		
	Pressure after close/open operation (Bar)		
	Pump running time in sec		
(iv)	Pressure before operation(Bar)		
	Pressure after open-close-open operation(Bar)		
	Pump running time(Sec)		

Factory test report ref no: _____

B. Pneumatic System

a) Operating system details

	R - Ø	Y - Ø	B - Ø	Remarks
Air receiver no.				
Control block no.				
Pneumatic drive no.				
Magnetic venting no.				

b) Motor details

Make		Volt	
Serial number		Amperes	
Type		Hp/ kW	
Year of manufacturer		O/L setting (Thermal Over load)	

c) ICU Details

Make	
Serial number	
Type	
Discharge	
Capacity	
Year of manufacturer	

d) Details of Relays / Contactors used

Schematic drawing no _____



Circuit Reference	Make	Type	NO+NC
Air Pressure Monitor			
Closing Lockout			
Auto Reclosing Lockout			
General Lockout			
Pole Discrepancy Timer			
Auxiliary			
Power Contactor in ICU			
SF6 Alarm/Lockout			

e) Pressure Switch setting

Circuit Reference	Factory Setting Value		Site Setting Value		Make	Remarks	
	Block	De-block	Block	De-block			
Operation lockout -1							
Operation lockout -2							
Closing lockout							
Auto reclosing ckt							
Low/high pressure							
Alarm circuit							
Compressor start/stop setting							
Compressor safety valve							

Factory test report ref. no: _____

f) Pressure drop during operation : (in kg/ sq.cm -bar)

SI No	Description	Factory Setting Value	Site Setting Value
1	Tripping through TC-I		
2	Tripping through TC- II		
3	Closing circuit		
4	Close-open operation		
5	Open - close - open		

Factory test report ref no: _____

g) Air pressure drop in 24 hrs

	Drop In Pressure In Kg/Sq.Cm Or Bar
Breaker "On"	
Breaker "Off"	

C. Spring Operating System**a) Motor details**

Make		Volt	
Sl no		Amperes	
Type		Hp/kw	
Year of Manufacture		Setting (thermal overload)	
Current taken by motor for charging the spring (amp)		IR of spring charging motor	

b) Details of relays/contactors used : schematic drawing no

Circuit Reference	Make	Serial No.	Type	No+Nc
Closing lockout				
Auto reclosing lockout				
General lockout				
Pole discrepancy timer				

c) Spring operating time

Details	R- Ø		Y- Ø		B- Ø	
	Factory	Site	Factory	Site	Factory	Site
Charging Time						

Factory test report ref no: _____

IV. SF6 DENSITY MONITOR DETAILS**A.**

	R- Ø		Y- Ø		B- Ø	
	R1 Ø	R2 Ø	Y1 Ø	Y2 Ø	B1 Ø	B2 Ø
Make						
Model						
Sl.no						
Year of manufacture						
Final filling pressure						

**B. SF6 density monitor settings**

SF6 gas filled at _____ bar at _____ deg. C on ____/____/____

Phase (Ø)	Details	Blocking		De-blocking	
		Factory	Site	Factory	Site
R1 Ø (Bus side)	Low Pressure alarm				
	Lock out pressure				
R2 Ø (Line side)	Low Pressure alarm				
	Lock out pressure				
Y1 Ø (Bus side)	Low Pressure alarm				
	Lock out pressure				
Y2 Ø (Line side)	Low Pressure alarm				
	Lock out pressure				
B1 Ø (Bus side)	Low Pressure alarm				
	Lock out pressure				
B2 Ø (Line side)	Low Pressure alarm				
	Lock out pressure				

Factory test report ref no: _____

C. Measurement of dew point of Sf6 gas

Sl. No	Measured Value	Measurement Pressure
1	R1 Ø (Bus side)	
2	R2 Ø (Line side)	
3	Y1 Ø (Bus side)	
4	Y2 Ø (Line side)	
5	B1 Ø (Bus side)	
6	B2 Ø (Line side)	

Note: Dew point measurement of SF6 gas needs to be done pole wise in close loop method without any wastage of SF6 gas

D. Leakage check

SL.NO	INTERVALS	UNIT	
A	Initial filling of SF6 gas at _____ deg C (As per temp. Correction chart)	BAR	
B	Drop in sf6 gas pressure in 24 hrs :	BAR	
C	Final SF6 pressure at _____ deg. C after all testing	BAR	
D	Additional leakage test by covering individual joint with polythene	YES	NO

V. COIL RESISTANCE MEASUREMENT

COIL DETAILS	MEASURED IR VALUE IN Ω					
	R1- $\emptyset$	R2- $\emptyset$	Y1- $\emptyset$	Y2- $\emptyset$	B1- $\emptyset$	B2- $\emptyset$
TRIP COIL- I						
TRIP COIL-II						
CLOSE COIL						

VI. CIRCUITRY / OPERATIONAL CHECKS

SI No	Circuit Reference	Circuitry Check		Operational Check	
		Local	Remote	Local	Remote
A	Tripping Through TC-I				
B	Tripping Through TC-II				
C	Closing Circuit				
D	Anti-hunting Feature				
	(Close Open Operation)				
E	Pole Discrepancy Feature				
F	Breaker Position Indication				
G	Heater In Switch Cubicle				
H	Heater In Control Cubicle				
I	Illum. In Switch Cubicle				
J	Illum. In Control Cubicle				

Note: In case wiring for remote operation is not ready, please indicate terminal number along with wire ferrule number in switch cubicle where remote cables shall be terminated. Remote operation can be checked from these terminals.

VII. OPERATING TIME (IN MILLI-SECONDS)

Phase ($\emptyset$)	Break	Close (Max 150ms)	Trip (Max 25ms 400kV & 765 kV, 35ms 220kV, 40ms 132kV/66kV)		Close Trip (Min. 35 ms)	
			Trip - I	Trip - II	Trip - I	Trip - II
R- $\emptyset$ main contact	Break -1					
R- $\emptyset$ PIR						
Auxiliary contact						
R - $\emptyset$ main contact	Break -2					
R - $\emptyset$ PIR						
Auxiliary contact						
R - $\emptyset$ main contact	Break -3					
R - $\emptyset$ PIR						
Auxiliary contact						
R - $\emptyset$ main contact	Break -4					
R - $\emptyset$ PIR						
Auxiliary contact						



Phase (Ø)	Break	Close (Max 150ms)	Trip (Max 25ms 400kV & 765 kV, 35ms 220kV, 40ms 132kV/66kV)		Close Trip (Min. 35 ms)	
			Trip - I	Trip - II	Trip - I	Trip - II
Y- Ø main contact	Break -1					
Y- Ø PIR						
Auxiliary contact						
Y - Ø main contact	Break -2					
Y - Ø PIR						
Auxiliary contact						
Y - Ø main contact	Break -3					
Y - Ø PIR						
Auxiliary contact						
Y - Ø main contact	Break -4					
Y - Ø PIR						
Auxiliary contact						
B - Ø main contact	Break -1					
B - Ø PIR						
Auxiliary contact						
B - Ø main contact	Break -2					
B - Ø PIR						
Auxiliary contact						
B - Ø main contact	Break -3					
B - Ø PIR						
Auxiliary contact						
B - Ø main contact	Break -4					
B - Ø PIR						
Auxiliary contact						

NOTE: for 765 kV, take measurements for four breaks

VIII. IR VALUE OF CONTROL CIRCUIT (USING 500 VOLT MEGGER)

Coil Details	Unit	Measurement Value	
		Pole - I	Pole - II
R - Ø TRIP COIL - I	MΩ		
R - Ø TRIP COIL - II	MΩ		
R - Ø CLOSE COIL	MΩ		
Y - Ø TRIP COIL - I	MΩ		
Y - Ø TRIP COIL - II	MΩ		
Y - Ø CLOSE COIL	MΩ		
B - Ø TRIP COIL - I	MΩ		
B - Ø TRIP COIL - II	MΩ		
B - Ø CLOSE COIL	MΩ		

CAUTION: Isolate necessary dc for trip coil-I and trip coil-II, closing coil before meggering.

IX. IR VALUE WITH BREAKER OPEN(USING 5000 VOLT MEGGER)

PHASE	ACROSS OPEN CONTACT BREAK 1	ACROSS OPEN CONTACT BREAK 2	ACROSS OPEN CONTACT BREAK 3	ACROSS OPEN CONTACT BREAK 4
R				
Y				
B				

MINIMUM VALUE 1000 M Ω **X. IR VALUE WITH RESPECT TO EARTH WITH BREAKER CLOSED, EARTH SWITCH AND ISOLATOR OPEN**

MEASURED IR VALUE IN M Ω					
R1 $\emptyset$ -G	R2 $\emptyset$ -G	Y1 $\emptyset$ -G	Y2 $\emptyset$ -G	B1 $\emptyset$ - G	B2 $\emptyset$ -G

MINIMUM VALUE 1000 M Ω **XI. MINIMUM PICKUP VOLTAGE OF COILS**

COIL DETAILS	PICKUP VOLTAGE IN VOLTS					
	R1- $\emptyset$	R2- $\emptyset$	Y1- $\emptyset$	Y2- $\emptyset$	B1- $\emptyset$	B2- $\emptyset$
TRIP COIL-I						
TRIP COIL -II						
CLOSING COIL						

XII. GRADING CAPACITOR

i. Details

Details	Interrupter 1			Interrupter 2		
	R	Y	B	R	Y	B
MAKE						
SERIAL NO.						
CAPACITANCE VALUE						
FACTORY VALUE						
YEAR OF MANUFAC.						

ii. Capacitance And Tan Delta Measurement (To Be Done In UST Mode)

Capacitance	Interrupter 1			Interrupter 2		
	R	Y	B	R	Y	B
SITE						
-FACTORY						
% DEVIATION						
TAN DELTA						
SITE						
-FACTORY						
% DEVIATION						

Permissible Limits

a) Tan delta of grading capacitors 0.005 (max.)

b) Capacitance of grading capacitors within $\pm 5\%$ of the rated value

XIII. CONTACT RESISTANCE MEASUREMENT (MICRO Ω)

PHASE	ACROSS EACH POLE		PHASE	ACROSS EACH POLE	
	FACTORY	SITE		FACTORY	SITE
R 1 - $\emptyset$			Y 3 - $\emptyset$		
R 2 - $\emptyset$			Y 4 - $\emptyset$		
R 3 - $\emptyset$			B 1 - $\emptyset$		
R 4 - $\emptyset$			B 2 - $\emptyset$		
Y 1 - $\emptyset$			B 3 - $\emptyset$		
Y 2 - $\emptyset$			B 4 - $\emptyset$		

a) Contact Resistance of CB (in Micro- Ω)

765 kV	400kV	220kV	132kV
75 $\mu\Omega$ /break	75 $\mu\Omega$ /break	75 $\mu\Omega$	100 $\mu\Omega$

b) Contact Resistance of CB terminal connector 10 Micro- Ω per connector

Factory test report ref no : _____

XIV. BREAKER OPERATION COUNTER READING

Counter Type	Put $\sqrt{\quad}$ Mark
ELECTRICAL	
MECHANICAL	

Sl.No	Phase	Reading	Date
A	R- $\emptyset$		
B	Y- $\emptyset$		
C	B- $\emptyset$		

XV. CHECK FOR ANNUNCIATION IN CONTROL ROOM AS PER THE FOLLOWING FORMATS AND RECORD THE READING

Sl No	Description Of Test	Source Of Initiation	Window Description	Result		Remark
				O K	NOT OK	
A	Switch off the dc switch in Control cubicle	Control cubicle dc Switch on/off	Source I/II dc fail / ac fail			
B	Switch off the ac Switch in control Cubicle	Control cubicle ac Switch on/off	Source I/II dc fail / ac fail			
C	Short the alarm contacts of sf6 Gas density monitor (R-Ø)	Density monitor	Sf6 gas density low			
D	Short the alarm contacts of sf6 Gas density monitor (Y-Ø)	Density monitor	Sf6 gas density low			
E	Short the alarm contacts of sf6 Gas density monitor (B-Ø)	Density monitor	Sf6 gas density low			
F	Remove the cable connected to density monitor (R-Ø)	Density monitor	Operation/closing lockout			
G	Remove the cable connected to density monitor (Y-Ø)	Density monitor	Operation/closing lockout			
H	Remove the cable connected to density monitor (B-Ø)	Density monitor	Operation/closing lock out			
I	Give tripping command to R-ph only and check the operation of pole discrepancy relay	Pole discrepancy relay at breaker Cubicle	Breaker pole discrepancy			
J	Give tripping command to Y-Ø Only and check the operation of pole discrepancy relay	Pole discrepancy relay at breaker Cubicle	Breaker pole discrepancy			
K	Give tripping Command to B-ph only and check the operation of pole discrepancy relay	pole discrepancy relay at breaker cubicle	Breaker pole discrepancy			
L	Check other alarms as per plant Circuit diagram					
M	Close the breaker and trip through Protection which are applicable	protection relay as per scheme	Breaker auto trip			

NOTE : The tripping details are to be checked as per the Scheme approved by engineering.

**XVI. DYNAMIC CONTACT RESISTANCE & TRAVEL MEASUREMENT**

Phase (Ø)	Factory	Site	Remarks	Approval From CC/OS Obtained
R				
Y				
B				

XVII. OPERATION TIME MEASUREMENT OF POLE DISCREPANCY RELAY

Pole discrepancy relay	Setting	Actual

Note- 2.5 Sec for CBs with Auto Reclose Function & 0.5 Sec for CBs without Auto Reclose Function.

CONTROLLED SWITCHING RELAY (If provided)

Make: **Model:** **Date of installation:**

Application: Reactor/ Transformer

Settings	Trip Operation	Close Operation
R- Ø		
Y- Ø		
B- Ø		

XVIII. MECHANICAL CLOSE INTERLOCK CHECKED (WHEREVER APPLICABLE)

Yes	No

XIX. FINAL DOCUMENTATION REVIEW

i. Factory test results are available

Yes	No

ii. Final documents of Pre- Commissioning checks reviewed and approved

Yes	No

iii. Document regarding spares equipment, O&M manuals etc available at site for O&M purpose

Yes	No

iv. After modification, if any, “As built Drawings” are available at site

Yes	No

v. CC-OS approved DCRM signatures available

Yes	No

Signature:

Signature:

Signature:

Signature:

Name:

Name:

Name:

Name:

Designation:

Designation:

Designation:

Designation:

Organization:
(Supplier
Representative)
(Wherever
Applicable)

(Erection Agency)

(POWERGRID Site
I/C)

(POWERGRID
Commissioning. Team)
Members:
1.
2.
3.
4.

Bharat Heavy Electricals Limited

Project: Substation package-SS19: Extension of 765kV Solapur, 765kV Aurangabad, 765kV Wardha, 400kV Khandwa, 400kV Rajgarh, 400kV Champa, 400/220kV Itarsi & 400/220kV Jabalpur substations

Section -3 of Technical Specification**Doc No. TB-408-316-S03, Rev.0**

SECTION-3

PROJECT DETAILS & GENERAL SPECIFICATION

SITE INFORMATION

Sl	Particular	Details	
a)	Owner	POWERGRID	
b)	Customer	POWERGRID	
c)	Project Title	Substation package-SS19: Extension of 765kV Solapur, 765kV Aurangabad, 765kV Wardha, 400kV Khandwa, 400kV Rajgarh, 400kV Champa, 400/220kV Itarsi & 400/220kV Jabalpur substations. Under Western Region System Strengthening Scheme (WRSS-20)	
d)	Location		
SL	Name of Substation	Name of State	Nearest Rail / Road Head
1	Solapur	Maharashtra	Solapur
2	Aurangabad	Maharashtra	Aurangabad
3	Wardha	Maharashtra	Wardha
4	Khandwa	M.P.	Khandwa
5	Rajgarh	M.P	Rajgarh
6	Champa	Chhattisgarh	Champa
7	Jabalpur	M.P.	Jabalpur
8	Itarsi	M.P.	Itarsi
e)	Transport Facilities	As above	
SITE CONDITIONS			
a)	Max. ambient air temp.	50°C	
b)	Min. ambient air temp.	0°C	
c)	Max. design ambient emp.	50°C	
d)	Design reference temp.	50°C	
e)	Average Humidity	Max. 100%	
f)	Special corrosion conditions	No	

Bharat Heavy Electricals Limited

Project: Substation package-SS19: Extension of 765kV Solapur, 765kV Aurangabad, 765kV Wardha, 400kV Khandwa, 400kV Rajgarh, 400kV Champa, 400/220kV Itarsi & 400/220kV Jabalpur substations

Section -3 of Technical Specification**Doc No. TB-408-316-S03, Rev.0**

g)	Solar Radiation	1.2kW/sqmtr																											
h)	Atmospheric UV radiation	High																											
i)	Altitude above sea level	Less than 1000meter																											
j)	Pollution Severity	Normal Pollution level																											
k)	Seismic Zone	As per the seismic zone defined in the relevant BIS / IEC-62271-300 but not less than 0.3g horrizontal																											
WIND DATA																													
	Wind velocity	As per IS																											
	Average No. of thunderstorm days per annum	As per IS																											
	Main Electrical Parameters:																												
	Fault Levels:																												
<table><tr><th>SL</th><th>Name of Substation</th><th>Fault level</th></tr><tr><td>1</td><td>765kV Solapur</td><td>40kA for 1sec</td></tr><tr><td>2</td><td>765kV Aurangabad</td><td>40kA for 1sec</td></tr><tr><td>3</td><td>765kV Wardha</td><td>40kA for 1sec</td></tr><tr><td>4</td><td>400kV Khandwa</td><td>40kA for 1sec</td></tr><tr><td>5</td><td>400kV Rajgarh</td><td>40kA for 1sec</td></tr><tr><td>6</td><td>400kV Champa</td><td>50kA for 1sec</td></tr><tr><td>7</td><td>400/220kV Jabalpur</td><td>40kA for 1sec</td></tr><tr><td>8</td><td>400/220kV Itarsi</td><td>40kA for 1sec</td></tr></table>			SL	Name of Substation	Fault level	1	765kV Solapur	40kA for 1sec	2	765kV Aurangabad	40kA for 1sec	3	765kV Wardha	40kA for 1sec	4	400kV Khandwa	40kA for 1sec	5	400kV Rajgarh	40kA for 1sec	6	400kV Champa	50kA for 1sec	7	400/220kV Jabalpur	40kA for 1sec	8	400/220kV Itarsi	40kA for 1sec
SL	Name of Substation	Fault level																											
1	765kV Solapur	40kA for 1sec																											
2	765kV Aurangabad	40kA for 1sec																											
3	765kV Wardha	40kA for 1sec																											
4	400kV Khandwa	40kA for 1sec																											
5	400kV Rajgarh	40kA for 1sec																											
6	400kV Champa	50kA for 1sec																											
7	400/220kV Jabalpur	40kA for 1sec																											
8	400/220kV Itarsi	40kA for 1sec																											
	Minimum Creepage Distance	25mm/kV for all equipments i.e. BPI / Bushing, CB, Isolator, CT, CVT, LA, NCT etc. 31mm/kV. For string insulators																											

ENCLOSED – “SECTION-GTR (GENERAL TECHNICAL REQUIREMENT) REV.14”
FOR DETAILS OF GENERAL TECHNICAL SPECIFICATION.

PLEASE READ TERMINOLOGY AS FOLLOWS -

1. Read "GTR" as "Section-3 of technical specification"
2. Read "Powergrid" as "BHEL/Powergrid".
3. Read "Employer" as "Powergrid".
4. Read "Contractor" as bidder

SECTION- GENERAL TECHNICAL REQUIREMENT (GTR)

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Annexure-I	Standard Drawing for open platform	1 sheet
Annexure- C1 Corona and Radio Interference Voltage (RIV) Test - 2 SHEET		

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

1.0 FOREWORD

The provisions under this section are intended to supplement requirements for the materials, equipments and services covered under other sections of tender documents and are not exclusive.

2.0 GENERAL REQUIREMENT

2.1 The contractor shall furnish catalogues, engineering data, technical information, design documents, drawings etc., fully in conformity with the technical specification during detailed engineering.

2.2 It is recognised that the Contractor may have standardised on the use of certain components, materials, processes or procedures different from those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered provided such proposals meet the specified designs, standard and performance requirements and are acceptable to Employer.

2.3 Wherever a material or article is specified or defined by the name of a particular brand, Manufacturer or Vendor, the specific name mentioned shall be understood as establishing type, function and quality and not as limiting competition.

2.4 Equipment furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or needed for erection, completion and safe operation of the equipment as required by applicable codes though they may not have been specifically detailed in the Technical Specifications unless included in the list of exclusions. Materials and components which are minor in nature and incidental to the requirement but not specifically stated in the specification and bid price schedule, which are necessary for commissioning and satisfactory operation of the switchyard/ substation unless specifically excluded shall be deemed to be included in the scope of the specification and shall be supplied without any extra cost. All similar standard components/parts of similar standard equipment provided, shall be inter-changeable with one another.

