BIHAR STATE POWER TRANSMISSION COMPANY LIMITED

MANUFACTURING QUALITY PLAN -- Invar Conductor

Manufacturers Details (Name, Works, Address etc.)	Customer	Vendor's Code	ITEM :	M.Q.P.No. 043	Valid From : 15.01.2016
	BSPTCL		Super Thermal Resistant Aluminium Alloy conductor, Al.Clad Invar Reinforced	Rev. No. 00	Valid upto : Till Revision
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Code 1	Indicates place where testing is planned to be performed i.e. Inspection location.
A	At equipment manufacturer's works
B	At Component manufacturer's works
C	At authorized distributors place
D	At independent Lab.
E	At turn key contractor's location
F	Not Specified

Code 2	Indicates who has to perform the tests i.e.Testing Agency
J	The Equipment Manufacturer
K	The Component Manufacturer
L	The Third Party
M	The Turn key Contractor

Code 3	Indicates who shall witness the tests i.e. Witnessing Agency
P	Component Manufacturer itself
Q	Component Manufacturer and Equipment Manufacturer
R	Component Manufacturer, Equipment Manufacturer and Contractor
S	Equipment Manufacturer itself
T	Equipment Manufacturer and Contractor
U	Equipment Manufacturer, Contractor and BSPTCL
V	Third Party itself

Code 4	Review of Test Reports/Certificates
W	By Equipment Manufacturer
X	By Contractor during product/process inspection
Y	By BSPTCL during product/process inspection.
Z	By Contractor and /or BSPTCL during product/process inspection.

Code 5	Whether specific approval of sub-vendor / component make envisaged?
E	Envisaged
N	Not Envisaged

Code 6	Whether test records required to be submitted after final inspection for issuance of Dispatch Clearances /Instructions ?
Y	Yes
N	No

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NOTES :

1. Proper co-relation of materials with test certificates from Raw Materials stage to finished conductor shall be maintained.
2. **Aluminium INGOTS/Aluminium Wire Rods:**

a) The equipment manufacturer shall obtain the following test certificates of Aluminium ingots for review by BSPTCL.

b) Chemical composition of Aluminium Ingots. All the test results of the test carried out by contractor shall be as noted in MQP Page No.3 for Super Thermal Resistant Al.Alloy wires.

3. **Aluminium Cladded INVAR wire:**

a) The equipment manufacturer shall obtain the following test certificates from their sub vendors for review by BSPTCL.

- Chemical composition of invar wire Rod.
- All the test results of the test carried out by sub vendor on finished invar wire.

4. The equipment manufacturer will carry out the acceptance test on aluminium and invar strands on 20% of the drums offered for inspection and will submit the records at the time of inspection. BSPTCL will witness the acceptance test on 5% of the offered drums.
5. All Aluminium and invar wire strands are required to be tested for each sample drawn for Acceptance test.
6. Adequate care shall be taken to avoid damages to aluminium cladding during preforming and post forming operations.
7. Test facilities / Calibration certificate shall be available at suppliers works.
   Calibration of various testing and measuring equipments and Standard Resistance for verification of Resistance bridges.
8. The area where conductor is to be manufactured shall be covered completely with rubber mat/ coir mat/ Wooden floor.
9. All guides, rollers, pulleys etc. used for manufacturing conductor shall be of Nylon/ Hylum/ Teflon or other soft material instead of steel.
10. Finished conductor shall be checked for length verification and surface finish on separate rewinding machine at (variable from 8 to 16 m/min at reduced speed)
    The rewinding facilities shall have appropriate clutch system and shall be free from vibration and jerks etc. with traverse laying facilities.
    If length(s) found less than declared length during rewinding, two more drums from the same lot shall be verified for declared length. In case, any of these drums is found having less length, the lot shall be accepted after deduction of length as observed in first case in rest of the drums ie. difference in length between declared length and actual length observed in the first drum shall be deducted from all drums of the lot. In case of defects in surface finish, additional two drums shall be taken for rewinding and if same same problem observed in surface, the entire lot shall be rejected.
11. The Aluminium Ingots shall be procured only from primary producers/LME proved Vendor.

