PFC CONSULTING LIMITED

On Behalf of

KERALA STATE ELECTRICITY BOARD LIMITED

As Bid Process Coordinator

(Invites bid through e-Tendering mode only)

FOR

TURNKEY CONTRACT PACKAGE OF

Constructing / Upgrading of 220/110kV line using MCMV / Double Circuit / Narrow base MCMV Towers of

I. Kottayam Line Package
II. North – South Interlink Package (Phase – I)
III. Thrissivaperur Lines Package (Phase-I)

VOLUME II

E- Tender No.- PFCCL/18-19/ET/1

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VOLUME II

(Special Instructions and Technical Specifications)

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GENERAL INFORMATION AND SCOPE OF THE WORK

1. PACKAGE SUMMARY

Constructing / Up-grading of 220/110 kV transmission lines using MCMV / Double Circuit / Narrow base towers, dismantling of existing conductor and towers, wherever required, supplying Towers / ACSR / ACCC conductor / OPGW with all accessories, polymeric suspension / tension insulator of approved type and capacity, stringing, supply of spares as per the specifications and other allied works as per the tower schedule and design provided by KSEBL and technical support and training for KSEBL staff and officers for O&M of the line, up to the full satisfaction of KSEBL on Turnkey Contract Basis. Work also includes design, proto-fabrication & type-testing of 400 & 220KV Multi-circuit / Double Circuit towers as per the details in the specifications.

2. SCOPE OF THE WORK

2.1 The following works are included in the scope of the Contract on Turnkey Basis: -

Package 1	**KOTTAYAM LINE PACKAGE (KLP)** Construction / Up gradation of 220/110kV line using narrow base MCMV Towers	
	Project A –	Construction of 23.8 km 220/110kV MCMV and 4.8km of 110 kV DC line from Kottayam to Thuravoor Project A comprises of 3 parts: • PART A1: Construction of 19.4km 220/110kV MCMV lines from Kottayam to Thuravoor (in Kottayam district) • PART A2: Construction of 4.4km 220/110kV MCMV lines from Kottayam to Thuravoor (in Alappuzha district) • PART A3: Construction of 4.8 km 110kV DC portion through Kuravilangad Town
	Project B –	Construction of 6.5 km 220kV (5.4km 220/110kV MCMV and 1.1km 220kV DC) line from 400 kV Kottayam substation to Ettumanoor SS
	Project C –	Construction of 3.8 km 220kV Multi Circuit LILO from 220 kV Pallom – Ambalamugal feeder to Kottayam 400 kV SS
	Project D –	Construction of 400 kV Multi Circuit/ Double Circuit Tower at Kottayam 400KV Substation (including tap line of approx. 100m)
Package 2	**NORTH – SOUTH INTERLINK PACKAGE (Phase – I)** Construction / Up gradation of 220/110kV line using narrow base MCMV Towers	
	Project A –	Construction of 11.726 km of 220/ 110kV MCMV line from Chalakudy to Konnakuzhy (Thrissur District) using 220/110kV MCMV Narrow/Broad based Towers.

	Project B – Construction of 15.85 km of 220/ 110kV MCMV line from Irinjalakuda to Kodungallur (Thrissur District)
Package 3	**THRISSIVAPERUR LINES PACKAGE Phase-I** PROJECT A: Construction of 23km of 220/ 110kV MCMV line from Wadakkanchery to Kunnamkulam (Thrissur District)

2.2 The general scope of work will include the following:

a) Detailed survey, Check survey and tower location marking, soil resistivity measurement & geotechnical investigation, wherever necessary, .

b) Fabrication and supply of all types of 400/220/110kV transmission line towers / special poles (if required) fully hot dip galvanized, with all types of tower accessories like phase plate, circuit plate, number plate, danger plate, anti-climbing device, Bird guard, earth pipe and counterpoise type earthing as per KSEBL's design / drawings including fasteners, anti-theft fasteners, step bolt, hangers, D-shackles etc.

c) Supply of Polymeric Insulators, Hardware Fittings, ACSR Conductor, OPGW and Accessories,

d) De-stringing & dismantling of towers, earthwire / OPGW, Insulators, Hard-ware & Accessories including dismantling of tower accessories like phase, danger and number plates, bird guards, anti-climbing devices etc.

e) Clearing grass & felling of trees, as required.

f) Design, Proto Fabrication, Assembly and Type Testing (non-destructive type) of new 400KV Multicircuit / Double Circuit towers, if required.

g) Proto Fabrication, Assembly and Type Testing (non-destructive type) of a 220KV Multicircuit Multivoltage towers, if required.

h) Installation of Emergency Restoration System (ERS) Work in existing 220 KV Double circuit Line Route (ERS Equipment will be supplied by KSEB).

i) Soil test, wherever found neccessary for asertaining type of foundation in-cluding taking pits/bore holes, collecting soil samples and testing at ap-proved laboratories as per relevant IS codes

j) Verification of the foundation schedule and casting of foundation for tower footings as per KSEBL foundations drawing.

k) Erection of towers, punching of bolts and nuts, tower earthing including counter poise earthing if required and measurement of earth resistance (should be less than 10 ohm), fixing of insulator strings, stringing of conductors and OPGW along with all necessary line accessories.

l) Painting of towers in bands of orange and white (above 45-meter height) and

supply & erection of marker balls, obstruction lights (wherever applicable) for aviation requirements (as required) as per IS 5613.

m) Erection of name boards, phase indicator, number plates, danger boards etc. as per standards on all towers.

n) Erection, Testing and commissioning of Junction Box and FODP for both ends of substations.

o) Testing & commissioning of the erected transmission lines, training to KSEBL staff and other items not specifically mentioned in this Specification but are required for the successful commissioning of the transmission line, unless specifically excluded in the Specification.

p) Supply of necessary spares as per the details mentioned in Price Schedule-2 – List of Material and Spares.

The contractor shall supply the spares mentioned, only after commissioning of the project and before submission of final bill of the project. The payment for the spares will be paid up on satisfactory completion of supply of complete spares as per the list.

2.3 Scope for Supply of Towers

a) KSEBL shall provide structural drawings, shop drawings & Bill of Materials of all type of transmission line towers and its extensions except for tower to be designed and proto tested under this specification, to the Contractor after placement of award, in sequence, suiting the project requirement. Similarly the drawings for all type of foundations for the towers shall also be provided by KSEBL to the Contractor.

b) The supply of required quantities of fabricated & galvanized steel parts as per specifications required for towers strictly.

c) Preparation of fabrication drawings for various types of towers required for project, including MCMV & narrow base special multi-circuit towers as per the design provided by KSEBL and proto fabrication.

d) Supply of the required quantities of fabricated & galvanized steel parts as per specifications required for towers, concrete, reinforcement steel for foundation and other items as given in appropriate price schedule. However, the work shall be executed as per approved construction drawings.

e) The various items of work are described very briefly in the appropriate price schedule. The various items of the price schedule shall be read in conjunction with the corresponding sections in the Technical Specifications including amendments and, additions, if any. The Bidder’s quoted rates shall be based on the description of activities in the price schedule as well as other necessary operations required to complete the works detailed in these Technical Specifications.

f) The Unit rates quoted shall include minor details which are obviously and fairly intended, and which may not have been included in these documents but are essential for the satisfactory completion of the various works.

g) The unit rate quoted shall be inclusive of all plant equipment, men, material skilled and unskilled labour etc. essential for satisfactory completion of various works.

h) All measurements for payment shall be in S.I. units, lengths shall be measured in meters corrected to two decimal places. Areas shall be computed in square meters & volume in cubic meters rounded off to two decimals.

2.4 The Bidder shall submit their offer taking into consideration that the tower and foundation **designs/drawings shall be developed/ provided by KSEBL and design rights will be strictly reserved with KSEBL**. Bidder shall quote the unit rates for various items of towers and foundations as per units mentioned in appropriate price schedule. **However, the mile stone payments to the contractor will be made as per the payment schedule mentioned in clause 41, section 5 of volume I of this tender document. Please note that supply of materials alone will not be paid, except for the spares to be supplied towards the end of the project.**

The payment to be made for towers/foundations shall be worked out based on the unit rates and approved Bill of Materials (BOM) for towers and quantities/volumes of concrete as per approved tower foundation drawings.

2.5 This specification also includes the supply of insulators & hardware fittings and all type of accessories for conductor and OPGW as detailed in the specification. Contractor shall clearly indicate in their offer, the sources from where they propose to procure these materials. The technical descriptions of these items are given in Technical specifications.

2.6 All the raw materials such as steel, zinc for galvanising, reinforcement steel, cement, coarse and fine aggregates for tower foundation, coke and salt for tower earthing etc. are included in the Contractor's scope of supply.

2.7 Bidder shall also indicate in the offer, the sources from where they propose to procure the fasteners, step bolts, hangers, D-shackles, tower accessories, Aerial marker balls, aviation signal etc.

2.8 Stringing

a) The entire stringing work of conductor and earth wire shall be carried out by tension stringing technique. However, the Bidder having requisite experience has freedom to use helicopter for stringing. The Bidder intending to use helicopter shall furnish detailed description of the procedure, type & number of helicopter & accessories etc., to be deployed for stringing operation. Necessary clearance/ permissions shall be obtained by the contractor while using helicopter for stringing.

b) In hilly terrain and thick forest or area with site constraints where deployment of tension stringing machine is not possible, manual stringing may be adopted

after getting approval of supervising Engineer. The contractor shall deploy appropriate tools/ equipments/ machinery to ensure that the stringing operation is carried out without causing damage to conductor/OPGW and conductor/ OPGW is installed at the prescribed sag-tension as per the approved stringing charts.

2.9 In case of special type pile or well foundations, some suitable execution agency may be engaged by the contractor for casting of foundations, with the permission of KSEBL. However, the Bidder shall be responsible for all the necessary co-ordination with the special foundation Contractor including stub-setting/fixing of base plate with anchor bolt.

2.10 Details of Transmission Line Routes and Terrain

Bidders may visit the line route to acquaint themselves with terrain conditions and associated details of the proposed transmission lines.

2.11 Location Details and Terminal Points

The proposed Transmission lines shall emanate from existing Sub stations and end at respective Sub stations/ Terminal towers. The Contractor shall have to construct both 220/110kV and 220/220kV Transmission lines completely up to dead end towers/ termination gantry on either end. Stringing works shall also be carried out from dead end tower to terminal arrangements/terminal points in all projects. Detailed Block diagram representation is depicted as Annexure A in part E of this volume.

2.12 Access to the Line and Right of Way

KSEBL is utilizing the existing RoW as far as possible. Right of way and way leave clearance shall be arranged by the KSEBL in accordance with work schedule. KSEBL will secure way leave and Right of way in the Forest area. Access to the Line and the locations described in section 3, part A of this volume, and the directions may be strictly followed.

3 TRANSMISSION TOWERS AND LINE DATA

3.1 Tower Data

a) The towers for the above transmission lines are classified as given below:

Type of Tower	Deviation Limit	Typical Use
KLA/ MA/ D3	0 – 2 deg.	1. To be used as tangent tower.
KLB/ MB	0 - 15 deg.	1. Angle towers with tension Insulator string.
		2. Also to be used for uplift force resulting from an uplift span up to 1000m under broken wire conditions.
		3. Also to be used for Anti Cascading Condition (for usage as

Type of Tower	Deviation Limit	Typical Use
		a section tower)
KLC/ MC/ D30	15 - 30 deg.	1. Angle towers with tension Insulator string.
		2. Also to be used for uplift force resulting from an uplift span up to 1000m under broken wire conditions.
		3. Also to be used for Anti Cascading Condition (for usage as a section tower)
KLD/ MD/ D60	30 - 60 deg.	1. Angle tower with tension insulator string.
		2. Also to be used for uplift forces resulting from an uplift span up to 1000m under broken wire condition

Note 1: KLA/KLB/KLC/KLD is for 220/110 kV MCMV Towers, MA/MB/MC/MD is for 220 kV Multi Circuit Towers and D3/D30/D60 is for 110kV Double circuit towers.

Note 2: The above towers can also be used for longer span with smaller angle of deviations without infringement of ground clearance. Similarly, D-type towers with lesser angles can be used as dead-end towers.

b) Extensions

The Multi Circuit Multi-voltage towers shall be designed so as to be suitable for adding +3m, +6m & +9m body extensions for maintaining adequate ground clearances without reducing the factor of safety (actual stress /allowable stress) available for the members of tested extensions in any manner.

c) Span and clearances

The minimum span and clearances are given in the design and will be provided with detailed tower schedule and should be strictly followed.

d) Electrical Clearances

The minimum electrical clearance between the lowest power conductors of crossing line over the crossed line should be as per the regulation 69 of CEA regulations on Safety and Electricity Supply 2010.

e) Ground Clearance

The minimum ground clearance should be followed as per regulation 58 (4) of CEA regulations on Safety and Electricity Supply – 2010. An allowance of 150mm shall be provided to account for errors in stringing.

4 Electrical System Data for 220/110 kV lines

Sl. No.	Description	Unit	For 220 kV	For 110 kV

Sl. No.	Description	Unit	For 220 kV	For 110 kV
1	System	kV	A.C.	A.C.
2	Nominal Voltage	kV	220	110
3	Maximum system voltage	kV	245	125
4	BIL (Impulse)/ Lightning Impulse Level	kV (Peak)	1050	650
5	Power frequency withstand voltage (Wet)	kV (rms)	460	275
6	Switching surge withstand voltage (Wet)	kV (rms)	NA	NA
7	Minimum Corona extinction voltage at 50 Hz AC system under dry condition	kV (rms) phase to earth	154 (min)	105 (min)
8	Radio interference voltage at one MHz for phase to earth voltage of 305 KV under dry condition.	Micro Volts	1000 (max)	500 (max)
9	Short circuit level	kA	40	31.5
10	Frequency i) Normal ii) Maximum iii) Minimum	Hz	50 51.5 47	

4.1 Details of line Materials:

a) Conductors

Sl. No.	Description	Unit	Conductor types					
	Type of Conductor		ACSR Moose	ACSR Zebra	ACSR Wolf	Double ACSR Panther	Single ACSR Panther	ACSR Kundah
1	Construction/ Size		54/3.53mm AL + 7/3.53mm steel	54/3.18mm AL + 7/3.18mm steel	30/2.59mm Al + 7/2.59 mm steel	30/3mm Al + 7/3 mm steel	30/3mm Al + 7/3 mm steel	42/3.5mm Al + 7/1.96 mm steel
2	Number of Conductor per Phase	Nos.	4	1	1	2	1	1
3	Nominal Overall Diameter	mm	31.77	28.62	18.13	21	21	26.88
4	Cross Section Area Total	mm^2	597.0	484.5	194.9	261.5	261.5	425.2
5	Nominal Weight	Kg/Km	2004	1621	727	974	974	1282
6	Modulus of Elasticity	Kg/mm^2	7036	7036		8158	8158	
7	Co-efficient of Linear Expansion	$/ {}^0C$	$19.35*10^{-6}$	$19.3*10^{-6}$		$17.8*10^{-6}$	$17.8*10^{-6}$	
8	Ultimate Tensile Strength	KN	159.6	130.32	67.34	89.67	89.67	88.79

Sl. No.	Description	Unit	Conductor types					
	Type of Conductor		ACSR Moose	ACSR Zebra	ACSR Wolf	Double ACSR Panther	Single ACSR Panther	ACSR Kundah
9	DC resistance at 20°C	Ω/km	0.05595	0.06868	0.1871	0.139	0.14	0.7311
10	Current Carrying Capacity at max operating temp.	Amp						
11	Maximum Operating Temperature	^{0}C	85	85	85	85	85	85

b) OPGW

Sl No	Description	Unit	Values Required
1	Name of Conductor		Optical Ground Wire (OPGW)
2	Identification		48 SMF

c) Insulator Strings

SL. No.	Particulars	Unit	400kV	220kV		110 kV	
			Tension	Suspension	Tension	Suspension	Tension
1	Type of String		T-String	V-String	I-String	I-String	I-String
2	No of individual Unit	No.	2	2	1	1	1
3	Core Diameter	mm	20	16	20	16	20
4	Size and designation of ball & socket	mm	20	16	20	16	20
5	Minimum Creepage Distance	mm	13,020	7595	7595	4495	4495
6	Nominal Length of Composite Insulator	mm	3150	2030	2175	1305	1450
7	Electro-Mechanical Strength of Insulator Unit	KN	160	90	120	70	90
8	Power frequency one-minute dry withstand voltage	kV (rms)		510	510	325	325
9	Power frequency one-minute wet withstand voltage	kV (rms)	650	460	460	275	275
10	Visible discharge Test voltage	kV (rms)		154	154	NA	NA
11	Minimum dry impulse withstand voltage 1.2x50 micro second wave, positive and negative	kV (peak)	1425	1050	1050	650	650

4.2 Climatic & Service Conditions

The materials offered shall be suitable for operation in tropical climate & shall be subject to the sun & inclement weather and shall be able to withstand wide range of temperature variations. The topography & climatic conditions in general are as under: -

Locations	**Kottayam, Alappuzha & Thrissur Districts under Kerala State**
Voltage levels	220/110 kV
Frequency	50HZ
Maximum ambient temperature	50º C
Minimum ambient temperature	10º C
Every day temperature (average)	32º C
Solar Absorption coefficient	0.5
Solar Radiation	220.83Watt/sqm
Emissivity Constant	0.5
Limits of ambient temperature over period of 24 hours	15º peak
Wind zone (as per IS: 875)	2
Maximum wind velocity (m/sec.)	39 m/sec. (as per IS: 875)
Maximum wind pressure	584 N/sq. meter
Minimum factor of safety	2.5
Terrain Category	2
Reliability level	2
Maximum relative humidity	85%
Average rainfall per year	3107mm. Approx.
Average number of thunder storm days/annum	50
Average number dust storms days/annum	5
Isokeraunic level	100/year
Average number of rainy days per year	90 days
Altitude not exceeding (above MSL)	2000m
Ice load on conductor	N32
Seismic zone	Zone 2
Number of months of tropical monsoon per year	5

Note: Climate varies from moderately hot and humid tropical climate to cold climate.

SECTION-2
GENERAL TECHNICAL CONDITIONS

1.0 GENERAL TECHNICAL CONDITIONS

1.1 General

The following provisions shall supplement all the detailed technical specifications and requirements brought out herein. The contractor's proposal shall be based on the use of materials complying fully with the requirements specified herein.

1.2 Engineering Data

1.2.1 The furnishing of engineering data by the Contractor shall be in accordance with the Schedule as specified in the Bidding Document. The review of these data by the KSEBL will cover only general conformance of the data to the specifications and not a thorough review of all dimensions, quantities and details of the materials, or items indicated, or the accuracy of the information submitted. This review by the KSEBL shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications.

1.2.2 All engineering data submitted by the Contractor after review by the KSEBL shall form part of the contract document.

1.3 Drawings

In addition to those stipulated in clause regarding drawings in GCC/SCC, the following also shall apply in respect of Contractor Drawings.

1.3.1 All drawings submitted by the Contractor including those submitted at the time of Bid shall be with sufficient details to indicate the type, size, arrangement, dimensions, material description, Bill of Materials, weight of each component break-up for packing and shipment, fixing arrangement required, the dimensions required for installation and any other information specifically requested in these specifications.

1.3.2 Each drawing submitted by the Contractor shall be clearly marked with the name of the KSEBL, the specification title, the specification number and the name of the Project. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be to the scale and in S.I. units.

1.3.3 The drawings submitted by the Contractor shall be reviewed by the KSEBL as far as practicable, within 15 days and shall be modified by the Contractor, if any modifications and/or corrections are required by the KSEBL. The Contractor shall incorporate such modifications and/or corrections and submit the final drawings for approval. Any delay arising out of failure by the Contractor to rectify the drawings in time shall not alter the contract completion date.

1.3.4 The drawings submitted for approval to the KSEBL shall be in quadruplicate. One print of such drawings shall be returned to the Contractor by the KSEBL marked "approved/approved with corrections". The contractor shall there upon furnish

the KSEBL additional prints as may be required along with one reproducible in original of the drawings after incorporating all corrections.

1.3.5 The work shall be performed by the Contractor strictly in accordance with these drawings and no deviation shall be permitted without the written approval of the KSEBL, if so required.

1.3.6 All manufacturing, fabrication and erection work under the scope of Contractor, prior to the approval of the drawings shall be at the Contractor's risk. The contractor may incorporate any changes in the design, which are necessary to conform to the provisions and intent of the contract and such changes will again be subject to approval by the KSEBL.

1.3.7 The approval of the documents and drawings by the KSEBL shall mean that the KSEBL is satisfied that:

(a) The Contractor has completed the part of the Works covered by the subject document (i.e. confirmation of progress of work).

(b) The Works appear to comply with requirements of Specifications.

In no case the approval by the KSEBL of any document does imply compliance with all technical requirements or the absence of errors in such documents.

If errors are discovered any time during the validity of the contract, then the Contractor shall be responsible for consequences.

1.3.8 All drawings shall be prepared using AutoCAD software version 2000 or later only. Drawings, which are not compatible to AutoCAD software version 2000 or later, shall not be accepted. After final approval, all the drawings (structural drawings, BOMs, shop sketches and tower accessories drawings) shall be submitted to the KSEBL in CDs.

A copy of each drawing reviewed will be returned to the Contractor as stipulated herein.

1.3.9 Copies of drawings returned to the Contractor will be in the form of a print with the KSEBL's marking, or a print made from a microfilm of the marked-up drawing.

1.3.10 The following is the general list of the documents and drawings that are to be approved by the KSEBL.

a) Work Schedule (Master Network) Plan.
b) Detailed survey report and profile drawings showing ground clearance and tower locations (as applicable).
c) Tower schedule and foundation classification for individual tower locations.
d) Stringing procedure
e) Tower accessories drawings like danger plate, name plate, phase plate, circuit plate, pipe and counter poise type earthing etc.
f) Quality plans for fabrication and site activities including Quality System, Vendor's approval, etc.
g) Line material drawings.
h) Type test report for line materials.

1.3.11 All rights of the design/drawing for all types of towers and foundations shall be strictly reserved with the KSEBL only and any designs/drawings/data sheets submitted by the contractor from time to time shall become the property of the KSEBL. Under no circumstances, the Contractor shall be allowed to use/offer above designs/ drawings/data sheets to any other authority without prior written permission of the KSEBL. Any deviation to above is not acceptable and may be a cause for rejection of the bid.

1.4 Contractor Execution Plan

1.4.1 The time and the date of completion of the Contract as stipulated in the Contract by the Owner without or with modifications, if any, and so incorporated in the Letter of Award, shall be deemed to be the essence of the Contract. The Contractor shall so organize his resources and perform his work as to complete it not later than the date agreed to.

1.4.2 The Contractor shall submit a detailed Work Breakdown Structure in MS Project within the time frame agreed consisting of adequate number of activities covering various key phases of the work such as design, procurement, manufacturing, shipment and field erection activities within fifteen (15) days of the date of Notification of Award. This network shall also indicate the interface facilities to be provided by the Owner and the dates by which such facilities are needed. The Contractor shall discuss the network so submitted with the Owner and the agreed network shall form part of the Contract documents. During the performance of the Contract, if in the opinion of the Engineer, proper progress is not maintained, suitable changes shall be made in the Contractor's operations to ensure proper progress without any cost implication to the Owner. The interface facilities to be provided by the Owner in accordance with the agreed network shall also be reviewed while reviewing the progress of the Contractor.

1.4.3 Based on the above agreed WBS fortnightly reports shall be submitted by the Contractor as directed by the Engineer.

1.4.4 Subsequent to the finalisation of the network, the Contractor shall make available to the Engineer a detailed manufacturing programme in line with the agreed Contract network. Such manufacturing programme shall be reviewed, updated and submitted to the Engineer once every two months thereafter.

1.4.5 The above bar charts/manufacturing programme shall be compatible with the Owner's computer environment and furnished to the Owner on such media as may be desired by the Owner.

1.5 Design Improvements

The KSEBL or the Contractor may propose changes in the specification and if the parties agree upon any such changes and the cost implication, the specification shall be modified accordingly.

1.6 Design Co-ordination

Wherever, the design is in the scope of Contractor, the Contractor shall be responsible for the selection and design of appropriate material/item to provide

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

1.7 Review Meeting

The contractor will be called upon to attend review meetings with the KSEBL, during the period of Contract. The contractor shall attend such meetings at his own cost at the Corporate Office of the KSEBL or at mutually agreed venue as and when required. Such review meeting will be held as and when required.

1.8 Quality Assurance, Inspection & Testing

1.8.1 Quality Assurance

To ensure that the supply and services under the scope of this Contract whether manufactured or performed within the Contractor's works or at his Sub-Contractor's premises or at site or at any other place of work are in accordance with the specifications. The Contractor shall adopt suitable quality assurance programme to control such activities at all points necessary. Such programme shall be broadly outlined by the Contractor and shall be finalised after discussions before the award of Contract. The detailed programme shall be submitted by the contractor after the award of contract and finally accepted by the KSEBL after discussion. A quality assurance programme of the Contractor shall generally cover but not limited to the following:

(a) His organization structure for the management and implementation of the proposed quality assurance programme.
(b) Documentation control System.
(c) Qualification data for Contractor's key personnel.
(d) The procedure for purchase of materials, parts components and selection of sub-Contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
(e) System for shop manufacturing including process controls and fabrication and assembly controls.
(f) Control of non-conforming items and system for corrective action.
(g) Control of calibration and testing of measuring and testing equipments.
(h) Inspection and test procedure for manufacture.
(i) System for indication and appraisal of inspection status.
(j) System for quality audits.
(k) System for authorizing release of manufactured product to the KSEBL.
(l) System for maintenance of records.
(m) System for handling storage and delivery and
(n) A quality plan detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to critical and important items of supply.
(o) The Quality plan shall be mutually discussed and approved by the KSEBL after incorporating necessary corrections by the Contractor as may be required.

1.8.2 Quality Assurance Documents

The Contractor shall be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of KSEBL's inspection of equipment/material.

1.8.3 The KSEBL or his duly authorized representatives reserves the right to carry out Quality Audit and quality surveillance of the systems and procedures of the Contractor's/his vendor's Quality Management and Control Activities.

1.8.4 KSEBL's Supervision

a) To eliminate delays and avoid disputes and litigation to the Contract, all matters and questions shall be resolved in accordance with the provisions of this document.

b) The manufacturing of the product shall be carried out in accordance with the specifications. The scope of the duties of the KSEBL, pursuant to the contract, will include but not be limited to the following.

i. Interpretation of all the terms and conditions of these Documents and Specifications.
ii. Review and interpretation of all the Contractor's drawings, engineering data etc.
iii. Witness or authorize his representative to witness tests at the manufacturer's works or at site, or at any place where work is performed under the contract.
iv. Inspect, accept or reject any equipment, material and work under the Contract, in accordance with the Specifications.
v. Issue certificate of acceptance and/or progressive payment and final payment certificate.
vi. Review and suggest modification and improvement in completion schedules from time to time, and
vii. Supervise the Quality Assurance Programme implementation at all stages of the works.