~~2.5 The Contractor shall also be responsible for the overall co-ordination with internal /external agencies; Supplier of Employer's supplied equipments, project management, training of Employer's manpower, loading, unloading, handling, insurance, moving to final destination for successful erection, testing and commissioning of the substation /switchyard.~~

~~2.6 The bidder shall be responsible for safety of human and equipment during the working. It will be the responsibility of the Contractor to co-ordinate and obtain Electrical Inspector's clearance before commissioning. Any additional items, modification due to observation of such statutory authorities shall be provided by the Contractor at no extra cost to the Employer.~~

3.0 STANDARDS

3.1 The works covered by the specification shall be designed, engineered, manufactured, built, tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of India.

3.2 The equipment to be furnished under this specification shall conform to latest issue with all amendments (as on the originally scheduled date of bid opening) of standard specified under Annexure-C of this section, unless specifically mentioned in the specification.

3.3 The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to compliment each other.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

- 3.4 The Contractor shall also note that list of standards presented in this specification is not complete. Whenever necessary the list of standards shall be considered in conjunction with specific IS/IEC.
- 3.5 When the specific requirements stipulated in the specifications exceed or differ than those required by the applicable standards, the stipulation of the specification shall take precedence.
- 3.6 Other internationally accepted standards which ensure equivalent or better performance than that specified in the standards specified under Annexure-C/individual sections for various equipments shall also, be accepted, however the salient points of difference shall be clearly brought out during detailed engineering along with English language version of such standard. The equipment conforming to standards other than specified under Annexure-C/individual sections for various equipments shall be subject to Employer's approval.

4.0 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED

- 4.1 The 800kV and 420kV system is being designed to limit the switching surge over voltage of 1.9 p.u. and 2.5 p.u., respectively and the power frequency over voltage of 1.4 p.u. and 1.5 p.u., respectively. In case of the 420kV system, the initial value of the temporary overvoltages could be 2.0 p.u. for 1-2 cycles. The equipment furnished under this specification shall perform all its functions and operate satisfactorily without showing undue strain, restrike etc under such over voltage conditions.
- 4.2 All equipments shall also perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation.
- 4.3 All equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, ice & snow, (wherever applicable) short circuit etc for the equipment.
- 4.4 The bidder shall design terminal connectors of the equipment taking into account various forces that are required to withstand.
- 4.5 The equipment shall also comply to the following:
- a) To facilitate erection of equipment, all items to be assembled at site shall be "match marked".
 - b) All piping, if any between equipment control cabinet/operating mechanism to marshalling box of the equipment, shall bear proper identification to facilitate the connection at site.

4.6 System Parameter

765kV, 400kV & 220kV System

SL No	Description of parameters	765kV System	400kV System	220kV System
1.	System operating voltage	765kV	400kV	220kV
2.	Maximum operating voltage of the system (rms)	800kV	420kV	245kV
3.	Rated frequency	50HZ	50Hz	50Hz
4.	No. of phase	3	3	3
5.	Rated Insulation levels			

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

SL No	Description of parameters	765kV System	400kV System	220kV System
i)	Full wave impulse withstand voltage (1.2/50 microsec.)	2100kVp	1550kVp	1050 kVp
ii)	Switching impulse withstand voltage (250/2500 micro sec.) dry and wet	1550kVp	1050kVp	-
iii)	One minute power frequency dry withstand voltage (rms)	830kV	630kV	-
iv)	One minute power frequency dry and wet withstand voltage (rms)	-	-	460kV
6.	Corona extinction voltage	508 kV	320kV	-
7.	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz	2500 μV at 508 kV rms	1000 μV at 266kV rms	1000 μV at 156kV rms
8.	Minimum creepage distance - for Equipment other than Insulator string	20000 mm (24800 mm for coastal area)	10500 mm (13020 mm for coastal area)	6125 mm (7595 mm for coastal area)
	Minimum creepage distance - for Insulator String	As specified in Section-Switchyard Erection		
9.	Min. clearances			
i.	Phase to phase	7600mm (for conductor-conductor configuration) 9400mm (for rod-conductor configuration)	4000mm (for conductor-conductor configuration) 4200mm (for rod -conductor configuration)	2100 mm
ii.	Phase to earth	4900mm (for conductor-structure) 6400mm (for rod- structure)	3500 mm	2100 mm
iii)	Sectional clearances	10300 mm	6500 mm	5000 mm
10.	Rated short circuit current for 1 sec. duration	40kA/50kA (as applicable)	40kA/50kA/ 63 kA (as applicable)	40kA/ 50kA(as applicable)
11.	System neutral earthing	Effectively earthed	Effectively earthed	Effectively earthed

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

132kV, 66kV, 33kV & 11kV System

SL No	Description of parameters	132 kV System	66kV System	33 kV System	11kV System
1.	System operating voltage	132kV	66kV	33kV	11kV
2.	Maximum operating voltage of the system(rms)	145kV	72.5kV	36kV	12kV
3.	Rated frequency	50Hz	50Hz	50Hz	50Hz
4.	No. of phase	3	3	3	3
5.	Rated Insulation levels				
i)	Full wave impulse withstand voltage (1.2/50 microsec.)	650 kVp	325 kVp	170 kVp	75 kVp
ii)	One minute power frequency dry and wet withstand voltage (rms)	275kV	140kV	70kV	28kV
6.	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz	500 μ V at 92kV rms	-	-	-
7.	Minimum creepage distance	3625 mm (4495mm for coastal area)	1813 mm (2248mm for coastal area)	900 mm (1116mm for coastal area)	300 mm (372mm for coastal area)
8.	Min. clearances				
i.	Phase to phase	1300 mm	750 mm	320 mm	280 mm
ii.	Phase to earth	1300 mm	630 mm	320 mm	140 mm
iii.	Sectional clearances	4000 mm	3000 mm	2800 mm	2800 mm
9.	Rated short circuit current	40kA/ 31.5 kA (as applicable) for 1 sec	31.5 kA for 3 sec	25 kA for 3 sec	25 kA for 3 sec
10.	System neutral earthing	Effectively earthed	Effectively earthed	Effectively earthed	Effectively earthed

Notes:

1. The above parameters are applicable for installations up to an altitude of 1000m above mean sea level. For altitude exceeding 1000m, necessary altitude correction factor shall be applicable as per relevant IEC.
2. The insulation and RIV levels of the equipments shall be as per values given in the Technical Specification of respective equipment.
3. Corona and radio interference voltage test and seismic withstand test procedures for equipments shall be in line with the procedure given at **Annexure-A** and **Annexure-B** respectively.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

5.0 ENGINEERING DATA AND DRAWINGS

5.1 The list of drawings/documents which are to be submitted to the Employer is enclosed in **Annexure-E**. In case any additional drawings/documents are required, the same shall also be submitted during execution of the contract.

5.2 The Contractor shall submit 4 (four) sets of drawings/ design documents /data / detailed bill of quantity and 1 (one) set of test reports for the approval of the Employer. The contractor shall also submit the softcopy of the above documents in addition to hardcopy.

5.3 Drawings

5.3.1 All drawings submitted by the Contractor shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, dimensions, internal & the external connections, fixing arrangement required and any other information specifically requested in the specifications.

5.3.2 Drawings submitted by the Contractor shall be clearly marked with the name of the Employer, the unit designation, the specifications title, the specification number and the name of the Project. POWERGRID has standardized a large number of drawings/documents of various make including type test reports which can be used for all projects having similar requirements and in such cases no project specific approval (except for list of applicable drawings alongwith type test reports) is required. However, distribution copies of standard drawings/documents shall be submitted as per provision of the contract. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in SI units.

5.3.3 The review of these data by the Employer will cover only general conformance of the data to the specifications and documents, interfaces with the equipment provided under the specifications, external connections and of the dimensions which might affect substation layout. This review by the Employer may not indicate a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. This review and/or approval by the Employer shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and documents.

5.5 All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at the Contractor's risk. The Contractor may make any changes in the design which are necessary to make the equipment conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Employer. Approval of Contractor's drawing or work by the Employer shall not relieve the contractor of any of his responsibilities and liabilities under the Contract.

5.6 All engineering data submitted by the Contractor after final process including review and approval by the Employer shall form part of the Contract Document and the entire works performed under these specifications shall be performed in strict conformity, unless otherwise expressly requested by the Employer in Writing.

5.7 Approval Procedure

The following schedule shall be followed generally for approval and for providing final documentation.

- | | | |
|----|--|--------------------|
| i) | Approval/comments/
by Employer on initial
submission | As per L2 schedule |
|----|--|--------------------|

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

ii)	Resubmission (whenever required)	Within 3 (three) weeks from date of comments
iii)	Approval or comments	Within 3 (three) weeks of receipt of resubmission.
iv)	Furnishing of distribution copies (2 hard copies to each substation and one scanned copy (pdf format)	2 weeks from the date of approval
v)	Furnishing of distribution copies of test reports	
	(a) Type test reports (one scanned softcopy in pdf format to each substation plus one for corporate centre & one hardcopy per substation)	2 weeks from the date of final approval
	(b) Routine Test Reports (one copy for each substation)	-do-
vi)	Furnishing of instruction/ operation manuals (2 copies per substation and one softcopy (pdf format) for corporate centre & per substation)	On completion of Engineering
(vii)	As built drawings (two sets of hardcopy per substation & one softcopy (pdf format) for corporate centre & per substation)	On completion of entire works

NOTE :

- (1) The contractor may please note that all resubmissions must incorporate all comments given in the earlier submission by the Employer or adequate justification for not incorporating the same must be submitted failing which the submission of documents is likely to be returned.
- (2) All drawings should be submitted in softcopy form, however substation design drawings like SLD, GA, all layouts etc. shall also be submitted in AutoCAD Version. SLD, GA & layout drawings shall be submitted for the entire substation in case of substation extension also.
- (3) The instruction Manuals shall contain full details of drawings of all equipment being supplied under this contract, their exploded diagrams with complete instructions for storage, handling, erection, commissioning, testing, operation, trouble shooting, servicing and overhauling procedures.
- (4) If after the commissioning and initial operation of the substation, the instruction manuals require any modifications/additions/changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the Contractor to the Employer.
- (5) The Contractor shall furnish to the Employer catalogues of spare parts.
- (6) All As-built drawings/documents shall be certified by site indicating the changes before final submission.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

5.8 The list of major drawings/documents to be approved to qualify for second advance as per Section SCC, shall be as per **Annexure-D**.

6.0 MATERIAL/ WORKMANSHIP

6.1 General Requirement

6.1.1 Where the specification does not contain references to workmanship, equipment, materials and components of the covered equipment, it is essential that the same must be new, of highest grade of the best quality of their kind, conforming to best engineering practice and suitable for the purpose for which they are intended.

6.1.2 In case where the equipment, materials or components are indicated in the specification as “similar” to any special standard, the Employer shall decide upon the question of similarity. When required by the specification or when required by the Employer the Contractor shall submit, for approval, all the information concerning the materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it is to be understood that the cost as well as the time delay associated with the rejection shall be borne by the Contractor.

6.1.3 The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety, subject to mutual agreements. All joints and fastenings shall be devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfill their required function. In general, screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the Employer.

6.1.4 Whenever possible, all similar part of the Works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall also be interchangeable and shall be made of the same materials and workmanship as the corresponding parts of the Equipment supplied under the Specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.

6.1.5 All materials and equipment shall be installed in strict accordance with the manufacturer’s recommendation(s). Only first-class work in accordance with the best modern practices will be accepted. Installation shall be considered as being the erection of equipment at its permanent location. This, unless otherwise specified, shall include unpacking, cleaning and lifting into position, grouting, levelling, aligning, coupling of or bolting down to previously installed equipment bases/foundations, performing the alignment check and final adjustment prior to initial operation, testing and commissioning in accordance with the manufacturer’s tolerances, instructions and the Specification. All factory assembled rotating machinery shall be checked for alignment and adjustments made as necessary to re-establish the manufacturer’s limits suitable guards shall be provided for the protection of personnel on all exposed rotating and / or moving machine parts and shall be designed for easy installation and removal for maintenance purposes. The spare equipment(s) shall be installed at designated locations and tested for healthiness.

6.1.6 The Contractor shall apply oil and grease of the proper specification to suit the machinery, as is necessary for the installation of the equipment. Lubricants used for installation purposes shall be drained out and the system flushed through where necessary for applying the lubricant required for operation. The Contractor shall apply all operational lubricants to the equipment installed by him.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

- 6.1.7 All oil, grease and other consumables used in the Works/Equipment shall be purchased in India unless the Contractor has any special requirement for the specific application of a type of oil or grease not available in India. If such is the case, he shall declare in the proposal, where such oil or grease is available. He shall help Employer in establishing equivalent Indian make and Indian Contractor. The same shall be applicable to other consumables too.

6.2 Provisions For Exposure to Hot and Humid climate

Outdoor equipment supplied under the specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity, heavy rainfall and environment favourable to the growth of fungi and mildew. The indoor equipments located in non-air conditioned areas shall also be of same type.

6.2.1 Space Heaters

- 6.2.1.1 The heaters shall be suitable for continuous operation at 240V as supply voltage. On-off switch and fuse shall be provided.

- 6.2.1.2 One or more adequately rated thermostatically connected heaters shall be supplied to prevent condensation in any compartment. The heaters shall be installed in the compartment and electrical connections shall be made sufficiently away from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.

6.2.2 FUNGI STATIC VARNISH

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on parts which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

6.2.3 Ventilation opening

Wherever ventilation is provided, the compartments shall have ventilation openings with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust.

6.2.4 Degree of Protection

The enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc. to be installed shall comply with following degree of protection as detailed here under:

- a) Installed out door: IP- 55
- b) Installed indoor in air conditioned area: IP-31
- c) Installed in covered area: IP-52
- d) Installed indoor in non-air conditioned area where possibility of entry of water is limited: IP-41.
- e) For LT Switchgear (AC & DC distribution Boards): IP-52

The degree of protection shall be in accordance with IS:13947 (Part-I)/IEC-60947 (Part-I)/IS 12063/IEC-60529. Type test report for IP-55 or higher degree of protection test, shall be submitted for approval.

6.3 RATING PLATES, NAME PLATES AND LABELS

- 6.3.1 Each main and auxiliary item of substation is to have permanently attached to it in a conspicuous position a rating plate of non-corrosive material upon which is to be engraved manufacturer's name, year of manufacture, equipment name, type or serial

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number together with details of the loading conditions under which the item of substation in question has been designed to operate, and such diagram plates as may be required by the Employer. The rating plate of each equipment shall be according to IEC requirement.

- 6.3.2 All such nameplates, instruction plates, rating plates of transformers, reactors, CB, CT, CVT, SA, Isolators, C & R panels and PLCC equipments shall be bilingual with Hindi inscription first followed by English. Alternatively two separate plates one with Hindi and the other with English inscriptions may be provided.

6.4 FIRST FILL OF CONSUMABLES, OIL AND LUBRICANTS

All the first fill of consumables such as oils, lubricants, filling compounds, touch up paints, soldering/brazing material for all copper piping of circuit breakers and essential chemicals etc. which will be required to put the equipment covered under the scope of the specifications, into operation, shall be furnished by the Contractor unless specifically excluded under the exclusions in these specifications and documents.

7.0 DESIGN IMPROVEMENTS / COORDINATION

- 7.1 The bidder shall offer the equipment meeting the requirement of the technical specification. However, the Employer or the Contractor may propose changes in the specification of the equipment or quality thereof and if the contractor & Employer agree upon any such changes, the specification shall be modified accordingly.
- 7.2 If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any change in the price and/or schedule of completion before the Contractor proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.
- 7.3 The Contractor shall be responsible for the selection and design of appropriate equipments to provide the best co-ordinated performance of the entire system. The basic design requirements are detailed out in this Specification. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.
- 7.4 The Contractor has to coordinate designs and terminations with the agencies (if any) who are Consultants/Contractor for the Employer. The names of agencies shall be intimated to the successful bidders.
- 7.5 The Contractor will be called upon to attend design co-ordination meetings with the Engineer, other Contractor's and the Consultants of the Employer (if any) during the period of Contract. The Contractor shall attend such meetings at his own cost at POWERGRID Corporate Centre, Gurgaon (Haryana) or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

8.0 QUALITY ASSURANCE PROGRAMME

- 8.1 To ensure that the equipment and services under the scope of this Contract, whether manufactured or performed within the Contractor's Works or at his Sub-Contractor's premises or at the Employer's site or at any other place of Work as applicable, are in accordance with the specifications, the Contractor shall ensure suitable quality assurance programme to control such activities at all points necessary. A quality assurance programme of the Contractor shall be in line with ISO requirements & shall generally cover the following:
- a) The organisation structure for the management and implementation of the proposed quality assurance programme.

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- b) System for Document and Data Control.
- c) Qualification and Experience data of Bidder's key personnel.
- d) The procedure for purchases of materials, parts, components and selection of sub-Contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
- e) System for shop manufacturing and site erection controls including process controls, fabrication and assembly control.
- f) System for Control of non-conforming products including deviation dispositioning, if any and system for corrective and preventive actions based on the feedback received from the Customers and also internally documented system for Customer complaints.
- g) Inspection and test procedure both for manufacture and field activities.
- h) System for Control of calibration of testing and measuring equipment and the indication of calibration status on the instruments.
- i) System for indication and appraisal of inspection status.
- j) System of Internal Quality Audits, Management review and initiation of corrective and Preventive actions based on the above.
- k) System for authorising release of manufactured product to the Employer.
- l) System for maintenance of records.
- m) System for handling, storage and delivery.
- n) A quality plan detailing out the specific quality control measures and procedure adopted for controlling the quality characteristics relevant to each item of equipment furnished and /or service rendered.
- o) System for various field activities i.e. unloading, receipt at site, proper storage, erection, testing and commissioning of various equipment and maintenance of records. In this regard, the Employer has already prepared Standard Field Quality Plan for transmission line/substation equipments as applicable, Civil/erection Works which is required to be followed for associated works.

The Employer or his duly authorised representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Contractor/his vendor's quality management and control activities.

8.2 Quality Assurance Documents

The Contractor shall ensure availability of the following Quality Assurance Documents:

- i) All Non-Destructive Examination procedures, stress relief and weld repair procedure actually used during fabrication, and reports including radiography interpretation reports.
- ii) Welder and welding operator qualification certificates.
- iii) Welder's identification list, welding operator's qualification procedure and welding identification symbols.
- iv) Raw Material test reports on components as specified by the specification and in the quality plan.

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- v) The Manufacturing Quality Plan(MQP) indicating Customer Inspection Points (CIPs) at various stages of manufacturing and methods used to verify that the inspection and testing points in the quality plan were performed satisfactorily.
- vi) Factory test results for testing required as per applicable quality plan/technical specifications/GTP/Drawings etc.
- vii) Stress relief time temperature charts/oil impregnation time temperature charts, wherever applicable.

8.3 INSPECTION, TESTING & INSPECTION CERTIFICATE

- 8.3.1 Contractor shall procure bought out items from sub-vendors as per the list in "Compendium of Vendors" available on POWERGRID web-site www.powergridindia.com after ensuring compliance to the requirements/conditions mentioned therein. Contractor shall explore first the possibilities of procuring the bought out items from POWERGRID approved existing vendors. In case of their unavailability / non-response, Contractor may approach POWERGRID for additional sub-vendor approval. In that case, the assessment report of proposed sub vendor by Contractor along with the enclosures as per **Annexure-F** shall be submitted within 60 days of the award. The proposal shall be reviewed and approval will be accorded based on the verification of the document submitted and/or after the physical assessment of the works as the case may be. The physical assessment conducted by POWERGRID, if required, shall be on chargeable basis. Charges shall be as per the POWERGRID norms prevailing at that time, which shall be intimated by POWERGRID separately. If proposal for sub-vendor is submitted after 60 days, the Contractor's proposal normally will not be considered for current LOA. However, POWERGRID may process the case for developing more vendors for referred items, if found relevant. In all cases, It is the responsibility of the Contractor that Project activities do not suffer on account of delay in approval/non approval of a new sub-vendor.

The responsibility and the basis of inspection for various items & equipment is placed at **Annexure-G** along with the requirement of MQP (Manufacturing Quality Plan), ITP(Inspection & Test Plan), FAT(Factory Acceptance Test) which should be valid & POWERGRID approved and Level of inspection envisaged against each item.

Contractor shall ensure that order for items where MQP/ITP/FAT is required will be placed only on vendors having valid MQP/ITP/FAT and where the supplier's MQP/ITP/FAT is either not valid or has not been approved by POWERGRID, MQP shall be generally submitted as per POWERGRID format before placing order.

Items not covered under MQP/ITP/FAT shall be offered for inspection as per POWERGRID LOA/technical Specifications/POWERGRID approved data sheets/ POWERGRID approved drawings and relevant Indian/International standards.

