



उत्तर दक्षिण हरियाणा बिजली वितरण निगम
UTTAR DAKSHIN HARYANA BIJI VITRAN NIGAM



Specification No.54/DH/UH/P&D/2010-2011

TECHNICAL SPECIFICATION AND REQUIREMENT OF L.T. INSULATION
PIERCING CONNECTORS SUITABLE FOR LT AERIAL BUNCHED XLPE
INSULATED ALUMINIUM CONDUCTOR CABLES WITH BARE
MESSENGER WIRE / BARE CONDUCTOR FOR LT OVER HEAD LINES
SUITABLE FOR WORKING VOLTAGE UPTO & INCLUDING 1100 VOLTS

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Common Specifications Committee UHBVN & DHBVN

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UHBVN	DHBVN	DHBVN	UHBVN	DHBVN	UHBVN	DHBVN	UHBVN



TECHNICAL SPECIFICATION AND REQUIREMENT OF L.T. INSULATION PIERCING CONNECTORS SUITABLE FOR LT AERIAL BUNCHED XLPE INSULATED ALUMINIUM CONDUCTOR CABLES WITH BARE MESSENGER WIRE / BARE CONDUCTOR FOR LT OVER HEAD LINES SUITABLE FOR WORKING VOLTAGE UPTO & INCLUDING 1100 VOLTS.

1. SCOPE

This specification covers the design, manufacture, assembly, testing and supply of Insulation piercing connectors for bare overhead line conductor to insulated service cable.

2. REFERENCE STANDARDS

The design, performance and test requirements shall confirm to this specification and the following standards. However in case of any conflict, the requirements of this specification shall prevail.

- 1.0 NFC 33-020 Insulation Piercing Connectors
- 2.0 REC Specification No 83/2010 for Insulation Piercing Connectors
- 3.0 NFC 33-003 Corrosion Resistance
- 4.0 NFC 20-540 Climatic Ageing
- 5.0 IS 14255 LV Aerial Bunched Cables
- 6.0 REC Specification 32/1984 for Aerial Bunched Cable for LT Lines
- 7.0 IS 7098 Part 1: XLPE Insulated Cables for working voltages upto 3.3 KV
- 8.0 IS 398 Part IV : aluminium alloy conductors

The Devices shall also be compatible with the cables of sizes & dimensions as defined in the Cable Specifications for the cables with which they are intended to be used, and this specification.

3. CLIMATIC CONDITIONS:

The climatic conditions under which are cables shall operate satisfactorily are as follows:

	Max. ambient air temperature	60 ⁰ C
	Min. ambient air temperature	(-)5 ⁰ C
	Average Daily max. ambient temperature	40 ⁰ C
	Max. yearly weighed average ambient temperature	32 ⁰ C
	Max. altitude above mean sea level (Meters)	1000



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	Minimum Relative Humidity (%age)	26
	Max. Relative Humidity (%age)	95
	Avg. No. of Rainy days/year	120
	Avg. annual rainfall	900 mm
	Maximum wind pressure	195 Kg./m Sq.

Note: Moderately hot & humid tropical climate conducive to rust & fungus growth. The climatic conditions are also prone to wide variations in ambient conditions. Smoke is also present in the atmosphere Heavy lightning also occurs during June to October.

4. CABLE DATA

The standard sizes and characteristics of the phase and street lighting conductors, messenger wires shall be as specified in IS: 14255-1995 or NFC 33 209.

5. TYPES OF INSULATION PIERCING CONNECTORS FOR BARE MAIN TO UNSULATED TAP

Insulation Piercing Bare Connectors (IPBC) are used for making Tee/Tap-off/Service connections to an ABC/Bare Overhead Line. IPBC are designed to make a connection between the bare main conductor and a branch cable conductor without having to strip the insulated branch cable. Instead, the tightening action of the IPBC will first pierce the Insulation, then make good electrical contact between the main end and branch conductor while simultaneously insulating and sealing the connection.

The insulation piercing bare connectors are of the following type depending on the applications.