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12. The equipment manufacture shalll obtain manufacturers test certificates for Invar wire atleast 20% of the coils for the test maintained at Sr.No.2.0 below.Further the contractor shall carry out the tests mentioned at Sr.No.2.0 below on 10% of the coils.The component manufacturer's test certificates and contractors records for the above tests shall be furnished to BSPTCL Inspector for review at the final Inspection.
13. The conductor ends are required to be sealed with heat shinkable sleaves and shall be properly secured with the drum with the help of "U" clamps after covering the conductor below clamp with PVC adhesive tape to avoid loosening of conductor layers during transit and handling.
14. The drums shall be suitable for wheel mounting and letting off the conductor under an minimum controlled tension of the order of 5 KN.
15. The wood used for drum shall meet the requirement of BSPTCL Specification. The conductor shall furnish an undertaking to this effort,that the wood used is seasoned wood and drums have been treated in line with CUSTOMER Specification requirements.
16. The wood used in the drum shall preferably be neutral(non corrosive)with pH (aqueous extract) 5.5 to 7.5 and the wood preservative Copper used compound shall be avoided.
17. EM has to ensure marking of Dispatch Clearances /Instructions no all drums before dispatches.
18. A copy of Dispatch Clearances /Instructions along with the test reports should be sent to the site along with the dispatches.
19. The Lay ratio of any Aluminium layer shall not be greater than the lay ratio of Aluminium layer immediately beneath it.
20. The MQP should be read in conjunction with the applicable technical specification against which the conductor is been manufactured.
21. In case any contradiction between technical specification / Approved drawing and MQP, detailed mentioned in Technical Specification and Approved drawing shall be final.
22. should maintain separate register, to be maintained in shop floor indicating joints/surface details of strands during manufracturing.
23. IEC 62004 for properties and testing of thermal-resistant aluminium alloy wires and IEC 60189 for conductor fabrication and testing.
24. Rejection & retest shall be as per IEC 61089 Standard

    In case of rejection due to quality parameters after testing as per MQP / Technical Specification / GTP, the rejected material and the samples already tested shall be strictly disposed off as follows :

    a) The rejected lot / tested samples shall be clearly identified and stored separately to avoid any mix up with any in-process / finished lot till the same is disposed off.

    b) The rejected material shall be cut in bits/parts to be sold as scrap. Incase of any other mode of disposal, same to be done with approval of BSPTCL. by the manufacturer with detail intimation to the corporate QA of BSPTCL to ensure that the same material is not re-offered/ supplied to BSPTCL.

    c) Necessary supporting documents in regard to (a) & (b) above shall be submitted for verification of BSPTCL and record shall be maintained at manufacturer's works.

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A.	**Section: RAW MATERIAL INSPECTION**												
1.0	**Aluminium Ingots OutSourced**	**Sources**	**100%**	**Suppliers TC**	**Only primary producers**	BSPTCL Reports				X/Y	E		From Approved sources or LME registered sources
1.1	**Chemical Composition**	Spectro Analysis	Suppliers TC- 1 sample per heat of 4 MT or part thereof	BSPTCL Spec.	AL 99.5 % (min)	BSPTCL Reports	A/B	J/K	S/P	W/X	-	N	
					Si 0.1 3% (max)								
			In absence of Manufacturers T.C's and/or proper co-relation, one sample per lot of 100 MT or part thereof shall be tested		Fe 0.30 % (Max)		B	K	P	W/Y	-	N	
					Cu 0.04 % (max)								
					Ti+Va 0.02 % (max)								
					Mn 0.01 % (Max)								
					Zr 0.01 % (Max)								
					Cr 0.01 % (Max)								
1.2	**Alloying Element Zirconium**	Supplier TC	Suppliers TC- 1 sample per Lot	--	Zirconium shall be in master alloy form of 10% Zr and remaining as Al.	Supplier T.C. Preserved with QC Dept	A/B	J/K	S/P	W/X	-	N	
1.3	Flux and Degasser	Supplier TC	Suppliers TC- 1 sample per Lot	--	--	--	--	--	--	--	--	--	
1.2	**Super Thermal Resistant Aluminium alloy wires (Type-AT3) (Continuously Casted)**										E		IN-HOUSE
1.2.1	Chemical Composition	Spectro Analysis	Suppliers TC- 1 sample per heat of 4 MT or part thereof	Inernal Plant Standard	AS PER APPROVED GTP		A/B	J/K	S/P	W/Y	-	N	
			In absence of Manufacturers T.C's and/or proper co-relation, one sample per lot of 100 MT or part thereof shall be tested				B	K	P	W/Y	-	N	
1.2.2	Diameter	Dimensional	1 sample from each coil.	Inernal Plant Standard	Min. 9.00 mm, / 11.50mm Nom. 9.50mm / 12.00mm Max. 10.00 mm / 12.50mm		A/B	J/K	S/P	W/Y	-	N	
1.2.3	Tensile Strength	Mechanical	1 sample from each coil.	Internal Plant standard	Internal Plant Standard		A/B	J/K	S/P	W/Y	-	N	

