1591555/2023/TBG-TB_ENG_SR

TECHNICAL QUALIFICATION REQUIREMENT

Name of Project: 400 KV S/s Dhule & Karad

Name of Customer: M/s MSETCL

Name of Item: CLAMP & CONNECTORS

TECHNICAL QUALIFICATION REQUIREMENT
The Bidder should have supplied 400 KV clamp & connectors in last 5 years from date of Enquiry.

SUPPORTING DOCUMENTS TO BE SUBMITTED BY BIDDER ALONG WITH TECHNICAL BID		
Sr	**Required Criteria**	**Supporting Documents**
1	Supply	1. Purchase order 2. Dispatch clearance / LR / Material Receipt certificate at site / etc. establishing bidder as proven supplier of offered item

PREPARED BY	REVIEWED BY	APPROVED BY
30/06/2023	30/06/2023	30/06/2023
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SECTION-1

SCOPE, SPECIFIC TECHNICAL REQUIREMENTS AND QUANTITIES

1.0 SCOPE

This specification covers design, manufacture, supply and delivery of Clamps & Connectors. In case of variance in the requirements specified under Section-I and other Sections of this specification, requirements of Section-1 shall prevail. In case of variance in the requirements specified in Section-2 & 3, Section-3 shall prevail.

1.1 SPECIFIC TECHNICAL REQUIREMENTS

1.1.1 Technical Particulars for Clamp & Connectors Karad & Dhule substation

	Karad & Dhule substation
Highest system voltage (kV)	36
Short circuit current	25 kA for 1 sec

1.2 BILL OF QUANTITIES

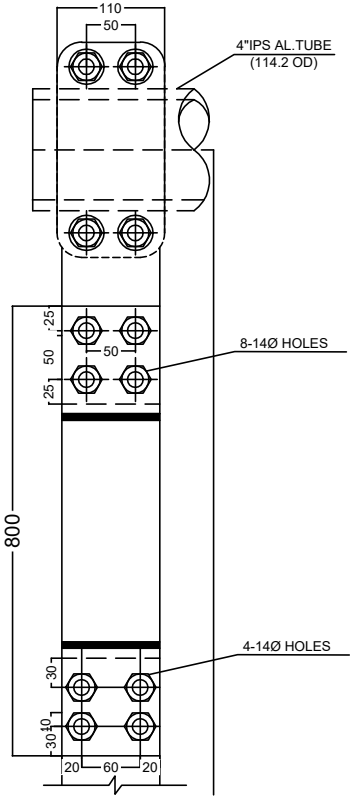
DESCRIPTION	QUANTITY (Nos)
SUPPLY- CLAMPS & CONNECTORS : 36KV, 3150A, REACTOR BUSHING CONNECTOR SUITABLE FOR AL TUBE 4 INCH IPS, FLEXIBLE TYPE	9

The following may be noted.

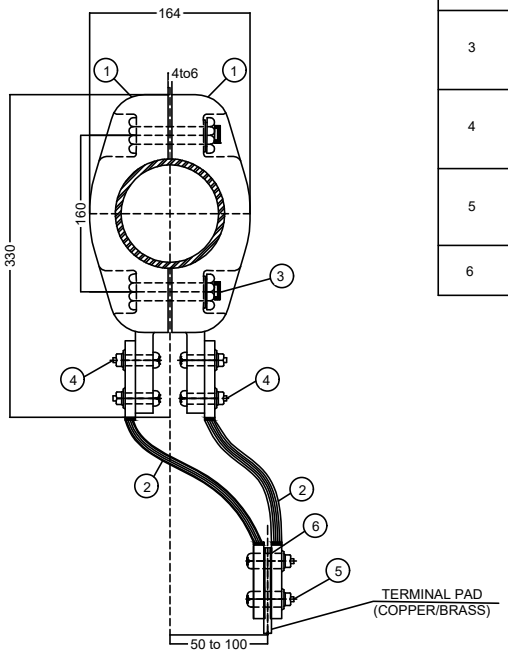
1. No deviations from specification shall be acceptable.
2. Please refer the reference drawing enclosed for details.

1.3 TYPE TESTING

Bidder shall submit valid type test reports (as per relevant IEC/IS Standard) for approval. The type test reports submitted shall be of tests conducted within last 10 years prior to the date of bid opening. The bidder should have conducted type test on identical or similar equipment/ components to those offered. In case type test reports are found to be technically unacceptable to BHEL/MSETCL, the type test shall be conducted without cost and delivery implication to BHEL.



ELEVATION



END VIEW

MATERIAL LIST:-

REF. NO	DESCRIPTION	MATERIAL	QTY.
1	CONNECTOR BODY	Al. ALLOY 4600 (A6) TO I.S : 617 -1994	2
2	EXTEND FLEXIBLE CONNECTION (LENGTH =800MM)	AL. LAMINATION (54 Nos.X28 SWG)	2
3	M16X60 BOLT WITH NUT , PLAIN & SPRING WASHER	BOLT, NUT & PW- M.S HOT DIP GALVED. SW - ELECTRO GALVED.	4
4	M16X60 BOLT WITH NUT , PLAIN & SPRING WASHER	- DO-	8
5	M12X9 0 BOLT WITH NUT, PLAIN & SPRING WASHER	- DO-	4
6	100X100X2 Th. B.M STRIP	ALUMINIUM - COPPER	2

NOTES:-

1. REF. STANDARD : IS 5561-1970
2. MAX. SYSTEM VOLTAGE : 36 KV.
3. CONTINOUS RATING : 3150 AMPS
   (MAX. TEMP RISE : 35'C OVER 50'C AMBIENT)
4. SHORT TIME RATING : 25 KA FOR 1 SEC.
5. MIN. THICKNESS OF CURRENT CARRYING PART : 10MM
6. ALL SHARP CORNERS SHALL BE SMOOTHY ROUNDED OFF.
7. BOLTS, NUTS & PLAN WASHERS SHALL BE M.S.HOT DIP GALVD. AS PER IS: 2629 AND TESTED AS PER IS:2633.
8. SPRING WASHER SHALL BE ELECTRO GALVANISED TO SUIT SERVICE CONDITION - 3 OF IS:1573.
9. BOLT TIGHTENING TORQUE : 400kg CM. FOR M12
   : 555kg CM. FOR M16
10. MANUFACTURING TOLERANCES:
    UPTO 50MM : ± 5% ; FROM 51 TO 100MM: ± 4%;
    FROM 101 TO 300MM : ± 3% ; ABOVE 300MM: ± 2%.

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SECTION 2

STANDARD SPECIFICATION

2.1 GENERAL

This section covers the general technical requirements of spacers and clamps & connectors. In case of any discrepancies between the requirements mentioned in this section and those specified in other section of this specification, the latter shall prevail and shall be treated as binding requirements.

2.1.1 Technical Particulars for spacers and Clamp & Connectors

Nominal system voltage	:	400kV	220 kV	132 kV	33kV
Highest system voltage	:	420kV	245 kV	145 kV	36kV
Current Rating	:	Compatible With Conductor rating			
Short circuit current for	:	40kA for 1sec	40 kA for 1sec	31.5kA for 1sec	25kA for 1 sec.
Frequency	:	50 Hz +5%	50 Hz +5%	50 Hz +5%	50 Hz +5%
Basic insulation level (1.2/50 microsecond wave)	:	1425kVp	1050 kVp	650 kVp	250kVp
Switching surge withstand: (250/2500 microsecond) Dry & wet		1050	---	---	---
System Earthing	:		--- Effectively earthed ---		
Spacing between sub-Conductors of the bus	:	450mm	250/330mm	250mm	150
Maximum working tension :					
a) Twin Conductor (Kg):		2000	2000	2000	400
b) Quad Conductor (Kg):		4000	4000	4000	800
Visual Corona withstand V	:	320 kV	156 kV	---	---

2.2 Applicable Standards

The spacers and clamps & connectors shall strictly conform to the following Indian and International standards as appropriate:

List of Standards :

IS 617:1994	Aluminium and aluminium alloy ingots and castings for general engineering purposes.
IS 1363 (All Parts):2002	Hexagon head bolts, screws and nuts of product grade C
IS 1364 (All Parts):2002	Hexagon head bolts, screws and nuts of product grades A and B
IS 1367 (Part I):2002	Technical Supply Conditions for threaded fasteners.
IS 1367 (Part 2):2002	Technical Supply Conditions for threaded fasteners.
IS 1367 (Part 3):2002	Technical Supply Conditions for threaded fasteners.
IS 1367 (Part 13):1983	Technical Supply Conditions for threaded fasteners.
IS 2121:1981 (Part -1 & 2)	Specification for conductors and earthwire accessories for overhead power lines
IS 2121:1992 (Part -3)	Specification for conductors and earthwire accessories for overhead power lines.
IS 2121:1991 (Part -4)	Specification for conductors and earthwire accessories for overhead power lines
IS 5561:1970	Electric power connectors.
IS 2633:1986	Methods for testing uniformity of coating of zinc coated articles.
IS 1573:1986	Electroplated coating of Zinc on Iron and Steel
IS 3138:1966	Hexagonal Bolts & Nuts (M42 to M150)
IS 4218 (Parts 1,2 & 4) 2001	Metric Screw Threads
IS 4218:(Part 3):1999	Metric Screw Threads

IS 4218:(Part 6):1978	Metric Screw Threads
IS 10162:1982	Spacers & spacer dampers for twin horizontal bundle conductors
ISO 272	Fasteners: Hexagonal Products -Width across Flats.
ISO 898	Fasteners, Screws & Studs
NEMA CC1	Electric power connectors for sub-station
NEMA CC3	Connectors for use between Aluminium or Aluminium-Copper Overhead Conductors.
IS 816:1969	Code of practice for use of metal arc welding for general construction in mild steel.
IS 4759:1996	Hot dip zinc coatings on structural steel and other allied products.
IS 2633:1986	Methods for testing uniformity of coating of zinc coated articles.
IS 2629:1985	Recommended practice for hot dip galvanising of iron and steel.

2.3 **Clamps and Connectors**

2.3.1 All the current carrying parts shall be designed and manufactured to have minimum resistance. Maximum tension per conductor is expected to be 1000kg in case of 220kV and 2000kg in case of 400kV. Clamps and fittings shall be so designed that the equipment shall not be subject to any abnormal stresses due to thermal changes in conductor. All the clamps and fittings shall enable the connection to be as short as possible. Wherever possible they shall be in two separate halves. No U bolts shall be used. Corona control ring shall be of such design and shape that they will prevent visual discharge forming on the hardware assemblies. They shall have minimum thickness of 2.5mm. All similar parts, particularly the removable one shall be interchangeable with one another.

2.3.2 The clamps and connectors shall be made of materials listed below:-

a) For connecting ACSR conductor material designation 4600 of IS 617:1994 for bolted type.

b) For connecting equipment terminals made of copper or brass to ACSR/AAC conductor, Bimetallic connector made from aluminium alloy casting conforming to designation 4600 of IS 617:1994, with 2mm thick cast copper liner shall be provided. Alternatively equivalent bimetallic strip can be provided.

c) For connecting GI shield wire : Forged steel.

d) Bolts, nuts, plan washers shall be hot dip galvanized & spring washers of spring steel (E.G.)

e) Wherever crimping is involved , such clamps shall be forged /extruded.

f) For copper to copper and copper to brass or brass connectors- copper alloy of the following composition shall be used:

Zinc	2 to 3%
Lead	2 to 2.5%
Tin	0.6 to 1.5%
Iron	0.5 to 1.0%
Copper	92% to 94%

The impurities if present shall not exceed the limits as indicated, below:

Nickel	0.03%
Antimony	0.03%
Manganese	0.04%
Silicon	0.04%
Phosphorous	0,04%

g) All casting shall be free from below holes surface blisters and shall be rounded off.

h) All sharp edges and corners hall be blurred and rounded off.

i) Thickness of the clamps and connectors shall not be less than 10mm.

j) Bolts and nuts shall have hexagonal heads and threads as per Indian standard.

Rated torque of the nuts shall be indicated on drawing.

k) For bimetallic clamps or connectors copper alloy liner of minimum thickness 2mm shall be cast integral with the aluminium alloy body. Equivalent bimetallic sleeve/ strips can also be provided.

k) For flexible connectors, braids or laminated straps shall be made from tinned copper strips or aluminium laminates depending upon the clamp. All Aluminium conductors of adequate current, mechanical stability & flexibility can also be provided.

l) Each clamp/ connector shall be identified with respective BOM & Drawing number.

m) The clamp shall be designed to carryout the same current as the conductor as specified in the specification. The temperature rise when carrying full load current shall not exceed 75°C for site ambient temperature.

n) Clamps and connectors shall be designed to be corona controlled. Corona extinction voltage for 400KV & 220 KV class clamps shall not be less than 320KV (rms) & 156 KV respectively and R.I.V. level shall not be more than 1000 micro volts at the test voltage specified in respective sections.

p) There should not be any significant change in Radio interference of associated conductor with & without clamps & fittings.

q) **Designs**:

Responsibility of satisfactory design of the clamps/connectors to safely withstand the specified mechanical stresses and carry the rated current without exceeding the temperature rise specified, shall solely rest with the bidder.

2.3.3 **Clamps and Connectors-Tests**

A. Type Tests

The clamps and connectors should be type tested design as per IS-5561. All clamps and connectors should have been type tested as per applicable clause no. as indicated against each test for the following in addition to the other tests indicated in IS-5561.

i) Tensile test (Cl. No. 10)

ii) Resistance test (Cl.No. 11)

iii) Temperature Rise test (Clause 12)

iv) Short time current test (Cl.No.13)

v) Dimensional Check (Cl. No. 14)

vi) Galvanization Test (Where applicable) (Cl. 15)

vii) Visual Corona & RIV test (for 400 & 220 kV systems) (if applicable)

B. Acceptance Test

Following acceptance tests shall be carried out as per applicable clause no. of IS:5561 indicated against each test :

i) Tensile test (Cl.No. 10)

ii) Resistance test (Cl.No. 11)

iii) Dimensional Check (Cl.No. 14)

iv) Galvanization Test (Where applicable) (Cl.15)

C. Routine Test

Following Routine tests shall be carried out as per applicable clause no. of IS:5561 indicated against each test :

i) Visual Check

ii) Dimensional Check (Cl.No.14)

2.4 **SPACERS**

2.4.1 **General** :

Spacer shall conform to IS : 10162 (latest version). The spacers are to be located at a suitable spacing to limit the short circuit forces and also to avoid snapping of sub conductors during short circuit conditions.

2.4.2 Constructional Features

a) No magnetic material shall be used in the fabrication of spacers except for GI bolts and Nuts.

b) Spacer design shall be made to take care of fixing and removing during installation and maintenance

c) The design of the spacers shall be such that the conductor dose not come in contact with any sharp edge.

2.4.3 **Tests**

Spacers should be type tested design as per IS-10162. Spacers should have been type tested for the following tests in addition to the other tests indicated in IS-10162.

A. **Type Tests**

a) **Clamp slip tests**
The sample shall be installed on test span of twin conductor bundle string or quadruple conductor bundle string (as applicable) at a tension of 44.2kN. One of the clamps of the sample when subjected to a longitudinal pull of 2.5kN parallel to the axis of the conductor shall not slip on the conductor. The permanent displacement between the conductor and the clamp of sample measured after removal of the load shall not exceed 1.0 mm. Similar tests be performed on the other clamps of the same sample.

b) Fault current test as per CI 5.14.2 of IS : 10162

c) Corona Extinction Voltage test (Dry) (if applicable)

This test shall be performed as per procedure mentioned at Annexure-A Section-2. Minimum corona extinction voltage shall be 320kV (rms) line to ground for 400 kV, 156kV (rms) line to ground for 220kV spacers respectively.

d) RIV Test (Dry) (if applicable)

This test shall be performed as per procedure mentioned at Annexure-A, Section-2. Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz at 320KV rms for 400KV system (1000 micro volts) and 156kV rms for 220kV system (1000 micro volts)

e) Resilience test (where applicable)

f) Log decrement test (applicable only for spacer dampers)

g) Galvanising test.

h) Movement test

i) Clamp bolt torque test

j) Assembly torque test

k) Tensile load test

l) Compression and pull off test.

m) Vibration test

n) Magnetic power loss test

B. Acceptance Test (As per IS : 10162)

a) Visual examination

b) Dimensional verification

c) Movement test

d) Clamp slip test

e) Clamp bolt torque test (if applicable)

f) Assembly torque test

g) Compression test

h) Tension test

i) Galvanising test

j) Hardness test for neoprene (if applicable)

The shore hardness of different points on the elastometer surface of cushion grip clamp shall be measured by shore hardness meter. It shall be between 65 to 80.

k) Ultimate Tensile Strength Test (where applicable)

The UTS of the retaining rods shall be measured. It shall not be less than 35 kg/Sq. Mm.

C Routine test

a) Visual examination

b) Dimensional verification

ANNEXURE - A

CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST

1.0 General

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

2.0 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.

3.0 Test Methods for RIV

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

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

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

3.4 Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100% and 110% of the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 400kV & 220kV is listed in Section-1/Section-2 of the specification together with maximum permissible RIV level in microvolts.

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

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

4.0 Test Methods 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 RIV test voltage and maintained there for five minutes. In case corona inception does not take place at 110%, test shall be stopped, otherwise test shall be continued and the voltage will then be decreased slowly until all visible corona disappears. The procedure shall be repeated at least 4 times with corona inception and extinction voltage recorded each time. The corona extinction voltage for purposes of determining compliance with the specification shall be the lowest of the four values at which visible corona (negative or positive polarity) disappears. Photographs with laboratory in complete darkness shall be taken under test conditions, at all voltage steps i.e. 85%, 100%, and 110%. Additional photographs shall be taken at corona inception and extinction voltages. At least two views shall be photographed in each case using Panchromatic film with an ASA daylight rating of 400 with an exposure of two minutes at a lens aperture of f/5.6 or equivalent. The photographic process shall be such that prints are available for inspection and comparison with conditions as determined from direct observation. Photographs shall be taken from above and below the level of connector so as to show corona on bushing,

insulators and all parts of energised connectors. The photographs shall be framed such that test object essentially, fills the frame with no cut-off.

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

4.1 The test shall be recorded on each photograph. Additional photograph shall be taken from each camera position with lights on to show the relative position of test object to facilitate precise corona location from the photographic evidence.

4.2 In addition to photographs of the test object preferably four photographs shall be taken of the complete test assembly showing relative positions of all the test equipment and test objects. These four photographs shall be taken from four points equally spaced around the test arrangement to show its features from all sides. Drawings of the laboratory and test set up locations shall be provided to indicate camera positions and angles. The precise location of camera shall be approved by Purchaser's inspector, after determining the best camera locations by trial energisation of test object at a voltage which results in corona.

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

4.4 However, both test shall be carried out with the same test set up and as little time duration between tests as possible. No modification on treatment of the sample between tests will be allowed. Simultaneous RIV and visible corona extinction voltage testing may be permitted at the discretion of Purchaser's inspector if, in his opinion, it will not prejudice other test.

5.0 Test Records

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

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

SECTION - 3
GENERAL TECHNICAL REQUIREMENTS

3.1 SITE INFORMATION

	DESCRIPTION	
3.1.1	**PROJECT INFORMATION**	
	a) Customer	**Maharashtra State Electricity Transmission Co. Ltd. (MSETCL)**
	b) Project	**420kV 80 MVAR on/off type Controlled shunt reactor (CSR) as line Reactor on 400kV Karad-Lonikand Line at 400kV Karad S/S. and 02 Nos. 420kV 50 MVAR on/off type Controlled shunt reactor (CSR) at 400kV Dhule S/S.**
	c) Project locations	**Karad and Dhule**
	d) Transport facilities Nearest Railway Station/Gauge Distance from Railway Station	**To follow**
	e) Access roads	**To follow**
3.1.2	**SITE CONDITIONS**	
3.1.2.1	Design Ambient Temp. (°C)	**50**
3.1.2.2	Minimum Design Ambient air temp. (°C)	**3.5**
3.1.2.3	Relative humidity	**10% to 100%**
3.1.2.4	Seismic Zone	**Seismic zone-III earthquake prone area with mild intensity almost month basis.**
3.1.2.5	Maximum altitude above sea level	**1000m**
3.1.2.6	Wind data	
	a) Wind velocity m/sec.	**As per IS**
3.1.2.7	Maximum annual rainfall	**1450mm**
3.1.2.8	isokeraunic level	**50 days/ year**