TECHNICAL PRE-QUALIFICATION REQUIREMENT

Name of Project: ± 800 kV, 6000 MW HVDC terminals associated with HVDC Link between Khavda Power Station-2 (KPS2), Gujarat and Nagpur, Maharashtra under Transmission system Package for potential REZ in Khavda area of Gujarat under Phase V-Part A (8GW)

Name of Customer : POWERGRID WEST CENTRAL TRANSMISSION LIMITED

Name of Item : **DC POST INSULATOR (POLYMER TYPE)**

TECHNICAL PRE-QUALIFICATION REQUIREMENT
The bidder should have manufactured, type tested (as per IS/IEC) and supplied 66kV (AC) or above class of Polymer Post insulator as on date of bid opening.

SUPPORTING DOCUMENTS TO BE ATTACHED
(As applicable as per PQ requirement)

Sr	Required Criteria	Supporting Documents to be submitted by bidder along with technical bid
1	Manufacturing	Approved Drawings / GTP / Approved Quality Plan / Factory Inspection Test Report etc
2	Supply	PO / Dispatch clearance / LR / Material Receipt certificate at site / installation or commissioning certificate etc.
3	Type Test	TTR approval from customer / Type Test Report etc.

Notes (General points):

1. Consideration of offer shall be subject to customer's approval of bidder's, if applicable.
2. Bidder to submit all supporting documents in English. If documents submitted by bidder are in language other than English, a self- attested English translated document should also be submitted.
3. Notwithstanding anything stated above, BHEL reserves the right to assess the capabilities and capacity of the bidder to perform the contract, should the circumstances warrant such assessment in the overall interest of BHEL.
4. After satisfactory fulfilment of all the above criteria / requirement, offer shall be considered for further evaluation as per NIT and all the other terms of the tender.

PREPARED BY

10/09/26

Amit Srivastava
Sr. Manager
TBEM

REVIEWED & APPROVED BY

Muneet Mehta
AGM
TBEM

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BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION BUSINESS HVDC ENGINEERING & SYSTEMS

DOCUMENT No.	**TB-437-316-116B**	Rev. No.	**00**	PREPARED	CHECKED	APPROVED
TYPE OF DOC.	**TECHNICAL SPECIFICATION**		SIGN			
TITLE			NAME	**AS**	**MM**	**MM**
DC POST INSULATOR (POLYMER TYPE)			DATE	10.09.26	10.09.26	10.09.26
			GROUP	**TBEM**	W.O. No	
CUSTOMER	**POWERGRID WEST CENTRAL TRANSMISSION LIMITED**					
PROJECT	**± 800 kV, 6000 MW HVDC terminals associated with HVDC Link between Khavda Power Station-2 (KPS2), Gujarat and Nagpur, Maharashtra under Transmission system Package for potential REZ in Khavda area of Gujarat under Phase V-Part A (8GW)**					

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SECTION 1

SCOPE, SPECIFIC TECHNICAL REQUIREMENTS AND QUANTITIES

1.0 SCOPE

This technical specification covers the requirements of design, manufacture, testing at works, packing, loading at works and transport to site of DC Polymer post insulators complete with all nuts, bolts and washers for inter unit joining & for bolting the Post insulators units to structure.

The specification comprises of following sections:

Section-1: Scope, Specific Technical Requirements & Quantities
Section-2: Equipment Specification & other relevant section.
Section-3: Project Details & General Technical Requirements
Section-4: Annexure– A, Schedule of Technical deviations.

In case of any conflict among the various sections of this specification, the order of precedence shall be section-1, section -2, section -3

1.1 The equipment is required for the following Projects.

Name of the Customer: POWER GRID CORPORATION OF INDIA LIMITED

Name of the Project:

± 800 kV, 6000 MW HVDC terminals associated with HVDC Link between Khavda Power Station-2 (KPS2), Gujarat and Nagpur, Maharashtra under Transmission system Package for potential REZ in Khavda area of Gujarat under Phase V-Part A (8GW)

***Note: The terms used in this specification namely, "Employer" refers to POWERGRID, "Purchase" refers to BHEL, "Contractor" refers to Bidder, "GTR" refers to "section-3".**

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1.2 BILL OF QUANTITY:

Refer Annexur-1 for BOQ.

1.3 SPECIFIC TECHNICAL PARTICULARS

Refer Section-2

FOR PGCIL KHAVDA SITE
Khavda site is under coastal region. The minimum weight of the zinc coating shall be 900 gm/sq.m for all items having thickness of 6mm and above. All factor as coastal consideration shall be applicable. Refer GTR for details.

1.3.2 QUALIFYING REQUIREMENTS:

Refer Annexure-TQR

1.3.3 TYPE TESTING, INSPECTION, TESTING & INSPECTION CERTIFICATE

i. 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.

ii. 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 equipment/ 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/representative authorized by POWERGRID/representative of Utility /representative of accredited test lab/representative of The National Accreditation Board for Certification Bodies (NABCB) certified agency shall also be acceptable.

Unless otherwise specified elsewhere, the type test reports submitted shall be of the tests conducted within 10 years from the date 22.11.24. In case the test reports are of the test conducted earlier than the 10 years from the date 22.11.24, the Bidder shall repeat these test(s) at no extra cost to BHEL/Employer.

iii. 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 BHEL/Employer. The Bidder shall intimate the Employer/BHEL 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.

iv. 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 except in the case of re-deputation if any, necessitated due to no fault of the Employer.

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1.3.4 Quality Plan

Bidder should have POWERGRID approved and valid quality plan at contract stage. In case bidder don't have POWERGRID approved Quality plan, it will be bidder's responsibility to get its quality plan approved directly from POWERGRID.

1.3.5 Deviations

The bidder shall list all the deviation from the specification separately in Annexure-A. 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.

1.3.6 PACKING

i. All equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and outdoor storage (for a minimum period of 6 months) at site till the time of erection. While packing all the materials, the limitations from the point of view of availability of transportation facilities in India should be considered. The Bidder shall be responsible for any loss or damage during transportation, handling and storage.

ii. The Bidder shall include and provide for security, protection and packing the equipment so as to avoid loss or damage during transport by any mode.

iii. All packing shall allow for easy removal and checking at site. Wherever necessary, proper arrangement for attaching slings for lifting shall be provided. All packages shall be clearly marked for with signs showing 'UP' and 'DOWN' side of boxes, and handling and unpacking instructions as considered necessary. Special precautions shall be taken to prevent rusting of steel and iron parts during transit and storage. Gas seals or other methods proposed to be adopted for protection against moisture during transit shall be to the satisfaction of the purchaser.

iv. The cases containing easily damageable material shall be very carefully packed and marked with appropriate caution symbols i.e. FRAGILE, HANDLE WITH CARE, USE NO HOOKS etc.

v. Each package delivered under the contract shall be marked by the Bidder at his expense and such marking must be distinct (all previous irrelevant marking being carefully obliterated). Such marking shall show the description and quantity of contents, the name of consignee and address, the gross and net weights of the package, the name of Bidder with a distinctive number of mark sufficient for purpose of identification. All markings shall be carried out with such materials as to ensure quickness of drying, fastness and legibility.

vi. Each Package shall contain a note quoting specifically the name of the Bidder, the number and date of contract or order and the name of office placing the contract, nomenclature of the stores and include a schedule of parts for each complete equipment giving the parts number with reference to the General Arrangement/ Assembly drawing and the quantity of each part, drawing number and tag numbers.

vii. All equipment/ material shall be suitably packed for transport, carriage at site and outdoor storage during transit. The Bidder shall be responsible for any damage to the equipment during transit. The contents of each package shall bear marking that can be readily identified from the package list and packing shall provide complete protection from moisture, termites and mechanical shocks etc.

viii. Any material found short inside the packing cases shall be supplied by the Bidder without any extra cost.

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ix. Notwithstanding anything stated in this clause the Bidder shall be entirely responsible for any loss, damage or depreciation to the stores.

x. Outdoor equipments shall be covered with waterproof and dustproof covers to protect them from water seepage and moisture ingress.

xi. All indoor equipments including control and protection panels, communication equipments and operating mechanism boxes, current carrying parts (Finger contacts) of isolators etc. of outdoor equipments shall be stored indoors.

xii. **Further, all equipments with polymer insulators/ housings, shall be provided with rodent proof arrangement (Preferably covered with stainless steel mesh**).

1.3.7 Approval of Engineering Drawings and Documents

Date of Submission of first lot of drawings will be counted only from the date of submission of reasonably correct drawings. List of drawings required for technical clearance of manufacturing are as follows:

1. Approved GTP
2. Approved GA.
3. Approved Type Test Reports

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ANNEXURE-1 BOQ

Station HVDC KPS2

SN	Item No.	Material Code	Item Description	Unit	Total Qty
1	346	TB9270000896	SUPPLY- POST INSULATORS : DC POST INSULATOR, POLYMER TYPE (82KV, FOR DC NEUTRAL, ITEM NO-346)	Nos.	50
2	347	TB9270000961	SUPPLY- POST INSULATORS : DC POST INSULATOR, POLYMER TYPE (66KV, FOR BIPOLE, ITEM NO-347)	Nos.	199
3	348	TB9270000903	SUPPLY- POST INSULATORS : DC POST INSULATOR, POLYMER TYPE (133.5KV, FOR DC FILTER 2/6, ITEM NO-348)	Nos.	22
4	349	TB9270000926	SUPPLY- POST INSULATORS : DC POST INSULATOR, POLYMER TYPE (66KV, FOR DC FILTER 2/6, ITEM NO-349)	Nos.	38
5	350	TB9270000931	SUPPLY- POST INSULATORS : DC POST INSULATOR, POLYMER TYPE (69.9KV, FOR DC FILTER 12/24, ITEM NO-350)	Nos.	34
6	351	TB9270000941	SUPPLY- POST INSULATORS : DC POST INSULATOR, POLYMER TYPE (66KV, FOR DC FILTER 12/24, ITEM NO-351)	Nos.	18
7	-	TB9270000955	SUPPLY- POST INSULATORS : DC POST INSULATOR, POLYMER TYPE (82KV, FOR DC DISCONNECTOR)	Nos.	42

Note:

Technical Paramter for S.no-7 above for DC POST INSULATOR, POLYMER TYPE (82KV, FOR DC DISCONNECTOR) is below. This insulator should meet the operational requirement of DC disconnector.

Refer Section-2 for technical parameter of item no 346 to 351.

Description	Rated DC voltage	Base voltage for creepage distance, phase-earth	SIWV	LIWV	Min Arching distance	Min Creepage distance	Min Cantilever Load	Shed profile
DC POST INSULATOR, POLYMER TYPE (82KV, FOR DC DISCONNECTOR)	70kVdc	82kVrms	460kVp	644kvp	-	FOR POLYMER TYPE 82x55=4510mm	2kN	DC Profile

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SECTION-2

This Section comprised of following documents.

1. Doc No.- 1JNL2470373: Bill of Material for Low Voltage Composite and Ceramic Post Insulator (Input to BHEL) for KPS2 HVDC & Nagpur HVDC.
2. Doc No.- 1JNL238249: DC Composite HTM Post Insulators for KPS2 HVDC & Nagpur HVDC
3. Doc No.- 1JNL2329626_en_APP Seismic Qualification Procedure for KPS2 HVDC & Nagpur HVDC
4. Section HVDC Equipment.
5. Section Switchyard Erection (Post Insulator) & Annexure-C: Corona & RIV test.

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HVDC

Parts list

± 800 kV, 6000 MW HVDC terminals associated with HVDC Link between Khavda Power Station-2 (KPS2), Gujarat and Nagpur, Maharashtra under Transmission system Package for potential REZ in Khavda area of Gujarat under Phase V-Part A (8GW) KPS2 HVDC & Nagpur HVDC	Customer Document number, revision TB202464-1002779-KP3660-LST-06088, 1		Page 2 of 9
	Lead Partner of JV's Doc. Number, revision 1JNL2470373, B		Language en
	Other Partner of JV's / Supplier Doc. Number, revision 1JNL2470373, B		
	Status Approved	Owning Organization Plants & Civil - Mechanical Plant Design	
Prepared Ashish Yadav, 2026-05-08	Approved Srinivasan Kaliyamurthy, 2026-05-11	Class.no 353	
Title Bill of Material for Low Voltage Composite and Ceramic Post Insulator (Input to BHEL) for KPS2 HVDC & Nagpur HVDC			

Contents

1. **Quantities for low voltage Insulators KPS2 (table 1).. 3**
2. **Quantities for low voltage Insulators Nagpur (table 2)5**
3. **Technical data for KPS2 (table 3) 6**
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HVDC

Parts list

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Title
Bill of Material for Low Voltage Composite and Ceramic Post Insulator (Input to BHEL) for KPS2 HVDC & Nagpur HVDC

Network/Cost Center/Order No.	RS No.
-	Refer BHEL document

1. Quantities for low voltage Insulators KPS2 (table 1)

Item No.	Description	Quantity, Valve Hall (for 4 poles)	Quantity, DC Hall (for 4 poles)	Quantity, DC Filter (for 4 poles)	Quantity, Bipole Area	Customer Spare	Total Quantity
	Valve Hall						
346	DC Neutral post insulator (Polymer)						50
347	Bipole post insulator (Polymer)						199
348	DC Filter 2/6 post insulator (Polymer)						22
349	DC Filter 2/6 post insulator (Polymer)						38
350	DC Filter 12/24 post insulator (Polymer)						34

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HVDC

Parts list

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Title
Bill of Material for Low Voltage Composite and Ceramic Post Insulator (Input to BHEL) for KPS2 HVDC & Nagpur HVDC

351	DC Filter 12/24 post insulator (Polymer)						18

Note:

1. Adequate installation spares will be provided, and any surplus installation spares will be taken back by Hitachi.

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HVDC

Parts list

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Title
Bill of Material for Low Voltage Composite and Ceramic Post Insulator (Input to BHEL) for KPS2 HVDC & Nagpur HVDC

3. Technical data for KPS2 (table 3)

Item No.	Description	Voltage to ground (kV)	SIWV (kV)	LIWV (kV)	Min. arcing distance (mm)	Min. creepage distance (mm)	Insulator length (mm)*	Max Mech. Load MML (kN)	Preferred base fitting	Preferred top fitting	Shed profile	Remarks
		Note 1			Note 2			Note 3			Note 4	Note 5
	(Porcelain)											
346	DC Neutral post insulator (Polymer)	82 kV	490	504	1250	4510	-	10	-	-	DC-profile	UpS
347	Bipole post insulator (Polymer)	66 kV	460	644	1350	3630	-	10	-	-	DC-profile	UpS
348	DC Filter 2/6 post insulator (Polymer)	133.5 kV	757	1154	2470	7343	-	10	-	-	DC-profile	UpS
349	DC Filter 2/6 post insulator (Polymer)	66 kV	627	753	1800	3630	-	10	-	-	DC-profile	UpS
350	DC Filter 12/24 post insulator (Polymer)	69.9 kV	515	834	1670	3845	-	10	-	-	DC-profile	UpS
351	DC Filter 12/24 post insulator (Polymer)	66 kV	460	644	1290	3630	-	10	-	-	DC-profile	UpS
	DC Hall CCT arrangement											

* Insulator Length shall be always equal or longer than the insulator arcing distance plus the flange's height.

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5. Application Notes

Note 1: Voltages are provided as reference.

Note 2: The supplier is requested to provide an insulator based on the following priorities: minimum insulator arcing length, insulator length and minimum creepage distance. For insulators with creepage distance longer than the minimum creepage requirement, the shed profile shall be evenly distributed along the whole insulator length. Definitions for insulators:

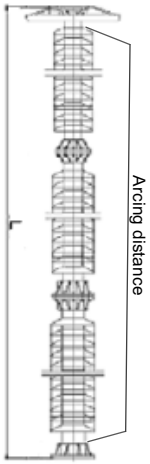

Figure 1. Definition of post insulator length

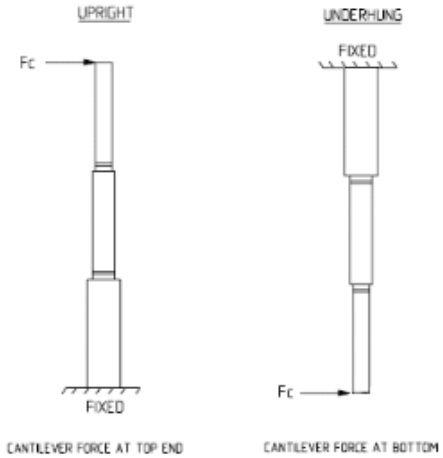

Figure 2. Definition of cantilever strength

Note 3: If not otherwise stated, the minimum specified mechanical load shall be carried out in bending.

Note 4: AC-profile or DC-profile according to insulators' technical specifications. N.A for insulators with no profile requirements.

Note 5: No comment (UpS): installed upright with support structure.
HNS: installed horizontal on the wall without support structure.
UpNS: installed vertically upright on the floor without support structure.
UnNS: installed vertically underhung hanging from the ceiling without supporting structure.