Inspection Levels: For implementation of projects in a time bound manner and to avoid any delay in deputation of POWERGRID or its authorized representative, involvement of POWERGRID for inspection of various items / equipment will be based on the level below:

- Level -I:** Contractor to raise all inspection calls and review the report of tests carried out by the manufacturer, on his own, as per applicable standards/ POWERGRID specification, and submit to concerned POWERGRID inspection office/Inspection Engineer. CIP/MICC will be issued by POWERGRID based on review of test reports/certificates of manufacturers.

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Level – II: Contractor to raise all inspection calls and carry out the inspection on behalf of POWERGRID on the proposed date of inspection as per applicable standards/specification. However, in case POWERGRID wishes to associate itself during inspection, the same would be intimated to Contractor and CIP/MICC will be issued by POWERGRID. Else, Contractor would submit their test reports/certificates to POWERGRID. CIP/MICC will be issued by POWERGRID based on review of test reports/certificates.

Level - III: Contractor to raise inspection calls for both, stage (as applicable) & final inspection and carry out the stage inspections (if applicable) on behalf of POWERGRID on the proposed date of inspection as per applicable standards/specification. However, in case POWERGRID wishes to associate itself during stage inspection, the same would be intimated to Contractor and CIP will be issued by POWERGRID. Else, Contractor would submit the test reports / certificates of stage inspection after their own review and CIP will be issued by POWERGRID based on review of test reports / certificates. Final inspection will be carried out by POWERGRID and CIP/MICC will be issued by POWERGRID.

Level – IV: Contractor to raise inspection calls for both, stage (as applicable) & final inspections. POWERGRID will carry out the inspection for both stage & final inspection as per applicable standards/specification and CIP/MICC will be issued by POWERGRID.

- 8.3.2 Contractor shall ensure that to implement the above inspection levels, particularly for the quality control and inspection at sub-vendor's works, they would depute sufficient qualified & experienced manpower in their Quality Control and Inspection department. Further, to assure quality of construction, Contractor shall have a separate workforce having appropriate qualification & experience and deploy suitable tools and plant for maintaining quality requirement during construction in line with applicable Field Quality Plan (FQP).
- 8.3.3 The Employer, his duly authorised representative and/or outside inspection agency acting on behalf of the Employer shall have at all reasonable times access to the Contractor's premises or Works and shall have the power at all reasonable times to ensure that proper Quality Management practices / norms are adhered to, inspect and examine the materials & workmanship of the Works, to carry out Quality/Surveillance Audit during manufacture or erection and if part of the Works is being manufactured or assembled at other premises or works. The Contractor shall obtain for the Employer and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. The item/equipment, if found unsatisfactory with respect to workmanship or material is liable to be rejected. The observations for improvements during product/ process inspection by POWERGRID shall be recorded in Quality Improvement Register (available & maintained at works) for review & timely compliance of observations.
- 8.3.4 Contractor shall submit inspection calls over internet through POWERGRID website. The required vendor code and password to enable raising inspection call will be furnished to the main Contractor within 30 days of award of contract on submission of documents by Contractor. After raising the inspection calls, Contractor shall then proceed as per the message of that particular call which is available on the message board.
- 8.3.5 The Employer reserves the right to witness any or all type, acceptance and routine tests specified for which the Contractor shall give the Employer/Inspector Twenty one (21) days written notice of any material being ready for testing for each stage of

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testing as identified in the approved quality plan as customer inspection point(CIP) for indigenous inspections. All inspection calls for overseas material shall be given at least forty five (45) days in advance. Such tests shall be to the Contractor's account except for the expenses of the Inspection Engineer. The Employer/inspector, unless witnessing of the tests is waived by Employer, will attend such tests within Twenty one (21) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed with the test which shall be deemed to have been made in the Inspector's presence and he shall forthwith forward to the Inspector three copies of tests, duly certified. Contractor shall ensure, before giving notice for type test, that all drawings and quality plans have been got approved. The equipment shall be dispatched to site only after approval of Routine and Acceptance test results and Issuance of Dispatch Clearance in writing by the Employer. CIP/Material Inspection clearance certificate (MICC) shall be issued by the Employer after inspection of the equipment or review of test reports as applicable. Employer may waive off the presence of Employer's inspecting engineer. In that case test will be carried out as per approved QP and test certificate will be furnished by the supplier for approval. CIP/MICC will be issued only after review and approval of the test reports.

- 8.3.6 Contractor shall generally offer material for inspection as per supply bar chart approved by POWERGRID and not before 30 days from schedule indicated in the bar chart. In case Contractor offers material(s) for inspection prior to 30 days from the scheduled date with necessary approval of POWERGRID, POWERGRID shall inspect the material and issue CIP only. However, in such an exceptional case, MICC shall be issued only as per provision of original / revised approved supply schedule.
- 8.3.7 Contractor shall minimize the number of inspection calls by offering optimum quantities in each inspection call at the respective manufacturer's works.
- 8.3.8 Contractor shall inspect the material themselves and only after they are fully convinced about the Quality, they shall offer the material for POWERGRID inspection and shall also ensure that relevant portion of LOA/NOA, approved drawing and data sheets along with applicable Quality Plans are available at the works of Contractor or their Sub-vendor before the material is offered for inspection.
- 8.3.9 Contractor shall ensure that material which has been cleared for dispatch after inspection will be dispatched within 30 days in case of domestic supplies and within 60 days in case of Off-shore supplies from the date of issuance of CIP. Material which is not dispatched within stipulated time as above will be reoffered for POWERGRID inspection or specific approval of POWERGRID QA&I shall be obtained for delayed dispatch.
- 8.3.10 The Employer or IE shall give notice in writing to the Contractor, of any objection either to conformance to any drawings or to any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and shall either make the modifications that may be necessary to meet the said objections or shall confirm in writing to the Employer/Inspection Engineer giving reasons therein, that no modifications are necessary to comply with the Contract.
- 8.3.11 All Test Reports and documents to be submitted in English during final inspection of equipment by POWERGRID or as and when required for submission.
- 8.3.12 When the factory tests have been completed at the Contractor's or Sub-Contractor's works, the Employer/Inspection Engineer(IE) shall issue a certificate to this effect within fifteen (15) days after completion of tests & submission of documents by Contractor/manufacturer but if the tests are not witnessed by the Employer/IE, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Employer/IE. Contractor shall, on completion of all tests, submit test

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reports within Ten (10) days to POWERGRID IE. Failure of the Employer/IE to issue such a certificate shall not prevent the Contractor from proceeding with the Works. The completion of these tests or the issue of the certificate shall not bind the Employer to accept the equipment should, it, on further tests after erection, be found not to comply with the Contract.

- 8.3.13 In all cases, where the Contract provides for tests whether at the premises or works of the Contractor or of any Sub- Contractor, the Contractor, except where otherwise specified, shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Employer/Inspector or his authorised representative to carry out effectively such tests of the equipment in accordance with the Contract and shall give facilities to the Employer/Inspection Engineer or to his authorised representative to accomplish testing.
- 8.3.14 The inspection and acceptance by Employer and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the Contract, or if such equipment is found to be defective at a later stage.
- 8.3.15 The Employer will have the right of having at his own expenses any other test(s) of reasonable nature carried out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests, to satisfy that the material comply with the specification.
- 8.3.16 The Employer reserves the right for getting any additional field tests conducted on the completely assembled equipment at site to satisfy that material complies with specifications.
- 8.3.17 Rework/ Re-engineering, if any, on any item/equipment shall be carried out only after mutual discussions and in accordance with mutually agreed procedure. Contractor shall submit Joint Inspection Report of equipments under Re-Work/Re-Engineering alongwith procedure for the same to POWERGRID for approval, before taking up the Re-Work/Re-Engineering, failing which POWERGRID reserves the right to reject the equipment.
- 8.3.18 Contractor may establish a field test Laboratory to execute Civil Construction testing requirements at site with the condition that all testing equipment shall be calibrated from POWERGRID approved accredited Testing laboratories, with calibration certificates kept available at site and all testing personnel employed in the Field Testing Laboratories to be qualified and experienced Engineers or testing to be carried out at POWERGRID approved Third Party Laboratories.
- 8.3.19 Contractor shall ensure that all possible steps are taken to avoid damages to the equipment during transport, storage and erection.
- 8.3.20 Contractor shall implement additional stringent quality checks and preparation during installation of GIS at site (if applicable) as per POWERGRID approved guidelines/Technical specifications.
- 8.3.21 Contractor shall ensure commissioning of all CSDs along with Circuit Breakers wherever applicable.
- 8.3.22 For EHV transformers/reactors:**
- Insulation oil shall be as per POWERGRID Technical specifications and same grade shall be used for impregnation of the active part & testing at the works of Transformer/Reactor Manufacturer and as well as for filling the Transformer/Reactors at site. Contractor to ensure that windings for Transformer/Reactors are made in air-conditioned environment. Core-coil assembly shall be performed in positive

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pressurized dust controlled environment. Dust measurements shall be monitored regularly at Transformer / Reactor Manufacturer works. Contractor shall ensure that respective civil foundations & Fire walls for Transformer/Reactors units to be commissioned, shall be made ready at concerned sites before receipt of Transformer/Reactors units. All the requisite material for Neutral & Delta Bus formation required for charging of complete bank of 765KV class 1-ph Transformer/Reactor units shall be made available at the concerned sites before receipt of the Transformer/Reactor units at site.

- 8.3.23 The Employer reserves the right to increase or decrease their involvement in inspections at Contractor's Works or at his Sub-Contractor's premises or at the Employer's site or at any other place of Work based on performance of Contractor/sub-Contractor.

9.0 TYPE TESTING & CLEARANCE CERTIFICATE

- 9.1 All equipment being supplied shall conform to type tests as per technical specification and shall be subject to routine tests in accordance with requirements stipulated under respective sections.

- 9.2 The reports for all type tests as per technical specification shall be furnished by the Contractor alongwith equipment / material drawings. However, type test reports of similar equipments/ material already accepted in POWERGRID shall be applicable for all projects with similar requirement. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited based on ISO / IEC Guide 25 / 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by POWERGRID or representative authorized by POWERGRID or Utility or representative of accredited test lab.

Unless otherwise specified elsewhere, the type test reports submitted shall be of the tests conducted within last 10 (ten) years from the date of NOA. In case the test reports are of the test conducted earlier than 10 (ten) years from the date of NOA, the contractor shall repeat these test(s) at no extra cost to the Employer.

Further, in the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design/manufacturing changes or due to non-compliance with the requirement stipulated in the Technical Specification or any/all type tests not carried out, same shall be carried out without any additional cost implication to the Employer.

The Contractor shall intimate the Employer the detailed program about the type tests atleast two (2) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies.

- 9.3 The Employer intends to repeat those type tests which are indicated in the price schedule and the same shall be payable as per provision of contract. The price of conducting type tests shall be included in Bid price and break up of these shall be given in the relevant schedule of Bid Proposal Sheets. These Type test charges would be considered in bid evaluation. In case Bidder does not indicate charges for any of the type tests or does not mention the name of any test in the price schedules, it will be presumed that the particular test has been offered free of charge. Further, in case any Bidder indicates that he shall not carry out a particular test, his offer shall be considered incomplete and shall be liable to be rejected. The Employer reserves the right to waive the repeating of type tests partly or fully and in case of waiver, test charges for the same shall not be payable.

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9.4 The Employer reserves the right to witness any or all the type tests. The Employer shall bear all expenses for deputation of Employer's representative(s) for witnessing the type tests.

9.5 The list of makes of various items, for which Type test reports are not required to be submitted are specified in Compendium of Vendors (COV).

10.0 TESTS

10.1 Pre-commissioning Tests

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Employer and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The list of pre-commissioning tests to be performed are given in respective chapters and shall be included in the Contractor's quality assurance programme.

10.2 Commissioning Tests

10.2.1 The available instrumentation and control equipment will to be used during such tests and the Employer will calibrate, all such measuring equipment and devices as far as practicable.

10.2.2 Any special equipment, tools and tackles required for the successful completion of the Commissioning Tests shall be arranged by the Contractor at his own cost.

10.2.3 The specific tests requirement on equipment have been brought out in the respective chapters of the technical specification.

10.3.4 PRECOMMISSIONING, COMMISSIONING, TRIAL-RUN & COMPLETION

As soon as the Facilities covered by these specifications are physically completed in all respects, the Pre commissioning, Commissioning, Trial-run and Completion of the Facilities, as mentioned below, shall be attained in accordance with the procedure given in the Conditions of Contract, Vol.-I of the Bidding Documents.

- (i) Pre commissioning : As per relevant Sections
- (ii) Commissioning : Charging of the Facilities at rated voltage.

Further, wherever appearing in these specifications, the words-'commissioning checks', 'installation checks', 'site tests', 'performance guarantee tests for fire protection system', are to be considered as 'pre commissioning checks'.

- (iii) Trial-run : Operation of the Facilities or any part thereof by the Contractor immediately after the Commissioning for a continuous period of 72 (Seventy two) hours continuously. In case of interruption due to problem/failure in the respective equipment, the contractor shall rectify the problem and after rectification, continuous 72 (Seventy two) hours period start after such rectification.

- (iv) Completion : Upon successful completion of Trial-run.

'Guarantee Test(s)' and/or 'Functional Guarantees' are applicable only for Substation Automation System as specified in Section-'Substation Automation System.'

10.3. The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning the equipment and the switchyard. However necessary fee shall be reimbursed by POWERGRID on production of requisite documents.

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11.0 PACKAGING & PROTECTION

- 11.1 All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. On request of the Employer, the Contractor shall also submit packing details/associated drawing for any equipment/material under his scope of supply, to facilitate the Employer to repack any equipment/material at a later date, in case the need arises. While packing all the materials, the limitation from the point of view of availability of Railway wagon sizes in India should be taken into account. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Employer takes no responsibility of the availability of the wagons.
- 11.2 All coated surfaces shall be protected against abrasion, impact, discolouration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and pipings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.

12.0 FINISHING OF METAL SURFACES

- 12.1 All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hot-dip galvanized after fabrication. All steel conductors including those used for earthing/grounding (above ground level) shall also be galvanized according to IS: 2629.

12.2 HOT DIP GALVANISING

- 12.2.1 The minimum weight of the zinc coating shall be 610 gm/sq.m and minimum average thickness of coating shall be 86 microns for all items having thickness 6mm and above **and 900 gm/sq.m for coastal area (30km from sea shore approximately) or as specified in Section-Project.** For items lower than 6mm thickness requirement of coating thickness shall be as per relevant ASTM. For surface which shall be embedded in concrete, the zinc coating shall be 610 gm/sq.m minimum **and 900 gm/sq.m for coastal area as specified in Section-Project.**
- 12.2.2 The galvanized surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surface, flaking or peeling off, etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.
- 12.2.3 After galvanizing, no drilling or welding shall be performed on the galvanized parts of the equipment excepting that nuts may be threaded after galvanizing. Sodium dichromate or alternate approved treatment shall be provided to avoid formation of white rust after hot dip galvanization.
- 12.2.4 The galvanized steel shall be subjected to four numbers of one minute dips in copper sulphate solution as per IS-2633.
- 12.2.5 Sharp edges with radii less than 2.5 mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions. The following galvanizing tests should essentially be performed as per relevant Indian Standards.
- Coating thickness
 - Uniformity of zinc

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- Adhesion test
- Mass of zinc coating

12.2.6 Galvanised material must be transported properly to ensure that galvanised surfaces are not damaged during transit. Application of touch-up zinc rich paint at site shall be allowed with approval of Engineer Incharge.

12.3 PAINTING

12.3.1 All sheet steel work shall be degreased, pickled, phosphated in accordance with the IS-6005 "Code of practice for phosphating iron and sheet". All surfaces, which will not be easily accessible after shop assembly, shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and swaf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

12.3.2 After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be stoved.

12.3.3 After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting.

12.3.4 The exterior and interior colour of the paint in case of new substations shall preferably be RAL 7032 for all equipment, marshalling boxes, junction boxes, control cabinets, panels etc. unless specifically mentioned under respective sections of the equipments. Glossy white colour inside the equipments /boards /panels/junction boxes is also acceptable. The exterior colour for panels shall be matching with the existing panels in case of extension of a substation. Each coat of primer and finishing paint shall be of slightly different shade to enable inspection of the painting. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipments.

12.3.5 In case the contractor proposes to follow his own standard surface finish and protection procedures or any other established painting procedures, like electrostatic painting etc., the procedure shall be submitted during detailed engineering for Employer's review & approval.

12.3.6 The colour scheme as given below shall be followed for Fire Protection and Air Conditioning systems

S.No.	PIPE LINE	Base colour	Band colour
<u>Fire Protection System</u>			
1	Hydrant and Emulsifier system pipeline	FIRE RED	-
2	Emulsifier system detection line – water	FIRE RED	Sea Green
3	Emulsifier system detection line –Air	FIRE RED	Sky Blue
4	Pylon support pipes	FIRE RED	
<u>Air Conditioning Plant</u>			
5	Refrigerant gas pipeline – at compressor suction	Canary Yellow	-

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S.No.	PIPE LINE	Base colour	Band colour
6	Refrigerant gas pipeline – at compressor discharge	Canary Yellow	Red
7	Refrigerant liquid pipeline	Dark Admiralty Green	-
8	Chilled water pipeline	Sea Green	-
9	Condenser water pipeline	Sea Green	Dark Blue

The direction of flow shall be marked by → (arrow) in black colour.



Base Colour Direction of flow Band Colour

- 12.3.7 For aluminium casted surfaces, the surface shall be with smooth finish. Further, in case of aluminium enclosures, the surface shall be coated with powder (coating thickness of 60 microns) after surface preparation for painting. For stainless steel surfaces, no painting is envisaged.

13.0 HANDLING, STORING AND INSTALLATION

- 13.1 In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Employer or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented. Commercial use of switchyard equipment means completion of all site tests specified and energisation at rated voltage.
- 13.2 Contractor may engage manufacturer's Engineers to supervise the unloading, transportation to site, storing, testing and commissioning of the various equipment being procured by them separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's supervisory Engineer(s) and shall extend full cooperation to them.
- 13.3 The contractor must ensure that the open storage platform (as per Drawing No. C-ENGG-CVL-STD-PLATFORM-01, Rev.0) is constructed for storage of outdoor type equipment/material prior to commencement of delivery at site. Outdoor equipment shall be stored on open storage platform, properly covered with waterproof and dustproof covers to protect them from water seepage and moisture ingress.
- However, all indoor equipments including control & protection panels, Communication equipments and operating mechanism boxes etc. of outdoor equipments shall be stored indoors.
- Storage of equipment on top of another one is not permitted if the wooden packing is used and there is possibility of equipment/packing damage. Material opened for joint inspection shall be repacked properly as per manufacturer's recommendations.
- During storage of material regular periodic monitoring of important parameters like oil level / leakage, SF₆ / Nitrogen pressure etc. shall be ensured by the contractor.
- 13.4 In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the Employer. Contractor shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawings/instructions correctly.
- 13.5 Where assemblies are supplied in more than one section, Contractor shall make all necessary mechanical and electrical connections between sections including the connection between buses. Contractor shall also do necessary adjustments/alignments

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for proper operation of circuit breakers, isolators and their operating mechanisms. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.

- 13.6 Contractor shall be responsible for examining all the shipment and notify the Employer immediately of any damage, shortage, discrepancy etc. for the purpose of Employer's information only. The Contractor shall submit to the Employer every week a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.
- 13.7 The Contractor shall be fully responsible for the equipment/material until the same is handed over to the Employer in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over by Employer, as well as protection of the same against theft, element of nature, corrosion, damages etc.
- 13.8 Where material / equipment is unloaded by Employer before the Contractor arrives at site or even when he is at site, Employer by right can hand over the same to Contractor and there upon it will be the responsibility of Contractor to store the material in an orderly and proper manner.
- 13.9 The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment which requires indoor storage.
- 13.10 The words 'erection' and 'installation' used in the specification are synonymous.
- 13.11 Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.
- 13.12 The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance throughout the service life. If at any stage during the execution of the Contract, it is observed that the erected equipment(s) do not meet the above minimum clearances the Contractor shall immediately proceed to correct the discrepancy at his risks and cost.

13.13 Equipment Bases

A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base unless otherwise agreed to by the Employer. Each base plate shall support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have threaded drain connections.

14.0 TOOLS

14.1 TOOLS & PLANTS (T&P)

The Contractor shall arrange all T&P (such as necessary supports, cranes, ladders, platforms etc.) for erection, testing & commissioning of the system at his own cost. Further, all consumables, wastage and damages shall be to the account of contractor.

All such T&P shall be taken back by the contractor after commissioning of the system.

14.2 SPECIAL TOOLS AND TACKLES

The contractor shall supply all special tools and tackles required for Operation and maintenance of equipment. The special tools and tackles shall only cover items which

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are specifically required for the equipment offered and are proprietary in nature. The list of special tools and tackles, if any, shall be finalized during detail engineering and the same shall be supplied without any additional cost implication to the Employer.

