



BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION PROJECTS ENGINEERING MANAGEMENT

DOCUMENT No.	TB-394-316-147	Rev. No.	01		Prepared	Checked	Approved
TYPE OF DOC.	TECHNICAL SPECIFICATION			NAME	SK	SK	RS/DM
TITLE 3"/4"/4.5" IPS (EH TYPE) ALUMINIUM TUBE				SIGN	-SD-	-SD-	-SD-
				DATE	02.11.17		
				GROUP	TBEM	W.O. No	86009
CUSTOMER	Tamilnadu Transmission Corporation Limited (TANTRANSCO)						
PROJECTS	765/400kV AIS S/S Ariyalur						

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01	14.06.18	SK <i>[Signature]</i>	SK <i>[Signature]</i>	DM/RS <i>[Signature]</i>	Specification revised			
Rev No.	Date	Altered	Checked	Approved	REVISION DETAILS			
				Distribution	TBMM	TBQM	TBCM	TBTS
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CHECKLIST FOR TECHNICAL EVALUATION

Along with the Technical Bids of the offers, the Bidder should submit this checklist confirming the inclusion of the enclosures as listed below. (Shall tick as ✓)

Sr No	Documents to be enclosed	Bidder to check & confirm
1	Copy of Unpriced BOQ as enclosed in the Technical Specification to confirm that bidder has quoted as per BOQ OF SECTION-1	
2.	Schedule of Technical Deviation format duly signed.	
3.	Supporting documents as asked in the Technical requirements (as per cl. No. 1.4 of section -1)	
4.	Checklist of Technical parameters as per Section-5 duly filled and signed.	
5.	Compliance to Technical Specification	

NOTE:- If the Bidder fails to submit any of the documents as asked in the above check list, their bid is likely to be rejected / not evaluated.

The above checklist is verified for:-

NIT Ref No. :

Name of Equipment :

Name of Project :

Name of Bidder :

Signed with Seal of Bidder.

Date

SECTION - 1

1.1 SCOPE-

This technical specification covers the requirements of design, manufacture, testing at works, packing and dispatch of Aluminium Tube to site.

This section covers the scope, quantities & project specific technical requirements as specified by the customer for Aluminium Tube. The Specific Technical Requirements for the above item are given in Section-2. The offered equipment shall also comply with the General Technical Requirements for the project as detailed under section-3 of this specification.

In case of any discrepancies between the requirements mentioned under Section-1, Section-2 and those specified in Section-3, the order of preference shall be Section-1, then Section-2 followed by Section-3 and shall be treated as binding requirement.

No deviation from the requirements specified in various clauses of this specification shall be allowed. A certificate to this effect shall have to be furnished along with the offer.

The equipment is required for the following project:

Customer : Tamilnadu Transmission Corporation Limited (TANTRANSCO)

Project : 765/400kV AIS S/S Ariyalur

The scope of supplies shall be as per commercial terms and conditions enclosed **separately with the enquiry.**

1.2 SPECIFIC TECHNICAL REQUIREMENTS-

Sl. No.	Description	Parameters
1	Grade of AL tube	63401WP(range 2) conforming the IS 5082/1981
2	Tolerance for Outside diameter(OD) & Thickness of tube	No minus tolerance
3	Tolerance for Inside diameter(ID)	No plus tolerance
4	Tensile strength	Not less than 20.5 kgf/Sq. mm

Note - Al tube shall be designed to meet the technical requirement specified in Section-2.