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1.2.4	Elongation at break	Mechanical	1 sample from each coil.	Internal Plant standard	Min. 8% at 250 mm gauge length		A/B	J/K	S/P	W/Y	-	N	
1.2.5	Resistivity and Conductivity	Electrical	1 sample from each coil.	Internal Plant standard	Internal Plant Standard		A/B	J/K	S/P	W/Y	-	N	
1.2.6	Cleanliness and surface smoothness	Visual	100% on each coil	IS 5484 & IS 398(Part V) & BSPTCL Spec..	The wire rod shall be free from pipes,laps,cracks,twists,seams & other injurious defects within the limits of good comercial practices.		A	J	S	W/Y	-	N	
2.0	**Aluminium Cladded invar wires**												Source : M/s ZTT China
2.1	Chemical Analysis	Chemical	**1 sample per heat.** In absence of Manufacturers T.C's and/or proper co-relation. One sample per lot of 100 MT or part thereof shall be tested at TPL.	-	AS PER APPROVED GTP		B D	K L	P V	W/Y W/Y	- -	N N	
2.2	Diameter	Dimensional	20 % Coils per lot	-	As per Approved Data sheet		A/B	J/K	S/P	W/Y	-	N	
2.3	Breaking Load	Mechanical	20 % Coils per lot	-	As per Approved Data sheet		A/B	J/K	S/P	W/Y	-	N	
2.4	Elongation at break	Mechanical	20 % Coils per lot	-	Min. 1.5% at 250 mm gauge length at fracture		A/B	J/K	S/P	W/Y	-	N	

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							1	2	3	4	5	6	
2.5	Resistance @ 20°C	Electrical	20 % Coils per lot	-	As per Approved Data sheet		A/B	J/K	S/P	W/Y	-	N	
2.6	Torsion Test	Mechanical	20 % Coils per lot	-	Min. 20 twists on guage length of 100 X d		A/B	J/K	S/P	W/Y	-	N	
2.7	Wrapping Test	Mechanical	20 % Coils per lot	-	Wrap-8 turns on the mandrel diameter of 5 times the wire diameter. The wire shall not break.		A/B	J/K	S/P	W/Y	-	N	
2.8	Aluminium Cladding Thickness	Physical	20 % Coils per lot	-	As per Approved Data sheet		A/B	J/K	S/P	W/Y	-	N	Direct Measurement through stripping method.
2.9	Surface finish of invar Wire coils	Visual	100 % Coils per lot	-	The Wires shall be smooth, uniform and free from imperfections such as spills, splits, scale inclusion, die marks, scratches, abrasion, blow holes etc.		A/B	J/K	S/P	W/Y	-	N	
2.10	Check for Joints	Visual	100 % Coils per lot	BSPTCL Spec.	There shall be NO JOINT		A/B	J/K	S/P	W/Y	-	N	
B.	**SECTION : IN PROCESS INSPECTION**												
3.0	**STAL wire drawing (Type - AT3 of IEC 62004)**												
3.1	Diameter of STAL Wire (Round and Trapezoidal shaped wires)	Dimensional	Three samples from each coil (Top end,middle end & bottom end)	-	As per Approved Data sheet		A	J	S	W/Y	-	N	By Weight method in case of Trapezoidal shaped wires
3.2	Breaking Load	Mechanical	Three samples from each coil (Top end,middle end & bottom end)	-	As per Approved Data sheet		A	J	S	W/Y	-	N	
3.3	Elongation at break	Mechanical	Three samples from each coil (Top end,middle end & bottom end)	-	As per IEC 62004		A	J	S	W/Y	-	N	