14.3 FACILITIES TO BE PROVIDED BY THE EMPLOYER

- 14.3.1 Employer shall make available the auxiliary supplies at a single point in the substation on chargeable basis. The prevailing energy rates of the state shall be applicable. All further distribution from the same for construction supply shall be made by the contractor. However, in case of failure of power due to any unavoidable circumstances, the contractor shall make his own necessary arrangements like diesel generator sets etc. at his own cost so that progress of work is not affected and Employer shall in no case be responsible for any delay in works because of non-availability of power.
- 14.3.2 Employer shall make available construction water supply at a single point in the substation. All further distribution for the same shall be made by the Contractor. In case of non-availability or inadequate availability of water for construction work, the contractor shall make his own arrangement at his own cost and the Employer shall in no case be responsible for any delay in works because of non-availability or inadequate availability of water.

15.0 AUXILIARY SUPPLY

- 15.1 The auxiliary power for station supply, including the equipment drive, cooling system of any equipment, air-conditioning, lighting etc shall be designed for the specified Parameters as under. The DC supply for the instrumentation and PLCC system shall also conform the parameters as indicated in the following table:

Normal Voltage	Variation in Voltage	Frequency in HZ	Phase/Wire	Neutral connection
415V	± 10%	50 ± 5%	3/4 Wire	Solidly Earthed.
240V	± 10%	50 ± 5%	1/2 Wire	Solidly Earthed.
220V	190V to 240V	DC	Isolated 2 wire System	-
110V	95V to 120V	DC	Isolated 2 wire System	-
48V	--	DC	2 wire system (+) earthed	-

Combined variation of voltage and frequency shall be limited to ± 10%.

16.0 SUPPORT STRUCTURE

- 16.1 The equipment support structures shall be suitable for equipment connections at the first level i.e 14.0 meter, 8.0 meter, 5.9 meter and 4.6 meter from plinth level for 765kV, 400kV, 220kV and 132kV substations respectively. All equipment support structures shall be supplied alongwith brackets, angles, stools etc. for attaching the operating mechanism, control cabinets & marshalling box (wherever applicable) etc.
- 16.2 The minimum vertical distance from the bottom of the lowest porcelain part of the bushing, porcelain enclosures or supporting insulators to the bottom of the equipment base, where it rests on the foundation pad shall be 2.55 metres.

17.0 CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS

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- 17.1 All power clamps and connectors shall conform to IS:5561 or other equivalent international standard and shall be made of materials listed below :

Sl. No.	Description	Materials
a)	For connecting ACSR conductors/AAC conductors/ Aluminium tube	Aluminum alloy casting, conforming to designation A6 of IS:617 and all test shall conform to IS:617
b)	For connecting equipment terminals mad of copper with ACSR conductors/AAC conductors/ Aluminium tube	Bimetallic connectors made from aluminum alloy casting, conforming to designation A6 of IS:617 with 2mm thick bimetallic liner/strip and all test shall conform to IS:617
c)	For connecting G.I	Galvanised mild steel shield wire
d)	Bolts, nuts & plain washers	Electro-galvanised for sizes below M12, for others hot dip galvanised.
e)	Spring washers	Electro-galvanised mild steel suitable for atleast service condition-3 as per IS:1573

- 17.2 Necessary clamps and connectors shall be supplied for all equipment and connections. If corona rings are required to meet these requirements they shall be considered as part of that equipment and included in the scope of work.
- 17.3 Where copper to aluminum connections are required, bi-metallic clamps shall be used, which shall be properly designed to ensure that any deterioration of the connection is kept to a minimum and restricted to parts which are not current carrying or subjected to stress.
- 17.4 Low voltage connectors, grounding connectors and accessories for grounding all equipment as specified in each particular case, are also included in the scope of Work.
- 17.5 No current carrying part of any clamp shall be less than 10 mm thick. All ferrous parts shall be hot dip galvanised. Copper alloy liner/strip of minimum 2 mm thickness shall be cast integral with aluminum body or 2 mm thick bi-metallic liner/strips shall be provided for Bi-metallic clamps.
- 17.6 All casting shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.
- 17.7 Flexible connectors, braids or laminated straps made for the terminal clamps for bus posts shall be suitable for both expansion or through (fixed/sliding) type connection of IPS AL tube as required. In both the cases the clamp height (top of the mounting pad to centre line of the tube) should be same.
- 17.8 Current carrying parts (500A and above) of the clamp/connector shall be provided with minimum four numbers of bolts preferably for 132kV & above.
- 17.9 All current carrying parts shall be designed and manufactured to have minimum contact resistance.
- 17.10 Power Clamps and connectors shall be designed to control corona as per requirement.

17.11 Tests

Clamps and connectors should be type tested as per IS:5561 and shall also be subjected to routine tests as per IS:5561. Following type test reports shall be submitted for

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approval. Type test once conducted shall hold good. The requirement of test conducted within last ten years, shall not be applicable.

- i) Temperature rise test (maximum temperature rise allowed is 35°C over 50°C ambient)
- ii) Short time current test
- iii) Corona (dry) [for 400kV and above] and RIV (dry) test [for 132kV and above voltage level clamps]
- iv) Resistance test and tensile test

18.0 CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES & MARSHALLING BOXES FOR OUTDOOR EQUIPMENT

18.1 All types of boxes, cabinets etc. shall generally conform to & be tested in accordance with IS-5039/IS-8623, IEC-60439, as applicable, and the clauses given below:

18.2 Control cabinets, junction boxes, Marshalling boxes & terminal boxes shall be made of stainless steel of atleast 1.5 mm thick or aluminum enclosure of atleast 1.6 mm thick and shall be dust, water and vermin proof. Stainless steel used shall be of grade SS304 (SS316 for coastal area) or better. The box shall be properly braced to prevent wobbling. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation. In case of aluminum enclosed box the thickness of aluminum shall be such that it provides adequate rigidity and long life as comparable with sheet steel of specified thickness.

18.3 A canopy and sealing arrangements for operating rods shall be provided in marshalling boxes / Control cabinets to prevent ingress of rain water.

18.4 Cabinet/boxes shall be provided with double hinged doors with padlocking arrangements. The distance between two hinges shall be adequate to ensure uniform sealing pressure against atmosphere.

18.5 All doors, removable covers and plates shall be gasketed all around with suitably profiled EPDM/Neoprene/PU gaskets. The gasket shall be tested in accordance with approved quality plan, IS:11149 and IS:3400. Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh made of brass.

Further, the gasketing arrangement shall be such that gaskets are pasted in slots (in door fabrication/gasket itself) in order to prevent ingress of dust and moisture inside the panels so that no internal rusting occurs in panels during the operation of the equipment.

18.6 All boxes/cabinets shall be designed for the entry of cables by means of weather proof and dust-proof connections. Boxes and cabinets shall be designed with generous clearances to avoid interference between the wiring entering from below and any terminal blocks or accessories mounted within the box or cabinet. Suitable cable gland plate above the base of the marshalling kiosk/box shall be provided for this purpose along with the proper blanking plates. Necessary number of cable glands shall be supplied and fitted on this gland plate. Gland plate shall have provision for some future glands to be provided later, if required. The Nickel plated glands shall be dust proof, screw on & double compression type and made of brass. The gland shall have provision for securing armour of the cable separately and shall be provided with earthing tag. The glands shall conform to BS:6121.

18.7 A 240V, single phase, 50 Hz, 15 amp AC plug and socket shall be provided in the cabinet with ON-OFF switch for connection of hand lamps. Plug and socket shall be of industrial grade.

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- 18.8 LED based illumination of minimum 9 watts shall be provided. The switching of the fittings shall be controlled by the door switch.
- For junction boxes of smaller sizes such as lighting junction box, manual operated earth switch mechanism box etc., plug socket, heater and illumination is not required to be provided.
- 18.9 All control switches shall be of MCB/rotary switch type and Toggle/piano switches shall not be accepted.
- 18.10 Earthing of the cabinet shall be ensured by providing two separate earthing pads. The earth wire shall be terminated on to the earthing pad and secured by the use of self etching washer. Earthing of hinged door shall be done by using a separate earth wire.
- 18.11 The bay marshalling kiosks shall be provided with danger plate and a diagram showing the numbering/connection/feruling by pasting the same on the inside of the door.
- 18.12 The following routine tests alongwith the routine tests as per IS:5039 shall also be conducted:
- i) Check for wiring
 - ii) Visual and dimension check
- 18.13 The enclosure of bay marshalling kiosk, junction box, terminal box and control cabinets shall conform to IP-55 as per IS:13947 including application of 2KV rms for 1 (one) minute, insulation resistance and functional test after IP-55 test.
- 19.0 DISPOSAL OF PACKING MATERIAL & WASTE FROM CONSTRUCTION SITE**
- After completion of the work, Contractor shall dispose-off all the packing & waste materials including empty conductor drums, cable drums, wooden containers, oil drums, gas cylinders and other waste/scrapped materials from construction site at his own cost and shall make the substation area properly cleaned.
- 20.0 TERMINAL BLOCKS AND WIRING**
- 20.1 Control and instrument leads from the switchboards or from other equipment will be brought to terminal boxes or control cabinets in conduits. All interphase and external connections to equipment or to control cubicles will be made through terminal blocks.
- 20.2 Terminal blocks shall be 650V grade and have continuous rating to carry the maximum expected current on the terminals and non-breakable type. These shall be of moulded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Screw clamp, overall insulated, insertion type, rail mounted terminals can be used in place of stud type terminals. But the terminal blocks shall be non-disconnecting stud type except for the secondary junction boxes of Current Transformer and Voltage Transformer.
- 20.3 Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. The current transformer secondary leads shall also be provided with short circuiting and earthing facilities.
- 20.4 The terminal shall be such that maximum contact area is achieved when a cable is terminated. The terminal shall have a locking characteristic to prevent cable from escaping from the terminal clamp unless it is done intentionally.
- 20.5 The conducting part in contact with cable shall preferably be tinned or silver plated however Nickel plated copper or zinc plated steel shall also be acceptable.
- 20.6 The terminal blocks shall be of extensible design, multilayer terminal arrangement is not allowed in any junction box (Common MB, Individual MB, JB etc.). There should be

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sufficient space at both sides of terminals so that ferrule number of wires / TB numbers are clearly visible during wire removal or insertion.

- 20.7 The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.
- 20.8 The terminal blocks shall be fully enclosed with removable covers of transparent, non-deteriorating type plastic material. Insulating barriers shall be provided between the terminal blocks. These barriers shall not hinder the operator from carrying out the wiring without removing the barriers.
- 20.9 Unless otherwise specified terminal blocks shall be suitable for connecting the following conductors on each side.
- | | | |
|----|------------------------------------|---|
| a) | All circuits except CT/PT circuits | Minimum of two of 2.5 sq mm copper flexible. |
| b) | All CT/PT circuits | Minimum of 4 nos. of 2.5 sq mm copper flexible. |
- 20.10 The arrangements shall be in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live.
- 20.11 Atleast 20 % spare terminals shall be provided on each panel/cubicle/box and these spare terminals shall be uniformly distributed on all terminals rows.
- 20.12 There shall be a minimum clearance of 250 mm between the First/bottom row of terminal block and the associated cable gland plate for outdoor ground mounted marshalling box and the clearance between two rows of terminal blocks shall be a minimum of 150 mm.
- 20.13 The Contractor shall furnish all wire, conduits and terminals for the necessary interphase electrical connections (where applicable) as well as between phases and common terminal boxes or control cabinets. For equipments rated for 400 kV and above the wiring required in these items shall be run in metallic ducts or shielded cables in order to avoid surge overvoltages either transferred through the equipment or due to transients induced from the EHV circuits.
- 20.14 All input and output terminals of each control cubicle shall be tested for surge withstand capability in accordance with the relevant IEC Publications, in both longitudinal and transverse modes. The Contractor shall also provide all necessary filtering, surge protection, interface relays and any other measures necessary to achieve an impulse withstand level at the cable interfaces of the equipment.

21.0 LAMPS & SOCKETS

21.1 Lamps & Sockets

All lamps shall use a socket base as per IS-1258, except in the case of signal lamps.

All sockets (convenience outlets) shall be suitable to accept both 5 Amp & 15 Amp pin round Standard Indian plugs. They shall be switched sockets with shutters.

21.2 Hand Lamp:

A 240 Volts, single Phase, 50 Hz AC plug point shall be provided in the interior of each cubicle with ON-OFF Switch for connection of hand lamps.

21.3 Switches and Fuses:

- 21.3.1 Each panel shall be provided with necessary arrangements for receiving, distributing, isolating and fusing of DC and AC supplies for various control, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with miniature circuit breaker / switch fuse units. Selection of the main and Sub-circuit fuse

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ratings shall be such as to ensure selective clearance of sub-circuit faults. Potential circuits for relaying and metering shall be protected by HRC fuses.

- 21.3.2 All fuses shall be of HRC cartridge type conforming to IS:9228 mounted on plug-in type fuse bases. Miniature circuit breakers with thermal protection and alarm contacts will also be accepted. All accessible live connection to fuse bases shall be adequately shrouded. Fuses shall have operation indicators for indicating blown fuse condition. Fuse carrier base shall have imprints of the fuse rating and voltage.

22.0 Bushings, Hollow Column Insulators, Support Insulators:

- 22.1 Bushings shall be manufactured and tested in accordance with IS:2099 & IEC-60137 while hollow column insulators shall be manufactured and tested in accordance with IEC-62155/IS:5621. The support insulators shall be manufactured and tested as per IS:2544/IEC-60168 and IEC-60273. The insulators shall also conform to IEC-60815 as applicable.

The bidder may also offer composite hollow insulators, conforming to IEC-61462.

- 22.2 Support insulators, bushings and hollow column insulators shall be manufactured from high quality porcelain. Porcelain used shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified tough and impervious to moisture.

- 22.3 Glazing of the porcelain shall be uniform brown in colour, free from blisters, burrs and similar other defects.

- 22.4 Support insulators/bushings/hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.

- 22.5 When operating at normal rated voltage there shall be no electric discharge between the conductors and bushing which would cause corrosion or injury to conductors, insulators or supports by the formation of substances produced by chemical action. No radio interference shall be caused by the insulators/bushings when operating at the normal rated voltage.

- 22.6 Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps and the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.

- 22.7 All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued up porcelain parts by grinding and metal parts by machining. Insulator/bushing design shall be such as to ensure a uniform compressive pressure on the joints.

22.8 Tests

In bushing, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests in accordance with IS:2099 & IS:2544 & IS:5621.

~~22.9 RTV Coating on porcelain insulators (for coastal area)~~

~~RTV coating shall be done at site on all porcelain insulators (i.e. bushings, hollow and solid insulators, disc insulators etc.) for substation(s) in coastal area as defined elsewhere. The cost of RTV coating shall be deemed to be included in the respective~~

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~~equipment/items' erection cost. The technical details of RTV coating is attached in Annexure H.~~

23.0 MOTORS

Motors shall be "Squirrel Cage" three phase induction motors of sufficient size capable of satisfactory operation for the application and duty as required for the driven equipment and shall be subjected to routine tests as per applicable standards. The motors shall be of approved make.

23.1 Enclosures

- a) Motors to be installed outdoor without enclosure shall have hose proof enclosure equivalent to IP-55 as per IS: 4691. For motors to be installed indoor i.e. inside a box, the motor enclosure, shall be dust proof equivalent to IP-44 as per IS: 4691.
- b) Two independent earthing points shall be provided on opposite sides of the motor for bolted connection of earthing conductor.
- c) Motors shall have drain plugs so located that they will drain water resulting from condensation or other causes from all pockets in the motor casing.
- d) Motors weighing more than 25 Kg. shall be provided with eyebolts, lugs or other means to facilitate lifting.

23.2 Operational Features

- a) Continuous motor rating (name plate rating) shall be at least ten (10) percent above the maximum load demand of the driven equipment at design duty point and the motor shall not be over loaded at any operating point of driven equipment that will rise in service.
- b) Motor shall be capable at giving rated output without reduction in the expected life span when operated continuously in the system having the particulars as given in Clause 15.0 of this Section.

23.3 Starting Requirements:

- a) All induction motors shall be suitable for full voltage direct-on-line starting. These shall be capable of starting and accelerating to the rated speed alongwith the driven equipment without exceeding the acceptable winding temperature even when the supply voltage drops down to 80% of the rated voltage.
- b) Motors shall be capable of withstanding the electrodynamic stresses and heating imposed if it is started at a voltage of 110% of the rated value.
- c) The locked rotor current shall not exceed six (6) times the rated full load current for all motors, subject to tolerance as given in IS:325.
- d) Motors when started with the driven equipment imposing full starting torque under the supply voltage conditions specified under Clause 15.0 shall be capable of withstanding atleast two successive starts from cold condition at room temperature and one start from hot condition without injurious heating of winding. The motors shall also be suitable for three equally spread starts per hour under the above referred supply condition.
- e) The locked rotor withstand time under hot condition at 110% of rated voltage shall be more than starting time with the driven equipment of minimum permissible voltage by at least two seconds or 15% of the accelerating time whichever is greater. In case it is not possible to meet the above requirement, the Bidder shall offer centrifugal type speed switch mounted on the motor shaft which shall remain closed for speed lower than 20% and open for speeds above

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20% of the rated speed. The speed switch shall be capable of withstanding 120% of the rated speed in either direction of rotation.

23.4 Running Requirements:

- a) The maximum permissible temperature rise over the ambient temperature of 50 degree C shall be within the limits specified in IS:325 (for 3-phase induction motors) after adjustment due to increased ambient temperature specified.
- b) The double amplitude of motor vibration shall be within the limits specified in IS: 4729. Vibration shall also be within the limits specified by the relevant standard for the driven equipment when measured at the motor bearings.
- c) All the induction motors shall be capable of running at 80% of rated voltage for a period of 5 minutes with rated load commencing from hot condition.

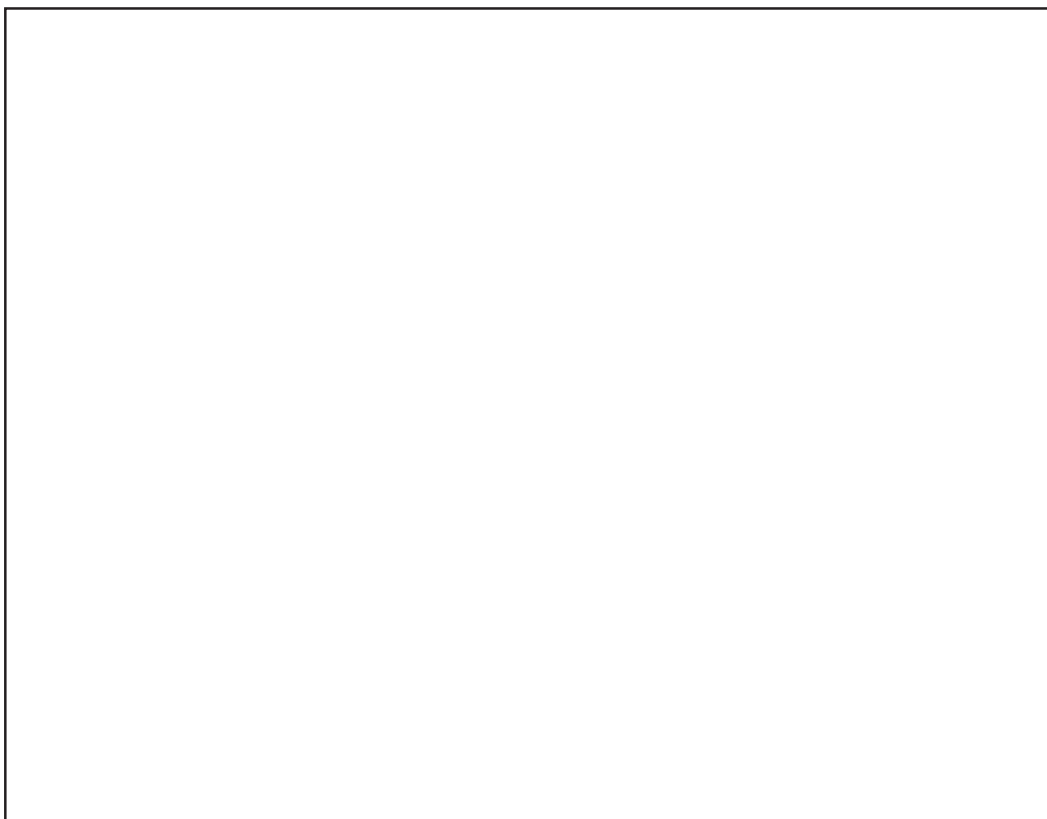
23.5 TESTING AND COMMISSIONING

An indicative list of tests is given below. Contractor shall perform any additional test based on specialties of the items as per the field Q.P./Instructions of the equipment Contractor or Employer without any extra cost to the Employer. The Contractor shall arrange all instruments required for conducting these tests alongwith calibration certificates and shall furnish the list of instruments to the Employer for approval.

- (a) Insulation resistance.
- (b) Phase sequence and proper direction of rotation.
- (c) Any motor operating incorrectly shall be checked to determine the cause and the conditions corrected.

24.