1.3 BILL OF QUANTITIES-

1.3.1 Main and mandatory Quantities

S. No.	Details	Unit	Main Quantity.	Mandatory spares Quantity.	Total Quantities
1.	4.5" Aluminium Tube (IPS – EH)	MT	29.75	1.0	30.75
2.	4.0" Aluminium Tube (IPS – EH)	MT	10.98	1.0	11.98
3.	3.0" Aluminium Tube (IPS – EH)	MT	5.6	0.5	6.11

Section -1

1.3.2 Special type test

S. No.	Details	Unit	Qty.
1.	Special type test-Radio interference and Corona inception /extinction on 4.5" Aluminium Tube (IPS – EH)	Lot	1
2.	Special type test-Radio interference and Corona inception /extinction on 4.0" Aluminium Tube (IPS – EH)	Lot	1
3.	Special type test-Radio interference and Corona inception /extinction on 3.0" Aluminium Tube (IPS – EH)	Lot	1
4.	Special type test -Temperature rise test for rated current on 4.5" Aluminium Tube (IPS – EH)	Lot	1
5.	Special type test -Temperature rise test for rated current on 4.0" Aluminium Tube (IPS – EH)	Lot	1
6.	Special type test -Temperature rise test for rated current on 3.0" Aluminium Tube (IPS – EH)	Lot	1
7.	Special type test -One second short circuit current test on 4.5" Aluminium Tube (IPS – EH)	Lot	1
8.	Special type test -One second short circuit current test on 4.0" Aluminium Tube (IPS – EH)	Lot	1
9.	Special type test -One second short circuit current test on 3.0" Aluminium Tube (IPS – EH)	Lot	1

NOTE:

- 1) Total qty. in weight may vary by $\pm 30\%$ at contract stage. However, individual quantities may vary up to any extent.
- 2) The negative/positive tolerance on the length of the section shall not exceed 10mm.
- 3) Refer Annexure-1 for detailed break-up of Al tube cut length. Al tube shall be manufactured and supplied as per actual cut length requirements only.
- 4) **Aluminium tube sample required for acceptance test during inspection shall be taken from BHEL ordered quantity. Short length due to consumption of Al. tube for acceptance test is acceptable for supply.**
- 5) Quantity variations caused by dimensional changes due to specified tolerance shall be accepted.
- 6) All applicable tests as per IS: 5082 shall be conducted by the bidder.
- 7) Aluminium tube should be suitable for bending at site as per switchyard layout requirements.
- 8) Above mentioned special type test on Al tube shall be conducted in any NABL accredited lab or government lab.
- 9) **All sample of Al tube used for special type testing shall be in the Bidder scope.**
- 10) **Special type test to be conducted after confirmation from customer/BHEL.**
- 11) One second short circuit current test (special test) on Al tube shall be conducted for following parameters .

Section -1

- (a) 4.5" Aluminium Tube (IPS – EH)-Used for 765kV switchyard with short circuit current 50kA for 1 second.
- (b) 4.0" Aluminium Tube (IPS – EH)-Used for 400kV switchyard with short circuit current 63kA for 1 second.
- (c) 3.0" Aluminium Tube (IPS – EH) - used for 132kV switchyard with short circuit current 40kA for 1 second.

12) Radio interference and Corona inception /extinction special type test on Al tube shall be conducted for **following voltage class.**

- (a) 4.5" Aluminium Tube (IPS – EH)-765kV
- (b) 4.0" Aluminium Tube (IPS – EH)-400kV
- (c) 3.0" Aluminium Tube (IPS – EH)-132kV

Radio interference and Corona inception /extinction value are mentioned below for special type test.

S. No.	parameters	765kV	400 kV	132kV
1.	Corona extinction voltage	508kV	320kV	105kV
2.	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz at 508 kV rms for 765kV, 266kV rms for 400kV system and 92kV rms for 132kV	2500 microvolts	1000 microvolts	500 microvolts

1.4 Technical Qualifying requirements -

- (1) The manufacturer should have manufactured and supplied at least **40MT Al tube** upto 4.5" (IPS – EH) size to any of the electricity board/power utilities in India in any one year during the last 5 years from the date of award of contract (i.e.31.03.2017).
- (2) Bidder shall be manufacturer of Aluminium tube.

1.5 INSPECTION & TESTING-

Before being fitted on the equipment, all components shall be subjected to routine tests at the Contractors factory, provided by the relevant IEC/IS standards. A detailed test report proving the successful passing of such tests shall be provided.