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1	2025-10-23	Updated Type tests list as per ROR comments	Dinesh H	Ragupathya Raja	Srinivasan Kaliyamurthy
0	2025-09-29	For Approval	Dinesh H	Ragupathya Raja	Srinivasan Kaliyamurthy

Client:

POWERGRID WEST CENTRAL TRANSMISSION LIMITED

Consultant:

पावर ग्रिड कॉर्पोरेशन ऑफ इंडिया लिमिटेड
(भारत सरकार का उद्यम)
POWER GRID CORPORATION OF INDIA LIMITED
(A Government of India Enterprise)

Lead Partner Of JV:

HITACHI ENERGY INDIA LIMITED

Other Partner Of JV:

BHARAT HEAVY ELECTRICALS LIMITED

Project title:

± 800 kV, 6000 MW HVDC terminals associated with HVDC Link between Khavda Power Station-2 (KPS2), Gujarat and Nagpur, Maharashtra under Transmission system Package for potential REZ in Khavda area of Gujarat under Phase V-Part A (8GW)

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	Category I:	Approved
	Category II:	Approved with Comments
	Category III:	Returned for Correction
	Category IV:	For Information

Contract Ref No:	Supplier:
CC/T/W-HVDC/DOM/A02/24/04941/NOA-1/24-114048/01,05,06,07 Date:22-11-2024 **CC/T/W-HVDC/DOM/A02/24/04941/NOA-2/24-114048/02 Date:22-11-2024** **CC/T/W-HVDC/DOM/A02/24/04941/CA-3/24-114048/03 Date:22-11-2024** **CC/T/W-HVDC/DOM/A02/24/04941/CA-4/24-114048/04 Date:22-11-2024**	**HVDC**

Document Type:	Station Name:	Product Class
Requirement specification	**KPS2 & Nagpur HVDC**	**353**

Document Title:

DC Composite HTM Post Insulators for KPS2 HVDC & Nagpur HVDC

Customer Document Number:	Revision:	Page:
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	Status Approved	Owning Organization Plants & Civil - Mechanical Plant Design	
Prepared Dinesh H, 2025-10-24	Approved Srinivasan Kaliyamurthy, 2025-10-27		Class.no 353
Title DC Composite HTM Post Insulators for KPS2 HVDC & Nagpur HVDC			

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1. General

This requirement specification state the general requirements on HVDC station insulators used to support high voltage bus works. This specification does not apply to equipment insulators where specific requirements specification exist.

This specification provides the general requirements on main circuit equipment deliveries for the converter stations for the Khavda-Nagpur 6000 MW, ± 800kV LCC HVDC Link.

The insulators shall also comply with the applicable requirements given in Section: HVDC Equipment Clause 10 (HVDC INSULATORS, BUSHINGS, BUSES AND HARDWARE), Section-(Switchyard Erection) 8.0 (BUS POST INSULATORS) & Annexure-C (ANNEXURE-C CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST) of the Customer's Technical specification and General Requirements for Main Circuit Apparatus 1JNL2918290. The insulators shall be complete including needed corona rings. In case of any conflict between this RS, Customer Technical Specification and General Requirements for Main Circuit Apparatus, the supplier shall inform Hitachi energy for a final decision.

In case of conflicting information between this requirement specification and the standards referred to, this requirement specification shall prevail.

1.1 Definitions

The following terms are used in this requirement specification:

- Owner: *Power Grid Corporation of India Limited*
- Contractor: Hitachi Energy, HVDC
- Manufacturer: Supplier of the polymer insulators

Composite insulator: A composite insulator is an insulator that is made, partly or completely, of polymeric materials of one or more types. More rigorous definitions are given in IEC 61462 [3], IEC 62231 [2], *IEC 62217 [4]* and DL/T 810-2002 [5].

HTM and non-HTM Material: Polymer materials exhibit hydrophobicity and the capability to transfer hydrophobicity to the layer of pollution are referred to in this requirement specification as hydrophobic property transferable material (HTM). Material with silicone rubber as base material is the most common HTM. Other materials, such as porcelain or other type of polymer materials, which do not exhibit hydrophobicity transfer, are referred to as non-HTM.

Installation angle**:** Vertical: The center axis of the insulator is within 90 ±15° to the horizontal plane.

Angled: The insulator is at other positions than vertical.

Average diameter: The average diameter of the insulator shall be calculated from the core diameter and sheds diameter as given in IEC/TS 60815-2 [7].

1.2 Access

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The Contractor and Owner shall have the right to inspect the Manufacturer's facilities that are used for carrying out the Contractor orders.

2. Quantities and technical data

Quantities and Technical Data shall be in accordance to the enclosed document 1JNL238306, 1JNL238307 [I].

3. Standards

The insulators shall be designed, according to applicable standards, see section 10.

4. Environment

4.1 Outdoor environment

		KPS2	*Nagpur*
Maximum temperature	°C	*50*	*50*
Maximum 24h average temperature	°C	*40*	*40*
Minimum temperature	°C	*0*	*0*
Annual mean dry bulb temperature	°C	*30*	*30*
Maximum wet bulb one hour average	°C	*33*	*33*
Dry bulb temperature for low ambient condition	°C	*33*	*33*
Wet bulb temperature for low ambient condition	°C	*23*	*23*
Elevation above sea level	m	*<1000m*	*<1000m*
Maximum gust (wind velocity)[1]	m/s	*50*[2]	*44*[2]
UV Radiation	W/m^2	*1000*	*1000*

[1] Wind speed shall be applicable at 10m height above mean ground level. Further reference shall be taken from National Building Code of India and IS 875.
All structures shall be designed for wind forces in accordance with IS -875 (Part III) – 2015[27].

[2] The basic wind speed (maximum gust) can be modified into design wind speed by considering the following factors as per National building code 2016.
KPS2 lies in wind Zone V with basic wind speed of 50m/s. The risk coefficient (K1 factor) shall be taken as 1.08. For Terrain, Height Factor (K2 factor) terrain category I shall be considered. Topography (K3 factor) shall be taken as 1. Importance factor for the cyclonic region (k4 factor) shall be taken as 1.3.
Nagpur lies in the wind Zone III with basic wind speed of 44m/s. The risk coefficient (K1 factor) shall be taken as 1.07. For Terrain, Height Factor (K2 factor) terrain category II shall be considered. Topography (K3 factor) shall be taken as 1. Importance factor for the cyclonic region (k4 factor) shall be taken as 1.

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Pollution level[3]	class	*e-very heavy*	*d - heavy*

4.2 Indoor with humidity controlled environment

Equipment in		*Valve hall*	*Indoor DC Hall (KPS2 station)*
Maximum temperature	°C	*60*	*50*
Minimum temperature	°C	*5*[4]	*0*
Maximum relative humidity	%	*60*[5]	*60*
Minimum relative humidity	%	*10*	*10*
ESDD[6] per year	mg/cm^2	*< 0.003*	-

4.3 Seismic requirements

The seismic design of apparatus shall comply with *1JNL2329626_en Seismic qualification procedure for KPS2 HVDC & Nagpur HVDC [III]*

Peak ground acceleration (PGA)	g	*0.27g for Zone V - KPS2*
Peak ground acceleration (PGA)	g	*0.08g for Zone II - Nagpur*

5. Design

The support insulators shall be in accordance with the relevant Clause of this Specification. The insulation levels shall be determined by the Contractor in accordance with RFP and the requirements of this Specification. If joint in insulator, tube or conductor is unavoidable, and then no relaxation in creepage & flash distance shall be acceptable. Joint in condenser core is not acceptable. Conductor and condenser tube shall be without joints.

5.1 External surface materials of insulators (HTM)

Insulators with HTM surface shall be examined and qualified by relevant tests and the test reports shall be sent to Hitachi Energy, HVDC for approval. Insulators without accepted test reports to qualify the hydrophobic characteristics shall be treated as insulators with non-HTM.

5.1.1 Qualification of HTM

Insulators with HTM surface are characterized by three criteria: exhibit hydrophobicity on the clean surface, the capability to transfer hydrophobicity

[3] Pollution level d - heavy for Nagpur station and e-very heavy for the KPS2 station as per IEC/TS 60815-1[6] shall be considered.
Khavda station is in coastal area with difficult environmental conditions, such as sandstorms and saline storms.
[4] The minimum temperature during normal operation is 10 °C in the Valve hall.
[5] The maximum relative humidity in the valve hall is 50% during normal operation
[6] ESDD = Equivalent Salt Deposit Density

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to the layer of pollution, and the capability to recovery its hydrophobicity after temporarily loss of the hydrophobicity. All these three characteristics shall be examined and qualified in type tests with relevant test methods as described in DL/T 810-2002 [5]. For an English version of the relevant parts of DL/T 810-2002, see Annex.

5.1.2 Resistance to tracking and erosion

All the composite insulators to be used in d.c. applications shall have a good ability to prevent tracking and erosion caused by discharges and leakage current.

For insulators used outdoors, this ability shall be examined and qualified in type tests with relevant test methods as described in IEC 61462 [3], IEC 62231 [2], and DL/T 810-2002 [12].

For insulators used indoors, this ability, classified as Comparative Tracking Index (CTI), should be examined and qualified in type tests with relevant test methods as described in IEC 60112 (2009) [9].

Note: Composite insulators which are qualified with respect to tracking and erosion for outdoor purposes are automatically qualified for indoor applications assuming a CTI>400, without any further testing.

5.2 Qualification of internal insulation

Internal insulation of polymer insulators is subject to a technical qualification. The technical qualification acceptance shall be issued by Hitachi Energy, HVDC.

5.3 Qualification of supplier

External suppliers are subject to a technical qualification from their technical solution to their manufacturing process and quality control and long-term reliability. The technical qualification acceptance shall be issued by Hitachi Energy, HVDC.

5.4 Creepage distances

5.4.1 General

The unified specific creepage distance (USCD), as per IEC/TS 60815-1 [6], shall be used. USCD is the creepage distance of an insulator divided by the rms value of the highest operating voltage across the insulator, given in mm/kV. This voltage is evaluated by:

$U_{rms} = \sqrt{U_{DC}^2 + \sum_n U_n^2}$, where U_n is the fundamental voltage including possible harmonics 'n' added across the insulator in rms.

5.4.2 Corrections

5.4.2.1 Diameter

For a.c. application, the correction factor due to diameter of insulator shall be taken in account. For HTM insulators it shall be taken in account according to IEC/TS 60815-3 [8].

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For DC application, the correction factor due to diameter of insulator shall be supposed to be 1 for HTM insulators.

5.4.2.2 Air density

When applicable, correction will be applied for the change of air density from reference conditions due to a higher temperature or/and a higher altitude for insulators with non-HTM. For insulators with HTM, correction for air density is not required.

5.4.3 Outdoor environment

For outdoor insulators the minimum nominal creepage distance shall be:

KPS2 station

- *DC Application: 55 mm/kV, based on U_{rms} given above*

Nagpur station

- *DC Application: 50 mm/kV, based on U_{rms} given above*

5.4.4 Indoor with humidity controlled environment

For indoor insulators with controlled environment the minimum nominal creepage distance shall be:

Valve Hall

- *for DC application (or AC plus DC)[7]: 21 mm/kV, based on U_{rms} given above*

Indoor DC Hall- KPS2 Station only

- *for DC application: 33 mm/kV, based on U_{rms} given above*

5.5 Insulator shed profile

5.5.1 General

The insulator shed profile (form) shall be according to the requirement by Hitachi Energy, HVDC. For profiles deviating from the requirement, drawing and justification of function shall be sent to Hitachi Energy for approval.

At the following conditions, deviations from the profile requirement may be accepted after approval by Hitachi Energy, HVDC:

1. No profile requirement for insulators used at the indoor conditions that maximum relative humidity is always lower than or equal to 60%.
2. No profile requirements for insulators at d.c. neutral voltage.
3. No profile requirements for insulators with an average diameter smaller than 100 mm.
4. No profile requirements for insulators at a near horizontal position

[7] 14 mm/kV can be used if CTI≥400 is fulfilled according to Clause 5.1.2 in 1JNL2918290_General Requirements for Main circuit Apparatus

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5. Profiles with smaller shed spacing than required may be accepted for the insulators used at the indoor conditions that maximum relative humidity may become higher than 60%.
6. Profiles that deviating from the requirement may be accepted for clean outdoor conditions (verified by systematic pollution measurement or by the satisfactory operational experience for more than 5 years of an existing project of the same voltage level).

Parameters of insulator sheds are given the figure below.

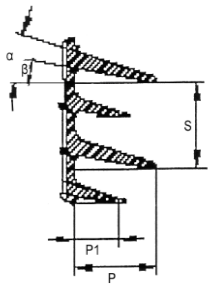

Figure 1. Parameters of insulator sheds. Alternating profile of a polymer insulator

5.5.2 Polymer insulators, DC

The polymer shed should have excellent electrical and mechanical characteristics. In addition, the polymer shed should be homogenous, free from laminations, cavities or other flaws affecting its mechanical strength or dielectric quality.

For polymer insulators with non-HTM, the shed profile requirement shall be the same as that for porcelain insulators.

Requirements for d.c. polymer insulators with HTM:

- Spacing for nominal d.c. voltage up to 525 kV: S ≥ 60 mm.
- Spacing for nominal d.c. voltage higher than 525 kV: S ≥ 65 mm
- The ratio between shed spacing and overhang: S/P ≥ 0.9.
- The overhang difference between big shed and small shed: 15 mm < (P-P1) ≤ 20 mm.
- Upper inclination angle α >10°
- Lower inclination angle β>3°.

Note: A too large value of β will result in an area with high pollution accumulation and therefore is not recommended.
If helicoid shed profile is used in vertically mounted insulators, the combination of pitch and α shall be such that the lip inclination shall be at least 4° less than α, so that rain water will run off the shed, rather than along it.

5.6 Colour of glaze

Colour of polymer insulators shall comply with requirements as per IEC 61462 [3]. *The colour shall preferably be grey, RAL 7035 or similar.* Other colours may be used after approval from Hitachi Energy, HVDC.

5.7 Surface treatment

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Ferrous metallic fittings shall be hot dip galvanized. Hot dip galvanized coating on fabricated iron and steel articles shall be according to ISO 1461 [12].

5.8 Visual corona

The insulator shall be corona free at 1.3 times the rated voltage according to IEC 61284 [11].

6. Marking

Each insulator shall be marked/identified as defined in IEC 61462 [3] for hollow core insulators. *Also shall be According to supplier's standard.*

7. Tests

7.1 General

The insulators shall be tested according to the service conditions for each insulator item given in the quantities and technical data [I]. Previous test reports may be accepted after approval from Hitachi Energy, HVDC.

The insulators shall be tested (type tests, sample tests and routine tests) according to IEC 61462 [3] for hollow core insulators. Relevant requirements given by the Owner in the Technical Specification of this project shall be responded accordingly.

Test certificates shall be certified test reports from official independent laboratories or under the surveillance of an internationally recognized inspection agency. Test records and reports shall be included in the supply of documentation.

7.2 Type tests

Electrical type tests shall be according to IEC 60168. Standard mounting arrangement standing on metal support of height 2.5 m shall be considered for type tests. Deviation from the standard mounting arrangement according to section 4.4.2 of IEC 60168 shall be accepted after approval from Hitachi Energy, HVDC.]

Mechanical type tests shall be according to IEC 61462 [3] for hollow core insulators.

Type tests shall be performed under the conditions stated below,

Certified type tests reports, from tests already performed on a similar (or identical) design may be accepted in lieu of performing new type tests, if those are performed later than November 22, 2009. To be applicable, both the design and testing requirements have to comply with this Requirement Specification. The justification for compliance shall be made by means of a Type Test Summary Report (TTSR), sufficiently detailed regarding similarities and differences in design and testing, to facilitate and support an approval of reports from previously performed type tests.

The certified type test reports and supporting TTSR shall be referred to in the ITP and submitted together with the ITP for approval.

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Failure of any unit to meet any test requirement shall constitute grounds for Hitachi Energy to reject all units of the design.

7.2.1 Radio interference test [dry]

Radio interference test shall be according to IEC 60437 [10]. Atmospheric correction shall be applied according to IEC 60060-1 [1].

It shall also comply as per Customer Technical specification, Annexure C (CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST)

7.2.2 Power frequency withstand test (dry & wet)

Test according to IEC 60168 [15] shall be performed.

7.2.3 Lightning impulse withstand voltage test (dry)

Test according to IEC 60168 [15] shall be performed. No flashover shall occur.

7.2.4 Switching impulse withstand voltage test (dry & wet) (For 420 kV and above class Insulator only)

Test according to IEC 60168 [15] shall be performed. No flashover shall occur.

7.2.5 Dry DC Withstand Voltage test

Test according to IEC/IEEE 65700-19-03 Clause 10.2.2 shall be performed as a dry test. No flashover shall occur.

7.2.6 Corona extinction voltage test (Dry)

Test according to IEC 61284 [11] and other applicable standards shall be performed and shall comply as per Customer Technical specification, Annexure C (CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST)

7.2.7 Mechanical failing load test/Verification of Specified Mechanical load/Mechanical tests

Test according to IEC 60168 [15] shall be performed.