24.1



SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-A****CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST****1. General**

Unless otherwise stipulated, all equipment together with its associated connectors, where applicable, shall be tested for external corona (for 400kV & above) both by observing the voltage level for the extinction of visible corona under falling power frequency voltage and by measurement of radio interference voltage (RIV) for 132kV and above.

2. Test Levels:

The test voltage levels for measurement of external RIV and for corona extinction voltage are listed under the relevant clauses of the specification.

3. Test Methods for RIV:

3.1 RIV tests shall be made according to measuring circuit as per International Special-Committee on Radio Interference (CISPR) Publication 16-1(1993) Part -1. The measuring circuit shall preferably be tuned to frequency with 10% of 0.5 Mhz but other frequencies in the range of 0.5 MHz to 2 MHz may be used, the measuring frequency being recorded. The results shall be in microvolts.

3.2 Alternatively, RIV tests shall be carried out in accordance with relevant IEC of respective equipment or NEMA standard Publication No. 107-1964.

3.3 In measurement of, RIV, temporary additional external corona shielding may be provided. In measurements of RIV only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 meters of terminals.

3.4 Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100%, and 110% of the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 765kV, 400 kV, 220 KV is listed in the detailed specification together with maximum permissible RIV level in microvolts.

3.5 The metering instruments shall be as per CISPR recommendation or equivalent device so long as it has been used by other testing authorities.

3.6 The RIV measurement may be made with a noise meter. A calibration procedure of the frequency to which noise meter shall be tuned shall establish the ratio of voltage at the high voltage terminal to voltage read by noise meter.

4. Test Methods for Visible Corona

The purpose of this test is to determine the corona extinction voltage of apparatus, connectors etc. The test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a search technique shall be used near the onset and extinction voltage, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 110% of specified corona extinction voltage and maintained there for five minutes. In case corona inception does not take place at 110%, test shall be stopped, otherwise test shall be continued and the voltage will then be decreased slowly until

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all visible corona disappears. The procedure shall be repeated at least 4 times with corona inception and extinction voltage recorded each time. The corona extinction voltage for purposes of determining compliance with the specification shall be the lowest of the four values at which visible corona (negative or positive polarity) disappears. Photographs with laboratory in complete darkness shall be taken under test conditions, at all voltage steps i.e. 85%, 100%, and 110%. Additional photographs shall be taken at corona inception and extinction voltages. At least two views shall be photographed in each case using Panchromatic film with an ASA daylight rating of 400 with an exposure of two minutes at a lens aperture of f/5.6 or equivalent. The photographic process shall be such that prints are available for inspection and comparison with conditions as determined from direct observation. Photographs shall be taken from above and below the level of connector so as to show corona on bushing, insulators and all parts of energised connectors. The photographs shall be framed such that test object essentially, fills the frame with no cut-off.

For recording purpose, modern devices utilizing UV recording methods such as image intensifier may also be used.

- 4.1 The test shall be recorded on each photograph. Additional photograph shall be taken from each camera position with lights on to show the relative position of test object to facilitate precise corona location from the photographic evidence.
- 4.2 In addition to photographs of the test object preferably four photographs shall be taken of the complete test assembly showing relative positions of all the test equipment and test objects. These four photographs shall be taken from four points equally spaced around the test arrangement to show its features from all sides. Drawings of the laboratory and test set up locations shall be provided to indicate camera positions and angles. The precise location of camera shall be approved by Employer's inspector, after determining the best camera locations by trial energisation of test object at a voltage which results in corona.
- 4.3 The test to determine the visible corona extinction voltage need not be carried out simultaneously with test to determine RIV levels.
- 4.4 However, both test shall be carried out with the same test set up and as little time duration between tests as possible. No modification on treatment of the sample between tests will be allowed. Simultaneous RIV and visible corona extinction voltage testing may be permitted at the discretion of Employer's inspector if, in his opinion, it will not prejudice other test.

5. Test Records:

In addition to the information previously mentioned and the requirements specified as per CISPR or NEMA 107-1964 the following data shall be included in test report:

- a) Background noise before and after test.
- b) Detailed procedure of application of test voltage.
- c) Measurements of RIV levels expressed in micro volts at each level.
- d) Results and observations with regard to location and type of interference sources detected at each step.
- e) Test voltage shall be recorded when measured RIV passes through 100 microvolts in each direction.
- f) Onset and extinction of visual corona for each of the four tests required shall be recorded.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-B****SEISMIC WITHSTAND TEST PROCEDURE**

The seismic withstanding test on the complete equipment (for 132kV and above) shall be carried out alongwith supporting structure.

The Bidder shall arrange to transport the structure from his Contractor's premises/ POWERGRID sites for the purpose of seismic withstand test only.

The seismic level specified shall be applied at the base of the structure. The accelerometers shall be provided at the Terminal Pad of the equipment and any other point as agreed by the Employer. The seismic test shall be carried out in all possible combinations of the equipment. The seismic test procedure shall be furnished for approval of the Employer.

The frequency range for the earthquake spectra shall be as per IEC-6227-300.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C****LIST OF GENERAL STANDARDS AND CODES**

CODES	TITLE
--	India Electricity Rules
--	Indian Electricity Act
--	Indian Electricity (Supply) Act
--	Indian Factories Act
IS-5	Colors for Ready Mixed Paints and Enamels
IS-335	New Insulating Oils
IS-617	Aluminium and Aluminium Alloy Ingots and Castings for General Engineering Purposes
IS-1448 (P1 to P 145)	Methods of Test for Petroleum and its Products
IS-2071 (P1 to P3)	Methods of High Voltage Testing
IS-12063	Classification of degrees of protection provided by enclosures of electrical equipment
IS-2165 ; P1:1997, P2:1983	Insulation Coordination
IS-3043	Code of Practice for Earthing
IS-6103	Method of Test for Specific Resistance (Resistivity) of Electrical Insulating Liquids
IS-6104	Method of Test for Interfacial Tension of Oil against Water by the Ring Method
IS-6262	Method of test for Power factor & Dielectric Constant of Electrical Insulating Liquids
IS-6792	Method for determination of electric strength of insulating oils
IS-5578	Guide for marking of insulated conductors
IS-11353	Guide for uniform system of marking & identification of conductors & apparatus terminals.
IS-8263	Methods for Radio Interference Test on High voltage Insulators
IS-9224 (Part 1,2&4)	Low Voltage Fuses
IEC-60060 (Part 1 to P4)	High Voltage Test Techniques
IEC 60068	Environmental Test
IEC-60117	Graphical Symbols
IEC-60156	Method for the Determination of the Electrical Strength of Insulation Oils
IEC-60270	Partial Discharge Measurements
IEC-60376	Specification and Acceptance of New Sulphur Hexafluoride
IEC-60437	Radio Interference Test on High Voltage Insulators
IEC-60507	Artificial Pollution Tests on High Voltage Insulators to be used on AC Systems
IEC-62271-1	Common Specification for High Voltage Switchgear & Control gear Standards
IEC-60815	Guide for the Selection of Insulators in respect of Polluted Conditions

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

CODES	TITLE
IEC-60865 (P1 & P2)	Short Circuit Current - Calculation of effects
ANSI-C.1/NFPA.70	National Electrical Code
ANSI-C37.90A	Guide for Surge Withstand Capability (SWC) Tests
ANSI-C63.21, C63.3	Specification for Electromagnetic Noise and Field Strength Instrumentation 10 KHz to 1 GHZ
C36.4ANSI-C68.1	Technique for Dielectric Tests
ANSI-C76.1/EEE21	Standard General Requirements and Test Procedure for Outdoor Apparatus Bushings
ANSI-SI-4	Specification for Sound Level Meters
ANSI-Y32-2/C337.2	Drawing Symbols
ANSI-Z55.11	Gray Finishes for Industrial Apparatus and Equipment No. 61 Light Gray
NEMA-107T	Methods of Measurements of RIV of High Voltage Apparatus
NEMA-ICS-II	General Standards for Industrial Control and Systems Part ICSI-109
CISPR-1	Specification for CISPR Radio Interference Measuring Apparatus for the frequency range 0.15 MHz to 30 MHz
CSA-Z299.1-1978h	Quality Assurance Program Requirements
CSA-Z299.2-1979h	Quality Control Program Requirements
CSA-Z299.3-1979h	Quality Verification Program Requirements
CSA-Z299.4-1979h	Inspection Program Requirements
TRANSFORMERS AND REACTORS	
IS:10028 (Part 2 & 3)	Code of practice for selection, installation & maintenance of Transformers (P1:1993), (P2:1991), (P3:1991)
IS-2026 (P1 to P4)	Power Transformers
IS-3347 (part 1 to Part 8)	Dimensions for Porcelain transformer Bushings for use in lightly polluted atmospheres
IS-3639	Fittings and Accessories for Power Transformers
IS-6600	Guide for Loading of oil immersed Transformers
IEC-60076 (Part 1 to 5)	Power Transformers
IEC-60214	On-Load Tap-Changers
IEC-60289	Reactors
IEC- 60354	Loading Guide for Oil - Immersed power transformers
IEC-60076-10	Determination of Transformer and Reactor Sound Levels
ANSI-C571280	General requirements for Distribution, Power and Regulating Transformers
ANSI-C571290	Test Code for Distribution, Power and Regulation Transformers
ANSI-C5716	Terminology & Test Code for Current Limiting Reactors
ANSI-C5721	Requirements, Terminology and Test Code for Shunt Reactors Rated Over 500 KVA
ANSI-C5792	Guide for Loading Oil-Immersed Power Transformers upto and including 100 MVA with 55 deg C or 65 deg C Winding Rise

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

CODES	TITLE
ANSI-CG,1EEE-4	Standard Techniques for High Voltage Testing
IEC 60076	Power transformers
IEC 60076-1	Part 1: General
IEC 60076-2	Part 2: Temperature rise
IEC 60076-3	Part 3: Insulation levels, dielectric tests and external clearances in air
IEC 60076-4	Part 4: Guide to the lightning impulse and switching impulse testing - Power transformers and reactors
IEC 60076-3-1	Part 3-1: Insulation Levels and Dielectric Tests –External Clearances in Air
IEC 60076-5	Part 5: Ability to withstand short circuit
IEC 60076-6	Part 6: Reactors
IEC 60076-7	Part 7: Loading guide for oil-immersed power transformers
IEC 60076-8	Part 8: Application guide
IEC 60076-10	Part 10: Determination of sound levels
IEC 60076-10-1	Part 10-1: Determination of sound levels - Application guide
IEC 60076-11	Part 11: Dry-type transformers
IEC 60076-12	Part 12: Loading guide for dry-type power transformers
IEC 60076-13	Part 13: Self-protected liquid-filled transformers
IEC 60076-14	Part 14: Design and application of liquid-immersed power transformers using high-temperature insulation materials
IEC 60076-15	Part 15: Gas-filled power transformers
IEC 60076-16	Part 16: Transformers for wind turbine applications
IEC 60076-18	Part 18: Measurement of frequency response
IEC 60076-19	Part 19: Rules for the determination of uncertainties in the measurement of losses in power transformers and reactors
IEC 60076-21	Part 21: Standard requirements, terminology, and test code for step-voltage regulators
IEC 60044, BS 3938	Current transformers
IEC 60050	International Electrotechnical Vocabulary
IEC 60050(421)	International Electrotechnical vocabulary- Chapter 421 : Power Transformers and Reactors
IEC 60060	High Voltage test techniques
IEC 60060-1	General definitions and test requirements
IEC 60060-2	Measuring systems
IEC 60071	Insulation co-ordination
IEC 60071-1	Part 1: Definitions, principles and rules
IEC 60071-2	Part 2 : Application guide
IEC 60137	Bushing for alternating voltage above 1000V
IEC 60214	On-Load Tap changers
IEC 255-21-3	Relays vibration

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

CODES	TITLE
IEC 60270	Partial discharge measurements
IEC 60296	Specification for Unused Mineral Oil for Transformers and Switchgear
IEC 60422	Supervision and Maintenance guide for Mineral Insulating Oil in Electrical Equipment
IEC 60475	Method of Sampling Liquid dielectrics
IEC 60529	Classification of Degrees of Protection provided by Enclosures
IEC 60542	Application Guide for On-Load Tap-Changers
IEC 60567	Guide for the Sampling of Gases and of Oil from Oil-filled Electrical Equipment for the Analysis of Free and Dissolved Gases
IEC 60651	Sound Level Meters
IEC 61083	Digital Recorders and Software for High Voltage Impulse testing
IEC 61083-1	Part 1: Requirements for digital recorders in high voltage impulse tests
IEC 61083-2	Part 2: Evaluation of software used for the determination of the parameters of impulse waveforms
CISPR 16	Specification for radio disturbance and immunity measuring apparatus
CISPR 16-1	Radio disturbance and immunity measuring apparatus
CISPR-18	Radio Interference Characteristics of Power Lines and High Voltage Equipment
ISO 9001	Quality system-Model for Quality Assurance in Design /development
Cigre Publication 202	Guidelines for conducting design reviews for transformers 100 MVA and 123 kV and above. August 2002-Cigre Working Group 12.22
WG 12-15	Guide for Customers Specifications for Transformers 100 MVA and 123 kV and above
WG 12 19	Short Circuit Performance of Transformers.
BS-4360	Specification for weldable structural steel
BS-5135	Specification for arc welding of carbon and carbon manganese steels
BS-5500	Specification for unfired fusion welded pressure vessels
IS-3618	Specification for phosphate treatment of iron & steel for protection against corrosion
IS-6005	Code of practice for phosphating of Iron and Steel
ISO-8501	Preparation of steel surface before application of Paints and related product
IEC-60599	Mineral oil impregnated electrical equipment in service – guide to the interpretation of dissolved and free gases analysis
IS-10593	Method of evaluating the analysis of gases in oil filled electrical equipment in service
IS-2099	Bushings for alternating voltages above 1000 volts

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

CODES	TITLE
IS-3347 Part I to 8	Dimension for porcelain transformer bushing
DIN-42530	Bushing up to 1000kV from 250A-5000A for liquid filled Transformer
IS-2026 Part 1 to 5	Power transformer
IS-4691	Degrees of protection provided by enclosure for rotating electrical machinery
IEC-60034-5	Degrees of protection provided by integral design of rotating electrical machines(IP Code) classification
IS:325 / IEC -60034	Performance of cooling fan / oil pump motor
IS-13947 part 1 to 5	Specification for low voltage switchgear and control gear
IS:3400	Methods of test for vulcanised rubber
IS:7016 part 1 to 14	Methods of test for coated and treated fabrics
IS:803	Code of practice for design, fabrication and erection of vertical mild steel cylindrical welded oil storage tanks.
IS:3637	Gas operated Relays
IS:335	New Insulating oils – Specification
IEC-62271-203	Gas insulated metal enclosed switchgear for rated voltage above 52kV
IEC-61639	Direct connection between power transformers and gas-insulated metal enclosed switchgear for rated voltages of 52.5 kV and above.
IS:3400 / BS 903 / IS:7016	Air cell (Flexible Air Separator)
IEC 60529 / IP : 55	Degree of protection for cooler control cabinet , MOLG, Cooling fan , oil pump, Buchholz Relay
IEC 60529 / IP : 56	Degree of protection for Pressure Relief Device
IEC 60529 / IP : 43	Degree of protection for Remote tap Changer cubicle (RTCC)
CIRCUIT BREAKERS	
IEC-62271-100	High-voltage switchgear and control gear - Part 100: Alternating current circuit-breakers
IEC-62271-101	High-voltage switchgear and control gear - Part 101: Synthetic testing
IEC-62155	Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1000 V
IEC-62271-110	High-voltage switchgear and control gear - Part 110: Inductive load switching
IEC-62271-109	High-voltage switchgear and control gear - Part 110: Inductive load switching
CURRENT TRANSFORMERS, VOLTAGE TRANSFORMERS AND COUPLING CAPACITOR VOLTAGE TRANSFORMERS	
IS-2705- (P1 to P4)	Current Transformers

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CODES	TITLE
IS:3156- (P1 to P4)	Voltage Transformers
IS-4379	Identification of the Contents of Industrial Gas Cylinders
IEC-61869 (Part-1)	Instrument transformers - Part 1: General requirements
IEC-61869 (Part-2)	Instrument transformers - Part 2: Additional requirements for current transformers
IEC-61869 (Part-3)	Instrument transformers - Part 3: Additional requirements for inductive voltage transformers
IEC-61869 (Part-4)	Instrument transformers - Part 4: Additional requirements for combined transformers
IEC-61869 (Part-5)	Instrument transformers - Part 5: Additional requirements for capacitor voltage transformers
IEC-61869 (Part-6)	Instrument transformers - Part 6: Additional general requirements for low-power instrument transformers
IEC-61869 (Part-9)	Instrument transformers - Part 9: Digital interface for instrument transformers
IEC-61869 (Part-102)	Instrument transformers - Part 102: Ferroresonance oscillations in substations with inductive voltage transformers
IEC-61869 (Part-103)	Instrument transformers - The use of instrument transformers for power quality measurement
BUSHING	
IS-2099	Bushings for Alternating Voltages above 1000V
IEC-60137	Insulated Bushings for Alternating Voltages above 1000V
SURGE ARRESTERS	
IS-3070 (PART2)	Lightning arresters for alternating current systems : Metal oxide lightning arrestors without gaps
IEC-60099-4	Metal oxide surge arrestors without gaps
IEC-60099-5	Selection and application recommendation
ANSI-C62.1	IEEE Standards for S A for AC Power Circuits
NEMA-LA 1	Surge Arresters
CUBICLES AND PANELS & OTHER RELATED EQUIPMENTS	
IS-722, IS-1248	Electrical relays for power system
IS-3231, 3231 (P-3)	Protection
IS:5039	Distributed pillars for Voltages not Exceeding 1000 Volts
IEC-60068.2.2	Basic environmental testing procedures Part 2: Test B: Dry heat
IEC-60529	Degree of Protection provided by enclosures
IEC-60947-4-1	Low voltage switchgear and control gear
IEC-61095	Electromechanical Contactors for household and similar purposes
IEC-60439 (P1 & 2)	Low Voltage Switchgear and control gear assemblies
ANSI-C37.20	Switchgear Assemblies, including metal enclosed bus
ANSI-C37.50	Test Procedures for Low Voltage Alternating Current Power

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CODES	TITLE
	Circuit Breakers
ANSI-C39	Electric Measuring instrument
ANSI-C83	Components for Electric Equipment
IS: 8623: (Part I to 3)	Specification for Switchgear & Control Assemblies
NEMA-AB	Moulded Case Circuit and Systems
NEMA-CS	Industrial Controls and Systems
NEMA-PB-1	Panel Boards
NEMA-SG-5	Low voltage Power Circuit breakers
NEMA-SG-3	Power Switchgear Assemblies
NEMA-SG-6	Power switching Equipment
NEMA-5E-3	Motor Control Centers
1248 (P1 to P9)	Direct acting indicating analogue electrical measuring instruments & their accessories
Disconnecting switches	
IEC-62271-102	High-voltage switchgear and control gear - Part 102: Alternating current disconnectors and earthing switches
IEC-60265 (Part 1 & 2)	High Voltage switches
ANSI-C37.32	Schedule of preferred Ratings, Manufacturing Specifications and Application Guide for high voltage Air Switches, Bus supports and switch accessories
ANSI-C37.34	Test Code for high voltage air switches
NEMA-SG6	Power switching equipment
PLCC and line traps	
IS-8792	Line traps for AC power system
IS-8793	Methods of tests for line traps
IS-8997	Coupling devices for PLC systems
IS-8998	Methods of test for coupling devices for PLC systems
IEC-60353	Line traps for A.C. power systems
IEC-60481	Coupling Devices for power line carrier systems
IEC-60495	Single sideboard power line carrier terminals
IEC-60683	Planning of (single Side-Band) power line carrier systems
CIGRE	Teleprotection report by Committee 34 & 35
CIGRE	Guide on power line carrier 1979
CCIR	International Radio Consultative Committee
CCITT	International Telegraph & Telephone Consultative Committee
EIA	Electric Industries Association
Protection and control equipment	
IEC-60051: (P1 to P9)	Recommendations for Direct Acting indicating analogue electrical measuring instruments and their accessories
IEC-60255 (Part 1 to 23)	Electrical relays
IEC-60297 (P1 to P4)	Dimensions of mechanical structures of the 482.6mm (19 inches)