Standard size ranges for IPBC for Bare Main to Insulated Branch cable are as below:

Type	Application	Main Cable Size Range (mm ²)	Branch Cable Size range (mm ²)
1	Street Lighting and service connections	16 - 95	1.5 – 10
2	Medium Service Connections	16 - 95	4 – 35



6. CONSTRUCTIONAL FEATURES OF INSULATION PIERCING BARE CONNECTORS

The following features of Insulation piercing bare connectors are to be met for the qualification criteria

1. The connector bodies shall be made entirely of mechanical and weather resistant plastic insulation material made of weather & UV resistant reinforced polymer and no metallic part outside the housing is acceptable except for the tightening bolt or nuts.
2. Any metallic part that is exposed must not be capable of carrying a potential during or after connector installation.
3. Screws or nuts assigned for fitting with IPBC (Insulating Piercing connector for Main to Insulated), must be fitted with torque limiting shear heads to prevent over tightening or under tightening. While the min & max torque values are to be specified by Manufacturer, these should not exceed 20 N mtr for IPC for main conductor < 95 sq mm, and 30 N mtr for main conductor >95, but < 150 sq mm.
4. The IPBC must perform piercing of Tap insulated conductor connection on Main cable simultaneously using single bolt for tightening as multiple bolts do not ensure even tightening. Design of connector needs to avoid the stripping of insulated tap conductor and make the connection by piercing the insulation.
5. The shear bolt/nut shall be suitable for tightening with a hexagonal spanner of 13 mm.
6. The contact blade of the connector is made of tinned copper/aluminium alloy
7. The IPBCs shall be water proof and the water tightness shall be ensured by appropriate elastomer materials and not by grease, gel or paste alone. Grease can be applied to protect the contact blade alone and shall not be visible on the outer surface of the connector. Connector should not be dipped in grease.
8. Each IPBC should be provided with a cap to seal the cut end of the insulated Branch cable. It should be of a design that once the connector is fitted, it shall not be possible to remove the cap without dismantling the connector.



9. Design of IPBC should be such as to not cause damage to insulation of adjacent conductors due to vibration and relative movement during service.
10. All the metallic parts of the connector should be corrosion resistant and there should not be any appreciable change in contact resistance & temperature after overloads & load cycling and should be confirm to the long duration tests specified in this standard.

7. TESTING REQUIREMENTS OF INSULATION PIERCING BARE CONNECTORS

The following tests are intended to intended to establish performance characteristics of insulation piercing connectors and categorized as follows.

Sr. No.	Clause	Test	Type Test	Acceptance Test	Routine Test
1	6.2.1	Visual		X	X
2	6.2.2	Dimensional		X	X
3	6.2.3	Mechanical			
	6.2.3.1	- Electrical Continuity and Shear head & mechanical behavior.	X		
	6.2.3.2	- Effect of tightening the mechanical strength of main core.	X	X	X
	6.2.3.3	- Checking mechanical strength of tap core.	X		
4	6.2.4.1	Water tightness test	X	X	X
5	6.2.5	Climatic Ageing Test	X		
6	6.2.6	Corrosion Test	X		
7	6.2.7	Electrical ageing test	X		

7.1 General Test Condition

Connectors to be tested shall be identified using the following elements

- Minimum marking details requested in this specification.
- The minimum and maximum operating torque of shear off head.
- Nominal torques of the re-usable tightening screws.
- Min-Max conductor range suitable for Main and Tap



7.1.1 Preparation of conductors

Preparation and selection of conductor is per specific to the requirement and test condition is as agreed between manufacturer and purchaser and as per the approved quality plan.

7.1.2 Installation of connectors

Connectors shall be installed in accordance with the instructions given by the manufacturer in the installation instructions. A torque meter shall be used for all tightening and untightening operations with a resolution of 0.1Nm at least.

7.1.3 Number of test samples

For each of the specified tests, the number of samples as well as the test sequences are given in annex A of this specification.

7.1.4 Ambient temperature and humidity condition

Unless otherwise specified, tests shall be carried out at an ambient temperature between 15°C and 30°C.

7.1.5 Frequency and waveform of a.c test voltages

The frequency of a.c test voltages shall be 50 Hz.

7.1.6 Cable failure during the tests

If a cable fails beyond any part of a connector, the test result shall be decaled void without discrediting the connector. Tests are repeated using a new connector and a new cable.