7.2.8 Bending test / Test for deflection under load

Test according to IEC 61462 [3] as per Clause 8.5 shall be performed.

7.2.9 Test for mechanical strength

Test according to IEC 60168 [15] shall be performed.

7.2.10 Internal Pressure test

Test according to IEC 61462 [3] as per Clause 8.4 shall be performed.

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7.2.11 Type test reports

A Type Test Summary Report (TTSR), with a complete summary of type tests with each required type test reports and verifications listed for each insulator type, shall be provided to the Contractor. Type tests reports performed on each type of insulator shall be provided to the Contractor.

The Manufacturer shall fill in the document numbers of applicable existing certified type test reports. If test reports and verifications from **previously performed** type tests or verifications are referred to, the Manufacturer shall give details regarding similarities and differences in the design and **supporting the approval of such test reports and verifications**. The report shall provide sufficient identification of the goods.

7.3 Sample test

Sample tests shall be performed as applicable on the number of post insulators selected at random from the lot. Sample tests shall be in according to IEC 61462 [3] & *IEC 60168 [15]* for hollow core insulators.

7.3.1 *Verification of dimensions*

Test according to IEC 60168 [15] / IEC 61462 [3] shall be performed.

7.3.2 *Temperature cycle test*

Test according to IEC 60168 [15] shall be performed.

7.3.3 *Mechanical failing load test/Verification of Specified Mechanical load/Mechanical tests*

Test according to IEC 60168 [15] / IEC 61462 [3] shall be performed.

7.3.4 *Porosity test*

Test according to IEC 60168 [15] / IEC 61462 [3] shall be performed.

7.3.5 *Puncture test*

Test according to IEC 60168 [15] shall be performed.

7.3.6 *Galvanizing test*

Test according to IEC 60168 [15] / IEC 61462 [3] shall be performed.

7.3.7 *Ultrasonic test*

Test according to IEC 60168 [15] shall be performed.

7.4 Routine tests

Every station insulator shall be subjected to the applicable tests according to IEC 61462 [3] for hollow core insulators

7.4.1 *Routine visual examination*

Test according to IEC 61462 [3] as per Clause 10.2 *shall be performed.*

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7.4.2 *Routine Mechanical test*

Test according to IEC 61462 [3] as per Clause 10.3 *shall be performed.*

7.4.3 *Routine Pressure test*

Test according to IEC 61462 [3] as per Clause 10.4 *shall be performed.*

7.4.4 *Routine Tightness test*

Test according to IEC 61462 [3] as per Clause 10.5 *shall be performed.*

7.4.5 Routine test reports

Routine tests shall be performed on each unit to demonstrate the integrity of manufacturing and the ability to meet design requirements. Certified routine test records shall always be submitted to contractor after completion of the testing.

The routine tests shall fulfil the requirements given in this requirement specification. The tests shall be sufficiently described, named according to applicable standard and with reference to the applicable standard stated.

A table of content shall be provided in case the equipment consists of combined apparatus subject to routine test. The report shall provide sufficient identification of product including the project specific references given by the Contractor.

7.5 *Additional test:*

In addition to acceptance/sample/routine tests as per IEC 60168 [15], the following tests shall also be carried out.

a) Soundness test, metallurgical tests and magnetic particle Inspection (MPI) test on MCI/SGI caps as acceptance test.

b) All hot dip galvanised components shall be subjected to check for uniformity of thickness and weight of zinc coating on sample basis as an acceptance test.

c) The bending test shall be carried out at 50% minimum cantilever strength load in four directions as a routine test and at 100% minimum cantilever strength load in four directions as an acceptance test.

d) Acceptance norms for visual defects allowed at site and also at works shall be agreed in the Quality plan.

7.5.1 Inspection and test plans (ITP)

The Manufacturer shall submit Inspection and Test Plans based on the requirements of this requirement specification.

The inspection and test plan shall cover all essential inspections for the product and shall state, detailed enough for full understanding, the required inspection and testing methods, acceptance criteria, reports, etc. All reference documents and quality records referred to in ITP's shall be open to purchaser and his client for review at the Manufacturer's premises.

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Hold points and/or witnessing points, normally including type- and/or routine tests, shall be defined in the ITP's.

8. Documentation

8.1 General

All documents shall conform to international practice and shall be issued with a unique and easily identifiable document number.

Whenever a document is changed in any way, a new revision of said document shall be issued. The revision number, date and reason for revision shall clearly be indicated. Page one of a document shall always be issued with a new revision number, whenever any other page of the document is revised.

The Manufacturer shall be responsible for any errors or omissions in the Manufacturer's documentation.

It is the Manufacturers responsibility to ensure that the information imparted in the documentation is sufficient in all respects.

The documentation shall be considered as of equal importance as any other part of the supply.

8.2 Document types

The delivery shall include, but not be limited to, the following document types:

- Outline drawing. A drawing for each type of insulator shall be provided with the necessary number of views showing:
  - Partial and total dimensions shown in different views
  - Center of gravity
  - Mounting details
  - Creepage distance
  - Mechanical properties
  - Type of insulator (ceramic/non ceramic)
  - Material
  - Color
  - Weight
  - Withstand test voltages
  - A title block showing the Contractor identity number.

  The drawings shall also include information of "Project name" or "Base Insulator" (as defined in the Bill of Quantity).

- Installation instructions
  The instruction shall describe in detail, the complete installation procedure, including installation verification, in step-by-step form. If any special tools or material are necessary, this should be mentioned at the beginning of the instruction.

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- Type Test Summary Report (TTSR)
- Type tests (if required by the Owner)
- Inspection and test plan (ITP).
- Final tests/acceptance reports (FAT reports)
- Material certificates (if required by the Owner).
- Spare parts list
  The list shall contain all spare parts included in the delivery. It shall be in tabular form and contain the following information about each spare part:
  - Article number (supplier's own)
  - Article description
  - Type, technical data, dimensions if applicable
  - Quantity
  - Equipment group
  - Position according to purchase order
  - Storage requirements
  - Drawing reference, where applicable
- Transport/storage instruction
  The instruction shall contain requirements on how to handle equipment during transportation and storage.
- Safety Data Sheet (SDS)
  The SDS shall be provided for all chemicals, lubricants, etc required for installation and maintenance of the delivered insulators.
- Demolishing/End of life handling
  Information of how to disassemble the equipment in a safe way and how to handle the respective parts of it at the end of life stage shall be provided.
  The document shall describe the composition of the product, describing which materials are included in the insulators and how the materials shall be handled in a safe way, both in health and safety and environmental aspects. Information should also be given of which materials can be recycled etc.

The outline drawings shall be submitted to the contractor for review and approval before start of manufacturing.

A 3D model of each type of insulator shall also be delivered to the contractor to make it possible to review the suitability of the selected design in the station 3D model. The preferred file format is step (*.stp).

8.3 Language

The language in all documents shall be in English.

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9. Enclosures

I.	1JNL238306, 1JNL238307	Quantities and Technical Data
II.	1JNL2918290	General Requirements for Main circuit Apparatus
III.	1JNL2329626	Seismic qualification procedure for KPS2 HVDC & Nagpur HVDC
IV.	*Section: HVDC Equipment Clause 10 (HVDC INSULATORS, BUSHINGS, BUSES AND HARDWARE), Section-(Switchyard Erection) 8.0 (BUS POST INSULATORS) & Annexure-C (ANNEXURE-C CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST) of the Customer's Technical specification*	

10. References

1.	IEC 60060-1	High-voltage test techniques. General definitions and test requirements
2.	IEC 62231	Composite station post insulators for substations with a.c. voltages greater than 1000 V up to 245 kV – Definitions, test methods and acceptance criteria
3.	IEC 61462	Composite hollow insulators – Pressurized and unpressurized insulators for use in electrical equipment with rated voltage greater than 1 000 V – Definitions, test methods, acceptance criteria and design recommendations
4.	IEC 62217	Polymeric Insulators for Indoor and Outdoor Use With a Nominal Voltage > 1000 V — General Definitions, Test Methods and Acceptance Criteria.
5.	DL/T 810-2002	Electric Power Industry Standard of the People's Republic of China: Technical specification for ±500 kV DC long rod composite insulators.
6.	IEC/TS 60815-1	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 1: Definitions, information and general principles
7.	IEC/TS 60815-2	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 1: Definitions, information and general principles
8.	IEC/TS 60815-3	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 3: Polymer insulators for a.c. systems

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9. IEC 60112 (2009)	Method for the determination of the proof and the comparative tracking indices of solid insulating materials
10. IEC 60437	Radio interference test on high-voltage insulators
11. IEC 61284	Overhead lines – Requirements and tests for fittings
12. ISO 1461	Hot dip galvanized coatings on fabricated iron and steel
13. CIGRE 442	Evaluation of Dynamic Hydrophobicity Properties of Polymeric Materials for Non-ceramic Outdoor Insulation (2010)
14. IEEE 693	IEEE Recommended practice for seismic design of substations
15. IEC 60168	Tests on indoor and outdoor post insulators of ceramic material or glass for systems with nominal voltages greater than 1000 V

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11. Revision History

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First Revision for approval		
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Revision text		
Updated Document as per ROR comments. Added Type tests as per IEC 60168 & IEC 61462		

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12. Annex: Qualification of HTM

The following text is an excerpt from translated English text of clause 5.6 of DL/T 810-2002.

12.1 Hydrophobicity test

This test is to evaluate the hydrophobicity performance of the insulator, including hydrophobicity of housing/shed, transference of after polluted, loss and recovery of hydrophobicity under specified conditions.

The hydrophobicity is described with Contact Angle (θ) and Hydrophobicity Class (HC).

12.2 Test specimens

The formula and vulcanized formation process of the specimens should be identical to the insulator shed/housing assembled on product line. In case of difference of formula and vulcanized formation process between the insulator housing and shed, this test should be conducted on materials of housing and shed respectively.

a. Contact Angle (CA) method: three flat-type specimens, each with area of (30~50) cm^2, thickness of (3~6)mm.

b. Hydrophobicity Class (HC) method: five flat-type specimens, each with area of (50~100) cm^2.

c. Surface cleaning prior to test: Use Ethanol absolute to clean the surface and then rinse the surface with deionized water (or distilled water). After dried, place the specimens in a dust-proof container and keep them under standard laboratory conditions for at least 24 hours.

d. Specimen polluting and transference of hydrophobicity: after the specimens are pre-cleaned, spray the specimens with methods specified in B2.2 and B2.3 of Annex B, with salt density of 0.1mg/cm2, ash density of 0.5mg/cm2. After polluted, place the specimens in a dust-proof container under standard laboratory ambient conditions for transference of hydrophobicity over 4 days.

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12.3 Method of hydrophobicity measurement

a. Contact Angle (CA) method: This method has the purpose of revealing the hydrophobicity state on surface by directly measuring the static contact angle of [water] droplets on a solid surface. The contact angle (θ) may be measured with a CA meter, measuring microscope or photography. The volume of each droplet is about (4~7) μl (i.e. each droplet weighs 4~7mg). For each specimen, the θ of five droplets will be measured (the average of the 15 measurements on the three specimens is denoted in θ_{av}, minimum denoted in θ_{min}).

b. Hydrophobicity class (HC) method: This method has the purpose of revealing the hydrophobicity state on a solid surface so as to classify it into hydrophobicity classes. Seven classes of hydrophobicity (HC 1~ HC7) have been defined. HC 1 corresponds to a completely hydrophobic (water-repellent) surface and HC 7 to a completely hydrophilic (easily wetted) surface. See Annex E for description and typical condition of different classes of hydrophobicity.

   (1) HC measurement procedure: Spray [water] 1 time per second from a distance of 25cm. The spraying shall continue for 25 seconds. There should be runnels flowing down from the surface after the sprays. The spraying direction should be perpendicular to the surface of the specimen if possible. The judgment of the hydrophobicity class shall be performed within 30 seconds after the spraying has been finished. The specimen should be placed 20^0~30^0 from the plane surface.

   (2) Sprayer: a spray bottle may be used. The volume of each spray should be 0.7~1 ml, dispersion angle 50^0~70^0. Verification of the spray dispersion angle may be measured with the following method: erect a newspaper 25cm away from the spray nozzle, with the spraying direction perpendicular to the newspaper. After 10~15 sprays, a wet area with diameter of 25~35cm will be formed.

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12.4 Test procedure and passing criteria

Measure both the θ and HC for the specimen, which shall comply with the following criteria:

a. Hydrophobicity: Measure the θ and HC of the clean surface of the specimen with the methods specified in 5.6.2. See 5.6.1 for the test specimens. For housing and shed of composite insulators, the following criteria apply:

   (1) $\theta_{av} \geq 100^0$, $\theta_{min} \geq 90^0$;

   (2) Generally HC1~HC2, no more than 1 specimen measured to HC3.

b. Loss of hydrophobicity: Immerse 5 clean specimens into a glass vessel containing distilled water, for 96 hours, under standard lab ambient conditions. The distilled water should be enough to completely immerse the specimens, whose conductivity is less than 10μS/cm. See 5.6.1 for test specimens.

After taking the specimens out of the vessel, dry the surface with filter paper. Then randomly select three of the specimens and measure their Contact Angle and Hydrophobicity Class. For the other two specimens, only HC is measured. The measurement on each specimen should be finished in 10 minutes. The conformance criteria are as follows:

   (1) $\theta_{av} \geq 90^0$, $\theta_{min} \geq 80^0$;

   (2) Generally HC3~HC4, no more than 1 specimen measured to HC5.

c. Recovery of hydrophobicity: After completing the measurement in 5.6.3 b, place the specimens under standard lab ambient conditions for 48 hours. Then randomly select three of the specimens and measure their Contact Angle and Hydrophobicity Class. For the other two specimens, only HC is measured. The conformance criteria are as follows:

   (1) $\theta_{av} \geq 95^0$, $\theta_{min} \geq 90^0$;

   (2) Generally HC2~HC3, no more than 1 specimen measured to HC4.

d. Transference of hydrophobicity: Randomly select three of the five specimens that have been polluted and hydrophobicity transferred for 4 days with the method specified in 5.6.1 d. Then, randomly select three of the specimens and measure their Contact Angle and Hydrophobicity Class. For the other two specimens, only HC is measured. The conformance criteria are as follows:

   (1) $\theta_{av} \geq 110^0$, $\theta_{min} \geq 100^0$;

   (2) Generally HC2~HC3, no more than 1 specimen measured to HC4.

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12.5 Tracking and erosion test

The following text is an excerpt from translated text of clause 5.5.1 of Ref. DL/T 810-2002.

12.1.1 Tracking and erosion test on housing/shed

a. Test specimens: five specimens shall be tested in a group. The dimension of each specimen should be 120mm*50mm*6mm. The formula and vulcanized formation process of the specimens shall be identical to the insulator shed/housing assembled on product line. In case of difference of formula and vulcanized formation process between the insulator housing and shed, this test should be conducted on materials of housing and shed respectively.

b. Test system: inclined plane method as stipulated in IEC 60587 will be used in this test. The test system should provide +4.5 kV DC voltage. During the test, in case of 60mA current flowing at the high-voltage side for 0.5s, the output voltage drop should not be greater than 5%. The polluting liquid flowing through the surface shall be (0.2±0.05) ml/min.

c. Test procedure: mount the specimens and supply polluting liquid to the specimens as per stipulations in IEC 60587. Apply +4.5 kV voltage to the specimens and record the time. The test will last 6 hours. Before and after the test, measure the polluting liquid volume flowing through each specimen, record the test duration of each specimen as well as the aggregate volume of the polluting liquid used. The polluting liquid should not be reused.

d. Evaluation of the test: The test is regarded as passed if, after the 6 h test, no tracking occurs and the erosion depth is no more than 2.5mm. In such case, it will be deemed that the specimens have come up to Class 4.5.

12.1.2 DC dielectric strength test

The following text is an excerpt from translated text of clause 5.5.2 of Ref. DL/T 810-2002.

12.1.3 DC dielectric strength test on housing/shed

a. Test specimens: The thickness of the specimen should be (2±0.1) mm, other dimension indexes should comply with stipulations of IEC 60243-1.

b. Test system and procedure: This test is conducted as per IEC 60243-1. DC voltage is used as the test voltage, with voltage ripple factor no greater than 5%. DC dielectric strength test is made on each of the five specimens.

c. Compliance criterion: the DC dielectric strength of the specimens should not be smaller than 30 kV/mm.

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BHARAT HEAVY ELECTRICALS LIMITED

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HVDC

Report

± 800 kV, 6000 MW HVDC terminals associated with HVDC Link between Khavda Power Station-2 (KPS2), Gujarat and Nagpur, Maharashtra under Transmission system Package for potential REZ in Khavda area of Gujarat under Phase V-Part A (8GW) KPS2 HVDC & Nagpur HVDC	Customer Document number, revision TB202464-1002779-COMMON-STUDY-SEISMIC-REQU, 1		Page 2 of 16
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Title Seismic Qualification Procedure for KPS2 HVDC & Nagpur HVDC			

Summary

This document gives the Seismic Qualification Procedures for Electrical Equipment for Khavda Nagpur 6000MW +/- 800kV DC LCC at KPS2 and Nagpur Stations. The proposed HVDC link is a bipole line having voltage rating of ±800 kV with a nominal power rating of 6000 MW for transmission between the converter stations at KPS2 and Nagpur (1200 km).