1.8.5 Contractors Supervision

The contractor shall appoint, sufficient number of competent and qualified Engineering personnel (graduate and diploma engineers) as required and approved by the Engineer in-charge for supervision and execution of the work. The necessary qualified supervisors for work execution/quality/safety/testing etc shall be employed by the contractor as per actual requirement of the work. The contractor shall intimate the Engineer-in-charge in writing the names and identity of technical personnel proposed to be engaged on the work.

1.9 Inspection and Tests

1.9.1 Inspection

a) The KSEBL, its duly authorized representative and/or outside inspection agency acting on behalf of the KSEBL shall have, at all reasonable times,

access to the premises and /or works of the contractor and/or their sub-contractor(s) /sub-vendors and shall have the right, at all reasonable times, to inspect and examine the materials and workmanship of the product during its manufacture.

b) The Contractor shall give the KSEBL's Inspector, fifteen (15) days (in case of domestic testing and thirty (30) days (in case of foreign testing), as the case may be, written notice of any material being ready for testing. In case of turnkey contract, the turnkey contractor shall give the notice for inspection and shall associate in the inspection with Employer's inspector. All such expenses towards inspections shall be to the Contractor's account . The KSEBL's inspector, unless witnessing of the tests is waived, will attend such tests within fifteen (15) days (in case of domestic testing) and thirty (30) days in (in case of foreign testing) of the date of which the equipment is notified as being ready for test/ inspection or on a mutually agreed date, failing which the Contractor may proceed with the test in accordance with the technical specification after informing the KSEBL in writing and he shall forthwith forward to the inspector duly certified copies of test reports / certificates in triplicate.

c) The KSEBL shall, within fifteen (15) days from the date of inspection, give notice in writing to the Contractor, of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and shall make the modifications that may be necessary to meet the said objections.

d) When the factory tests have been completed at the Contractor's or Sub-Contractor's works, the KSEBL shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the KSEBL's inspector, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test Certificate by the KSEBL. The completion of these tests or the issue of the certificate shall not bind the KSEBL to accept the equipment should it, on further tests after erection, be found not to comply with the Contract.

e) In all cases where the Contract provides for test whether at the premises or works of the Contractor or of any Sub-Contractor, the Contractor except where otherwise specified, shall provide free of charge such item as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the KSEBL's inspector or his authorised representative to carry out effectively such tests of the equipment in accordance with the Contract and shall give facilities to the KSEBL's Inspector or to his authorised representative to accomplish testing.

f) The inspection by KSEBL and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed Quality Assurance Programme forming a part of the Contract.

g) **i)** The Contractor shall keep the KSEBL informed in advance about the time of starting and of the progress of manufacture and fabrication of various

tower parts at various stages, so that arrangements could be made for inspection.

ii) The acceptance of any part of items shall in no way relieve the Contractor of any part of his responsibility for meeting all the requirements of the Specification.

h) The KSEBL or his representative shall have free access at all reasonable times to those parts of the Contractor's works which are concerned with the fabrication of the KSEBL's material for satisfying himself that the fabrication is being done in accordance with the provisions of the Specification.

i) Unless specified otherwise, inspection shall be made at the place of manufacture prior to dispatch and shall be concluded so as not to interfere unnecessarily with the operation of the work.

j) Should any member of the structure be found not to comply with the supplied design, it shall be liable to rejection. No member once rejected shall be resubmitted for inspection, except in cases where the KSEBL or his authorized representative considers that the defects can be rectified.

k) Defect which may appear during fabrication shall be made good with the consent of, and according to the procedure proposed by the Contractor and approved by the KSEBL.

l) All gauges and templates necessary to satisfy the KSEBL shall be supplied by the contractor.

m) The specified grade and quality of steel shall be used by the Contractor. To ascertain the quality of steel used, the inspector may at his discretion get the material tested at an approved laboratory.

1.9.2 Tests

a) The type, acceptance and routine tests and tests during manufacture shall be carried-out on the material and shall mean as follows:

i. Type Tests shall mean those tests which are to be carried out to prove the process of manufacture and general conformity of the material to this Specification. These tests shall be carried out on samples prior to commencement of commercial production against the order.

ii. Acceptance Tests shall mean those tests which are to be carried out on samples taken from each lot offered for pre-dispatch inspection, for the purposes of acceptance of that lot.

iii. Routine Tests shall mean those tests, which are to be carried out on the material to check requirements which are likely to vary during production.

iv. Tests during manufacture shall mean those tests, which are to be carried out during the process of manufacture and end inspection by the Contractor to ensure the desired quality of the end product to be supplied by him.

b) The norms and procedure of sampling for these tests will be as per the Quality Assurance Programme to be mutually agreed to by the Contractor and the KSEBL.

c) The standards and norms to which these tests will be carried out are listed against them. Where a particular test is a specific requirement of this Specification, the norms and procedure of the test shall be as specified in respective Annexures or as mutually agreed to between the Contractor and the KSEBL in the Quality Assurance Programme.

d) For all type and acceptance tests, the acceptance values shall be the values specified in this Specification or guaranteed by the Bidder, as applicable.

1.10 Guaranteed Technical Particulars (GTP)

The Guaranteed Technical Particulars (GTP) of the various items is given in the relevant schedule of the specification. **The bidder is required to comply with the same in line with technical requirements of the items/ materials as mentioned in part B of volume II**.

1.11 Packing

a) All the materials shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing.

b) The Contractor shall include and provide for securely protecting and packing the materials so as to avoid loss or damage during transport by air, sea, rail and road. All packing shall allow for easy removal and checking at site. Wherever necessary, proper arrangement for attaching slings for lifting shall be provided. All packages shall be clearly marked for with signs showing 'up' and 'down' on the sides of boxes, and handling and unpacking instructions as considered necessary. Special precaution shall be taken to prevent rusting of steel and iron parts during transit by sea.

c) The cases containing easily damageable material shall be very carefully packed and marked with appropriate caution symbols, i.e. fragile, handle with care, use no hook etc. wherever applicable.

d) Each package shall be legibly marked by the Contractor at his expenses showing the details such as description and quantity of contents, the name of the consignee and address, the gross and net weights of the package, the name of the Contractor etc.

e) Angle section shall be wire bundled.

f) Cleat angles, gusset plates, brackets, fillet plate, hanger and similar loose pieces shall be tested and bolted together in multiples or securely wired through holes.

g) Bolts, nuts washers and other attachments shall be packed in double gunny

bags accurately tagged in accordance with the contents.

h) The packing shall be properly done to avoid losses & damages during transit. Each bundle or package shall be appropriately marked.

2.0 KSEBL'S ENVIRONMENT AND SOCIAL POLICY AND ITS IMPLEMENTATION

2.1 Development and growth of mankind through Industrialization and unwarranted use of natural resources has inflicted considerable impact on Environment and Society. As a result, Environmental and Social issues have emerged as the focal point of global debate.

KSEBL's activities by their inherent nature and flexibility have negligible impacts on environmental and social attributes. In order to address these issues and to match the rising expectations of a cleaner, safer and healthier environment, KSEBL has evolved its Environmental and Social Policy and Procedures (ESPP). The key principles of KSEBL's Environmental and Social Policy are:

i) Avoidance of environmentally and socially sensitive areas while planning project activities.
ii) Minimisation of impacts when project activities occur in environmentally and socially sensitive areas.
iii) Mitigation of any unavoidable adverse impacts arising out of its projects.

2.2 Basic issues to be kept in mind while carrying out construction activities are to:

i) Avoid socially sensitive areas with regard to human habitations and areas of cultural significance.
ii) Secure the interest of people affected by KSEBL's projects.
iii) Involve local people affected by transmission line projects as per requirement and suitability.
iv) Consult affected people in decisions having implication to them if considered necessary.
v) Apply efficient and safe technology/practices.
vi) Keep abreast of all potential dangers to people's health, occupational safety and safety of environment and the respective mitigation measures.
vii) Establish preventive mechanisms to guarantee safety.
viii) Mitigation measures in case of accidents.
ix) Avoid unwarranted cutting of trees in forest area.

2.3 While constructing the lines through forest stretches the contractor will provide alternate arrangements to its employee e.g. working labours/supervisors etc. in order to avoid cutting of forest woods. Contractor will ensure safety to the wild life, during working/ camping near to the National park. Contractor during construction of lines in agricultural fields will ensure minimum damages to the crops, trees, bunds, irrigation etc. If the same is un-avoidable, the decision of Engineer- in-charge shall be final.

2.4 The waste/excess material/debris should be removed from the construction site including agricultural field, forest stretches, river etc. immediately after construction work. The Contractor will ensure least disturbance to the hill slope and natural drainage so as to avoid soil erosion. Natural drainage in plain area if

disturbed is to be restored to the satisfaction of Engineer-in-charge. As far as possible, existing path/kutchcha road/ approach shall be used for the construction. The Contractor will ensure supply of stone chips/sand from authorized/approved quarry areas, proper documentation of above, if any.

3.0 STANDARDS

The Indian Standard Specification (IS), British Standards (BS), IEC, ISO, ASTM, CBIP manual etc. relevant to transmission line design, testing and construction as amended up to date shall be applicable to the materials and works used in this project.

SECTION - 3
SITE ACCESS

1. WAY LEAVES

A preliminary line route shall be provided by the KSEBL to enable the Contractor to start with the Contract works. The line route plan does not include facilities for storing material.

The Contractor will satisfy himself that the necessary rights of entry and access have been obtained before entry is affected. The Contractor shall indicate to the Engineer such pipes or other obstructions, telephone, telegraph and power lines which infringe the clearances specified or otherwise fail to satisfy the requirements of the Specification.

The necessary permission for the removal of obstructions such as trees, houses, etc. and for the permanent removal or guarding of pipes, telegraph, telephone and power lines will be in the responsibility of the Contractor. The KSEBL shall assist the Contractor in getting that permission, if required for such works.

2. ACCESS TO SITE, NOTICE OF ENTRY

2.1 Access Routes – General

The KSEBL may indicate to the Contractor the general route for access to each or any position as agreed by the KSEBL, otherwise the Contractor shall make all necessary arrangements (other than questions of way leaves) with the occupier.

Subject to the provisions of the preceding paragraph the Contractor shall before commencing work, at his own expenses, do what is necessary to make the access suitable for his use and shall take all reasonable precautions to avoid damage, including, if required the erection of temporary fences or gates where permanent fences, hedges or gates have been removed. The Contractor shall not be entitled to any additional payment in the event of a particular access being difficult.

The Contractor shall be responsible for maintaining agreed access routes, without undue widening, in a usable condition for the duration of the Contract and the occupier shall not be put to any inconvenience in gaining access to his land or buildings. No unauthorised access route shall be taken by the Contractor.

2.2 Commencement of Work

The Contractor shall be responsible, before beginning work on any property for obtaining confirmation from the Engineer that way leaves are in order and any agreed accesses, have not been altered and for giving not less than 48 hours' notice to the occupiers that work is to begin. Work shall proceed on any land within the requisite period of such notice being given to the occupier.

2.3 Suspension of Work

Where work is to be suspended without the expectation of it being resumed within the specified period, the Contractor must notify the occupier of such intention and shall similarly give the occupier prior notification of the resumption

of work. The purpose of this Clause is to assist in maintaining good relations between the occupier, the Contractor and the KSEBL and to keep the occupier informed of what is going to happen on or across his land.

2.4 Compliance with Occupier's Requirements

The Contractor shall at all times during the execution of the Works ensure compliance with all such reasonable requirements of the occupier as are brought to the Contractor's notice by the Engineer.

2.5 Notice to Authorities

Before the Contractor carries out the stringing of conductors along, or across power or telecommunication circuits, public roads, etc., he shall give the requisite notice of the time and date when he proposes to perform the work to the Engineer and the Engineer will follow up the matter with appropriate Authorities.

3 ROUTE CLEARANCE

For details of the clearance requirements for survey, access routes, line route, tower locations and conductor stringing reference shall be given by KSEBL.

4 ACCESS ROADS

Access roads/ routes shall be identified by the Contractor themselves as and where necessary and shall be constructed by them at their own expense.

5 CROSSING OF OBSTACLES

5.1 General

The Contractor shall, at his own expense, make necessary arrangements and take the necessary precautions where the route crosses buildings, telecommunication, power or pipe lines, orchards, gardens, railways, antiquities or other obstructions or ground over or across which erection cannot be carried out in the normal manner or has to be avoided. These arrangements must be submitted to the Engineer.

Where a tower is set across a fence, hedge, bank or wall, the Contractor shall remove and reinstate the fence, hedge, bank or wall at his own expense and he shall be responsible at his own expense for making good to the satisfaction of the Engineer, owners and tenants concerned, all land, property, roads, drains, fences, walls, hedges, gates and the like which he has damaged or disturbed during the execution of tile Contract Works and shall remove all surplus material after erection. The Contractor shall take proper precautions to prevent the straying of and damage to livestock until after the backfilling of excavations and permanent reinstatement of fences, walls, hedges, gates and the like is completed.

5.2 Public Utilities

The Contractor shall ensure that the erection of the Contract Works does not cause damage to or interference with existing telecommunication, power or pipe lines. Where appropriate Authorities affected deem it necessary for the

protection of their employees, property, or the public or for the assistance of traffic to provide flagmen and watchmen, the cost of such provision shall be borne by the Contractor. Where required by the appropriate Authorities, work shall be carried on outside normal hours and at the Contractor's own expense.

The Contractor shall also be liable to make good at least to the original condition or compensate the owners, operators and users or any public undertaking in respect of any damage however caused to their property, lands or roads arising, out of or in consequence of the execution of the Works.

5.3 Scaffolding

The Contractor shall provide all necessary scaffolding and the like for the crossing of telecommunications or power lines, roads, railways, buildings or other obstacles. The Contractor shall advise the KSEBL in each instance of the scaffolding he proposes to use. Drawings of the proposed scaffolding shall be submitted to the KSEBL, and the appropriate regulatory authorities for approval.

6 DAMAGE

6.1 General

The Contractor shall take all reasonable precautions to avoid damage to land, property, roads, crops, field drains, fences walls, hedges, gates, trees and the like and shall ensure that the work is adequately supervised so that any damage is reduced to the minimum. The Contractor shall pay compensation to the owners/tenants for damages of crops, trees and houses during the project implementation within the way leaves (right-of-way) which are unavoidable for construction of the transmission line. The KSEBL's representative shall assist the Contractor in his negotiations with the landowners about such compensation.

6.2 Contractor's Responsibility

The Contractor's liability for loss or damage shall extend to any such loss or damage resulting from the employment of a Subcontractor. This does not relieve the Contractor of his liability for all actions of his Subcontractor.

6.3 Livestock, Dogs

Adequate provision shall be made by the Contractor to prevent the straying of or injury to livestock during the execution of the Works and until the permanent reinstatement of fences, walls, hedges, gates and the like is completed.

The Contractor shall not bring any dog on or near the site or suffer or permit any of his employees, representatives or agents or any Subcontractor to bring any dog on or near the site and shall cause the immediate removal of any dog which may be on or near the Site in breach of this provision.

The Contractor shall be liable for any injury to or loss of livestock due in the opinion of the Engineer to failure to comply with the above requirements.

7 STANDARDS

The reference standards and other documents referred to in this Section of the specification are listed below:

BS 1139:	Metal scaffolding
BS 5950:	Structural use of steel work in building
BS EN 12811-1:	Code of practice for access and working scaffolds and special scaffold structures in steel
BS 6323:	Specification for seamless and welded steel tubes for automobile, mechanical and general engineering purposes.
BS EN 12810-1:	Facade Scaffolds
EN 10296/10297/10305:	Welded circular steel tubes/seamless circular tubes/steel tubes for precision application

Sd/-

ED (Unit –4&5)
PFC Consulting Limited

PART B

TECHNICAL SPECIFICATIONS OF MATERIALS

SECTION - 4

TECHNICAL SPECIFICATIONS OF TOWER & ACCESSORIES

TABLE OF CONTENT

SECTION – 4

TECHNICAL SPECIFICATIONS OF TOWER & ACCESSORIES

A) GENERAL INFORMATION AND SCOPE

1. Scope

The following 400/220/110 kV Towers & Materials are included in the scope of the Contractor: -

Sl. No.	Item Description
1	400/220/110kV MCMV Galvanized Lattice towers, Stub & Cleat, Template, Bolt and Nut and all other accessories complete
2	ACSR/ACCC conductors
3	Dead End Fitting-single & twin
4	Suspension Clamp - single & twin
5	Mid Span Joint
6	Repair Sleeve
7	Pilot Suspension Clamp
8	Vibration Damper
9	70 KN / 90 kN /120 kN Long Rod Composite Insulator
10	Suspension Fitting-single & twin
11	Tension Fitting-single & twin
12	Pilot Suspension Fitting
13	Tee-Taps with Connectors
14	OPGW 48 Pair with accessories
15	Single Tension Dead End Fitting
16	Suspension Clamp
17	Double tension set for pass through location
18	Double tension set for Joint Box location
19	Vibration Damper
20	Down Lead clamp
21	Joint Box 48 Fiber
22	Reinforcing Rod for damper
23	FODP
24	Pipe Earthing Set 3M with all accessories
25	Counterpoise earthing set complete
26	Galvanized Earth Wire

Note: The items are tentative and actual may vary as per site conditions

2. Transmission Tower

The general description of towers applicable for the package and technical particulars thereof are indicated in Section–I of this Specification.

2.1 Design and Drawings

2.1.1 The basic drawings for all the towers and their extensions, except for a 400KV Multi-circuit & 1 no. 220KV MCMV towers, will be provided by KSEBL, which shall include structural drawings/erection drawings and / or shop fabrication drawings, Bill of Materials for all the towers and their extensions as well as construction drawings for foundations. Bidder shall include in their offer the following:

a) Design, Proto Fabrication, Assembly and Type Testing (non-destructive type) of new 400KV Multi Circuit / Double Circuit towers as per clause 2.2 below. Bidder may also offer already designed & type-tested tower meeting the above requirement.

b) Proto Fabrication, Assembly and Type Testing (non-destructive type) of 220KV MCMV towers as per approved design & drawings of KSEBL complete in all respects as per as per clause 2.2 below.

2.1.2 The tower members can be directly fabricated from the structural/erection drawings wherever the required fabrication details are provided on the same or shop fabrication drawings. Before taking up mass fabrication, the Contractor shall arrange for one number proto-assembly for each type of tower and extensions which shall be inspected by KSEBL. After assembly inspection, the Contractor shall incorporate revisions in the drawings. The revised drawing shall be submitted in 3 (three) copies for final approval by the KSEBL.

2.1.3 All the drawings shall have a proper name plate clearly displaying the name of KSEBL on right hand bottom corner. The exact format of the nameplate shall be handed over to the successful bidder for incorporation of the same on all the drawings.

2.1.4 While submitting the structural drawings, bill of materials, shop drawings and any other drawings pertaining to the subject transmission line, the Contractor shall clearly indicate on each drawing KSEBL Specification No., Name of the specific Transmission line and project, letter reference no. and date on which the submission are made. The same practice is also to be followed while submitting distribution copies.

2.1.5 The bidder shall submit the tower accessories drawings like number plate, phase plate, Danger plate, bird guard, circuit plate, step bolt, earthing, etc after endorsing the name of the project. Also drawing of anti-climbing device, D-shackle etc. shall be prepared by the Contractor and shall be submitted to the KSEBL, in three (3) copies for approval. This drawing shall be prepared in A4 size only.

2.1.6 The drawings prepared and submitted by the Contractor shall be approved / commented by the KSEBL as the case may be, within fifteen (15) days of receipt of drawings in his office. If the designs/drawings are commented by the KSEBL, the Contractor shall submit revised design/drawings duly incorporating all comments within fifteen (15) days of date of issue of comments. The Contractor

shall submit 15 copies of all approved structural drawings and BOM for tower extensions as well as for tower accessories for further distribution by the KSEBL.

The mass fabrication shall be taken up from the approved shop drawings. The overall responsibility of fabricating tower members correctly lies with the Contractor only and the Contractor shall ensure that all the tower members can be assembled / fitted while erecting without any undue strain on them**.**

2.2 Design, Proto Fabrication, Assembly and Type Testing (non-destructive type)

2.2.1 This Specification covers proto fabrication, assembly and type testing of 220 kV narrow base MCMV tower as per Owner's design as indicated in the Bid Proposal Sheets (BPS) as described hereunder. The testing of the towers shall be carried out at Bidder's own test bed or a suitable test bed, where adequate facilities are available. The Owner shall provide designs of the towers required for carrying out type testing, to the successful Bidders within 15 days of placement of award and acceptance of award by the Bidder. The scope of this specification also provides for development of structural drawings and fabrication shop drawings, Bill of Materials including bolts/nuts and spring washers, section wise steel requirement chart, fabrication and supply of prototype tower and its assembly, inspection, transportation of prototype tower material to the test bed along with bolts/nuts & spring washer and necessary tower accessories required for tower testing, erection of the tower at the test bed and testing the same to the full design load and additional loads as specified for verification of overall capacity of the tower.

2.2.2 The entire tower testing work covered hereunder shall be completed as per the completion schedule specified in the annexure-I.

2.2.3 Above towers shall be tested with +9m body extension. For all other body/leg extensions, the Contractor shall prepare structural drawings, shop drawings, Bill of Materials based on single line diagram supplied by the Owner. Contractor shall also arrange proto-assembly of test tower with +9 M body extension. At the time of proto-assembly, if any modification is required to be carried out on the fabrication shop drawings or on the structural drawings, the same shall be properly incorporated and fresh drawings submitted by the Contractor.

2.2.4 The Contractor shall also be required to develop stub and stub setting template drawings for all body extensions based on the design inputs provided by the Owner.

a) The unit rates quoted shall include minor details, which are obviously and fairly intended, and which may not have been explicitly described in these documents but are essential for the satisfactory completion of the various works.

b) The unit rates quoted shall be inclusive of all plant, equipment, men, material, skilled & unskilled labour.

2.2.5 In addition to the above, Bidder shall design, Proto Fabrication, Assembly and Type Testing (non-destructive type) of a 400 kV Multi-circuit &/or Double Circuit tower with +9m body extension. The design carried out shall be the most optimum as per the best practices prevailing in the market. The design

calculations shall be submitted to KSEBL for their approval. All subsequent activities shall be governed by clauses stated above.

2.3 Materials

2.3.1 Tower Steel Sections

IS Steel Sections of tested quality of conformity with IS:2062:2006 grade E250 (Designated Yield Strength. 250 MPa) and/ or grade E350 (Designated Yield Strength 350 MPa) are to be used in towers, extensions, stubs and stub setting templates. The Contractor can use other equivalent grade of structural steel angle sections and plates conforming to latest International Standards. However, use of steel grade having designated yield strength more than that of EN 10025 grade S355 JR/JO (designated yield strength 355 MPa) is not permitted, unless otherwise indicated in this specification.

Steel plates below 6mm size exclusively used for packing plates/packing washers produced as per IS 1079 -1994 (Grade -0) are also acceptable. However, if below 6mm size plate are used as load bearing plates viz gusset plates, joint splices etc. the same shall conform to IS : 2062 / or equivalent standard meeting mechanical strength/ metallurgical properties corresponding to grade E250 or grade E350 (designated yield strength not more than 355MPa), depending upon the type of grade incorporated into design. Flats of equivalent grade meeting mechanical strength/ metallurgical properties may also be used in place of plates for packing plates/ packing washers. The chequered plates shall conform to IS: 3502. SAILMA 350HI grade plate can also be accepted in place of HT plates (EN 10025 grade S355 JR/JO / IS 2062:2006 – grade 350, as applicable) provided SAILMA 350HI grade plate meet all the mechanical properties of plate as per EN 10025 grade S355 JR/JO (designated yield strength 355 MPa) / IS 2062:2006 – grade 350.

For designing of towers, preferably rationalised steel sections have been used. During execution of the project, if any particular section is not available, the same shall be substituted by higher section. Any cost on account of the same shall be borne by the Contractor. However, design approval for such substitution shall be obtained from the Board before any substitution and records of such substitutions shall be maintained by the Contractor.

2.3.2 Fasteners: Bolts, Nuts and Washers

All tower members shall be joined together with Bolts and nuts. The joints shall be connected with hexagonal bolts and nuts. All hexagonal bolts and nuts shall conform to IS-12427. They shall have hexagonal head and nuts, the heads being forged out of the solid, truly concentric, and square with the shank, which must be perfectly straight. Anti-theft bolts and nuts shall have round tapered heads with hexagonal shear nuts. They shall confirm to IS: 12427 and IS: 1367 for property class 5.6/5 except for dimensions. All bolts and nuts shall be galvanised as per IS: 1367 (Part-13)/IS: 2629.

a) The bolt shall be of 16/24 mm diameter and of property class 5.6 as specified in IS: 1367 (Part-III) and matching nut of property class 5.0 as specified in IS: 1367 (Part-VI).

b) Bolts up to M16 and having length up to 10 times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of bolts for 5.6 grade should be 310 MPa minimum as per IS: 12427. Bolts should be provided with washer face in accordance with IS: 1363 (Part-I) to ensure proper bearing.

c) Nuts for hexagonal bolts should be double chamfered as per the requirement of IS: 1363 Part-III. It should be ensured by the manufacturer that nuts should not be over tapped beyond 0.4mm oversize on effective diameter for size up to M 16.

d) Fully threaded bolts shall not be used. The length of bolts shall be such that the threaded portion will not extend into the place of contact of the members.

e) All bolts shall be threaded to take the full depth of the nuts and threaded for enough to permit firm gripping of the members, but not further. It shall be ensured that the threaded portion of each bolt protrudes not less than 3mm and not more than 8mm when fully tightened. All nuts shall fit tight to the point where the shank of the bolt connects to the head.

f) Flat and tapered washers shall be provided wherever necessary. Spring washers shall be provided for insertion under all nuts. These washers shall be steel electro galvanised, positive lock type and 3.5 mm in thickness for 16 mm dia bolt and 4.5 mm for 24 mm bolt.

g) To avoid bending stress in bolts or to reduce it to minimum, no bolt shall connect aggregate thickness of members more than three times its diameter.

h) The bolt positions in assembled towers shall be as per structural drawing.

i) Bolts at the joints shall be so staggered that nuts shall be tightened with spanners without fouling.

j) To ensure effective in-process Quality control it is desirable that the manufacturer should have in house testing facility for all tests like weight of zinc coating, shear strength and other tests etc. The manufacturer should also have proper Quality Assurance System which should be in line with the requirement of this specification and IS: 14000 series Quality System Standard.

3 Tower Accessories

Arrangement shall be provided for fixing of all tower accessories to the tower, at a height between 2.5 meters and 3.5 meters above the ground level.