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

CODES	TITLE
	series
IEC-60359	Expression of the performance of electrical & electronic measuring equipment
IEC-60387	Symbols for Alternating-Current Electricity meters
IEC-60447	Man machine interface (MMI) - Actuating principles
IEC-60521	Class 0.5, 1 and 2 alternating current watt hour metres
IEC-60547	Modular plug-in Unit and standard 19-inch rack mounting unit based on NIM Standard (for electronic nuclear instruments)
ANSI-81	Screw threads
ANSI-B18	Bolts and Nuts
ANSI-C37.1	Relays, Station Controls etc
ANSI-C37.2	Manual and automatic station control, supervisory and associated telemetering equipment
ANSI-C37.2	Relays and relay systems associated with electric power apparatus
ANSI-C39.1	Requirements for electrical analog indicating instruments
MOTORS	
IS-325	Three phase induction motors
IS-4691	Degree of protection provided by enclosure for rotating electrical machinery
IEC-60034 (P1 to P19:)	Rotating electrical machines
IEC-Document 2	Three phase induction motors
(Central Office)	Motors and Generators
NEMA-MGI	
Electronic equipment and components	
MIL-21B, MIL-833 & MIL-2750	Environmental testing
EC-60068 (P1 to P5)	Printed boards
IEC-60326 (P1 to P2)	Material and workmanship standards
IS-1363 (P1 to P3)	Hexagon head bolts, screws and nuts of product grade C
IS-1364 (P1 to P5)	Hexagon head bolts, screws and nuts of products grades A and B
IS-3138	Hexagonal Bolts and Nuts (M42 to M150)
ISO-898	Fasteners: Bolts, screws and studs
ASTM	Specification and tests for materials
Clamps & connectors	
IS-5561	Electric power connectors
NEMA-CC1	Electric Power connectors for sub station
NEMA-CC 3	Connectors for Use between aluminium or aluminum-Copper Overhead Conductors
Bus hardware and insulators	
IS: 2121	Fittings for Aluminum and steel cored Al conductors for overhead

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

CODES	TITLE
	power lines
IS-731	Porcelain insulators for overhead power lines with a nominal voltage greater than 1000 V
IS-2486 (P1 to P4)	Insulator fittings for overhead power lines with a nominal voltage greater than 1000 V
IEC-60120	Dimensions of Ball and Socket Couplings of string insulator units
IEC-60137	Insulated bushings for alternating voltages above 1000 V
IEC-60168	Tests on indoor and outdoor post insulators of ceramic material or glass for Systems with Nominal Voltages Greater than 1000 V
IEC-62155	Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1 000 V
IEC-60273	Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V
IEC-61462	Pressurized and un-pressurized insulator for use in electrical equipment with rated voltage greater than 1000V – Definitions, Test methods, acceptance criteria and design recommendations
IEC-60305	Insulators for overhead lines with nominal voltage above 1000V-ceramic or glass insulator units for ac systems Characteristics of String Insulator Units of the cap and pin type
IEC-60372 (1984)	Locking devices for ball and socket couplings of string insulator units : dimensions and tests
IEC-60383 (P1 and P2)	Insulators for overhead lines with a nominal voltage above 1000 V
IEC-60433	Characteristics of string insulator units of the long rod type
IEC-60471	Dimensions of Clevis and tongue couplings of string insulator units
ANSI-C29	Wet process porcelain insulators
ANSI-C29.1	Test methods for electrical power insulators
ANSI-C92.2	For insulators, wet-process porcelain and toughened glass suspension type
ANSI-C29.8	For wet-process porcelain insulators apparatus, post-type
ANSI-G.8	Iron and steel hardware
CISPR-7B	Recommendations of the CISPR, tolerances of form and of Position, Part 1
ASTM A-153	Zinc Coating (Hot-Dip) on iron and steel hardware
Strain and rigid bus-conductor	
IS-2678	Dimensions & tolerances for Wrought Aluminum and Aluminum Alloys drawn round tube
IS-5082	Wrought Aluminum and Aluminum Alloy Bars. Rods, Tubes and Sections for Electrical purposes
ASTM-B 230-82	Aluminum 1350 H19 Wire for electrical purposes

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CODES	TITLE
ASTM-B 231-81	Concentric - lay - stranded, aluminum 1350 conductors
ASTM-B 221	Aluminum - Alloy extruded bar, rod, wire, shape
ASTM-B 236-83	Aluminum bars for electrical purpose (Bus-bars)
ASTM-B 317-83	Aluminum-Alloy extruded bar, rod, pipe and structural shapes for electrical purposes (Bus Conductors)
Batteries	
IS:1651	Stationary Cells and Batteries, Lead-Acid Type (with Tubular Positive Plates)
IS:1652	Stationary Cells and Batteries, Lead-Acid Type (with Plante Positive Plates)
IS:1146	Rubber and Plastic Containers for Lead-Acid Storage Batteries
IS:6071	Synthetic Separators for Lead-Acid Batteries
IS:266	Specification for Sulphuric Acid
IS:1069	Specification for Water for Storage Batteries
IS:3116	Specification for Sealing Compound for Lead-Acid Batteries
IS:1248	Indicating Instruments
IS:10918	Vented type nickel Cadmium Batteries
IEC:60896-21&22	Lead Acid Batteries Valve Regulated types – Methods of Tests & Requirements
IEC: 60623	Vented type nickel Cadmium Batteries
IEC:60622	Secondary Cells & Batteries – Sealed Ni-Cd rechargeable single cell
IEC:60623	Secondary Cells & Batteries – Vented Ni-Cd rechargeable single cell
IEC:60896-11	Stationary Lead Acid Batteries – Vented Type – General requirements & method of tests
IEEE-485	Recommended practices for sizing of Lead Acid Batteries
IEEE-1115	Sizing of Ni-Cd Batteries
IEEE-1187	Recommended practices for design & installation of VRLA Batteries
IEEE-1188	Recommended practices for design & installation of VRLA Batteries
IEEE-1189	Guide for selection of VRLA Batteries
Battery Charger	
IS:3895	Mono-crystalline Semiconductor Rectifier Cells and Stacks
IS:4540	Mono-crystalline Semiconductor Rectifier Assemblies and Equipment
IS:6619	Safety Code for Semiconductor Rectifier Equipment
IS:2026	Power Transformers
IS:2959	AC Contactors for Voltages not Exceeding 1000 Volts

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

CODES	TITLE
IS:1248	Indicating Instruments
IS:2208	HRC Fuses
IS:13947 (Part-3)	Air break switches, air break disconnectors & fuse combination units for voltage not exceeding 1000V AC or 1200V DC
IS:2147	Degree of protection provided by enclosures for low voltage switchgear and control gear
IS:6005	Code of practice for phosphating of Iron and Steel
IS:3231	Electrical relays for power system protection
IS:3842	Electrical relay for AC Systems
IS:5	Colours for ready mix paint
IEEE-484	Recommended Design for installation design and installation of large lead storage batteries for generating stations and substations
IEEE-485	Sizing large lead storage batteries for generating stations and substations
Wires and cables	
ASTMD-2863	Measuring the minimum oxygen concentration to support candle like combustion of plastics (oxygen index)
IS-694	PVC insulated cables for working voltages upto and including 1100 Volts
IS-1255	Code of practice for installation and maintenance of power cables, upto and including 33 kV rating
IS-1554 (P1 and P2)	PVC insulated (heavy duty) electric cables (part 1) for working voltage upto and including 1100 V Part (2) for working voltage from 3.3 kV upto and including 11kV
IS:1753	Aluminium conductor for insulated cables
IS:2982	Copper Conductor in insulated cables
IS-3961 (P1 to P5)	Recommended current ratings for cables
IS-3975	Mild steel wires, formed wires and tapes for armouring of cables
IS-5831	PVC insulating and sheath of electric cables
IS-6380	Elastometric insulating and sheath of electric cables
IS-7098	Cross linked polyethylene insulated PVC sheathed cables for working voltage upto and including 1100 volts
IS-7098	Cross-linked polyethylene insulated PVC sheathed cables for working voltage from 3.3kV upto and including 33 kV
IS-8130	Conductors for insulated electrical cables and flexible cords
IS-1753	Aluminum Conductors for insulated cables
IS-10418	Specification for drums for electric cables
IEC-60096 (part 0 to p4)	Radio Frequency cables
IEC-60183	Guide to the Selection of High Voltage Cables
IEC-60189 (P1 to P7)	Low frequency cables and wires with PVC insulation and PVC sheath

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

CODES	TITLE
IEC-60227 (P1 to P7)	Polyvinyl Chloride insulated cables of rated voltages up to and including 450/750V
IEC-60228	Conductors of insulated cables
IEC-60230	Impulse tests on cables and their accessories
IEC-60287 (P1 to P3)	Calculation of the continuous current rating of cables (100% load factor)
IEC-60304	Standard colours for insulation for low-frequency cables and wires
IEC-60331	Fire resisting characteristics of Electric cables
IEC-60332 (P1 to P3)	Tests on electric cables under fire conditions
IEC-60502	Extruded solid dielectric insulated power cables for rated voltages from 1 kV upto to 30 kV
IEC-754 (P1 and P2)	Tests on gases evolved during combustion of electric cables
AIR conditioning and ventilation	
IS-659	Safety code for air conditioning
IS-660	Safety code for Mechanical Refrigeration
ARI:520	Standard for Positive Displacement Refrigeration Compressor and Condensing Units
IS:4503	Shell and tube type heat exchanger
ASHRAE-24	Method of testing for rating of liquid coolers
ANSI-B-31.5	Refrigeration Piping
IS:2062	Steel for general structural purposes
IS:655	Specification for Metal Air Dust
IS:277	Specification for Galvanised Steel Sheets
IS-737	Specification for Wrought Aluminium and Aluminium Sheet & Strip
IS-1079	Hot rolled cast steel sheet & strip
IS-3588	Specification for Electrical Axial Flow Fans
IS-2312	Propeller Type AC Ventilation Fans
BS-848	Methods of Performance Test for Fans
BS-6540 Part-I	Air Filters used in Air Conditioning and General Ventilation
BS-3928	Sodium Flame Test for Air Filters (Other than for Air Supply to I.C. Engines and Compressors)
US-PED-2098	Method of cold DOP & hot DOP test
MIL-STD-282	DOP smoke penetration method
ASHRAE-52	Air cleaning device used in general ventilation for removing particle matter
IS:3069	Glossary of Terms, Symbols and Units Relating to Thermal Insulation Materials
IS:4671	Expanded Polystyrene for Thermal Insulation Purposes
IS:8183	Bonded Mineral Wool
IS:3346	Evaluation of Thermal Conductivity properties by means of

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

CODES	TITLE
	guarded hot plate method
ASTM-C-591-69	Standard specification for rigid preformed cellular urethane thermal insulation
IS:4894	Centrifugal Fans
BS:848	Method of Performance Test for Centrifugal Fans
IS:325	Induction motors, three-phase
IS:4722	Rotating electrical machines
IS:1231	Three phase foot mounted Induction motors, dimensions of
IS:2233	Designations of types of construction and mounting arrangements of rotating electrical machines
IS:2254	Vertical shaft motors for pumps, dimensions of
IS:7816	Guide for testing insulation resistance of rotating machines
IS:4029	Guide for testing three phase induction motors
IS: 4729	Rotating electrical machines, vibration of, Measurement and evaluation of
IS:4691	Degree of protection provided by enclosures for rotating electrical machinery
IS:7572	Guide for testing single-phase ac motors
IS:2148	Flame proof enclosure for electrical apparatus
BS:4999(Part-51)	Noise levels
Galvanizing	
IS-209	Zinc Ingot
IS-2629	Recommended Practice for Hot-Dip galvanizing on iron and steel
IS-2633	Methods for testing uniformity of coating of zinc coated articles
ASTM-A-123	Specification for zinc (Hot Galvanizing) Coatings, on products Fabricated from rolled, pressed and forged steel shapes, plates, bars and strips
ASTM-A-121-77	Zinc-coated (Galvanized) steel barbed wire
Painting	
IS-6005	Code of practice for phosphating of iron and steel
ANSI-Z551	Gray finishes for industrial apparatus and equipment
SSPEC	Steel structure painting council
Fire protection system	
--	Fire protection manual issued by tariff advisory committee (TAC) of India
HORIZONTAL CENTRIFUGAL PUMPS	
IS:1520	Horizontal centrifugal pumps for clear, cold and fresh water
IS:9137	Code for acceptance test for centrifugal & axial pumps
IS:5120	Technical requirement – Rotodynamic special purpose pumps
API-610	Centrifugal pumps for general services Hydraulic Institutes Standards

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

CODES	TITLE
BS:599	Methods of testing pumps
PTC-8.2	Power Test Codes - Centrifugal pumps
DIESEL ENGINES	
IS:10000	Methods of tests for internal combustion engines
IS:10002	Specification for performance requirements for constant speed compression ignition engines for general purposes (above 20 kW)
BS:5514	The performance of reciprocating compression ignition (Diesel) engines, utilizing liquid fuel only, for general purposes
ISO:3046	Reciprocating internal combustion engines performance
IS:554	Dimensions for pipe threads where pressure tight joints are required on threads
ASME Power Test Code	Internal combustion engine PTC-17
--	Codes of Diesel Engine Manufacturer's Association, USA
PIPING VALVES & SPECIALITIES	
IS:636	Non percolating flexible fire-fighting delivery hose
IS:638	Sheet rubber jointing and rubber inserting jointing
IS:778	Gun metal gate, globe and check valves for general purpose
IS:780	Sluice valves for water works purposes (50 to 300 mm)
IS:901	Couplings, double male and double female instantaneous pattern for fire fighting
IS:902	Suction hose couplings for fire-fighting purposes
IS:903	Fire hose delivery couplings branch pipe nozzles and nozzle spanner
IS:1538	Cast iron fittings for pressure pipes for water, gas and sewage
IS:1903	Ball valve (horizontal plunger type) including floats for water supply purposes
IS:2062	SP for weldable structural steel
IS:2379	Colour Code for the identification of pipelines
IS:2643	Dimensions of pipe threads for fastening purposes
IS:2685	Code of Practice for selection, installation and maintenance of sluice valves
IS:2906	Sluice valves for water-works purposes (350 to 1200 mm size)
IS:3582	Basket strainers for fire-fighting purposes (cylindrical type)
IS:3589	Electrically welded steel pipes for water, gas and sewage (150 to 2000 mm nominal diameter)
IS:4038	Foot valves for water works purposes
IS:4927	Unlined flax canvas hose for fire fighting
IS:5290	Landing valves (internal hydrant)
IS:5312 (Part-I)	Swing check type reflex (non-return) valves
IS:5306	Code of practice for fire extinguishing installations and equipment on premises

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

CODES	TITLE
Part-I	Hydrant systems, hose reels and foam inlets
Part-II	Sprinkler systems
BS:5150	Specification for cast iron gate valves
MOTORS & ANNUNCIATION PANELS	
IS:325	Three phase induction motors
IS:900	Code of practice for installation and maintenance of induction motors
IS:996	Single phase small AC and universal electric motors
IS:1231	Dimensions of three phase foot mounted induction motors
IS:2148	Flame proof enclosure of electrical apparatus
IS:2223	Dimensions of flange mounted AC induction motors
IS:2253	Designations for types of construction and mounting arrangements of rotating electrical machines
IS:2254	Dimensions of vertical shaft motors for pumps
IS:3202	Code of practice for climate proofing of electrical equipment
IS:4029	Guide for testing three phase induction motors
IS:4691	Degree of protection provided by enclosure for rotating electrical machinery
IS:4722	Rotating electrical machines
IS:4729	Measurement and evaluation of vibration of rotating electrical machines
IS:5572	Classification of hazardous areas for electrical (Part-I) installations (Areas having gases and vapours)
IS:6362	Designation of methods of cooling for rotating electrical machines
IS:6381	Construction and testing of electrical apparatus with type of protection 'e'
IS:7816	Guide for testing insulation for rotating machine
IS:4064	Air break switches
IEC DOCUMENT 2 (Control Office) 432	Three Phase Induction Motor
VDE 0530 Part I/66	Three Phase Induction Motor
IS:9224 (Part-II)	HRC Fuses
IS:6875	Push Button and Control Switches
IS:694	PVC Insulated cables
IS:1248	Indicating instruments
IS:375	Auxiliary wiring & busbar markings
IS:2147	Degree of protection
IS:5	Colour Relay and timers
IS:2959	Contactors
PG Test Procedures	

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

CODES	TITLE
NFPA-13	Standard for the installation of sprinkler system
NFPA-15	Standard for water spray fixed system for the fire protection
NFPA-12A	Standard for Halong 1301 Fire Extinguishing System
NFPA-72E	Standard on Automatic Fire Detectors
--	Fire Protection Manual by TAC (Latest Edition)
NFPA-12	Standard on Carbon dioxide extinguisher systems
IS:3034	Fire of industrial building
--	Electrical generating and distributing stations code of practice
IS:2878	CO ₂ (Carbon dioxide) Type Extinguisher
IS:2171	DC (Dry Chemical Powder) type
IS:940	Pressurised Water Type
D.G. SET	
IS:10002	Specification for performance requirements for constant speed compression ignition (diesel engine) for general purposes
IS:10000	Method of tests for internal combustion engines
IS:4722	Rotating electrical machines-specification
IS:12063	Degree of protection provided by enclosures
IS:12065	Permissible limit of noise levels for rotating electrical machines
--	Indian Explosive Act 1932
Steel structures	
IS-228 (1992)	Method of Chemical Analysis of pig iron, cast iron and plain carbon and low alloy steels.
IS-802 (P1 to 3)	Code of practice for use of structural steel in overhead transmission line towers
IS-806	Code of practice for use of steel tubes in general building construction
IS-808	Dimensions for hot rolled steel beam, column channel and angle sections
IS-814	Covered electrodes for manual arc welding of carbon of carbon manganese steel
IS-816	Code of Practice for use of metal arc welding for general construction in Mild steel
IS-817	Code of practice for training and testing of metal arc welders. Part 1 : Manual Metal arc welding
IS-875 (P1 to P4)	Code of practice for design loads (other than earthquake) for buildings and structures
IS-1161	Steel tubes for structural purposes
IS-1182	Recommended practice for radiographic examination of fusion welded butt joints in steel plates
IS-1363 (P1 to P3)	Hexagonal head bolts, screws & nuts of products grade C
IS-1364	Hexagon head bolts, screws and nuts of product grades A and B
IS-1367 (P1 to P18)	Technical supply condition for threaded steel fasteners

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

CODES	TITLE
IS-1599	Methods for bend test
IS-1608	Method for tensile testing of steel products
IS-1893	Criteria for earthquake resistant design of structures
IS-1978	Line Pipe
IS-2062	Steel for general structural purposes
IS-2595	Code of practice for Radiographic testing
IS-3063	Single coil rectangular section spring washers for bolts, nuts and screws
IS-3664	Code of practice for ultrasonic pulse echo testing by contact and immersion methods
IS-7205	Safety code for erection of structural steel work
IS-9595	Recommendations for metal arc welding of carbon and carbon manganese steels
ANSI-B18.2.1	Inch series square and Hexagonal bolts and screws
ANSI-B18.2.2	Square and hexagonal nuts
ANSI-G8.14	Round head bolts
ASTM-A6	Specification for General Requirements for rolled steel plates, shapes, sheet piling and bars of structural use
ASTM-A36	Specifications of structural steel
ASTM-A47	Specification for malleable iron castings
ASTM-A143	Practice for safeguarding against embilement of Hot Galvanized structural steel products and procedure for detaching embriement
ASTM-A242	Specification for high strength low alloy structural steel
ASTM-A283	Specification for low and intermediate tensile strength carbon steel plates of structural quality
ASTM-A394	Specification for Galvanized steel transmission tower bolts and nuts
ASTM-441	Specification for High strength low alloy structural manganese vanadium steel
ASTM-A572	Specification for High strength low alloy colombium-Vanadium steel of structural quality
AWS D1-0	Code for welding in building construction welding inspection
AWS D1-1	Structural welding code
AISC	American institute of steel construction
NEMA-CG1	Manufactured graphite electrodes
Piping and pressure vessels	
IS-1239 (Part 1 and 2)	Mild steel tubes, tubulars and other wrought steel fittings
IS -3589	Seamless Electrically welded steel pipes for water, gas and sewage
IS-6392	Steel pipe flanges
ASME	Boiler and pressure vessel code

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

CODES	TITLE
ASTM-A120	Specification for pipe steel, black and hot dipped, zinc-coated (Galvanized) welded and seamless steel pipe for ordinary use
ASTM-A53	Specification for pipe, steel, black, and hot-dipped, zinc coated welded and seamless
ASTM-A106	Seamless carbon steel pipe for high temperature service
ASTM-A284	Low and intermediate tensile strength carbon-silicon steel plates for machine parts and general construction
ASTM-A234	Pipe fittings of wrought carbon steel and alloy steel for moderate and elevated temperatures
ASTM-S181	Specification for forgings, carbon steel for general purpose piping
ASTM-A105	Forgings, carbon steel for piping components
ASTM-A307	Carbon steel externally threaded standard fasteners
ASTM-A193	Alloy steel and stainless steel bolting materials for high temperature service
ASTM-A345	Flat rolled electrical steel for magnetic applications
ASTM-A197	Cupola malleable iron
ANSI-B2.1	Pipe threads (Except dry seal)
ANSI-B16.1	Cast iron pipe flanges and flanged fitting. Class 25, 125, 250 and 800
ANSI-B16.1	Malleable iron threaded fittings, class 150 and 300
ANSI-B16.5	Pipe flanges and flanged fittings, steel nickel alloy and other special alloys
ANSI-B16.9	Factory-made wrought steel butt welding fittings
ANSI-B16.11	Forged steel fittings, socket-welding and threaded
ANSI-B16.14	Ferrous pipe plug, bushings and locknuts with pipe threads
ANSI-B16.25	Butt welding ends
ANSI-B18.1.1	Fire hose couplings screw thread
ANSI-B18.2.1	Inch series square and hexagonal bolts and screws
ANSI-B18.2.2	Square and hexagonal nuts
ANSI-B18.21.1	Lock washers
ANSI-B18.21.2	Plain washers
ANSI-B31.1	Power piping
ANSI-B36.10	Welded and seamless wrought steel pipe
ANSI-B36.9	Stainless steel pipe
Other civil works standards	
IS-269	33 grade ordinary portland cement
IS-2721	Galvanized steel chain link fence fabric
IS-278	Galvanized steel barbed wire for fencing
IS-383	Coarse and fine aggregates from natural sources for concrete
IS-432 (P1 and P2)	Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