Load definitions and combinations are given as well as procedures and scope of documentation.

The basic procedures for the seismic qualification of equipment shall be according to IS-1893 [2] with an asymptotic Peak Ground Acceleration (PGA) of 0.27g with the Design Response Spectrum (DBE) as depicted in Figure 2 in Appendix A. The PGA at Nagpur is 0.08g. This is a low seismic level where requirement on mechanical strength from seismic perspective is low compared to other mechanical stress factors like wind and weight etc. Therefore, as per relevant standards, no extra considerations, including test and reporting of tests, are needed for the equipment in Nagpur.

Alternatively, equipment can be judged qualified if they fulfill IEEE693 Moderate Level RRS 0.25g [4], IEC AF5 RRS 0.5g as defined in [5], or IEC AG5 RRS 0.5g as defined in [6], with relevant safety factors and applicable structural amplification of each standard.

The proposed procedures are intended to fully comply with the owner specification.

The seismic calculations for the equipment wherever applicable will be carried out by our inhouse expert team on seismic effect /external agencies having expertise on the seismic calculations as per the practice followed for other similar projects having high seismic requirements. Hitachi Energy team have engineers with extensive experience and fulfill requirement for seismic calculation expertise according to relevant standards, including IEEE 693-2018 section A.6.2. However, we have no access to any agency certifying the calculations done by our inhouse experts /external agencies.

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Appendix A – Design Response Spectra 12

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1. General

Hitachi Energy has an outstanding experience of seismic qualification of HVDC equipment satisfying severe seismic requirements for very strong earthquakes (California/USA and New Zealand) as wells as areas with moderate earthquake hazard (India, Quebec/Canada, among others).
Hitachi Energy has for the practical seismic verification process engaged experts with over 40 years' experience in the field dealing with Hitachi Energy deliveries of electrical high voltage equipment all over the world.
The seismic design philosophy based on previous experience is that basically standard configuration of electrical equipment can be used.
All significant equipment shall be carefully analyzed, checking all critical structural parts in order to demonstrate sufficient seismic withstand capability. The verification work shall be appropriately documented in technical reports and presented for information and review of the owner.
Hitachi Energy intends to fully comply with technical specifications and design procedures.

2. Load Specification and Load Combination

Stations Khavda and Nagpur are located in zone V and II, respectively, according to Map of Seismic Zones specified in IS-1893 [2].
Zone V gives the Seismic Intensity Very Severe with the zone factor Z=0.36, and Zone II gives Seismic Intensity Low with the zone factor Z=0.1. Assuming soft soil (Type III) which may be somewhat conservative, gives the asymptotic Peak Ground Acceleration (PGA) of 0.27g for Zone V and 0.08g for Zone II. 2% damping shall be used for equipment unless otherwise can be shown.
The shape of proposed design response spectra is as directed in Indian Standard IS 1893 scaled to given peak zone factor z/2 times the importance factor I=1.5 as defined in Table 8 Clause 7.2.3 [2]. This corresponds to the DBE-Design Base Earthquake. The zone factor Z according to IS 1893 refers to the MCE-Maximum Considered Earthquake. The structure factor is taken to be R=1.0 for electrical equipment with possible brittle behavior. According to IS1893, for electrical equipment, the value of I/R=1.5 is used. This conservative assumption is due to that electrical equipment, with in particular brittle porcelain insulators, are more sensitive for its well function than typical more ductile building structures.
The Design Response Spectrum (DBE) is depicted in Figure 2 in Appendix A.

2.1 Seismic Load Specification

2.1.1 Static Analysis

For static analysis of dynamically rigid equipment (normally, lowest natural frequency above 35 Hz) the forces on each component of the equipment shall be obtained by multiplying the values of the mass of the component by the ground acceleration amplitude times the factors specified in each of the standards applicable. The resulting force shall be applied at the center-of-

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gravity of the component. As defined as simplified analysis method according to Indian Standard IS-1893 (2015) (Part 4), cl. 17.1 [3].
Clear definition regarding the frequency of the lowest eigenmode is to be stated to ensure static evaluation can be used.

The vertical force (67% of the horizontal) shall act simultaneously with both horizontal seismic forces. The horizontal forces are applied in the direction of the orthogonal axes.

The three forces at each component's center-of-gravity shall be applied using the SRSS (Square Root of the Sum of Squares) method.

2.1.2 Dynamic Analysis

Response spectrum analysis
Response spectrum analysis is commonly used for evaluating structural response to earthquake ground motion. The dynamic loads are defined in the time domain, but their corresponding response spectra have been computed and are presented in Figure 2 in Appendix A. The design response spectrum in vertical direction is 67% of horizontal one.
Response spectrum analysis is applicable to structures with overall linear behavior and will be the default analysis method.
Optional: Static coefficient method
For equipment having a few important modes in the seismic range, static coefficient method can optionally be used. The seismic forces on each component of the equipment are obtained by multiplying the values of the mass times the maximum peak of the design level spectra times the static coefficient. An equivalent static acceleration load of 1.5 times the peak spectral acceleration is to be applied to the equipment, unless otherwise noted herein, with 80% of the horizontal value being applied in the vertical axis [4]. The 1.5 factor accounts for multimodal effects.
Note that static coefficient analysis is not to be confused with static analysis, as described in 2.1.1. When applicable, static coefficient analysis is robust and conservative, enveloping RRS analysis. See also section 4 and section 5 (for each equipment type) for details.
Time history analysis
For structures associated with significant nonlinear behavior, time history analysis will be used. Time history analysis shall follow rules and guidelines in [4], section A.1.4.8. The applicable ground motion, as defined for each equipment type in section 5 will be applied and the structural response (displacements, stresses etc) will be computed at discrete time intervals, typically around 1/100th of a second.

2.2 Load Combination

Together with seismic load, applicable normal operational loads and dead weight shall be included, and also including the terminal connection forces, Table 1 [4], but not wind or short circuit load. Even though short circuit may be likely to occur during the seismic event, the peak response will be randomly correlated and not occurring at exactly the same instance as peak seismic response.

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Table 1 - Terminal forces for seismic qualification [4].

Voltage class	Direction	Terminal forces
< 110 kV < 90 kV DCV for surge arresters	Horizontal	None
110 kV to < 230 kV 90 to < 180 kV DCV for surge arresters		375 N
≥ 230 kN ≥ 180 kN DCV for surge arresters		300 N
All	Vertical	None

3. Design Criteria and Allowable Values

The equipment shall remain undamaged and operational during and after a seismic event within the design limits. For ductile structural materials such as structural steel and aluminum grades, local stress levels exceeding the yield strength can be accepted if the overall load bearing capacity is not exceeded.

For brittle components like porcelain insulator allowable load shall be less than 67% of minimum failure load (i.e. safety factor of 1.5). Different type of forces (axial tension/compression and bending) shall be combined appropriately into a design load. Note that safety factor when using IEEE693-2018 is typically between 2-2.5 depending on the number of porcelain insulator tested, as described in appendix X in IEEE693-2018 [4].

For polymeric insulators maximum load shall be 67 % of Specified Mechanical Load (SML-allowable exceptional force with short duration). Typically, SML is 2.5 times the Maximum Design Load (allowable long-term force).

4. Qualification Methods

In general, the seismic verification shall be done with analytical methods or testing.

Static analysis will be used for dynamically rigid equipment, i.e. with no natural frequencies below 35 Hz.

The basic method for dynamic analysis shall be response spectrum analysis, supplemented by time history analysis if required by the structural behavior or equipment design (for example non-linear behavior).

Optionally, for equipment with a few important modes in the seismic range, static coefficient method can be implemented, using the peak spectral acceleration of the design response spectra (Figure 2 in Appendix A) and a static coefficient 1.5 or as defined in Table 9 in cl. 17.1 in the Indian standard IS-1893 (Part 4) [3].

If structural damping value is above 2%, it shall be verified by dynamic testing, for example free oscillation or so-called snap-back test.

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All seismic motion considered in analysis shall be triaxial, and normal operational loads including dead weight and terminal forces.

In response spectrum analysis modal contribution shall be with SRSS (Square Root of Sum of the Squares) for well separated modes, but also consider closely spaced modes (frequency separated by less than 10%) correctly by using Complete Quadratic Combination (CQC). The response from horizontal and vertical seismic input shall be combined with SRSS method for a resultant design value.

Qualification by test shall demonstrate that the equipment can withstand a seismic motion defined by design response spectra (Figure 2 in Appendix A) without malfunction and damage in accordance with IS 1893.

5. Seismic Design Consideration

5.1 General

In general, the design of equipment and equipment supports should be made to minimize the seismic loads. It is essential to avoid resonance and other types of interaction as far as possible. Vibration isolation by frequency separation and increased energy dissipation is often used to reduce the seismic response if necessary. Special attention should be paid to the protection of brittle parts, such as porcelain insulators. Overload protection of vulnerable parts can be achieved by for instance easy to replace yielding devices.

5.2 Converter Valves

The ceiling suspended valve design provides an excellent vibration isolation with respect to separation of fundamental frequencies and corresponding reduction of response acceleration. A consequence of the ceiling suspension is that the building becomes part of the dynamic structure and needs to be analyzed as such. The stresses in the valve structure are usually determined by interaction between the building sway modes and some harmonic in the valve structure or valve hangers. The low pendulum frequencies of the valve result in large displacements, which have to be considered estimating electrical clearances and in the design of electrical connections. Displacement can be reduced with damper device at bottom of the valve structure.

For hanging converter valve structures only Response Spectrum Analysis or Time History analysis is allowable verification methods. The Design Response Spectrum (DBE) as defined in Figure 2 in Appendix A, may be too conservative and resulting into large displacements, this is due to Soft Soil (Type III) assumption. The use of Site-Specific conditions for the Thyristor Valves is recommended.

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5.3 Converter Transformer

The converter transformers are heavy pieces, the critical parts being projecting items such as bushing, oil coolers and conservator tank. Special care should be exercised to avoid resonance between the vibration modes of the transformer tank and those projecting parts. If necessary, the high voltage bushings maybe given controlled fundamental frequencies by design of the attachment flanges or introduction of spring devices. The foundation anchorage should be thoroughly designed to prevent sliding and overturning.

5.4 Switchyard Equipment

The typical piece of high voltage switchyard equipment is a cantilever type structure on a single post support. Preferably analysis shall be done with equipment and steel support. If the support is not including, the seismic input shall be increased with a structure factor as described in 5.7. A suitable method for improvement of the seismic capability, if required, is install spring or damper device at base of the electrical apparatus.

Supplier must consider if the equipment is mounted on a support structure, the influence of the support must be considered in the verification of the equipment as described in section 5.7.

5.5 Auxiliary power and Control Equipment

Control and switchgear cubicles may need improvement with respect to transmission of horizontal forces through adequate bracing or shear panels in all directions. The advantage of connecting the cubicles in rows should be recognized. The attachment to the floor shall have positive anchorage for uplift forces and shear. Cubicles are often located at an elevated level in the service building, which is considered in the load definition by appropriate secondary response spectra derived from dynamic analysis of the building.

5.6 System Design

The clearances between different pieces of equipment as well as to other structures are chosen sufficiently large to accommodate the seismic displacements with appropriate margins with respect to electrical clearances, physical space and electrical connections.

The different electrical components are usually dynamically decoupled by using flexible electrical connections. In the case of rigid connections, the system is analyzed as a whole with respect to seismic response.

In the station layout and location of components, precautions should be taken to prevent not seismically classified equipment from jeopardizing the seismic performance of essential equipment.

5.7 Equipment Supports

The basic approach shall be a strong and stiff support based on a static coefficient method, using the peak spectral acceleration of the design response spectra (Figure 2 in Appendix A) and a static coefficient 1.5 or as

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defined in Table 9 in cl. 17.1 in the Indian standard IS-1893 (Part 4) [3]. Or alternately an amplification factor of 2 for IEC [5][6] and 2.5 for IEEE [4].

Support may alternatively be verified by dynamic analysis together with the equipment.

6. Documentation

6.1 General

The verification work is accounted for in a seismic qualification report. The extent of the report is defined in the following sections. Sufficient details are given for the understanding of analysis or test procedures and models and to facilitate verification of major results.

6.2 Analysis Results

The analytical report contains the following information as applicable regarding the method used:

Static and Static Coefficient Methods:

a) Short summary including
- Equipment identification and a brief description
- Motivation for using the Static- or Static Coefficient-method, stated verification of lowest eigenmode
- Major input conditions such as equipment mass, methods used and load definitions
- Added amplification factors
- If Static Coefficient Method; motivated choice of MML factor 1.3 / 1.5
- If Static Coefficient Method; Spectral amplification factor used
- Principal results such as structure response, factors of safety
- Statement regarding the seismic withstand capability of the equipment

b) Description of the structure and the corresponding
- Principal dimensions
- Mass distribution
- Centers of gravity
- Material and section properties
- Boundary conditions

c) Loads and load combinations

d) System response
- Displacements
- Section forces and moments (if needed)
- Stresses, compared to allowable

Response Spectrum Method:

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a) Short summary including
- Equipment identification and a brief description
- Major input conditions such as equipment mass, methods used and load definitions
- Principal results such as fundamental frequencies, maximum response and factors of safety
- Statement regarding the seismic withstand capability of the equipment

b) Description of the structure and the corresponding
- Principal dimensions
- Mass distribution
- Centers of gravity
- Material and section properties
- Damping values
- Boundary conditions
- Anchoring details

c) Loads and load combinations

d) Method description and justification
- Analytical procedure
- Combination of modal responses

e) Results from modal analysis
- Natural frequencies
- Mode shapes (selection)
- Modal participation factors

f) System response
- Displacements
- Section forces and moments (if needed)
- Stresses, compared to allowable
- Strength of joints and anchoring (if needed)
- Foundation loads (if needed)

7. References

[1] 1JNL2632741, RFP for Selection of Bidder as Transmission Service Provider

[2] IS 1893 (2016), *Criteria for Earthquake Resistant Design of Structures, Part 1: General Provisions and Buildings (Sixth Revision)*, ICS 91.120.25.

[3] IS 1893 (Part 4), (2024), *Criteria for Earthquake Resistant Design of Structures, Part 4: Industrial Structures Including Stack-Like Structures*. ICS 91.120.25

[4] IEE693-2018, *IEEE Recommended Practice for Seismic Design of Substations*.

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[5] IEC 62271-300 (2006), *High-voltage switchgear and control gear-Part 300: Seismic qualification of alternating current circuit-breakers.*

[6] IEC TS 61463 (2016), *Technical Specification Bushings – Seismic qualification*.

8. Revision History

Rev.	Prepared	Approved
B	Yang Zhou, 2025-03-18	Daniel Holback
Revision text		
Updated per ROR.		
Rev.	Prepared	Approved
A	Yang Zhou, 2025-02-04	Daniel Holback,2025-02-05
Revision text		
First Revision for approval		

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Appendix A – Design Response Spectra

The shapes of the Design Response Spectrum as defined in IS 1893 [2], for Khavda station can be seen in Figure 2, and Nagpur station in Figure 3.

This spectrum corresponds to seismic Zone V with the Seismic Intensity Very Severe and the Zone Factor Z=0.36. Assuming Soft Soil (Type III) which may be somewhat conservative, and with 2% damping gives the asymptotic Peak Ground Acceleration (PGA) of 0.27g, by assuming frequency f= 10000Hz, according to Clause 7.3.2 [3][2].

$$A_{\mathrm{h}} = \frac{Z}{2}\left(\frac{S_{\mathrm{a}}}{g}\right)\frac{I}{R}$$

Importance factor is 1.5 as defined in table 8 Clause 7.2.3 [2], and the structure Response Reduction Factor R=1 for electrical equipment with possible brittle behavior. According to IS1893, for electrical equipment, the value of I/R=1.5 is used. This conservative assumption is due to that electrical equipment, with in particular brittle porcelain insulators, are more sensitive for its well function than typical more ductile building structures. $\frac{S_a}{g}$ is design acceleration coefficient for different soil types, Figure 1, for 5% damping [2].

$$\frac{S_{\mathrm{a}}}{\mathrm{g}} = \begin{cases} \text{For rocky or hard soil sites} \begin{cases} 1+15T & T<0.10\ \mathrm{s} \\ 2.5 & 0.10\ \mathrm{s}<T<0.40\ \mathrm{s} \\ \frac{1}{T} & 0.40\ \mathrm{s}<T<4.00\ \mathrm{s} \\ 0.25 & T>4.00\ \mathrm{s} \end{cases} \\ \text{For medium stiff soil sites} \begin{cases} 1+15T & T<0.10\ \mathrm{s} \\ 2.5 & 0.10\ \mathrm{s}<T<0.55\ \mathrm{s} \\ \frac{1.36}{T} & 0.55\ \mathrm{s}<T<4.00\ \mathrm{s} \\ 0.34 & T>4.00\ \mathrm{s} \end{cases} \\ \text{For soft soil sites} \begin{cases} 1+15T & T<0.10\ \mathrm{s} \\ 2.5 & 0.10\ \mathrm{s}<T<0.67\ \mathrm{s} \\ \frac{1.67}{T} & 0.67\ \mathrm{s}<T<4.00\ \mathrm{s} \\ 0.42 & T>4.00\ \mathrm{s} \end{cases} \end{cases}$$

Figure 1 – Design acceleration coefficient for different soil types with 5% damping.

For brittle components like porcelain insulator allowable load shall be less than 67% of minimum failure load (i.e. safety factor of 1.5).

Ductile structural parts (excluding bolts) shall not be stressed beyond 80% of the yield strength. Local peak stresses exceeding the allowable stress is acceptable if overall nominal stresses are within the limit.

The AC and DC Bushings shall qualify Seismic requirement as per IEC 61463:2016 [6].

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The design response spectrum in vertical direction is 67% of horizontal one as defined in Figure 2 and Table 2, and Figure 3 and Table 3 for tabulated values of the design response spectra.

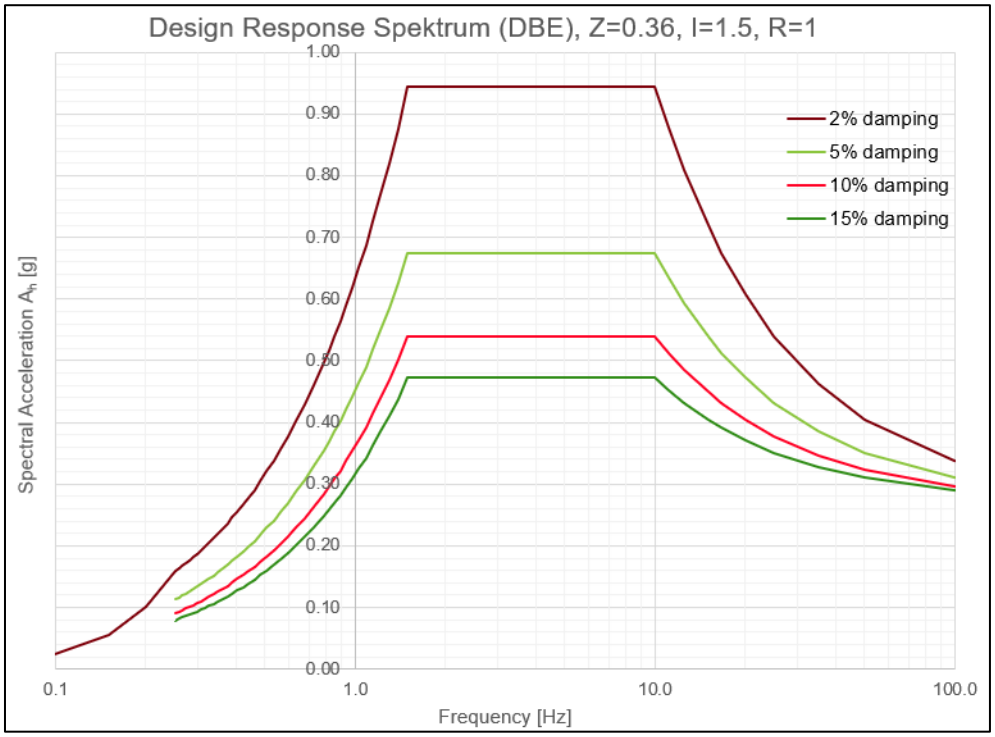

Figure 2 – Design Response Spectra corresponding to Design Base Earthquake (DBE) for Khavda station, seismic zone V.

Table 2 – Tabulated values of the Response Spectra corresponding to Design Base Earthquake (DBE) for Khavda station, seismic zone V.

Horizontal		Vertical	
Freq [Hz]	Ah [g]	Freq [Hz]	Av [g]
0.100	0.025	0.100	0.017
0.150	0.056	0.150	0.038
0.200	0.100	0.200	0.067
0.252	0.159	0.252	0.106
0.258	0.163	0.258	0.109
0.265	0.167	0.265	0.112
0.272	0.172	0.272	0.115
0.280	0.177	0.280	0.118
0.288	0.182	0.288	0.122
0.297	0.187	0.297	0.126
0.306	0.193	0.306	0.129
0.315	0.199	0.315	0.133
0.326	0.206	0.326	0.138
0.337	0.213	0.337	0.142
0.348	0.220	0.348	0.147
0.361	0.228	0.361	0.153
0.375	0.236	0.375	0.158

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0.389	0.246	0.389	0.165
0.405	0.256	0.405	0.171
0.422	0.266	0.422	0.178
0.441	0.278	0.441	0.186
0.461	0.291	0.461	0.195
0.483	0.305	0.483	0.204
0.508	0.320	0.508	0.215
0.535	0.338	0.535	0.226
0.565	0.357	0.565	0.239
0.599	0.378	0.599	0.253
0.637	0.402	0.637	0.269
0.680	0.429	0.680	0.288
0.730	0.461	0.730	0.309
0.787	0.497	0.787	0.333
0.820	0.517	0.820	0.347
0.855	0.540	0.855	0.361
0.893	0.564	0.893	0.378
0.935	0.590	0.935	0.395
0.980	0.619	0.980	0.415
1.031	0.651	1.031	0.436
1.087	0.686	1.087	0.460
1.149	0.726	1.149	0.486
1.220	0.770	1.220	0.516
1.299	0.820	1.299	0.549
1.389	0.877	1.389	0.587
1.493	0.945	1.493	0.633
2.857	0.945	2.857	0.633
3.333	0.945	3.333	0.633
4.000	0.945	4.000	0.633
5.000	0.945	5.000	0.633
6.667	0.945	6.667	0.633
10.000	0.945	10.000	0.633
11.111	0.878	11.111	0.588
12.500	0.810	12.500	0.543
15.000	0.720	15.000	0.482
16.667	0.675	16.667	0.452
20.000	0.608	20.000	0.407
25.000	0.540	25.000	0.362
35.001	0.463	35.001	0.310
50.000	0.405	50.000	0.271
100.000	0.338	100.000	0.226
1000.000	0.277	1000.000	0.185
10000.000	0.271	10000.000	0.181

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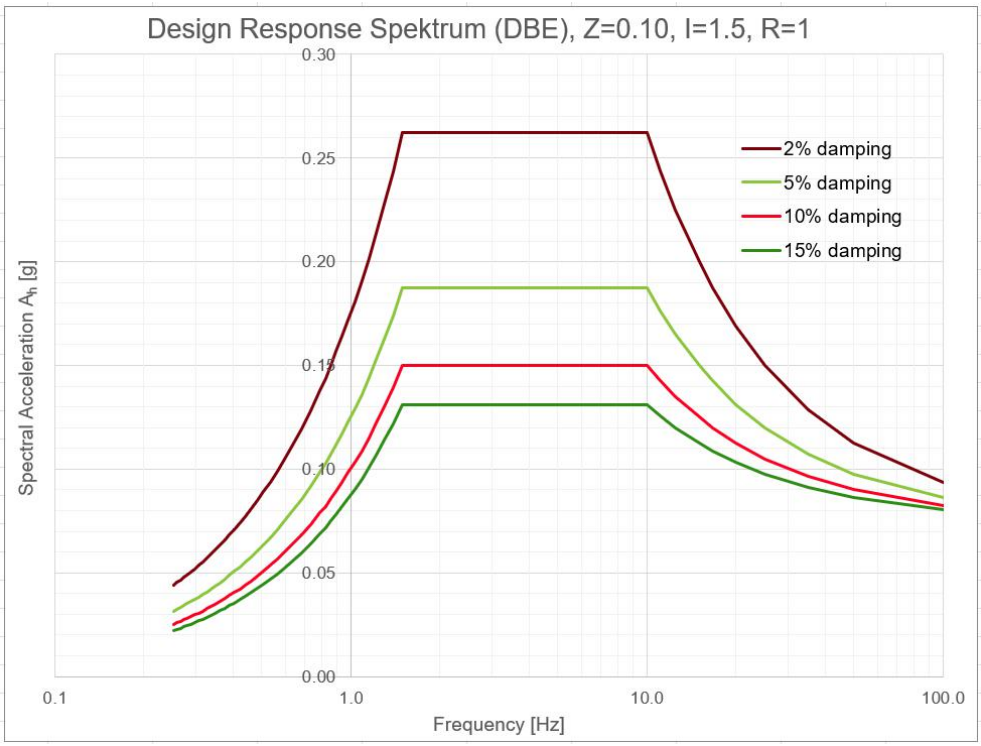

Figure 3 – Design Response Spectra corresponding to Design Base Earthquake (DBE) for Nagpur station, seismic zone II.

Table 3 – Tabulated values of the Response Spectra corresponding to Design Base Earthquake (DBE) for Nagpur station, seismic zone II.

Horizontal		Vertical	
Freq [Hz]	Ah [g]	Freq [Hz]	Av [g]
0.252	0.044	0.252	0.029
0.258	0.045	0.258	0.030
0.265	0.047	0.265	0.031
0.272	0.048	0.272	0.032
0.280	0.049	0.280	0.033
0.288	0.051	0.288	0.034
0.297	0.052	0.297	0.035
0.306	0.054	0.306	0.036
0.315	0.055	0.315	0.037
0.326	0.057	0.326	0.038
0.337	0.059	0.337	0.039
0.348	0.061	0.348	0.041
0.361	0.063	0.361	0.042
0.375	0.066	0.375	0.044
0.389	0.068	0.389	0.045
0.405	0.071	0.405	0.047
0.422	0.074	0.422	0.049
0.441	0.077	0.441	0.051
0.461	0.081	0.461	0.054
0.483	0.085	0.483	0.056

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0.508	0.089	0.508	0.059
0.535	0.094	0.535	0.063
0.565	0.099	0.565	0.066
0.599	0.105	0.599	0.070
0.637	0.112	0.637	0.074
0.680	0.119	0.680	0.080
0.730	0.128	0.730	0.085
0.787	0.138	0.787	0.092
0.820	0.144	0.820	0.096
0.855	0.150	0.855	0.100
0.893	0.157	0.893	0.104
0.935	0.164	0.935	0.109
0.980	0.172	0.980	0.115
1.031	0.181	1.031	0.121
1.087	0.191	1.087	0.127
1.149	0.202	1.149	0.134
1.220	0.214	1.220	0.143
1.299	0.228	1.299	0.152
1.389	0.244	1.389	0.162
1.493	0.263	1.493	0.175
2.857	0.263	2.857	0.175
3.333	0.263	3.333	0.175
4.000	0.263	4.000	0.175
5.000	0.263	5.000	0.175
6.667	0.263	6.667	0.175
10.000	0.263	10.000	0.175
11.111	0.244	11.111	0.163
12.500	0.225	12.500	0.150
15.000	0.200	15.000	0.133
16.667	0.188	16.667	0.125
20.000	0.169	20.000	0.113
25.000	0.150	25.000	0.100
35.001	0.129	35.001	0.086
50.000	0.113	50.000	0.075
100.000	0.094	100.000	0.063
1000.000	0.077	1000.000	0.051
10000.000	0.075	10000.000	0.050

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specified in Section Switchgear-Isolator to the extent applicable.

9.2 TESTS

All routine and type test (if required) shall be as per relevant IEC.

10. HVDC INSULATORS, BUSHINGS, BUSES AND HARDWARE

10.1 GENERAL

The Contractor shall furnish all bus work necessary to meet the operational & performance requirement of this Specification. All HVDC insulators, bushings, buses, conductors, connectors and hardware etc. shall be in accordance with the relevant standards and other relevant publications and as modified herein. All bushings inside valve halls including wall bushings shall be silicone rubber housing. Corona shields shall be provided as required.

10.2 BUSHINGS, SUPPORT INSULATORS, STRING INSULATORS & HARDWARE

The support insulators and bushings shall be in accordance with the relevant Clause of this Specification. The insulation levels shall be determined by the Contractor in accordance with RFP and the requirements of this Specification.

All bushings shall preferably be one piece only and no joints shall be accepted. However, if joint in insulator, tube or conductor is unavoidable, and then no relaxation in creepage & flash distance shall be acceptable. Joint in condenser core is not acceptable. Additional type tests to be carried out if joint is provided in bushing as follows:

1. Mechanical Bonding test at Jointed Section
2. Tracking and Erosion Test(IEC-60587)
3. Water diffusion Test (Samples to be taken from jointed area)
4. Gas leakage test followed by Mechanical tests at the Joint area

When wall bushings are used, the Contractor shall provide necessary measures to avoid uneven wetting of the same.

All the bushings inside the valve hall (HVDC wall bushing for valve hall) shall be dry type/SF6 gas filled gas-insulated or combination of both. The neutral side DC wall bushing for valve hall shall be dry type/SF6 gas filled or combination of both. For HVDC Bus post Insulators (Both HV and LV side) and HVDC outdoor equipment (Both HV and LV side) support insulator shall be of silicon rubber. However, porcelain support insulators for HVDC disconnectors (HV Side) and for neutral and dc filter equipment shall be acceptable

10.3 TUBULAR BUS CONDUCTORS, FLEXIBLE BUS-BARS, EARTHWIRE, CLAMPS, CONNECTORS, SPACERS ETC.

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The size of the tubular bus-conductors, number of sub-conductors, earthwire, clamp and connector along with their configuration, etc. shall be determined by the Contractor in line with relevant IEC/ Annexure-RFP.

10.4 TYPE AND ROUTINE TESTS

The type test (if required) and routine tests for HVDC insulators, bushings, busses, conductors etc. shall be in accordance with the applicable IEC Standards. DC Bushings shall be type and routine tested according to IEC 65700.

11. DC MEASURING DEVICES

11.1 GENERAL

The Contractor shall supply all HVDC measuring devices that are necessary for control, protection, interlocking, and measurement to ensure safe and reliable operation of the HVDC system and the associated HVAC equipment in accordance with the requirements of the Specification. Included with the supply of measuring devices shall be all necessary indoor cubicles and outdoor cabinets for mounting the associated equipment and for housing the secondary cable terminations & other necessary ancillaries.

DC Current measuring devices & Voltage measuring devices shall be governed by Annexure-RFP requirement. Type and routine testing shall be as per IEC 61869-15

12. AC VALVE TIMING VOLTAGE MEASURING DEVICE

RC type Voltage Transformer for measuring Voltage signal for Control of valve/ valve timing measurement control shall have following suitable feature:

(i) Accurate over the range from DC up to more than 3 kHz and shall have linear properties in this frequency range Harmonics can be measured with an accuracy better than 1 % & phase deviation better than 10

(ii) Bandwidth up to 2 MHz

(iii)Suitable transient characteristics for measuring Voltage signal for Control of valve

(iv)Voltage transformers shall cover all IEC metering requirements of class 0.2 or lower. Voltage Transformers shall also be used for Control of Valve firing protection purposes, according IEC or ANSI standards.

Alternatively, Bidder may propose capacitor voltage divider type measuring device with electromagnetic units or inductive type voltage transformers meeting the functional requirements for valve timing measurement.

Testing shall be as per applicable IEC.

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8.0 **BUS POST INSULATORS**

The post insulators shall conform in general to latest IS: 2544, IEC-60168, IEC 60273 and IEC-60815.

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8.1 **Constructional Features**

8.1.1 Bus Post insulators shall consist of a porcelain part permanently secured in a metal base to be mounted on the supporting structures. They shall be capable of being mounted upright. They shall be designed to withstand any shocks to which they may be subjected to by the operation of the associated equipment. Only solid core insulators will be acceptable.

8.1.2 Porcelain used shall be homogeneous, free from lamination, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.

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

8.1.4 The insulator shall have alternate long and short sheds with aerodynamic profile, The shed profile shall also meet the requirements of IEC-60815 for the specified pollution level.

8.1.5 When operating at normal rated voltage there shall be no electric discharge between conductor and insulators which would cause corrosion or damage to conductors or insulators by the formation of substance produced by chemical action.

8.1.6 The design of the insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.

8.1.7 All ferrous parts shall be hot dip galvanised in accordance with the latest edition of IS: 2633, & IS: 2629. The zinc used for galvanising shall be grade Zn 99.95 as per IS: 209. The zinc coating shall be uniform, adherent, smooth, reasonably bright, continuous and free from imperfections such as flux ash, rust stains, bulky white deposits and blisters. The metal parts shall not produce any noise generating corona under the operating conditions.

8.1.8

a) Every bolt shall be provided with a hop dip galvanised steel washer under the nut so that part of the threaded portion of the bolts is within the thickness of the parts bolted together.

b) Flat washer shall be circular of a diameter 2.5 times that of bolt and of suitable thickness. Where bolt heads/nuts bear upon the beveled surfaces they shall be provided with square tapered washers of suitable thickness to afford a seating square with the axis of the bolt.

c) All bolts and nuts shall be of steel with well formed hexagonal heads forged from the solid and shall be hot dip galvanised. The nuts shall be good fit on the bolts and two clear threads shall show through the nut when it has been finally tightened up.

8.1.9 Bidder shall furnish drawings for the essential design features of assembly of shells and metal parts, and number of shells per insulator.

8.2 **Tests**

In accordance with the stipulations of the specification, the post insulators shall be subjected to type, acceptance, sample and routine tests as per IEC-60168.

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8.2.1 In accordance with the stipulation of specification, the following **type tests** reports of the post insulators shall be submitted for approval as per clause 9.2 of Section - GTR.

a) Power frequency withstand test (dry & wet)

b) Lightning impulse test (dry)

c) Switching impulse test (wet) (For 420 kV and above class Insulator only)

d) Measurement of R.I.V (Dry) (As per Annexure – C)

e) Corona extinction voltage test (Dry) (As per Annexure – C)

.

f) Test for deflection under load

g) Test for mechanical strength.

8.**2.2** In addition to acceptance/sample/routine tests as per IEC-60168, the following tests shall also be carried out.

a) Soundness test, metallurgical tests and magnetic particle Inspection **(MPI)** test on MCI/SGI caps as acceptance test.

b) All hot dip galvanised components shall be subjected to check for uniformity of thickness and weight of zinc coating on sample basis as an acceptance test.

c) The bending test shall be carried out at 50% minimum cantilever strength load in four directions as a routine test and at 100% minimum cantilever strength load in four directions as an acceptance test.

d) Acceptance norms for visual defects allowed at site and also at works shall be agreed in the Quality plan.

8.3 **Technical Parameters of Bus Post Insulators.**

Sl. No.	**Description**	**800 kV**	**420 kV**	**245 kV**	**145 kV**
a)	Type	Solid Core	Solid Core	Solid Core	Solid Core
b)	Voltage Class (kV)	800	420	245	145
c)	Dry and wet one minute power frequency withstand voltage (kV rms)	830	680	460	275
d)	Dry lightning impulse withstand Voltage (kVp)	±2100	±1425	±1050	±650
e)	Wet switching surge withstand voltage (kVp)	±1550	±1050	—-	—-
f)	Max. radio interference voltage (in microvolts) - **Dry**	1000 at 508 kV	500 at 305 kV	500 at 156 kV	500 at 105 kV
g)	Corona extinction voltage (kV rms) (min.)	508	320	156	105

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h)	Cantilever Strength				
(i)	Total minimum cantilever strength (Kg)	800	800	800	600
i)	Minimum torsional moment	As per IEC-60273	As per IEC-60273	As per IEC-60273	As per IEC-60273
j)	Total height of insulator (mm)	5700	3650	2300	1500
k)	P.C.D Top (mm)	225	127	127	127
	Bottom (mm)	325	300	254	254
l)	No. of bolts				
	Top	4	4	4	4
	Bottom	8	8	8	8
m)	Diameter of bolt/holes (mm)				
	Top	M16	M16	M16	M16
	Bottom dia	18	18	18	18
n)	Pollution level as per IEC-60815	Heavy(III)	Heavy(III)	Heavy(III)	Heavy(III)
o)	Minimum total creepage distance for Heavy Pollution (mm)	20000	10500	6125	3165

8.3.1 If corona extinction voltage is to be achieved with the help of corona ring or any other similar device, the same shall be deemed to be included in the scope of the Contractor. Aluminium used for corona ring shall be of grade 63401 or 19501 conforming to IS:5082.

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ANNEXURE-C

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 noisel 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

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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.

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SECTION-3

PROJECT DETAILS & GENERAL TECHNICAL REQUIREMENTS

SITE INFORMATION

Sl. No.	Particular	Details
a)	Customer	M/s. KHAVDA V-A POWER TRANSMISSION LTD (100% owned subsidiary of M/s POWERGRID)
b)	Consultant	Power Grid Corporation of India Ltd. (POWERGRID)
c)	Project Title	Package-I for ± 800 kV, 6000MW HVDC terminals at Khavda Pooling Station-2 (KPS2) (HVDC) & Nagpur (HVDC) and interconnection/extension of existing 400kV GIS Substation at KPS2 associated with "Transmission System for Evacuation of power from potential renewable energy zone in Khavda area of Gujarat under Phase-V Part A (8 GW)"
d)	Location: Location of the Substation - The location of substation is indicated below:	

Sl. No.	Name of Substation	Name of State	Nearest Rail Head	Nearest Airport
1	KPS2 HVDC	Gujarat	Bhuj	Bhuj
2	NAGPUR S/S	Maharashtra	Nagpur	Nagpur

e)	Transport Facilities	As above

METEOROLOGICAL DATA

The meteorological data and other parameters of sub-stations are as under:

Sl. No.	Parameter	KPS2 HVDC	NAGPUR
1	Max Ambient temperature (dry bulb one hour average) Minimum Ambient temp. Max dry bulb 24hr average	50º C 0º C 40º C	50º C 0º C 40º C
2	Snowfall (mm)	NA	NA
3	Average annual rainfall	As per rainfall map of IMD	As per rainfall map of IMD
4	Iso-keraunic level	As applicable	As applicable
5	Relative humidity	100%	100%

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6	Basic wind speed as per National Building Code 2016	50 m/s	44 m/s
7	Seismic zone as per IS-1893	Zone-V	Zone-II
8	Altitude (above M.S.L. in m)	<1000 m	<1000 m
9	Pollution level (IEC 60815)	Heavy	Heavy
10	Hottest month	May/June	May/June
11	Annual mean dry bulb Temperature	30	30
12	Maximum wet bulb one hour average	33	33
13	Dry bulb temperature for low ambient condition	33	33
14	Wet bulb temperature for low ambient condition	23	23
15	Coastal Considerations	Yes	No

SYSTEM PARAMETERS

Sl. No.	Parameter	KPS2 HVDC	NAGPUR
1	Fault Level	63 kA for 1 Sec (400 kV)	50 kA for 1 Sec for 765 kV 63 kA for 1 Sec for 400 kV
2	Minimum Creepage Distance	35 mm/kV	25 mm/kV

Note: NOA Date, wherever appearing in the document to be read as 22.11.2024.

ENCLOSED:

Section-GTR (general technical requirement) rev.15A" 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 "EPC Contractor" as "BHEL"

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SECTION-3 of Technical Specification

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1.0 FOREWORD

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

2.0 GENERAL REQUIREMENT

2.1 a) All equipment/materials/items, as per Annexure-K, as applicable under present scope of works, shall be procured and supplied from domestic manufacturers only

Any imported equipment/material/item/parts/component (comprising of embedded systems) to be supplied under the contract shall be tested in the certified laboratories to check for any kind of embedded malware/trojans/cyber threats and for adherence to Indian Standards as per the directions issued by Ministry of Power/Govt. of India from time to time. In case of such import from specified "prior reference" countries, the requirement of prior permission from the Govt. of India including protocol for testing in certified and designated laboratories by Ministry of Power/Govt. of India shall also be complied with by the bidder.

The bidder/bidder shall list out the products and components producing Toxic e-waste under the contract and shall furnish to the Employer the procedure of safe disposal at the time of closing of the contract

2.1 b) The Supplier/Manufacturer 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 Bidder 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.

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 offered by the bidder shall at least conform to the requirements specified under relevant IS standard. In case of discrepancy between IS and other international standard, provisions of IS shall prevail. The Bidder shall also note that the list of standards presented in this specification at Annex-C is not complete. Whenever necessary, the list of standards shall be considered in conjunction with specific IS. If the IS standard is not available for an equipment/material, then other applicable International standard (IEC/Equivalent), as per the specification, shall be accepted.

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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.

3.4 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.

3.5 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 Switching surge over voltage and power frequency over voltage is specified in the system parameters below. In case of the 400kV system, the initial value of the temporary over voltages 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 If indicated in Section – 1, the Bidder shall design terminal connectors of the equipment taking into account various forces as mentioned at Sl.No.4.3 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	765 kV System	400 kV 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			
i)	Full wave impulse withstand voltage (1.2/50 microsec.)	2100kVp	1550kVp	1050 kVp

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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

132kV, 66kV, 52kV , 33kV & 11kV System

SL No	Description of parameters	132 kV System	66kV System	52 kV System	33 kV System	11kV System
1.	System operating voltage	132kV	66kV	52kV	33kV	11kV
2.	Maximum operating voltage of the system(rms)	145kV	72.5kV	52kV	36kV	12kV
3.	Rated frequency	50Hz	50Hz	50Hz	50Hz	50Hz
4.	No. of phase	3	3	3	3	3
5.	Rated Insulation Levels					

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SL No	Description of parameters	132 kV System	66kV System	52 kV System	33 kV System	11kV System
i)	Full wave impulse withstand voltage (1.2/50 microsec.)	650 kVp	325 kVp	250 kVp	170 kVp	75 kVp
ii)	One minute power frequency dry and wet withstand voltage (rms)	275kV	140kV	95kV	70kV	28kV
6.	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz	500 µV at 92kV rms	-	-	-	-
7.	Minimum creepage distance	3625 mm (4495mm for coastal area)	1813mm (2248mm for coastal area)	300mm (1612 mm for coastal area)	900 mm (1116mm for coastal area)	300 mm (372mm for coastal area)
8.	Min. Clearance					
i.	Phase to phase	1300 mm	750 mm	530mm	320 mm	280 mm
ii.	Phase to earth	1300 mm	630 mm	480mm	320 mm	140 mm
iii.	Sectional clearances	4000 mm	3100 mm	3100mm	2800 mm	2800 mm
9.	Rated short circuit current	40kA/ 31.5 kA (as applicable) for 1 sec	31.5 kA for 3 sec/25kA for 3 Sec*	25kA for 1 Sec	25 kA for 3 sec	25 kA for 3 sec
10.	System neutral earthing	Effectively earthed	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/IS.
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.
4. "*" For tertiary loading Equipment's fault level shall be 25kA for 3 Sec. For other switchyard equipment shall be as specified in Section project.
5. Costal Area is to be considered only if defined in Section project.

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4.7 **Planning and Designing in purview of Vulnerability Atlas of India**

Vulnerability Atlas of India (VAI) is a comprehensive document which provides existing hazard scenario for the entire country and presents the digitized State/UT wise hazard, maps with respect to earthquakes, winds and floods for district wise identification of vulnerable areas. It also includes additional digitized maps for thunderstorms, cyclones and landslides. The main purpose of this Atlas is its use for disaster preparedness and mitigation at policy planning and project formulation stage.

This Atlas is one of its kind single point source for the various stakeholders including policy makers, administrators, municipal commissioners, urban managers, engineers, architects, planners, public etc. to ascertain proneness of any city/ location/ site to multi-hazard which includes earthquakes, winds, floods thunderstorms, cyclones and landslides. While project formulation, approvals and implementation of various urban housing, buildings and infrastructures schemes, this Atlas provides necessary information for risk analysis and hazard assessment.

The Vulnerability Atlas of India has been prepared by Building Materials and Technology Promotion Council under Ministry of Housing and Urban Affairs, Government of India and available at their website https://www.bmtpc.org/. It is mandatory for the bidders to refer Vulnerability Atlas of India for multi-hazard risk assessment and include the relevant hazard proneness specific to project location while planning and designing the project in terms of:

i) Seismic zone for earthquakes,
ii) Wind velocity
iii) Area liable to floods and Probable max. surge height
iv) Thunderstorms history
v) Number of cyclonic storms/ severe cyclonic storms and max sustained wind specific to coastal Region
vi) Landslides incidences with Annual rainfall normal
vii) District wise Probable Max. Precipitation

5.0 ENGINEERING DATA AND DRAWINGS

5.3 Drawings

5.3.1 All drawings submitted by the Bidder 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 Bidder 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 Bidder, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and documents.

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5.5 All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at the Bidder's risk. The Bidder 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 Bidder's drawing or work by the Employer shall not relieve the bidder of any of his responsibilities and liabilities under the Contract.

5.6 All engineering data submitted by the Bidder 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

ii) Resubmission (whenever required)

iii) Approval or comments

iv) Furnishing of distribution copies (2 hard copies to each substation and one scanned copy (pdf format)

Please refer activity schedule attached in commercial terms of tender specifications.

v) Furnishing of distribution copies of reports

(a) Type test reports (one scanned softcopy in pdf format to each substation plus one for corporate centre & one hardcopy per substation)

(b) Routine Test Reports (one copy for each substation)

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 bidder 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) 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.

(3) 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 Bidder to the Employer.

(4) The Bidder shall furnish to the Employer catalogues of spare parts.

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(5) All As-built drawings/documents shall be certified by site indicating the changes before final submission.

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 Bidder 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 Bidder.

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 Bidder 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 Bidder shall apply all operational lubricants to the equipment installed by him.

6.1.7 All oil, grease and other consumables used in the Works/Equipment shall be purchased in India unless the Bidder 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 source of oil/grease /other consumables in the GTP/Drawings, where such oil or grease is

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available. He shall help Employer in establishing equivalent Indian make and Indian Bidder. 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/IEC60947; IS/IEC/60529. Type test report for of relevant 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, Customer Name, year of manufacture, equipment name, type or serial 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 IS/ 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.

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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 Bidder 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 Bidder may propose changes in the specification of the equipment or quality thereof and if the bidder & 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 Bidder proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.

7.3 The Bidder 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 Bidder has to coordinate designs and terminations with the agencies (if any) who are Consultants/Bidder for the Employer. The names of agencies shall be intimated to the successful bidders.

7.5 The Bidder will be called upon to attend design co-ordination meetings with the Engineer, other Bidder's and the Consultants of the Employer (if any) during the period of Contract. The Bidder 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 Manufacturer's Works or at his Sub-Vendor's premises or at the Employer's site or at any other place of Work as applicable, are in accordance with the specifications, the Bidder shall ensure suitable quality assurance programme to control such activities at all points necessary. A quality assurance programme of the Bidder 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.

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 vendors'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.

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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 Bidder/his vendor's quality management and control activities.

8.2 **Quality Assurance Documents**

The Bidder 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.

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 Bidder 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. Bidder shall explore first the possibilities of procuring the bought out items from POWERGRID approved existing vendors. In case of their unavailability / non-response, Bidder may approach POWERGRID for additional sub-vendor approval. In that case, the assessment report of proposed sub vendor by Bidder 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

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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 Bidder'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 Bidder 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.

Bidder 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: EPC 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.

Level – II: EPC 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 EPC Contractor and CIP/MICC will be issued by POWERGRID. Else, EPC 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: EPC 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 EPC Contractor and CIP will be issued by POWERGRID. Else, EPC 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: EPC 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 Bidder 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, Bidder shall have a separate workforce having

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appropriate qualification & experience and deploy suitable tools and plant for maintaining quality requirement during construction in line with applicable Field Quality Plan (FQP).

Wherever references to SFQP is made in Technical Specifications, it shall be the latest edition/revision of the same uploaded up to seven (7) days prior to the actual date of bid opening.

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 Bidder'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 Bidder shall obtain for the Employer and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Bidder'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 EPC 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 EPC Contractor within 30 days of award of contract on submission of documents by EPC Contractor. After raising the inspection calls, EPC 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 Bidder shall give the Employer/Inspector Twenty-one (21) days written notice of any material being ready for testing for each stage of 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 Bidder'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 Bidder 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. Bidder 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 Bidder 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 Bidder 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 Bidder shall minimize the number of inspection calls by offering optimum quantities in each inspection call at the respective manufacturer's works.

8.3.8 Bidder 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

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applicable Quality Plans are available at the works of Bidder or their Sub-vendor before the material is offered for inspection.

8.3.9 Bidder 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 Bidder, 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 Bidder 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 Bidder's or Sub-Bidder'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 Bidder/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 Bidder's Test certificate by the Employer/IE. Bidder shall, on completion of all tests, submit test reports within Ten (10) days to POWERGRID IE. Failure of the Employer/IE to issue such a certificate shall not prevent the Bidder 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 Bidder or of any Sub-vendor, the Bidder, 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 Bidder 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 Bidder'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. Bidder 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 ReWork/Re-Engineering, failing which POWERGRID reserves the right to reject the equipment.

8.3.19 Bidder shall ensure that all possible steps are taken to avoid damages to the equipment during transport, storage and erection

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8.3.20 Bidder 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 Bidder shall ensure commissioning of all CSDs along with Circuit Breakers wherever applicable.

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

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 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/representative authorized by POWERGRID/representative of Utility /representative of accredited test lab/ representative of The National Accreditation Board for Certification Bodies (NABCB) certified agency shall also be acceptable.

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

Extract from Section Project:

The bidder shall offer type tested equipment for the project and the Employer shall accept the equipment type test reports under the following conditions:

(i) Type test in accordance with the relevant specified Standards & Technical specification.
(ii) The Type tested equipment shall be of a similar design, insulation class as per the equipment offered under this contract. Technical justification shall be submitted for differences between tested and offered equipment, if any. Employer's interpretation in this regard shall be final.

In the event that equipment furnished includes important modifications of, or significant departure from, the designs of equipment on which type test report has been furnished or if there is evidence that the equipment does not comply with the requirements of the Specifications, type test procedure was not properly followed as laid down in standards, the Bidder shall conduct the type test without any cost implication to the Employer.

In the price bid, the test charges shall be included in the contract price and no separate test charges shall be indicated by the bidder.

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

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S.No	Name of Equipment	Validity of type test (in years)
1	Power Transformer	5
2	LT Transformer (33 kV and below)	5
3	Shunt Reactor	5
4	OLTC	10
5	Bushing of Power Transformers/Reactors	7
6	Fittings and accessories for Power transformers, Reactors	10
7	Circuit Breaker	10
8	Isolator	10
9	Lighting Arrester	10
10	Wave Trap	10
11	Instrument transformer	10
12	GIS & Hybrid GIS	15
13	LT Switchgear, MV Switchgear	10
14	Cable and associated accessories	10
15	Relay	7
16	Capacitors	10
17	Battery & Battery Charger	7
18	Conductor & Earth wire	10
19	AC Insulators (Porcelain/Glass)	10
20	AC Composite Insulators	5
21	PLCC	5
22	DC equipment (Converter Transformer and bushings, Thyristor valves, DC measuring devices, Smoothing Reactor, AC & DC Filter components, DC switchgear, DC wall bushings, DC arresters, PLC/RI or other high frequency filter components or any equipment covered under HVDC system)	15

Table- 1: Validity of Type test for major equipment

Fibre-optic communication equipment, ventilation system and any other equipment not covered above, tests performed within 10 years from date of NOA shall be considered subject to condition that either the type tests were performed on the identical equipment or performed on an equipment of similar design. A justification report shall also be submitted by Bidder along with the type-test report for Employer's review.

For standard market products (like motors, air-compressors, air-conditioners, fans etc), of reputed make, from POWERGRID approved compendium of vendors, the same can be accepted on submission of suitable documentation as per standard POWERGRID practice in other projects.

All equipment shall be supplied from same manufacturing works, where from the previous equipment/ sample of same design/ process was manufactured and successfully type tested as per relevant (IS/IEC).

Acceptance of the type test reports shall be at the discretion of the Employer. In case the test reports are of the test conducted earlier than the years specified above from the date of NOA, the bidder shall repeat these test(s) at no extra cost to the Employer.

All type tests for equipment, if performed after the date of award of the Contract shall be witnessed by the Employer unless authority to proceed with the tests in his absence is

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received from the Employer in writing. All expenses towards Employer deputation for witnessing of type testing, shall be borne by Employer.

The Bidder shall intimate the Employer 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: For all other equipment's validity of type test shall be 10 years from date of NOA

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 Bidder shall intimate the Employer 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.

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 waival, test charges for the same shall not be payable.

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 except in the case of re-deputation if any, necessitated due to no fault of the Employer.

9.5 The list of makes of various items, for which Type test reports are not required to be submitted are specified at Annexure-J.

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 Bidder 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 Bidder'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 Bidder 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.

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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 Bidder 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 Bidder 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 Bidder. 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 (if defined 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 (if 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
- 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.

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12.3 PAINTING

12.3.1 All sheet steel work shall be degreased, pickled, phosphated in accordance with the IS6005 "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 Hot Phosphating shall be done for phosphating process under pretreatment of sheets 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 bidder 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
Fire Protection System			
1	Hydrant and Emulsifier system pipeline/NIFPS	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	
Air Conditioning Plant			
5	Refrigerant gas pipeline – at compressor suction	Canary Yellow	-
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

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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.

12.3.8 Band colour is required for Emulsifier system detection line only if both water and air detection lines are present at the same substation. Further, band colour shall be applied at an interval of 2 meters approx. along the length and minimum width of band shall be 25mm.

13.0 HANDLING, STORING AND INSTALLATION

13.2 EPC 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. EPC 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.

13.5 Bidder shall also do necessary adjustments/alignments 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 Bidder at his own expense.

13.6 The Bidder shall be solely responsible for any shortages or damages in loading, handling and in transit of the equipment up to Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Bidder.

13.12 The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance throughout the service life.

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.

13.14 Erection, testing and commissioning of Transformers, Reactors, Circuit breakers, Isolators, Substation automation system, Control & protection panels, PLCC, PMU, Telecommunication Equipments, NIFPS System etc. shall be done by the EPC Contractor under the supervision of respective equipment manufacturers. Charges for the above supervision shall be included by the bidder for the respective equipment in the BPS.

14.0 TOOLS

14.1 TOOLS & PLANTS (T&P) – Please refer Section-1 for scope under 14.1

The Bidder 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 bidder.

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

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14.2 SPECIAL TOOLS AND TACKLES

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

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%.

15.2 Pickup value of binary input modules of Intelligent Electronic Devices, Digital protection couplers, Analog protection couplers shall not be less than 50% of the specified rated station auxiliary DC supply voltage level.

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/polymer part of the bushing, porcelain/polymer 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

(In bidder's scope if indicated in Section-1)

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 **4600** of IS:617 and all test shall conform to IS:617

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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 **4600** 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 and 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 on minimum three samples as per IS:5561 and shall also be subjected to routine tests as per IS:5561. Following type test reports shall be submitted for 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) and RIV (dry) test [for 132kV and above voltage level clamps]

iv) Resistance test and Pullout strength test

v) Cantilever Strength test on bus support clamps & connectors

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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/IEC 61439-0, as applicable, and the clauses given below:

18.2 Control cabinets, junction boxes, Marshalling boxes & terminal boxes, Out door ACDB cum DCDB panels 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.

Control cabinets, junction boxes, marshalling boxes & terminal boxes, out-door ACDB cum DCDB panels shall have adequate space/clearance as per guidelines/technical specifications to access/replace any component. Necessary component labelling to be also done on non-conducting sheet.

For CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES MARSHALLING BOXES

FOR OUTDOOR EQUIPMENT Junction Box, wire should be as per IS or equivalent IEC with FRLS grade

Machine laid PU Foam gasket may be permitted for use in Control Cabinets etc.

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 with width more than 700 mm 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 ingression 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.

18.8 LED based illumination of minimum 9 watts shall be provided. The switching of the fittings shall be controlled by the door switch.

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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/IEC60947 including application of 1kV rms for 1 (one) minute, after IP-55 test.

19.0 DISPOSAL OF PACKING MATERIAL & WASTE FROM CONSTRUCTION SITE

After completion of the work, Bidder 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 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, nondeteriorating 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.

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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 Bidder 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.

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 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 relevant IS 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.

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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.

22.10 In case, different designs of lattice and pipe structures other than Employer supplied structures are required to be adopted in view of higher creepage (31mm/kV) of the switchgear/equipment's, insulator strings, bushings & bus post insulators etc., Design, supply & erection of such structures shall be in the scope of bidder against respective standard structure. However dimensional details (except height) shall not be less than that specified in standard structure drawing of respective equipment's.

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.

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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 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. Bidder shall perform any additional test based on specialities of the items as per the field Q.P./Instructions of the equipment Bidder or Employer without any extra cost to the Employer. The 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.

(b) Phase sequence and proper direction of rotation.

(c) Any motor operating incorrectly shall be checked to determine the cause and the conditions corrected.

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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 all

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visible corona disappears. The procedure shall be repeated at least 3 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 three values at which visible corona (negative or positive polarity) disappears.

The test to determine the visible corona extinction voltage need not be carried out simultaneously with test to determine RIV levels.

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.

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SEISMIC WITHSTAND TEST PROCEDURE

The seismic withstanding test on the complete equipment (for 400kV and above) shall be carried out along with supporting structure. Seismic Withstand Test carried out using either lattice or pipe structure is acceptable." **Seismic Calculations certified by NABL Labs shall also be acceptable**

The Bidder shall arrange to transport the structure from his Bidder'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–62271-300.

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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 Hexafloride
IEC-60437	Radio Interference Test on High Voltage Insulators
IEC-60507	Artificial Pollution Tests on High Voltage Insulators to be used on AC Systems

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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
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	Techniquest 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 ICSI109
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

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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
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

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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
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.

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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
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 gasinsulated 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

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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
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

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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	IEE 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 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

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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) 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

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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) NEMA-MGI	Motors and Generators
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 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

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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 1000Vceramic 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
ASTM-B 231-81	Concentric - lay - stranded, aluminum 1350 conductors
ASTM-B 221	Aluminum - Alloy extruded bar, road, 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)

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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
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

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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 polyethyle 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
IEC-60227 (P1 to P7)	Polyvinyl Chloride insulated cables of rated voltages up to and including 450/750V
IEC-60228	Conductors of insulated cables

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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

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IS:3346	Evaluation of Thermal Conductivity properties by means of 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 Galavanizing) 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

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IS:5120	Technical requirement – Rotodynamic special purpose pumps
API-610	Centrifugal pumps for general services Hydraulic Institutes Standards
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)

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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
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

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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	
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	CO2 (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

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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
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 embrilement
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

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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
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 threated 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 flangesand glanged 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 piple threads
ANSI-B16.25	Butt welding ends

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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
NSI-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
IS2721	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-dawn steel wire for concrete reinforcement
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-dawn 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

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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) rame land 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
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

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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-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

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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
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

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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
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

Note: If any standard is expired or does not exist anymore than other standard which has substituted it, shall be applicable.

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Annexure- F

Assessment report from Bidder for proposed sub-vendor along with following enclosures (to the extent available):

1. Registration / License of the works
2. Organization chart with name and qualification of key persons
3. List of Plant and Machinery.
4. List of testing equipment with their calibration status.
5. List of Raw material, bought out items with sourcing details
6. List of out-sourced services with sourcing details.
7. List of supply in last three years.
8. Third party approval, if any (viz. ISO, BIS),
9. Pollution clearance wherever applicable
10. Energy Conservation & Efficiency report
    (Applicable to industries having contract load more than 100 KVA)
11. Formats for RM, in process and acceptance testing
12. Type test approvals conducted in last 5 years, if applicable
13. Performance Certificates from customers
14. Photographs of factory, plant and machinery & testing facilities

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Annexure-G

MQP & INSPECTION LEVEL REQUIREMENT

Sl. No	Item / Equipment	Reference document for inspection	Inspection Level
A.01	LT Transformer /Power Transformer/ Reactor/ Converter Transformer/ Filter Reactor	MQP/ITP	IV
A.02	Bushing	MQP	IV
A.03	Insulating Oil	POWERGRID TS	III
A.04	Oil storage tank for transformers	MQP	III
A.05	Nitrogen injection based explosion prevention system	FAT/ITP	III
A.06	On Line oil drying system for transformers	POWERGRID TS	II**
A.07	On Line DGA and moisture monitoring system	POWERGRID TS	II**
A.08	Flow sensitive conservator isolation valve	POWERGRID TS	II**
A.09	Oil Filtration Machine	MQP	III
B.01	Circuit Breakers	MQP	IV
B.02	Current Transformers	MQP/ITP	IV
B.03	CVT/PT/IVT	MQP	IV
B.04	Isolators	MQP/ITP	IV
B.05	Surge Arrestors	MQP/ITP	III
B.06	Line Trap & Air Core Reactor	MQP/ITP	III
B.07	Point On switching device (CSD) for Circuit Breaker (wherever required)	FAT/ITP	IV
C.01	STATCOM including Valve, valve base electronics, DC capacitor, series reactor and all accessories	ITP	IV
C.02	Mechanically switched Reactor bank (3-ph) including all accessories (MSR Branches)	ITP	IV
C.03	Mechanically switched Capacitor bank (3-ph) including all accessories (MSC Branches)	ITP	IV
C.04	Harmonic Pass filters	ITP	IV
C.05	HT Capacitor	MQP	IV
D.01	Thyristor Valve	FAT/ITP	III
D.02	PLC Capacitors for HVDC	FAT/ITP	III
D.03	Valve Cooling system for	FAT/ITP	III

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Annexure-G

Sl. No	Item / Equipment	Reference document for inspection	Inspection Level
	HVDC		
D.04	AC/DC Filter Resistors	ITP	III
D.05	DC Current and Voltage measuring device for HVDC	FAT/ITP	III
D.06	Maintenance platform for valve hall	POWERGRID TS	II
D.07	Optical signal column for FSC	FAT/ITP	II
E.01	GIS including spares	MQP/ITP	IV
E.02	Dew Point Meter for GIS	POWERGRID TS	I*
E.03	Portable Partial Discharge monitoring system for GIS	POWERGRID TS	I*
E.04	Partial Discharge Monitoring System (Online) for GIS	ITP	III
E.05	PEB Structure and Puf Panels	MQP	III
F.01	Substation Automation system	FAT/MQP	III
F.02	Event Logger	POWERGRID TS	III
F.03	PLCC equipment Viz PLCC Terminal, Carrier equipment, Protection Coupler, Coupling Device but excluding EPAX / HF Cable	MQP	III
F.04	Control & Relay Panels	MQP	III
G.01	EHV Cables	MQP/ITP	III
G.02	Power Cables & Control Cables	MQP	III
G.03	Cable Joints (11 kV and above)	POWERGRID TS	II
G.04	Cable Lugs & Glands / Clamps/Terminations	POWERGRID TS	I
H.01	LT Switchgear & ACDB/DCDB/MLDB/ELDB	MQP	III
H.02	Battery	POWERGRID TS	II
H.03	Battery Charger	MQP	III
H.04	UPS & Voltage Stablizer	MQP/FAT	III
H.05	D. G. Set	FAT/ITP	III
H.06	Lighting Panel	POWERGRID TS	II
H.07	Lighting Poles	POWERGRID TS	II
H.08.1	Lighting Fixtures, Lighting Earthwire, Switches / sockets, Conduits, Lamps & fans including exhaust fans	POWERGRID TS	I
H.8.2	Solar based LEDs System including street light/pole solar panel, Inverter controller/LED fixture	FAT	III
H.09	MS/GI /PVC Pipes for cable	POWERGRID TS	I

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Annexure-G

Sl. No	Item / Equipment	Reference document for inspection	Inspection Level
	trenches and lighting		
H.10	Outdoor Receptacle	POWERGRID TS	I
H.11	Split A.C/window A.C./ precision AC/ Kiosk AC/ Cascade AC/ Tower AC	POWERGRID TS	I
H.12	Occupancy sensors for control of lighting	POWERGRID TS	I
H.13	Solar based street lighting pole including Solar Panel, Inverter, Controller, etc.	POWERGRID TS	III
H.14	Junction Box / Lighting Switch Boards / Bay MB / Portable Flood Light Panel	POWERGRID TS	II
H.15	Lighting transformer	POWERGRID TS	II
I.01	SF6 gas processing unit, SF6 gas Leakage detector, SF6 gas Analyzer	POWERGRID TS	I*
I.02	SF6 Gas	POWERGRID TS	I
I.03	Spark Gap	FAT/ITP	III
I.04	Time synchronizing Equipment (GPS Clock)	POWERGRID TS	I
I.05	Galvanized Cable trays	POWERGRID TS	II
I.06	Video Monitoring System	FAT/ITP	I
I.07	Public Address System (All Components)	POWERGRID TS	I
I.08	Building Management System (All components)	POWERGRID TS	I
I.09	Access Control System (All Components)	POWERGRID TS	I
I.10	Video Display system/ Video Projection system	POWERGRID TS	I
I.11	VESDA (smoke detector)	POWERGRID TS	I
I.12	High Mast Pole	MQP	III
J.01	Aluminium ladder	POWERGRID TS	I
J.02	Hume Pipes	POWERGRID TS	I
J.03	Castle Key	POWERGRID TS	I
J.04	Water Treatment plant (All components).	POWERGRID TS	I
J.05	Furniture	POWERGRID TS	I
J.06	DOL Starter	POWERGRID TS	I
J.07	Oil Sample Bottles and Syringe	POWERGRID TS	I
J.08	Test & Measuring Equipment, T&P	POWERGRID TS	I*
K.01	EOT Crane	POWERGRID TS	II
K.02	Boom Crane/Golf Cart/Platform Truck/Man Lift/ Fork Lift/ Lifts	POWERGRID TS	II

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Annexure-G

Sl. No	Item / Equipment	Reference document for inspection	Inspection Level
L.00	Fire Protection System		
L.001	Panels, Hydro pneumatic tank for fire protection system.	POWERGRID TS	III
L.002	Deluge valve, Strainers, MS/GI pipes, Pumps, motors, air compressor, and other valves, Diesel Engines	POWERGRID TS	II
L.003	Others	POWERGRID TS	I
M.00	HVAC SYSTEM		
M.001	Air Cooled Chiller	POWERGRID TS	III
M.002	Pump	POWERGRID TS	II
M.003	Air Handling Unit	POWERGRID TS	II
M.004	Fan Filter Unit With Centrifugal Blower	POWERGRID TS	II
M.005	Axial Flow Fan	POWERGRID TS	II
M.006	Main Climate Control Unit (Dehumidifier)	POWERGRID TS	I
M.007	Dampers	POWERGRID TS	II
M.008	Fire Dampers	POWERGRID TS	II
M.009	Pressure Gauge, Thermometers, Other Instruments / Sensors	POWERGRID TS	I
M.010	Grill, Diffuser, Jet Nozzle, Louvers etc	POWERGRID TS	I
M.011	Ducting	POWERGRID TS	III
M.012	M S Pipe	POWERGRID TS	II
M.013	Pipe Insulation Material	POWERGRID TS	I
M.014	Duct Insulation Material	POWERGRID TS	I
M.015	Underdeck Insulation Material	POWERGRID TS	I
M.016	Gate Valve & Non Return valve	POWERGRID TS	I
M.017	Y Strainer	POWERGRID TS	II
M.018	Ball Valve/ Motorised Butterfly Valve/ Balancing Valve	POWERGRID TS	I
M.019	Closed Expansion Tank	POWERGRID TS	II
M.020	Air Separator	POWERGRID TS	I
M.021	MCC /PLC /Electrical Panels	POWERGRID TS	III
M.022	Propeller Fan/ Conduit	POWERGRID TS	II
M.023	Air Filter/ Mixing Valve with Thermostat	POWERGRID TS	I
N.01	SDH Equipment	FAT/ITP	IV
N.02	Termination Equipment Primary/ DI Multiplexer	FAT/ITP	IV

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Annexure-G

Sl. No	Item / Equipment	Reference document for inspection	Inspection Level
N.03	DACS	FAT/ITP	IV
N.04	Optical Amplifier	FAT/ITP	IV
N.05	FODP including pigtail, Joint Box, FDMS	FAT/ITP	II
N.06	IMPS	FAT/ITP	IV
N.07	Optical bypass switch	FAT/ITP	IV
N.08	Air Purifier	FAT/ITP	I
N.09	Patch cord & connector	FAT/ITP	I
N.10	NMS	FAT/ITP	IV
N.11	OPGW Cable	MQP/ITP/FAT	III
N.12	Hardware Fittings for OPGW cable	MQP/ITP	III
N.13	DCPS	FAT/ITP	III
N.14	Radio Links	FAT/ITP	III
N.15	SMPS based DC Power Supply (DCPS) system	FAT/ITP	III
N.16	WAMS (PMU & Accessories)	FAT/ITP	III
N.17	PUF Shelter	FAT/ITP	III
N.18	Aerial OFC/UGOFC/ADSS/FO Cable	FAT/ITP	III
N.19	DWDM	FAT/ITP	III
N.20	OTN	FAT/ITP	III
N.21	MPLS-TP Equipment	FAT/ITP	III
N.22	L2 Switch	FAT/ITP	III
N.23	IP-MPLS Router	FAT/ITP	III
N.24	HDPE Pipes	POWERGRID TS	II
N.25	Equipment Cabinets	POWERGRID TS	II
N.26	Main Distribution Frame	POWERGRID TS	I
N.27	Telephone system, EPAX, Telephone wires, Telephone sockets	POWERGRID TS	I
N.28	Fibre Optic Cable	MQP	III
N.29	Hardware Fittings for Fibre Optic cable	MQP	III
O.01	Re-rollers of MS/HT Angle Section and galvanized tower parts.	MQP	IV
O.02	Conductor	MQP	IV
O.03	Hardware fittings and Conductor & Earthwire Accessories	MQP	IV
O.04	Earth wire	MQP	IV
O.05	Insulator	MQP	IV
O.06	Bolts & Nuts of Gr 8.8 / 8	MQP	IV
O.07	Mono Pole	MQP	IV

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Annexure-G

Sl. No	Item / Equipment	Reference document for inspection	Inspection Level
O.08	Foundation Bolts & Anchor Bolts	POWERGRID TS	III
O.09	D-shackle/ Hanger / Links and associated Special bolt/nuts	MQP	III
O.10	Span Marker, Obstruction lights and Wind Measuring Equipment	POWERGRID TS	III
O.11	MS ROD rolled by Approved Re-roller of POWERGRID	MQP	III
O.12	MS ROD rolled by Approved steel producers of POWERGRID	POWERGRID TS	I
O.13	Spring Washers & Pack washers	POWERGRID TS	II
O.14	Bolts & Nuts Gr up to 5.6/5	POWERGRID TS	II
O.15	ACD & Barbed wire for ACD/Bird guard	POWERGRID TS	II
O.16	Danger Plate /Phase Plate / Number Plate / Circuit plate	POWERGRID TS	I
O.17	Sub Station Structure (lattice/pipe type)	MQP	III
O.18	Clamps & Connecters (including equipment connectors)	MQP	III
O.19	MS/ GI Flat, rod type, pipe type and other earthing material.	POWERGRID TS	II
O.20	Aluminium Tube & Busbar materials	POWERGRID TS	II
O.21	Pipe Type & Counter Poise Earthing	POWERGRID TS	II
O.22	DTS System	POWERGRID TS	II

For Equipment where requirement of MQP is envisaged, ITP/FAT will be followed If sourced from off shore. For items required in S/S or T/L or TELECOM/LD&C, same inspection level as specified shall be followed for all the cases.

*MICC for test and measuring equipment (inspection level I or II) shall be issued only after actual verification/ demonstration of satisfactory performance at site.

** Though level-2 items, CIP/MICC can be issued also on review of TCs and visual inspection of these item.

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ANNEXURE-J

LIST OF THE MAKES FOR WHICH TYPE TEST REPORTS NOT REQUIRED TO BE SUBMITTED

Sl. No.	ITEM DESCRIPTION	MAKE
A.	***Substation Accessories [Type Testing is not envisaged]***	
1.	Outdoor receptacles	CGL/B&C/BCH/Sakti, Chennai/Indo Asian/AVAIDS
2.	Trefoil clamp	Moulded Fibre Glass Products, Calcutta
3.	Diesel Engine	Cummins/Ruston & Hornsby/Greaves Cotton/Kirloskar/Mahindra/Ashok Leyland
4.	Alternator	AVK/KIRLOSKAR/STAMFORD/ Leroy Somer
5.	Motors	KEC/Siemens/NGEF/Crompton/ABB
6.	Cable Glands	Sunil & Co./Arup/ Comet/QPIE
7.	Junction Box	Sarvana/ECS/C&S/Vikas/Maktel/Unilac/Jasper/ Amara raja/AVAIDS
8.	EPAX	MATRIX, BPL
9.	ACSR Conductor (Bersimis/Moose/Zebra)	Sterlite/Apar/HVPL/Sharavathy/Hiren Aluminium Ltd./Smita/Deepak Cables/Polycab wires/Cabcon/JSK
10.	AAC Conductor (BULL)	Sterlite/Cabcon /JSK
11.	G.S. Earthwire	Sharavathy/Bharat Wire Ropes/Ramswarup
12.	Lighting Fixtures	Phillips/CGL/Bajaj /Havels
13.	Lighting Transformer	Gujarat-Plug-In
14.	Lighting Panels	Vikas/Makel/Nitya/AVAIDS
15.	MCCB/ACB/Protective relays of LT Switchgear Boards	All approved makes as per Compendium of Vendors
16.	EOT Crane	Reva
B.	***ACCESSORIES FOR TRANSFORMER & REACTOR [Earlier approved type test reports is applicable and not required to be submitted]***	
17.	BUCHHOLZ RELAY *[Upto 765kV Transformer & Reactor]*	(i) M/S CEDESPE, ITLAY [Model Type-EE 3 (Plug & Socket type)]/ (ii) M/s VIAT INSTRUMENTS PVT. LTD.KOLKATA [Model type-GOR-3M (Plug & Socket type)]
18.	PRESSURE RELIEF DEVICE *[Upto 765kV Transformer & Reactor]*	(i) M/S SUKRUT UDYOG, Pune [Model type-T-6-MS15-SHB-PS (Plug & Socket type)] /
19.	MAGNETIC OIL LEVEL GAUGE *[Upto 765kV Transformer & Reactor]*	(i) M/S SUKRUT UDYOG PUNE [Model type-SO-HE-10-M-ATMS-PS (Plug & Socket type)], [Model Type:- SO-6-M-P-PS (Plug & Socket type)]/
20.	AIR CELL (FLEXIBLE AIR SEPARATOR) *[Upto 765kV Transformer & Reactor]*	Type test of following makes are not to be submitted (i) M/S PRONAL FRANCE / (ii) FUJIKURA, JAPAN / (iii) PRONAL ASIA, MALAYSIYA / (vi) SHENYANG HONGDA GENERAL RUBBER

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ANNEXURE-J

LIST OF THE MAKES FOR WHICH TYPE TEST REPORTS NOT REQUIRED TO BE SUBMITTED

Sl. No.	ITEM DESCRIPTION	MAKE
		FACTORY / (v) BAODING XINKE RUBBER PRODUCT INSTITUTE, CHINA / (vi) M/S ZENITH INDUSTRIAL RUBBER PRODUCTS PVT. LTD. THANE/ (vii) M/S UNIRUB TECHNO PUNE
21.	OTI & WTI *[Upto 765kV Transformer & Reactor]*	(i) M/S PRESIMEASURE BANGALORE [Model type-1005A
22.	OIL PUMP *[Upto 765kV Transformer & Reactor]*	(i) FLOWWELL PUMPS & METERS, BANGALORE [Model type-1220D, 1250D
23.	COOLING FAN AND MOTOR ASSEMBLY *[Upto 765kV Transformer & Reactor]*	(i) M/S MARATHON LTD KOLKATA [Model Type:-36M/K75-P8, 0.7kW, 725RPM, 22J/K37-P6, 0.25kW, 940RPM, AFF 915103, 0.625kW, 550RPM]
24.	Sudden Pressure Relay *[Upto 765kV Transformer & Reactor]*	(i) Qualitrol [Model/Drawing No.900-003-02 CS46518, 900-003-32 CS-46369] / (ii) Shenyang KEQI Electrical Equipment Co. Ltd. [Model/Drawing No. SYJ9-50-25TH]
25.	BUCHHOLZ RELAY *[Upto 400kV Transformer & Reactor]*	(i) M/S CEDASPE, ITALY [Model type-EE3 (Plug & Socket type)]/ (ii) VIAT INSTRUMENTS [Model type-GOR-3M (Plug & Socket type)]
26.	PRESSURE RELIEF DEVICE *[Upto 400kV Transformer & Reactor]*	(i) M/S SKURUT UDYOG, PUNE [Model type-T-6-MS-15-SHB-PS (Plug & Socket type)]
27.	MAGNETIC OIL LEVEL GAUGE *[Upto 400kV Transformer & Reactor]*	(i) M/S SUKRUT UDYOG PUNE [Model type-SOHE-10-M-ATMS-PS (Plug & Socket type)], [Model Type: SO-6-M-P-PS (Plug & Socket type)]/ (ii) M/S YOGYA ENTERPRISES, JHANSI [Model type-SO-10 (Plug & Socket type)]
28.	AIR CELL (FLEXIBLE AIR SEPARATOR) *[Upto 400kV Transformer & Reactor]*	Type test of following makes are not to be submitted (i) M/S THE RUBBER PRODUCTS MUMBAI / (ii) M/S UNIRUB TECHNO PUNE / (iii) M/S PRONAL FRANCE/ (iv) M/S ZENITH INDUSTRIAL RUBBER PRODUCTS PVT. LTD. THANE / (v) SHENYANG HONGDA GENERAL RUBBER FACTORY, CHINA
29.	Sudden Pressure Relay *[Upto 400kV Transformer & Reactor]*	(i) Qualitrol [Model/Drawing No.900-003-02 CS46518, 900-003-32 CS-46369] / (ii) VIAT INSTRUMENTS [Model/Drawing No.950 / (iii) Shenyang KEQI Electrical Equipment Co. Ltd. [Model/Drawing No.SYJ9-50-25TH]
30.	RIP Bushing (52kV, 3150A)	ABB Micafil, Switzerland [Model/Drawing No. 1ZCD073617 (Rev F)]
31.	RIP Bushing (420kV, 1250A)	ABB, SWEDEN [Model/Drawing No.1ZSC005378A0001 REV. K]
32.	RIP Bushing (245kV, 1250A)	ABB, SWEDEN [Model/Drawing No.1ZSC005416A0001 (Rev. D)]

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ANNEXURE-J

LIST OF THE MAKES FOR WHICH TYPE TEST REPORTS NOT REQUIRED TO BE SUBMITTED

Sl. No.	ITEM DESCRIPTION	MAKE
33.	RIP Bushing (245kV, 2000A)	ABB, SWEDEN [Model/Drawing No.1ZSC005373A0001 (Rev. C)]
34.	RIP Bushing (420kV, 1250A)	HSP Germany [Model/Drawing No.327470]
35.	RIP Bushing (245kV, 2000A)	HSP Germany [Model/Drawing No.329260]
36.	RIP Bushing (52kV, 3150A)	HSP Germany [Model/Drawing No.329280]
37.	RIP Bushing (420kV, 1250A)	Izolyator, Russia [Model/Drawing No.686354.603]
38.	RIP Bushing (245kV, 2000A)	Izolyator, Russia [Model/Drawing No.686353.602]
39.	RIP Bushing (52kV, 3150A)	Izolyator, Russia [Model/Drawing No.686351.601]
40.	RIP Bushing (145kV, 1250A)	Izolyator, Russia [Model/Drawing No.686352.604]
41.	RIP Bushing (420kV, 1250A)	TRENCH, CHINA [Model/Drawing No. ECT 707 (C2)]
42.	RIP Bushing (245kV, 2000A)	TRENCH, CHINA [Model/Drawing No. ECT 617 (C3)]
43.	RIP Bushing (245kV, 1250A)	TRENCH, CHINA [Model/Drawing No. ECT 616 (C3)]
44.	RIP Bushing (145kV, 1250A)	TRENCH, CHINA [Model/Drawing No. ECT 516 (C3)]
45.	RIP Bushing (52kV, 1250A)	TRENCH, CHINA [Model/Drawing No. ECT 415 (C3)]
46.	RIP Bushing (52kV, 3150A)	TRENCH, CHINA [Model/Drawing No. ECT 419 (C3)]
47.	RIP Bushing (420kV, 1250A)	Xian China [Model/Drawing No. 75706 (Rev 09)]
48.	RIP Bushing (245kV,2000A)	Xian China [Model/Drawing No. 75618 (Rev 09)]
49.	RIP Bushing (52kV, 3150A)	Xian China [Model/Drawing No. 75366 (Rev 03)]
50.	RIP Bushing (52kV, 3150A)	Xian China [Model/Drawing No. 75332 (Rev 08)]
51.	OIP Bushing (800kV, 2500A)	ABB, SWEDEN [Model / Drawing No. GOE-2550-16002500-0.6-B, 1ZSC026186-AAM REV. H]
52.	OIP Bushing (420kV, 2500A)	ABB, SWEDEN [Model / Drawing No.GOE-1425-11502500-0.6, 1ZSC026186-AAL REV. F]
53.	OIP Bushing (800kV, 2500A)	TBEA, CHINA [Model / Drawing No. TBEA-500-765TA0035-01, REV. 02]
54.	OIP Bushing (420kV, 2500A)	TBEA, CHINA [Model / Drawing No. TBEA-500-765TA0035-02, REV. 02]
55.	OIP Bushing (420kV, 2500A)	TRENCH, CHINA [Model / Drawing No. OT-738-1 (C 5)]
56.	OLTC (500MVA, 765kV ICT)	MR Germany [Model/Drawing No. MI 1503 72.5/RC- 12231WR]
57.	OLTC (500MVA, 400kV ICT)	Easun MR, Chennai [Model/Drawing No. 3 x MI 1200 300/D 10.19.3W]
58.	OLTC (220kV & below rating transformer)	BHEL, Bhopal [Model/Drawing No. MIII 600 110/C 10.19.3W]
C.	***TESTING EQUIPMENT FOR TRANSFORMER & REACTOR***	
59.	Oil BDV Test Kit	Baur [Model/Drawing No. DTA 100C]

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ANNEXURE-J

LIST OF THE MAKES FOR WHICH TYPE TEST REPORTS NOT REQUIRED TO BE SUBMITTED

Sl. No.	ITEM DESCRIPTION	MAKE
60.	Oil BDV Test Kit	Megger [Model/Drawing No. OTS 100AF]
61.	Online Dissolved Gas (Multi-gas) and Moisture Analyser	A Eberle GmbH & Co. KG [Model/Drawing No. HYDROCAL 1008]
62.	Online Dissolved Gas (Multi-gas) and Moisture Analyser	Ningbo Ligong Online Monitoring Technology Co. LTD [Model/Drawing No. MGA2000]
63.	Online Dissolved Gas (Multi-gas) and Moisture Analyser	GE Energy [Model/Drawing No. KELMAN TRANSFIX]
64.	Online Dissolved Gas (Multi-gas) and Moisture Analyser	Qualitrol Company LLC [Model/Drawing No. SERVERON TM 8]
65.	On line Insulating Oil Drying System	CEE DEE Vacuum Equipment Pvt. Ltd. [Model/Drawing No. TRANSDRY CD-002]
66.	On line Insulating Oil Drying System	PTSS [Model/Drawing No. PTSS-TDS1GA6XS]
67.	Portable Dissolved Gas Analysis of Insulating Oil	GE Energy [Model/Drawing No. KELMAN TRANSPORT X]

NOTES:-

1. For sub-station accessories mentioned at Sr. No. A above, model specific separate approval of type test report is not required.

2. For Transformer/Reactor accessories & testing equipment mentioned at Sr. No. B & C above, wherever, model/drawing no. is specified separate approval of type test report and drawing/documents is not required, thus requirement of type test report validity of 10 years is not applicable.

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SECTION-4

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

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

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