3.1 Step Bolts & Ladders

Each tower shall be provided with step bolts as per specification drawings. The contractor shall submit distribution copies of the same endorsing the package details (i.e. line name, LOI No. etc). The step bolts conforming to IS: 10238 of not less than 16mm diameter and 175mm long spaced not more than 450mm apart and extending from 2.5 meters above the ground level to the top of the tower. However, the head diameter shall be 50mm. For Double circuit tower the step bolt shall be fixed on two diagonally opposite legs up to top of the towers. Each step bolt shall be provided with two nuts on one end to fasten the bolt securely to the tower and button head at the other end to prevent the feet from slipping away.

The step bolts shall be capable of withstanding a vertical load not less than 1.5 KN. For special towers, where the height of the super structure exceeds 50 meters, ladders along with protection rings, as per KSEBL approved design shall be provided in continuation of the step bolts on one face of the tower from 30 meters above ground level to the top of the special structure. In this case the bidder shall supply the relevant drawings of the ladder to KSEBL for approval. From 2.5 m to 30m height of super structure step bolts shall be provided. Suitable platform using 6 mm thick perforated chequered plates along with suitable railing for access from step bolts to the ladder and from the ladder to each cross-arm tip and the ground wire support shall also to be provided. The platform shall be fixed on tower by using counter-sunk bolts.

3.1.1 **Insulator Strings and Earth wire Clamps Attachments**

3.1.2 For the attachment of suspension Insulator string, a suitable dimensioned swinging hanger on the tower shall be provided so as to obtain specified clearances under respective swinging condition of the strings. The hanger, extensions links, D-shackles etc. as required and considered in the design of the tower shall have minimum ultimate tensile strength of 90 kN /70 KN for single suspension string and 120 kN/90 KN for double suspension string for 220/110 KV suspension towers. The design and supply of hanger, D-shackles, strain plate, extension link etc. are also in the scope of Contractor.

3.1.3 At tension towers, strain plates of suitable dimensions under each cross-arm tip, shall be provided for taking the hooks or D-shackles of the tension insulator strings. Full details of the attachments shall be provided to the contractor. To achieve requisite clearances, if the design calls for providing extra D-shackles, link plate etc. before connecting the insulator string the same shall be supplied by the Contractor.

3.1.4 Earth wire Clamps Attachments

a) Suspension Clamp

Wherever required, the Contractor shall supply U – bolts, D – Shackles, copper bond etc. for attachment of Suspension clamp to the tower and take KSEBL's approval for details of the attachments before the mass fabrication.

b) Tension Clamps

c) Earth wire peaks of tension towers shall be provided with suitable plates to accommodate the shackle of tension clamps. The contractor shall also supply the U-bolts wherever required and take KSEBL's approval for details of the

attachments before the mass fabrication.

3.1.5 **Anti-climbing Device & Bird Guard**

Barbed wire type anti climbing device shall be provided and installed by the Contractor for all towers. The barbed wire shall conform to IS-278 (size designation A1). The barbed wires shall be hot dip galvanized as per procedure laid down in IS: 4826. The drawings of ACD shall be approved by KSEBL.

The bird guards for suspension towers shall be made of galvanized iron sheet and shall conform to IS: 5613 (Part-2/Section-1)-1985. Necessary holes shall be provided on the cross arm of the suspension towers for fixing the bird guards.

3.1.6 **Danger, Number, Circuit and Phase plate**

Danger Plates, Phase Plates and Number plates shall be provided and installed by the Contractor. Further Circuit plates also shall be provided and installed by the contractor for the Double circuit towers. These Danger/Number/Phase/ circuit Plate shall be as per the drawing enclosed in the section of drawing. The contractor shall submit distribution copies of the same endorsing the package details (i.e. line name, LOI No. etc) and installed by the Contractor.

a) Each tower shall be fitted with a danger plate, number plate and a set of phase plates for each circuit. The transposition towers should have provision of fixing phase plates on both the transverse faces. Circuit plates shall be provided on all the Multi Circuit towers.

b) The letters, figures and the conventional skull and bones of danger plates shall conform to IS-2551 and shall be in a signal red on the front of the plate.

c) The corners of the danger, number and circuit plates shall be rounded off to remove sharp edges.

d) The letters of number and circuit plates shall be red enamelled with white enamelled background.

4 Tower Fabrication

The tower members shall be fabricated in accordance with IS: 802(Part –II)-1978 with the latest revision thereof. Following important points relevant to work are described as below: -

4.1 All parts of towers shall be fabricated in accordance with the shop drawings prepared from approved detailed assembly drawings.

4.2 Towers shall have bolted connection. Welding shall not be permitted at any point unless otherwise previously approved by the KSEBL.

4.3 The tower members shall be accurately fabricated, so that these could be bolted together easily at site without undue strain on the bolts or members.

4.4 No angle member shall have the two leg flanges brought together by closing the angle.

4.5 The structure shall be such that all parts are accessible for inspection and cleaning. Drain holes shall be provided at all points where pockets of depression are likely to hold water. It will be ensured that the stressed members will not have any blank hole after final assembly, except for holes on account of step bolts

or planned holes in stubs.

4.6 Fabrication of towers shall be carried out in conformity with the latest practice employed in the manufacture of transmission line towers by using power driven cropping, punching, shearing and drilling machines. The extent of various operations shall be governed by relevant Indian standards or any other approved standard specifications and standard practice followed by such operations.

4.7 All sections before any work is done on them, shall be carefully levelled, straightened and made true to detailed drawing by methods which will not injure the material so that when assembled, the adjacent matching surface are in clear contact throughout. The steel sections shall be straightened and trued by pressure and not by hammering. No rough edge shall be permitted anywhere in the entire structure. The flanges of the angle sections at the ends of members shall be properly chamfered, if there are even slight chances of its fouling with other members or if they cause difficulty in proper tightening of bolts. All clippings, back cuts, grindings, bends, holes etc. shall be as per the detailed drawings and free from burrs.

4.8 Full interchangeability shall be guaranteed.

4.9 No welding, filling or plugging shall be permitted unless previously approved. Welding of two or more pieces to obtain length of members specified will not be permitted.

4.10 All sections, plates and bars, before any work is done on them, shall be straightened, free from twists, carefully levelled and made true to detailed drawings by methods, which will not injure the materials so that when assembled, the adjacent surfaces are in close contact throughout. Hammering shall not be permitted for straightening or flattening of members.

4.11 Cuttings of members shall be affected by shearing, cropping, flame cutting or sawing. Members preferably over 10 mm thickness shall be sawn, or flame cut followed by grinding. The surface so cut shall be clean, smooth, reasonably square and free from any distortion.

4.12 Members shall be bent hot, but in case of small bends, the cold bending may be done with the prior approval of the Engineer, provided no fracture of materials occurs. All the bending operations shall be done by pressure. No bending of members shall be done for slope above 45^0.

4.13 When members are spliced by a lap joint, heel of inside angles shall be rounded to the minimum possible radius consistent with proper fit with the fillet of the outside angle. The thickness of the ground heel shall not be less than that of leg. Flat heeling will not be allowed.

4.14 The fabrication tolerances shall be as per IS: 7215-1974.

5 Drilling and Punching

5.1 Before any cutting work is started, all steel sections shall be carefully straightened and trued by pressure and not by hammering. They shall again be trued after being punched and drilled.

5.2 Holes in the members shall be either punched or drilled with the help of jigs and

fixtures. Drilled holes will be preferred. However, members up to 12 mm thickness may be punched. Members over 12 mm thickness shall be drilled. All burrs left after drilling or punching should be removed completely. Holes adjacent to the bend shall be drilled or punched after bending. Tolerances regarding punch holes are as follows: -

5.2.1 Holes must be perfectly circular and no tolerances in this respect are permissible.

5.2.2 The maximum allowable difference in diameter of the holes on the two sides of plates or angle is 0.8mm. i.e. the allowable taper in a punched hole should not exceed 0.8mm on diameter.

5.2.3 Holes must be square with the plates or angles and have their walls parallel.

5.3 Holes for bolts shall be circular. Oval or lobbed forms of holes shall not be permitted. The diameter of holes shall be 1.5 mm more than diameter of bolts.

5.4 The accuracy of location of holes shall be such that for any group when assembled, it shall admit the bolt at right angles to the plane of connection.

5.5 All burns left by drills or punch shall be removed completely. When the tower members are in position the holes shall be truly concentric/matching to each other. Drilling or reaming to enlarge holes shall not be permitted.

6 Erection mark

6.1 Each individual member shall have erection mark conforming to the component number given to it in the fabrication drawings. The mark numbers shall be marked with marking dies of 16 mm size before galvanising and shall be legible after galvanising,

6.2 Erection Mark shall be A – BB – CC – DDD

A = KSEBL code assigned to the Contractors – Alphabet
BB = Contractor's Mark-Numerical
CC = Tower Type Alphabet.
DDD = Number mark to be assigned by Contractor – Numerical. Erection mark for high tensile steel members shall be prefixed by the letter "H"

7 Quantities and weights

7.1.1 The quantities of the following items have been envisaged in Metric Tonne (MT) in the relevant price Schedules for various types of towers: -

i) Basic Body.

ii) Body Extensions.

iii) Leg Extension.

iv) Stubs & Cleats

v) Bolts & Nuts including spring washers and step bolts etc.

7.1.2 During detail engineering, proto assembly of each of the above items shall be inspected and approved by KSEBL and subsequently shall be released for fabrication and manufacturing as per the Technical Specification by the Contractor. The manufacturing of the above items shall be taken up in such a manner that the Equipment/Material offered for inspection to KSEBL are on

completed tower basis for each type of tower, completed Stubs & Cleats set basis so as to facilitate availability of erectable tower of each type and erectable stubs & cleats set for casting of foundation. After inspection of the offered Equipment/Material by KSEBL representative(s), MDCC shall be issued only on completed tower basis for each type of tower, on completed tower extensions basis of each type tower and on completed Stubs & Cleats set basis for each type of tower foundations.

7.1.3 The provisional quantities required are mentioned in the respective Price Schedule. The final quantities of tower shall be confirmed by the KSEBL based on the requirement of quantities of various towers furnished by the Contractor after completion of check survey.

The KSEBL reserves the right to order the final quantities including reasonable quantities of spares for which the rates quoted in the Bid shall be valid.

7.1.4 The estimated total weight of tower/tower parts as well as bolts & nuts along with spring washers and step bolts to be supplied by the Contractor under various packages have been envisaged in the relevant Price Schedule. Though fully galvanised tower parts are to be supplied, the weight of tower shall mean the weight of tower calculated by using the black sectional (i.e. non-galvanised) weight of steel members of the size indicated in the approved fabrication drawings and bill of materials, without taking into consideration the reduction in weights due to holes, notches and level cuts etc. but taking into consideration the weight of the D shackles, hangers, strain plates, pack plates, gusset plates and pack washers etc.

The weight of stub and cleats also shall be calculated in similar manner. The weight of gusset plates shall mean the weight of its circumscribing rectangle, without taking into considerations the reductions in weight due to holes, notches etc. For bolts and nuts along with spring washers and step bolts, the weight per tower shall be calculated from the bolt schedule applicable to each type of towers and body extensions as per approved B.O.M.

7.1.5 The contractor is permitted to get inspected and supply up to 2.5% extra fasteners to take care of losses during erection. No payment shall be admissible for these extra supplies.

8 Galvanising

8.1 Fabricated Tower Parts & Stubs

8.1.1 The tower parts, stubs and pack washers shall be hot dip galvanized. The galvanization shall be done as per requirements of IS 4759 after all fabrication work is completed. The contractor shall also take guidelines from the recommended practices for hot dip galvanizing laid down in IS: 2629 while deciding and implementing galvanizing procedure. The mandatory requirements however, are specified herein.

8.1.2 Unless otherwise specified, the fabricated tower parts and stubs shall have a minimum overall Zinc coating of 610 gms per sq. m of surface except for plates below 5mm which shall have Zinc coating of 460 gms per sq. m of surface. The average zinc coating for sections 5 mm & above shall be maintained as 87 microns and that for sections below 5mm shall be maintained as 65 microns.

8.1.3 The zinc coating shall be adherent, reasonably uniform, smooth, continuous and free from imperfections such as black/ bare spots, ash rust strains, bulky white deposits / wet storage strains and blisters.

8.1.4 The surface preparation for fabricated tower parts and stubs for hot dip galvanizing shall be carried out as indicated herein below:

a) Degreasing & Cleaning of Surface: Degreasing and cleaning of surface, wherever required, shall be carried out in accordance with clause 4.1 of IS: 2629-1985.After degreasing the article shall be thoroughly rinsed. However, if acidic degreasers are used rinsing is not required.

b) Pickling: Pickling shall be done using either hydrochloric or sulphuric acid as recommended at clause 4.3 of IS 2629 -1985. The actual concentration of the acids and the time duration of immersion shall be determined by the Contractor depending on the nature of material to be pickled. Suitable inhibitors also shall be used with the acids to avoid over pickling. The acid concentration, inhibitors used, and maximum allowable iron content shall form part of plant standard to be formulated and submitted to employer along with Quality Assurance Program.

c) Rinsing: After pickling, the material shall be rinsed, preferably in running water to remove acid traces, iron particles or any other impurities from the surface. Two rinse tanks are preferable, with water cascading from the second tank to the first to ensure thorough cleaning. Wherever single tank is employed, the water shall be periodically changed to avoid acid contamination, and removal of another residue from the tank.

d) Fluxing: The rinsed article shall be dipped in a solution of Zinc ammonium chloride. The concentration and temperature of the flux solution shall be standardized by the contractor depending on the article to be galvanized and individual circumstances. These shall form part of plant standard to be formulated and submitted to employer along with Quality Assurance Program. The specific gravity of the flux solution shall be periodically monitored and controlled by adding required quantity of flux crystals to compensate for drag-out losses. Free acid content of the flux solution also shall be periodically checked and when it is more than two (2) grams of free acid per litre of the solution, it shall be neutralized. Alternatively, Ph value should be monitored periodically and maintained between 5.0 to 5.5.

e) Drying: When dry galvanizing is adopted the article shall be thoroughly dried after fluxing. For the purpose of drying, the contractor may use hot plate, air oven or any other proven method ensuring complete drying of the article after fluxing and prior to dipping in the molten zinc bath. The drying process shall be such that the article shall not attain a temperature at which the flux shall get decomposed. The article thus dried shall be galvanized before the flux coating picks up moisture from the atmosphere or the flux layer gets damaged or removed from the surface. The drying procedure, time duration, temperature limits, time lag between fluxing, drying, galvanizing etc shall form part of plant standard to be formulated and submitted to employer along with Quality Assurance Program.

f) Quality of Zinc: Any one or combination of the grades of zinc specified in IS

209 or IS 13229 or other comparable international standard shall be used for galvanizing. The contractor shall declare the grade(s) of zinc proposed to be used by them for galvanizing. The molten metal in the zinc bath shall contain minimum 98.5 % zinc by mass. It shall be periodically measured and recorded. Zinc aluminum alloy shall be added as per IS 2629.

g) Dipping Process: The temperature of the galvanizing bath shall be continuously monitored and controlled. The working temperature of the galvanizing bath shall be maintained at 450 +/ - 10-degree C. The article should be immersed in the bath as rapidly as possible without compromising on safety aspects. The galvanizing bath temperature, immersion angle & time, time duration of immersion, rate of withdrawal etc shall be monitored and controlled depending upon the size, shape, thickness and chemical composition of the article such that the mass of zinc coating and its uniformity meets the specified requirements and the galvanized surface is free from imperfections and galvanizing defects.

h) Post Treatment: The article shall be quenched in water. The quench water is to be changed / drained periodically to prevent corrosive salts from accumulating in it. If water quenching is not done, then necessary cooling arrangements should be made. The galvanized articles shall be dipped in chromating solution containing sodium dichromate and sulphuric acid or chromic acid base additive at a predetermined concentration and kept at room temperature to retard white rust attack. The temperature of the chromate solution shall not exceed 65-degree C. The articles shall not be stacked immediately after quenching and dichromating. It shall be ensured that the articles are dry before any further handling operation.

i) Storing, Packing and Handling: In order to prevent white rust formation sufficient care should be exercised while storing handling and transporting galvanized products. The articles shall be stored in an adequately ventilated area. The articles shall be stored with spacers in between them and kept at an inclination to facilitate easy drainage of any water collected on the articles. Similar care is to be taken while transporting and storing the articles at site.

The Contractor shall prepare a detailed galvanizing procedure including Flow Chart with control parameters and all plant standards as required above and submit to KSEBL for approval as part of Quality Assurance Plan.

8.2 Fasteners.

For fasteners, the galvanizing shall conform to IS-1367(Part-13). The galvanizing shall be done with centrifuging arrangement after all mechanical operations are completed. The nuts, may however be tapped (threaded) or rerun after galvanizing and the threads oiled. The threads of bolts & nuts shall have a neat fit and shall be such that they can be turned with finger throughout the length of the threads of bolts and they shall be capable of developing full strength of bolts. Spring washers shall be electro galvanized as per Grade-IV of IS-1573.

9 Earthing

Each tower shall be earthed. The tower footing resistance shall not exceed 10 ohms. The Contractor shall measure the tower footing resistance (TFR) of each tower during dry weather after it has been erected and before the stringing of the

earth wire. Pipe type earthing and counter poise type earthing shall be done as required in accordance with the following standards:

IS: 3043 Code of practice for Earthing.

IS: 5613 Code of practice for Design, Installation and maintenance (Part-II/Section-2) of overhead power lines.

9.1 The drawings and standards for pipe & counterpoise type earthing are as per CBIP manual.

9.2 Pipe Type Earthing

Each earthing arrangement will consist of 50 mm dia, not less than 3000 mm long heavy-duty G.I. pipe driven at least 3650mm away from the nearest leg of the tower so that the same is outside earthing zone of the tower itself. 50x6 mm G.S. strip 4650 mm long and placed 600 mm below the ground level shall be used to connect the tower with the pipe. Bolt holes of the leg members joining the bottom most bracing shall be used for connecting the G.S. strip. The quoted rates will include the supply of these earthing materials complete with necessary bolts and nuts required for connection of strip with pipe and of the strip with tower.

9.3 Counterpoise Type Earthing

Where necessary, because of difficulties in grounding pipes in rocks or to control excessively high footing resistance, counterpoise earth shall be provided by the contractor. The counterpoise earth will be of size not less than 7/9 SWG (3.67 mm) galvanized steel wire having suitable galvanised steel lugs forged at its one end. The length of each counterpoise earth will not be less than 30 meters.

The contractor shall furnish full details of counterpoise earth and the supply is also included under the scope of the contractor.

9.4 Earthing of River Crossing Tower

Galvanised earthing strip of flat 50 x 6 mm is to be provided in two legs of tower for each location with proper arrangement of connecting these strips by 16mm bolts shall be provided in the stubs. For well/pile foundation, the strip has to be taken up to scour level along the concrete of well/pile foundations. Only bolted connections are allowed for connecting this strip to achieve desired length. Contractor shall submit the detailed drawing for approval of KSEBL before installations.

10 Standards

10.1 The design, manufacturing, fabrication, galvanising, testing, erection procedure and materials used for manufacture and erection of towers, design and construction of foundations shall conform to the following Indian Standards (IS)/International Standards which shall mean latest revisions, with amendments/changes adopted and published, unless specifically stated otherwise in the Specification.

In the event of supply of material conforming to Standards other than specified, the Bidder shall confirm in his bid that these Standards are equivalent to those specified. In case of award, salient features of comparison between the Standards proposed by the Bidder and those specified in this document will be provided by the Contractor to establish their equivalence.

The material and services covered under these specifications shall be performed as per requirements of the relevant standard code referred hereinafter against each set of equipment and services. Other internationally acceptable standards which ensure equal or higher performance than those specified shall also be accepted.

11 Classification of Towers

The towers for 220/110 kV MCMV, DC towers are classified as given below:

Type of Tower	Deviation Limit	Typical Use
KLA/MA/D3	0-2 deg	To be used as Suspension tower.
KLB/MB	2 deg-15 deg	Small Angle towers with tension insulator string.
KLC/MC/D30	15 deg - 30 deg	Medium Angle towers with tension insulator string.
KLD/MD/D60	30 deg – 60 deg.	Large Angle towers with tension insulator string.

Note: The above towers can also be used for longer span with smaller angle of deviations without infringement of ground clearance.

12 Extensions

12.1 The towers are designed so as to be suitable for adding 3M, 6M and 9M body extensions/leg extensions for maintaining adequate ground clearances without reducing the specified factor of safety in any manner.

12.2 All above extension provisions to towers and foundations shall be treated as part of normal towers and foundations only.

13 Span and clearances

13.1 Normal Span

The normal ruling span of the line is 335m.

13.2 Wind Span

The wind span is the sum of the two half spans adjacent to the support under consideration. For normal horizontal spans this equals to normal ruling span.

13.3 Weight span

The weight span is the horizontal distance between the lowest points of the conductors on the two spans adjacent to the tower. For spotting of structures, the span limits given in following table shall prevail: -

Sl. No.	Description	Type of tower (Suspension)	Type of tower (Small Angle)	Type of tower (Med Angle)	Type of tower (Large Angle)
1	Wind Span	335	335	335	335
2	Weight Span (Max. Effect of Both Span	525/488	1000/1000	1000/1000	1000/1000

Sl. No.	Description	Type of tower (Suspension)	Type of tower (Small Angle)	Type of tower (Med Angle)	Type of tower (Large Angle)
3	Weight Span(Min) Effect of Both Span	200/195	-1000/-1000	-1000/-1000	-1000/-1000
4	Weight Span (Max) Effect of Single Span	319/195	600/600	600/600	600/600
5	Weight Span (Min) Effect of Single Span	100/104	-600/-600	-600/-600	-600/-600
6	Permissible Sum of adjacent spans for various deviation angles		15° - 671 14° - 727 13° - 783 12° - 840 11° - 896 10° - 953 09° - 1009 08° - 1065 07° - 1122 06° - 1179 05° & Below-1235	30° -671 29° -725 28° -781 27° -836 26° -891 25° -946 24° -1001 23° -1057 22° -1112 21° -1168 20°-& Below-1224	60° -671 59° -720 58° -770 57° -820 56° -869 55° -920 54° -970 53° -1021 52° -1071 51° -1122 50°-& Below-1174

14 Electrical Clearances

14.1 Ground Clearance

The minimum ground clearance from the bottom conductor shall not be less than 6100 mm for 110KV lines at the maximum sag conditions i.e at 180° C and still air.

- An allowance of 150mm shall be provided to account for errors in stringing.
- Conductor creep shall be compensated by over tensioning the conductor at a temperature of 32°C lower than the stringing temperature for ACSR conductor.

15 Service Condition

Equipment/material to be supplied against this specification shall be suitable for satisfactory continuous operation under conditions as specified below:

Maximum ambient temperature (Degree Celsius)	40^0C
Minimum ambient temperature (Degree Celsius)	10^0C
Relative humidity (% range)	10-100
Maximum annual rainfall &snowfall (Cm)	as per published Meteorological/ climatological data
Wind zone (as per IS: 875)	2
Maximum wind velocity (m/sec.)	39 m/sec. (as per IS: 875)

Maximum altitude above mean sea level (Metre)	Below 1000 m
Isokeraunic level (days/years)	100/Year

Note: Climate varies from moderately hot and humid tropical climate to cold climate.

SECTION – 5

TECHNICAL SPECIFICATIONS OF CONDUCTORS

TABLE OF CONTENT

SECTION – 5

TECHNICAL SPECIFICATIONS OF CONDUCTORS

1 SCOPE

This section provides the technical details of Conductors for use on this transmission lines package. The material and services under this specification shall be performed as per the requirements of the latest revisions and amendments available at the time of placement of order of all the relevant Indian Standards/Codes listed in Clause-2 STANDARDS here under or equivalent International Standards, except as modified in this document.

The materials covered here under this specification shall be supplied complete in all respects, including all components, fittings and accessories which are necessary or are usual for their efficient performance and satisfactory maintenance under the various operating and atmospheric conditions. Such parts shall be deemed to be within the scope of the Contract, whether specifically included or not in the Specification or in the Contract Schedules.

2 STANDARDS

Sl. No.	Indian Standard	Title	International Standard
1.	IS: 209-1992	Specification for zinc	BS:3436-1986
2.	IS: 398-1982	Specification for Aluminium Conductors for Overhead Transmission Purposes	IEC:1089-1991 BS:215-1970
3.	IS:398-1990 Part-II	Aluminium Conductor Galvanised Steel Reinforced	BS;215-1970 IEC:1089-1991
4.	IS:398 (Part-IV)	Aluminium Alloy stranded conductor	IEC: 208-1966 BS-3242-1970
6.	IS: 1521-1991	Method of Tensile Testing of Steel Wire	ISO 6892-1984
7.	IS: 1778-1980	Reels and Drums for Bare Conductors	BS:1559-1949
8.	IS: 2633-1992	Method of Testing Uniformity of Coating on Zinc Coated Articles	
9.	IS: 4826-1992	Galvanised Coating on Round Steel Wires	IEC: 888-1987 BS:443-1969
10.	IS: 6745-1990	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles	BS:433-1969 ISO 1460 - 1973
11.	IS: 8263-1990	Method of Radio Interference Tests on High Voltage Insulators	IEC:437-1973 NEMA:107-

			1964 CISPR
12.	IS: 9997-1988	Aluminium Alloy Redraw Rods	IEC 60104-1987
13.		Method of measurement of resistivity of metallic materials	IEC:468
14.		Calculating the Current Temperature of Bare Overhead Conductors	IEEE 738-2006
15.		Aluminium-Coated Steel Core Wire for Aluminium Conductors, Steel Reinforced	ASTM B341

The standards mentioned above are available from:

Reference Abbreviation	Name and Address
BS	British Standards, British Standards Institution 101, Pentonvile Road, N - 19-ND, UK
IEC/CISPR	International Electro Technical Commission, Bureau Central de la Commission, electro Technique international, 1 Rue de verembe, Geneva, SWITZERLAND
BIS/IS	Bureau of Indian Standards. Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi – 110001, INDIA
ISO	International Organisation for Standardization. Danish Board of Standardization Danish Standardizing Sraat, Aurehoegvej-12 DK-2900, Heeleprup, DENMARK.
ASTM	ASTM Headquarters, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, USA

Material meeting with the requirements of other authoritative standards, which ensure equal or better performance than the standards mentioned above, shall also be considered. When the material offered by the bidder conforms to other standards, salient points of difference between standards adopted & the standards specified in this specification shall be clearly brought out in the relevant schedules. Three copies of such standards with authentic translation in English shall be furnished along with the bid.

3 SITE CLIMATIC CONDITIONS

The materials offered shall be suitable for operation in tropical climate & shall be subject to the sun & inclement weather and shall be able to withstand wide range of temperature variations. The topography & climatic conditions are furnished in clause 4.2, section 1, part A of volume II.

4 TECHNICAL DETAILS OF CONDUCTOR

Technical details of conductors are mentioned in clause 4.1, Section 1, Part A of this volume.