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							1	2	3	4	5	6	
3.4	Resistance @ 20°C	Electrical	Three samples from each coil (Top end,middle end & bottom end)	-	As per Approved Data sheet		A	J	S	W/Y	-	N	
3.5	Wrapping Test	Mechanical	Three samples from each coil (Top end,middle end & bottom end)	-	Wrap-8 turns on the wire itself. The wire shall not break.		A	J	S	W/Y	-	N	
3.6	Surface and cleanliness	Visual	100% on each spool	IEC 62004 & BSPTCL Specn.	Shall be free from imperfection, fins, chips, dirt etc		A	J	S	W/Y	-	N	There shall not be any joint
4.0	**Invar Core Stranding Process**												
4.1	Lay Ratio/ Direction & Compactness	Measurement and Visual	At the beginning of Each set up & Once in a day	IEC 61089 and BSPTCL Spec..	As per Approved Data sheet		A	J	S	W/Y	-	N	
4.2	Pre-forming and post forming of Steel core	Visual	One sample from each length	BSPTCL Spec..	No Spreading of strands when composite core wire is cut		A	J	S	W/Y	-	N	
4.3	**Check for Joints**	Visual	100 % on each drum	BSPTCL Spec..	There shall be NO JOINT		A	J	S	W/Y	-	N	
4.4	surface smoothness	Visual	100 % on each drum	BSPTCL Spec..	The wire shall be free from defects		A	J	S	W/Y	-	N	
5.0	**Final Conductor Stranding Process**												
5.1	Lay Ratio/ Direction & Compactness	Physical	At the beginning of Each set up & Once in a day	IEC 61089 & BSPTCL SPECN.	As per Approved Data sheet		A	J	s	W/Y	-	Y	

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							1	2	3	4	5	6	
5.2	**Check for Joints**	Visual	100 % on each drum	BSPTCL Spec..	There shall be NO JOINT in on the outermost layer. Joints are allowed in inner layers but no two such joints shall be less than 15 meters EMt in completed conductor.		A	J	S	W/Y	-	N	
5.3	**Surface smoothness of Strands and stranded conductor**	Visual	100%	BSPTCL Spec..	The finished conductor shall be smooth, compact, uniform and free from all imperfections including kinks (protrusion of wires), wires cross over, over riding, looseness (wire being dislocated by finger/hand pressure and or unusual bangle noise on tapping)		A	J	S	W/Y	-	N	
5.4	**Surface cleanliness**	Visual	100%	BSPTCL Spec..	Medium grade Kraft/crepe paper/ polythene sheet shall be used in between the layers of conductor. After reeling the conductor, the exposed surface of the outermost layer of conductor shall be wrapped with water proof thick bituminized paper or polythene sheet.		A	J	S	W/Y	-	N	
C.	**Section: FINAL TESTING**												
6.0	**Routine Test on Finished Conductor**												
6.1	All acceptance tests as per clause no. 7.0 to 9.0	-	20 % of the drums	BSPTCL SPECIFICATION	Shall pass all the requirements.	BSPTCL Reports	A	J	S	W/Y	-	N	
6.2	Check for Joints,Surface condition of strands and stranded conductor.	-	100 % on each drum	BSPTCL SPECIFICATION	Shall pass all the requirements.	BSPTCL Reports	A	J	S	W/Y	-	N	