7.2 Tests

In order to demonstrate satisfactory performance characteristics to meet the intended application the following tests are a pre-requirement of supplies on a general commercial basis.

7.2.1 Visual

Design aspects of the IPC needs to be visually verified as per the descriptions of this specification under clause (5) and criteria defined by the manufacturer in the quality plan and as accepted by customer. Following Mandatory marking should be available.

7.2.1.1 Marking

IPC should bear



- Manufacturers trade mark and logo
- Product Code or Reference
- Traceability Code /Batch Number
- Min- Max Conductor Range for Main and Tap

7.2.2 Dimensional

Dimensional verification of IPC with respect to the connector to be carried out against the drawing approved by the customer.

7.2.3 Mechanical Tests

The following tests are designed to ensure that IPC is both mechanically sound and does not damage the conductor it connects.

Applicable range of tolerance of tensile strength applied is higher of the following.

0 + 5%

Or

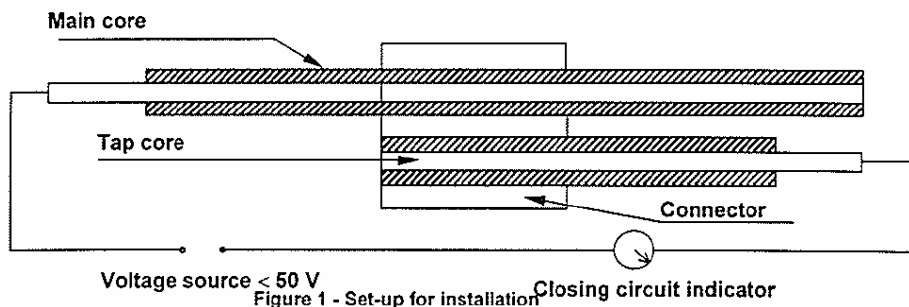
0 + 10N

7.2.3.1 Checking Electrical Continuity, Shear Head Behaviour and Mechanical Strength of Connector

Connectors shall be installed on cores of minimum length of 0.5 meter and should be tested in the following combination as indicated in the connectors.

Main	Branch
Max.	Max.
Min.	Max.

Connectors shall be tightened with a torque with torque meter of 0.1 Nm least resolution. Set up for measurement of continuity to adopted as per fig 1.



For connectors with simultaneous tightening, tightening shall be carried out up to 0.7 times the minimum torque indicated by the manufacturer then up to the break down of the shear head and finally up to 1.5 times the maximum torque indicated by the manufacturer.

For connectors fitted with two screws tightening should be equivalent and alternative using a torque meter.

Acceptance Criteria:-

At 0.7 times the minimum torque, electrical contact shall have occurred between the cores.

Maximum torques measured shall be within the range of the minimum and maximum torques indicated by the manufacturer.

At 1.5 times the maximum torques indicated by the manufacturer, there shall be no breakdown of the connector or the core.

7.2.3.2 Effect of tightening on mechanical strength of Main Cable

This is to ensure that the mechanical strength of main cable is not damaged due the installation of connector. The test shall be conducted for the following combination

Main	Branch
Max.	Max.
Min.	Max.

Connector shall be installed on the main cable at the center, and to be mounted on a suitable tensile device. Connector shall be tightened up to maximum toque indicated by the manufacturer.



An increasing tensile stress shall be applied to the conductor of main core, at a rate between 1 kN/min and 5 kN/min up to the value indicated in table below and shall be maintained for 1 minute.

Phase	Neutral Messenger
60% MBL	90% MBL

MBL:- Minimum breaking load of conductor per respective standard.

Acceptance Criteria:-

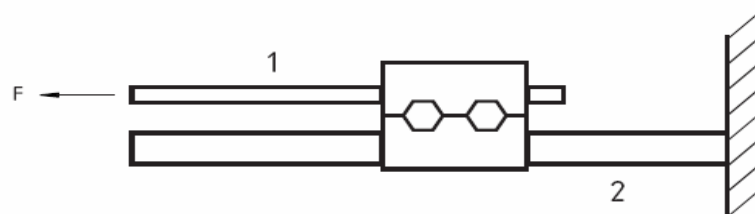
No breaking of cable shall be observed during the application of load.