Prior to dispatch, the routine & acceptance tests shall be carried out on equipment in accordance with the applicable IEC/IS and the material shall be offered for final inspection by BHEL and TANTRANSOCO in accordance with agreed quality plan with 3 weeks advance information. The charges for these shall be deemed to be included in the equipment price.

1.6 QUALITY PLAN-

The contractor shall carry out contract works in accordance with sound quality management principles which shall include such as controls which are necessary to ensure full compliance to all requirements of the specification & applicable international standards. These quality management requirement shall apply to all activities during design, procurement, manufacturing, inspection, testing, packaging, shipping, inland transportation, storage, site erection & commissioning. Contractor shall submit detailed Quality Plan for BHEL / customer's approval. It will be the bidder's responsibility to get its QP approved from the ultimate customer.

Section -1

3"/4"/4.5" IPS (EH type) Aluminium tube **cut length details** for 765/400kV
Ariyalur S/S

Sl. no.	4.5" Al Cut length details	Unit	Main Quantity.	Mandatory spares Quantity.	Total Quantities
1	4.0 m	Nos.	61	0	61
2	4.5 m	Nos.	0	0	0
3	5.0 m	Nos.	27	7	34
4	5.5 m	Nos.	56	0	56
5	6.0 m	Nos.	58	0	58
6	6.5 m	Nos.	94	0	94
7	7.0 m	Nos.	150	8	158
Total length		m	2696	91	2787
Total Nominal weight		MT	29.75	1.00	30.75

Sl. no.	4.0" Al Cut length details	Unit	Main Quantity.	Mandatory spares Quantity.	Total Quantities
1	4.0 m	Nos.	77	0	77
2	4.5 m	Nos.	2	0	2
3	5.0 m	Nos.	40	5	45
4	5.5 m	Nos.	4	0	4
5	6.0 m	Nos.	4	0	4
6	6.5 m	Nos.	0	0	0
7	7.0 m	Nos.	123	15	138
Total length		m	1424	130	1554
Total Nominal weight		MT	10.98	1.00	11.98

Sl. no.	3.0" Al Cut length details	Unit	Main Quantity.	Mandatory spares Quantity.	Total Quantities
1	4.0 m	Nos.	25	0	25
2	4.5 m	Nos.	0	0	0
3	5.0 m	Nos.	36	5	41
4	5.5 m	Nos.	0	0	0
5	6.0 m	Nos.	35	0	35
6	6.5 m	Nos.	0	0	0
7	7.0 m	Nos.	81	10	91
Total length		m	1057	95	1152
Total Nominal weight		MT	5.6	0.5	6.11

SECTION – 2

EQUIPMENT SPECIFICATION

TECHNICAL SPECIFICATIONS FOR ALUMINIUM TUBE

1.0 TECHNICAL DATA OF ALUMINIUM TUBE

S. No.	PARTICULARS	DATA
1.	Applicable Grade & Standard	Grade 63401 WP (Range 2) as per IS 5082: 1981
2.	Manufacturing Process	a) Hot extrusion process through die and mandrel (Solid billet process). Heat treatment shall be done after hot extrusion of the tube; or b) Bridge extrusion process and then cold drawn. Heat treatment shall be done after hot extrusion of the tube.
3.	Chemical Composition	Copper- 0.05% Max Magnesium- 0.4 to 0.9% Silicon- 0.3 to 0.7% Iron- 0.5% Max Manganese- 0.03 Max. Aluminium - Balance
4.	Min. 0.2% proof Stress	17.34 kg/sq. mm
5.	Min. UTS	20.5 kg/sq. mm
6.	Min. Elongation on 50 mm	10%
7.	Max. Electrical Resistivity at 20°C	0.03135 Ω -mm/ mm ²
8.	Min. Electrical Conductivity at 20°C	55% of IACS
9.	Temp. Coefficient of resistance	0.00364/°C
10.	Temp. Coefficient of Linear Expansion over 20°C to 200°C	0.000023/°C
11.	Thermal Conductivity at 100°C	0.43 Cal/s/mm ² /cm/°C

12.	Nominal Size, IPS (EH type)	3 Inch	4 Inch	4.5 Inch
13.	Outside Diameter	88.90 mm	114.2 mm	120 mm
14.	Tolerance on outer diameter	+2.2, -0.0.mm	+2.2, -0.0.mm	+1.5, -0.0.mm
15.	Thickness	7.62mm	8.51mm	12mm
16.	Tolerance on Thickness	+2.2, -0.0.mm	+2.2, -0.0.mm	+1.0, -0.0.mm
17.	Nominal Cross Section	1951 sq.mm	2825.61 sq.mm	4071.50 sq.mm
18.	Nominal Weight	5.3 kg/m	7.71 kg/m	11.034 kg/m
19.	Modulus of elasticity	6700 kg/ sq. mm		
20.	Packing	Hessian covering		
21.	Required Length	As per BOQ in Section-1.		

No deviation on above-indicated parameters shall be accepted.

Note -

- a) All tubes shall be supplied straightened & reasonably free from twist.
- b) The surface of the Aluminium tubes shall have a bright smooth finish, free from seams, cracks & other imperfections. Special attention shall be given to avoid formation of corona. The finished tubes shall be perfectly straight.
- c) The ingot to be used for producing the Aluminium tubular busbars of grade 63401 W.P (Range 2), shall comply with the requirements specified in Table1 (Clause 6.1) of IS:5082 when analysed in accordance with IS:504 or any other standard instrumental method of analysis.
- d) Aluminium Tube should be suitable for bending at site as per switchyard layout requirement.

2.0 TESTS:

In addition to routine tests/acceptance test on the aluminium tubes as per IS 5082, Test Reports for following tests shall also be submitted:

- i) Chemical composition
- ii) Dimensions
 - a. Outer diameter
 - b. Ovality
 - c. Straightness
 - d. Length
 - e. Wall thickness
- iii) Mechanical properties
 - a. Ultimate Tensile Strength
 - b. 0.2% proof tests both on the parent metal and aluminium tube as per standards, as appropriate.
 - c. Percentage Elongation on 50.0 mm specification
- iv) Electrical properties
- v) Surface finish & verification of cut lengths

SECTION – 3

GENERAL TECHNICAL REQUIREMENTS

3.0 FOREWORD

The provisions under this section are intended to supplement general requirements for the materials, equipment's and services covered under other sections.

3.1 PROJECT INFORMATION AND SYSTEM PARAMETERS

a) Customer : M/s Tamil Nadu Transmission Corporation Limited

b) Project Title : 765/400KV AIS SUB STATION AT ARIYALUR

c) Transport facilities : Road/Rail

Physical and other parameters:

3.1.1 Location of the substation

3.1.2 Nearest Railway station : Tindivanam
Railway : Southern Railway

3.1.3 Meteorological data

- | | |
|---|---------------------|
| (i) Atmosphere | : Polluted |
| (ii) Maximum ambient temperature | : 50°C |
| (iii) Minimum ambient temperature | : 20°C |
| (iv) Maximum daily average ambient air temperature | : 45° C |
| (v) Maximum yearly average ambient air temperature | : 32° C |
| (vi) Maximum Humidity (%) | : 100% |
| (vii) Average thunder storm days per annum | : 50 |
| (viii) Average rainy days per annum | : 65 |
| (ix) Average annual rainfall (mm) | : 750 mm |
| (x) No. of months during which tropical monsoon condition prevail | : 3 |
| (xi) Maximum wind pressure | : 150 Kg/Sqmm |
| (xii) Altitude above MSL | : <1000M |
| (xii) Basic Wind Speed | : 39 m/s (Zone -2) |

However for design purpose, ambient temperature should be considered as 50° C and relative humidity as 100%.