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7.0	**Acceptance Tests of Finished Conductor.**												
7.1	Lay Ratio / Direction & Compactness	Physical	One sample from every 10 Drums or part thereof.	BSPTCL SPECIFICATION	As per Approved Data sheet		A	J	U	Y	-	Y	
8.0	**Acceptance Tests on STAL strands of Finished Conductor.**												
8.1	Diameter of STAL Wire (Round and Trapezoidal shaped wires)	Dimensional	One sample from every 10 Drums or part thereof.	-	As per Approved Data sheet		A	J	U	Y	-	Y	By Weight method in case of Trapezoidal shaped wires.
8.2	Tensile strength	Mechanical	One sample from every 10 Drums or part thereof.	-	As per Approved Data sheet		A	J	U	Y	-	Y	
8.3	Elongation at break	Mechanical	One sample from every 10 Drums or part thereof.	-	As per IEC 62004		A	J	U	Y	-	Y	
8.4	Resistance @ 20°C	Electrical	One sample from every 10 Drums or part thereof.	-	As per Approved Data sheet		A	J	U	Y	-	Y	
8.5	Wrapping Test	Mechanical	One sample from every 10 Drums or part thereof.	-	Wrap-8 turns on the wire itself. The wire shall not break.		A	J	U	Y	-	Y	
8.6	Thermal Resistance Test at 280°C, +5 / -3 Deg C for 1 Hour.	Thermal & mechanical	One sample from every 10 Drums or part thereof.	IEC 62004	Residual strength of the wire shall not be less than 90% of the strength measured before heating.		A	J	U	Y	-	Y	Five wire specimen from each selected drums shall be taken for this test.
8.7	UTS test on welded joints of STAL strands	Mechanical	5 specimen against each lot	BSPTCL Specn.	The minimum breaking load shall be not less than the specified value in Data Sheet	Inspection report	A	J	U	Y	-	Y	

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9.0	**Acceptance Tests on Aluminium Cladded invar wires**												
9.1	Diameter	Dimensional	One sample from every 10 Drums or part thereof.	IEC 61232	As per Approved Data sheet		A	J	U	Y	-	Y	
9.2	Breaking Load	Mechanical	One sample from every 10 Drums or part thereof.	-	As per Approved Data sheet		A	J	U	Y	-	Y	
9.3	Elongation at break	Mechanical	One sample from every 10 Drums or part thereof.	-	As per Approved Data sheet		A	J	U	Y	-	Y	
9.4	Resistance @ 20°C	Electrical	One sample from every 10 Drums or part thereof.	-	As per Approved Data sheet		A	J	U	Y	-	Y	
9.5	Torsion Test	Mechanical	One sample from every 10 Drums or part thereof.	-	Min. 20 twists on guage length of 100 X d		A	J	U	Y	-	Y	
9.6	Aluminium Cladding Thickness	Physical	One sample from every 10 Drums or part thereof.	-	As per Approved Data sheet		A	J	U	Y	-	Y	Direct Measurement through stripping method. The test results shall be verified with TS and supplier test report.
9.7	Wrapping Test	Mechanical	One sample from every 10 Drums or part thereof.	-	Wrap-8 turns on the mandrel diameter of 5 times the wire diameter. The wire shall not break.		A	J	U	Y	-	Y	
10.0	**Length measurement of Finished Conductor**												
10.1	Check for joints, surface finish and length measurement by rewinding	Visual & Measurement	One sample from every 20 Drums or part thereof.	IS 398-P-2 &5 and BSPTCL Spec..	No scale on the surface and the surface shall be free from any imperfections. No joint on the outermost layer.The Conductor length should be as per the Offered packing list & Drums as per approved drawing approved by customer.	Inspn. Report	A	J	U	Y	-	Y	

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11.0	**Wooden Drums and packing materials**												
11.1	Dimensional check of wooden drums	Dimensional	One sample from every 20 Drums or part thereof	IS : 1778 & BSPTCL approved Drum drawing	As per CUSTOMER Specification .	Inspn. Report	A	J	U	Y	-	Y	
11.2	Barrel Batten Test	Mechanical	One sample from every 20 Drums or part thereof	IS 1778	Barrel Baten strength Min. 300 Kgf.	Inspn. Report	A	J	U	Y	-	Y	
11.3	Chemical Test on Packing paper	Chemical	One sample per batch of paper	-	Chloride - 0.05 % max., Sulphate- 0.25 % max., Copper - 0.01 % Max., pH- 5.5 to 7.5	Independent Lab. Report	D	L	V	Z	-	N	
11.4	Visual check of wooden drums	Visual	100% drums	IS : 1778 & BSPTCL approved Drum drawing	The inner cheek of the flanges & drum barrels surface shall be painted with Bitumen based paint. Before reeling, waterproof HDPE sheet shall be secured to the drum barrel and inside of the flanges of drum.	Inspn. Report	A	J	U	Z	-	Y	
12.0	**Packing, Marking and Dispatch**												100% Checking by EM and 10% by BSPTCL.
12.1	Application of water proof paper	Visual	100%	BSPTCL Spec.	BSPTCL Spec.	Joint Inspn. Report	A	J	S/U	Y	-	N	Inspection Point