7.2.3.3 Effect of tightening on mechanical strength of Tap Cable

This is to ensure that the mechanical strength of tap cable is not damaged due to the installation of connector. The test shall be conducted for the following combination

Main	Branch
Max.	Min.
Min.	Min.

Connector shall be installed on the main cable at the center, and to be mounted on a suitable tensile device as shown in figure 2 below. Connector shall be tightened up to maximum torque indicated by the manufacturer.



Sl.No

1 Tap Cable

2 Main cable

Figure 2 – Test Set-up

An increasing tensile stress shall be applied to the conductor of main core, at a rate between 0.1 kN/min and 0.5 kN/min up to 10% Minimum breaking Load of the tap cable and shall be maintained for 1 minute.



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Acceptance Criteria:-

No breaking or slippage of tap cable ($\geq 3\text{mm}$) shall be observed during the application of load.

7.2.4 Water Tightness Test

Test should be conducted for the following combination.

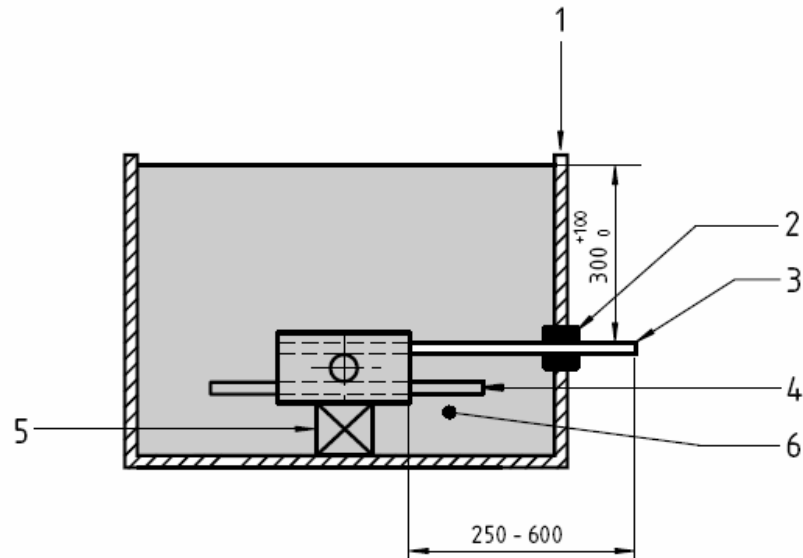
Main	Branch
Max.	Min.
Min.	Min.

Connector shall be installed on cable with above combination and tightened up to minimum rated torque indicated by the manufacturer.

Assembly of connector and cable to be maintained in a rigid manner and is placed at the bottom of the water tank with suitable measurement system for depth indication. The water height is measured from the upper part of the connector, and the cables are long enough out of the water to avoid flashover as shown in figure 4 below. Dimension indicated in the test set up to be maintained during testing

The branch cable crosses the tank with an appropriate sealing provision, without excessive stress.

The assembly is left in water for 24 hours.



Dimensions are in mm

Sl.No			
1	Test Tank	4	Main Cable
2	Seal	5	Support
3	Branch Cable	6	Water

Figure 4 – Water tightness Test Set-up

Acceptance Criteria:-

No trace of water shall be observed at the end of tap cable core.



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7.2.5 Climatic Ageing Test

These tests are carried out on samples having completed the voltage and watertightness tests described in clause 7.2.4.1 and 7.2.4.2.

The samples are submitted to the climatic ageing test as per NFC 20-540 or HD 626-2 sub-clause 2.5.1 with following details. During the test the wavelength and intensity of the UV at the location of the Connector under test shall be measured and must meet with the requirements of the Test Procedure of NFC 20 -540.

6 weekly cycles are required at the enclosure temperature $(70\pm 2)^{\circ}\text{C}$ for phases A & C. After completion of the Climatic Test, and after more than 24 hours but within 72 hours under ambient conditions, the connector shall be tested with requirement as below:

7.2.5.1 Requirement

- A) After exposure to the Climatic test, the connector shall be tested for water tightness test as per clause 7.2.4.2. The immersion time will be limited to 12h. Connectors are left at laboratory atmosphere.