CODES	TITLE
IS-456	Code of practice for plain and reinforced concrete
IS-516	Method of test for strength of concrete
IS-800	Code of practice for general construction in steel
IS-806	Steel tubes for structural purposes
IS-1172	Basic requirements for water supply, drainage and sanitation
IS-1199	Methods of sampling and analysis of concrete
IS-1566	Hard-drawn steel wire fabric for concrete reinforcement
IS-1742	Code of Practice for Building drainage
IS-1785	Plain hard-drawn steel wire for pre-stressed concrete
IS-1786	High strength deformed Steel Bars and wires for concrete reinforcement
IS-1811	Methods of sampling Foundry sands
IS-1893	Criteria for earthquake resistant design of structures
IS-2062	Steel for general structural purposes
IS-2064	Selection, installation and maintenance of sanitary appliances-code of practices
IS-2065	Code of practice for water supply in buildings
IS-2090	High tension steel bars used in pre-stressed concrete
IS-2140	Standard Galvanized steel wire for fencing
IS-2470 (P1 & P2)	Code of practice for installation of septic tanks
IS-2514	Concrete vibrating tables
IS-2645	Integral cement waterproofing compounds
IS-3025 (Part 1 to Part 48)	Methods of sampling and test (Physical and chemical) for water and waste water
IS-4091	Code of practice for design and construction of foundations for transmission line towers and poles
IS-4111 (Part 1 to P5)	Code of practice for ancillary structures in sewerage system
IS-4990	Plywood for concrete shuttering work
IS-5600	Sewage and drainage pumps
National building code of India 1970	
USBR E12	Earth Manual by United States Department of the interior Bureau of Reclamation
ASTM-A392-81	Zinc/Coated steel chain link fence fabric
ASTM-D1557-80	test for moisture-density relation of soils using 10-lb (4.5 kg) rammer and 18-in. (457 mm) Drop
ASTM-D1586(1967)	Penetration Test and Split-Barrel Sampling of Soils
ASTM-D2049-69	Test Method for Relative Density of Cohesionless Soils
ASTM-D2435	Test method for Unconsolidated, (1982) Undrained Strengths of Cohesive Soils in Triaxial Compression
BS-5075	Specification for accelerating Part I Admixtures, Retarding Admixtures and Water Reducing Admixtures

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

CODES	TITLE
CPWD	Latest CPWD specifications
ACSR MOOSE CONDUCTOR	
IS:6745 BS:443-1969	Methods for Determination of Mass of zinc coating on zinc coated Iron and Steel Articles
IS:8263	Methods for Radio Interference
IEC:437-1973 NEMA:107-1964 CISPR	Test on High Voltage Insulators
IS:209, BS:3436-1961	Zinc Ingot
IS:398 Part - V IEC:209-1966	Aluminum Conductors for Overhead Transmission Purposes
BS:215(Part-II), IEC:209-1966	Aluminium Conductors galvanized steel reinforced extra high voltage (400 kV and above)
IS:1778, BS:1559-1949	Reels and Drums for Bare Conductors
IS:1521, ISO/R89-1959	Method for Tensile Testing of steel wire
IS:2629	Recommended practice for Hot dip Galvanising on Iron and Steel
IS:2633	Method for Testing Uniformity of coating of zinc Coated Articles
IS:4826/ ASTMA-472-729	Hot dip galvanised coatings on round steel wires
GALVANISED STEEL EARTHWIRE	
IS:1521, ISO/R:89-1959	Method for Tensile Testing of Steel Wire
IS:1778	Reels and Drums for Bare Conductors
IS:2629	Recommended practice for Hot Dip Galvanising on Iron and Steel
IS:2633	Methods for testing Uniformity of Coating of Zinc Coated Articles
IS:4826/ ASTM: A 475-72a BS:443-1969	Hot dip Galvanised Coatings on Round Steel Wires
IS:6745/ BS:443-1969	Method for Determination of mass of Zinc Coating on Zinc coated Iron and Steel Articles.
IS:209/ BS:3463-1961	Zinc ingot
IS:398 (Pt. I to P5:1992)/ BS:215 (Part-II	Aluminum Conductors for overhead transmission purposes
Lighting Fixtures and Accessories	
IS:1913	General and safety requirements for electric lighting fittings
IS:3528	Water proof electric lighting fittings
IS:4012	Dust proof electric lighting fittings
IS:4013	Dust tight proof electric lighting fittings
IS:10322	Industrial lighting fittings with metal reflectors
IS:10322	Industrial lighting fittings with plastic reflectors
IS:2206	Well glass lighting fittings for use under ground in mines (non-

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

CODES	TITLE
	flameproof type)
IS:10322	Specification for flood light
IS:10322	Specification for decorative lighting outfits
IS:10322	Luminaries for street lighting
IS:2418	Tubular fluorescent lamps
IS:9900	High pressure mercury vapour lamps
IS:1258	Specification for Bayonet lamp fluorescent lamp
IS:3323	Bi-pin lamp holder tubular fluorescent lamps
IS:1534	Ballasts for use in fluorescent lighting fittings. (Part-I)
IS:1569	Capacitors for use in fluorescent lighting fittings
IS:2215	Starters for fluorescent lamps
IS:3324	Holders for starters for tubular fluorescent lamps
IS:418	GLS lamps
IS:3553	Water tight electric fittings
IS:2713	Tubular steel poles
IS:280	MS wire for general engg. Purposes
Conduits, Accessories and Junction Boxes	
IS:9537	Rigid steel conduits for electrical wiring
IS:3480	Flexible steel conduits for electrical wiring
IS:2667	Fittings for rigid steel conduits for electrical wiring
IS:3837	Accessories for rigid steel conduits for electrical wiring
IS:4649	Adaptors for flexible steel conduits
IS:5133	Steel and Cast Iron Boxes
IS:2629	Hot dip galvanising of Iron & Steel
Lighting Panels	
IS:13947	LV Switchgear and Control gear(Part 1 to 5)
IS:8828	Circuit breakers for over current protection for house hold and similar installations
IS:5	Ready mix paints
IS:2551	Danger notice plates
IS:2705	Current transformers
IS:9224	HRC Cartridge fuse links for voltage above 650V(Part-2)
IS:5082	Wrought aluminium and Al. alloys, bars, rods, tubes and sections for electrical purposes
IS:8623	Factory built Assemblies of Switchgear and Control Gear for voltages upto and including 1000V AC and 1200V DC
IS:1248	Direct Acting electrical indicating instruments
Electrical Installation	
IS:1293	3 pin plug
IS:371	Two to three ceiling roses

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

CODES	TITLE
IS:3854	Switches for domestic and similar purposes
IS:5216	Guide for safety procedures and practices in electrical work
IS:732	Code of practice for electrical wiring installation (system voltage not exceeding 650 Volts.)
IS:3043	Code of practice for earthing
IS:3646	Code of practice of interior illumination part II & III
IS:1944	Code of practice for lighting of public through fares
IS:5571	Guide for selection of electrical equipment for hazardous areas
IS:800	Code of practice for use of structural steel in general building construction
IS:2633	Methods of Testing uniformity of coating on zinc coated articles
IS:6005	Code of practice for phosphating iron and steel
	INDIAN ELECTRICITY ACT
	INDIAN ELECTRICITY RULES
LT SWITCHGEAR	
IS:8623 (Part-I)	Specification for low voltage switchgear and control gear assemblies
IS:13947 (Part-I)	Specification for low voltage switchgear and control gear, Part 1 General Rules
IS:13947 (part-2)	Specification for low voltage switchgear and control gear, Part 2 circuit breakers
IS:13947 (part-3)	Specification for low voltage switchgear and control gear. Part 3 Switches, Disconnectors, Switch-disconnectors and fuse combination units
IS:13947 (part-4)	Specification for low voltage switchgear and control gear. Part 4 Contactors and motors starters
IS:13947 (part-5)	Specification for low voltage switchgear and control gear. Part 5 Control-circuit devices and switching elements
IS:13947 (part-6)	Specification for low voltage switchgear and control gear. Part 6 Multiple function switching devices
IS:13947 (part-7)	Specification for low voltage switchgear and control gear. Part 7 Ancillary equipments
IS:12063	Degree of protection provided by enclosures
IS:2705	Current Transformers
IS:3156	Voltage Transformers
IS:3231	Electrical relays for power system protection
IS:1248	Electrical indicating instruments
IS:722	AC Electricity meters
IS:5578	Guide for Marking of insulated conductors of apparatus terminals
IS:13703 (part 1)	Low voltage fuses for voltage not exceeding 1000V AC or 1500V DC Part 1 General Requirements
IS:13703 (part 2)	Low voltage fuses for voltage not exceeding 1000V AC or 1500V DC Part 2 Fuses for use of authorized persons

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**

CODES	TITLE
IS:6005	Code of practice of phosphating iron and steel
IS:5082	Wrought Aluminum and Aluminum alloys for electrical purposes
IS:2633	Hot dip galvanising

COMPREHENSIVE LIST OF DRAWINGS		
SL. NO.	DRAWINGS/DOCUMENTS TITLE	CATEGORY
1.00	SUBSTATION LAYOUT DRAWINGS	
1.01	Single Line Diagram of substation	A
1.02	Electrical layout (plan & section) drawing	A
1.03	Overall General Arrangement drawing	A
1.04	Structure loading diagram cum layout drawing	A
1.05	DSLIP Layout drawing	A
1.06	Switchyard Foundation layout drawing	A
1.07	Erection Key Diagram (plan & section) & Erection Bill of quantity	A
1.08	Indoor Cable trench layout drawing	A
1.09	Outdoor Cable trench layout drawing	A
1.10	Buried cable trench layout drawing	A
1.11	Lighting Fixture & conduit layout – Control room building	A/R
1.12	Lighting Fixture & conduit layout – FFPH building	A/R
1.13	Lighting Fixture & conduit layout – Transit camp (if applicable)	A/R
1.14	Lighting Fixture & conduit layout – Switchyard/Street	A/R
1.15	Lighting Fixture & conduit layout – Switchyard panel room	A/R
1.15	Earthing layout - Control Room building	A
1.16	Earthmat layout – Outdoor Switchyard area	A
1.17	Layout drawing for gravel and fence	A
1.18	Switchyard Road & drain layout drawing	A
1.19	Layout drawing of Visual Monitoring System	A
1.20	SLD of LT AC/DC systems	A
1.21	LT switchgear room -Panel layout	A
1.22	Fire Fighting Piping layout in the switchyard	A
1.23	Fire protection system (Hydrant system & Extinguishers) for Control room building, GIS Building & FFPH building etc	A
1.24	HVW spray system drawings (plan, elevation, side view, isometric view and pylon support location details)	A
1.25	NIFPS drawings	A
1.26	Fire detection & Alarm system for Control room building, GIS Building & Switchyard panel room	A
1.27	Panel layout in Control room building	A
1.28	Layout drawing for LT station	A
1.29	Switchyard Panel room - Panel layout	A
1.30	Power cable termination schedule	R
1.31	Control cable termination schedule	R
	Applicable for GIS	
1.32	Gas System Line Diagram (GAS SLD) indicating compartment details & Weight	A
1.33	GIS Layout drawing including outdoor GIB (Plan & Section)	A
1.34	Layout drawing of UHF sensors for PD Measurement	A
1.35	GIS building - Layout drawing	A
1.36	GIS Building – Lighting Fixture & conduit layout	A
1.37	GIS Building - Layout drawing of Ventilation System	A

COMPREHENSIVE LIST OF DRAWINGS		
1.38	GIS Building (Panel Room) – Air Conditioning system layout drawing	A
1.39	GIS Building – Indoor cable trench Layout drawing	A
2.00	DESIGN CALCULATION	
2.01	DSL P Calculation	A
2.02	Sag Tension & Short Circuit Force Calculation (if applicable)	R
2.03	Lighting system design calculation (if applicable)	R
2.04	Earthing system design calculation (if applicable)	R
2.05	Battery/Charger sizing calculation (if applicable)	R
2.06	Hydraulic calculations for Fire protection system	R
2.07	AC & Ventilation calculation for GIS Building (if applicable)	R
2.08	EOT crane sizing for GIS building	R
3.00	GAS INSULATED SWITCHGEAR	
3.01	Design Review document along with all supporting documents	A
3.02	Guaranteed Technical Particular (GTP)	A
3.03	Components GA drawing for CB, DS, ES, GIB, CT, VT, Spacers, Bushings etc.	A
3.04	Schematics for CB, DS, ES, CT, VT etc. (Except for LCC)	A
3.05	Type Test Reports for GIS Equipments	A
3.06	Detailed drawing of Bus Extension Module	
3.07	Foundation plan for GIS (Including Loading Data)	A
3.08	Platform Arrangement	R
3.09	Name Plates	R
3.10	GA & Schematic drawings of Local Control Cabinets (LCC)	A
3.11	GA & Schematic drawings of overhead crane	A
3.12	Earthing layout inside GIS building	R
3.13	Catalogues for	R
a)	SF6 gas leakage detector	
b)	SF6 gas filling & evacuation plant	
c)	SF6 gas Analyser	
d)	On line partial discharge monitoring system	
3.14	List of Mandatory spares	A
3.15	List of Special Tools & Tackles	A
3.16	Instruction Manual including catalogue of sensors	R
4.00	AUTOTRANSFORMER	
4.01	Design Review	A
4.02	Guaranteed Technical Particulars	A
4.03	Outline General Arrangement Drawing with Bill of material (OGA parts list)	A
4.04	Foundation Plan	A
4.05	Over Fluxing withstand duration curve	R
4.06	Hysteresis Characteristics & specific loss vs flux density curve of iron core	R
4.07	General Arrangement & Control Schematic of OLTC along with write-up	A
4.08	General Arrangement & Control Schematic of Marshalling Box, Common Marshalling Box and Cooler control cubicle along with write-up	A

COMPREHENSIVE LIST OF DRAWINGS		
4.09	General Arrangement & Control Schematic of Digital RTCC relay and cubicle	A
4.10	Interconnection diagram of Drive Mechanism Box, Marshalling Box, Common Marshalling Box & Digital RTCC.	A
4.11	SCADA communication interface of online monitoring equipment	A
4.12	Transport Drawing	R
4.13	Technical Particulars of Online DGA, Drying system, FO system	A
4.14	Outline and control schematic of NIFPS	A
4.15	GA & GTP of bushings	A
4.16	Earthing Arrangement Drawing (Internal & External)	A
4.17	Drawing of Aircell, Conservator & Radiator	A
4.18	Conservator & Tank Oil filling procedure plate	R
4.19	Magnetizing Characteristics of bushings CT	R
4.20	Rating and Diagram plate	A
4.21	Oil flow Diagram	R
4.22	Valve Schedule plate drawing	A
4.23	GA of Twin-Bi directional roller	A
4.24	Instruction Manual	R
4.25	Type Test Report	A
5.00	REACTOR	
5.01	Design Review	A
5.02	Guaranteed Technical Particulars	A
5.03	Outline General Arrangement Drawing with Bill of material (OGA parts list)	A
5.04	Foundation Plan	A
5.05	General Arrangement & Control Schematic of Marshalling Box, Common Marshalling Box along with write-up	A
5.06	SCADA communication interface of online monitoring equipment	A
5.07	Transport Drawing	R
5.08	Technical Particulars of Online DGA, Drying system, FO system	A
5.09	Outline and control schematic of NIFPS	A
5.10	GA & GTP of bushings	A
5.11	Earthing Arrangement Drawing (Internal & External)	A
5.12	Drawing of Aircell, Conservator & Radiator	R
5.13	Conservator & Tank Oil filling procedure plate	R
5.14	Magnetization characteristics of Reactor Core and bushing CTs	R
5.15	Hysteresis Characteristics & specific loss vs flux density curve of iron core	R
5.16	Rating and diagram plate	A
5.17	Voltage Ampere curve for Reactor	R
5.18	Valve Schedule plate drawing	A
5.19	GA of Twin bi-directional roller	A
5.20	Instruction Manual	R
5.21	Type test Report	A
6.00	NEUTRAL GROUNDING REACTOR (NGR)	
a)	AIR CORE TYPE NGR	

COMPREHENSIVE LIST OF DRAWINGS		
6.01	Design Review Document	A
6.02	General Technical Particulars	A
6.03	General Arrangement Drawing with BOM	A
6.04	Main Coil Lifting Details	R
6.05	Foundation Detail Drawing	R
6.06	Main Coil & Insulator Assembly Drawing	A
6.07	Terminal Detail Drawing	A
6.08	Rating & Diagram Plate	A
6.09	Transport Drawing	R
6.10	NGR Pedestal Drawing	A
b) OIL FILLED TYPE NGR		
6.11	Design Review Document	A
6.12	General Technical Particulars	A
6.13	General Arrangement Drawing with BOM	A
6.14	Foundation Detail Drawing	R
6.15	Combined Foundation of Reactor, NGR and LA	A
6.16	Rating & Diagram Plate	A
6.17	Transport Drawing	R
6.18	Control Schematic	A
7.00 CIRCUIT BREAKER		
7.01	GA drawing of SF6 CB	A
7.02	GTP	A
7.03	OGA drawing of control unit	A
7.04	OGA drawing of support insulator, interrupter insulator, PIR chamber insulator, grading capacitor insulator (as applicable)	R
7.05	Support structure & foundation plan drawing	A
7.06	Schematic drawings/Wiring diagrams	A
7.07	Rating and name plate drawing	A
7.08	SF6 gas connection diagram	R
7.09	Schematic diagram of operating mechanism	R
7.10	GA drawing, GTP & Type Test Reports of Controlled Switching Device	A
7.11	Terminal pad and corona rings	R
7.12	Sectional view of interrupter	R
7.13	Type Test Reports	A
7.14	Instruction Manual	R
8.00 ISOLATOR		
8.01	GA drawing of Isolator with/without earth switch	A
8.02	GTP	A
8.03	Contact blade assembly (main & earth switch)	R
8.04	Terminal pad & hinge contacts	R
8.05	GA of MOM – main switch	R
8.06	Schematic & wiring drawing for main switch	R
8.07	Name plate - details	A
8.08	GA of terminal pad	A

COMPREHENSIVE LIST OF DRAWINGS		
8.09	GA of post insulator for isolator	R
8.10	Type Test Report	A
8.11	Instruction Manual	R
9.00	INSTRUMENT TRANSFORMER (CT/CVT/IVT)	
9.01	General Arrangement	A
9.02	GTP	A
9.03	Sectional view	R
9.04	Sec. terminal box GA	R
9.05	Wiring drawing of JB incl. interpole	R
9.06	Terminal pads	A
9.07	Schematic & rating plate	R
9.08	Porcelain insulator	R
9.09	Corona ring	R
9.10	Type Test Reports	A
9.11	Instruction Manual	R
10.00	SURGE ARRESTER	
10.01	GA of Surge Arrester	A
10.02	GTP	A
10.03	Porcelain/ Polymer insulator	R
10.04	Cross sectional view	R
10.05	Arrestor and unit name plate	A
10.06	Corona & Grading rings	R
10.07	Insulating base / surge counter detail	R
10.08	Outline drawing of surge counter	R
10.09	Circuit diagram of surge counter	R
10.10	GA drawing of ZnO element	R
10.11	Line terminal bracket with corona rings	R
10.12	Drawing showing pressure relief arrangement.	R
10.13	Type Test Report	A
10.14	Instruction Manual	R
11.00	BUS POST INSULATOR	
11.01	GA drawing & GTP	A
11.02	Type Test Reports	A
12.00	Marshalling Box, Junction Boxes	
12.01	GA drawings	A
12.02	Schematic drawings	A
12.03	Type Test Reports	A
13.00	CONDUCTOR, AL. TUBE & GS EARTH WIRE	
13.01	Type Test Reports (if applicable)	A