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MANUFACTURING QUALITY PLAN -- Invar Conductor

Manufacturers Details (Name, Works, Address etc.)	Customer	Vendor's Code	ITEM :	M.Q.P.No. 043	Valid From : 15.01.2016
	BSPTCL		Super Thermal Resistant Aluminium Alloy conductor, Al.Clad Invar Reinforced	Rev. No. 00	Valid upto : Till Revision
				Date : 07.01.2016	Page No. 1 2 O F 1 3

Sr. No.	Components/ Operations & Description of Test	Type of Check	Quantum of Check/ Sampling with basis	Reference document for Testing	Acceptance Norms	Format of Record	Applicable Codes						Remarks
							1	2	3	4	5	6	
12.2	Distance between outermost layer and inner surface of protective laggings	Visual	100%	BSPTCL Spec..	BSPTCL Spec.. (Min - 75mm)	Inspn. Report	A	J	S/U	Y	-	N	Inspection Point
12.3	No. of turns in outer most layer	Visual	100%	BSPTCL Spec..	BSPTCL Spec..	Inspn. Report	A	J	S/U	Y	-	N	Inspection Point
12.4	Contract/ Award Letter no.	Visual	100%	BSPTCL Spec..	BSPTCL Spec..		A	J	S/U	Y	-	N	Inspection Point
12.5	Manufacturer's Name and Address	Visual	100%	BSPTCL Spec..	BSPTCL Spec..		A	J	S/U	Y	-	N	Inspection Point
12.6	Drum No.	Visual	100%	BSPTCL Spec..	BSPTCL Spec..		A	J	S/U	Y	-	N	Inspection Point
12.7	Size and Code Name of Conductor	Visual	100%	BSPTCL Spec..	BSPTCL Spec..		A	J	S/U	Y	-	N	Inspection Point
12.8	Length of Conductor	Visual	100%	BSPTCL Spec..	BSPTCL Spec..		A	J	S/U	Y	-	N	Inspection Point
12.9	Gross weight of drum after Lagging	Visual	100%	BSPTCL Spec..	BSPTCL Spec..		A	J	S/U	Y	-	N	Inspection Point
12.10	Tare weight without lagging	Visual	100%	BSPTCL Spec..	BSPTCL Spec..		A	J	S/U	Y	-	N	Inspection Point
12.11	Net weight of conductor in the Drum without Lagging	Visual	100%	BSPTCL Spec..	BSPTCL Spec..		A	J	S/U	Y	-	N	Inspection Point

BIHAR STATE POWER TRANSMISSION COMPANY LIMITED

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	BSPTCL			**Rev. No. 00**	**Valid upto : Till Revision**
				Date : 07.01.2016	**Page No. 1 3 O F 1 3**

Sr. No.	**Components/ Operations & Description of Test**	**Type of Check**	**Quantum of Check/ Sampling with basis**	**Reference document for Testing**	**Acceptance Norms**	**Format of Record**	**Applicable Codes**						**Remarks**
							1	**2**	**3**	**4**	**5**	**6**	
12.12	Arrow Marking for rolling the conductor drum	Visual	100%	BSPTCL Spec..	BSPTCL Spec..		A	J	S/U	Y	-	N	Inspection Point
12.13	Conductor Sealing	Visual	100%	As per BSPTCL sealing procedure	As per BSPTCL sealing procedure		A	J	S/U	Y	-	N	Inspection Point
12.14	Position of conductor ends	Visual	100%	BSPTCL Spec..	BSPTCL Spec..		A	J	S/U	Y	-	N	Inspection Point
12.15	Tack welding on Nuts on the barrel and Hub Plates.	Visual	100%	BSPTCL Spec..	BSPTCL Spec..		A	J	S/U	Y	-	N	Inspection Point
12.16	Name and address of consignee	Visual	100%	BSPTCL Spec..	BSPTCL Spec..	-	A	J	S/U	Y	-	N	Inspection Point