There shall be no trace of water at the end of the core.

- C) Marking indicated for sample identification is to be examined after climatic ageing test cycles.

The marking should be legible when examines with normal corrected vision, without magnification.

7.2.6 Corrosion Test

Equipments for aerial networks with bare or insulated cables are submitted to more or less humid and corrosive natural atmospheres.

The two main factors involved in atmosphere corrosiveness after the duration during which a surface stays we are :

- Chloride ion, mainly in marine atmosphere :
- Sulphur dioxide, mainly in industrial atmosphere ;
- Occasionally, both at the same time, in ,ixed, marine and industrial atmospheres.

The connector is installed with a main core and with 1 or 2 minimum cross-section tap core(s). The connector is placed in the middle of the



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main core of 0.5 m to 1.5 m. Then it is tightened up to the minimum torque indicated by the manufacturer.

Then the corrosion test defined in the standard NFC 33 003 is applied to the connector and conductor.

There are 4 cycles of 14 days. Each 14 day period, or basic module, comprises two weekly sequences :

- 7 Days (168 h) with salt spray exposure ;Concentration shall be (5±1)% in weight and the enclosure temperature shall be maintained at (35±2)°C.
- & cycles of 24 h (168h), each cycle including 8 h exposure with saturated humidity and high sulphur dioxide content atmosphere (that is 56h), and a 16h exposure at the laboratory atmosphere by opening the enclosure door (that is 112h). volume concentration of sulphur dioxide shall be 0.067%. Each cycle of 24 h includes first a 8 h heating period, and secondly a 16 h rest period. During the first period the temperature is raised to (40±3)°C in a humidity saturated atmosphere. During the second period the enclosure remains at ambient temperature.

No cleaning shall be performed between both sequences.

At the end of each 14day period, the samples shall be cleaned first by normal water for 5 minutes to 10 min and then by demineralized water for the same duration. Water temperature shall not exceed 35°C during both operations.

7.2.6.1 Requirement

- A) At the end of the corrosion test, the connectors shall be un-tightened to a torque below than or equal to the maximum torque indicated below

For conductor cross section $\leq 95\text{mm}^2$ – Max torque shall not exceed 20Nm

For conductor cross section $> 95\text{mm}^2$ and $\geq 150\text{mm}^2$ – Max torque shall not exceed 30Nm

- A) A continuously increasing load is applied to the main core up to 90% of the MBL of the conductor. The load is maintained for 1 minute without any breakdown of the conductor.

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7.2.7 Electrical Ageing Test

Test to be conducted for each type of connector installed in a cable loop with either of the two configuration mentioned below.

Configuration	Main Cable Cross-section	Tap Cable Cross-section
Configuration 1	Maximum	Maximum
Configuration 2	Maximum (Applicable for customer)	Maximum

Connectors are tightened at the minimum torque indicated by the manufacturer :

Electrical ageing test to be performed as per standard NFC 33 004.

Two classes of connectors are covered by this standard

Class A :- Network Connectors. These connectors are to be subjected to heat cycles and over current tests.

Class B :- Servicing/ Street Lighting Connectors. These are subjected to heat cycles only.

During the test the connectors has to undergo a series of ageing thermal cycles, each including an heating period obtained by flowing a A.C Current followed by a cooling period.

Total 200 heating and cooling period are to be carried out. For class A connectors only after 50th cycle, 4 over currents are applied. Test loop of each type of connector is to be selected as described in the standard.

7.2.7.1 Requirements

Following characteristics will be evaluated at the end of the tests and requirement of each are as follows.

7.2.7.1.1 Resistance – The initial scatter δ

The scatter between the six values of R_j (one value for each connector) at cycles zero is to be analyses as defined in the standard.

The value of δ shall be lower than or equal to 0.30.



7.2.7.1.2 Assessment of resistance stability

The larger relative change of each connector resistance shall be calculated over the last eleven measures.

For each connector

$$\overline{R}_j = \sum_{j=1}^{11} \frac{R_j}{11}$$

And

$$\Delta R_j = R_j \text{ max} - R_j \text{ min}$$
$$\frac{\Delta R_j}{\overline{R}_j} \text{ shall be lower than or equal to 12\%}$$

7.2.1.3 Temperature

The temperature stability of each connector shall be estimated over the last eleven measures.