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3.1.4 System Parameter

SL No	Description of parameters	765kV System	400 kV System
1.	System operating Voltage	765kV	400kV
2.	Maximum operating voltage of the system(rms)	800kV	420kV
3.	Rated Frequency	50HZ	50HZ
4.	Number of Phases	3	3
5.	Rated Insulation Levels (i)Full wave impulse withstand voltage.(1.2 to 50 micro sec) (ii)Switching impulse withstand voltage(250/2500 micro sec) dry and wet. (iii) One minute power frequency dry withstand voltage (rms)frequency dry withstand voltage (rms)	2100kVp 1550kVp 830kV	1550kVp 1050kVp 630kV
6.	Corona extinction voltage	508kV	320kV
7.	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz at 508 kV rms for 765kV, and 266kV rms for 400kV system	2500 microvolts	1000 microvolts
8.	Minimum creepage distance (25mm/kV)	20000 mm	10500 mm
9.	Rated short circuit current for 1 sec. Duration	50kA	63kA
10.	System neutral earthing	Effectively earthed	Effectively earthed
11.	Seismic acceleration	0.3g horizontal	0.3g horizontal
12.	Plinth level of switchyard	300mm above FGL	300mm above FGL

For 132kV system – Maximum radio interference voltage for frequency between 0.5 MHz and 2 MHz is 500 micro volt at 92kV rms. Corona extinction voltage is 105kV

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3.2 STANDARD:

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.

The equipment to be furnished under this specification shall conform to latest issue with all amendments (as on the date of bid opening) of standards specified in each section.

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

The Bidder 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. 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.

3.3 TYPE TEST:

The Type Test for all the equipment's/materials used for this project should have been conducted in any approved Government/Govt. recognized laboratories conforming to latest IS/IEC. The above type test certificates should accompany the drawings of the materials equipment's, duly signed under seal by the Institution, who have issued the type test certificate. The above type test should have been conducted not earlier than Ten years, subject to no change in design as on the originally scheduled date of technical bid opening i.e. **30.09.2016**

In case the type tests were conducted earlier than 10 (ten) years prior to the originally scheduled date of bid opening, the contractor shall repeat these test (s) at no extra cost to the purchaser.

3.4 INSPECTION:

The inspection may be carried out by the TANTRANSCO/BHEL at any stage of manufacture. The supplier shall grant free access to TANTRANSCO's/BHEL representative at a reasonable time when the work is in progress. The TANTRANSCO/BHEL shall have access at all times to the works and all other places of manufacture/fabrication, where the equipments are being manufactured/fabricated and the bidder shall provide TANTRANSCO's/BHEL representative all facilities for unrestricted inspection of the works, raw materials, manufacture of all the accessories and for conducting necessary tests.

Inspection and acceptance of any equipment under this specification by the TANTRANSCO/BHEL shall not relieve the supplier of his obligation of furnishing equipment in accordance with the specification and shall not prevent subsequent rejection if the equipment is found to be defective. The supplier shall keep the TANTRANSCO/BHEL informed in advance, about the manufacturing programme so that arrangement can be made for inspection.

The TANTRANSCO/BHEL, reserves the right to insist for witnessing the acceptance/routine testing of the bought out items. No material shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested.

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The correct grade and quality of steel shall be used by the supplier. To ascertain quality of steel, the TANTRANSCO/BHEL may at his discretion get the material tested at an approved laboratory.

The bidder shall take an account the fabrication wastage while quoting the rates. The Employer will not accept any liability in connection with the wastage of steel during fabrication or otherwise. Steel shall be procured exclusively from the main producers. However, sections not rolled by main producers can be procured from reroller, provided rerolling of structural steel section is done from billets/ingots of tested quality. Rerolled sections are duly tested as per relevant standards. Supplier should obtain approval of list of primary producers of Steel and Zinc before Proto assembly.

The BHEL/TANTRANSCO or his representative shall have the right to inspect and/or test the goods /works to confirm their conformity to the supplier. BHEL/TANTRANSCO shall notify the supplier in writing of the identity of any representatives authorized for these purposes.

The inspections and tests may be conducted on the premises of the supplier or his Sub vendor at the point of delivery and /or at the goods' final destination. Where tests are conducted in the premises of Supplier, all reasonable facility and assistance including access to drawings and production data shall be furnished at no charge to the BHEL.

Should any inspected or tested goods fail to conform to specifications, the BHEL/TANTRANSCO may reject them and the supplier shall either replace the rejected goods or make all alterations necessary to meet specification requirements free of cost to the BHEL/TANTRANSCO within one week of intimation.

The BHEL/TANTRANSCO's right to inspect, test and where necessary reject the goods after the goods; arrival at the site, shall in no way be limited or waived by reason of the goods having been previously inspected. Tested and passed by the BHEL/TANTRANSCO or his representative prior to the goods dispatch.

Not less than 15 (Fifteen) days advance intimation shall be given about the quantity of materials that will be ready for inspection by the officers of TANTRANSCO/ BHEL/Third agency authorized by the Corporation. The materials should not be dispatched without instruction from the Corporation.

3.5 QUALITY ASSURANCE PLAN :

The bidder shall invariably furnish following information along with his offer. (i) Statement giving list of important raw materials including but not limited to:

- (a) Contact material
- (b) Insulation
- (c) Porcelain
- (d) Sealing material
- (e) Contactor, limit switches, etc. in control cabinet.

Name of sub-supplier for the raw materials, list of standards according to which the raw materials are tested, list of test normally carried out on raw materials in presence of bidder's representative, copies of test certificates.

- (ii) Information and copies of test certificates as in

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- (i) above in respect of bought out accessories.
- (iii) List of areas in manufacturing process, where such inspections are normally carried out for quality control and details of such tests and inspections.
- (iv) Special features provided in the equipment to make it maintenance free.
- (v) List of testing equipment available with the Bidder for final testing of breakers vis-à-vis, the type, special, acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in the relevant schedule i.e. schedule of deviations from specified test requirements.

The supplier shall submit following information to the TANTRANSCO.

- 1) List of raw materials as well bought out accessories and the names of sub-suppliers selected from those furnished along with offer.
- 2) Type test certificates of the raw material and bought out accessories.
- 3) Quality assurance plan (QAP) withhold points for TANTRANSCO inspection. The quality assurance plan and hold point shall be discussed between the employer and supplier before the QAP is finalized.

The supplier shall submit the routine test certificates of bought out items and raw material, at the time of routine testing of the fully assembled breaker.

3.6 APPROVAL PROCEDURE

The scheduled dates for the submission of drawings as well as for, any data/information to be furnished by the Employer would be as per the following schedule. The supplier shall also submit required no. of copies as mentioned in this specification of all drawings/design documents/test reports for approval by the BHEL/TANTRANSCO. The following schedule shall be followed generally for approval.

i.	First Submission	7 days after LOI/PO
ii.	Approval/comments/by employer on Initial submission	Reasonable time
iii.	Resubmission	Within 7 days (whenever from date of comments required) Including both ways postal time.
iv.	Approval or comments	Within 2 weeks of receipt of resubmission.
v.	Furnishing of distribution copies	2 weeks from the date of last approval.

Note: The supplier may please note that all resubmissions must incorporate, all comments given in the submission by the BHEL/TANTRANSCO failing which the submission of documents is likely to be returned. Every revision shall be a revision number, date and subject, in a revision block provided in the drawing, clearly marking the changes incorporated.

The title block of drawings shall contain the following information incorporated in all contract drawings. Please refer below mention Title block for Submission of Documents.

TAMIL NADU TRANSMISSION CORPORATION LIMITED
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Title Block

Customer	M/s Tamil Nadu Transmission Corporation Limited
Project:	765/400KV Air Insulated substation Ariyalur
Contractor	BHEL

3.7 DOCUMENTS TO BE SUBMITTED ALONGWITH OFFER

Drawings, GTP ,Type Test Reports and List of Past Supplies. Drawings & Documents submitted at the time of offer shall be subject to review at contract stage.

3.8 DOCUMENTATION SCHEDULE

Following Documentation schedule to be followed per project.

S. No.	DESCRIPTION	TENDER STAGE	CONTRACT STAGE FOR APPROVAL	FINAL DOCUMENTATION	
			Prints	Prints	CDs
1	Drawings and Data Sheets	1	7	10	5
2	Drawings "As Built "	-	-	10	
3	Type Test Reports	1	7	10	
4	Erection Manuals	-	7	10	
5	Operation and Maintenance Manuals	-	7	10	
6	Manufacturing Quality Plan	-	7	10	
7	Field Quality Plan	-	7	10	
8	Inspection Test Reports	-	7	10	

Note: Drawings will also be submitted in CD/DVD in Latest AUTOCAD-2004 or Later version or any other CAD package along with conversion files for all major items. Final Documentation shall be submitted in bound volumes with details of Customer & Project etc. written on top.

SECTION – 4

GUARANTEED TECHNICAL PARTICULARS OF STRANDED ALUMINIUM TUBE

S. No.	PARTICULARS	DATA
1)	Applicable Grade & Standard	
2)	Manufacturing Process	
3)	Chemical Composition	
4)	Min. 0.2% proof Stress	
5)	Min. UTS	
6)	Min. Elongation on 50 mm	
7)	Max. Electrical Resistivity at 20°C	
8)	Min. Electrical Conductivity	
9)	Temp. Coefficient of resistance	
10)	Temp. Coefficient of Linear Expansion over 20°C to 200°C	
11)	Thermal Conductivity at 100°C	
12)	Modulus of Elasticity	
13)	Nominal Size, IPS (EH type)	
14)	Minimum Outside Diameter in mm (no negative tolerance permitted)	
15)	Minimum Thickness in mm (no negative tolerance permitted)	
16)	Nominal Cross Section Area, in Sqmm	
17)	Nominal Weight, kg/m	
18)	Current rating (minimum) at 50°C	
19)	Packing	
20)	Required Length	

NOTE – *Separate GTP shall be submitted for each type of tube – It is not required at tender stage*

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SECTION - 5

CHECK LIST FOR Al tube

Put a tick mark (✓) in 'YES/NO' Column if the specified requirement is met, or put a (X) mark, if the specified requirement is not met and give comments in the "Remarks" column.

S. No.	Parameters	Specified Requirement			Yes/No	Remarks
1.	Size of Al tube	3" IPS (EH type)	4" IPS (EH type)	4.5" IPS (EH type)		
2.	Applicable Grade & Standard	Grade 63401 WP (Range 2) as per IS 5082: 1981				
3.	Outside Diameter	88.90 mm	114.2 mm	120 mm		
4.	Tolerance on outer diameter	+2.2, -0.0.mm	+2.2, -0.0.mm	+1.5, -0.0.mm		
5.	Thickness	7.62mm	8.51mm	12mm		
6.	Tolerance on Thickness	+2.2, -0.0.mm	+2.2, -0.0.mm	+1.0, -0.0.mm		
7.	Nominal Cross Section	1951 sq.mm	2825.61 sq.mm	4071.50 sq.mm		
8.	Nominal Weight	5.3 kg/m	7.71 kg/m	11.034 kg/m		
9.	Modulus of elasticity	6700 kg/ sq. mm				
10.	Chemical Composition	Copper- 0.05% Max Magnesium- 0.4 to 0.9% Silicon- 0.3 to 0.7% Iron- 0.5% Max Manganese- 0.03 Max. Aluminium - Balance				
11.	Packing	Hessian covering				
12.	Min. 0.2% proof Stress	17.34 kg/sq. mm				
13.	Min. UTS	20.5 kg/sq. mm				

14.	Max. Electrical Resistivity at 20°C	0.03135 Ω -mm/ mm ²		
15.	Min. Electrical Conductivity at 20°C	55% of IACS		
16.	Temp. Coefficient of resistance	0.00364/°C		
17.	Temp. Coefficient of Linear Expansion over 20°C to 200°C	0.000023/°C		
18.	Thermal Conductivity at 100°C	0.43 Cal/s/mm ² /cm/°C		
19.	Min. Elongation on 50 mm	10%		
20.	Test	As per Clause 2 of Section-2		