COMPREHENSIVE LIST OF DRAWINGS		
14.00	DISC INSULATOR	
14.01	GA drawing & GTP	A
14.02	Type Test Reports	A
15.00	LONG ROD POLYMER INSULATOR	
15.01	GA drawing & GTP	A
15.02	Type Test Reports	A
16.00	INSULATOR STRING(S) WITH HARDWARE ASSEMBLY	
16.01	GA drawing & GTP	A
16.02	Component drawings	R
16.03	Type Test Reports	A
17.00	CLAMPS & CONNECTORS	
17.01	GA Drawings	A
17.02	Type Test Reports	A
18.00	HORN GAP FUSE	
18.01	GA drawing & GTP	A
18.02	Type Test Reports	A
19.00	BATTERY AND BATTERY CHARGER	
19.01	GA drawing & GTP of Battery Bank	A
19.02	GA drawing, GTP & Schematic Drawings of Battery Charger	A
19.03	Type Test Reports of Battery & Charger	A
20.00	ILLUMINATION	
20.01	GTP/Catalogue of fittings/fixtures	A
20.02	GA drawing of lighting poles/posts	A
20.03	GA drawing of Junction box	A
20.04	GA drawing of street lighting panel/outdoor/indoor lighting panel	A
20.05	GA drawing of Receptacles	A
20.06	Schematic drawing of panel/LDBs to fixtures	R
21.00	LT SWITCHGEAR	
21.01	SLD, GA & Schematic drawings of MSB	A
21.02	SLD, GA & Schematic drawings of ACDB	A
21.03	SLD, GA & Schematic drawings of 220V DCDB	A
21.04	SLD, GA & Schematic drawings of 48V DCDB	A
21.05	SLD, GA & Schematic drawings of MLDB	A
21.06	SLD, GA & Schematic drawings of ELDB	A
21.07	Type Test Reports	A
21.08	Instruction Manual	R

COMPREHENSIVE LIST OF DRAWINGS		
22.00	HT POWER CABLES	
22.01	GTP & Catalogue	A
22.02	Type Test Reports	A
23.00	POWER & CONTROL CABLES	
23.01	Type Test Reports for control cables	A
23.02	Type Test Reports for power cables	A
24.00	CONTROL AND RELAY PANELS & SUBSTATION AUTOMATION SYSTEM (SAS), VISUAL MONITORING SYSTEM (VMS)	
24.01	GTP for all protection relays, Travelling Wave Fault Locator, SAS Equipment	A
24.02	Type Test Reports of all protection relays, Travelling Wave Fault Locator & SAS IEDs	A/R
24.03	GA and schematic drgs. for :-	
a)	Relay and protection panels for all type of line(s)	A
b)	Relay and protection panels for all type transformer(s) including tertiary loading	A
c)	Relay and protection panels for bus/line reactor(s) (switchable & non-switchable as applicable)	A
d)	Relay and protection panels for tie bay(s)	A
e)	Relay and protection panels for TBC bay(s)	A
f)	Relay and protection panels for BC bay(s)	A
g)	Relay and protection panels for Bus Sectionalizer bay(s)	A
h)	Busbar protection panel (s)	A
i)	Breaker relay panel(s)	A
j)	Interface panel	A
24.04	SAS Architecture	A
24.05	Relay Settings	A
24.06	GTP/Catalogue of VMS equipment	A/R
24.07	GTP/Catalogue of Camera	A/R
24.08	VMS architecture drawing	A
24.09	Technical Literature and O&M manuals	R
25.00	PLCC EQUIPMENTS	
25.01	GTP/Drawings for PLCC Carrier Equipment	A/R
25.02	GTP/Drawings for Wave traps	A
25.03	GTP/Drawings Coupling device	A
25.04	Digital/ Analog Protection coupler	A
25.05	SNR calculation (if applicable)	R
25.06	GTP/Drawing of HF cable	A
25.07	Type Test Reports of PLCC equipment	A
25.08	Testing & maintenance equipments	R
25.09	Frequency Planning	A
25.10	Technical literature and O&M Manuals	R

COMPREHENSIVE LIST OF DRAWINGS		
26.00	DG SET	
26.01	GTP	A
26.02	Drawings/manuals	A
27.00	AIR CONDITIONING & VENTILATION SYSTEM	
27.01	Drawings/GTP/Catalogues	A
27.02	A/C sizing calculation	A
28.00	LT TRANSFORMER	
28.01	GTP	A
28.02	Drawings	A
28.03	Type Test Reports	A
29.00	FIRE PROTECTION SYSTEM	
29.01	Fire Fighting Annunciation & control panels	A
29.02	GA and Schematic for LCP for deluge valve operation	A
29.03	Hydraulic calculations for HVW spray network	R
29.04	Drawing for deluge valve housing	A
29.05	GTP & drawings for strainers (Y type & basket strainer)	A
29.06	Drawing of valve pit details	A
29.07	System write-up with various settings	A
29.08	GTP & drawing for gate valve, check valve, solenoid valve, outdoor hydrant valve	A
29.09	GTP & catalogue for deluge valve, spray nozzles & projectors	A
29.10	GTP & catalogue for quatrzoid bulb detector	A
29.11	GTP & drawing for pressure switch, pressure gauge	A
29.12	GTP for G.I. & M.S. pipes & pipe accessories	A
29.13	Any other drawing/document required for completion of work	A/R
30.00	CONTROL ROOM BUILDING / TRANSIT CAMP /FFPH BUILDING/ SWITCHAYRD PANEL ROOM/INDOOR HT SWITCHGEAR ROOM/TOWNSHIP BUILDINGS (AS applicable)	A
30.01	Architectural drawing	
a)	Plan, section & elevation	
b)	Doors & windows schedule	
30.02	Building design calculation (if applicable)	
30.03	Civil Construction design/drawings	
31.00	DRAWING FOR GIS BUILDING (If applicable)	A
31.01	Architectural drawing	
a)	Plan, section & elevation	
b)	Doors & windows schedule	
31.02	GIS building superstructure drawings & design calculation	
31.03	Civil Construction design/drawings	

COMPREHENSIVE LIST OF DRAWINGS		
31.04	GIS Equipment foundation inside GIS building	
32.00	Switchyard Civil Construction Drawings (as applicable)	A
a)	Tower Foundation	
b)	Equipment Foundation	
c)	Transformer foundation	
d)	Reactor foundation	
e)	Road construction including culverts, rail cum road	
f)	Switchyard fencing & Gate	
g)	Cable trench section	
h)	Drain section	
i)	Rain harvesting	
j)	Boundary wall	
k)	DG set foundation	
l)	LT transformer foundation	
m)	Car Parking Shed/Security Room	
n)	Outdoor GIB foundation	
o)	Outdoor Sf6/Air bushing foundation	
p)	BMK/ Lighting pole foundation	
q)	Fire Wall	
r)	Drawing of contour levels	
s)	Drawing of Formation levels	
t)	Soil Investigation Report	
u)	Any other foundation inside switchyard	
33.00	DESIGN, FABRICATION & PROTO CORRECTED DRAWINGS OF ALL TYPES OF TOWERS & BEAMS	A/R
34.00	DESIGN, FABRICATION DRAWINGS FOR EQUIPMENT SUPPORT STRUCTURES	A/R
35.00	MISCELLANEOUS CIVIL DRGS	A/R

LEGEND:- A – for Approval; R- for Record

NOTES:-

1. In case any additional drawings/documents are required, the same shall also be submitted during execution of the contract.
2. In case, some drawings as mentioned in the above list are not applicable for the scope of work, the same shall not be referred to.

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**Annexure-G****MQP & INSPECTION LEVEL REQUIREMENT**

Sl. No.	Item / Equipment	Requirement of MQP/ITP/FAT	Inspection Level
1 A	Transformer /Reactor	Yes	IV
1 B	Circuit Breakers	Yes	IV
2	Current transformer	Yes	IV
3	Capacitive voltage transformers/Potential transformer	Yes	IV
4	Isolators	Yes	IV
5	Lightening Arrestors	Yes	III
6	Line Trap	Yes	III
7	Control & Relay Panels	Yes	III
8	Power Cables	Yes	III
9	Control Cables	Yes	III
10	LT Switchgear & ACDB/DCDB/MLDB/ELDB/ Lighting Panels	Yes	III
11	Fire protection system		
11-A	Panels, Deluge valve, Hydro pneumatic tank.	No	III
11-B	Strainers, extinguishers, MS/GI pipes, Pumps, motors, air compressor, and other valves, Diesel Engines	No	II
11-C	Others	No	I
12	Insulator (Disc, Long Rod, Solid Core)	Yes	IV
13	Conductor	Yes	IV
14	Clamps & Connectors (including equipment connectors)	Yes	III
15	Junction Box / Lighting Switch Boards / Bay MB/Telecom Equipment Cabinet	No	II
16	Cable lugs	No	I
17	Lighting Fixtures ,Lamps & fans	No	I
18	Switches	No	I
19	Conduits	No	I
20	Lighting Poles	No	II
21	MS/GI /PVC Pipes for cable trenches and lighting	No	I
22	Hume Pipes	No	I
23	Galvanized Cable trays	No	II
24	MS/ GI Flat and earthing material	No	II
25	MS Round for Earthmat (40mm dia)	No	I
26	Lighting Earthwire	No	I
27	Aluminium Tube & Busbar materials	No	II
28	Outdoor Receptacle	No	I
29	Nut / Bolts / Spring Washers (Gr 5.6/5)	No	II
30	LT Transformer	Yes	III
31	Battery	No	II
32	Battery Charger	Yes	III

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**Annexure-G**

Sl. No.	Item / Equipment	Requirement of MQP/ITP/FAT	Inspection Level
33	D. G. Set	No	II
34	Split A.C/window A.C.	No	I
35	Substation Automation system	No	III
36	Telephone wires	No	I
37	Telephone sockets	No	I
38	Aluminium ladder	No	I
39	Occupancy sensors for control of lighting	No	I
40	Sub Station Structure (lattice/pipe type)	Yes	III
41	HG fuse	No	II
42	PLCC equipment Viz PLCC Terminal ,Carrier equipment, Protection Coupler , Coupling Device but excluding EPAX / HF Cable/ SDH Equipment	Yes	III
43	HF Cable / GPS Clock	No	I
44	EPAX	No	I
45	Cable Glands / Joints /Clamps/ Termination	No	I
46	Video Monitoring System	No	II
47	Controller for switching	No	IV
48	Solar based street lighting pole including solar panel as per technical specification	No	III
49	Event Logger	No	III
50	Lighting transformers	Yes	II
51	String Hardware	Yes	IV
52	Test Equipment	No	I *
53	GS Earthwire	Yes	IV
54	Oil Storage Tank	Yes	III
55	Insulating Oil	No	III
56	Flow sensitive conservator isolation valve	No	II **
57	On-Line insulating oil drying system	No	II **
58	On line DGA & Moisture Analyzer	No	II **
59	WAMS-(PMU & Accessories)	Yes	III
60	FO Cable	Yes	III
61	Re-rollers of MS/HT Angle Section and galvanized tower parts.	Yes	IV
62	Hardware fittings & Earthwire Accessories	Yes	IV
63	OPGW & H/W	Yes	III
64	Bolts & Nuts Gr up to 5.6/5	Yes	II
65	Bolts & Nuts of Gr 8.8 / 8	Yes	IV
66	D-shackle/ Hanger / Links	Yes	IV
67	Danger Plate /Phase Plate / Number Plate / Circuit plate	No	I
68	Pipe Type & Counter Poise Earthing	No	II
69	Spring Washer	No	II
70	ACD & Barbed wire for ACD/Bird guard	No	II

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**Annexure-G**

Sl. No.	Item / Equipment	Requirement of MQP/ITP/FAT	Inspection Level
71	Span Marker & Obstruction Light	No	III
72	GIS including spares	Yes	IV
73	GIS Bus Duct	Yes	IV
74	GIS Bushing	Yes	IV
75	SF6 Gas processing Unit	No	II
76	Partial Discharge Monitoring System	No	II
77	STATCOM including Valve, valve base electronics, DC capacitor, series reactor and all accessories	Yes	IV
78	Mechanically switched Reactor bank (3-ph) including all accessories (MSR Branches)	Yes	IV
80	Mechanically switched Capacitor bank (3-ph) including all accessories (MSC Branches)	Yes	IV
81	Pass Harmonic filters	Yes	IV
82	Valve cooling system	Yes	III
	FODP including pigtail	No	II
	Radio link Telecom	Yes	III
	Hardware Fittings for Fibre Optic approach cable	Yes	III
	SDH Equipments (ADM), PDH, Primary Multiplexer	Yes	IV
	Drop & Insert Multiplexer	Yes	IV
	DACS	Yes	IV
	Main Distribution Frame	No	I
	HDPE Pipe	No	II
	NMS, TMN	Yes	IV
	Synchronization Equipment	No	Level-I
93	HT Capacitor	Yes	IV
94	PLC Capacitor	Yes	III
95	48V DCPS	Yes	III
96	Nitrogen Injection system	Yes	III
97	Foundation/Anchor bolts	Yes	III
98	EOT crane/Lift	No	II
99	Optical Signal Column	No	II
100	Maintenance Platform	No	II
101	Spark Gap	Yes	III
102	Thyristor Valve	Yes	III
103	DC current & voltage measuring device	ITP	III
104	Furniture	No	I

Note:

- * MICC for test and measuring equipment shall be issued only after actual verification/demonstration of satisfactory performance at site.
- ** Though level-2 items, CIP can be issued also on review of TCs and visual inspection of these items.

SECTION - (SE) **SWITCHYARD ERECTION**

ANNEX C1

CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST

1. General

Unless otherwise stipulated, all equipment together with its associated connectors, where applicable, shall be tested for external corona both by observing the voltage level for the extinction of visible corona under falling power frequency voltage and by measurement of radio interference voltage (RIV).

2. Test Levels:

The test voltage levels for measurement of external RIV and for corona extinction voltage are listed under the relevant clauses of the specification.

3. Test Methods for RIV:

3.1 RIV tests shall be made according to measuring circuit as per International Special-Committee on Radio Interference (CISPR) Publication 16-1(1993) Part -1. The measuring circuit shall preferably be tuned to frequency with 10% of 0.5 Mhz but other frequencies in the range of 0.5 MHz to 2 MHz may be used, the measuring frequency being recorded. The results shall be in microvolts.

3.2 Alternatively, RIV tests shall be in accordance with NEMA standard Publication No. 107-1964, except otherwise noted herein.

3.3 In measurement of, RIV, temporary additional external corona shielding may be provided. In measurements of RIV only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 meters of terminals.

3.4 Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100% and 110% of the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 765kV, 400kV, 220kV is listed in the detailed specification together with maximum permissible RIV level in microvolts.

3.5 The metering instruments shall be as per CISPR recommendation or equivalent device so long as it has been used by other testing authorities.

3.6 The RIV measurement may be made with a noise meter. A calibration procedure of the frequency to which noise meter shall be tuned shall establish the ratio of voltage at the high voltage terminal to voltage read by noise meter.

4. Test Methods for Visible Corona [applicable for 400kV and above]

The purpose of this test is to determine the corona extinction voltage of apparatus, connectors etc. The test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a search technique shall be used near the onset and extinction voltage, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 110% of RIV test voltage and maintained there for five minutes. In case corona inception does not take place at 110%, test shall be stopped, otherwise test shall be continued and the voltage will then be decreased slowly until all visible corona disappears. The procedure shall be repeated at least 4

times with corona inception and extinction voltage recorded each time. The corona extinction voltage for purposes of determining compliance with the specification shall be the lowest of the four values at which visible corona (negative or positive polarity) disappears. Photographs with laboratory in complete darkness shall be taken under test conditions, at all voltage steps i.e. 85%, 100%, and 110%. Additional photographs shall be taken at corona inception and extinction voltages. At least two views shall be photographed in each case using Panchromatic film with an ASA daylight rating of 400 with an exposure of two minutes at a lens aperture of f/5.6 or equivalent. The photographic process shall be such that prints are available for inspection and comparison with conditions as determined from direct observation. Photographs shall be taken from above and below the level of connector so as to show corona on bushing, insulators and all parts of energised connectors. The photographs shall be framed such that test object essentially, fills the frame with no cut-off.

In case corona inception does not take place at 110%, voltage shall not be increased further and corona extinction voltage shall be considered adequate.

- 4.1 The test shall be recorded on each photograph. Additional photograph shall be taken from each camera position with lights on to show the relative position of test object to facilitate precise corona location from the photographic evidence.
- 4.2 In addition to photographs of the test object preferably four photographs shall be taken of the complete test assembly showing relative positions of all the test equipment and test objects. These four photographs shall be taken from four points equally spaced around the test arrangement to show its features from all sides. Drawings of the laboratory and test set up locations shall be provided to indicate camera positions and angles. The precise location of camera shall be approved by Purchaser's inspector, after determining the best camera locations by trial energisation of test object at a voltage which results in corona.
- 4.3 The test to determine the visible corona extinction voltage need not be carried out simultaneously with test to determine RIV levels.
- 4.4 However, both test shall be carried out with the same test set up and as little time duration between tests as possible. No modification on treatment of the sample between tests will be allowed. Simultaneous RIV and visible corona extinction voltage testing may be permitted at the discretion of Purchaser's inspector if, in his opinion, it will not prejudice other test.

5. Test Records:

In addition to the information previously mentioned and the requirements specified as per CISPR or NEMA 107-1964 the following data shall be included in test report:

- a) Background noise before and after test.
- b) Detailed procedure of application of test voltage.
- c) Measurements of RIV levels expressed in micro volts at each level.
- d) Results and observations with regard to location and type of interference sources detected at each step.
- e) Test voltage shall be recorded when measured RIV passes through 100 microvolts in each direction.
- f) Onset and extinction of visual corona for each of the four tests required shall be recorded.

ANNEXURE-A

COMPLIANCE CERTIFICATE OF TECHNICAL SPECIFICATION

The bidder shall confirm compliance to the following by signing/ stamping this compliance certificate and furnishing same with the offer.

1. The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusion/ deviation with regard to same.
2. There are no deviation(s) with respect to specification other than those furnished in the 'schedule of deviations'.
3. Only those technical submittals which are specifically asked for in NIT to be submitted at tender stage shall be considered as part of offer. Any other submission, even if made, shall not be considered as part of offer.
4. Any comments/ clarifications on technical/ inspection requirements furnished as part of bidder's covering letter shall not be considered by BHEL, and bidder's offer shall be construed to be in conformance with the specification.
5. Any changes made by the bidder in the price schedule with respect to the description/ quantities from those given in 'BOQ' of the specification shall not be considered (i.e., technical description & quantities as per the specification shall prevail).

Date:

Bidder's Stamp & Signature

ANNEXURE - B

SCHEDULE OF TECHNICAL DEVIATIONS

Bidder shall list below all technical deviation clause wise w.r.t. tender specifications:

S.No.	Section/ Page No.	Clause No.	Deviation	Reason / Justification
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Any deviation not specifically brought out in this section shall not be admissible for any commercial implication at later stage. Except to the technical deviations listed in this schedule, bidder's offer shall be considered in full compliance to the tender specifications irrespective of any such deviation indicated / taken elsewhere in the submitted offer.

Date:

Tenderer's Stamp & Signature

CHECK LIST

1	Technical Qualifying Requirement		
1.1	The bidder to furnish relevant documents for meeting the qualifying requirement. Performance certificates shall be submitted in English. Translated pages should be attested by the ultimate customer, if attested only by the bidder it shall be notarized.	Confirmed	Yes/No
1.2	The bidder's scope includes supply and services such as Supervision of installation, Testing and commissioning.	Confirmed	Yes/No
2	Un-priced BOQ		
2.1	Confirm that all items have been quoted separately. (If any item has not been quoted, the same shall be specifically brought out with technical reasons thereof) Record the same in schedule of technical deviations.	Confirmed	Yes/No
3	Technical		
3.1	Minimum Number of auxiliary contacts on each Circuit Breaker - Besides requirement of technical specification, the manufacturer shall wire up 10 NO + 10 NC contacts of each phase/ pole exclusively for purchaser's use and shall be wired up to common marshalling box of 765, 400 & 220kV CB.	Confirmed	Yes/No
3.2	TB's for (for incoming AC Power Cables) shall be suitable for size 4Cx16 Sqmm Al (minimum).	Confirmed	Yes/No
3.3	Catalogues, indicative OGA of the offered equipment is attached.	Enclosed with bid	Yes/No
4	Technical Deviations		
4.1	Confirm that the Complete systems have been offered as per the requirements of Technical Specification and Technical Deviation sheet has been submitted. Deviations mentioned elsewhere in the bid will not be considered.	Confirmed	Yes/No
5	GTP		
5.1	All equipment being supplied shall conform to Gurantee Technical Particulars as per technical specification and applicable IS / IEC	Confirmed	Yes/No
6	TYPE TESTS REQUIREMENTS		
6.1	All equipment being supplied shall conform to type tests as per technical specification and shall be subject to routine tests in accordance with requirements stipulated under respective sections.	Confirmed	Yes/No
6.2	In case the test reports are not found technically valid during contract stage by BHEL/Customer, the bidder shall repeat these test(s) <u>at no extra cost to the purchaser and no delivery implication.</u> Technical valid - Any error or incompleteness (any/all additional type tests not carried out) or discrepancy in the test reports vis-à-vis offered equipment due to any design / manufacturing changes (including substitution of components) or non-compliance with the requirement stipulated in the Technical Specification.	Confirmed	Yes/No

Date:

Bidder's Stamp & Signature

Contact Details: