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BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION BUSINESS HVDC ENGINEERING & SYSTEMS

DOCUMENT No.	TB-442-316-115	Rev. No.	00	Prepared	Checked	Approved
TYPE OF DOC.	TECHNICAL SPECIFICATION		SIGN			
TITLE			NAME	SS	SKS	SKS
DC PORCELAIN POST INSULATOR			DATE	25.06.26	25.06.26	25.06.26
			GROUP	TBEM	W.O. No	

CUSTOMER	ADANI ENERGY SOLUTIONS LIMITED
PROJECT	±800kV, 6000MW HVDC Terminals at Bhadla (HVDC) & Fatehpur (HVDC) along with associated AC substations and AC Substation extension at Bhadla-3 associated with "Transmission system for evacuation of Power from REZ in Rajasthan (20GW) under Phase-III, Part-I

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3	Project Details and General Technical Requirements	1+58
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Rev No.	Date	Altered	Checked	Approved	REVISION DETAILS

Distribution	To	TBEM	TBMM	TBQM	Vendor
	Copies	1	1	1	1

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SECTION-1

Scope, Bill of Quantity, Specific Technical Requirements

1.1 Scope

This technical specification covers the requirements of design, manufacture, testing at works, packing, loading at works and transport to site of Indoor DC Porcelain 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
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

The equipment is required for the following project:

Name of the customer : ADANI ENERGY SOLUTIONS LIMITED

Client : RAJASTHAN PART I POWER TRANSMISSION LIMITED

Name of the project : ±800kV, 6000MW HVDC Terminals at Bhadla (HVDC) & Fatehpur (HVDC) along with associated AC substations and AC Substation extension at Bhadla-3 associated with "Transmission system for evacuation of Power from REZ in Rajasthan (20GW) under Phase-III, Part-I

Station : **BHADLA HVDC & FATEHPUR HVDC Terminal**

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

1.2 Bill of Quantities

1.2.1 For quantity refer bellow documents:

BHADLA HVDC: 1JNL2441569, Rev- C: Part list, ceramic post insulator
FATEHPUR HVDC: 1JNL2441570, Rev- C: Part list, ceramic post insulator

1.3 Specific Technical Requirements

1.3.1. Refer below documents for technical data:

BHADLA HVDC: 1JNL2441569, Rev- C: Part list, ceramic post insulator
FATEHPUR HVDC: 1JNL2441570, Rev- C: Part list, ceramic post insulator

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Requirement Specification, 1JNL2441579, Rev- D: Ceramic Post Insulators

1.3.2. Technical Qualifying Requirement

Refer Annexure-TQR

1.3.3. Type Tests

(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 Contractor along with equipment / material drawings. The type tests conducted earlier should have 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 ADANI/representative authorized by ADANI/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 as mentioned in latest CEA Guideline for validity period of Type test from the date of 20/01/2025. In case the test reports are of the test conducted earlier than CEA Guideline from the date of 20/01/2025, the contractor shall repeat these test(s) at no extra cost to the Employer.

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

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

(iii) 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 test has been offered free of charge. Further, in case any Bidder indicates that he shall not carry out a particular test, his offer shall be considered incomplete and shall be liable to be rejected. The Employer reserves the right to waive the repeating of type tests partly or fully and in case of waiver, test charges for the same shall not be payable.

(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.

1.3.4. Quality Plan

Bidder should submit quality plan at contract stage for approval in line with the attached QAP, SQP NO: TRN/QA/SQP/E/326

1.3.5. Deviations

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

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1.3.6. Packing

1.3.6.1. All equipment 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.

1.3.6.2. 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.

1.3.6.3. 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.

1.3.6.4. 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.

1.3.6.5. 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.

1.3.6.6. 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.

1.3.6.7. 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.

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

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

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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adani Energy Solutions	**Adani Energy Solution Ltd.**
RAJASTHAN PART I POWER TRANSMISSION LIMITED	

Approved in	CAT-1		CAT-1*		CAT-2		CAT-3		CAT-4	
May 8, 2026		✕		✕		✕		✕		✓

Checked by	Reviewed by	Approved by	
	Raiju Hassan	Sonu Karekar	Mahesh Ambardekar
Priyanka Nakum	RcHassan	SKarekar	Amb

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Rev.	Issued Date	Description	Created by	Checked by	Approved by
C	2026-04-17	For Information	Gargi Maheshwari	Ragupathya Raja	Srinivasan Kaliyamurthy
B	2026-03-31	For Information	Gargi Maheshwari	Ragupathya Raja	Srinivasan Kaliyamurthy
A	2025-11-12	For Information	Gargi Maheshwari	Ragupathya Raja	Srinivasan Kaliyamurthy

Client:

RAJASTHAN PART I POWER TRANSMISSION LIMITED

Contractor:

HITACHI **HITACHI ENERGY INDIA LIMITED**

Contractor:

BHEL **BHARAT HEAVY ELECTRICALS LIMITED**

Project title:

±800kV, 6000MW HVDC Terminals at Bhadla (HVDC) & Fatehpur (HVDC) along with associated AC substations and AC Substation extension at Bhadla-3 associated with "Transmission system for evacuation of Power from REZ in Rajasthan (20GW) under Phase-III, Part-I"

Contractor Document Number:	Contractor Rev no.:
1JNL2441569	**C**

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Document Type:	Station Name:	Product Class
Parts list	**Bhadla HVDC**	**353**

Document Title:

Ceramic Post Insulators

Client Document Number:	Revision:	Page:
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RS No.
1JNL2441579

1. Quantities For Ceramic Insulator Bhadla (Table 1)

Item No.	Description	Total Quantity
361	Valve Hall post insulator (Porcelain)	36
362	DC neutral post insulator (Porcelain – RTV coated)	20
363	DC Common, DC Filter post insulator (Porcelain – RTV coated)	294
364	DC Filter 12/24 post insulator (Porcelain – RTV coated)	8
365	DC Filter 12/24 post insulator (Porcelain – RTV coated)	12
366	DC Filter 12/24 post insulator (Porcelain – RTV coated)	20
367	DC Filter 2/6 post insulator (Porcelain – RTV coated)	12
368	DC Filter 2/6 post insulator (Porcelain – RTV coated)	16
369	DC yard OCT arrangement Post	8

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2. Technical Data For Ceramic Insulator Bhadla (Table 2)

Item No.	Description	Voltage to ground (kVrms)	SIWV (kV)	LIWV (kV)	Min. arcing distance (mm)	Min. creepage distance (mm)	Insulator length (mm)[1]	Max Mech. Load MML (kN)	Preferred base fitting	Preferred top fitting	Shed profile	Remarks
		Note 1			Note 2			Note 3			Note 4	Note 5
361	Valve Hall post insulator (Porcelain)	61	516	544	1500	1281		10			DC-profile	UpS
362	DC neutral post insulator (Porcelain – RTV coated)	61	516	544	1350	3660		10			DC-profile	UpS
363	DC Common , DC Filter post insulator (Porcelain – RTV coated)	50	460	644	1350	3000		10			DC-profile	UpS
364	DC Filter 12/24 post insulator (Porcelain – RTV coated)	69.9	515	834	1670	4194		10			DC-profile	UpS
365	DC Filter 12/24 post insulator (Porcelain – RTV coated)	8.4	-	687	1380	4194		10			DC-profile	UpS
366	DC Filter 12/24 post insulator (Porcelain – RTV coated)	67.1	460	644	1290	4026		10			DC-profile	UpS
367	DC Filter 2/6 post insulator (Porcelain – RTV coated)	133.5	757	1154	2470	8010		10			DC-profile	UpS
368	DC Filter 2/6 post insulator (Porcelain – RTV coated)	124	627	753	1800	8010		10			DC-profile	UpS
369	DC yard OCT arrangement Post insulator (Only for mechanical support)	-	-	-	-	-	500-550	10			DC-profile	UpS

[1] Insulator Length shall be always equal or longer than the insulator arcing distance plus the flanges height.

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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:

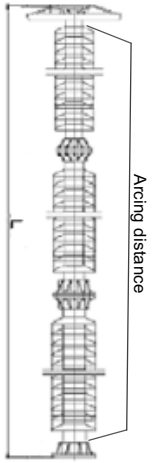

Figure 1. Definition of post insulator length

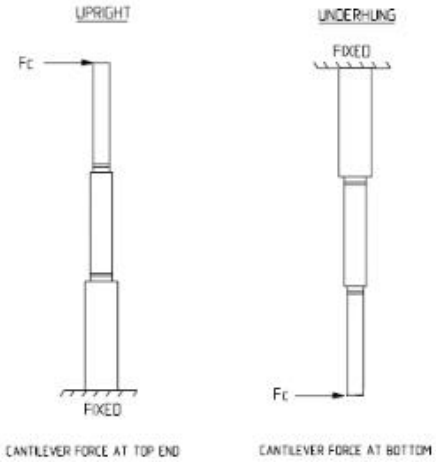

Figure 2. Definition of cantilever strength

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 specification. 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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C	Gargi Maheshwari,17-04-2026	Srinivasan Kaliyamurthy
Revision text		
-Updated Technical Data For Item 369		
B	Gargi Maheshwari,31-03-2026	Srinivasan Kaliyamurthy
Revision text		
-Updated RS Number. - LIWV,SIWV and arcing distance is updated for Item No.364,365,366,367 and 368. -MML for all the items has been updated.		
A	Gargi Maheshwari,12-11-2025	Srinivasan Kaliyamurthy
Revision text		
First Issue		

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adani Energy Solutions	**Adani Energy Solution Ltd.**

RAJASTHAN PART I POWER TRANSMISSION LIMITED

Approved in	CAT-1		CAT-1*		CAT-2		CAT-3		CAT-4	
May 8, 2026		✕		✕		✕		✕		✓

Checked by	Reviewed by	Approved by	
Priyanka Nakum	Raiju Hassan	Sonu Karekar	Mahesh Ambardekar

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C	2026-04-17	For Information	Gargi Maheshwari	Ragupathya Raja	Srinivasan Kaliyamurthy
B	2026-03-31	For Information	Gargi Maheshwari	Ragupathya Raja	Srinivasan Kaliyamurthy
A	2025-11-12	For Information	Gargi Maheshwari	Ragupathya Raja	Srinivasan Kaliyamurthy

Client:

RAJASTHAN PART I POWER TRANSMISSION LIMITED

Contractor:

HITACHI **HITACHI ENERGY INDIA LIMITED**

Contractor:

BHEL **BHARAT HEAVY ELECTRICALS LIMITED**

Project title:

±800kV, 6000MW HVDC Terminals at Bhadla (HVDC) & Fatehpur (HVDC) along with associated AC substations and AC Substation extension at Bhadla-3 associated with "Transmission system for evacuation of Power from REZ in Rajasthan (20GW) under Phase-III, Part-I"

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Document Type:	Station Name:	Product Class
Parts list	**Fatehpur HVDC**	**353**

Document Title:

Ceramic Post Insulators

Client Document Number:	Revision:	Page:
		1 of 5

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RS No.
1JNL2441579

1. Quantities For Ceramic Insulator Fatehpur (Table 1)

Item No.	Description	Total Quantity
361	Valve Hall post insulator (Porcelain)	36
362	DC neutral post insulator (Porcelain – RTV coated)	20
363	DC Common Area, DC Filter post insulator (Porcelain – RTV coated)	286
364	DC Filter 12/24 post insulator (Porcelain – RTV coated)	8
365	DC Filter 12/24 post insulator (Porcelain – RTV coated)	12
366	DC Filter 12/24 post insulator (Porcelain – RTV coated)	20
367	DC Filter 2/6 post insulator (Porcelain – RTV coated)	12
368	DC Filter 2/6 post insulator (Porcelain – RTV coated)	16
369	DC yard OCT arrangement Post insulator(Only for mechanical support)	8

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2. Technical Data For Ceramic Insulator Fatehpur (Table 2)

Item No.	Description	Voltage to ground (kV)	SIWV (kV)	LIWV (kV)	Min. arcing distance (mm)	Min. creepage distance (mm)	Insulator length (mm)[1]	Max Mech. Load MML (kN)	Preferred base fitting	Preferred top fitting	Shed profile	Remarks
		Note 1			Note 2			Note 3			Note 4	Note 5
361	Valve Hall post insulator (Porcelain)	45	490	476	1250	945		10			DC-profile	UpS
362	DC neutral post insulator (Porcelain – RTV coated)	45	490	476	1250	2700		10			DC-profile	UpS
363	DC Common post, DC Filter insulator (Porcelain – RTV coated)	15	-	125	300	900		10			DC-profile	UpS
364	DC Filter 12/24 post insulator (Porcelain – RTV coated)	27.5	197	375	750	1650		10			DC-profile	UpS
365	DC Filter 12/24 post insulator (Porcelain – RTV coated)	8.4	-	317	640	1650		10			DC-profile	UpS
366	DC Filter 12/24 post insulator (Porcelain – RTV coated)	19.2	190	228	460	1152		10			DC-profile	UpS
367	DC Filter 2/6 post insulator (Porcelain – RTV coated)	117	612	1008	2020	7020		10			DC-profile	UpS
368	DC Filter 2/6 post insulator (Porcelain – RTV coated)	106.1	533	640	1380	7020		10			DC-profile	UpS
369	DC yard OCT arrangement Post insulator(Only for mechanical support)	-	-	-	-	-	500-550	10			DC-profile	UpS

[1] Insulator Length shall be always equal or longer than the insulator arcing distance plus the flanges height.

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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:

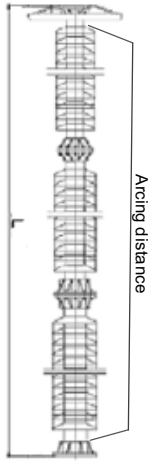

Figure 1. Definition of post insulator length

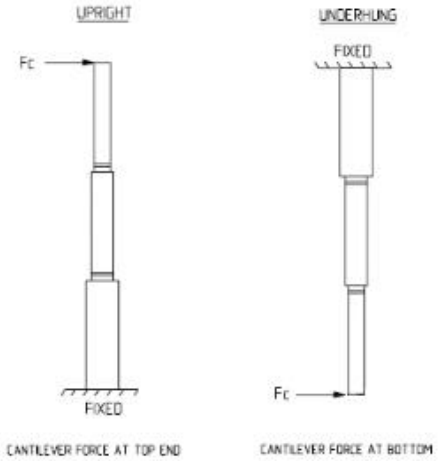

Figure 2. Definition of cantilever strength

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 specification. 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.
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C	Gargi Maheshwari,17-04-2026	Srinivasan Kaliyamurthy
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-LIWV,SIWV and arcing distance is updated for Item No.365,366,367 and 368. -MML for all the items has been updated.		
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Annexure – TQR.

TECHNICAL PRE QUALIFICATION REQUIREMENT

Name of Project : ±800kV, 6000MW HVDC Terminals at Bhadla (HVDC) & Fatehpur (HVDC) along with associated AC substations and AC Substation extension at Bhadla-3 associated with "Transmission system for evacuation of Power from REZ in Rajasthan (20GW) under Phase-III, Part-I

Name of Customer : ADANI ENERGY SOLUTIONS LIMITED

Name of Item : DC PORCELAIN POST INSULATOR

TECHNICAL PRE-QUALIFICATION REQUIREMENT
The bidder should have manufactured, type tested (as per IEC / IS) and supplied 220KV(AC) or above class of Porcelain Post insulators as on date 20/01/2025.

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 e.t.c
4	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

SHOBHNA SINGH
DGM-TBEM

REVIEWED & APPROVED BY

SANJEEV KUMAR SHRIVASTAVA
AGM-TBEM

Receipt No. 2167664/2026/TBG-TB_HVDC (Computer No. 2167664)
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					M	C/A					M	C	A	
1	2	3	4	5	6		7	8	9	*D	**10			11
1. RAW MATERIAL														
1.1	Calcined Alumina Powder	Visual Inspection	Major	Visual	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		Supplier TC/Manufacturer's Incoming Quality Report		P	V	V	
		D50 Particle Size	Major	Physical							P	V	V	
		Magnetic Iron	Major	Physical						√	P	V	V	
		Alumina as AL 203	Major	Chemical						√	P	V	V	
		Chemical Analysis												
		LOI at 1000 Deg C	Major	Chemical						√	P	V	V	
		Soluble Soda	Major	Chemical						√	P	V	V	
1.2	Feldspar Powder	Visual Inspection	Minor	Visual	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		Supplier TC/Manufacturer's Incoming Quality Report		P	V	V	
		Particle Size Residue on (150 BS mesh)	Major	Physical						√	P	V	V	
		Free magnetic iron	Major	Physical						√	P	V	V	
		Sample Fired Appearance Test	Major	Physical							P	V	V	
		Chemical Analysis												
		LOI at 1000 deg C	Major	Chemical						√	P	V	V	
		SIO2%	Major	Chemical						√	P	V	V	
		AL2O3%	Major	Chemical						√	P	V	V	
		Fe2O3%	Major	Chemical						√	P	V	V	
		TiO2%	Minor	Chemical						√	P	V	V	
		CaO%	Major	Chemical						√	P	V	V	
		MgO%	Minor	Chemical						√	P	V	V	
		K2O%	Major	Chemical						√	P	V	V	
		Na2O%	Major	Chemical						√	P	V	V	
1.3	RMBC - 01 Ball clay	Particle Size Residue on (240 BS mesh)	Major	Physical	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		Supplier TC/Manufacturer's Incoming Quality Report		P	V	V	
		Particle size analysis	Major	Physical						√	P	V	V	
		Dry Shrinkage	Minor	Physical						√	P	V	V	
		Dry MOR	Minor	Physical						√	P	V	V	
		Water absorption	Minor	Physical						√	P	V	V	
		Fired shrinkage	Minor	Physical						√	P	V	V	
		Fired colour	Minor	Physical						√	P	V	V	
		Warpage	Major	Physical						√	P	V	V	
		Chemical Analysis												
		LOI at 1000 deg C	Major	Chemical						√	P	V	V	
		SIO2%	Major	Chemical						√	P	V	V	
		AL2O3%	Major	Chemical						√	P	V	V	
		Fe2O3%	Major	Chemical						√	P	V	V	
		TiO2%	Minor	Chemical						√	P	V	V	
		CaO%	Major	Chemical						√	P	V	V	
		MgO%	Minor	Chemical						√	P	V	V	
		KNaO%	Major	Chemical						√	P	V	V	
1.4	RMBC - 02 Ball clay	Particle Size Residue on (240 BS mesh)	Major	Physical	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		Supplier TC/Manufacturer's Incoming Quality Report		P	V	V	
		Particle size analysis	Major	Physical						√	P	V	V	
		Dry Shrinkage	Minor	Physical						√	P	V	V	
		Dry MOR	Minor	Physical						√	P	V	V	
		Water absorption	Minor	Physical						√	P	V	V	
		Fired shrinkage	Minor	Physical						√	P	V	V	
		Fired colour	Minor	Physical						√	P	V	V	
		Warpage	Major	Physical						√	P	V	V	

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1	2	3	4	5	6		7	8	9	*D	**10			11
1.4	RMBC - 02 Ball clay	**Chemical Analysis**			To be specified by Manufacturer	-	Mfg. standard procedure/ATL TS		Supplier TC/Manufacturer's Incoming Quality Report		P	V	V	
		LOI at 1000 deg C	Major	Chemical						√	P	V	V	
		SIO2%	Major	Chemical						√	P	V	V	
		AL2O3%	Major	Chemical						√	P	V	V	
		Fe2O3%	Major	Chemical						√	P	V	V	
		TiO2%	Minor	Chemical						√	P	V	V	
		CaO%	Major	Chemical						√	P	V	V	
		K2O%	Minor	Chemical						√	P	V	V	
		Na2O%	Major	Chemical						√	P	V	V	
1.5	RMBC - 03 Ball clay	Particle Size Residue on (240 BS mesh)	Major	Physical	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		Supplier TC/Manufacturer's Incoming Quality Report		P	V	V	
		Particle size analysis	Major	Physical							P	V	V	
		Dry Shrinkage	Minor	Physical						√	P	V	V	
		Dry MOR	Minor	Physical						√	P	V	V	
		Water absorption	Minor	Physical						√	P	V	V	
		Fired shrinkage	Minor	Physical						√	P	V	V	
		Fired colour	Minor	Physical							P	V	V	
		Warpage	Major	Physical						√	P	V	V	
		Chemical Analysis												
		LOI at 1000 deg C	Major	Chemical						√	P	V	V	
		SIO2%	Major	Chemical						√	P	V	V	
		AL2O3%	Major	Chemical						√	P	V	V	
		Fe2O3%	Major	Chemical						√	P	V	V	
		TiO2%	Minor	Chemical						√	P	V	V	
		CaO%	Major	Chemical						√	P	V	V	
		MgO%	Minor	Chemical						√	P	V	V	
		KNaO%	Major	Chemical						√	P	V	V	
1.6	RMBC - 04 Ball clay	Particle Size Residue on (240 BS mesh)	Major	Physical	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		Supplier TC/Manufacturer's Incoming Quality Report		P	V	V	
		Particle size analysis	Major	Physical							P	V	V	
		Dry Shrinkage	Minor	Physical							P	V	V	
		Dry MOR	Minor	Physical						√	P	V	V	
		Water absorption	Minor	Physical						√	P	V	V	
		Fired shrinkage	Minor	Physical						√	P	V	V	
		Fired colour	Minor	Physical						√	P	V	V	
		Warpage	Major	Physical						√	P	V	V	
		Chemical Analysis												
		LOI at 1000 deg C	Major	Chemical						√	P	V	V	
		SIO2%	Major	Chemical						√	P	V	V	
		AL2O3%	Major	Chemical						√	P	V	V	
		Fe2O3%	Major	Chemical						√	P	V	V	
		TiO2%	Minor	Chemical						√	P	V	V	
		CaO%	Major	Chemical						√	P	V	V	
		MgO%	Minor	Chemical						√	P	V	V	
		KNaO%	Major	Chemical						√	P	V	V	
1.7	RMBC - 05 Ball clay	Particle Size Residue on (240 BS mesh)	Major	Physical	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		Supplier TC/Manufacturer's Incoming Quality Report		P	V	V	
		Particle size analysis	Major	Physical							P	V	V	
		Dry Shrinkage	Minor	Physical						√	P	V	V	
		Dry MOR	Minor	Physical						√	P	V	V	
		Water absorption	Minor	Physical						√	P	V	V	
		Fired shrinkage	Minor	Physical						√	P	V	V	
		Fired colour	Minor	Physical						√	P	V	V	
		Warpage	Major	Physical						√	P	V	V	

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					M	C/A					M	C	A	
1	2	3	4	5	6		7	8	9	*D		**10		11
1.7	RMBC - 05 Ball clay	**Chemical Analysis**			Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		Supplier TC/Manufacturer's Incoming Quality Report					
		LOI at 1000 deg C	Major	Chemical						√	P	V	V	
		SIO2%	Major	Chemical						√	P	V	V	
		AL2O3%	Major	Chemical						√	P	V	V	
		Fe2O3%	Major	Chemical						√	P	V	V	
		TiO2%	Minor	Chemical						√	P	V	V	
		CaO%	Major	Chemical						√	P	V	V	
		MgO%	Minor	Chemical						√	P	V	V	
		KNaO%	Major	Chemical						√	P	V	V	
1.8	RMBC - 06 Ball clay	Particle Size Residue on	Major	Physical	To be specified by Manufacturer	-	Mfg. standard procedure/ATL TS		Supplier TC/Manufacturer's Incoming Quality Report	-	P	V	V	
		Particle size analysis	Major	Physical							P	V	V	
		Dry Shrinkage	Minor	Physical						√	P	V	V	
		Dry MOR	Minor	Physical						√	P	V	V	
		Water absorption	Minor	Physical						√	P	V	V	
		Fired shrinkage	Minor	Physical						√	P	V	V	
		Fired colour	Minor	Physical						√	P	V	V	
		Warpage	Major	Physical						√	P	V	V	
		Chemical Analysis												
		LOI at 1000 deg C	Major	Chemical						√	P	V	V	
		SIO2%	Major	Chemical						√	P	V	V	
		AL2O3%	Major	Chemical						√	P	V	V	
		Fe2O3%	Major	Chemical						√	P	V	V	
		TiO2%	Minor	Chemical						√	P	V	V	
		CaO%	Major	Chemical						√	P	V	V	
		MgO%	Minor	Chemical						√	P	V	V	
		KNaO%	Major	Chemical						√	P	V	V	
1.9	RMCC - 01 China clay	Particle Size Residue on (240 BS mesh)	Major	Physical	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		Supplier TC/Manufacturer's Incoming Quality Report		P	V	V	
		Particle size analysis	Major	Physical							P	V	V	
		Dry Shrinkage	Minor	Physical						√	P	V	V	
		Dry MOR	Minor	Physical						√	P	V	V	
		Water absorption	Minor	Physical						√	P	V	V	
		Fired shrinkage	Minor	Physical						√	P	V	V	
		Fired colour	Minor	Physical						√	P	V	V	
		Fired Magnetic iron	Major	Physical						√	P	V	V	
		Warpage	Major	Physical						√	P	V	V	
		Chemical Analysis												
		LOI at 1000 deg C	Major	Chemical						√	P	V	V	
		SIO2%	Major	Chemical						√	P	V	V	
		AL2O3%	Major	Chemical						√	P	V	V	
		Fe2O3%	Major	Chemical						√	P	V	V	
		TiO2%	Minor	Chemical						√	P	V	V	
		CaO%	Major	Chemical						√	P	V	V	
		MgO%	Minor	Chemical						√	P	V	V	
		KNaO%	Major	Chemical						√	P	V	V	
1.10.	RMCC - 02 China clay	Particle Size Residue on (240 BS mesh)	Major	Physical	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		Supplier TC/Manufacturer's Incoming Quality Report		P	V	V	
		Particle size analysis	Major	Physical							P	V	V	
		Dry Shrinkage	Minor	Physical						√	P	V	V	
		Dry MOR	Minor	Physical						√	P	V	V	
		Water absorption	Minor	Physical						√	P	V	V	
		Fired shrinkage	Minor	Physical						√	P	V	V	
		Fired colour	Minor	Physical						√	P	V	V	
		Warpage	Major	Physical						√	P	V	V	
		Chemical Analysis												
		LOI at 1000 deg C	Major	Chemical						√	P	V	V	
		SIO2%	Major	Chemical						√	P	V	V	

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1.10.	RMCC - 02 China clay	AL2O3%	Major	Chemical	Mfg. standard procedure	-	To be specified by Manufacturer		Supplier TC/Manufacturer's Incoming Quality Report	√	P	V	V	
		Fe2O3%	Major	Chemical						√	P	V	V	
		TiO2%	Minor	Chemical						√	P	V	V	
		CaO%	Major	Chemical						√	P	V	V	
		MgO%	Minor	Chemical						√	P	V	V	
		KNaO%	Major	Chemical						√	P	V	V	
1.11	RMCC - 03 China clay	Particle Size Residue on (240 BS mesh)	Major	Physical	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		Supplier TC/Manufacturer's Incoming Quality Report		P	V	V	
		Particle size analysis	Major	Physical							P	V	V	
		Dry Shrinkage	Minor	Physical						√	P	V	V	
		Dry MOR	Minor	Physical						√	P	V	V	
		Water absorption	Minor	Physical						√	P	V	V	
		Fired shrinkage	Minor	Physical						√	P	V	V	
		Fired colour	Minor	Physical						√	P	V	V	
		Free magnetic iron	Major	Physical						√	P	V	V	
		Warpage	Major	Physical						√	P	V	V	
		Chemical Analysis												
		LOI at 1000 deg C	Major	Chemical						√	P	V	V	
		SIO2%	Major	Chemical						√	P	V	V	
		AL2O3%	Major	Chemical						√	P	V	V	
		Fe2O3%	Major	Chemical						√	P	V	V	
		TiO2%	Minor	Chemical						√	P	V	V	
		CaO%	Major	Chemical						√	P	V	V	
		MgO%	Minor	Chemical						√	P	V	V	
1.12	Water	pH Value	Major	Physical	Mfg. standard procedure	-			Supplier TC/Manufacturer's Incoming Quality Report		P	V	V	
		Chemical Analysis (Hardness)	Minor	Chemical							V	V	V	
1.13	Iron Oxide	Visual Inspection	Minor	Visual	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		Supplier TC/Manufacturer's Incoming Quality Report		P	V	V	
		Grain size on 240 BS Mesh (Fineness)	Minor	Physical							P	V	V	
		Chemical Analysis (Fe2O3% Min)	Major	Chemical						√	P	V	V	
1.14	Dolomite Powder	Visual Inspection	Minor	Visual	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		Supplier TC/Manufacturer's Incoming Quality Report		P	V	V	
		Grain size on 240 BS Mesh (Fineness)	Major	Physical							P	V	V	
		Inspection of fired sample	Minor	Physical						√	P	V	V	
		Chemical Analysis												
		LOI at 1000 deg C	Minor	Chemical							V	V	V	
		CaO	Major	Chemical							V	V	V	
		MgO	Major	Chemical							V	V	V	
1.15	Steatite Powder	Visual Inspection	Major	Visual	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		Supplier TC/Manufacturer's Incoming Quality Report		P	V	V	
		Inspection of fire sample	Major	Physical							P	V	V	
		Chemical Analysis												
		LOI at 1000 deg C	Minor	Chemical							V	V	V	
		SiO2	Major	Chemical							V	V	V	
		Fe2O3	Major	Chemical							V	V	V	
		CaO	Major	Chemical							V	V	V	
		MgO	Major	Chemical							V	V	V	

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1.16	Manganese Dioxide	Visual Inspection	Major	Visual	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		Supplier TC/Manufacturer's Incoming Quality Report		P	V	V	
		Grain size on 240 BS Mesh (Fineness)	Minor	Physical							P	V	V	
		Colour Intensity of fired sample	Minor	Physical							P	V	V	
		Chemical Analysis												
		LOI at 1000 deg C	Minor	Chemical							V	V	V	
		MnO2	Major	Chemical							V	V	V	
1.17	Chromium Oxide	Visual Inspection	Major	Visual	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		Supplier TC/Manufacturer's Incoming Quality Report		P	V	V	
		Grain size on 240 BS Mesh (Fineness)	Minor	Physical							P	V	V	
		Colour Intensity of fired sample	Minor	Physical							P	V	V	
		Chemical Analysis												
		LOI at 1000 deg C	Minor	Chemical							P	V	V	
		Cr203	Major	Chemical							P	V	V	
1.18	Rapid Hardening (Portland Cement)	Visual Inspection	Minor	Visual	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		Supplier TC/Manufacturer's Incoming Quality Report		P	V	V	
		Grain size on 200 BS Mesh (Fineness)	Major	Physical							V	V	V	
		Compressive Strength (1 Day)	Major	Physical							P	V	V	
		Initial Setting Time	Major	Physical							V	V	V	
		Final Setting Time	Major	Physical							V	V	V	
		Auto Clave Test	Major	Physical							V	V	V	
1.19	Bituminous paint	Visual Inspection	Minor	Visual	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		Supplier TC/Manufacturer's Incoming Quality Report		P	V	V	
		Density	Major	Physical							P	V	V	
		Viscosity B4-bitra cup method	Major	Physical							P	V	V	
		Drying Time	Major	Physical							P	V	V	
1.20.	Resilient cork padding	Thickness	Minor	Physical	Mfg. standard procedure	2% consignme nt	Mfg. standard procedure/ATL TS		Supplier TC/Manufacturer's Incoming Quality Report		P	V	V	
		Visual Inspection	Minor	Visual							P	V	V	
		Dia of cur circle	Minor	Physical							P	V	V	
1.21	Malleable Cast Iron (MCI) Spherical	Visual Inspection	Minor	Physical	Mfg. standard procedure	100%	IS 14329 / IS 1865	Free from porosity, blow tubes, cracks, distortions, hard, spots, etc	Supplier TC/Manufacturer's Incoming Quality Report		P	V	V	
		Soundness Test	Major	Physical				Ringing Sound			P	V	V	
1.22	Graphite Iron (SGI) (Black Condition)	Dimension check	Major	Physical	Mfg. standard procedure	2% /Lot	IS 14329 / IS 1865	Apprvd Drg	Supplier TC/Manufacturer's Incoming Quality Report		P	V	V	

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1.23	Graphite Iron (SGI) (Black Condition)	Magnetic practical inspection	Major	Physical	Mfg. standard procedure	-	IS 3703/ No cracks	No cracks	Supplier TC/Manufacturer's Incoming Quality Report		P	V	V	
		Tensile Load Test (Test Bar)	Major	Mechanical			IS 1865 /IS 14329	IS 1865 /IS 14329			P	V	V	
		% Elongation (Test Bar)	Major	Mechanical			MCI 12%, SGI 15%	IS 1865 /IS 14329			P	V	V	
		Hardness Test (Test Bar)	Major	Mechanical			IS 14328 / IS 1865	150 Max			P	V	V	
		Chemical Analysis	Major	Chemical			IS 14328/ IS 1865	Phosphorous 0.12% max			P	V	V	
		Microstructure	Major	Physical			IS 14328/ IS 1865	Free from Primary Graphite			P	V	V	
		Proof load test (called strength of Test Bar)	Major	Mechanical			IS 14329 / IS1885	IS 14329 / IS1885			P	V	V	
1.24	Galvanizing Test	Visual Inspection	Major	Physical	5%	5%	IS 2486 - P I	No red deposition	Supplier TC/Manufacturer's Incoming Quality Report/NABL TPL lab TC for purity of Zn	√	P	V	V	
		Gauge Checking	Major	Physical	5%	5%	IS 2486 - P II	App Drg.		√	P	V	V	
		Mass of Zn Coating	Major	Physical	2% of Lot	2% of Lot	IS 4759 / IS 6745 / ATL-PO/RFP/BOQ/TS/ Approved Drawing	**ATL -PO,RFP,BOQ,TS & Approved Drawing (which one is stringent)** **1. For Non coastal Area :** Minimum value of Mass of Zn Coating . 610 gm/m2 2. **For Coastal Area :** Minimum value of Mass of Zn Coating 900 gm/m2 3. **Other than Non Coastal & Coastal area :** Minimum value of Mass of Zn Coating shall be as per the project specific contract agreement.		√	P	V	V	***Please coordinate with ATL engineering for clarity on material will use in coastal area OR Non Coastal area before manfacturing and confirmation for the same shall be provided to inspector during inspection.** *** Don't go with assumption during mfg. / inspection. Req. of confirmation is mandatory** *** Please refer General Note no. 11 for coastal area definition**
		Uniformity of Zn Coating	Major	Chemical	2% of Lot	2% of Lot	IS 2629/IS 2633	Min 6 dips one minute each		√	P	V	V	
		Purity of Zinc	Major	Chemical	one sample/consignment	one sample/consignment	IS 209	99.95% purity		√	P	V	V	**Zinc shall be procured from Hindustan Zinc Limited & Binani Zinc Limited. Raw material test certificate of Zn used for lot shall be submitted for review during final inspection.**

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SL No.	COMPONENT/ OPERATION	CHARACTERISTICS	CATEGORY OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		INSPECTION AGENCY			REMARKS
					M	C/A					M	C	A	
1	2	3	4	5	6		7	8	9	*D	**10			11
1.25	Electro Plated Spring Washer	Visual Inspection	Major	Physical	IS 6821	IS 6821	IS 1573/ IS 3063	IS 1573/ IS 3063	Supplier TC/Manufacturer's Incoming Quality Report	-	P	V	V	
		Dimension check	Major	Physical						√	P	V	V	
		Galvanizing uniformity of Zn coating thickness of Zn coating	Major	Physical						√	P	V	V	
		Permanent Set	Major	Physical						√	P	V	V	
		Twist	Major	Physical						√	P	V	V	
		Hardness	Major	Physical						√	P	V	V	
		Permanent Load Test	Major	Physical						√	P	V	V	
1.26	Corona Ring	Visual Inspection	Major	Visual	100%	100%	App. Drg	No dent, scratch & breaking of welded joints	Supplier TC/Manufacturer's Incoming Quality Report	√	P	V	V	
		Dimension Check	Major	Physical	1 %/Lot	1 %/Lot	App. Drg	App. Drg		√	P	V	V	
		D.P. Test on Welded Joint	Major	Physical	1 %/Lot	1 %/Lot	App. Drg / IS 3658	No crack on welded portion		√	P	V	V	
		Tensile Test	Major	Mechanical	1 %/Lot	1 %/Lot	IS 5082	150 Kg/cm2		√	P	V	V	
		Chemical Analysis	Major	Chemical	1 Sample/ Lot of 100 or less	1 Sample/ Lot of 100 or less	IS 5082	IS 5082		√	P	V	V	
2. IN PROCESS														
2.1	Glaze Making	Glaze fired flow	Minor	Physical	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		ITR		P	V	V	
		Physical appearance	Major	Physical							P	V	V	
		Liter weight	Minor	Physical							P	V	V	
		Sieva Residue (300 BS Mesh)	Major	Physical							P	V	V	
		pH	Minor	Physical							P	V	V	
2.2	Fresh Body Slurry Preparation	Liter weight	Major	Physical	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		ITR		P	V	V	
		Sieva Residue (240 BS Mesh)	Major	Physical							P	V	V	
2.3	Slip Preparation in Blunger Agitator & Pit	Liter weight	Major	Physical	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		ITR		P	V	V	
		Sieva Residue (240 BS Mesh)	Major	Physical							P	V	V	
		Free iron content	Minor	Physical							P	V	V	
2.4	Filter Pressing	Moisture Content	Major	Physical	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		ITR		P	V	V	
2.5	Extrusion	Moisture	Major	Physical	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		ITR		P	V	V	
		De-aicing Check	Minor	Physical							P	V	V	
		Slice Behaviour	Major	Physical							P	V	V	
		Vacuum Achievement	Major	Physical							P	V	V	

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					M	C/A					M	C	A	
1	2	3	4	5	6		7	8	9	*D	**10			11
2.6	Properties of Unfired Porcelain	Selve residue on 240 BS Mesh	Major	Physical	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		ITR		P	V	V	
		Dry MOR	Minor	Physical							P	V	V	
		Dry Shrinkage	Minor	Physical							P	V	V	
		Fired shrinkage	Minor	Physical							P	V	V	
		Chemical Analysis												
		LOI at 1000 deg C	Major	Chemical					STC		P	V	V	
		SIO2%	Major	Chemical							P	V	V	
		AL2O3%	Major	Chemical							P	V	V	
		Fe2O3%	Major	Chemical							P	V	V	
		TiO2%	Minor	Chemical							P	V	V	
		CaO%	Major	Chemical							P	V	V	
		MgO%	Minor	Chemical							P	V	V	
		Kna (O)	Major	Chemical							P	V	V	
2.7	Straping	Dimension check	Major	Physical	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		ITR		P	V	V	
		Penetrometer Reading (stiffness)	Minor	Physical							P	V	V	
		Moisture Content	Minor	Physical							P	V	V	
		Free iron content	Minor	Physical							P	V	V	
2.8	Drying of Green Wares	Temperature Control	Major	Physical	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		ITR		P	V	V	
		Visual Check (before dry finishing)	Major	Visual							P	V	V	
		Moisture Content (before cooling)	Major	Physical							P	V	V	
2.9	Glazing	Litter Weight	Major	Physical	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		ITR		P	V	V	
		Viscosity B4-bitra cup method	Minor	Physical							P	V	V	
		Glaze Thickness	Major	Physical							P	V	V	
		Visual Exam after glazing	Major	Physical							P	V	V	
2.10.	For Sanding/ Gravel	Grain size	Minor	Physical	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		ITR		P	V	V	
2.11	Firing of Green Wares	Visual Inspection	Major	Physical	Mfg. standard procedure	-	Mfg. standard procedure/ATL TS		ITR		P	V	V	
		Temperature Control	Major	Physical							P	V	V	
		Atmosphere Control	Major	Physical							P	V	V	
		Pressure Control	Major	Physical							P	V	V	
		Fuel Oil Control	Major	Physical							P	V	V	
2.12	Sorting of fired Insulators	Visual Examination	Major	Visual	100%	100%	IS 2544/IEC 60168		ITR		P	V	V	
		Porosity Test (Dye Penetration Test)	Major	Physical	1 sample from each cycle	1 sample from each cycle	IS 2544 /IEC 60168	IS 2544 /IEC 60168			P	V	V	
2.13	Cutting and Grinding	Dimensional Check for cutting length	Major	Physical	100%	100%	Mfg. standard procedure/ATL TS		ITR		P	V	V	

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					M	C/A					M	C	A	
1	2	3	4	5	6		7	8	9	*D	**10			11
2.14	Inspection of shells	Visual Inspection	Major	Visual	100%	100%	IS 2544 /IEC 60168	IS 2544/IEC 60168	ITR		P	V	V	
		Glaze defects and glaze appearance	Major	Visual	100%	100%					P	V	V	
		Dimensional Check	Major	Physical	2 Nos./ Lot	2 Nos./ Lot	App. drawing	App. drawing			P	V	V	
		Ultrasonic Test	Major	Visual	100%	100%	IS 2544 /IEC 60168	No flow in Insulator			P	V	V	
		Porosity Test	Major	Visual	01 Sample /Lot after breaking	01 Sample / Lot after breaking	IS 2544 /IEC 60168	No Penetration of dye			P	V	V	
2.15	Assembly	Cement Cube Test	Minor	Physical	10 Cubes /Week	10 Cubes /Week	Mfg. standard procedure/ATL TS		ITR		P	V	V	
		Cementing Quality Check	Major	Physical	Each Shift	Each Shift					P	V	V	
		Cement mix check	Major	Physical							P	V	V	
		Cold water Curing	Minor	Physical	100%	100%					P	V	V	
3. FINISHED PRODUCT														
3.1	Routine Test	Visual Examination, check for surface defects and glazing defects	Major	Visual	100%	100%	IEC 60168 / IS 2544	IEC 60168 / IS 2544	IR	√	P	V	V	
		Dimensional checks eccentricity and parallelism (critical dimension)	Major	Physical	2 Pcs/Lot	2 Pcs/Lot			IR	√	P	V	V	
		Bending test in four direction (50% min falling load)	Major	Mechanical	100%	100%				√	P	V	V	
		Deflection at 50% load (one direction)	Major	Mechanical	100%	100%				√	P	V	V	
3.2	Acceptance Tests	Visual inspection for Insulator and its accessories	Major	Visual	IEC 60168/ IS 2544	IS 2544 /MIN 5 PICS	IEC 60168 / IS 2544	IEC 60168 / IS 2544	IR	√	P	H	H	**Note 1:- For lot size upto 500 nos., destructive testing shall be carried out on min. 1 sample/kN rating/lot**
		Verification of Dimension for Insulator and its accessories as per approved drawings	Major	Physical						√	P	H	H	
		Temperature Cycle Test	Major	Thermal						√	P	H	H	
		Mechanical Strength Test	Major	Thermal						√	P	H	H	
		Deflection test at 20%,50% & 70% of min falling load on complete stack	Major	Mechanical						√	P	H	H	
		Bending test 100% min of falling load in all four direction on complete stack and finally breaking load of actual breaking(not applicable on operating rod insulator)	Major	Mechanical						√	P	H	H	
		Torsion Test	Major	Mechanical						√	P	H	H	
		Porosity Test	Major	Mechanical						√	P	H	H	

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SL No.	COMPONENT/ OPERATION	CHARACTERISTICS	CATEGORY OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		INSPECTION AGENCY			REMARKS
					M	C/A					M	C	A	
1	2	3	4	5	6		7	8	9	*D	**10			11
3.2	Acceptance Tests	**Galvanizing test**								√	P	H	H	***Please coordinate with ATL engineering for clarity on material will use in coastal area OR Non Coastal area before manfacturing and confirmation for the same shall be provided to inspector during inspection. * Don't go with assumption during mfg. / inspection. Req. of confirmation is mandatory * Please refer General Note no. 11 for coastal area definition**
		Mass of Zn Coating	Major	Physical			IS 4759 / IS 6745 / ATL-PO/RFP/BOQ/TS/ Approved Drawing	**ATL -PO,RFP,BOQ,TS & Approved Drawing (which one is stringent)** **1. For Non coastal Area :** Minimum value of Mass of Zn Coating . 610 gm/m2 2. **For Coastal Area :** Minimum value of Mass of Zn Coating 900 gm/m2 3. **Other than Non Coastal & Coastal area :** Minimum value of Mass of Zn Coating shall be as per the project specific contract agreement.	IR	√	P	H	H	
		Uniformity of Zn Coating	Major	Physical			IS 2629/ IS 2633	IS 2629/ IS 2633		√	P	H	H	
3.3	Packing & Dispatch	Structure of woodent strip	Major	Physical	1 % of lot		Nil	No bend and koots			P	-	-	
		Dimension check	Minor	Physical	1 % of lot		Nil	As per SGEL drw			P	-	-	

4. 0 Type Test : Type test reports duly reviewed and accepted by Owner's Engg. shall be submitted along with inspection call. In case type test is specially required as per technical specification , same shall be witnessed by owner engineer.

LEGEND:- D* Records identified with tick (√) shall be essentially included by supplier & manufacturer in Quality Documentation package.
** M: Manufacturer / Sub-Supplier, C: Main Supplier / Main Contractor , A: Adani or their authorized representative.
Use the following term as appropriate in columns 10. P: Perform, V: verification and H: Customer Hold Point to be witnessed and work shall not proceeded till it is witnessed and cleared in writing.
Format of Record: STC:- Supplier's Test Certificate, MTC: Manufacturer/Sub-supplier Test Certificate, ITR: In process Test Report/Record, IR: Inspection Report

GENERAL NOTE :

1)This is generalised SQP, hence should be read in cojunction with PO, BOQ, RFP,TS, GTP, DRAWING and shall deem to include additional test / requirements / Stringent parameter asked if any as per the contract specific requiremens as applicable to specific contract and Bidder shall compliance the same without any commercial implication to owner.
2) Testing Instruments used during Inspection must be calibrated from NABL accredited lab only. Instruments used during testing should be within valid calibration date.
3) All packing case should be marked with ATL PO No., Name of project, Item details and MDCC number details.
4) Manufacturer shall ensure that all the test mentioned in technical specification of project / package need to be carried out strictly without fail. if it is not covered under SQP.
5) The manufacturer shall maintain the proper co relation from raw material test certificates / records to finish product and records should be offered for verification during inspection by ATL / Their nominated TPIA.
6) Whenever Indian standard / International standard are referred their last amended shall be included. The same shall be applicable if manufacturer specification / plant standard also so long as these changes are made with the approval of competent authority of manufacturer.
7) ATL may review the effective implementation of the processes during the product stage / final inspection.
8) If any test req. to carry out at Third party lab , such lab facility shall be accredited by NABL.
9) Inspection of spare items ordered by ATL shall also be governed by provision of this SQP. Items if not governed under SQP shall be offered for inspection as per ATL specifications / relevant Indian / International standards.
10) Manufacturer shall show the approval of ATL engineering for all contract specific type tests, including specific type tests if any as per ATL specifications at the time of Final inspection.
11)The area / location consider under coastal area if it is following under 30 km radius from sea shore or as specified in section-project.
12) As per Plastic Waste Management Rules, 2016, rule 4 clause (d) the contactor/Supplier/Vendor shall not use plastic sheet of less than 50 (Fifty) microns in thickness for the purpose of packing or wrapping the commodity/Commodities supplied to Adani Transmission Limited

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SECTION-2

Refer Requirement Specification, 1JNL2441579: Ceramic Post Insulators Rev-D

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D	2026-04-09	For Information	Gargi Maheshwari	Ragupathya Raja	Srinivasan Kaliyamurthy
C	2026-03-05	For Information	Gargi Maheshwari	Ragupathya Raja	Srinivasan Kaliyamurthy
B	2026-02-13	For Information	Gargi Maheshwari	Ragupathya Raja	Srinivasan Kaliyamurthy
A	2024-12-05	For Information	Gargi Maheshwari	Ragupathya Raja	Srinivasan Kaliyamurthy
Rev.	Issued Date	Description	Created by	Checked by	Approved by

Client:

RAJASTHAN PART I POWER TRANSMISSION LIMITED

Contractor:

HITACHI **HITACHI ENERGY INDIA LIMITED**

Contractor:

BHARAT HEAVY ELECTRICALS LIMITED

Project title:

±800kV, 6000MW HVDC Terminals at Bhadla (HVDC) & Fatehpur (HVDC) along with associated AC substations and AC Substation extension at Bhadla-3 associated with "Transmission system for evacuation of Power from REZ in Rajasthan (20GW) under Phase-III, Part-I"

Contractor Document Number:	Contractor Rev no.:
1JNL2441579	**D**

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

Document Type:	Station Name:	Product Class
Requirement specification	**Bhadla - Fatehpur HVDC**	**353**

Document Title:

Ceramic Post Insulators

Client Document Number:	Revision:	Page:
		1 of 16

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Bhadla-Fatehpur ±800 kV, 6000MW HVDC Link Bhadla - Fatehpur HVDC	Document number, revision 1JNL2441579	Page 2 of 16	Language en
	Status Approved	Owning Organization Plants & Civil - Mechanical Plant Design	
Prepared Gargi Maheshwari, 2026-06-04	Approved Srinivasan Kaliyamurthy	Class.no 353	
Title Ceramic Post Insulators			

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7.2.3 Dry switching impulse withstand voltage test 9
7.2.4 Wet switching impulse withstand voltage test 9
7.2.5 Dry power-frequency withstand voltage test 9
Test according to IEC 60168 [2] shall be performed. This test is applicable only to post insulators for indoor use. 9
7.2.6 Wet power-frequency withstand voltage test 9
Test according to IEC 60168 [2] shall be performed. This test is applicable only to post insulators for outdoor use. 9
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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 60168 [2] as listed below, ... 10
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1. General

This requirement specification state the general requirements on *Bhadla-Fatehpur 6000 MW, ± 800kV LCC* HVDC station insulators used to support high voltage bus works. This specification does not apply to equipment insulators where specific requirements specification exist.

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: *Adani Energy Solutions Limited*
- Contractor: Hitachi Energy, HVDC
- Manufacturer: Supplier of the ceramic insulators

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 [5].

1.2 Access

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 *1JNL2441569, 1JNL2441570* [I].

3. Standards

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

4. Environment

4.1 Outdoor environment

		Bhadla	Fatehpur
Maximum temperature 1h average dry bulb	°C	50	50
Maximum 24h average temperature dry bulb	°C	40	40
Minimum temperature 1h average dry bulb	°C	0	0
Average yearly temperature	°C	30	30

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Elevation above sea level	m	<1000m	<1000m
Maximum gust (wind velocity)[1]	m/s	47[6]	47[6]
UV Radiation	W/m^2	1000	1000
Pollution level[7]	class	*d - heavy*	*d - heavy*

4.2 Indoor with humidity controlled environment

Equipment in		Valve hall for Bhadla and Fatehpur
Maximum temperature	°C	60
Minimum temperature	*°C*	*5*[2]
Maximum relative humidity	%	60[3]
Minimum relative humidity	%	*10*
ESDD[4] per year	mg/cm^2	< 0.003

4.3 Seismic requirements

The seismic design of apparatus shall comply with IEEE 693.

Peak ground acceleration (PGA)	*Zone 3 (0.12g) as per IS1893 [10]/ AF2 as per IEC 62271-3002*[5] *[11]*

5. Design

5.1 Creepage distances

[1] Wind speed shall be applicable at 10m height above mean ground level. Further reference shall be taken from National Building Code of India [13]and IS 875[12].
[2] The minimum temperature during normal operation is 10 °C in the Valve hall.
3 The maximum relative humidity in the valve hall is 50% during normal operation
[4] ESDD = Equivalent Salt Deposit Density
[5]Alternatively, equipment can be judged qualified if they fulfill IEC62271-3002 AF2 RRS 0.2g as defined in 11, with relevant safety factors and applicable structural amplification of the standard.
[6] Bhadla lies in wind Zone IV with basic wind speed of 47m/s. The risk coefficient (K1 factor) shall be taken as 1.07. 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.
Fatehpur lies in the wind Zone IV with basic wind speed of 47m/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.
[7] Pollution level d - heavy for Fatehpur station and d- heavy for the Bhadla station as per IEC/TS 60815-1[5] shall be considered.
[8] *14 mm/kV can be used if CTI≥400 is fulfilled according to 1JNL2935651 Clause 12.2.3.*

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5.1.1 General

The unified specific creepage distance (USCD), as per IEC/TS 60815-1 [4], 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.

5.1.2 Corrections

5.1.2.1 Diameter

For a.c. application, the correction factor due to diameter of insulator shall be taken in account according to IEC/TS 60815-2 [5] for porcelain insulators and non-HTM insulators.

For DC application, the correction factor due to diameter of insulator shall be taken in account according to formula below for porcelain insulator and non-HTM insulators.

$\frac{l_2}{l_1} = \left(\frac{D_2}{300}\right)^{0.23}$, where l_1 is the required creepage distance for insulators with an average diameter equal or smaller than 300 mm; D_2 is the average diameter (in mm) of the insulator for which creepage distance l_2 is sought.

5.1.2.2 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.

5.1.3 Outdoor environment

For outdoor insulators the minimum nominal creepage distance shall be:

5.1.3.1 HTM

Bhadla station

- *for DC application **(Porcelain-RTV Coated)**: 60 mm/kV, based on Urms given above.*

Fatehpur station

- *for DC application **(Porcelain-RTV Coated)**: 60 mm/kV, based on Urms given above.*

5.1.4 Indoor with humidity controlled environment

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

HTM/non-HTM

Valve Hall

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- *for DC application (or AC plus DC)[8]: 21 mm/kV, based on U_{rms} given above*

- *Insulator type used in indoor will be Porcelain.*

5.2 Insulator shed profile

5.2.1 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
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.

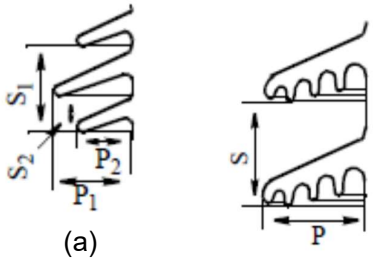

Figure Parameters of insulator sheds: (a) alternating profile of a porcelain insulator; (b) deep under-rib profile of a porcelain insulator

5.2.2 Porcelain insulators, DC

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.

Requirements for d.c. porcelain insulators:

- Shed spacing of alternating profile: $S_1 \geq 70$ mm.
- Shed spacing of deep under-rib profile: S = 95 mm.
- The ratio between shed spacing and overhang for both alternating and deep under-rib profiles: S_1/P_1 or $S/P \geq 1$.

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- For alternating profile, the overhang difference between big and small shed (P_1- P_2) ≥ 20mm.
- For alternating profile, the inclination of sheds should be within the range: 10˚~ 25˚

5.3 Colour of glaze

Colour of porcelain insulators shall comply with requirements as per IEC 62155 [3]. The colour shall preferably be brown glazed, according to RAL 8016 or similar. Other colours may be used after approval from Hitachi Energy, HVDC.

5.4 Surface treatment

Ferrous metallic fittings shall be hot dip galvanized. Hot dip galvanized coating on fabricated iron and steel articles shall be according to ISO 1461 [8].

The equipment shall have sufficient corrosion resistance by the use of corrosion resistant materials or by using coatings. The choice of protection shall be based on the environmental classification given in ISO 12944-2[18]. The environmental classifications for the different areas in both the stations are:

Area	Class
Outdoor	C4
Indoor with controlled environment	C1

5.5 *RTV coating*

Porcelain insulators installed outdoors, shall be coated with Room Temperature Vulcanizing (RTV) Silicone Rubber Insulator Coating. RTV coating shall be done at site on all porcelain insulators. The technical details of RTV coating is attached in Annexure-A of this document.

RTV COATING is not in BPI supplier scope.

5.6 Visual corona

The insulator and its corona ring shall be corona free at 1.3 times the rated voltage according to IEC 61284 [7].

6. Marking

Each insulator shall be marked/identified as defined in IEC 60168[2] for ceramic post insulators.

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 60168 [2] for ceramic post insulators. Relevant requirements given by the Owner in the Technical Specification of this project shall be responded accordingly.

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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

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.

The following type tests shall be performed, as applicable, once only for a given post insulator

7.2.1 Radio interference test

Radio interference test shall be according to IEC 60437 [6]. Atmospheric correction shall be applied according to IEC 60060-1 [1].

7.2.2 Dry lightning impulse withstand voltage test

Test according to IEC 60168 [2] shall be performed.

7.2.3 Dry switching impulse withstand voltage test

Test according to IEC 60168 [2] shall be performed. This test is applicable only to post insulators for indoor use.

7.2.4 Wet switching impulse withstand voltage test

Test according to IEC 60168 [2] shall be performed. This test is applicable only to post insulators for outdoor use.

7.2.5 Dry power-frequency withstand voltage test

Test according to IEC 60168 [2] shall be performed. This test is applicable only to post insulators for indoor use.

7.2.6 Wet power-frequency withstand voltage test

Test according to IEC 60168 [2] shall be performed. This test is applicable only to post insulators for outdoor use.

7.2.7 Mechanical failing load test.

Test according to IEC 60168 [2] shall be performed.

7.2.8 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.

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Certified type test 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 February 08, 2016.The Manufacturer may submit test reports from earlier performed tests to the Contractor for review and approval. Such test reports approved by the Contractor will be accepted in lieu of performing new type tests. Failing which type test/s shall be performed on at least one sample of that current carrying type/s, imitates most onerous condition.

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 60168 [2] as listed below,

a) Verification of the dimensions
b) Temperature cycle test
c) Mechanical failing load test
d) Puncture test
e) Porosity test
f) Galvanizing test

7.4 Routine tests

Every station insulator shall be subjected to the applicable Routine tests according to IEC 60168 [2] as listed below,

a) Routine thermal shock test
b) Routine visual examination
c) Routine electrical test
d) Routine mechanical test

7.4.1 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.

7.4.2 Inspection and test plans (ITP)

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

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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.

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.

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If any special tools or material are necessary, this should be mentioned at the beginning of the instruction.

- 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.	1JNL2441569, 1JNL2441570	Quantities and Technical Data
II.	1JNL2935651	General Requirements for Main circuit Apparatus

10. References

1.	IEC 60060-1	High-voltage test techniques. General definitions and test requirements
2.	IEC 60168	Tests on indoor and outdoor post insulators of ceramic material or glass for systems with nominal voltages greater than 1000 V
3.	IEC 62155	Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1000 V
4.	IEC/TS 60815-1	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 1: Definitions, information and general principles
5.	IEC/TS 60815-2	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 1: Definitions, information and general principles
6.	IEC 60437	Radio interference test on high-voltage insulators
7.	IEC 61284	Overhead lines – Requirements and tests for fittings
8.	ISO 1461	Hot dip galvanized coatings on fabricated iron and steel
9.	IEEE 693	IEEE Recommended Practice for seismic design of substations
10.	IS1893 PART-1 (2016)	Criteria earthquake resistant design of structures
11.	IEC 62271-300 (2006)	High-voltage switchgear and control gear-Part 300: Seismic qualification of alternating current circuit-breakers
12.	*IS875 PART-III (2015)*	*Code of Practice for Design Loads (other than earthquake) for Building and Structures*
13.	*NATIONAL BUILDING CODE OF INDIA 2016 VOL 1*	*Wind speed*

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11. Revision History

Rev.	Prepared	Approved
D	Gargi Maheshwari,2026-04-09	Srinivasan Kaliyamurthy
4.1 Note updated for basic wind speed and pollution level. 7.2.8 Type Test Validity updated to 10 years.		
C	Gargi Maheshwari, 2026-03-05	Srinivasan Kaliyamurthy
4.2 Added the note "The minimum temperature during normal operation is 10 °C in the Valve hall." as mention in "1JNL2935651_en General Requirements for Main Circuit Apparatus for Bhadla-Fatehpur" 4.3 Added note for maximum relative humidity for Valve Hall and ESDD. 5.1.4 The note “14 mm/kV can be used if CTI≥400 is fulfilled according to 1JNL2935651 Clause 12.2.3". 7.2.8 Type test validity updated to 15 years		
B	Gargi Maheshwari, 2026-01-23	Srinivasan Kaliyamurthy
Revision text 1.1 Installation angle and Average diameter added 4.1 Outdoor Environment Table Updated as per General Requirement for Main Circuit Apparatus. 4.2 Detail of minimum temperature and minimum relative humidity as per General Requirement for Main Circuit Apparatus is updated in the section. 5.1.3 Section Number is updated to 5.1.3.1. 5.1.4 Type of insulator used in indoor has been specified in the section and the note “14 mm/kV can be used if CTI 400 is fulfilled according to Clause 12.2.3" is updated in the section. 5.4 Added Corrosion resistance lines from General Requirement for Main Circuit Apparatus, the environmental classification for different areas in both stations is updated. 7.2.8 Type Test validity information has been updated in the section. - Reference numbers corrected in all sheets.		
Rev.	Prepared	Approved
A	Gargi Maheshwari, 2025-12-05	Srinivasan Kaliyamurthy
Revision text First Issue		

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ANNEXURE-A: RTV SILICONE HIGH VOLATGE INSULATION COATING

1. General

The scope of work shall include supply, delivery, and application of RTV silicone high voltage insulation coating for Substations at coastal area.

1.1 The supplied virgin RTV coating material shall have sufficient margin before expiry of its shelf life (Date of manufacturing shall not be older than two months from date of delivery). Application of RTV coating material on the equipment after expiry of its shelf life will not be permitted.

1.2 All the required materials, tools, and tackles, testing equipment, consumables etc. for application of HVIC coating shall be in the contractor's scope.

1.3 Surface preparation: All insulation surfaces of the equipment to be coated shall be made free from dust, grease, oil, and any other foreign material without damaging the surface. The surface of the equipment shall be made dry before application of the RTV coating.

1.4 Preparation/mixing of the virgin RTV coating materials shall be done strictly as per recommendations of the original manufacturer only.

1.5 The application of the properly prepared /mixed virgin RTV coating materials shall be done by certified applicants of original manufacturer only.

1.6 The coating shall cover the complete insulation surface of the equipment.

1.7 The coated insulation surface of the equipment after full cure shall be smooth and free from any defect viz. scratches, uneven surface etc.

1.8 The following tests are to be carried out by the contractor after full care of coatings.

a. Hydrophobic test on 1-2 coated equipment as per STRI guidelines and the results shall be HC2 class or better.

b. BDV testing of fully cured coating in the lab.

c. Bonding/adherence test at site: The sample coated insulator shall be put in water and boiled for 02 hours and removed. The coating shall not exhibit water blisters at the interface between the insulator surface and the coating.

d. High pressure water withstand test at site: A high pressure water wash test shall be performed on sample coated insulator. The RTV coating shall withstand the pressure without any damage to it.

e. Thickness measurement of RTV coating at site: Test shall be performed on each of the equipment coated to confirm the thickness of the coating on the respective equipment.

1.9 Any other item which is not specifically mentioned above but are required for successful completion of the work shall be in this scope of work.

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2. Technical Requirements

2.1 RTV Silicon compound in its liquid form

Material Properties	Requirement
Material Type	One-part RTV
Appearance	Paint
Filler Type	ATH, Quartz, or both
Colour	Grey
Substrate Application Temperature Range °C	-4°C to 121°C
Track free at 25°C and 50% RH	30 minutes

2.2 Properties of RTV Silicon compound after cured.

Parameters	Requirement
Application Area	Glass, Porcelain, station insulators, as well as bushing, instrument transformers and related devices
Full cure time	Max. 24 hours
Recommended coating thickness	500 microns+ 10%, dry film
Dielectric Strength, (ASTM D 149)	>25 kV/mm
Volume Resistivity, ohm.cm (ASTM D257)	9.0*10^14
T racking wheel withstand, hours	5000 Hours
Min. Salinity Level withstood during "Artificial Pollution Test using Salt Fog Method"	>160 kg/mA3
Hydrophobic Recovery Test (REC specification 76/2006)	To H1 or H2
Method of Application	Airless Spray
Arc resistance	420 sec or better (As per ASTM D 495 - 99 (Reapproved 2004))
Tracking resistance	1A 4.5 or better (As per IEC 60587, i.e., 5 specimens shall survive tracking
Primer Required	No primer materials shall be allowed
Resistant to	Marine salt fog, Water, Industrial (cement dust, fly ash, acid emission etc.), Rough Weather Conditions
Other Properties	Non-Hazardous to environment, surface after full cure shall be smooth

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SECTION-3

Refer document **General Technical Requirements: TB-4424-316-000 Rev 00.**

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TRANSMISSION BUSINESS ENGINEERING MANAGEMENT

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DOCUMENT No.	**TB-442-316-000**	Rev. No.	**01**		Prepared	Checked & Approved	
TYPE OF DOC.	**TECHNICAL SPECIFICATION**			SIGN			
TITLE	**GENERAL TECHNICAL REQUIREMENTS**			NAME	DM	SKS	
				DATE	23/10/2025	23/10/2025	
				GROUP	TBEM	W.O.	

CUSTOMER	**ADANI ENERGY SOLUTIONS LIMITED**
Project	±800kV, 6000MW HVDC Terminals at Bhadla (HVDC) & Fatehpur (HVDC) along with associated AC substations and AC Substation extension at Bhadla-3 associated with "Transmission system for evacuation of Power from REZ in Rajasthan (20GW) under Phase-III, Part-I
Station	**Fatehpur HVDC Terminal/ Bhadla HVDC Terminal/ Bhadla-3 Extension**

SL. No.	Description	Sheet
1	Site Information	1
2	GENERAL TECHNICAL REQUIREMENTS	56

RevNo.	Date	Altered	Checked	Approved	REVISION DETAILS

Distribution	To	TBEM	TBMM	TBQM	Supplier
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Site Information

S.No.	Particular	Details		
a)	Clent	**RAJASTHAN PART I POWER TRANSMISSION LIMITED**		
b)	Customer	**ADANI ENERGY SOLUTIONS LIMITED (AESL)**		
c)	Project Title	**±800kV, 6000MW HVDC Terminals at Bhadla (HVDC) & Fatehpur (HVDC) along with associated AC substations and AC Substation extension at Bhadla-3 associated with "Transmission system for evacuation of Power from REZ in Rajasthan (20GW) under Phase-III, Part-I**		
d)	Location	**Fatehpur, Uttar Pradesh**	**Bhadla, Rajasthan**	**Bhadla-3 Extension, Rajasthan**
e)	Transport Facilities	Road/Train Nearest Rail Head - **Fatehpur** Nearest Airport -**Kanpur**	Road/Train Nearest Rail Head - **Bhadla** Nearest Airport - **Jodhpur**	Road/Train Nearest Rail Head - **Bhadla** Nearest Airport – **Jodhpur**
SITE CONDITIONS				
f)	Max Ambient temperature (dry bulb one-hour average)	50°C		
g)	Min. ambient air temp.	0°C		
h)	Max dry bulb 24hr average	40°C		
i)	Costal area consideration	No		
j)	Altitude above sea level	Less than 1000 meter above mean sea level (MSL)		
k)	Seismic Zone as per IS-1893	Zone-III		
l)	Wind Zone as per IS -1893	Zone-IV (As per National Building Code 2016)		
m)	Snow fall	NIL		
n)	Average annual rainfall	As per rainfall map of IMD		
o)	Iso-keraunic level	As applicable		
p)	Relative humidity	100%		
q)	Pollution level (IEC 60815)	Heavy		

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GENERAL TECHNICAL REQUIREMENTS (GTR)

REVISION STATUS SHEET

REV NO.	DATE	DESCRIPTION	PREPARED BY	CHECKED BY	APPROVED BY
2	01-01-2025				SHEKHAR AGARWAL

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SECTION – GENERAL TECHNICAL REQUIREMENTS (GTR)

1. FOREWORD

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

The specification covers scope of design, engineering, fabrication, manufacturing, shop assembly, inspection and testing at manufacturer's works, properly packing / dispatch, transportation to site with transit insurance, supply & delivery at destination on F.O.R. basis at site. The bidder has also to do unloading & storage at site, assembly, erection, testing & commissioning, getting approval from Owner & Electrical Inspector and putting into successful operation complete with all materials, support structures, anchoring bolts & anchoring rails, accessories.