For each Connector:

- 1.) d_j = difference between the reference core temperature and the tested connector temperature.

Calculation of the mean value of this difference:

$$d_j = \frac{\sum_{j=1}^{11} d_j}{11}$$
$$\overline{d}_j - 10 \leq d_j \leq \overline{d}_j + 10$$

- 2.) Each connector temperature θ_j shall be lower than or equal to the warmer reference core: $\theta_j \leq \theta_R$

8. SAMPLING PLAN FOR ACCEPTANCE TESTS

Sampling Plan for acceptance tests on Anchor, Suspension Clamp Assemblies, SS Straps and Buckles are as per ISO 2859-1 as mentioned below.

8.1 For Visual and Dimensional

Sampling Level: General Inspection Level 1

AQL: 4% Rejection in sample size acceptable

SL NO	LOT SIZE	SAMPLE SIZE
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1	51 to 90	5
2	91 to 150	8
3	151 to 280	13
4	281 to 500	20
5	501 to 1200	32
6	1201 to 3200	50
7	3201 to 10000	80
8	10001 to 35000	125
9	35001 to 150000	200
10	150001 to 500000	315
11	500001 & over	500

8.2 For Mechanical and Voltage Tests

Sampling Level: Special Inspection Level S-2

AQL: 0.1% Rejection in sample size acceptable

SL NO	LOT SIZE	SAMPLE SIZE
1	51 to 90	3
2	91 to 150	3
3	151 to 280	5
4	281 to 500	5
5	501 to 1200	5
6	1201 to 3200	8
7	3201 to 10000	8
8	10001 to 35000	13
9	35001 to 150000	13
10	150001 to 500000	13
11	500001 & over	13

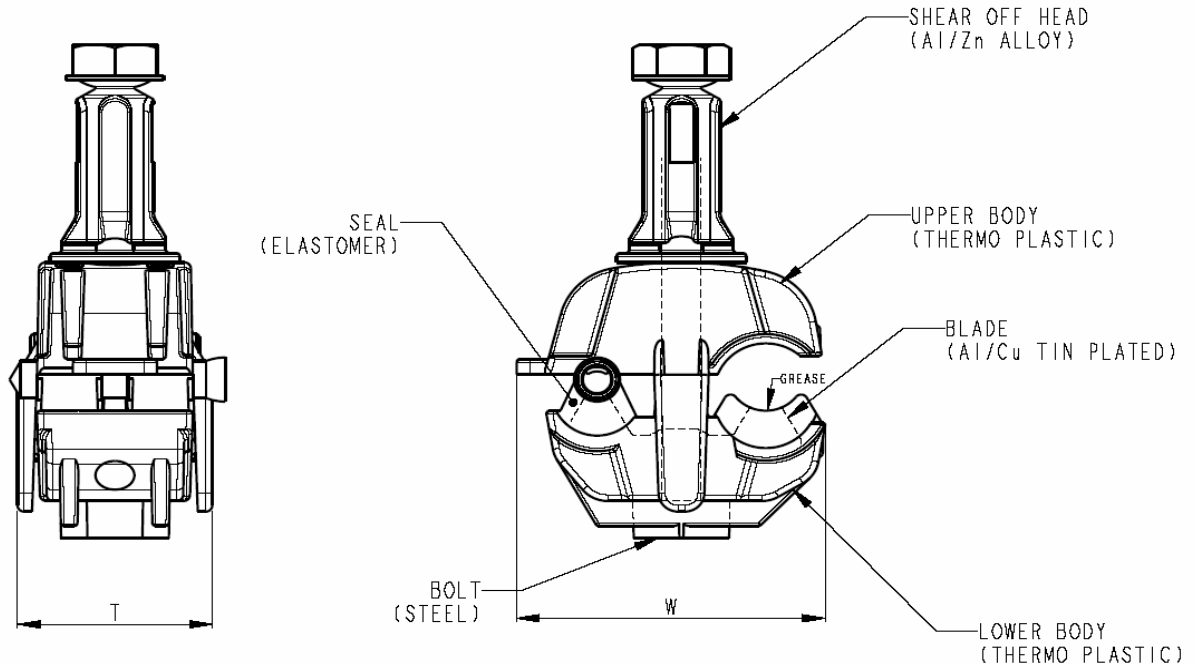
9. QUALIFICATION TEST REPORTS

For all accessories, the Qualification Test Report should be from an Independent NABL Accredited Laboratory like ERDA/CPRI or the International Laboratory Accreditation Corporation, Mutual Recognitions Arrangement (ILAC,MRA) signatory Laboratory in case of a foreign global manufacturer. The bidder shall submit the type test reports along with the bid. The Type Test Report shall include product GA drawings showing principal parts, material of construction (polymer, steel, aluminium alloy etc), overall dimensions & sizes for which it is suitable. This drawing should be signed and stamped by the Testing Laboratory and form part of the Report.

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10. TYPICAL GENERAL ARRANGEMENT



11. FAKE INSPECTION CLAUSE:

The manufacturer shall be responsible to pay penalty of Rs 20,000/- for each occasion at which the fake inspection call has been made or the material is rejected during testing/inspection by the authorized agency/representative of the Nigam. This penalty would be in addition to the expenses incurred by the Nigam in deputing the Inspecting Officer, carrying out such inspection.

12. CHALLENGE CLAUSE:-

The material offered/received after the inspection by the authorized Inspecting Officer may again be subjected to the test for losses or any other parameters from any testing house/in house technique of the Nigam having requisite capabilities and facilities. The results if found deviating/ unacceptable or non-complying to approved GTPs the lot shall be rejected and bidder shall arrange to supply the replacement within thirty (30) days of such detection at his cost including to & fro transportation. In addition to this penalty @10% of cost of the inspected lot of material shall be imposed.



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13. WARRANTY PERIOD:-

The supplier shall be responsible to replace, free of cost, with no transportation or insurance cost to the purchaser, up to destination, the whole or any part to the material which in normal and proper use proves the defective in quality or workmanship, subject to the condition that the defect is noticed within 18 months from the date of receipt of material in stores or 12 months from the date of commissioning whichever period may expire earlier. The consignee or nay other officer of Nigam actually using the material will give prompt notice of each such defect to the supplier. The replacement shall be effected by the supplier within a reasonable time, but not, in any case, exceeding 45 days/ The supplier shall, also, arrange to remove the defective within a reasonable period, but not exceeding 45 days from the date of issue of notice in respect thereof, failing which, the purchaser reserve the right to dispose of defective material in any manner considered fit by him (purchaser), at the sole risk and cost of the supplier. Any sale proceeds of the defective material after meeting the expenses incurred on its custody, disposal handling etc., shall however be credited to the supplier's account and set off against any outstanding dues of the purchaser against the supplier. The warranty for 12/18 months shall be one time.

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14. **GURANTEED TECHINAL PATRICULAR DECLARATION FORMAT
FOR PIERCING TYPE BARE CONNECTORS**

Sr. No.	Particulars	
1	Name of the Manufacturer	
2	Is manufacturer of accessories an ISO 9001- 2000 company. a) Copy of certificates enclosed? b) Are GA drawings enclosed ?	
3	Application standard	NFC 33 020
4	Type of connection required	
5	Application	
6	Is any metallic part carrying potential in operation exposed during installation	No
7	Are end caps of branch cable a) Slide on type (b) Rigid	
8	Are torque limiting shear heads provided to tightening bolts	Yes.
9	Range of cable sizes accommodated for Main & Branch	Main : Tap :
10	Minimum & Maximum torque defined (Nm)	
11	Torque for establishing connection between main and branch (Nm)	
13	Max. Tensile load for no breakdown of Main conductor (for each cross section)	
14	Max. Tensile load on branch conductor for no break/slippage	
15	Water tightness test	24 hours
16	Is electrical Ageing test report submitted	Yes.
17	No. of Cycles	200
18	Max. Temp. at each cycle	120° C
19	Current Rating during heating	
20	Marking and embossing on the connector	
21	Are all type test reports submitted as per NFC 33 020?	Yes.

Note: Particular mentioned in the format are mandatory and requested to be confirmed by the manufacturer

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