Commissioning spares & maintenance spares, special spanners for GIS, tools & tackles, any specific required ancillary services, SF6 Gas for first filling & additional spare gas, recommended and mandatory spares are in bidder's scope,

Bidders are to consider the following orders / notifications / guidelines issued by MoP and CEA. Any type of cost involved is to be inbuilt in supply price and no price escalation / implication shall be entertained by the owner:

a. Order issued by Ministry of Power, Government of India, dated 18th November, 2020 and Order issued Dated 02/07/2020 "Testing of all equipment, components, and parts imported for use in the power Supply System and Network in the country to check for any kind of embedded malware / trojans /cyber threat and for adherence to Indian Standards- Regarding" and "to protect the security, integrity and reliability of the strategically important and critical Power Supply System & Network" respectively.

b. CEA (CENTRAL ELECTRICITY AUTHORITY), as applicable and latest amendment, if any.

2. GENERAL REQUIREMENT

2.1.

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

b. 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 contractor.

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

c. Equipment/Material/Items from a Indian manufacture who have specified transfer of technology (TOT) arrangement with an entity from a country which shares land border with India shall be accepted only if the Indian Manufacturer is complying the requirement of prevailing Guideline by Government of India under Rule 144(xi) of the General financial Rule (GFR) **2017**

2.2. It is recognized that the Contractor may have standardized 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.

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

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

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

3. STANDARDS

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

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

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

3.4. The Contractor shall also note that list of standards presented in this specification is not complete. Whenever necessary the list of standards shall be considered in conjunction with specific IS/IEC.

3.5. When the specific requirements stipulated in the specifications exceed or differ than those required by the applicable standards, the stipulation of the specification shall take precedence.

3.6. Other internationally accepted standards which ensure equivalent or better performance than that specified in the standards specified under Annexure-C/ individual sections for various equipments shall also, be accepted, however the salient points of difference shall be clearly brought out during detailed engineering along with English language version of such standard. The equipment conforming to standards other than specified under Annexure-C/individual sections for various equipments shall be subject to Employer's approval.

4. SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED

4.1. The 800kV and 420kV system is being designed to limit the switching surge over voltage of 1.9 p.u. and 2.5 p.u., respectively and the power frequency over voltage of 1.4 p.u. and 1.5 p.u., respectively. In case of the 420kV system, the initial value of the temporary 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. The bidder shall design terminal connectors of the equipment considering various forces that are required to withstand.

4.5. The equipment shall also comply to the following:

a) To facilitate erection of equipment, all items to be assembled at site shall be "match marked".

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b) All piping, if any between equipment control cabinet/operating mechanisms to marshalling box of the equipment, shall bear proper identification to facilitate the connection at site.

4.6. **System Parameter:**

765, 400 & 220kV System

Sr. No	Description of parameters	765kV System	400kV System	220kV System
1.	System operating voltage	765kV	400kV	220kV
2.	Maximum operating voltage of the system (rms)	800kV	420kV	245kV
3.	Rated frequency	50Hz	50Hz	50Hz
4.	No. of phase	3	3	3
5.	Rated Insulation levels			
i)	Full wave impulse withstand voltage (1.2/50 micro sec.)	2100kVp	1550kVp	1050 kVp
ii)	Switching impulse withstand voltage (250/2500 micro sec.) dry and wet	1550kVp	1050kVp	
iii)	One minute power frequency dry withstand voltage (rms)	830kV	630kV	
iv)	One minute power frequency dry and wet withstand voltage (rms)			460kV
6.	Corona extinction voltage	508 kV	320kV	-
7.	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz	2500 µV at 508 kV rms	1000 µV at 266kV rms	1000 µV at 156kV rms
8.	Minimum creepage distance - for Equipment other than Insulator string	20000 mm (24800 mm for coastal area)	10500 mm (13020 mm for coastal area)	6125 mm (7595 mm for coastal area)
	Minimum creepage distance - for Insulator String	As specified in Section-Switchyard Erection		
9.	Min. clearances			
i.	Phase to phase	7600mm (for conductor-conductor configuration) 9400mm (for rod-conductor configuration)	4000mm (for conductor-conductor configuration) 4200mm (for rod -conductor configuration)	2100 mm
ii.	Phase to earth	4900mm (for conductor-structure) 6400mm (for rod- structure)	3500 mm	2100 mm
iii)	Sectional clearances	10300 mm	6500 mm	5000 mm
10.	Rated short circuit current for 1 sec. duration	50/63 kA (as applicable)	63/80 kA (as applicable)	40kA/50/63 kA (as applicable)
11.	System neutral earthing	Effectively	Effectively	Effectively

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

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

Notes:

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

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.

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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 multihazard 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. ENGINEERING DATA AND DRAWINGS

5.1. **The list of drawings/documents which are to be submitted to the Employer shall be finalized between Employer & contractor. In case any additional drawings/documents are required, the same shall also be submitted during execution of the contract.**

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

5.3. **Drawings**

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

5.3.2. Drawings submitted by the Contractor shall be clearly marked with the name of the Employer, the unit designation, the specifications title, the specification number and the name of the Project. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in SI units.

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

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

5.3.5. All engineering data submitted by the Contractor after final process including review and approval by the Employer shall form part of the Contract Document and the entire works performed under these

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specifications shall be performed in strict conformity, unless otherwise expressly requested by the Employer in Writing.

5.3.6. Contractor to provide the editable copy of drawings wherever required by Employer.

5.4. **Approval Procedure**

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

i.	Approval Comments by Employer on initial submission	As per L2 Schedule
i.	Resubmission (whenever required)	Within 1 (One) week from date of comments
i.	Approval or comments	Within 1 (One) weeks of receipt of resubmission
v.	Furnishing of distribution copies (2 hard copies to each substation and one scanned copy (pdf format)	2 weeks from the date of approval
v.	Furnishing of distribution copies of test reports a) Type test reports (one scanned softcopy in pdf format to each substation plus one for corporate centre & one hardcopy per Substation) (b) Routine Test Reports (one copy for each substation)	2 weeks from the date of final approval -do-
i.	Furnishing of instruction/ operation manuals (2 copies per substation and one softcopy (pdf format) for corporate centre & per substation)	On completion of Engineering
i.	As built drawings (two sets of hardcopy per substation & one softcopy (pdf format) for corporate centre & per substation)	On completion of entire works

Note:

(1) The contractor may please note that all resubmissions must incorporate all comments given in the earlier submission by the Employer or adequate justification for not incorporating the same must be submitted failing which the submission of documents is likely to be returned.

(2) All drawings should be submitted in softcopy form; however, substation design drawings like SLD, GA, all layouts and Cable schedule etc. shall also be submitted in AutoCAD Version and Excel respectively. SLD, GA & layout drawings shall be submitted for the entire substation in case of substation extension also.

(3) The instruction Manuals shall contain full details of drawings of all equipment being supplied under this contract, their exploded diagrams with complete instructions for storage, handling, erection, commissioning, testing, operation, trouble shooting, servicing and overhauling procedures.

(4) If after the commissioning and initial operation of the substation, the instruction manuals require any modifications/additions/changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the Contractor to the Employer.

(5) The Contractor shall furnish to the Employer catalogues of spare parts.

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

(7)

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6. MATERIAL/ WORKMANSHIP

6.1. General Requirement

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

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

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

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

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

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

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

6.2. Provisions for Exposure to Hot and Humid climate

Outdoor equipment supplied under the specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity, heavy rainfall and environment favorable 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

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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 outdoor: IP- W55 **with canopy**

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-42.

e) For LT Switchgear (AC & DC distribution Boards): IP-52

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

6.3. **RATING PLATES, NAME PLATES AND LABELS**

6.3.1. Each main and auxiliary item of substation is to have permanently attached to it in a conspicuous position a rating plate of non-corrosive material upon which is to be engraved manufacturer's name, year of manufacture, equipment name, type or serial number together with details of the loading conditions under which the item of substation in question has been designed to operate, and such diagram plates as may be required by the Employer. The rating plate of each equipment shall be according to IEC requirement

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

6.4. **FIRST FILL OF CONSUMABLES, OIL AND LUBRICANTS**

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

7. DESIGN IMPROVEMENTS / COORDINATION

7.1. The bidder shall offer the equipment meeting the requirement of the technical specification. However, the Employer or the Contractor may propose changes in the specification of the equipment or quality thereof and if the contractor & Employer agree upon any such changes, the specification shall be modified accordingly.

7.2. If any such agreed upon change is such that it affects the price and schedule of completion, the

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parties shall agree in writing as to the extent of any change in the price and/or schedule of completion before the Contractor proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.

7.3. The Contractor shall be responsible for the selection and design of appropriate equipments to provide the best coordinated performance of the entire system. The basic design requirements are detailed out in this Specification. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.

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

7.5. The Contractor will be called upon to attend design co-ordination meetings with the Engineer, other Contractor's and the Consultants of the Employer (if any) during the period of Contract. The Contractor shall attend such meetings at his own cost at Employer's Office or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

8. QUALITY ASSURANCE PROGRAMME

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

a) The organization 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 subcontractor'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 internally documented system for Customer complaints.

g) Inspection and test procedure both for manufacture and field activities.

h) System for Control of calibration of testing and measuring equipment and the indication of calibration status on the instruments.

i) System for indication and appraisal of inspection status.

j) System of Internal Quality Audits, Management review and initiation of corrective and Preventive actions based on the above.

k) System for authorizing 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.

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

8.2. **Quality Assurance Documents**

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

i) All Non-Destructive Examination procedures, stress relief and weld repair procedures 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.

i) Factory test results for testing required as per applicable quality plan/technical specifications/GTP/Drawings etc.

ii) Stress relief time temperature charts/oil impregnation time temperature charts, wherever applicable.

8.3. **INSPECTION, TESTING & INSPECTION CERTIFICATE**

8.3.1. Contractor shall procure bought out items from Approved vendor list of Employer. The contractor shall explore first the possibilities of procuring the items bought from approved vendors. In case of their unavailability / non-response, Contractor may approach Employer for additional sub-vendor approval. In that case, the assessment report of proposed sub vendor by Contractor along with the supporting documents/credential shall be submitted within 60 days of the award. The proposal shall be reviewed, and approval will be agreed based on the verification of the document submitted and/or after the physical assessment of the works. If proposal for sub-vendor is submitted after 60 days, the Contractor's proposal normally will not be considered for current LOA. However, Employer may process the case for developing more vendors for referred items, if found relevant. In all cases, it is the responsibility of the Contractor that Project activities do not suffer on account of delay in approval/non approval of a new sub-vendor.

8.3.2. For the quality control and inspection at sub-vendor's works, Contractor would depute sufficient qualified & experienced manpower in their Quality Control and Inspection department. Further, to assure quality of construction, Contractor shall have a separate workforce having appropriate qualification & experience and deploy suitable tools and plant for maintaining quality requirement during construction in line with applicable Field Quality Plan (FQP).

8.3.3. The Employer, his duly authorized representative and/or outside inspection agency acting on behalf of the Employer shall have at all reasonable times access to the Contractor's premises or Works and shall have the power at all reasonable times to ensure that proper Quality Management practices / norms are adhered to, inspect and examine the materials & workmanship of the Works, to carry out Quality/Surveillance Audit during manufacture or erection and if part of the Works is being manufactured or assembled at other premises or works. The Contractor shall obtain for the Employer and for his duly authorized representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. The item/equipment, if found unsatisfactory with respect to workmanship or material is liable to be rejected. The observations for improvements during product/ process inspection by Employer shall be recorded in Quality Improvement Register (available & maintained at works) for review & timely compliance of observations.

8.3.4. Contractor shall submit inspection calls over Employer's online portal. The required vendor code and password to enable raising inspection call will be furnished to the main Contractor within 30 days of award of contract on submission of documents by Contractor. After raising the inspection calls, Contractor shall then proceed as per the message of that call which is available on the message board.

8.3.5. The Employer reserves the right to witness any or all type, acceptance and routine tests specified for which the Contractor shall give the Employer/Inspector Twenty-one (21) days written notice of any material being ready for testing for each stage of testing as identified in the approved quality plan as

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

8.3.6. Contractor shall generally offer material for inspection as per supply bar chart approved by Employer and not before 30 days from schedule indicated in the bar chart. In case Contractor offers material(s) for inspection prior to 30 days from the scheduled date with necessary approval of Employer, Employer shall inspect the material and issue CIP only. However, in such an exceptional case, MDCC shall be issued only as per provision of original / revised approved supply schedule.

8.3.7. Contractor shall minimize the number of inspection calls by offering optimum quantities in each inspection call at the respective manufacturer's works.

8.3.8. Contractor shall inspect the material themselves and only after they are fully convinced about the Quality, they shall offer the material for Employer inspection and shall also ensure that relevant portion of LOA, approved drawing and data sheets along with applicable Quality Plans are available at the works of Contractor or their Sub-vendor before the material is offered for inspection.

8.3.9. Contractor shall ensure that material which has been cleared for dispatch after inspection will be dispatched within 30 days in case of domestic supplies and within 60 days in case of Off-shore supplies from the date of issuance of CIP. Material which is not dispatched within stipulated time as above will be reoffered for Employer inspection or specific approval of Employer QA&I shall be obtained for delayed dispatch.

8.3.10. The Employer or IE shall give notice in writing to the Contractor, of any objection either to conformance to any drawings or to any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and shall either make the modifications that may be necessary to meet the said objections or shall confirm in writing to the Employer/Inspection Engineer giving reasons therein, that no modifications are necessary to comply with the Contract.

8.3.11. All Test Reports and documents to be submitted in English during final inspection of equipment by Employer or as and when required for submission.

8.3.12. When the factory tests have been completed at the Contractor's or Sub-Contractor's works, the Employer/Inspection Engineer (IE) shall issue a certificate to this effect within fifteen (15) days after completion of tests & submission of documents by Contractor/manufacturer but if the tests are not witnessed by the Employer/IE, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Employer/IE. Contractor shall, on completion of all tests, submit test reports within Ten (10) days to Employer. Failure of the Employer/IE to issue such a certificate shall not prevent the Contractor from proceeding with the Works. The completion of these tests or the issue of the certificate shall not bind the Employer to accept the equipment should, it, on further tests after erection, be found not to comply with the Contract.

8.3.13. In all cases, where the Contract provides for tests whether at the premises or works of the Contractor or of any Sub- Contractor, the Contractor, except where otherwise specified, shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Employer/Inspector or his authorized 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 authorized representative to accomplish testing.

8.3.14. The inspection and acceptance by Employer and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the Contract, or if such equipment is found to be defective at

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a later stage.

8.3.15. The Employer will have the right of having at his own expenses any other test(s) of reasonable nature carried out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests, to satisfy that the material complies with the specification.

8.3.16. The Employer reserves the right for getting any additional field tests conducted on the completely assembled equipment at site to satisfy that material complies with specifications.

8.3.17. Rework/ Re-engineering, if any, on any item/equipment shall be carried out only after mutual discussions and in accordance with mutually agreed procedure. Contractor shall submit Joint Inspection Report of equipments under Re-Work/Re-Engineering along with procedure for the same to Employer for approval, before taking up the Re-Work/Re-Engineering, failing which Employer reserves the right to reject the equipment.

8.3.18. Contractor may establish a field test Laboratory to execute Civil Construction testing requirements at site with the condition that all testing equipment shall be calibrated from accredited Testing laboratories, with calibration certificates kept available at site and all testing personnel employed in the Field-Testing Laboratories to be qualified and experienced Engineers or testing to be carried out at Employer approved Third Party Laboratories.

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

8.3.20. Contractor shall implement additional stringent quality checks and preparation during installation of GIS at site (if applicable) as per Employer approved guidelines/Technical specifications.

8.3.21. Contractor shall ensure commissioning of all CSDs along with Circuit Breakers wherever applicable.

8.3.22. **For EHV transformers/reactors**:

Insulation oil shall be as per Employer Technical specifications and same grade shall be used for impregnation of the active part & testing at the works of Transformer/Reactor Manufacturer and as well as for filling the Transformer/Reactors at site. Contractor to ensure that windings for Transformer/Reactors are made in air-conditioned environment. Core-coil assembly shall be performed in positive pressurized dust-controlled environment. Dust measurements shall be monitored regularly at Transformer / Reactor Manufacturer works. Contractor shall ensure that respective civil foundations & Fire walls for Transformer/Reactors units to be commissioned, shall be made ready at concerned sites before receipt of Transformer/Reactors units. All the requisite material for Neutral & Delta Bus formation required for charging of complete bank of 765KV class 1-ph Transformer/Reactor units shall be made available at the concerned sites before receipt of the Transformer/Reactor units at site.

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

9. TYPE TESTING & CLEARANCE CERTIFICATE

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

9.2. The reports for all type tests as per technical specification shall be furnished by the Contractor along with equipment / material drawings. The type tests conducted earlier should have 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 ADANI/representative authorized by ADANI/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 as mentioned in latest CEA Guideline for validity period of Type test from the date of LOA. In case the test reports are of the test conducted earlier than CEA Guideline from the date of LOA, the contractor shall repeat these test(s) at no extra cost to the Employer.

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

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The Contractor 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 test has been offered free of charge. Further, in case any Bidder indicates that he shall not carry out a particular test, his offer shall be considered incomplete and shall be liable to be rejected. The Employer reserves the right to waive the repeating of type tests partly or fully and in case of waiver, test charges for the same shall not be payable.

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.

10. TESTS

10.1. **Pre-commissioning Tests**

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

10.2. **Commissioning Tests**

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

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

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

10.2.4. **PRECOMMISSIONING, COMMISSIONING, TRIAL-RUN & COMPLETION**

As soon as the Facilities covered by these specifications are physically completed in all respects, the Pre commissioning, Commissioning, Trial-run and Completion of the Facilities, as mentioned below, shall be attained in accordance with the contract documents.

(i) **Pre commissioning:** As per relevant Sections

(ii) **Commissioning:** Charging of the Facilities at rated voltage.

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

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

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

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

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

11. PACKAGING & PROTECTION

11.1. All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. On request of the Employer, the Contractor shall also submit packing details/associated drawings for any

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equipment/material under his scope of supply, to facilitate the Employer to repack any equipment/material later, 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 considered. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharf age and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Employer takes no responsibility of the availability of the wagons.

11.2. All coated surfaces shall be protected against abrasion, impact, discoloration, 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 piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.

12. FINISHING OF METAL SURFACES

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

12.2. **HOT DIP GALVANISING**

12.2.1. The minimum weight of the zinc coating shall be 610 gm/sq. m. and minimum average thickness of coating shall be 86 microns for all items having thickness 6mm and above **and 900 gm/sq. m. for coastal area (30km from sea shore approximately) or as specified in Section-Project**. For items lower than 6mm thickness requirement of coating thickness shall be as per relevant ASTM. For surface which shall be embedded in concrete, the zinc coating shall be 610 gm/sq. m. minimum **and 900 gm/sq. m. for coastal area.**

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 discolored 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 dips 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. Galvanized material must be transported properly to ensure that galvanized surfaces are not damaged during transit. Application of touch-up zinc rich paint at site shall be allowed with approval of Engineer in charge.

12.3. **PAINTING**

12.3.1. All sheet steel work shall be degreased, pickled, phosphated in accordance with the IS- 6005 "Code of practice for phosphating iron and sheet". All surfaces, which will not be easily accessible after shop assembly, shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and swarf 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.

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12.3.2. Hot Phosphating shall be done for phosphating process, 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 color 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 color inside the equipments /boards /panels/junction boxes is also acceptable. The exterior color for panels shall be matching with the existing panels in case of extension of a substation. Each coat of primer and finishing paint shall be of slightly different shade to enable inspection of the painting. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipments.

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

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

Sr. No.	PIPELINE	Base color	Band color
Fire Protection System			
1	Hydrant and Emulsifier system pipeline	FIRE RED	-
2	Emulsifier system detection line - water	FIRE RED	Sea Green
3	Emulsifier system detection line -Air	FIRE RED	Sky Blue
4	Pylon support pipes	FIRE RED	
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
The direction of flow shall be marked by ^ (arrow) in black color.			

Base Color Direction of flow Band Color

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. HANDLING, STORING AND INSTALLATION

13.1. In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Employer or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented. Commercial use of switchyard equipment means completion of all site tests specified and energization at rated voltage.

13.2. Contractor may engage manufacturer's Engineers to supervise the unloading, transportation to site, storing, testing and commissioning of the various equipment being procured by them separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's supervisory Engineer(s) and shall extend full cooperation to them.

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13.3. The contractor must ensure that the open storage platform is constructed for storage of outdoor type equipment/material prior to commencement of delivery at site. Outdoor equipment shall be stored on open storage platform, properly covered with waterproof and dustproof covers to protect them from water seepage and moisture ingress.

However, all indoor equipments including control & protection panels, Communication equipments and operating mechanism boxes etc. of outdoor equipments shall be stored indoors.

Storage of equipment on top of another one is not permitted if the wooden packing is used and there is the possibility of equipment/packing damage. Material opened for joint inspection shall be repacked properly as per manufacturer's recommendations.

During storage of material regular periodic monitoring of important parameters like oil level / leakage, SF6 / Nitrogen pressure etc. shall be ensured by the contractor.

13.4. In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the Employer. Contractor shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawings/instructions correctly.

13.5. Where assemblies are supplied in more than one section, Contractor shall make all necessary mechanical and electrical connections between sections including the connection between buses. Contractor shall also do necessary adjustments/alignments for proper operation of circuit breakers, isolators and their operating mechanisms. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.

13.6. Contractor shall be responsible for examining all the shipment and notify the Employer immediately of any damage, shortage, discrepancy etc. for the purpose of Employer's information only. The Contractor shall submit to the Employer every week a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site. Any demurrage, wharf age and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

13.7. The Contractor shall be fully responsible for the equipment/material until the same is handed over to the Employer in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over by Employer, as well as protection of the same against theft, element of nature, corrosion, damages etc.

13.8. Where material / equipment is unloaded by Employer before the Contractor arrives at site or even when he is at site, Employer by right can hand over the same to Contractor and there upon it will be the responsibility of Contractor to store the material in an orderly and proper manner.

13.9. The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment which requires indoor storage.

13.10. The words 'erection' and 'installation' used in the specification are synonymous.

13.11. Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.

13.12. The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance throughout the service life. If at any stage during the execution of the Contract, it is observed that the erected equipment(s) do not meet the above minimum clearances the Contractor shall immediately proceed to correct the discrepancy at his risks and cost.

13.13. **Equipment Bases**

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

14. TOOLS

14.1. **TOOLS & PLANTS (T&P)**

The Contractor shall arrange all T&P (such as necessary supports, cranes, ladders, platforms etc.) for

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erection, testing & commissioning of the system at his own cost. Further, all consumables, wastage and damages shall be to the account of contractor.

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

14.2. **SPECIAL TOOLS AND TACKLES**

The contractor shall supply all special tools and tackles required for Operation and maintenance of equipment. The special tools and tackles shall only cover items which are specifically required for the equipment offered and are proprietary in nature. The list of special tools and tackles, if any, shall be finalized during detail engineering and the same shall be supplied without any additional cost implication to the Employer

14.3. **FACILITIES TO BE PROVIDED BY THE EMPLOYER**

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

14.3.2. Contractor to make his own arrangement for construction water supply.

15. 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. 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 along with 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 enclosures or supporting insulators to the bottom of the equipment base, where it rests on the foundation pad shall be 2.55 meters.

17. CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS

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:

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Sr. No.	Description	Materials
a)	For connecting ACSR conductors/AAC conductors/ Aluminium tube	Aluminum alloy casting, conforming to designation A6 of IS:617 and all tests shall conform to IS:617
b)	For connecting equipment terminals made of copper with ACSR conductors/AAC conductors/ Aluminium tube	Bimetallic connectors made from aluminum alloy casting, conforming to designation A6 of IS:617 with 2mm thick bimetallic liner/strip and all tests shall conform to IS:617
c)	For connecting G.I	Galvanized mild steel shield wire
d)	Bolts, nuts & plain washers	Electro-Galvanized for sizes below M12, for others hot dip Galvanized.
e)	Spring washers	Electro-Galvanized mild steel suitable for at least 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 is 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 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 Galvanized. 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 and through (fixed/sliding) type connection of IPS AL tube as required. In both the cases the clamp height (top of the mounting pad to centre line of the tube) should be same.

17.8. Current carrying parts (500A and above) of the clamp/connector shall be provided with minimum four numbers of bolts preferably for 132kV & above.

17.9. All current carrying parts shall be designed and manufactured to have minimum contact resistance.

17.10. Power Clamps and connectors shall be designed to control corona as per requirement.

17.11. **Tests**

Clamps and connectors should be type tested as per IS:5561 and shall also be subjected to routine tests as per IS:5561. Following type test reports shall be submitted for approval. Type test once conducted shall hold good. The requirement of test conducted within last ten years, shall not be applicable.

i) Temperature rise test (maximum temperature rise allowed is 35°C over 50°C ambient)

ii) Short time current test

iii) Corona (dry) [for 400kV and above] and RIV (dry) test [for 132kV and above voltage level clamps]

iv) Resistance test and tensile test Pull Out strength Test.

v) Cantilever strength test on bus support clamps & connectors

18. 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 IEC-61439, as applicable, and the clauses given below:

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

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

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. 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.

18.6. 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

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

18.8. 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) to prevent ingression of dust and moisture inside the panels so that no internal rusting occurs in panels during the operation of the equipment.

18.9. All boxes/cabinets shall be designed for the entry of cables by means of weatherproof 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.

18.10. 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.

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

For junction boxes of smaller sizes such as lighting junction box, manual operated earth switch mechanism box etc., plug socket, heater and illumination is not required to be provided.

18.12. All control switches shall be of MCB/rotary switch type and Toggle/piano switches shall not be accepted.

18.13. 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.

18.14. 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.

18.15. The following routine tests along with the routine tests as per IS:5039 shall also be conducted:

i) Check for wiring

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ii) Visual and dimension check

18.16. The enclosure of bay marshalling kiosk, junction box, terminal box and control cabinets shall conform to IP-55 as per IS:13947 including application of 2KV rms for 1 (one) minute, insulation resistance and functional test after IP-55 test.

19. DISPOSAL OF PACKING MATERIAL & WASTE FROM CONSTRUCTION SITE

After completion of the work, Contractor shall dispose-off all the packing & waste materials including empty conductor drums, cable drums, wooden containers, oil drums, gas cylinders and other waste/scrapped materials from construction site at his own cost and shall make the substation area properly cleaned.

20. 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 arrangements 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.

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 made 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. At least 20 % spare terminals shall be provided on each panel/cubicle/box and these spare terminals shall be uniformly distributed on all terminal's 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.

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20.13. The Contractor shall furnish all wire, conduits and terminals for the necessary interphase electrical connections (where applicable) as well as between phases and common terminal boxes or control cabinets. For equipments rated at 400 kV and above the wiring required in these items shall be run in metallic ducts or shielded cables to avoid surge over voltages either transferred through the equipment or due to transients induced from the EHV circuits.

20.14. All input and output terminals of each control cubicle shall be tested for surge withstand capability in accordance with the relevant IEC Publications, in both longitudinal and transverse modes. The Contractor shall also provide all necessary filtering, surge protection, interface relays and any other measures necessary to achieve an impulse withstand level at the cable interfaces of the equipment.

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

22. 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 color, free from blisters, burrs and similar other defects.

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

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

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

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porcelain.

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

22.8. Tests

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

In case, different designs of lattice and pipe structures other than Employer supplied structures are required to be adopted in view of higher creep age (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 contractor against respective standard structure. However dimensional details (except height) shall not be less than that specified in standard structure drawing of respective equipment's.

22.9. **RTV Coating on porcelain insulators**

RTV coating shall be done at site on all porcelain insulators (i.e. bushings, hollow and solid insulators, disc insulators etc.) for substation(s). The cost of RTV coating shall be deemed to be included in the respective equipment/items' erection cost. The technical details of RTV coating is attached in **Annexure-H.**

23. MOTORS

Motors shall be IE3 "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 IPW-55 with canopy 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 demand of the driven equipment at design duty point and the motor shall not be overloaded at any operating point of driven equipment that will rise in service.

b) Motor shall be capable at giving rated output without reduction in the expected life span when operated continuously in the system having the particulars as given in Clause 15.0 of this Section.

23.3. **Starting Requirements:**

a) All induction motors shall be suitable for full voltage direct-on-line starting. These shall be capable of starting and accelerating to the rated speed along with 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 at least two successive starts

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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 rises over the ambient temperature of 50-degree C shall be within the limits specified in IS:325 (for 3-phase induction motors) after adjustment due to increased ambient temperature specified.

b) The double amplitude of motor vibration shall be within the limits specified in IS: 4729. Vibration shall also be within the limits specified by the relevant standard for the driven equipment when measured at the motor bearings.

c) All the induction motors shall be capable of running at 80% of rated voltage for a period of 5 minutes with rated load commencing from hot condition.

23.5. **TESTING AND COMMISSIONING**

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

(a) Insulation resistance.

(b) Phase sequence and proper direction of rotation.

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

24. TECHNICAL REQUIREMENT OF EQUIPMENTS

The following equipment shall be offered from the manufacturer(s) who meets the technical requirements as stipulated here, provided the same equipment are not covered under the Bidder's Qualifying requirement of the Bidding Documents.

Legend:

***** **:** voltage class of respective equipment as applicable.

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

@: Circuit Breaker Bay means a bay used for controlling a line or a transformer or a reactor or a bus section or a bus coupler and comprising of at least one circuit breaker, one disconnector and three nos. of single phase CTs / Bushing CTs

NOA: means Notification of Award

24.1. **Technical requirements for 765/400/220/132/110kV* Air Insulated Switchgear (AIS) Equipment* (i.e. Circuit Breaker, Isolator, Current Transformer, Capacitive Voltage transformer, Inductive Voltage transformer, Surge Arrester and Wave Trap)**

(i) The manufacturer(s) whose 765/400/220/132/110kV* equipment(s) are offered, must have, manufactured, type tested (as per IEC/IS or equivalent standard) and supplied 765/400/220/132/110kV or higher voltage class equipment(s), which are in satisfactory operation# for at least two (2) years as on the date of NOA.

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

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a) 765/400/220/132/110kV * or higher Voltage class equipment(s) must have been manufactured in the above Indian works & type tested (as per IEC/IS standard) and supplied as on the date of NOA.

b) In case manufacturer meets the technical requirement through clause (ii) above, warranty obligations for additional warranty of two (2) years over & above the warranty period as specified in the bidding documents shall be applicable for the entire quantity of the offered equipment to be supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 3% of the ex-works cost of the equipments(s)* for the additional warranty period in addition to the contract performance guarantee to be submitted by the contractor

24.2. **Technical Requirement for 765kV class Transformer**

(i) The Manufacturer whose 765kV Transformer(s) are offered must have designed, manufactured, tested & supplied 765 kV or higher voltage class one (1) number three phase Transformer of at least 500 MVA capacity (or equivalent capacity in a bank of three (3) numbers of single-phase units). These transformer(s) must have been in satisfactory operation# for at least two (2) years as on the date of NOA.

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

a) 765kV or higher voltage class one (1) number three phase Transformer of at least 500 MVA capacity (or equivalent capacity in a bank of three (3) numbers of single-phase units) must have been manufactured in the above Indian works based on technological support of collaborator, type tested (as per IEC/IS standard) and supplied as on the date of NOA.

b) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer / license to design, manufacture, test and supply 765kV transformer in India, shall be submitted.

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

24.3. **Technical Requirement for 765kV class Reactor**

i. The Manufacturer whose 765kV Reactor(s) are offered must have designed, manufactured, tested & supplied 765kV or higher voltage class one (1) number three f three (3) numbers of single-phase units). These Reactor(s) must have been in phase Reactor of at least 240 MVAR capacity (or equivalent capacity in a bank satisfactory operation# for at least two (2) years as on the date of NOA.

OR

The Manufacturer must have designed, manufactured, tested & supplied 765kV or higher voltage class one (1) number three phase Transformer of at least 500MVA capacity (or equivalent capacity in a bank of three (3) numbers of single-phase units). These Transformer(s) must have been in satisfactory operation# for at least two (2) years as on the date of NOA. And the manufacturer must have designed, manufactured, tested & supplied 400kV or higher voltage class one (1) number three phase Reactor of at least 50MVAR capacity (or equivalent capacity in a bank of three (3) numbers of single-phase units). These Reactors must have been in satisfactory operation# for at least two (2) years as on the date of NOA.

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

a) 765kV or higher voltage class one (1) number three phase Reactor of at least 240MVAR capacity (or equivalent capacity in a bank of three (3) numbers of single-phase units) must have been manufactured in the above Indian works based on technological support of collaborator, type tested (as per IEC/IS standard) and supplied as on the date of NOA.

b) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer/license to design, manufacture, test and supply 765kV Reactor in India, shall be submitted.

c) the collaborator shall furnish performance guarantee for an amount of 10% of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to contract performance guarantee to be submitted by the contractor. 75

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24.4. **Technical Requirement for 400kV, 220kV, 132kV and 110kV class Transformer**

(i) The manufacturer whose transformer(s) are offered must have designed, manufactured, tested and supplied 400kV/220kV/132kV/110kV* or higher voltage class transformers. These Transformer(s) must have been in satisfactory operation# for at least two (2) years as on the date of NOA.

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

a) 220kV (applicable for supply of 400kV and 220kV class Transformer)/ 132kV (applicable for supply of 132kV & 110kV class Transformer) or higher voltage class transformers must have been designed, manufactured in the above Indian works based on technological support of collaborator, type tested (as per IEC/IS standard) and supplied as on the date of NOA.

b) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer / license to design, manufacture, test and supply 400kV/220kV/132kV/110kV* transformer in India, shall be submitted.

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

24.5. **Technical Requirement for 400kV, 220kV and 132kV class Reactor**

(i) The Manufacturer whose 400kV/220kV/132kV* Reactor(s) are offered must have designed, manufactured, tested & supplied 400kV/220kV/132kV* or higher voltage class. These Reactor(s) must have been in satisfactory operation# for at least two (2) years as on the date of NOA.

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

a) Such manufacturer has designed, manufactured based on technological support of collaborator, type tested (as per IEC/IS standard) and supplied 400kV class transformer or 220kV or above class shunt reactors as on the date of NOA.

b) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer/license to design, manufacture, test and supply the Reactor in India, shall be submitted.

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

24.6. **Technical Requirement for 400 kV Grade XLPE Power Cables**

(i) The manufacturer(s) whose XLPE Power Cables are offered must have designed, manufactured, type tested and supplied in a single contract at least 5 (five) km of single core, 400kV grade XLPE insulated cable which must be in operation for at least 2 (two) years as on the date of NOA.

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

a) The manufacturer must have designed, manufactured, type tested and supplied 400kV grade XLPE insulated cable, and which must be in satisfactory operation# for at least one (1) year as on the date of NOA.

OR

b) The manufacturer must have designed, manufactured, type tested and completed Pre-qualification (PQ) tests as per IEC for 400kV grade XLPE insulated Cable as on the date of NOA.

24.7. **Technical Requirement for 220KV Grade XLPE Power Cables**

(i) The manufacturer(s) whose XLPE Power Cables are offered must have designed, manufactured, type tested and supplied in a single contract at least 5 (five) km of single core, 220kV or higher grade XLPE insulated cable which must be in operation for at least 2 (two) years as on the date of NOA.

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

a) The manufacturer must have designed, manufactured, type tested and supplied 220kV or higher grade

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XLPE insulated cable, and which must be in satisfactory operation# for at least one (1) year as on the date of NOA.

OR

b) The manufacturer must have designed, manufactured, type tested and completed Pre-qualification (PQ) tests as per IEC for 220kV or higher grade XLPE insulated Cable as on the date of NOA.

24.8. **Technical Requirement for 132KV, 110kV, 66kV Grade XLPE Power Cables**

(i) The manufacturer(s) whose XLPE Power Cables are offered must have designed, manufactured, type tested and supplied in a single contract at least 5 (five) km of single core, 132KV/110kV/66kV* or higher grade XLPE insulated cable which must be in satisfactory operation# for at least two (2) years as on the date of NOA.

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

a) The manufacturer must have designed, manufactured, type tested and supplied 132KV/110kV/66kV* or higher grade XLPE insulated cable, and which must be in satisfactory operation# for at least one (1) year as on the date of NOA.

24.9. **Technical Requirement for 1.1 KV Grade PVC Control Cable**

The manufacturer(s), whose PVC control cables are offered, must have designed, manufactured, tested and supplied in a single contract at least 100 Kms of 1.1kV grade PVC insulated control cables as on the originally scheduled date of bid opening. Further the manufacturer must also have designed, manufactured, tested and supplied at least 1 km of 27C x 2.5 Sq.mm or higher size as on the date of NOA.

24.10. **Technical Requirement for 1.1 KV Grade PVC Power Cable**

The manufacturer(s), whose PVC Power Cables are offered, must have designed, manufactured, tested and supplied in a single contract at least 100 Kms of 1.1 kV or higher-grade PVC insulated power cables as on the date of NOA/award. Further the manufacturer must also have designed, manufactured, tested and supplied at least 1 km of 1C x 150 Sq. mm or higher size as on the date of NOA.

24.11. **Technical Requirement for 1.1 KV Grade XLPE Power Cables**

The manufacturer(s), whose XLPE Power cables are offered, must have designed, manufactured, tested and supplied in a single contract at least 25 Kms of 1.1 KV or higher grade XLPE insulated power cables as on the date of NOA/award. Further the manufacturer must also have designed, manufactured, tested and supplied at least 1 km of 1C x 630 Sq. mm or higher size as on the date of NOA.

24.12. **Technical Requirement for LT Switchgear**

i) The manufacturer whose LT Switchgear(s) are offered, must be a manufacturer of LT Switchboards of the type and rating being offered. He must have designed, manufactured, tested and supplied at least 50 nos. draw out circuit breaker panels, out of which at least 5 nos. should have been with relay and protection schemes with current transformer. He must have also manufactured at least 50 nos. MCC panels comprising of MCCBs (i.e. Moulded Case Circuit Breakers) modules of the type offered which must be in satisfactory operation# as on the date of NOA.

ii) The Switchgear items (such as circuit breakers, fuse switch units, contactors etc.), may be of his own make or shall be procured from reputed manufacturers and of proven design, at least one hundred circuit breakers of the make and type being offered must have been in satisfactory operation# as on the date of NOA.

24.13. **Technical Requirements for Battery**

The manufacturer whose Batteries are offered, must have designed, manufactured and supplied DC Batteries of the type specified and being offered, having a capacity including future bays requirement. and must be satisfactory operation# for at least two (2) years in the power sector or industrial installations as on the date of NOA.

24.14. **Technical Requirements for Battery Charger**

The manufacturer whose Battery Chargers are offered, must have designed, manufactured and supplied Battery Chargers generally of the type offered, with static automatic voltage regulators and having a continuous output of at least ten (10) KW and these must have been in satisfactory operation# as on the date

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24.15. **Technical Requirements for LT Transformer**

i) The manufacturer, whose LT transformer(s) are offered, must have designed, manufactured, type tested including short circuit test as per IEC/IS or equivalent standards and supplied transformer(s) of at least 33kV class of 630kVA or higher. The transformer must have been in satisfactory operation# for at least two (2) years as on the date of NOA.

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

a) At least 33kV class of 630 kVA or higher rating LT transformer(s) must have been designed, manufactured in the above Indian works, type tested (as per IEC/IS standard) including short circuit test and supplied as on the date of NOA.

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

24.16. **Technical Requirements for Composite Long Rod Polymer Insulator (765kV & 400kV)**

(i) The manufacturer whose Composite Long Rod Insulator are offered, must have designed, manufactured, tested and supplied Composite Long Rod Insulator of 120KN or higher electro-mechanical strength for 765kV/400kV* or higher voltage class and the same must have been in satisfactory operation# for at least two (2) years as on the date of NOA.

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

a) The manufacturer must have designed, manufactured, type tested and supplied Composite Long Rod Insulator of 120KN or above electro-mechanical strength for 765kV/400kV* or higher voltage class and the same must have been in satisfactory operation# as on the date of NOA.

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

24.17. **Technical Requirements for Control, Relay & Protection System and Sub-Station Automation System**

The manufacturer whose Control, Relay & Protection System (Control & protection Intelligent Electronic Devices (IEDs)), and Sub-station Automation System (as applicable) are offered, must have designed, manufactured, tested, installed and commissioned Control, Relay & Protection system along with Sub-station Automation System which must have been in satisfactory operation# on (i) 400 kV system [applicable for 765kV substation] & (ii) specified voltage level or above [applicable for 400kV & below substation] for at least two (2) years as on the date of NOA.

AND

The Manufacturer or their joint venture or subsidiary company or parent company must be a manufacturer of control and protection IEDs and must have established repair, testing and integration (at least for 4 bays) facilities for Control, Relay & Protection System and Sub-Station Automation System in India.

24.18. **Technical Requirements for analog and digital PLCC panels (765kV, 400kV, 220kV&132kV)**

(i) The manufacturer whose PLCC panels are offered, must have designed, manufactured, tested, supplied and commissioned PLCC panels for (i) 400kV system or above [applicable for 765 kV & 400 kV substation], (ii) 220 kV System or above [applicable for 220 kV Substation] & (iii) 132 kV system or above [applicable for 132 kV substation] and the same must have been in satisfactory operation# for at least two (2) years as on the date of NOA.

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

a) PLCC panels must have been manufactured in the above Indian works based on technological support of collaborator, type tested (as per IEC/IS standard) and supplied as on the date of NOA.

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

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c) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer/license to design, manufacture, test and supply PLCC panels in India, shall be submitted.

24.19. **Technical Requirement of Communication Equipment**

The SDH equipment shall be offered from a manufacturer(s) who has been manufacturing SDH equipments for the last three (3) years and SDH equipment manufactured by such manufacturer(s) shall have been satisfactory operation in 110kV or higher voltage Power Substations for at least two (2) years as on the date of NOA.

24.20. **Technical Requirement of "Indian Associate" for execution of on shore supply and services for 765 kV Transformer & Reactor package**

Indian associate must have erected at least two (2) or more circuit breaker equipped bays of 345 kV or above voltage level or at least two (2) nos. of 345 kV or above voltage class transformer/reactor; during last seven (7) years and above bays/transformer/reactors must be in satisfactory operation# as on the date of NOA.

24.21. **DELTA FORMATION** (Applicable for 1 – Phase Transformer)

The tertiary winding terminals of the transformer shall be brought out through bushing. The delta formation of tertiary winding of single-phase units of a three phase bank shall be done outside the transformer. IPS Aluminium tube of suitable size (e.g. 3" IPS) with heat shrinkable insulating sleeves or cables of suitable voltage class, bus post insulators, support structures, conductors, clamps & connectors of suitable size required for tertiary delta formation shall be provided. The insulation tape or sleeve (wherever used) shall be of at least 52kV class for 33kV tertiary bus.

24.22. **Technical Requirement of Sub-contractors of GIS Packages**

In case of GIS is supplied from Indian GIS manufacturer, the erection, testing & commissioning of GIS shall be executed either by the bidder himself or by the Subcontractor meeting the following technical requirement:

The bidder/Subcontractor must have erected, tested and commissioned at least two (2) nos. GIS/AIS Circuit breaker equipped bays@ of voltage class** as specified below or higher in one (1) substation or switchyard during the last seven (7) years and these bays must be in satisfactory operation# as on the date of NOA.

S.no	Voltage class of GIS Package	Minimum Voltage class Circuit Breaker Equipped of Bay(**)
1	765kV & 400kV GIS	345kV
2	220kV	220kV
3	132kV	110kV
4	66kV	66kV

Further, the sub-contractor shall also meet the requirement specified at Clause No. 25.0 of this section.

Note:

1. (@) For the purpose of technical requirement, one no. of circuit breaker bay shall be considered as a bay used for controlling a line or a transformer or a reactor or a bus section or a bus coupler and comprising of at least one circuit breaker, one disconnector and three nos. of single phase CTs / Bushing CTs. GIS means SF6 Gas insulated Switchgear. AIS Means Air Insulated Switchgear.
2. # satisfactory operation means certificate issued by the Owner/Utility certifying the operation without any adverse remark.

25. The technical parameters for 36kV & 12kV Horn gap fuse

1. 36kV Horn Gap Fuse

1	Rated voltage	33 kV
2	Maximum Continuous voltage	36 kV

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3	Rated current	50 Amps (min)
4	Rated short time withstand (in KA)	25KA for 1 sec.
5	Lighting Impulse voltage withstand	170 KV (Between Live and earth) 195 KV (Across open terminals)
6	One minute Power frequency voltage withstand (Dry and Wet)	70 KV (Between Live and earth) 80 KV (Across open **terminals)**
7	Creepage	900mm

2. 12kV Horn Gap Fuse

1	Rated voltage	11 kV
2	Maximum Continuous voltage	12 kV
3	Rated current	50 Amps (min)
4	Rated short time withstand (in KA)	12KA for 1 sec.
5	Lighting Impulse voltage withstand	75 KV (Between Live and earth) 85 KV (Across open terminals)
6	One minute Power frequency voltage withstand (Dry and Wet)	28 KV (Between Live and earth) 32 KV (Across open **terminals)**

Applicable standard: IS9385

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ANNEXURE- A

CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST

1. General

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

2. Test Levels:

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

3. Test Methods for RIV:

3.1 RIV tests shall bemade 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 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 tests 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 another test.

5. Test Records:

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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 regarding 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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ANNEXURE- B

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 Contractor's premises/ ADANI 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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ANNEXURE- C

LIST OF GENERAL CODES MUST BE FOLLOWED

CODES	TITLE
--	India Electricity Rules
--	Indian Electricity Act
--	Indian Electricity (Supply) Act
--	Indian Factories Act
IS-5	Colours 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 Hexa Fluoride
IEC-60437	Radio Interference Test on High Voltage Insulators
IEC-60507	Artificial Pollution Tests on High Voltage Insulators to be used on AC Systems
IEC-62271-1	Common Specification for High Voltage Switchgear & Control gear Standards
IEC-60815	Guide for the Selection of Insulators in respect of Polluted Conditions
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	Techniques 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	Grey Finishes for Industrial Apparatus and Equipment No. 61 Light Grey
NEMA-107T	Methods of Measurements of RIV of High Voltage Apparatus
NEMA-ICS-II	General Standards for Industrial Control and Systems Part ICSI-109
CISPR-1	Specification for CISPR Radio Interference Measuring Apparatus for the

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	frequency range 0.15 MHz to 30 MHz
CSA-Z299.1-1978h	Quality Assurance Program Requirements
CSA-Z299.2-1979h	Quality Control Program Requirements
CSA-Z299.3-1979h	Quality Verification Program Requirements
CSA-Z299.4-1979h	Inspection Program Requirements
TRANSFORMERS AND REACTORS	
IS:10028 (Part 2 & 3)	Code of practice for selection, installation & maintenance of Transformers (P1:1993), (P2:1991), (P3:1991)
IS-2026 (P1 to P4)	Power Transformers
IS-3347 (part 1 to Part 8)	Dimensions for Porcelain transformer Bushings for use in lightly polluted atmospheres
IS-3639	Fittings and Accessories for Power Transformers
IS-6600	Guide for Loading of oil immersed Transformers
IEC-60076 (Part 1 to 5)	Power Transformers
IEC-60214	On-Load Tap-Changers
IEC-60289	Reactors
IEC-60354	Loading Guide for Oil -Immersed power transformers
IEC-60076-10	Determination of Transformer and Reactor Sound Levels
ANSI-C571280	General requirements for Distribution, Power and Regulating Transformers
ANSI-C571290	Test Code for Distribution, Power and Regulation Transformers
ANSI-C5716	Terminology & Test Code for Current Limiting Reactors
ANSI-C5721	Requirements, Terminology and Test Code for Shunt Reactors Rated Over 500 KVA
ANSI-C5792	Guide for Loading Oil-Immersed Power Transformers up to and including 100 MVA with 55 deg C or 65 deg C Winding Rise

NSI-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

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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 Electro technical Vocabulary
IEC 60050(421)	International Electro technical 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.
BS-4360	Specification for wieldable structural steel

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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 vulcanized rubber
IS:7016 part 1 to 14	Methods of test for coated and treated fabrics
IS:803	Code of practice for design, fabrication and erection of vertical mild steel cylindrical welded oil storage tanks.
IS:3637	Gas operated Relays
IS:335	New Insulating oils - Specification
IEC-62271-203	Gas insulated metal enclosed switchgear for rated voltage above 52kV
IEC-61639	Direct connection between power transformers and gas- insulated metal enclosed switchgear for rated voltages of 52.5 kV and above.
IS:3400 / BS 903 / IS:7016	Air cell (Flexible Air Separator)
IEC 60529 / IP: 55	Degree of protection for cooler control cabinet, MOLG, Cooling fan, oil pump, Buchholz Relay
IEC 60529 / IP: 56	Degree of protection for Pressure Relief Device
IEC 60529 / IP: 43	Degree of protection for Remote tap Changer cubicle (RTCC)
CIRCUIT BREAKERS	
IEC-62271-100	High-voltage switchgear and control gear - Part 100: Alternating current circuit-breakers
IEC-62271-101	High-voltage switchgear and control gear - Part 101: Synthetic testing

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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), IEC 61869	Current Transformers

IS:3156- (P1 to P4) IEC 61869	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: Ferro resonance oscillations in substations with inductive voltage transformers
IEC-61869 (Part-103)	Instrument transformers - The use of instrument transformers for power quality measurement
BUSHING	
IS-2099	Bushings for Alternating Voltages above 1000V
IEC-60137	Insulated Bushings for Alternating Voltages above 1000V
SURGE ARRESTERS	
IS-3070 (PART2)	Lightning arresters for alternating current systems : Metal oxide lightning arrestors without gaps
IEC-60099-4	Metal oxide surge arrestors without gaps
IEC-60099-5	Selection and application recommendation
ANSI-C62.1	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

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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
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	Tele protection 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
CODES	TITLE 89

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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 meters
IEC-60547	Modular plug-in Unit and standard 19-inch rack mounting unit based on NIM Standard (for electronic nuclear instruments)
ANSI-81	Screw threads
ANSI-B18	Bolts and Nuts
ANSI-C37.1	Relays, Station Controls etc.
ANSI-C37.2	Manual and automatic station control, supervisory and associated telemetering equipment
ANSI-C37.2	Relays and relay systems associated with electric power apparatus
ANSI-C39.1	Requirements for electrical analog indicating instruments
MOTORS	
IS-325	Three phase induction motors
IS-4691	Degree of protection provided by enclosure for rotating electrical machinery
IEC-60034 (P1 to P19:)	Rotating electrical machines
IEC-Document 2	Three phase induction motors
(Central Office) 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 core Al conductors for overhead power lines
CODES	TITLE

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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 1000 V
IEC-60273	Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V
IEC-61462	Pressurized and un-pressurized insulator for use in electrical equipment with rated voltage greater than 1000V - Definitions, Test methods, acceptance criteria
IEC-60305	Insulators for overhead lines with nominal voltage above 1000V- ceramic or glass insulator units for ac systems Characteristics of String Insulator Units of the cap
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
CODES	TITLE
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)
Batteries	
IS:1651	Stationary Cells and Batteries, Lead-Acid Type (with Tubular Positive Plates)

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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
IEEE-80 (LATEST)	IEEE Guide for Safety in AC Substation
IEEE-998	IEEE Guide for Direct Lightning Stroke Shielding of Substations
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
CODES	TITLE
IS:1248	Indicating Instruments
IS:2208	HRC Fuses
IS:13947 (Part-3)	Air break switches, air break disconnectors & fuse combination units for voltage not exceeding 1000V AC or 1200V DC
IS:2147	Degree of protection provided by enclosures for low voltage switchgear and control gear
IS:6005	Code of practice for phosphating of Iron and Steel
IS:3231	Electrical relays for power system protection
IS:3842	Electrical relay for AC Systems
IS:5	Colors 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)

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IS-694	PVC insulated cables for working voltages up to and including 1100 Volts
IS-1255	Code of practice for installation and maintenance of power cables, up to and including 33 kV rating
IS-1554 (P1 and P2)	PVC insulated (heavy duty) electric cables (part 1) for working voltage up to and including 1100 V Part (2) for working voltage from 3.3 kV up to 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 up to and including 1100 volts
IS-7098	Cross-linked polyethyle insulated PVC sheathed cables for working voltage from 3.3kV up to 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
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 colors 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 up 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 Galvanized Steel Sheets

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IS-737	Specification for Wrought Aluminium and Aluminium Sheet & Strip
IS-1079	Hot rolled cast steel sheet & strip
IS-3588	Specification for Electrical Axial Flow Fans
IS-2312	Propeller Type AC Ventilation Fans
BS-848	Methods of Performance Test for Fans
BS-6540 Part-I	Air Filters used in Air Conditioning and General Ventilation
BS-3928	Sodium Flame Test for Air Filters (Other than for Air Supply to I.C. Engines and Compressors)
US-PED-2098	Method of cold DOP & hot DOP test
MIL-STD-282	DOP smoke penetration method
ASHRAE-52	Air cleaning device used in general ventilation for removing particle matter
IS:3069	Glossary of Terms, Symbols and Units Relating to Thermal Insulation Materials
IS:4671	Expanded Polystyrene for Thermal Insulation Purposes
IS:8183	Bonded Mineral Wool
IS:3346	Evaluation of Thermal Conductivity properties by means of guarded hot plate method
CODES	TITLE
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

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IS-2633	Methods for testing uniformity of coating of zinc coated articles
ASTM-A-123	Specification for zinc (Hot Galvanizing) Coatings, on products Fabricated from rolled, pressed and forged steel shapes, plates, bars and strips
ASTM-A-121-77	Zinc-coated (Galvanized) steel barbed wire
Painting	
IS-6005	Code of practice for phosphating of iron and steel
ANSI-Z551	Gray finishes for industrial apparatus and equipment
SSPEC	Steel structure painting council
Fire protection system	
--	Fire protection manual issued by tariff advisory committee (TAC) of India
HORIZONTAL CENTRIFUGAL PUMPS	
IS:1520	Horizontal centrifugal pumps for clear, cold and fresh water
IS:9137	Code for acceptance test for centrifugal & axial pumps
IS:5120	Technical requirement - Rotodynamic special purpose pumps
API-610	Centrifugal pumps for general services Hydraulic Institutes standards
CODES	TITLE
BS:599	Methods of testing pumps
PTC-8.2	Power Test Codes - Centrifugal pumps
DIESEL ENGINES	
IS:10000	Methods of tests for internal combustion engines
CPCB IV issued by Central Pollution Control Board: CPCB	**CPCB IV is a set of emission standards for diesel generators that aims to reduce the amount of pollutants they emit**
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 & SPECIALTIES	
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

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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	Color Code for the identification of pipelines
IS:2643	Dimensions of pipe threads for fastening purposes
IS:2685	Code of Practice for selection, installation and maintenance of sluice valves
IS:2906	Sluice valves for water-works purposes (350 to 1200 mm size)
IS:3582	Basket strainers for fire-fighting purposes (cylindrical type)
IS:3589	Electrically welded steel pipes for water, gas and sewage (150 to 2000 mm nominal diameter)
IS:4038	Foot valves for water works purposes
IS:4927	Unlined flax canvas hose for fire fighting
IS:5290	Landing valves (internal hydrant)
IS:5312 (Part-I)	Swing check type reflex (non-return) valves
IS:5306	Code of practice for fire extinguishing installations and equipment on premises
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 96

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IEC DOCUMENT 2 (Control Office) 432	Three Phase Induction Motor
VDE 0530 Part I/66	Three Phase Induction Motor
IS:9224 (Part-II)	HRC Fuses
IS:6875	Push Button and Control Switches
IS:694	PVC Insulated cables
IS:1248	Indicating instruments
IS:375	Auxiliary wiring & bus bar markings
IS:2147	Degree of protection
IS:5	Color 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	Pressurized Water Type
D.G. SET	
IS:10002	Specification for performance requirements for constant speed compression ignition (diesel engine) for general purposes
IS:10000	Method of tests for internal combustion engines
IS:4722	Rotating electrical machines-specification
IS:12063	Degree of protection provided by enclosures
IS:12065	Permissible limit of noise levels for rotating electrical machines
--	Indian Explosive Act 1932
Steel structures	
IS-228 (1992)	Method of Chemical Analysis of pig iron, cast iron and plain carbon and low alloy steels.
IS-802 (P1 to 3)	Code of practice for use of structural steel in overhead transmission line towers
IS-806	Code of practice for use of steel tubes in general building construction
IS-808	Dimensions for hot rolled steel beam, column channel and angle sections
IS-814	Covered electrodes for manual arc welding of carbon of carbon manganese steel
IS-816	Code of Practice for use of metal arc welding for general construction in Mild steel
IS-817	Code of practice for training and testing of metal arc welders. Part 1 : Manual Metal arc welding
IS-875 (P1 to P4)	Code of practice for design loads (other than earthquake) for buildings and structures
IS-1161	Steel tubes for structural purposes

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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
ASTM-441	Specification for High strength low alloy structural manganese vanadium steel
ASTM-A572	Specification for High strength low alloy columbium-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

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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 Galvanizing on Iron and Steel
IS:2633	Method for Testing Uniformity of coating of zinc Coated Articles
IS:4826/ ASTMA-472-729	Hot dip Galvanized coatings on round steel wires
GALVANIZED STEEL EARTHWIRE	
IS:1521, ISO/R:89-1959	Method for T ensile Testing of Steel Wire
IS:1778	Reels and Drums for Bare Conductors
IS:2629	Recommended practice for Hot Dip Galvanizing on Iron and Steel
IS:2633	Methods for testing Uniformity of Coating of Zinc Coated Articles
IS:4826/ ASTM: A475-72a BS:443-1969	Hot dip Galvanized 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 underground in mines (non – flameproof type)
CODES	**TITLE**
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 vapor lamps
IS:1258	Specification for Bayonet lamp fluorescent lamp
IS:3323	Bi-pin lamp holder tubular fluorescent lamps

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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 engineering Purposes
Conduits, Accessories and Junction Boxes	
IS:9537	Rigid steel conduits for electrical wiring
IS:3480	Flexible steel conduits for electrical wiring
IS:2667	Fittings for rigid steel conduits for electrical wiring
IS:3837	Accessories for rigid steel conduits for electrical wiring
IS:4649	Adaptors for flexible steel conduits
IS:5133	Steel and Cast Iron Boxes
IS:2629	Hot dip galvanizing 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 household 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 up to 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
CODES	TITLE
IS:3854	Switches for domestic and similar purposes
IS:5216	Guide for safety procedures and practices in electrical work
IS:732	Code of practice for electrical wiring installation (system voltage not exceeding 650 Volts)
IS:3043	Code of practice for earthing
IS:3646	Code of practice of interior illumination part II & III
IS:1944	Code of practice for lighting of public through fares
IS:5571	Guide for selection of electrical equipment for hazardous areas
IS:800	Code of practice for use of structural steel in general building construction
IS:2633	Methods of Testing uniformity of coating on zinc coated articles
IS:6005	Code of practice for phosphating iron and steel
	INDIAN ELECTRICITY ACT
	INDIAN ELECTRICITY RULES
LT SWITCHGEAR	

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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:16227	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 galvanizing
IEC 61439	low-voltage switchgear and controlgear assemblies

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ANNEXURE- H

RTV Silicone high voltage insulation coating (HVIC)

1.0 General

The scope of work shall include supply, delivery and application of RTV silicone high voltage insulation coating for Substations at coastal area.

a) The supplied virgin RTV coating material shall have sufficient margin before expiry of its shelf life (Date of manufacturing shall not be older than two months from date of delivery). Application of RTV coating material on the equipment after expiry of its shelf life will not be permitted.

b) All the required materials, tools and tackles, testing equipment, consumables etc. for application of HVIC coating shall be in the contractor's scope.

c) Surface preparation: All insulation surfaces of the equipment to be coated shall be made free from dust, grease, oil and any other foreign material without damaging the surface. The surface of the equipment shall be made dry before application of the RTV coating.

d) Preparation/mixing of the virgin RTV coating materials shall be done strictly as per recommendations of the original manufacturer only.

e) The application of the properly prepared /mixed virgin RTV coating materials shall be done by certified applicants of original manufacturer only.

f) The coating shall cover complete insulation surface of the equipment.

g) Coated insulation surface of the equipment after full cure shall be smooth and free from any defect viz. scratches, uneven surface etc.

h) Following tests are to be carried out by the contractor after full care of coatings.

(i) Hydrophobic test on 1-2 coated equipment as per STRI guidelines and the results shall be HC2 class or better.

(ii) BDV testing of fully cured coating in the lab.

(iii) Bonding/adherence test at site: The sample coated insulator shall be put in water and boiled for 02 hours and removed. The coating shall not exhibit water blisters at the interface between the insulator surface and the coating.

(iv) High pressure water withstand test at site: A high-pressure water wash test shall be performed on sample coated insulator. The RTV coating shall withstand the pressure without any damage to it.

(v) Thickness measurement of RTV coating at site: Test shall be performed on each of the equipment coated to confirm the thickness of the coating on the respective equipment.

i) Any other item which is not specifically mentioned above but are required for successful completion of the work shall be in this scope of work.

2.0 Technical Requirements

a) RTV Silicon compound in its liquid form

Material Properties	**Requirement**
Material Type	One part RTV
Appearance	Paint
Filler type	ATH, Quartz or both
Color	Grey
Substrate Application Temperature Range °C	-4°C to 121°C
Tack free at 25°C and 50% RH	30 minutes

b) Properties of RTV Silicon compound after cured

Parameters	**Requirement**

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Parameters	**Requirement**
Application Area	Glass, Porcelain, station insulators, as well as bushing, instrument transformers and related devices
Full cure time	Max. 24 hours
Recommended coating thickness	500 microns+ 10%, dry film
Dielectric Strength, (ASTM D 149)	>25 kV/mm
Volume Resistivity, ohm.cm (ASTM D257)	9.0*10^A14
T racking wheel withstand, hours	5000 Hours
Min. Salinity Level withstood during "Artificial Pollution Test using Salt Fog Method"	>160 kg/mA3
Hydrophobic Recovery Test (REC specification 76/2006)	To H1 or H2
Method of Application	Airless Spray
Arc resistance	420 sec or better (As per ASTM D 495 - 99 (Reapproved 2004))
Tracking resistance	1A 4.5 or better (As per IEC 60587, i.e. 5 specimen shall survive tracking
Primer Required	No primer materials shall be allowed
Resistant to	Marine salt fog, Water, Industrial (cement dust, fly ash, acid emission etc.), Rough Weather Conditions
Other Properties	Non-Hazardous to environment, surface after full cure shall be smooth

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SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR) Annexure K (Rev 01)

Sl. No.	Power System Equipment	Minimum Local Content (%)
1	Power Transformers (up to 765 kV, including Generator Transformers)	60
2	Instrument Transformer (up to 765 kV)	60
3	Transformer Oil Dry Out System (TODOS)	60
4	Reactors up to 765 kV	60
5	Oil Impregnated Bushing (Up to 400kV)	60
6	Resin Insulated Paper (RIP) bushings (up to 145 kV)	50
7	Circuit Breakers (up to 765kV AC-Alternating Current)	60
8	Disconnectors, Isolators (up to 765kV AC)	60
9	Wave Trap (up to 765kV AC)	60
10	Oil Filled Distribution Transformers up to & including 33kV [Cold Rolled Grain Oriented (CRGO)/Amorphous, Aluminium/Copper wound]	60
11	Dry type Distribution Transformers up to & including 33kV (CRGO/Amorphous, Aluminium/Copper wound)	60
12	Conventional conductor	60
13	Accessories for conventional conductors	60
14	High Temperature/High Temperature Low Sag (HTLS) conductors (such as Composite core, GAP, ACSS, INVAR, AL59) and accessories	60
15	Optical ground wire (OPGW)- all designs	60
16	Fiber Optic Terminal Equipment (FOTE) for OPGW	50
17	OPGW related Hardware and accessories	60
18	Remote Terminal Unit (RTU)	50
19	Power Cables and accessories up to 33kV	60
20	Control cables including accessories	60
21	XLPE cables up to 220kV	60
22	Substation Structures	60
23	Transmission Line Towers	60
24	Porcelain (Disc/Long Rod) Insulators	60
25	Bus Post Insulators (Porcelain)	60
26	Porcelain Disc Insulators with Room Temperature Vulcanisation (RTV) coating	50
27	Porcelain Long Rod Insulators with Room temperature Vulcanisation (RTV) coating	50
28	Hardware Fittings for porcelain Insulators	60
29	Composite/Polymeric Long Rod Insulators	60
30	Hardware Fittings for Polymer Insulators	60
31	Bird Flight Diverter (BFD)	60
32	Power Line Carrier Communication (PLCC) system (up to 800kV)	60
33	Gas Insulated Switchgear (up to 400kV AC)	60
34	Gas Insulated Switchgear (above 400kV AC)	50
35	Surge/Lightning Arrester (up to 765kV AC)	60
36	Power Capacitors	60
37	Packaged Sub-station (6.6kV to 33kV)	60
38	Ring Main Unit (RMU) (up to 33kV)	60

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SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR) Annexure K (Rev 01)

39	Medium Voltage (MV) GIS panels (up to 33kV)	60
40	Automation and Control system/Supervisory Control and Data Acquisition (SCADA) system in Power system	50
41	Control and Relay panel (including Digital/Numerical relays)	50
42	Electrical motors 0.37kW to 1MW	60
43	Energy meters excluding smart meters	50
44	Control and Power cables and accessories (up to 1.1kV)	60
45	Diesel Generating (DG) set	60
46	DC system (DC Battery & Battery Charger)	60
47	AC and DC Distribution board	60
48	Indoor Air Insulated Switchgear (AIS) up to 33kV	60
49	Poles (PCC, PSCC, Rolled Steel Joist, Rail Pole, Spun, Steel Tubular)	60
50	Material for Grounding/earthing system	60
51	Illumination system	60
52	Overhead Fault Sensing Indicator (FSI)	50
53	Power Quality Meters	50
54	Auxiliary Relays	50
55	Load Break Switch	50
56	Cranes, EOT cranes, gantry crane & chain pulley blocks, etc	60
57	Elevator	60
Fire Protection and Detection system		
58	Motor driven fire water pumps	60
59	Diesel engine driven fire water pumps	60
60	Hydrant system	60
61	High velocity water spray system	60
62	Medium velocity water spray system	60
63	Foam Protection system	60
64	Inert gas flooding system	60
65	Fire tenders	60
66	Portable fire-extinguishers	60

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Section-4

ANNEXURE – A

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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