5 MATERIAL & WORKMANSHIP

5.1 The material offered shall be of best quality and workmanship. The Aluminium conductor strands will consist outer stranding of fully annealed aluminium wire of 1350-O & inner core shall be of aluminium conductor steel reinforced for 220 &110kV.

5.2 The steel wires for conductor shall be evenly and uniformly coated with Zn complying with ASTM B498/957.

5.3 The Aluminium and steel strands shall be smooth, uniform and free from all imperfections, such as spills and splits, die marks, scratches, abrasions, etc., after drawing and also after stranding.

5.4 The finished conductor shall be smooth, compact, uniform and free from all imperfections including kinks (protrusion of wires), wire cross over, over riding, looseness (wire being dislocated by finger/hand pressure and/or unusual bangle noise on tapping), material inclusions, white rust, powder formation or black spot (on account of reaction with trapped rain water etc.), dirt, grit etc.

5.5 The steel strands shall be pre-formed and post formed in order to prevent spreading of strands in the event of cutting of core wire. Care shall be taken to avoid, damages to galvanization during pre-forming and post-forming operation.

6 JOINTS IN WIRES

6.1 Aluminium Wires

During stranding, no aluminium wire welds shall be made for the purpose of achieving the required conductor length.

No joints shall be permitted in the individual wires in the outer most layer of the finished conductor. However, Joints in the inner layers are permitted in addition to those made in the base rod or wire before final drawing, but no two such joints shall be less than 15 meters apart in the complete stranded conductor. Joints shall be made by cold pressure butt welding and shall withstand a stress of not less than the breaking strength of individual strand guaranteed.

6.2 Steel Wires

There shall be no joint of any kind in the finished wire entering into the manufacture of the strand. There shall also be no strand joints or strand splices in any length of the completed stranded steel core of the conductor.

6.3 STRANDING

For all constructions, each alternate layer shall be stranded in opposite directions. The wires in each layer shall be evenly and closely stranded round the under laying wire or wires. The final layer of wires shall have a right hand lay.

6.4 STANDARD LENGTH

6.4.1 The standard length of the conductor shall be 2000 meters . A tolerance of +/5% on the standard length offered by the Bidder shall be permitted. All lengths outside this limit of tolerance shall be treated as random lengths.

6.4.2 Random lengths will be accepted provided no length is less than 70% of the standard length and the total quantity of such random lengths shall not be more than 10% of the total quantity ordered.

6.4.3 Bidder shall also indicate the maximum single length, above the standard length, he can manufacture in the guaranteed technical particulars of offer. This is required for special stretches like river crossing etc. The Owner reserves the right to place orders for the above lengths on the same terms and conditions applicable for the standard lengths during the pendency of the Contract.

6.5 TOLERANCES

Manufacturing tolerances on the dimensions to the extent of one per cent shall be permitted for individual strands and the complete conductor.

7 TEST ON CONDUCTORS

The following tests should have been conducted for conductor in last five year for which offer is made.

In the event of any discrepancy in the test report (i.e., any test report not applicable due to any design/ material/manufacturing process change including substitution of components or due to noncompliance with the requirement stipulated in the Technical Specification) the tests shall be conducted by the Contractor at no extra cost to the KSEBL.

7.1 Type Tests

I) On Complete Conductor

a)	DC resistance test on stranded conductor	: As per Annexure-5A
b)	UTS test on stranded conductor	: As per Annexure-5A
c)	Stress- Strain test on stranded conductor and core at room temperature	: IEC 1089
d)	Stress-strain test on stranded conductor and core at elevated temperature	: As per Annexure-5A
e)	Crush Strength Test	: As per Annexure-5A
f)	Torsional Ductility & Wrapping Test	: As per Annexure-5A
g)	Corona Extinction Voltage Test	: As per Annexure-5A

h) Radio Interference Voltage Test : As per Annexure-5A

II) On Conductor Strand/ Core

a) Heat resistance test on Aluminium Alloy strands : As per Annexure-5A

b) Bending test on core : As per Annexure-5A

c) Compression test on core : As per Annexure-5A

d) Coefficient of linear expansion on core/ core strand : As per Annexure-5A

7.2 Acceptance Tests

a) Visual and dimensional check on drum : As per Annexure-5A

b) Visual check for joints scratches etc. and length measurement of conductor by rewinding : As per Annexure-5A

c) Dimensional check on steel and aluminium strands : As per Annexure-5A

d) Check for lay-ratios of various layers : As per Annexure-5A

e) Galvanizing test : As per Annexure-5A

f) Aluminium thickness on aluminium clad wires (if applicable) : As per Annexure-5A

g) Torsion and Elongation tests on core strand/composite core : As per Annexure-5A

h) Breaking load test on core and Aluminium strands : As per Annexure-5A

i) Wrap test on core & Aluminium strands : IEC: 888 & 889

j) Minimum conductivity test on conductor strands. : IEC: 889

k) Minimum conductivity test on core Strands (if applicable) : As per Annexure-5A

l) Procedure qualification test on welded joint of Aluminium strands : As per Annexure-5A

Note: All the above tests except (j) shall be carried out on aluminium and steel strands after stranding only.

7.3 Routine Test

a) Check to ensure that the joints are as per Specification

b) Check that there are no cuts, fins etc., on the strands.

c) Check that drums are as per Specification

d) All acceptance test as mentioned above to be carried out on 10% of drums

7.4 Tests During Manufacture

a) Chemical analysis of zinc used for galvanizing (if applicable) : As per Annexure-5A
b) Chemical analysis of Aluminium used for making Aluminium strands : As per Annexure-5A
c) Chemical analysis of core strand : As per Annexure-5A

7.5 Test Reports

7.5.1 Copies of type test reports shall be furnished in at least six copies along with one original. One copy will be returned duly certified by the Owner only after which the commercial production of the material shall start.

7.5.2 Record of routine test reports shall be maintained by the Supplier at his works for periodic inspection by the Owner's representative.

7.5.3 Test Certificates of tests during manufacture shall be maintained by the Supplier. These shall be produced for verification as and when desired by the Owner.

7.6 Inspection

7.6.1 The Owner's representative shall at all times be entitled to have access to the works and all places of manufacture, where conductor shall be manufactured, and representative shall have full facilities for unrestricted inspection of the Supplier's works, raw materials and process of manufacture for conducting necessary tests as detailed herein.

7.6.2 The Supplier shall keep the Owner informed in advance of the time of starting and of the progress of manufacture of conductor in its various stages so that arrangements can be made for inspection.

7.6.3 No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested, unless the inspection is waived off by the Owner in writing. In the latter case also, the conductor shall be dispatched only after satisfactory testing for all tests specified herein have been completed.

7.6.4 The acceptance of any quantity of material shall in no way relieve the Supplier of any of his responsibilities for meeting all requirements of the Specification and shall not prevent subsequent rejection it such material is later found to be defective.

7.7 Test Facilities

The following additional test facilities shall be available at the Supplier's works:

Calibration of various testing and measuring equipment including tensile testing machine, resistance measurement facilities, burette, thermometer, barometer etc.

Standard resistance for calibration of resistance bridges.

Finished conductor shall be checked for length verification and surface finish on separate rewinding machine at reduced speed (variable from 8 to 16 meters per minute). The rewinding facilities shall have appropriate clutch system and free of vibrations, jerks etc. with traverse laying facilities.

8 PACKING

8.1 The conductor shall be supplied in non-returnable, strong, wooden drums provided with lagging of adequate strength, constructed to protect the conductor against all damage and displacement during transit, storage and subsequent handling and stringing operations in the field. The Supplier shall be responsible for any loss or damage during transportation handling and storage due to improper packing. The drums shall generally conform to IS:1778, except as otherwise specified hereinafter.

8.2 The drums shall be suitable for wheel mounting and for letting off the conductor under a minimum controlled tension of the order of 5 KN.

8.3 The Bidder should submit their proposed drum drawings along with the bid.

8.4 For conductor, one standard length shall be wound on each drum.

8.5 All wooden components shall be manufactured out of seasoned soft wood free from defects that may materially weaken the component parts of the drums. Preservative treatment shall be applied to the entire drum with preservatives of a quality which is not harmful to the conductor.

8.6 The flanges shall be of two ply construction with each ply at right angles to the adjacent ply and nailed together. The nails shall be driven from the inside face flange, punched and then clenched on the outer face. The thickness of each ply shall not vary by more than 3mm from that indicated in the figure. There shall be at least 3 nails per plank of ply with maximum nail spacing of 75mm. Where a slot is cut in the flange to receive the inner end of the conductor the entrance shall be in line with the periphery of the barrel.

8.7 The wooden battens used for making the barrel of the conductor shall be of segmental type. These shall be nailed to the barrel supports with at least two nails. The battens shall be closely butted and shall provide a round barrel with smooth external surface. The edges of the battens shall be rounded or chamfered to avoid damage to the conductor.

8.8 Barrel studs shall be used for the construction of drums. The flanges shall be holed, and the barrel supports slotted to receive them. The barrel studs shall be threaded over a length on either end, sufficient to accommodate washers, spindle plates and nuts for fixing flanges at the required spacing.

8.9 Normally, the nuts on the studs shall stand protruded of the flanges. All the nails used on the inner surface of the flanges and the drum barrel shall be counter sunk. The ends of barrel shall generally be flushed with the top of the nuts.

8.10 The inner cheek of the flanges and drum barrel surface shall be painted with a bitumen-based paint.

8.11 Before reeling, card board or double corrugated or thick bituminized water-proof bamboo paper shall be secured to the drum barrel and inside of flanges of the drum by means of a suitable commercial adhesive material. After reeling the conductor, the exposed surface of the outer layer of conductor shall be wrapped with water proof thick bituminized bamboo paper to preserve the conductor from dirt, grit and damage during transport and handling.

8.12 A minimum space of 75 mm for conductor shall be provided between the inner surface of the external protective tagging and outer layer of the conductor.

8.13 Each batten shall be securely nailed across grains as far as possible to the flange, edges with at least 2 nails per end. The length of the nails shall not be less than twice the thickness of the battens. The nails shall not protrude above the general surface and shall not have exposed sharp, edges or allow the battens to be released due to corrosion.

8.14 The nuts on the barrel studs shall be tack welded on the one side in order to fully secure them. On the second end, a spring washer shall be used.

8.15 A steel collar shall be used to secure all barrel studs. This collar shall be located between the washers and the steel drum and secured to the central steel plate by welding.

8.16 Outside the protective lagging, there shall be minimum of two binders consisting of hoop iron/galvanised steel wire. Each protective lagging shall have two recesses to accommodate the binders.

8.17 The conductor ends shall be properly sealed and secured on the side of one of the flanges to avoid loosening of the conductor layers during transit and handling.

8.18 As an alternative to wooden drum Bidder may also supply the conductors in non-returnable painted steel drums. After preparation of steel surface according to IS:9954, synthetic enamel paint shall be applied after application of one coat of primer. Wooden/Steel drum will be treated at par for evaluation purpose and accordingly the Bidder should quote in the package.

9 MARKING

Each drum shall have the following information stencilled on it in indelible ink along with other essential data:

(a) Contract/Award letter number.

(b) Name and address of consignee.

(c) Manufacturer’s name and address.

(d) Drum number

(e) Size of conductor

(f) Length of conductor in meters

(g) Arrow marking for unwinding

(h) Position of the conductor ends

(i) Distance between outer-most Layer of conductor and the inner surface of lagging.

(k) Barrel diameter at three locations & an arrows marking at the location of the measurement.

(l) Number of turns in the outer most layer.

(m) Gross weight of drum after putting lagging.

(n) Tear weight of the drum without lagging.

(o) Net weight of the conductor in the drum.

(p) CIP/MICC No.

The above should be indicated in the packing list also.

10 VERIFICATION OF CONDUCTOR LENGTH

The Owner reserves the right to verity the length of conductor after unreeling at least ten (10) percent of the drums in a lot offered for inspection.

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SCHEDULE -1			
GUARANTEED TECHNICAL PARTICULARS OF ACSR / ACCC CONDUCTOR (Separate sheet to be submitted for each type of conductor i.e. Moose/Zebra, Panther, Wolf, Kundah etc. appearing in Price Schedule -2 Material and Spares)			
Sl.	**Description**	**Unit**	**Value guaranteed by the Bidder**
1	Name & address of Manufacturer		
2	Construction of conductor/ Designation of conductor as per IEC:1089		
3	PARTICULARS OF RAW MATERIALS		
3.1	Outer Layers a) Applicable Standard (if any) b) Type of Aluminum alloy c) Minimum purity of aluminium d) Maximum Copper content e) Zirconium content e.f.i.i) Maximum e.f.i.ii) Minimum g) Other elements---------- e.g.i) ---------- e.g.ii) ----------	 % % % % % %	
3.2	Inner Core a) Applicable Standard (if any) b) Material of core c) Chemical composition of core i)---------- ii) ----------	 % %	
3.3	Zinc used for galvanization of inner core a) Minimum purity of zinc	 %	

SCHEDULE -1			
GUARANTEED TECHNICAL PARTICULARS OF ACSR / ACCC CONDUCTOR (Separate sheet to be submitted for each type of conductor i.e. Moose/Zebra, Panther, Wolf, Kundah etc. appearing in Price Schedule -2 Material and Spares)			
Sl.	**Description**	**Unit**	**Value guaranteed by the Bidder**
3.4	Aluminium used for Aluminium Cladding (if applicable) a) Minimum purity of aluminum b) Maximum Copper content c) Other----------elements---------- i) ii)……..	 % % % %	
4.	STRANDS OF OUTER CONDUCTING PART (AFTER STRANDING)		
4.1	Number of outer layers	Nos.	
4.2a	Number of strands		
	a) 1st Layer from core	Nos.	
	b) 2nd Layer from core	Nos.	
	c) 3rd Layer from core	Nos.	
4.2b	Diameter of strands		
	a) Nominal	mm	
	b) Maximum	mm	
	c) Minimum	mm	
4.3	Minimum Breaking load of strand		
	a) Before stranding	kN	
	b) After stranding	kN	
4.4	Resistance of 1m length of strand at 20 deg C	Ohm	
4.5	Final Modulus of elasticity	Kg/sq. mm	
4.6	Final Coefficient of linear expansion	Per C	
5	INNER CORE STRANDS/ INNER CORE (AFTER STRANDING)		

SCHEDULE -1			
GUARANTEED TECHNICAL PARTICULARS OF ACSR / ACCC CONDUCTOR (Separate sheet to be submitted for each type of conductor i.e. Moose/Zebra, Panther, Wolf, Kundah etc. appearing in Price Schedule -2 Material and Spares)			
Sl.	**Description**	**Unit**	**Value guaranteed by the Bidder**
5.1	Number of layers in inner core (excluding central wire)		
5.2	Number of strands		
	a) 1st Layer from centre (excluding central wire)	Nos.	
	b) 2nd Layer from centre	Nos.	
	c) 3rd Layer from centre	Nos.	
5.3a	Diameter		
	a) Nominal	mm	
	b) Maximum	mm	
	c) Minimum	mm	
5.3b	Minimum Breaking load of strand / Core		
	a) Before stranding	kN	
	b) After stranding	kN	
5.4	Resistance of 1m length of strand at 20 deg.C	Ohm	
5.5	Final Modulus of elasticity	Kg/sq. mm	
5.6	Final coefficient of linear expansion	Per 0 C	
5.7	Aluminum cladding of core (if applicable)		
	a) Thickness of cladding		
	i) Maximum	mm	
	ii) Minimum	mm	
	b) Minimum no. of twists in a guage length equal to 100 times diameter of wire which the strands can withstand in the torsion test		
	a) Before stranding	Nos.	
	b) After stranding Nos.	Nos.	
	c) Minimum elongation of strand for a gauge length of 250 mm	%	
	d) Resistance of 1m length of strand at 20 deg. C	Ohm	
6	Galvanising coating		
	a) Minimum mass of zinc coating per sqm. Of uncoated wire surface.	gm	
	b) Min. no. of twists which a single strand shall withstand during torsion test for a length equal to 100times dia of wire after stranding	Nos.	

SCHEDULE -1			
GUARANTEED TECHNICAL PARTICULARS OF ACSR / ACCC CONDUCTOR (Separate sheet to be submitted for each type of conductor i.e. Moose/Zebra, Panther, Wolf, Kundah etc. appearing in Price Schedule -2 Material and Spares)			
Sl.	**Description**	**Unit**	**Value guaranteed by the Bidder**
	c) Minimum elongation of strand for a gauge length of 250 mm	%	
7	COMPLETE ACSR PANTHER CONDUCTOR		
7.1	Cross section drawing of the offered conductor enclosed	Yes / no	
7.2	Diameter of conductor		
	a) Nominal	mm	
	b) Maximum	mm	
	c) Minimum	mm	
7.3	UTS (minimum) of Conductor	kN	
7.4	Lay ratio of conductor		Max.
	a) 1st layer from centre (excluding central wire)		
	b) 2nd Layer		
	c) 3rd Layer		
	d) 4th Layer		
7.5	DC resistance of conductor at 20°C		
7.6	Final Modulus of elasticity		
	a) Up to transition temperature	Per deg C	
	b) Above transition temperature	Per deg C	
7.7	Coefficient of linear expansion		
	Upto transition temperature	Per deg C	
	Above transition temperature	Per deg C	
7.8	Calculation for transition temperature Enclosed	Yes/no	
7.12	Maximum permissible conductor temperature for continuous operation	Deg. C	
7.13	Maximum permissible conductor temperature for short term operation	Deg. C	
7.14	Permissible duration of above short-term	Minutes	

SCHEDULE -1			
GUARANTEED TECHNICAL PARTICULARS OF ACSR / ACCC CONDUCTOR (Separate sheet to be submitted for each type of conductor i.e. Moose/Zebra, Panther, Wolf, Kundah etc. appearing in Price Schedule -2 Material and Spares)			
Sl.	**Description**	**Unit**	**Value guaranteed by the Bidder**
	operation		
7.15	Steady state conductor temperature at specified conductor current of ..... A and under Ambient conditions.		
7.16	AC resistance at maximum continuous operating temperature corresponding to specified maximum operating current	Ohm/ km	
7.17	AC resistance at continuous operating temperature corresponding to specified operating current of .....A	Ohm/ km	
7.18	Details of Creep characteristic for ACSR PANTHER conductor enclosed	Yes/No	
7.19	Sag Tension Calculation		
7.19.1	Sag Tension Calculation enclosed	Yes/No	
7.19.2	Tension at 32 deg. C & no wind	Kg	
7.19.3	Sag & tension at maximum continuous operating temperature	Meters & Kgs	
	i. Tension for following conditions:		
	32 deg. C & full wind condition	kg	
	32 deg. C & Nil wind condition	kg	
	Minimum tempt. & 36% of full wind condition		
	32 deg. C & 75% of full wind condition		
7.20	Direction of lay for outside layer		
7.21	Linear mass of the Conductor		
	a) Standard	Kg/km	
	b) Minimum	Kg/km	
	c) Maximum	Kg/km	
7.22	Standard length of conductor	M	
7.23	Maximum length of conductor that can be offered as single length	M	
7.24	Tolerance on standard length of conductor	%	
7.25	Drum is as per specification	Yes/No	
7.26	No. of cold pressure butt welding equipment	Nos.	

SCHEDULE -1			
GUARANTEED TECHNICAL PARTICULARS OF ACSR / ACCC CONDUCTOR (Separate sheet to be submitted for each type of conductor i.e. Moose/Zebra, Panther, Wolf, Kundah etc. appearing in Price Schedule -2 Material and Spares)			
Sl.	**Description**	**Unit**	**Value guaranteed by the Bidder**
	available at works		

GTP-2			
GUARANTEED TECHNICAL PARTICULARS OF SUSPENSION HARDWARE FITTINGS (Bidder to submit information for all type of Conductors appearing in Price Schedule -2 Material and Spares)			
Sl. No.	**Description**	**Unit**	**Value guaranteed by the Bidder**
1	Name & address of Manufacturer		
2	Address of Manufacturer		
3	Drawing enclosed	Yes/No	
4	Maximum magnetic power loss of suspension clamp at conductor / sub conductor current of ---- amperes (at steady state conductor temperature)	Watt	
5	Slipping strength of suspension assembly (clamp torque Vs slip curve shall be enclosed)	kN	
6	Particulars of standard/AGS Standard / AGS preformed armour rod set for suspension assembly **a)** No. of rods per set **b)** Direction of lay **c)** Overall length after fitting on conductor **d)** Actual length of each rod along its helix **e)** Diameter of each rod **f)** Tolerance in i. Length of each rod ii. Diameter of each rod iii. Difference of length between the longest and shortest rod in a set **g)** Type of Aluminium alloy used for manufacture of PA rod set **h)** UTS of each rod	No Mm Mm Mm ±mm ±mm ±mm Kg/mm^2	
7	Particulars of Elastomer (For AGS Clamp only)		
	a) Supplier of elastomer		
	b) Type of elastomer		

GTP-2			
GUARANTEED TECHNICAL PARTICULARS OF SUSPENSION HARDWARE FITTINGS (Bidder to submit information for all type of Conductors appearing in Price Schedule -2 Material and Spares)			
	c) Shore hardness of elastomer		
	d) Temperature range for which elastomer is Designed		
	e) Moulded on insert	Yes/No	
8	UTS of suspension clamp	Yes/No	
9	Purity of Zinc used for galvanising	%	
12	Maximum permissible continuous operating temperature of		
	i) Clamp body ii) Standard/AGS preformed rods		

GTP-3				
GUARANTEED TECHNICAL PARTICULARS OF TENSION HARDWARE FITTINGS (separate sheet for Single & Double Tension for each type of conductor appearing in Price Schedule -2 Material and Spares)				
Sl.	**Description**	**Unit**	**Value guaranteed by the Bidder**	
1	Name of Manufacturer			
2	Address of Manufacturer			
3	Drawing enclosed		Yes / No	
4	Purity of aluminium used for aluminium sleeve	%		
5	Material for steel sleeve			
	(i) Type of material with chemical composition			
	(ii) Range of Hardness of material (Brinnel Hardness)	BHN	From …….to ……..	
	(iii) Weight of zinc coating	gm/m^2		
			Aluminium/ Alloy	Steel
6	Outside diameter of sleeve before compression	mm		
7	Inside diameter of sleeve before compression	mm		
8	Length of sleeve before compression			
9	Dimensions of sleeve after compression			
	(a) Corner to Corner			
	(b) Surface to Surface			
10	Length of sleeve after compression			
11	Weight of sleeve			
	(a) Aluminium / Aluminium Alloy	kg		
	(b) Steel	kg		
	(c) Total	kg		
12	Electrical resistance of dead end assembly as a percentage of equivalent length of Conductor	%		
13	Slip strength of dead end assembly	kN		
14	UTS of dead end assembly	kN		

15	Purity of Zinc used for galvanising	%	
16	Design calculation of yoke plates and sag adjustment plate enclosed.		Yes / No
19	Maximum permissible continuous operating temperature of dead end assembly		

SCHEDULE -4			
GUARANTEED TECHNICAL PARTICULARS OF MID SPAN COMPRESSION JOINT FOR ACSR / ACCC CONDUCTOR (separate sheet for each type of conductor appearing in Price Schedule -2 Material and Spares)			
Sl.	**Description**	**Unit**	**Value guaranteed by the Bidder**
1.	Name of Manufacturer		
2	Address of Manufacturer		
3	Drawing enclosed	Yes / No	
4	Suitable for conductor size	mm	
5	Purity of aluminium used for aluminium sleeve	%	
6	Material for steel sleeve		
	(i) Type of material with chemical composition		
	(ii) Range of Hardness of material (Brinnel Hardness)	BHN	From …….to …….
	(iii) Weight of zinc coating	gm/m^2	
			Aluminium/alloy
7	Outside diameter of sleeve before compression	mm	
8	Inside diameter of sleeve before compression	mm	
9	Length of sleeve before compression		
10	Dimensions of sleeve after compression		
	(a) Corner to Corner		
	(b) Surface to Surface		
11	Length of sleeve after compression		
12	Weight of sleeve		
	(a) Aluminium	kg	
	(b) Steel	kg	
	(c) Total	kg	
13	Slip strength	kN	

SCHEDULE -4			
GUARANTEED TECHNICAL PARTICULARS OF MID SPAN COMPRESSION JOINT FOR ACSR / ACCC CONDUCTOR (separate sheet for each type of conductor appearing in Price Schedule -2 Material and Spares)			
14	Resistance of the compressed unit expressed, as percentage of the resistivity of equivalent length of bare conductor.	%	
17	Maximum permissible continuous operating temperature of mid span compression joint	Deg. C	

SCHEDULE -5			
GUARANTEED TECHNICAL PARTICULARS OF REPAIR SLEEVE FOR ACSR / ACCC CONDUCTOR (separate sheet for each type of conductor appearing in Price Schedule -2 Material and Spares)			
Sl.	**Description**	**Unit**	**Particulars/ Value**
1.	**Material**		
2.	**Dimension of Aluminum sleeve <u>Before compression</u>**		
i)	Inside diameter	mm	
ii)	Outside diameter	mm	
iii)	Length	mm	
3.	**Dimensions of Aluminum Sleeve <u>After compression</u>**		
i)	Outside dimension (Corner to corner)	mm	
ii)	Outside dimension (face to face)	mm	
4.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	
5.	Maximum Radio Interference Voltage at 1 MHz for phase to earth voltage of 510 kV (rms) under dry condition	Micro Volts (μV)	

SCHEDULE - 6			
GUARANTEED TECHNICAL PARTICULARS OF VIBRATION DAMPER FOR ACSR / ACCC CONDUCTOR (separate sheet for each type of conductor appearing in Price Schedule -2 Material and Spares)			
Sl.	**Description**	**Unit**	**Value guaranteed by the Bidder**
1	Name of Manufacturer		
2	Address of Manufacturer		
3	Drawing enclosed		
	(a) Design Drawing	YES / NO	
	(b) Placement Chart	YES / NO	
4	Suitable for conductor size		
5	Total weight of one damper		
			Right
6	Diameter of each damper mass	mm	
7	Length of each damper mass	mm	
8	Weight of each damper mass	kg	
9	Material of damper masses		
10	Material of clamp		
11	Material of the stranded messenger cable		
12	Number of strands in stranded messenger cable		
13	Lay ratio of stranded messenger cable		
14	Minimum ultimate tensile strength of stranded messenger cable	Kg/mm^2	
15	Slip strength of stranded messenger cable (mass pull off)	kN	
16	Resonance frequencies		
	(a) First frequency	Hz	
	(b) Second frequency	Hz	
17	Designed clamping torque	Kg-m	

SCHEDULE - 6			
GUARANTEED TECHNICAL PARTICULARS OF VIBRATION DAMPER FOR ACSR / ACCC CONDUCTOR (separate sheet for each type of conductor appearing in Price Schedule -2 Material and Spares)			
18	Slipping strength of damper clamp		
	(a) Before fatigue test	kN	
	(b) After fatigue test	kN	
19	Magnetic power loss per vibration damper watts for ---Amps, 50 Hz Alternating Current [average continuous operating current]	watts	
20	Maximum permissible continuous operating temperature of Vibration Damper	Deg. C	
22	Percentage variation in reactance after fatigue test in comparison with that. before fatigue test	%	
23	Percentage variation in power dissipation after fatigue test in comparison with that before fatigue test	%	

ANNEXURE-5A

TESTS ON CONDUCTORS

1.1 UTS Test on Stranded Conductor

Circles perpendicular to the axis of the conductor shall be marked at two places on a sample of conductor of minimum 5 m length between fixing arrangement suitably fixed by appropriate fittings on a tensile testing machine. The load shall be increased at a steady rate up to 50% of minimum specified UTS and held for one minute. The circles drawn shall not be distorted due to relative movement of strands. Thereafter the load shall be increased at steady rate to minimum UTS and held for one minute. The Conductor sample shall not fail during this period. The applied load shall then be increased until the failing load is reached, and the value recorded.

1.2 Corona Extinction Voltage Test

One sample of conductor of 5m length shall be strung. In case of twin conductor, two samples shall be arranged with the actual sub-conductor spacing between them. This sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not less than 154 KV (rms) for 220 KV system line to ground under dry condition. There shall be no evidence of corona on any part of sample when all possible sources of corona are photographed in a darkened room. The test shall be conducted without corona control rings. The voltage shall be corrected for standard atmospheric conditions. However, small corona rings shall be used to prevent corona in the end fittings.

1.3 Radio Interference Voltage Test

Under the conditions as specified under (1.2) above, the insulator string along with complete hardware fittings shall have a radio interference voltage level below 1000 micro volts at one MHz when subjected to 50 Hz AC voltage of 154kV line to ground under dry condition for 220kV AC line. The test procedure shall be in accordance with IS: 8263/ IEC: 60437. The Test may be carried out with corona control rings and arcing horns.

1.4 D.C. Resistance Test on Stranded Conductor

On a conductor sample of minimum 5m length two contact-clamps shall be fixed with a predetermined bolt torque. The resistance shall be measured by a Kelvin double bridge or using micro ohm meter of suitable accuracy by placing the clamps initially zero meter and subsequently one meter apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20^0C as per IS: 398 (Part-IV)/(Part-V). The resistance corrected at 20deg C shall conform to the requirements of this Specification.

1.5 Coefficient of linear expansion for core/core strands

The temperature and elongation on a sample shall be continuously measured and recorded at interval of approximately 15degree C from 15degree C to maximum designed continuous operating temperature corresponding to rated current as of

specification by changing the temperature by suitable means. Coefficient of linear expansion shall be determined from the measured results.

1.6 Breaking load test on Aluminium Alloy & Core strands and D.C Resistance test on Aluminium Alloy wire

The above tests shall be carried out as per IEC: 888/889 and the results shall meet the requirements of the specification.

1.7 Wrap test on Steel Core strand

The wrap test on steel strands shall be meet the requirements of IEC: 888.0. In case of aluminium clad core wire, the same shall be wrapped around a mandel of diameter of five times that of the strand to form a helix of eight turns. The strand shall be unwrapped. No breakage of strand shall occur.

1.8 Heat Resistance test on Aluminium Alloy wire (If Applicable)

Breaking load test as per clause 1.5 above shall be carried out before and after heating the sample in uniform heat furnace at 280 degC (+5/-3 degC) temperature for one hour. The breaking strength of the wire after heating shall not be less than the 90% of the breaking strength before heating.

1.9 Chemical Analysis of Aluminium Alloy and Core

Samples taken from the Aluminium and core coils/strands shall be chemically/spectrographically analyzed. The same shall be in conformity to the particulars guaranteed by the bidder so as to meet the requirements stated in this Specification.

1.10 Visual and Dimensional Check on Drums

The drums shall be visually and dimensionally checked to ensure that they conform to the approved drawings.

1.11 Visual Check for Joints, Scratches etc.

Conductor drums shall be rewound in the presence of the Owner. The Owner shall visually check for scratches, joints etc. and that the conductor generally conform to the requirements of this Specification. Ten percent (10%) drums from each lot shall be rewound in the presence of the Owner's representative.

1.12 Dimensional Check on Core Strands and Aluminium Alloy Strands

The individual strands shall be dimensionally checked to ensure that they conform to the requirement of this Specification.

1.13 Check for Lay-ratios of Various Layers

The lay-ratios of various layers shall be checked to ensure that they conform to the guaranteed values furnished by the Contractor.

1.14 Procedure Qualification test on welded Aluminium Alloy strands.

Two Aluminium Alloy wire shall be welded as per the approved quality plan and shall be subjected to tensile load. The breaking strength of the welded joint of the wire shall not be less than the guaranteed breaking strength of individual strands.

1.15 Chemical Analysis of Zinc

Samples taken from the zinc ingots shall be chemically/ spectrographically analyzed. The same shall be in conformity to the requirements stated in the Specification.

1.16 Galvanizing Test

The test procedure shall be as specified in IEC: 888.0. The material shall conform to the requirements of this Specification. The adherence of zinc shall be checked by wrapping around a mandrel four times the diameter of steel wire.

1.17 Torsion and Elongation Tests on Core Strands

The test procedures shall be as per clause No. 10.3 of IEC: 888.0. In torsion test, the number of complete twists before fracture shall not be less than 18 on a length equal to 100 times the standard diameter of the strand. In case test sample length is less or more than 100 times the stranded diameter of the strand, the minimum number of twists will be proportioned to the length and if number comes in the fraction then it will be rounded off to next higher whole number. In elongation test, the elongation of the strand shall not be less than 1.5% for a gauge length of 250 mm.

1.18 Bending test on conductor core strand

A sample of conductor core strand measuring 30 cm in length shall be subject to bending with help of a vise. The vised length of wire should be 5 cm and radius of bend 4.8 mm. The bending should be first 90 degrees left and 90 degrees right. After this operation the strand should cut at the bending point. There should be no separation of core and aluminium at the bending point after this operation.

1.19 Compression test on steel strand

A sample of steel core strand 10 mm in length is to be compressed by a plate with a load of 3600 kgs. The aluminium and core strand should not break.

1.20 Aluminium conductivity test on aluminium clad strand (If Applicable)

Resistivity test as per IEC-468 shall be conducted to confirm minimum conductivity as per specification requirement.

1.21 Minimum conductivity test on thermal resistant aluminium alloy strands (If Applicable)

Resistivity test as per IEC-468/IEC 889 shall be conducted to confirm minimum conductivity as per specification requirement.

1.22 Stress-strain test at elevated temperature

Stress-strain test as per IEC-1089 shall be conducted keeping conductor temperature at designed maximum temperature. The guaranteed Core UTS shall be considered for performing the test.

1.23 High Temperature endurance & creep test

A conductor sample of length equal to at least 100 X d + 2 X a (where, d is the conductor diameter and a is the distance between the end fitting and the gauge length) shall be strung at tension equal to 25 % of conductor UTS. The distance, a, shall be at least 25 % of the gauge length or 2 m whichever is the smaller. The conductor sample shall be subjected to two tests as indicated below:

(i) The conductor temperature shall be maintained at 20 deg C for 1000 hours. The elongation/creep strain of the conductor during this period shall be measured and recorded at end of 1 hour, 10 hour, 100 hour and subsequently every 100 hour up to 1000 hours' time period.

(ii) The conductor temperature shall be increased to design maximum temperature in steps of 20 deg. C and thermal elongation of the conductor sample shall be measured & recorded at each step. The temperature shall be held at each step for sufficient duration for stabilization of temperature. Further, the temperature of the conductor shall be maintained at maximum designed continuous operating temperature (+10 Deg. C) for 1000 hours. The elongation/creep strain of the conductor during this period shall be measured and recorded at end of 1 hour, 10 hour, 100 hour and subsequently every 100 hour up to 1000 hours' time period. After completion of the above, the core of the conductor sample shall be subjected to UTS test where the conductor core should achieve 95% of the guaranteed core UTS. The supplier shall plot the thermal elongation with temperature. In case of polymer composite core conductor, the flexural strength & glass transition temperature of the core shall also be evaluated and the same shall not be degraded by more than 10 % over the initial value. The supplier shall plot the thermal elongation with temperature.

The supplier shall furnish details of creep characteristic in respect of the conducted based on laboratory test and other laboratory investigations/ experimental conducted on similar type of conductor and shall indicate creep strain values corresponding to 1 month, 6 month, 1 year, 10 year & 20 year creep at everyday tension & continuous designed temperature as well as room temperature.

1.24 Axial Impact Test

The conductor sample shall be suspended vertically and load applied by dropping a 650 Kg from an elevation of 4 meters above the sample. The impact velocity shall be not be less than 8 m/sec. with an initial pre-tension of 200 kgs. The curve for load vs time shall be recorded and recorded load of failure for core shall not be less than UTS of core.

1.25 Crush Strength Test

A section of conductor is to be crushed between two six inch steel plates. Load shall be held at 350 Kgs for 1 minute and then released. All the core strands shall be subsequently disassembled and tensile tested. All the core strands shall exhibit full strength retention

1.26 Torsional Ductility Test

The conductor sample of 10-15m shall be loaded to 20% of UTS and then loaded in increasing steps of +/-180 deg, the core shall withstand at least 16 such rotation for steel core and there shall be no damage to steel core wires and incase of trapezoidal shaped conductor or composite conductor, after 4 rotations and after separation of aluminum strands, the aluminum wires shall be cut and removed from the conductor and the exposed core shall be twisted and shall withstand up to 16 rotations.

1.27 Sheaves Test (if required)

The conductor sample of minimum length of 35 meter shall be tensioned at 22 % of the UTS and shall be passed through pulleys having diameter of 32 times that of the conductor with angle of 20 deg. between the pulleys. The conductor shall be passed over the pulleys 36 times a speed of 2 m/sec. After this test UTS test on the conductor shall be carried out.

SECTION –6

TECHNICAL SPECIFICATION OF OPGW

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SECTION –6

TECHNICAL SPECIFICATION OF OPGW

1 SPECIFICATION FOR OPGW CABLING AND ASSOCIATED HARDWARE & FITTINGS

The broad scope of this specification includes the design, engineering, manufacturing, supply, transportation, insurance, delivery at site, unloading, handling, storage, supervision of erection/ installation, installation, splicing, termination, testing, demonstration for acceptance and commissioning and documentation for:

a) OPGW fibre optic cable including all associated hardware, accessories & fittings

b) Fibre Optic Distribution Panels (FODP) & Joint Box

c) Supply of spares

d) Splicing of fibres

e) Supply of all test equipment

f) All other associated work/items described in the technical specifications.

This section of the technical specification describes the functional and technical specifications of OPGW cabling and associated hardware and fittings.

1.1 Fibre Optic Cabling

In this section of the technical specification, the functional & technical specifications of OPGW cable, associated hardware & fittings for the requirements for G.652D Dual-Window Single Mode (DWSM) telecommunications grade fibre optic cable is mentioned.

All optical fibre cabling including fibre itself and all associated installation hardware shall have a minimum guaranteed design life span of 25 years. Documentary evidence in support of guaranteed life span of cable & fibre shall be submitted by the Contractor during detailed engineering.

1.2 Required Optical Fibre Characteristics

The optical fibre to be provided should have following characteristic.

1.3 Physical Characteristic

Dual-Window Single mode (DWSM), G.652D optical fibres shall be provided in the fibre optic cables. DWSM optical fibres shall meet the requirements defined in Table 6a.

1.4 Attenuation

The attenuation coefficient for wavelengths between 1525 nm and 1575 nm shall not exceed the attenuation coefficient at 1550 nm by more than 0.05 dB/km. The

attenuation coefficient between 1285 nm and 1330 nm shall not exceed the attenuation coefficient at 1310 nm by more than 0.05 dB/km. The attenuation of the fibre shall be distributed uniformly throughout its length such that there are no point discontinuities in excess of 0.10 dB. The fibre attenuation characteristics specified in table 6a shall be "guaranteed" fibre attenuation of any & every fibre reel. The overall optical fibre path attenuation shall not be more than calculated below:

Maximum attenuation @ 1550nm: 0.21 dB/km x total km + 0.05 dB/splice x no. of splices + 0.5 dB/connector x no. of connectors

Maximum attenuation @ 1310nm: 0.35dB/km x total km + 0.05 dB/splice x no. of splices + 0.5 dB/connector x no. of connectors

TABLE 6a: DWSM OPTICAL FIBRE CHARACTERISTICS

Fibre Description:	Dual-Window Single-Mode
Mode Field Diameter:	8.6 to 9.5 µm (± 0.6µm)
Cladding Diameter:	125.0 µm ± 1 µm
Mode field concentricity error	≤ 0.6µm
Cladding non-circularity	≤ 1%
Cable Cut-off Wavelength l cc	≤ 1260 nm
1550 nm loss performance	As per ITU-T G.652 D
Proof Test Level	≥ 0.69 GPa
Attenuation Coefficient:	@ 1310 nm ≤ 0.35 dB/km & @ 1550 nm ≤ 0.21 dB/km
Chromatic Dispersion; Maximum: Zero Dispersion Wavelength: Zero Dispersion Slope:	18 ps/ (nm x km) @ 1550 nm, 3.5 ps/ (nm x km) 1288-1339nm 5.3 ps/ (nm x km) 1271-1360nm, 1300 to 1324nm 0.092 ps/ (nm^2 x km) maximum
Polarization mode dispersion coefficient	≤ 0.2 ps/km^½
Temperature Dependence:	Induced attenuation ≤ 0.05 dB (-60°C - +85°C)
Bend Performance:	@ 1310 nm (75±2 mm dia Mandrel), 100 turns; Attenuation Rise ≤ 0.05 dB @ 1550 nm (30±1 mm radius Mandrel), 100 turns; Attenuation Rise ≤ 0.05 dB @ 1550 nm (32±0.5 mm dia Mandrel, 1 turn; Attenuation Rise ≤ 0.50 dB

1.5 Fibre Optic Cable Construction

The OPGW (Optical Ground Wire) cable is proposed to be installed on the 220/110KV MCMV transmission lines. The design of cable shall account for the varying operating and environmental conditions that the cable shall experience while in service. The OPGW cable to be supplied shall be designed to meet the overall requirements of all the transmission lines. Normally the tower span of the lines shall not exceed 600m, however, some of the spans may be up to around 1000m or more.

1.6 Optical Fibre Cable Link Lengths

The estimated optical fibre link lengths shall be provided by Contractor for transmission line route length. However, the Contractor shall supply & install the optical fibre cable as required based on detailed site survey already carried out by KSEBL. The Contractor shall verify the transmission line route length and the Contract price shall be adjusted accordingly.

For the purpose of payment, the optical fibre link lengths are defined as transmission line route lengths from Gantry at one terminating station to the Gantry in the other terminating station. The actual cable lengths to be delivered shall take into account various factors such as sag, service loops, splicing, working lengths & wastage etc. The unit rate for FO cable quoted in the Bid price Schedules shall take into account all such factors.

1.7 Optical Fibre Identification

Individual optical fibres within a fibre unit and fibre units shall be identifiable in accordance with EIA/TIA 598 or IEC 60304 or Bellcore GR-20 colour-coding scheme.

Colouring utilized for colour coding optical fibres shall be integrated into the fibre coating and shall be homogeneous. The colour shall not bleed from one fibre to another and shall not fade during fibre preparation for termination or splicing.

Each cable shall have traceability of each fibre back to the original fibre manufacturer's fibre number and parameters of the fibre. If more than the specified number of fibres is included in any cable, the spare fibres shall be tested by the cable manufacturer and any defective fibres shall be suitably bundled, tagged and identified at the factory by the vendor.

1.8 Buffer Tube

Loose tube construction shall be implemented. The individually coated optical fibre(s) shall be surrounded by a buffer for protection from physical damage during fabrication, installation and operation of the cable. The fibre coating and buffer shall be strippable for splicing and termination. Each fibre unit shall be individually identifiable utilizing colour coding. Buffer tubes shall be filled with a water-blocking gel.

1.9 Optical Fibre Strain & Sag-Tension chart

The OPGW cable shall be designed and installed such that the optical fibres experience no strain under all loading conditions defined in IS 802. Zero fibre strain condition shall apply even after a 25 year cable creep.

For the purpose of this specification, the following definitions shall apply:

- Maximum Working Tension (MWT) is defined as the maximum cable tension at which there is no fibre strain.
- The no fibre strain condition is defined as fibre strain of less than or equal to 0.05%, as determined by direct measurements through IEC/ ETSI (FOTP) specified optical reflectometry.
- The Cable strain margin is defined as the maximum cable strain at which there is no fibre strain.
- The cable Maximum Allowable Tension (MAT) is defined as the maximum tension experienced by the Cable under the worst case loading condition.
- The cable max strain is defined as the maximum strain experienced by the Cable under the worst case loading condition.
- The cable Every Day Tension (EDT) is defined as the maximum cable tension on any span under normal conditions.
- The Ultimate /Rated Tensile Strength (UTS/ RTS/ breaking strength) is defined as the maximum tensile load applied and held constant for one minute at which the specimen shall not break.
- While preparing the Sag-tension charts for the OPGW cable the following conditions shall be met:
- The Max Allowable Tension (MAT) / max strain shall be less than or equal to the MWT/ Strain margin of the cable.
- The sag shall not exceed the earth wire sag in all conditions.
- The Max Allowable Tension shall also be less than or equal to 0.4 times the UTS of OPGW. However, Maximum Allowable Tension up to 0.5 times the UTS of OPGW may be accepted, subject to no fibre strain.
- The 25 year creep at 25% of UTS (creep test as per IEEE 1138) shall be such that the 25 year creep plus the cable strain at Max Allowable Tension (MAT) is less than or equal to the cable strain margin.
- The everyday tension (EDT) shall not exceed 20% of the UTS for the OPGW cable.

The Sag-tension chart of OPGW cable indicating the maximum tension, cable strain and sag shall be calculated and submitted along with the bid under various conditions mentioned below:

1. 53° C, no wind and no ice

2. 32° C, no wind and no ice
3. 0°C, no wind and no ice
4. 32° C, full wind and no ice
5. 32° C, 75% full wind and no ice
6. 0° C, 2/3rd / 36% of full wind (IS 802)

The above cases shall be considered for the spans from 100 m to 600 m or higher span length in the range of 50 m spans. Max. Vertical sag, max. tension and max sag at 0°C & no wind shall be considered in line with the design parameter of transmission line. The full wind load shall be considered as the design wind load for all the specified transmission lines as per relevant IS 802 version and the sag-tension chart shall be submitted considering the transmission lines. In case of any span higher than 600m, suitable OPGW cable meeting sag-tension requirement of transmission line shall also be provided by the Contractor. The Contractor shall submit the stringing chart for review of KSEBL.

1.10 Cable Materials

The materials used for optical fibre cable construction, shall meet the following requirements:

1.11 Filling Materials

The interstices of the fibre optic unit and cable shall be filled with a suitable compound to prohibit any moisture ingress or any water longitudinal migration within the fibre optic unit or along the fibre optic cable. The water tightness of the cable shall meet or exceed the test performance criteria as per IEC 60794-1-F-5.

The filling compound used shall be a non-toxic homogeneous waterproofing compound that is free of dirt and foreign matter, non-hygroscopic, electrically non-conductive and non-nutritive to fungus. The compound shall also be fully compatible with all cable components it may come in contact with and shall inhibit the generation of hydrogen within the cable.

The waterproofing filling materials shall not affect fibre coating, colour coding, or encapsulant commonly used in splice enclosures, shall be dermatologically safe, non-staining and easily removable with a non-toxic cleaning solvent.

1.12 Metallic Members

When the fibre optic cable design incorporates metallic elements in its construction, all metallic elements shall be electrically continuous.

1.13 Marking, Packaging and Shipping

This section describes the requirements for marking, packaging and shipping the overhead fibre optic cable.

(a) Drum Markings: Each side of every reel of cable shall be permanently marked in white lettering with the vendors' address, the Purchaser’s destination

address, cable part number and specification as to the type of cable, length, number of fibres, a unique drum number including the name of the transmission line & segment no., factory inspection stamp and date.

(b) Cable Drums: All optical fibre cabling shall be supplied on sturdy, corrosion resistant, steel drums suitable for long periods of storage and re-transport & handling. All drums provided with lagging or PP sheets of adequate strength, constructed to protect the cabling against all damage and displacement during transit, storage and subsequent handling during installation. Both ends of the cable shall be sealed as to prevent the escape of filling compounds and dust & moisture ingress during shipment and handling. Spare cable caps shall be provided with each drum as required.

The spare cable shall be supplied on sturdy, corrosion resistant, steel drums suitable for long periods of storage and re-transport & handling.

There shall be no factory splices allowed within a continuous length of cable. Only one continuous cable length shall be provided on each drum. The lengths of cable to be supplied on each drum shall be determined by a "schedule" prepared by the Contractor and approved by the owner.

1.14 Optical Ground Wire (OPGW)

OPGW cable construction shall comply with IEEE-1138, 2009. The cable provided shall meet both the construction and performance requirements such that the ground wire function, the optical fibre integrity and optical transmission characteristics are suitable for the intended purpose. The cable shall consist of optical fibre units as defined in this specification. There shall be no factory splices within the cable structure of a continuous cable length.

The composite fibre optic overhead ground wire shall be made up of multiple buffer tubes embedded in a water tight aluminium/ aluminium alloy/stainless steel with aluminium coating protective central fibre optic unit surrounded by concentric-lay stranded metallic wires in single or multiple layers. In case of central Aluminum tube type OPGW, each buffer tube shall have maximum 12 no. of fibers and all fibers in single buffer tube is not acceptable. The dual purpose of the composite cable is to provide the electrical and physical characteristics of conventional overhead ground wire while providing the optical transmission properties of optical fibre.

1.15 Central Fibre Optic Unit

The central fibre optic unit shall be designed to house and protect multiple buffered optical fibre units from damage due to forces such as crushing, bending, twisting, tensile stress and moisture. The central fibre optic unit and the outer stranded metallic conductors shall serve together as an integral unit to protect the optical fibres from degradation due to vibration and galloping, wind and ice loadings, wide temperature variations, lightning and fault current, as well as environmental effects which may produce hydrogen.

The OPGW design of dissimilar materials such as stainless steel tube with aluminium or aluminium–clad-steel wire strands are not allowed. Central fibre

optic unit may be of aluminium or stainless steel tube with aluminium protective coating. In case of aluminium protective coating, the coating must completely cover the tubes leaving no exposed areas of tubing that can make electrical contact either directly or indirectly through moisture, contamination, protrusions, etc with the surrounding stranded wires. The tube may be fabricated as a seamless tube, seam welded, or a tube without a welded seam.

1.16 Basic Construction

The OPGW cable construction shall conform to the applicable requirements of this specification, applicable clauses of IEC 61089 related to stranded conductors. In addition, the basic construction shall include bare concentric-lay stranded metallic wires with the outer layer having left hand lay. The wires may be of multiple layers with a combination of various metallic wires within each layer. The direction of lay for each successive layer shall be reversed. The finished wires shall contain no joints or splices unless otherwise agreed to by the KSEBL and shall conform to all applicable clauses of IEC 61089 as they pertain to stranded conductors.

The wires shall be so stranded that when the complete OPGW is cut, the individual wires can be readily regrouped and then held in place by one hand.

1.17 Breaking Strength

The rated breaking strength of the completed OPGW shall be taken as not more than 90 percent of the sum of the rated breaking strengths of the individual wires, calculated from their nominal diameter and the specified minimum tensile strength.

The rated breaking strength shall not include the strength of the optical unit. The fibre optic unit shall not be considered a load bearing tension member when determining the total rated breaking strength of the composite conductor.

1.18 Electrical and Mechanical Requirements

“Table 6b” provides OPGW Electrical and Mechanical Requirements for the minimum performance characteristics. Additionally, the OPGW mechanical & electrical characteristics shall be similar to that of the earthwire being replaced such that there is no or minimal consequential increase in stresses on towers. For the purposes of determining the appropriate Max Working Tension limit for the OPGW cable, IS 802 shall be applied. However, the OPGW installation sag & tension charts shall be based on IS 802 version to which the line is originally designed. For the OPGW cable design selection and preparation of sag tension charts, the limits specified in this section shall also be satisfied.

TABLE 6b: OPGW ELECTRICAL AND MECHANICAL REQUIREMENTS

1)	Everyday Tension	≤ 20% of UTS of OPGW
2)	D.C. Resistance at 20ºC:	< 1.0 ohm/Km
3)	Short Circuit Current	≥ 6.32 kA for 1.0 second (for 220 KV & above lines) ≥ 5.6 kA for 1.0 second (for 132 KV & 66 KV lines) Short Circuit shall be applicable as per the voltage level of the line
4)	Ultimate tensile Strength(UTS)	The following parameter of the existing earth wire also shall be considered for UTS design
4a)	Outer diameter(220/100kV)	10.98/9.75 mm
4b)	UTS (220/110kV)	68.4/56.02 KN
4c)	Weight per Km (220/110kV)	583/428 Kgs

1.19 Operating conditions

Since OPGW shall be located at the top of the transmission line support structure, it will be subjected to Aeolian vibration, Galloping and Lightning strikes. It will also carry ground fault currents. Therefore, its electrical and mechanical properties shall be same or similar as those required of conventional ground conductors.

1.20 Installation Hardware

The scope of supply includes all required fittings and hardware such as Tension assembly, Suspension assembly, Vibration dampers, reinforcing rods, Earthing clamps, Down-lead clamps, splice enclosure etc. The Bidder shall provide documentation justifying the adequacy and suitability of the hardware supplied. The quantity of hardware & fittings to meet any eventuality during site installation minimum @ 1% shall also be provided as part of set/ km for each transmission line without any additional cost to KSEBL.

The OPGW hardware fittings and accessories shall follow the general requirements regarding design, materials, dimensions & tolerances, protection against corrosion and markings as specified in clause 4.0 of EN 61284: 1997 (IEC 61284). The shear strength of all bolts shall be at least 1.5 times the maximum installation torque. The OPGW hardware & accessories drawing & GTP (DRS) document shall consist of three parts:

(1) A technical particular sheet

(2) An assembly drawing i.e. level 1 drawing and

(3) Component level drawings i.e. level 2 & lower drawings. All component reference numbers, dimensions and tolerances, bolt tightening torques & shear strength and ratings such as UTS, slip strength etc shall be marked on the drawings.

The fittings and accessories described herein are indicative of installation hardware typically used for OPGW installations and shall not necessarily be limited to the following:

(a) Suspension Assemblies: Preformed armour grip suspension clamps and aluminium alloy armour rods/ reinforcing rods shall be used. The suspension clamps shall be designed to carry a vertical load of not less than 25 KN. The suspension clamps slippage shall occur between 12kN and 17 kN as measured.

The Contractor shall supply all the components of the suspension assembly including shackles, bolts, nuts, washers, split pins, etc. The total drop of the suspension assembly shall not exceed 150 mm (measured from the centre point of attachment to the centre point of the OPGW). The design of the assembly shall be such that the direction of run of the OPGW shall be the same as that of the conductor.

(b) Dead End Clamp Assemblies: All dead-end clamp assemblies shall preferably be of preformed armoured grip type and shall include all necessary hardware for attaching the assembly to the tower strain plates. Dead end clamps shall allow the OPGW to pass through continuously without cable cutting. The slip strength shall be rated not less than 95% of the rated tensile strength of the OPGW.

(c) Clamp Assembly Earthing Wire: Earthing wire consisting of a 1500 mm length of aluminium or aluminium alloy conductor equivalent in size to the OPGW shall be used to earth suspension and dead-end clamp assemblies to the tower structure. The earthing wire shall be permanently fitted with lugs at each end. The lugs shall be attached to the clamp assembly at one end and the tower structure at the other.

(d) Structure Attachment Clamp Assemblies: Clamp assemblies used to attach the OPGW to the structures, shall have two parallel grooves for the OPGW, one on either side of the connecting bolt. The clamps shall be such that clamping characteristics do not alter adversely when only one OPGW is installed. The tower attachment plates shall locate the OPGW on the inside of the tower and shall be attached directly to the tower legs/cross-members without drilling or any other structural modifications.

(e) Vibration Dampers: Vibration dampers type 4R Stockbridge or equivalent, having four (4) different frequencies spread within the Aeolian frequency bandwidth corresponding to wind speed of 1m/s to 7 m/s, shall be used for suspension and tension points in each span. The Contractor shall determine the exact numbers and placement(s) of vibration dampers

through a detailed vibration analysis as specified in technical specifications.

One damper minimum on each side per OPGW cable for suspension points and two dampers minimum on each side per OPGW cable for tension points shall be used for nominal design span of 400 meters. For all other ruling spans, the number of vibration damper shall be based on vibration analysis.

The clamp of the vibration damper shall be made of high strength aluminum alloy of type LM-6. It shall be capable of supporting the damper and prevent damage or chaffing of the conductor during erection or continued operation. The clamp shall have smooth and permanent grip to keep the damper in position on the OPGW cable without damaging the strands or causing premature fatigue failure of the OPGW cable under the clamp. The clamp groove shall be in uniform contact with the OPGW cable over the entire clamping surface except for the rounded edges. The groove of the clamp body and clamp cap shall be smooth, free from projections, grit or other materials which could cause damage to the OPGW cable when the clamp is installed. Clamping bolts shall be provided with self-locking nuts and designed to prevent corrosion of threads or loosening in service.

The messenger cable shall be made of high strength galvanised steel/stainless steel. It shall be of preformed and post formed quality in order to prevent subsequent drop of weight and to maintain consistent flexural stiffness of the cable in service. The messenger cable other than stainless steel shall be hot dip galvanised in accordance with the recommendations of IS:4826 for heavily coated wires.

The damper mass shall be made of hot dip galvanised mild steel/cast iron or a permanent mould cast zinc alloy. All castings shall be free from defects such as cracks, shrinkage, inclusions and blow holes etc. The surface of the damper masses shall be smooth.

The damper clamp shall be casted over the messenger cable and offer sufficient and permanent grip on it. The messenger cable shall not slip out of the grip at a load less than the mass pull-off value of the damper. The damper masses made of material other-than zinc alloy shall be fixed to the messenger cable in a suitable manner in order to avoid excessive stress concentration on the messenger cables which shall cause premature fatigue failure of the same. The messenger cable ends shall be suitably and effectively sealed to prevent corrosion. The damper mass made of zinc alloy shall be casted over the messenger cable and have sufficient and permanent grip on the messenger cable under all service conditions.

The contractor must indicate the clamp bolt tightening torque to ensure that the slip strength of the clamp is maintained between 2.5 kN and 5 kN. The clamp when installed on the OPGW cable shall not cause excessive stress concentration on the OPGW cable leading to permanent deformation of the OPGW strands and premature fatigue failure in operation.

The vibration analysis of the system, with and without damper and dynamic characteristics of the damper as detailed in Technical Specification, shall have to be submitted. The technical particulars for vibration analysis and damping design of the system are as follows:

Sl No.	Description	Technical Particulars
1	Span Length in meters (i) Ruling design span: (ii) Maximum span: (iii) Minimum Span:	 400 meters 1100 meters 100 meters
2	Configuration:	As per Specifications
3	Tensile load in each:	As per sag tension calculations
4	Armour rods used:	Standard preformed armour rods/AGS
5	Maximum permissible dynamic strain:	5 +/- 150 micro strains

The damper placement chart for spans ranging from 100m to 1100m shall be submitted by the Contractor. Placement charts should be duly supported with relevant technical documents and sample calculations.

The damper placement charts shall include the following

(1) Location of the dampers for various combinations of spans and line tensions clearly indicating the number of dampers to be installed per OPGW cable per span.

(2) Placement distances clearly identifying the extremities between which the distances are to be measured.

(3) Placement recommendation depending upon type of suspension clamps (viz Free center type/Armour grip type etc.)

(4) The influence of mid span compression joints, repair sleeves and armour rods (standard and AGS) in the placement of dampers.

1.21 Fibre Optic Splice Enclosures (Joint Box)

All splices shall be encased in Fibre Optic Splice Enclosures. Suitable splice enclosures shall be provided to encase the optical cable splices in protective, moisture and dust free environment. Splice enclosures shall comply with ingress protection class IP 66 or better. The splice enclosures shall be designed for the storage and protection of required number of optical fibre splices and equipped with sufficient number of splice trays for splicing all fibres in the cable. Not more than 12 fibres shall be terminated in a single splice tray. They shall be filled with suitable encapsulate that is easily removable should re-entry be required into the enclosures.

Splice enclosures shall be suitable for outdoor use with each of the cable types provided under this contract. Splice enclosures shall be appropriate for mounting on transmission line towers above anti-climb guard levels at about 10 metres from top of the tower and shall accommodate pass-through splicing. Contractor shall be responsible for splicing of fibres and installation of splice enclosures.

1.22 Optical Fibre Splices

Splicing of the optical fibre cabling shall be minimized through careful Contractor planning. There shall be no mid-span splices allowed. All required splices shall be planned to occur on tower structures. All optical fibre splicing shall comply with the following:

(a) All fibre splices shall be accomplished through fusion splicing.

(b) Each fibre splice shall be fitted with a splice protection sheath fitted over the final splice.

(c) All splices and bare fibre shall be neatly installed in covered splice trays.

(d) For each link, bi-directional attenuation of single mode fusion splices, shall not average more than 0.05 dB and no single splice loss shall exceed 0.1 dB when measured at 1550 nm.

(e) For splicing, fibre optic cable service loops of adequate length shall be provided so that all splices occurring at tower structures can be performed at ground level.

1.23 Service Loops

For purposes of this specification, cable and fibre service loops are defined as slack (extra) cable and fibre provided for facilitating the installation, maintenance and repair of the optical fibre cable plant.

(a) Outdoor Cable Service Loops: In-line splice enclosures installed outdoors and mounted on the utility towers shall be installed with sufficient fibre optic cable service loops such that the recommended minimum bend radius is maintained while allowing for installation or maintenance of the cable to be performed in a controlled environment at ground level.

(b) Fibre Units Service Loops: For all fibre optic cable splicing, the cable shall be stripped back a sufficient length such that the fan-out of fibre units shall provide for at least one (1) metre of fibre unit service loop between the stripped cable and the bare fibre fan-out.

(c) Pigtail Service Loops: Connectorised pigtails spliced to bare fibres shall provide at least 1 metre of service loop installed in the FODP fibre organizer and at least one (1) metre of service loop to the couplings neatly stored behind the FODP coupling panels.

(d) Fibre Service Loops: At least 0.5 metre of bare fibre service loop shall be provided on each side of all fibre splices. The bare fibre service loops shall be neatly and safely installed inside covered splice trays.

2 INSPECTION & TESTING REQUIREMENT

All materials furnished, and all work performed under this Contract shall be inspected and tested. Deliverables shall not be shipped until all required inspections and tests have been completed, and all deficiencies have been corrected to comply with this Specification and approved for shipment by the KSEBL.

Except where otherwise specified, the Contractor shall provide all manpower and materials for tests, including testing facilities, logistics, power and instrumentation, and replacement of damaged parts. The costs shall be borne by the Contractor and shall be deemed to be included in the contract price.

The entire cost of testing for factory, production tests and other test during manufacture specified herein shall be treated as included in the quoted unit price of materials, except for the expenses of Inspector/KSEBL's representative.

Acceptance or waiver of tests shall not relieve the Contractor from the responsibility to furnish material in accordance with the specifications.

All tests shall be witnessed by the KSEBL and/or its authorized representative (hereinafter referred to as the KSEBL) unless the KSEBL authorizes testing to proceed without witness. The KSEBL representative shall sign the test form indicating approval of successful tests.

Should any inspections or tests indicate that specific item does not meet Specification requirements; the appropriate items shall be replaced, upgraded, or added by the Contractor as necessary to correct the noted deficiencies at no cost to the KSEBL. After correction of a deficiency, all necessary retests shall be performed to verify the effectiveness of the corrective action.

The KSEBL reserves the right to require the Contractor to perform, at the KSEBL's expense, any other reasonable test(s) at the Contractor's premises, on site, or elsewhere in addition to the specified Type, Acceptance, Routine, or Manufacturing tests to assure the KSEBL of specification compliance.

2.1 Test Plans and Procedures

Test plans and test procedures for both factory and site acceptance tests shall be provided by the Contractor. Test plans and test procedures shall ensure that each factory and site test is comprehensive and verify all the features of the equipment to be tested. Test plans and test procedures shall be modular to allow individual test segments to be repeated upon request.

The Contractor shall give the KSEBL twenty-one (21) days written notice of any material being ready for testing. Fifteen days prior to the scheduled testing, the KSEBL shall provide written notice to the Contractor of any drawings, equipment, material, or workmanship in which the KSEBL's opinion, are not compliant to the specification. The contractor shall give due consideration to such objections, if valid, effecting the corrections as necessary or shall prove, in writing, that said modifications are unnecessary for contract compliance.

2.2 Factory and Site Test Plans

A test plan for factory and site acceptance tests shall be submitted for the KSEBL approval, at least four (4) weeks before the start of testing. The test plan shall be a single overview document that defines the overall schedule and individual responsibilities associated with conducting the tests, documenting the test results, and successfully completing the test criteria.

2.3 Test Procedures

Test procedures for factory and site testing shall be submitted for the KSEBL approval at least four (4) weeks before each individual test. Testing shall not commence without approved test procedures.

All test equipment and/or instruments shall bear calibration stickers indicating valid calibration on and beyond the testing date. The time lapsed since last calibration shall not exceed the test equipment/ jig manufacturer recommended calibration interval or the interval recommended in the test lab's internal quality procedures.

The Contractor shall ensure that all testing will be performed by qualified testing personnel well experienced in performing such tests.

2.4 Test Records

Complete and indexed records of all factory and site acceptance tests results shall be maintained and provided to the KSEBL by the Contractor in hard & soft copy. The records shall be keyed to the steps enumerated in the test procedures.

All principle test records, test certificates and performance curves shall be supplied for all tests carried out as proof of compliance with the specifications and/or each and every specified test. These test certificates, records and performance curves shall be supplied for all tests, whether or not they have been witnessed by the KSEBL within the specified duration after the completion of test. Information given on such test certificates and curves shall be sufficient to identify the material or equipment to which the certificates refer and shall also bear the Contractor's reference and heading.

2.5 Rejection of Elements

Any item or component which fails to comply with the requirements of this Specification in any respect, at any stage of manufacture, test, erection or on completion at site may be rejected by the KSEBL either in whole or part as considered necessary. Material or components with defects of such a nature that do not meet the requirements of the Specification by adjustment or modification shall be replaced by the Contractor at his own expense. After adjustment or modification, the Contractor shall submit the items to the KSEBL for further inspection and/or tests.

2.6 Testing Requirements: Following are the requirements of testing:

1. Type Testing
2. Factory Acceptance Testing
3. Site Acceptance Testing

2.7 Type Testing

"Type Tests" shall be defined as those tests which are to be carried out to prove the design, process of manufacture and general conformity of the materials to this Specification. Type Testing shall comply with the following:

(a) All cable & equipment being supplied shall conform to type tests as per technical specification.

(b) The test reports submitted shall be of the tests conducted within last seven (7) years for OPGW cable prior to the date of proposal/offer submitted. In case the test reports are older than seven (7) years for OPGW cable on the date of proposal/offer, the Contractor shall repeat these tests at no extra cost to the KSEBL.

(c) The Contractor shall submit, within 30 days of Contract Award, copies of test reports for all of the Type Tests that are specified in the specifications and that have previously (before Contract award) been performed.

These reports may be accepted by the KSEBL only if they apply to materials and equipment that are essentially identical to those due to be delivered under the Contract and only if test procedures and parameter values are identical to those specified in this specification carried out at accredited labs and witnessed by third party / customer's representatives.

In the event of any discrepancy in the test reports or any type tests not carried out, same shall be carried out by Contractor without any additional cost implication to the KSEBL.

In case the Type Test is required to be carried out, then following shall be applicable: -

(a) Type Tests shall be certified or performed by reputed laboratories using material and equipment data sheets and test procedures that have been approved by the KSEBL. The test procedures shall be formatted as defined in the technical specifications and shall include a complete list of the applicable reference standards and submitted for KSEBL approval at least four (4) weeks before commencement of test(s). The Contractor shall provide the KSEBL at least 30 days written notice of the planned commencement of each type test.

(b) The Contractor shall provide a detailed schedule for performing all specified type tests. These tests shall be performed in the presence of a representative of the KSEBL.

(c) The Contractor shall ensure that all type tests can be completed within the time schedule offered in his Technical Proposal.

In case of failure during any type test, the Supplier is either required to manufacture a fresh sample lot and repeat all type tests successfully or repeat that particular type test(s) at least three times successfully on the samples selected from the already manufactured lot at his own expenses. In case a fresh lot is manufactured for testing then the lot already manufactured shall be rejected.

2.8 Type Test Samples

The Contractor shall supply equipment/material for sample selection only after the Quality Assurance Plan has been approved by the KSEBL. The sample material shall be manufactured strictly in accordance with the approved Quality Assurance

Plan. The Contractor shall submit for KSEBL approval, the type test sample selection procedure. The selection process for conducting the type tests shall ensure that samples are selected at random. For optical fibres/ Fibre Optic cables, at least three reels/ drums of each type of fibre/cable proposed shall be offered for selection. For FO cable installation hardware & fittings at least ten (10) samples shall be offered for selection. For Splice enclosures at least three samples shall be offered for selection.

2.9 List of Type Tests

The type testing shall be conducted on the following items

(a) Optical fibres

(b) OPGW Cable

(c) OPGW Cable fittings

(d) Vibration Damper

(e) Splice Enclosure (Joint Box)

2.10 Type Tests for Optical Fibres

The type tests listed below in Table 6d shall be conducted on DWSM fibres to be supplied as part of overhead cables. The tests specific to the cable type are listed in subsequent sections.

Table 6d: TYPE TESTS FOR OPTICAL FIBRES

Sl NO.	TEST NAME	ACCEPTANCE CRITERIA	TEST PROCEDURE
1	Attenuation	As per Clause-1 of TS	IEC 60793-1-40 Or EIA/TIA 455-78A
2	Attenuation Variation with Wavelength	As per Clause-1 of TS	IEC 60793-1-40 Or EIA/TIA 455-78A
3	Attenuation at Water Peak	As per Clause-1 of TS	IEC 60793-1-40 Or EIA/TIA 455-78A
4	Temp. Cycling (Temp dependence of Attenuation)	As per Clause-1 of TS	IEC 60793-1-52 Or EIA/TIA 455-3A, 2 cycles
5	Attenuation with Bending (Bend Performance)	As per Clause-1 of TS	IEC 60793-1-47 Or EIA/TIA 455-62A
6	Mode Field dia.	As per Clause-1 of TS	IEC 60793-1-45 Or EIA/TIA 455-164A/167A/174
7	Chromatic Dispersion	As per Clause-1 of TS	IEC 60793-1-42 Or EIA/TIA 455-168A/169A/175A
8	Cladding Diameter	As per Clause-1 of TS	IEC 60793-1-20 Or EIA/TIA 455-176
9	Point Discontinuities of Attenuation	As per Clause-1 of TS	IEC 60793-1-40 Or EIA/TIA 455-59
10	Core –Clad concentricity error	As per Clause-1 of TS	IEC 60793-1-20 Or EIA/TIA 455-176
11	Fibre Tensile Proof Testing	As per Clause-1 of TS	IEC 60793-1-30 Or EIA/TIA 455-31B

2.11 Type Tests for OPGW Cables

The type tests to be conducted on the OPGW cable are listed in Table 6e Type Tests for OPGW Cables. Unless specified otherwise in the technical specifications or the referenced standards, the optical attenuation of the specimen, measured during or after the test as applicable, shall not increase by more than 0.05 dB/Km.

Table 6e: TYPE TESTS FOR OPGW CABLE

SR. NO.	TEST NAME	TEST DESCRIPTION	TEST PROCEDURE	
1	Water Ingress Test	IEEE 1138-2009	IEEE 1138-2009(IEC 6074-1-2 Method F5 or EIA/TIA 455-82B)	Test duration: 24 hours
2	Seepage of filling compound	IEEE 1138-2009	IEEE 1138-2009 (EIA/ TIA 455-81B)	Preconditioning period: 72 hours. Test duration: 24 hours.
3	Short Circuit Test	IEEE 1138-2009	IEEE 1138-2009	Fibre attenuation shall be continuously monitored and recorded through a digital data logging system or equivalent means. A suitable temperature sensor such as thermocouple shall be used to monitor and record the temperature inside the OPGW tube in addition to monitoring & recording the temperatures between the strands and between optical tube and the strand as required by IEEE 1138. Test shall be conducted with the tension clamps proposed to be supplied. The cable and the clamps shall be visually inspected for mechanical damage and photographed after the test.
		Or IEC60794-4-10/IEC 60794-1-2 (2003) Method H1		Initial temperature during the test shall be greater than or equal to ambient field temperature.
4	Aeolian Vibration Test	IEEE 1138-2009 Or IEC60794-4-10 / IEC 60794-1-2,	IEEE 1138-2009	Fibre attenuation shall be continuously monitored and recorded through a digital data logging system or equivalent means. The vibration frequency and amplitude shall be monitored and recorded continuously. All fibres of the test cable

		Method E19		sample shall be spliced together in serial for attenuation monitoring. Test shall be conducted with the tension/suspension clamps proposed to be supplied. The cable and the clamps shall be visually inspected for mechanical damage and photographed after the test.
5	Galloping test	IEEE 1138-2009	IEEE 1138-2009	Test shall be conducted with the tension/suspension clamps proposed to be supplied. The cable and clamps shall be visually inspected for mechanical damage and photographed after the test. All fibres of the test cable sample shall be spliced together in serial for attenuation monitoring.
6	Cable Bend Test	Procedure 2 in IEC 60794-1-2 Method E11		The short-term and long-term bend tests shall be conducted in accordance with Procedure 2 in IEC60794-1-2 E11 to determine the minimum acceptable radius of bending without any increase in attenuation or any other damage to the fibre optic cable core such as bird caging, deformation, kinking and crimping.
7	Sheave Test	IEEE 1138-2009 OR IEC 60794-1-2 (2003) Method E1B	IEEE 1138-2009	Fibre attenuation shall be continuously monitored and recorded through a digital data logging system or equivalent means. The Sheave dia. shall be based on the pulling angle and the minimum pulley dia employed during installation. All fibres of the test cable sample shall be spliced together in serial for attenuation monitoring.
8	Crush Test	IEEE 1138-2009	IEEE 1138-2009	The crush test shall be carried out on a sample of approximately one (1) metre

			(IEC 60794-1-2, Method E3/ EIA/TIA 455-41B)	long in accordance with IEC 60794-1-2 E3. A load equal to 1.3 times the weight of a 400-metre length of fibre optic cable shall be applied for a period of 10 minutes. A permanent or temporarily increase in optical attenuation value greater than 0.1 dB change in sample shall constitute failure. The load shall be further increased in small increments until the measured attenuation of the optical waveguide fibres increases and the failure load recorded along with results.
9	Impact Test	IEEE 1138-2009	IEEE 1138-2009, (IEC 60794-1-2 E4/ EIA/TIA 455- 25B)	The impact test shall be carried out in accordance with IEC 60794-1-2 E4. Five separate impacts of 0.1-0.3kgm shall be applied. The radius of the intermediate piece shall be the reel drum radius ± 10%. A permanent or temporary increase in optical attenuation value greater than 0.1 dB/km change in sample shall constitute failure.
10	Creep Test	IEEE 1138-2009	IEEE 1138-2009	As per Aluminium Association Method, the best-fit straight line shall be fitted to the recorded creep data and shall be extrapolated to 25 years. The strain margin of the cable at the end of 25 years shall be calculated. The time when the creep shall achieve the strain margin limits shall also be calculated.
11	Fibre Strain Test	IEEE 1138-1994	IEEE 1138-1994	
12	Stress strain Test	IEEE 1138-2009	IEEE 1138-2009	
13	Cable Cut-off Wavelength test	IEEE 1138-1994	IEEE 1138-1994	
14	Temperature Cycling Test	IEEE 1138-2009	IEEE 1138-2009 Or IEC 60794-1-2, Method F1	

15	Corrosion (Salt Spray) Test	EIA/TIA 455-16A/IEEE 1138: 2009	
16	Tensile Performance Test	IEC 60794-1-2 E1 / EIA/TIA 455-33B	The test shall be conducted on a sample of sufficient length in accordance with IEC 60794-1-2 E1. The attenuation variation shall not exceed 0.05 dB/Km up to 90% of RTS of fibre optic cable. The load shall be increased at a steady rate up to rated tensile strength and held for one (1) minute. The fibre optic cable sample shall not fail during the period. The applied load shall then be increased until the failing load is reached, and the value recorded.
17	Lightning Test	IEC 60794-4-10 / IEC 60794-1-2 (2003)	The OPGW cable construction shall be tested in accordance with IEC 60794-1-2, Method H2 for Class 1.
18	DC Resistance Test (IEC 60228)	On a fibre optic cable sample of minimum 1 metre length, two contact clamps shall be fixed with a predetermined bolt torque. The resistance shall be measured by a Kelvin double bridge by placing the clamps initially zero metre and subsequently one metre apart. The tests shall be repeated at least five times and the average value recorded after correcting at 20°C.	

2.12 Type Test on OPGW Cable Fittings

The type tests to be conducted on the OPGW Cable fittings and accessories are listed below:

(i) Mechanical Strength Test for Suspension/Tension Assembly

Applicable Standards: IEC 61284, 1997.

SUSPENSION ASSEMBLY

The armour rods /reinforcement rods are assembled on to the approved OPGW using the Installation Instructions to check that the assembly is correctly fitted and is the same that will be carried out during installations.

Part 1:

The suspension assembly shall be increased at a constant rate up to a load equal to 50% of the specified minimum Failure Load increased and held for one minute for the test rig to stabilize. The load shall then be increased at a steady rate to

67% of the minimum Failure Load and held for five minutes. The angle between the cable, the Suspension Assembly and the horizontal shall not exceed 16°. This load shall then be removed in a controlled manner and the Protection Splice disassembled. Examination of all the components shall be made and any evidence of visual deformation shall be documented.

Part 2:

The Suspension clamp shall then be placed in the testing machine. The tensile load shall gradually be increased up to 50% of the specified Minimum Failure Load of the Suspension Assembly and held for one minute for the Test Rig to stabilize and the load shall be further increased at a steady rate until the specified minimum Failure Load is reached and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached, and the value shall be documented.

TENSION ASSEMBLY

The Tension Assembly is correctly fitted and is the same that will be carried out during installations.

Part 1:

The tension assembly (excluding tension clamp) shall be increased at a constant rate up to a load equal to 50% of the specified minimum Failure Load increased at a constant rate and held for one minute for the test rig to stabilize. The load shall then be increased at a steady rate to 67% of the minimum Failure Load and held for five minutes. This load shall then remove in a controlled manner and the Tension Assembly disassembled. Examination of the Tension Dead-End and associated components shall be made, and any evidence of visual deformation shall be documented.

Part 2:

The Tension Dead-End and associated components shall then be reassembled, and bolts tightened as before. The tensile load shall gradually be increased up shall gradually be increased up to 50% of the specified Minimum Failure Load of the Tension Assembly and held for one minute for the Test Rig to stabilize and the load shall be further increased at a steady rate until the specified minimum Failure Load is reached and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached, and the value shall be documented.

Acceptance Criteria for Tension/Suspension Assembly:

- No evidence of binding of the Nuts or Deformation of components at end of Part 1 of Test.
- No evidence of Fracture at the end of one minute at the minimum failure load during Part 2 of the Test.

Any result outside these parameters shall constitute a failure

(ii) Clamp Slip Strength Test for Suspension Assembly

The suspension assembly shall be vertically suspended by means of a flexible attachment. A suitable length fibre optical cable shall be fixed in the clamps.

Once the Suspension Clamp has been assembled, the test rig is tensioned to 1 kN and the position scale on the recorder 'zeroed'. The test rig is then tensioned to 2.5 kN and the relative positions of the Reinforcing Rods, Armour Rods and Suspension Clamp shall be marked by a suitable means to confirm any slippage after the test has been completed. The relative positions of the helical Armour Rods and associated Reinforcing Rods at each end shall be marked and also 2 mm relative position between clamp body and Armour Rods shall be marked on one side. The load shall be increased to 12 kN at a loading rate of 3 kN/min and held for one minute. At the end of this one minute period, the relative displacement between clamp body and the armour rods shall be observed. If the slippage is 2 mm or above, the test shall be terminated. Otherwise, at the end of one minute the position of the clamp body and 2 mm. relative positions between clamp body and armour rods shall be marked on the other side. After the one minute pause, the load shall be further increased at a loading rate of 3 kN/min, and recording of load and displacement shall continue until either the relative Position displacement between clamp body and armour rods reaches more than 2 mm or the load reaches the maximum slip load of 17 kN. On reaching either of the above values the test is terminated. Visual examination of all paint marks shall be recorded, and a measurement of any displacement recorded in the Table of Results.

Acceptance Criteria:

The Suspension Clamp has passed the Slip Test if the following conditions are met:

No slippage* shall occur at or below the specified minimum slip load.

Definition of no slippage in accordance with IEC 61284, 1997: - Any relative movement less than 2 mm is accepted. The possible couplings or elongations produced by the cable as a result of the test itself are not regarded as slippage.

Slippage shall occur between the specified maximum and minimum slip load of 12 - 17 kN.

There shall be no slippage of the Reinforcing Rods over the cable, and no slippage of the Armour Rods over the Reinforcing Rods.

The relative movement (i.e. more than 2 mm between Armour Rods & Clamp body) between minimum 12 kN and maximum slip 17 kN, shall be considered as slip.

The Armour Rods shall not be displaced from their original lay or damaged**.

** Definition of no damage in accordance with convention expressed in IEC 61284:1997 no damage, other than surface flattening of the strands shall occur.

Any result outside these parameters is a failure.

(iii) Slip Strength Test of Tension Clamp

Tension clamps shall be fitted on an 8 m length of fibre optic cable on both ends. The assembly shall be mounted on a tensile testing machine and anchored in a manner similar to the arrangement to be used in service. A

tensile load shall gradually be applied up to 20% of the RTS of OPGW. Displacement transducers shall be installed to measure the relative movement between the OPGW relative to the Reinforcing Rods and Tension Dead –End relative to Reinforcing Rods. In addition, suitable marking shall be made on the OPGW and Dead-End to confirm grip. The load shall be gradually increased at a constant rate up to 50 % of the UTS and the position scale of the recorder is zeroed. The load shall then gradually have increased up to 95 % of the UTS and maintained for one minute. After one minute pause, the load shall be slowly released to zero and the marking examined and measured for any relative movement.

Acceptance Criteria:

- No movement* shall occur between the OPGW and the Reinforcing Rods, or between the Reinforcing Rods and the Dead-End assembly.
- No failure or damage or disturbance to the lay of the Tension Dead-End, Reinforcing Rods or OPGW.
- Definition of no movement as defined in IEC 61284: Any relative movement less than 2 mm is accepted. The possible couplings or elongations produced by the conductor as a result of the test itself are not regarded as slippage.

Any result outside these parameters shall constitute a failure

(iv) Grounding Clamp and Structure Mounting Clamp Fit Test

For structure mounting clamp, one series of tests shall be conducted with two fibre optic cables installed, one series of tests with one fibre optic cable installed in one groove, and one series of tests with one fibre optic cable in the other groove. Each clamp shall be installed including clamping compound as required on the fibre optic cable. The nut shall be tightened on to the bolt by using torque wrench with a torque of 5.5 kgm or supplier's recommended torque and the tightened clamp shall be held for 10 minutes. After the test remove the fibre optic cable and examine all its components for distortion, crushing or breaking. Also, the fibre optic cable shall be checked to ensure free movement within the core using dial callipers to measure the diameter of the core tube. The material shall be defined as failed if any visible distortion, crushing, cracking or breaking of the core tube is observed or the fibre optic cable within the core tube is not free to move, or when the diameter of the core tube as measured at any location in the clamped area is more than 0.5 mm larger or smaller of the core diameter as measured outside the clamped area.

(v) Structure Mounting Clamp Strength Test

The clamp and mounting assembly shall be assembled on a vertical 200 mm x 200 mm angle and a short length of fibre optic cable installed. A vertical load of 200 kg shall be applied at the end of the mounting clamp and held for 5 minutes. Subsequently, the load shall be increased to 400 kg and held for 30 seconds. Any visible distortion, slipping or breaking of any component of the mounting clamp or assembly shall constitute failure.

2.13 Type Test on Vibration Damper

(a) Dynamic Characteristic Test

The damper shall be mounted with its clamp tightened with torque recommended by the manufacturer on shaker table capable of simulating sinusoidal vibrations for Critical Aeolian Vibration frequency band ranging from 0.18/d to 1.4/d – where d is the OPGW cable diameter in meters. The damper assembly shall be vibrated vertically with a ±1 mm amplitude from 5 to 15 Hz frequency and beyond 15 Hz at 0.5 mm to determine following characteristics with the help of suitable recording instruments.

(i) Force Vs frequency

(ii) Phase angle Vs frequency

(iii) Power dissipation Vs frequency

The Force Vs frequency curve shall not show steep peaks at resonance frequencies and deep troughs between the resonance frequencies. The resonance frequencies shall be suitably spread within the Aeolian vibration frequency-band between the lower and upper dangerous frequency limits determined by the vibration analysis of fibre optic cable without dampers.

Acceptance criteria for vibration damper:

(i) The above dynamic characteristics test on five dampers shall be conducted.

(ii) The mean reactance and phase angle Vs frequency curves shall be drawn with the criteria of best fit method.

(iii) The above mean reactance response curve should lie within following limits:

V.D. for OPGW - 0.060 f to 0.357 f kgf/mm*

Where f is frequency in Hz.

(iv) The above mean phase angle response curve shall be between 25^{o} to 130^{o} within the frequency range of interest.

(v) If the above curve lies within the envelope, the damper design shall be considered to have successfully met the requirement.

(vi) Visual resonance frequencies of each mass of damper is to be recorded and to be compared with the guaranteed values.

(b) Vibration Analysis

The vibration analysis of the fibre optic cable shall be done with and without damper installed on the span. The vibration analysis shall be done on a digital computer using energy balance approach. The following parameters shall be taken into account for the purpose of analysis.

(i) The analysis shall be done for single fibre optic cable without armour rods. The tension shall be taken as 25% of RTS of fibre optic cable for a span ranging from 100 m to 1100 m.

(ii) The self-damping factor and flexural stiffness (EI) for fibre optic cable shall be calculated on the basis of experimental results. The details to experimental analysis with these data shall be furnished.

(iii) The power dissipation curve obtained from Damper Characteristics Test shall be used for analysis with damper.

(iv) Examine the Aeolian Vibration level of the fibre optic cable with and without vibration damper installed at the recommended location or wind velocity ranging from 0 to 30 Km per hour, predicting amplitude, frequency and vibration energy input.

(v) From vibration analysis of fibre optic cable without damper, antinode vibration amplitude and dynamic strain levels at clamped span extremities as well as antinodes shall be examined and thus lower and upper dangerous frequency limits between which the Aeolian vibration levels exceed the specified limits shall be determined.

(vi) From vibration analysis of fibre optic cable with damper(s) installed at the recommended location, the dynamic strain level at the clamped span extremities, damper attachment points and the antinodes on the fibre optic cable shall be determined. In addition to above damper clamp vibration amplitude and antinodes vibration amplitudes shall also be examined.

The dynamic strain levels at damper attachment point, clamped span extremities and antinodes shall not exceed the specified limits. The damper clamp vibration amplitude shall not be more than that of the specified fatigue limits.

(c) Fatigue Tests

(i) Test Set Up

The fatigue tests shall be conducted on a laboratory set up with a minimum effective span length of 30m. The fibre optic cable shall be tensioned at 25% of RTS of fibre optic cable and shall not be equipped with protective armour rods at any point. Constant tension shall be maintained within the span by means of lever arm arrangement.

After the fibre optic cable has been tensioned, clamps shall be installed to support the fibre optic cable at both ends and thus influence of connecting hardware fittings are eliminated from the free span. The clamps shall not be used for holding the tension on the fibre optic cable. There shall be no loose parts, such as suspension clamps, U bolts, on the test span supported between clamps mentioned above. The span shall be equipped with vibration inducing equipment suitable for producing steady standing vibration. The inducing equipment shall have facilities for step less speed control as well as step less amplitude arrangement. Equipment shall be available for measuring the frequency, cumulative number of cycles and amplitude of vibration at any point along the span.

(ii) Fatigue Test

The vibration damper shall be installed on the test span with the manufacturer's specified tightening torque. It shall be ensured that the damper shall be kept minimum three loops away from the shaker to eliminate stray signals influencing damper movement.

The damper shall then be vibrated at the highest resonant frequency of each damper mass.

For dampers involving torsional resonant frequencies, tests shall be done at torsional modes also in addition to the highest resonant frequencies at vertical modes. The resonance frequency shall be identified as the frequency at which each damper mass vibrates with the maximum amplitude on itself. The amplitude of vibration of the damper clamp shall be maintained not less than ±25/f mm where f is the frequency in Hz.

The test shall be conducted for minimum ten million cycles at each resonant frequency mentioned above. During the test, if resonance shift is observed, the test frequency shall be tuned to the new resonant frequency.

The clamp slip test as mentioned herein shall be repeated after fatigue tests without retorquing or adjusting the damper clamp, and the clamp shall withstand a minimum load equal to 80% of the slip strength for a minimum duration of one minute.

After the above tests, the damper shall be removed from fibre optic cable and subjected to dynamic characteristics test. There shall not be any major deterioration in the characteristics of the damper. The damper then shall be cut open and inspected. There shall not be any broken, loose, or damaged part. There shall not be significant deterioration or wear of the damper. The fibre optic cable under clamp shall also be free from any damage.

For purposes of acceptance, the following criteria shall be applied:

(1) There shall not be any resonant frequency shift before and after the test by more than ± 20%

(2) The power dissipation of the damper before and after test at the individual resonant frequencies do not differ by more than ± 20%

Beside above tests, the type tests listed below in the table shall also be conducted on Vibration Damper

Sl No.	**Test Name**	**Test Procedure**
1	Visual examination & Dimensional and material verification	IEC 61897 Clause 7.1 & 7.2
2	Clamp Slip test	IEC 61897 Clause 7.5
3	Clamp bolt tightening test	IEC 61897 Clause 7.7
4	Attachments of weights to messenger cable	IEC 61897 Clause 7.8
5	Attachment of clamps to messenger cable	IEC 61897 Clause 7.8

6	Damper effectiveness evaluation	IEC 61897 Clause 7.11.3.2

2.14 Type Tests for Splice Enclosures (Joint Box)

Following Type tests shall be demonstrated on the Splice Enclosure(s) (Splice Enclosure/Box). For certain tests, lengths of the fibre optic cable shall be installed in the splice box, and the fibres must be spliced and looped in order to simulate conditions of use. The attenuation of the fibres shall be measured, during certain tests, by relevant Fibre Optic Test Procedures (EIA/TIA 455 or IEC 60794-1 procedures).

(i) Temperature Cycling Test

FO cable is installed in the splice enclosure and optical fibres spliced and looped. The box must be subjected to 5 cycles of temperature variations of -40°C to +65°C with a dwell time of at least 2 hours on each extreme.

Fibre loop attenuation shall be measured in accordance with EIA 455-20 / IEC 60794-1-C10. The variation in attenuation shall be less than ±0.05dB. The final humidity level, inside the box, shall not exceed the initial level, at the closing of the box.

(ii) Humid Heat test

The sealed splice enclosure, with fibres spliced and looped inside, must be subjected to a temperature of +55°C ±2°C with a relative humidity rate of between 90% and 95% for 5 days. The attenuation variation of the fibres during the duration of the test shall be less than ±0.05dB, and the internal humidity rate measured, less than 2%.

(iii) Rain Withstand Test / Water Immersion test

The splice enclosure with optical fibres cable installed and fibres spliced fixed, shall be subjected to 24 hours of simulated rain in accordance with IEC 60060 testing requirements.

No water seepage or moisture shall be detected in the splice enclosure. The attenuation variation of the fibres after the test shall be less than ±0.05dB.

(iv) Vibration Test

The splice enclosure, with fibres united inside, shall be subjected to vibrations on two axes with a frequency scanning of 5 to 50 Hz. The amplitude of the vibrations shall be constant at 0.450mm, peak to peak, for 2 hours, for each of the vibrations' axes. The variation in attenuation, of the fibres, shall be less than ±0.05dB. The splice enclosure shall be examined for any defects or deformation. There shall be no loosening or visible damage of the FO cable at the entry point.

(v) Bending and Torsion test

The splice enclosure, with fibres spliced inside, shall be firmly held in place and be subjected to the following sequence of mechanical stresses on the cable:

a) 3 torsion cycles of ±180° shall be exercised on the cable. Each cycle shall be less than one minute.

b) 3 flexure cycles of the cable, of ±180° with one cycle less than one minute.

The variation in the attenuation, of the fibres, shall be less than ±0.05dB. The cables connection ring shall remain securely fixed to the box with the connection maintained firmly.

No defects/fissures shall be noted on the joint ring or on the splice enclosure

(vi) Tensile test

The splice enclosure with cable fixed to the boxes shall be subjected to a minimum tension of 448 N for a period of two minutes. No fissure shall be noted in the connections or on the box.

(vii) Drop Test

With 2 lengths of 11 meters of cable fixed to the box, it shall be dropped five times from a height of 10 meters. There shall be no fissure, at all, of the box, and the connections shall remain tight. The test surface shall be carried out in accordance with IEC 60068-2-32.

2.15 Factory Acceptance Tests

Factory acceptance tests shall be conducted on randomly selected final assemblies of all equipment to be supplied. Factory acceptance testing shall be carried out on OPGW Cable and associated hardware & fittings, Approach Cable, Joint Box, FODP etc. and all other items for which price has been identified separately in the Bid Price Schedules.

Material shall not be shipped to the KSEBL until required factory tests are completed satisfactorily, all variances are resolved, full test documentation has been delivered to the KSEBL, and the KSEBL has issued Material Inspection & Clearance Certificate (MICC).

Successful completion of the factory tests and the KSEBL approval to ship, shall in no way constitute final acceptance of the system or any portion thereof. These tests shall be carried out in the presence of the KSEBL's authorised representatives unless waiver for witnessing by KSEBL's representatives is intimated to the contractor.

Factory acceptance tests shall not proceed without the prior delivery to and approval of all test documentation by the KSEBL.

The factory acceptance tests for the supplied items shall be proposed by the Contractor in accordance with technical specifications and Contractor's (including Sub-Contractor's / supplier's) standard FAT testing program. In general, the FAT for other items shall include at least: Physical verification, demonstration of technical characteristics, various operational modes, functional interfaces etc.

For Test equipment FAT shall include supply of proper calibration certificates, demonstration of satisfactory performance, evidence of correct equipment configuration and manufacturer's final inspection certificate/ report.

2.16 Sampling for FAT

From each batch of equipment presented by the Contractor for Factory acceptance testing, the KSEBL shall select random sample(s) to be tested for acceptance. Unless otherwise agreed, all required FAT tests in the approved FAT procedures, shall be performed on all samples.

The Sampling rate for the Factory acceptance tests shall be minimum 10% of the batch size (minimum 1) for all items. The physical verification shall be carried out on 100% of the offered quantities as per the approved FAT procedure. In case any of the selected samples fail, the failed sample is rejected, and additional 20% samples shall be selected randomly and tested. In case any sample from the additional 20% also fails the entire batch may be rejected.

For the OPGW cable hardware fittings & accessories, the minimum sampling rate, and batch acceptance criteria shall be as defined in IS 2486.

The Sampling rate for the Factory acceptance tests shall be 10% of the batch size (minimum 2) for FO cable drums, FODPs, Joint box and other similar items.

Since FAT testing provides a measure of assurance that the Quality Control objectives are being met during all phases of production, the KSEBL reserves the right to require the Contractor to investigate and report on the cause of FAT failures and to suspend further testing/ approvals until such a report is made and remedial actions taken, as applicable.

2.17 Production Testing

Production testing shall mean those tests which are to be carried out during the process of production by the Contractor to ensure the desired quality of end product to be supplied by him. The production tests to be carried out at each stage of production shall be based on the Contractor's standard quality assurance procedures. The production tests to be carried out shall be listed in the Manufacturing Quality Plan (MQP), along with information such as sampling frequency, applicable standards, acceptance criteria etc.

The production tests would normally not be witnessed by the KSEBL. However, the KSEBL reserves the right to do so or inspect the production testing records in accordance with Inspection rights specified for this contract.

2.18 Factory Acceptance Tests on Optical Fibre to be supplied with OPGW

The factory acceptance tests listed in table below are applicable for the Optical fibres to be supplied. The listed tests follow testing requirements set forth in IEEE standard 1138/IEC 60794. The referenced sections specify the detailed test description. The acceptance norm shall be as specified in the above-mentioned IEEE standards unless specified otherwise in the technical specifications.

Table 6g: Factory Acceptance Tests for Optical Fibres: Optical Tests

Sr. No.	Test Name	Acceptance Criteria	Test procedure
1	Attenuation Coefficient	As per T S	EIA/TIA 455- 78A
2	Point Discontinuities of attenuation	As per T S	EIA/TIA 455-59

3	Attenuation at Water Peak	As per T S	EIA/TIA 455- 78A
4	Chromatic Dispersion		EIA/TIA 455-168A/169A/175A
5	Core – Clad Concentricity Error		EIA/TIA 455-/176
6	Cladding diameter		EIA/TIA 455-176
7	Fibre Tensile Proof Testing		EIA/TIA 455-31B

The test report for the above tests for the fibers carried out by the Fiber Manufacturer and used in the OPGW cables shall be shown to the inspector during OPGW cable FAT and shall be submitted along with the OPGW cable FAT report.

2.19 Factory Acceptance Test on OPGW Cable

The factory acceptance tests for OPGW cable specified below in Table follow the requirements set forth in IEEE standard 1138 / IEC 60794. The FAT shall be carried out on 10% of offered drums in each lot as specified in technical specifications and the optical tests shall be carried out in all fibres of the selected sample drums. The Rated Tensile Strength test shall be carried out on one sample in each lot.

Table 6h: Factory Acceptance Tests on OPGW

Applicable standard: IEEE 1138 / IEC 60794

Sr. No.	Factory Acceptance Test on Manufactured OPGW
1	Attenuation Co-efficient at 1310 nm and 1550 nm
2	Point discontinuities of attenuation
3	Visual Material verification and dimensional checks as per approved DRS/Drawings
4	Rated Tensile Strength
5	Lay Length Measurements

2.20 Factory Acceptance Test on OPGW Fittings

The factory acceptance tests for OPGW Fittings as specified below. The sampling plan shall be as per relevant standard:

Factory Acceptance Tests on OPGW Fittings

S. No.	Factory Acceptance Test
Suspension Assembly	
1	UTS/ Mechanical Strength of the assembly
2	Clamp Slip Test
3	Visual Material verification and dimensional checks as per approved DRS/ Drawings
4	Mechanical strength of each component
5	Galvanizing test
Tension Assembly	
6	Clamp Slip Strength test
7	Visual Material verification and dimensional checks as per approved DRS/Drawings
8	Mechanical strength of each component
9	Galvanizing Test
Vibration Damper	
10	Galvanizing test on damper, masses and messenger wires
11	Damper response (resonant frequencies)
12	Clamp Slip test
13	Strength of messenger wires

14	Attachments of weights to messenger cable
15	Attachments of clamps to messenger cable
16	Clamp bolt tightening test
17	Clamp bolt torque test
18	Dynamic characteristic test.
19	Visual Material verification and dimensional checks as per approved DRS/Drawings
Structure Mounting Clamp	
20	Clamp fit test
21	Clamp Strength test
22	Visual Material verification and dimensional checks as per approved DRS/Drawings

2.21 Factory Acceptance Test on Splice Enclosure (Joint Box) /FODP

The factory acceptance tests for Splice Enclosures/FODP as specified below.

Factory Acceptance Tests on Splice Enclosures (Joint Box)/FODP

Sr. No.	Factory Acceptance Test
1	Visual check of Quantities and Specific Component Number for each component of Splice Enclosure/FODP and dimensional checks against the approved drawings.

2.22 Factory Acceptance Test on Test Equipment & other items

As per technical specification and approved DRS/Documents

2.23 Site Acceptance Tests

The Contractor shall be responsible for the submission of all material & test equipment supplied in this contract for site tests and inspection as required by the KSEBL. All equipment shall be tested on site under the conditions in which it will normally operate.

The tests shall be exhaustive and shall demonstrate that the overall performance of the contract works satisfies every requirement specified. At a minimum Site Acceptance Testing requirement for FO cable etc. is outlined in following section. This testing shall be supplemented by the Contractor's standard installation testing program, which shall be in accordance with his quality plan(s) for FO installation.

During the course of installation, the KSEBL shall have full access for inspection and verification of the progress of the work and for checking workmanship and

accuracy, as may be required. On completion of the work prior to commissioning, all equipment shall be tested to the satisfaction of the KSEBL to demonstrate that it is entirely suitable for commercial operation.

2.24 Minimum Site Acceptance Testing Requirement for FO Cabling

Prior to installation, every spooled fibre optic cable segment shall be tested for compliance with the Pre-shipment data previously received from the manufacturer. This requirement will preclude the installation of out of specification cable segments that may have been damaged during shipment.

2.25 Phases of Site Acceptance Testing

SAT shall be carried out link by link from Tap tower joint enclosure to Gantry side joint enclosure. SAT may be performed in parts in case of long links.

The tests, checks, adjustments etc conducted by the Contractor prior to offering the equipment for SAT shall be called Pre-SAT activities. The Pre-SAT activities shall be described in the installation manuals and Field Quality Plan documents.

Sag and tension of OPGW shall generally be as per approved sag-tension chart and during installation, sag and tension of OPGW shall be documented. Upon completion of a continuous cable path, all fibres within the cable path shall be demonstrated for acceptance of the cable path. Fibre Optic cable site testing minimum requirements are provided in Tables below:

Fibre Optic Cable Pre-Installation Testing

Item	Description
1	Physical Inspection of the cable assembly for damage
2	Optical fibre continuity and fibre attenuation with OTDR at 1550 nm
3	Fibre Optic Cable length measurement using OTDR
Fiber Optic Cable Post-Installation Testing (Each section)	
4	Physical Inspection of the installed OPGW and hardware fittings
5	Optical fiber continuity, fiber attenuation and cable length with OTDR

Fibre Optic Cable Splicing Testing

Item	Description
1	Per splice bi-directional average attenuation with OTDR
2	Physical inspection of splice box/enclosure for proper fibre / cable routing techniques
3	Physical inspection of sealing techniques, weatherproofing, etc.

Fibre Optic Cable Commissioning Testing

Item	Description
1	End to End (FODP to FODP) bi-directional average attenuation of

	each fibre at 1310 nm and 1550 nm by OTDR.
2	End to End bi-directional average attenuation of each fibre at 1310 nm and 1550 nm by Power meter.
3	Bi-directional average splice loss by OTDR of each splice as well as for all splices in the link.
4	Proper termination and labelling of fibres & fibre optic cables at as per approved labeling plan.

3 INSTALLATION OF OPGW CABLING

3.1 OPGW cable installation

The OPGW cable shall be installed at the top of the tower. The OPGW shall be installed generally in accordance with the IEEE Guide to the Installation of Overhead Transmission Line Conductors (IEEE STD. 524 with latest revisions), with additional instructions and precautions for fibre optic cable handling. The stringing procedure shall be submitted by the Contractor prior to stringing for KSEBL's approval.

The OPGW cable sections shall normally be terminated & spliced only on tension towers. In exceptional circumstances and on KSEBL specific approval, cable may be terminated on Suspension towers, but in this case tower strength shall be examined to ensure that tower loads are within safe limits and if required, necessary tower strengthening shall be carried out by the Contractor.

The stringing shall be carried by the Transmission Line Contractor as per the stringing chart/ procedure submitted by them and approved by KSEBL. The following shall be under the scope of OPGW Cabling Package Contractor:

- Supply of OPGW Cable & Hardware Fittings needed to tie the OPGW cable to the towers/gantries.
- Supervision of stringing of OPGW Cable at sites as per instruction by KSEBL. The supervision shall include the inspection as per stringing procedure, proper location of drum site, installation of stringing blocks/pulleys, proper sagging, proper installation of hardware, proper tension as per Sag-Tension chart, provision of service loops of OPGW in jointing locations
- The Splicing work of OPGW Cable and after that testing of link.

  While handing over the OPGW drums, the testing (fibre loss and length measurement using OTDR) of OPGW in each drum shall be carried out by Fibre Optic Cabling Package Contractor in presence of Tower package contractor(s) and KSEBL representative. After installation of OPGW cable, the testing of each section shall be carried out again by the Fibre Optic Cabling Package Contractor in presence of Transmission Line Package contractor(s) and KSEBL representative. In case of any damage/ high loss in the fibre, the total length of that particular section of OPGW cable shall be replaced by Transmission Line Package Contractor(s). Fibre Optic Cabling Package Contractor shall supply new OPGW cable in place of damaged cable. The Contract price shall be adjusted accordingly.

3.2 Installation Hardware

All required hardware's shall be installed along with OPGW Cable.

3.3 Methodology for Installation and Termination

All optical fibre cable termination, installation, stringing and handling plans, guides and procedures, and engineering analysis (e.g. tension, sag, vibration etc.) shall be submitted to the KSEBL for review and approval in the engineering/design phase of the project. All installation practices shall be field proven, and ISO accredited.

All cable segments shall include service loops as specified in this specification. The maximum allowable stringing tension, maximum allowable torsional shear stress, crush strength and other physical parameters of the cable shall not be exceeded. The preventative measures to be taken shall be documented in detail and submitted to KSEBL in advance of installation.

Optical fibre attenuation shall be measured after installation and before splicing. Any increase in attenuation or step discontinuity in attenuation shall not be acceptable and shall constitute a cable segment failure. In the event of cable damage or any fibre damage, the complete section (tension location to tension location) shall be replaced as mid-span joints are not acceptable.

Any or all additional steel work or modifications required to attach the fibre cabling to the overhead transmission/ distribution line towers shall also be carried out by the Contractor. It shall be the Contractors responsibility to provide adequate communications among all crew members and support staff to ensure safe and successful installations.

3.4 Cable Raceways

To the extent possible, existing cable raceways shall be utilized. The Contractor is required to provide and install any additional indoor cable raceways which may be required for proper implementation of the fibre optic cabling system. This requirement shall be finalized during survey.

The cable raceways shall conform to the following:

(a) All cable raceways shall be sized to support full loading requirements plus at least a 200% safety loading factor.

(b) Indoor cable raceways shall be fabricated from construction grade aluminium, galvanized iron or anodized sheet metal or any other suitable material approved by the KSEBL. Suitable anticorrosion measures shall be provided. Steel fabricated raceways shall be finished inside and out, treated to resist rust and to form a metal-to- paint bond.

(c) Mechanical construction drawings of the cable raceways shall be submitted for KSEBL's information & review.

Expected Contents & Structure of FO Cable Installation Manual for Overhead FO cable		
Sl no.	Chapters	Description
1	Installation procedure	Description of activities of installation gangs: Preparation & Setting up, Stringing, sagging, attaching hardware, attaching down lead clamps & cable routing on the tower, securing cable ends (for protection before work by jointing gang). Precautions for preventing cable damage shall be highlighted.
2	Safety Instructions	Instructions & procedures related to ensuring installation crew safety: personnel grounding & safety, installation equipment safety, Safety for power system & environment (viz preventing accidental tripping, precaution for railway crossings etc)
3	Description of Installation Equipment	Sketches, drawings, photographs, safe working ratings of installation equipment, tools & tackles etc., handling instructions & precautions.
4	Cable routing	Illustrations of the positions of tower attachment clamps (down lead clamps), routing of FO cable on the tower, service loop(s), joint box position. References to other related documents covering the test
5	References	installation, jointing & testing, such as SAT administrative & functional test plans & procedures
		Jointing Procedures
		Field Quality Plan & Field Quality Audit Storage & Handling Instructions
		FO cable & hardware drawings, technical parameters, DRS etc.
		KSEBL & Statutory safety rules, safety manuals, standards, codes of practices etc.

DRS Form 1

DATA REQUIREMENTS SHEETS FOR OVERHEAD FIBRE OPTIC CABLE

OPTICAL GROUND WIRE (OPGW) – 48 Fibre

Manufacturer:

Part:

Configuration:

CABLE CONSTRUCTION			
Sr. No.	**Parameter**	**As per Technical Specification**	**As per Bidder Offering**
1	No. of Fibres Dual Window Single-Mode:	48	
2	Buffer Type:	Loose Tube	
3	Buffer Tube material	As applicable	
4	No. of Buffer Tubes:	As applicable	
5	No. of Fibers per Buffer Tube:	As applicable	
6	Expected Cable Life	25 Year	

DATA REQUIREMENTS SHEETS FOR OPTICAL FIBRE

DUAL-WINDOW SINGLE MODE (DW-SM)

OPTICAL PARAMETERS			
Sr. No.	**Parameter**	**As per Technical Specification**	**As per Bidder Offering**
1	Fibre manufacturer(s)/Type:		
2	Attenuation Coefficient @ 1310 nm: @ 1550 nm:	 ≤ 0.35 dB/km ≤ 0.21 dB/km	
3	Point discontinuity @ 1310nm: @ 1550nm:	 ≤ 0.05 dB ≤ 0.05 dB	
4	Nominal Mode Field Diameter @ 1310 nm: @ 1550 nm:	 8.6 to 9.5 µm (± 0.6µm)	
5	Chromatic Dispersion Coefficient @ 1310 (1288-1339) nm: @ 1310 (1271-1360) nm: @ 1550 nm:	 3.5 ps/ (nm x km) 5.3 ps/ (nm x km) 18 ps/ (nm x km)	
6	Zero dispersion wavelength:	1300 to 1324 nm	
7	Cutoff wavelength:	≤1260 nm	
PHYSICAL AND MECHANICAL PROPERTIES			
8	Bend Performance: (37.5 mm radius, 100 turns) @1310 nm (30 mm radius, 100 turns) @1550 nm (16mm radius, 1 turn) @1550nm	 ≤ 0.05 dB ≤ 0.05 dB ≤ 0.50 dB	
9	Cladding Diameter (nominal ± deviation):	 125.0 µm ± 1 µm	
10	Polarization mode dispersion coefficient	≤ 0.2 ps/km$^{1/2}$	
11	Proof test level	≥ 0.69 GPa	

PART – III GUARANTEED TECHNICAL PARTICULARS FOR OPTICAL GROUND WIRE (OPGW) & ACCESSORIES

The following sets of GTP are required to be filled up by the bidders to aid in the evaluation process. The response shall be brief and to the point and shall be supported by the printed product description and other literature. The same GTP format duly filled and the relevant drawings shall also be submitted during the detailed engineering along with the relevant technical brochures.

The bidder shall fill in the guaranteed technical particulars in the Proforma given in this section and submit the same with his tender, without which bid will not be considered.)

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GTP-1 GUARANTEED TECHNICAL PARTICULARS OF OPTICAL GROUND WIRE (OPGW)			
Manufacturer:			
Model Name:			
GENERAL PARAMETERS			
Sl. No	**Parameter**	**Units**	**Particulars**
1	Fibre Manufacturer Dual Window Single-Mode		
2	No. of Fibres Dual Window Single-Mode:	each	
3	Buffer Type		
4	Buffer Tube Diameter	mm	
5	Buffer Tube material		
6	No. of Buffer Tubes	each	
7	No. of Fibers per Tube	each	
8	Identification/numbering of individual tubes		
9	No. of empty tubes (If any)		
10	Filling material		
11	Filling material compliant with technical specifications?		
12	Strength member(s)		
13	Binding yarn/ tape		
14	Describe Central Core Design		
15	Aluminum Clad steel wire Diameter Number	 mm each	
16	Aluminum alloy wires Diameter Number	 mm each	
17	Aluminum tube inner diameter	mm	
18	Aluminum tube outside diameter	mm	
19	Cable Diameter (nominal ± deviation)	mm	
20	Cable cross-section area (Nominal)	mm^2	
21	Cable cross-section area (Effective)	mm^2	
22	Fully Compliant with IEEE 1138	Yes/No	
Mechanical Properties of Cable			
23	Max. breaking load/ Ultimate Tensile Strength (UTS)	kN	
24	Fibre strain margin	%	
25	Zero fibre strain up to load	kN	
26	Weight	kg/km	

27	Crush strength	kg/mm	
28	Equivalent Modulus of elasticity	KN/mm2	
29	Minimum Bending Radius without microbending	mm	
30	Maximum Bending Radius:ShortTerm:Long Term (Continuous)	mm	
31	Tensile proof test (Screening) level	KN/mm^2	
32	Maximum permissible tensile stress	KN/mm^2	
33	Permissible CTS. tensile stress	KN/mm^2	
34	Maximum sag at maximum temperature and design span with no wind	mm	
35	Everyday tension at 32ºC, no wind	% of UTS	
36	Maximum tension at Every day condition with full wind pressure	Kg	
	Thermal Properties of Cable		
37	Coefficient of linear expansion	per °C	
38	Coefficient of expansion Cladding : Core :	 per °C per °C	
39	Nominal operating temperature range	°C	
40	SC current transient peak temperature	°C	
41	Maximum allowable temperature for lightning strike	°C	
	CABLE SPOOL and DRUM		
42	Available length per spool Maximum : Nominal :	 m	
43	Size of drum :	m	
44	Weight of empty drum :	kg	
45	Weight of drum with cable spooled :	kg	
46	Will drum length scheduling be practiced to match transmission line span lengths?	Yes/No	
47	Describe Drum materials :		
48	Describe cable end capping and protection against abrasion etc. :		

INSTALLATION			
49	Splice Loss Maximum : Average :	 dB dB	
50	Operating Temperature Range : 	°C	
51	Rated Isokeraunic No.		
52	Expected Cable Life :	Years	
53	Installation rate per team : 	km/day	
54	No. of persons per team : 	no.	
55	Max. possible span for specified operating conditions : 	M	
56	Midspan sag at 0°C with no wind loading :	Mm	
57	Midspan sag at max temp. with no wind loading : 	Mm	
58	Midspan sag at max temp. and wind loading	Mm	
59	Cable swing angles Worst Case : Everyday :		
60	Describe Installation method(s) : 		
Sag tension chart parameters like sag and tension at various spans and applicable wind and ice load conditions shall be submitted along with the DRS. The cable parameters like coefficient of liner expansion, modulus of elasticity shall also be indicated.			

GTP- 2			
GUARANTEED TECHNICAL PARTICULARS OF DUAL-WINDOW SINGLE MODE (DWSM)			
OPTICAL PARAMETERS			
Sl. No.	**Parameter**	**Unit**	**Particulars**
1	Fiber manufacturer(s)/Type :		
2	Fiber production method :		
3	Attenuation Coefficient @ 1310 nm : @ 1550 nm :	 dB/km dB/km	
4	Attenuation Variation with Wavelength (±25 nm) :	dB/km	
5	Attenuation at water peak :	dB/km	
6	Point discontinuity @ 1310nm : @ 1550nm :	dB dB	
7	Temperature dependence (induced attenuation) :	dB	
8	Nominal Mode Field Diameter @ 1310 nm : @ 1550 nm :	 µm	
9	Mode Field Diameter Deviation @ 1310 nm : @ 1550 nm :	 µm	
10	Mode field non-circularity :	%	
11	Chromatic Dispersion Coefficient @ 1310 (1288-1339) nm : @ 1310 (1271-1360) nm : @ 1550 nm :	 Ps/nm.km	
12	Zero dispersion wavelength :	nm	
13	Zero dispersion Slope :	ps/nm2.km	
14	Cut-off wavelength :	nm	
15	Refractive Index :		
16	Refractive Index profile :		
17	Cladding Design :		
18	Numerical aperture :		

PHYSICAL and MECHANICAL PROPERTIES			
Sl. No.	**Parameter**	**Unit**	**Particulars**
19	Bend Performance : (37.5 mm radius, 100 turns) @1310 nm (30 mm radius, 100 turn) @1550 nm (16mm radius, 1 turn) @ 1550nm	dB dB	
20	Core Diameter (nominal± deviation) :	µm	
21	Core non-circularity :	%	
22	Cladding Diameter (nominal ± deviation) :	µm	
23	Core- Clad concentricity Error :	µm	
24	Cladding non-circularity :	%	
25	Fibre cut-off wavelength	µm	
26	Protective Coating type & material Primary : Secondary :		
27	Protective Coating Diameter (nominal ± deviation) :	µm	
28	Protective Coating removal method :		
29	Coating Concentricity	µm	
30	Polarisation mode dispersion coefficient	ps/km1/2	
31	Proof test level	kpsi	
32	Colour coding scheme compliant with EIA/TIA 598 or IEC 60304 or Bellore GR-20.	Yes/No	
33	Colouring material compliant with technical specs?	Yes/No	

GTP- 3 GUARANTEED TECHNICAL PARTICULARS FOR HARDWARE AND ACCESSORIES			
Suspension Clamp Assembly			
Manufacturer:			
Type:			
Drawing No.			
Sl. No.	**Parameter**	**Unit**	**Particulars**
1	Minimum vertical Strength	kN	
2	Maximum Slip Strength	kN	
3	Minimum Slip Strength	kN	
4	Length (nominal)	mm	
5	Weight (nominal)	kg	
6	Total Drop (maximum) including shackles	mm	
7	Tightening torque (nominal)	Nm	
8	Details of Armour Rod Set		
	No. of rods per clamp		
	Direction of Lay		
	Overall length	mm	
	Diameter of each Rod	mm	
	e) Tolerances (i) Diameter of each rod (ii) Length of each rod	 ±% ±%	
	Material of manufacture		
	UTS of each Rod	kN	
	Weight	kg	
9	Details of Protection Splice Set (Reinforcing Rods)		
	i) No. of rods per clamp		
	j) Direction of Lay		

	k) Overall length	mm	
	l) Diameter of each Rod	mm	
	m) Tolerances (i) Diameter of each rod (ii) Length of each	 ±% ±%	
	n) Material of manufacture		
	o) UTS of each Rod	kN	
	p) Weight	kg	

Dead End Clamp Assembly

Manufacturer:			
Type:			
Drawing No.:			
1	Minimum Slip Load	kN	
2	Length (nominal)		
	a) Reinforcing Rods	mm	
	b) Dead end	mm	
3	Weight (nominal)		
	a) Reinforcing Rods	kg	
	b) Dead end	kg	
4	Breaking strength (minimum)	kN	
5	Wire Size		
	a) Reinforcing Rods	mm	
	b) Dead end	mm	

Vibration Damper

Manufacturer:			
Type:			
Drawing No.:			

1	Total Weight	Kg	
2	Weight of each Damper		
3	Material of Damper Weight		
4	Clamp Material		
5	Clamp bolt tightening torque	Nm	
6	Clamp bolt material		
7	Messenger Cable Material		
8	No. of Strands in Messenger Cable		
9	Breaking Strength of Messenger Cable	kN	
10	Resonance Frequencies		
	First Frequency	Hz	
	Second Frequency	Hz	
	Third Frequency	Hz	
	Forth Frequency	Hz	
11	Minimum Slip Strength of Damper Clamp		
	a) Before Fatigue Test	kN	
	b) After fatigue Test	kN	

Down Lead Clamp /Fastening Clamp

Manufacturer:

Type:

Drawing No.:

1	Material:		
2	Suitable for OPGW (range) :	mm	
3	Tightening torques	Nm	
4	Vertical load	kN	
5	Filler details :		
	Material		
	diameter	mm	

6	Tower attachment arrangement		
Earth lead assembly			
Manufacturer:			
Type:			
Drawing No.:			
1	Weight	kg	
2	Material		
3	length	mm	
4	Short circuit current	KA	

GTP- 4 **GUARANTEED TECHNICAL PARTICULARS FOR SPLICE ENCLOSURES (JOINT BOX) FOR OVERHEAD FO CABLE**			
Splice Enclosures (Joint Box)			
Manufacturer:			
Type:			
Drawing No.:			
1	Dimensions H * W * D :	cm	
2	Weight :	Kg	
3	Colour and Finish :		
4	Cable Glanding& Fixing		
5	Construction materials & Gauge		
6	Locking arrangements :		
7	Installation Clearances : Front Access : Rear Access : Top * Bottom * Sides :	cm	
8	IP Protection	Class	
9	Total number of optical couplings	ea	
10	Provision of pass through splicing	Yes/No	
11	Whether filled with suitable encapsulant	Yes/No	
12	Method(s) for mounting with the tower :		
Optical Fibre Cable Accommodations			
13	Cable Glanding :		
14	Maximum number of cables that can beaccommodated :		
15	Diameter(s) of cables that can be accommodated :	each	
16	Describe Cable entries :		
Cable Termination Splice Accommodations			
17	Details of Splice Trays :		
	Dimension :		
	Material/Gauge :		
	Weight :	kg	

	Colour & Finish		
	Method of mounting		
18	Maximum number of splice trays	ea	
19	Number of splices per tray	ea	
20	Provision of Splice organisors		
21	Do splice trays require a separate enclosure? If so	Yes/No	
	Manufacturer		
	Dimensions H * W * D	cm	
	Weight:	Kg	
	Colour and Finish:		
	Method(s) of Mounting:		
	Construction materials & Gauge:		
	Locking arrangements:		
22	Installation Clearances Front Access : Rear Access : Top * Bottom * Sides : Excess length of fibre service loops	m	

GTP- 5
GUARANTEED TECHNICAL PARTICULARS FOR FIBRE OPTIC DISTRIBUTION PANELS (FODPs)

Manufacturer :

Model :

Sl. No.	Parameter	Unit	Particulars
1	Dimensions H * W * D :	cm	
2	Weight :	kg	
3	Colour and Finish :		
4	Cable Glanding& Fixing :		
5	Construction materials & Gauge		
6	Locking arrangements :		
7	Installation Clearances: Front Access : Rear Access : Top * Bottom * Sides :	cm	
8	IP Protection	Class	
9	Total number of optical couplings	ea	
10	Provision of pass through splicing	Yes/No	
11	Whether filled with suitable encapsulant	Yes/No	
12	Method(s) for mounting		
	Optical Fibre Cable Accommodations		
13	Cable Glanding :		
14	Maximum number of cables that can be accommodated :		
15	Diameter(s) of cables that can be accommodated :	each	
16	Describe Cable entries :		
	Cable Termination Splice Accommodations		
17	Details of Splice Trays :		
	Dimension :		

	Material/Gauge :		
	Weight :	kg	
	Colour & Finish		
	Method of mounting		
18	Maximum number of splice trays	ea	
19	Number of splices per tray	ea	
20	Provision of Splice organizers		
21	Do splice trays require a separate enclosure? If so	Yes/No	
	Manufacturer		
	Dimensions H * W * D	cm	
	Weight	Kg	
	Colour and Finish		
	Method(s) of Mounting		
	Construction materials & Gauge		
22	Locking arrangements		
	Installation Clearances Front Access : Rear Access : Top * Bottom * Sides : Excess length of fibre service loops	m	

SECTION 7
TECHNICAL SPECIFICATIONS OF POLYMERIC INSULATORS
TABLE OF CONTENT

SECTION 7
TECHNICAL SPECIFICATIONS OF POLYMERIC INSULATORS

1 SCOPE

This specification covers design, manufacturing, testing, inspection, packing and supply of Silicon Rubber housed composite Insulators for satisfactory operation on various transmission lines and Substations situated in any part of Kerala State.

These insulators are to be used as insulating part of Multi circuit Multi voltage tower structures single/double suspension & tension (dead end) for 220kV/110kV MCMV transmission lines. The configuration on structure may be single or double insulators per phase at required locations.

The materials covered here under this specification shall be supplied complete in all respects, including all components, fittings and accessories which are necessary or are usual for their efficient performance and satisfactory maintenance under the various operating and atmospheric conditions. Such parts shall be deemed to be within the scope of the Contract, whether specifically included or not in the Specification or in the Contract Schedules.

2 STANDARDS

2.1 Unless otherwise specified elsewhere in this specification, the rating as well as performance & testing of the Polymer Insulators shall conform but not limited to the latest revision & amendments available at the time of placement of order of all the relevant standards as listed hereunder, except as modified in this document.

Sl. No.	Indian Standard	Title	International Standard
1	IS:209	Specification for Zinc	BS:3436
2	IS:406	Method for Chemical Analysis of Slab Zinc	BS:3436
3	IS:731	Porcelain insulators for overhead power lines with a nominal voltage greater than 1000V	IEC:61109-1992
4	IS:2071 Part I, II, III	Method of High Voltage Testing	IEC:60060-1
5	IS:2486 Part-I Part-II Part-III	Specification for insulator fittings for overhead power lines with a nominal voltage greater than 1000V- General Requirements, Tests, Dimensional Requirements, Locking Devices	IEC-60575 IEC-60120 IEC:60372
6	IS:2629	Recommended practice for Hot Dip Galvanization for iron & steel	ISO:1461(E)

7	IS:2633	Testing for Uniformity of Coating of Zinc coated articles	
8	IS: 3203	Methods of testing of local thickness of electroplated coatings	ISO: 2178
9	IS: 4699	Specification for refined secondary zinc	
10	IS: 4759	Hot dip zinc coatings on structural steel & other allied products	ISO: 1459, ISO: 1461
11	IS:6745	Determination of Weight of Zinc coating on Zinc coated iron and steel articles	BS:443-1969 ISO 1460-1973
12	IS: 8263	Methods of RIV Test of HV Insulators	IEC:60487
13	IS:8269	Methods for Switching impulse test on HV insulators	IEC:60506
14	IS:13134	Guide for the selection of insulators in respect of polluted conditions	IEC: 60815
15		Standard for insulators– Composite - Distribution Dead end type	ANSI C29 13-2000
16		Standard specification for glass fiber strands	ASTM D 578-05
17		Standard test method for compositional analysis by Thermo gravimetry	ASTM E 1131-03
18		Characteristics of string insulator units of the long rod type	IEC: 60433
19		Verification of Dimensions of Polymer Insulators	IEC:61109
20		Hydrophobicity classification guide	STRI guide 1.92/1
21		Tests on insulators of Ceramic material or glass or glass for overhead lines with a nominal voltage greater than 1000V	IEC:60383
22		Salt Fog Pollution Voltage Withstand Test	IEC:60507
23		Thermal Mechanical Performance test and mechanical performance test on string insulator units	IEC: 60575
24		Electrical Insulating materials used under severe ambient conditions –Test methods for evaluating resistance to tracking and erosion	IEC 60587
25		Selection and dimensioning of high voltage insulators intended for use in	IEC:60815-3

		polluted conditions: Polymer Insulators for AC systems	
26		Composite insulators for A.C. Overhead lines with nominal voltage greater than 1000V – Definitions, test methods and acceptance criteria	IEC 61109
27		Composite string insulator units for overhead lines with a nominal voltage above 1000V : i) Standard strength classes and end fittings ii) Dimensional and electrical characteristics	IEC 61466-1 IEC 61466-1
29		Polymeric insulators for indoor and outdoor use with nominal voltage greater than 1000V- General definitions, tests, methods and acceptance criteria.	IEC 62217

The standards mentioned above are available from:

Reference Abbreviation	Name and Address
BS	British Standards, British Standards Institution 101, Pentonvile Road, N – 19-ND UK
IEC/CISPR	International Electro Technical Commission, Bureau Central de la Commission, electro Technique international, 1 Rue de verembe, Geneva SWITZERLAND
BIS/IS	Bureau of Indian Standards. Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi – 110001. INDIA
ISO	International Organisation for Standardization. Danish Board of Standardization Danish Standardizing Sraat, Aurehoegvej-12, DK-2900, Heeleprup, DENMARK.
NEMA	National Electric Manufacture Association, 155, East 44th Street. New York, NY 10017 U.S.A.

2.2 Material meeting with the requirements of other authoritative standards, which ensure equal or better performance than the standards mentioned above, shall also be considered. When the material offered by the bidder conforms to other standards, salient points of difference between standards adopted & the standards specified in this specification shall be clearly brought out in the relevant schedules. Three copies of such standards with authentic translation in English shall be furnished along with the bid.

3 ELECTRIC SYSTEM DATA & SITE CLIMATIC CONDITIONS

Electrical system data and site climatic conditions are furnished in clause 4, section 1, part A of volume II.

4 DETAILS OF CONDUCTOR

Details of conductors are furnished in clause 4.1, section 1, part A of volume II.

5 DETAILS OF COMPOSITE POLYMER INSULATORS

5.1 The technical specifications of composite polymer insulators are furnished in clause 4.1, section 1, part A of this volume

5.2 The Composite Polymer insulator shall be suitable for a three phase 50 Hz, effectively earthed 220/110kV transmission systems in a moderately polluted atmosphere.

5.3 The specified values and dimensions, impulse and power frequency voltages, electromechanical strength [EMS] of Polymer insulators are as under. The values given are minimum which apply to all cases. Specified withstand and flashover voltages are referred to standard atmospheric condition.

5.4 Composite Polymer Insulators shall have sheds with good self-cleaning properties. Insulator shed profile, spacing, projection etc., and selection in respect of polluted conditions shall be generally in accordance with the recommendation of IEC-60815/IS: 13134

5.5 Dimensional Tolerance of Composite Insulators

The tolerances on all dimensions e.g. diameter, length and creepage distance shall be allowed as follows in line with IEC 61109:

± (0.04d + 1.5) mm when d≤300mm

± (0.025d+6) mm when d>300mm

Where, “d” being the dimensions in millimeters for diameter, length or creepage distance as the case may be.

However, no negative tolerance shall be applicable to creepage distance

6 GENERAL TECHNICAL REQUIREMENTS

6.1 CORE

The core shall be glass-fiber reinforced epoxy resin rod (FRP) of high strength. Both, glass fiber and resin shall be optimized in the FRP rod. Glass fibers with low content in alkalies shall be boron free E glass or Boron free electrically corrosion resistance (ECR) glass. Use of resin with hydrolysis trend due to water penetration should be prevented i. e. matrix of the FRP rod shall be Hydrolysis resistant. Suitability of Epoxy matrix as well as interface between matrix and fibers is to be

considered as design parameter to prevent brittle fracture. The FRP rod should be void free and shall be manufactured through Pultrusion process.

6.2 HOUSING (SHEATH)

The core of the Polymer insulator shall be completely covered by a continuous housing consisting of a sheath-weathershed. For moulding of entire weathershed structure on to the rod in a one shot moulding process to be employed to avoid multiple interfaces.

Hardware i.e. metal fittings may be installed on the rod prior to moulding of the shed controlling moulding lines. The base polymer shall be 100% Silicon Rubber prior to the addition of reinforcing fillers. The thickness of compounding material on core should be minimum 3 mm.

Manufacturer should furnish a description of its Quality Assurance Programme including fabrication, testing and inspection for any material (i.e. rubber), components (i.e. rod) or hardware (i.e. end fittings). The manufacturer has had fabricated by others should also be included. Manufacturing methods and material composition documentation will be a part of Technical Bid to be submitted along with offer. Insulator should have hermetically sealed structure in which the housing material is moulded to cover the interface between the end fittings and the FRP Prod. This seal should never be broken during testing or otherwise.

6.3 END FITTINGS

The Polymer insulators shall be socket and ball type with the necessary coupling arrangement such that pin shall move freely in the socket but do not get disengaged while in service under various operating and atmospheric conditions.

The socket & ball type metal end fittings shall be designed to transmit the mechanical load to the core & the end fittings shall maintain uniform and consistent mechanical strength Material and methods used in the fabrication of metal parts shall be selected to provide good toughness and ductility. Metal end fittings shall be made from a quality malleable cast iron or forged steel or Spheroidal Graphite Iron (SGI) and shall be hot dipped galvanized in accordance with IS 2629. Metal end fittings shall be uniform and without sharp edges or corners and shall be free of cracks, flakes, slivers, slag, blow-holes shrinkage defects and localized porosity.

The attachment to the FRP rod shall be performed with a symmetrically controlled crimping method control by acquistic method that compresses the metal radically onto the rod without damage to the rod fibers or resin matrix while providing a strength equal to or greater than the defined and specified ultimate strength to the insulator. The material used in fittings shall be corrosion resistant.

Nominal dimensions of the pin, ball and socket interior shall be in accordance with the standard. No joints in ball & socket or pin will be allowed. Outer portion of ball or socket should be Zinc sleeved with minimum 99.95% purity of

electrolytic high-grade Zinc. The finished surface shall be smooth and shall have a good performance. The surface shall not crack or get chipped due to ageing effect under normal and abnormal service conditions or while handling during transit or erection. The design of the fittings and the insulators shall be such that there is no local corona formation or discharges likely to cause the interference to either sound or vision transmission.

6.4 GRADING RINGS

Grading rings shall be provided when system voltages are equal to or greater than 220kV. For 220kV transmissions, grading ring is to be provided at the energized end only.

All grading rings and brackets shall be designed as an integral part of the insulator assembly with a positive mounting system that allows mounting in one position. The design of the grading ring shall be such that ring can only be mounted with its orientation towards the weather sheds for maximum RIV and Corona control. Grading rings shall be designed in such a manner that the rings can be readily installed and removed with hot line tools without disassembling any other part of the insulator assembly.

Grading ring height (is the distance from the end of the end fitting to the top of corona ring) should be so selected that maximum field minimizes and uniformly distributed along the insulator. Manufacturer should provide reports of successful electric field modeling testing for the specific insulator design. The EFM should be three dimensional with result containing drawing depicting the electric field in various colours, each of a different voltage level. The result of this study should show that the voltage field surrounding the polymer insulators is optimum along the entire length of the insulator, with the effected hot end of the insulator being a critical location. The threshold at which corona may or may not be present should be defined as a figure in KV/mm for the designed insulator.

6.5 VERIFICATION OF HOUSING MATERIAL

The manufacturer should provide written verification about housing material, for which base polymer shall be 100% Silicon Rubber prior to the addition of reinforcing fillers considered will provide satisfactory performance in the particular environment It shall meet following requirements Be homogenous, impermeable, with no fissures, bubbles and strange materials inclusions. Be designed in order to avoid formation of localized discharges and to prevent interfaces humid penetration. Be resistant to corona, UV radiation, ozone, atmospheric contamination, water penetration and power arcs.

6.6 BALL AND SOCKET DESIGNATION

The dimensions of the Ball and Socket shall be 16mm designation for 70KN and 90KN Polymer insulators and 20 mm &24MM designation for 120 KN and 160 KN Polymer insulators in accordance with the standard dimensions stated in IEC:60120/IS:2486(Part-II)

6.7 **MARKINGS**:

6.7.1 Each insulator shall be legibly and indelibly marked with the following details as per IEC – 61109.

a. Name or trademark of the manufacturer.

b. Voltage and Type.

c. Month and year of manufacturing.

d. Minimum failing load / guaranteed mechanical strength in kilo Newton followed by the word 'KN' to facilitate easy identification.

e. Country of manufacture

6.7.2 One 10 mm thick ring of suitable quality of paint shall be marked on the end fitting of particular strength for easy identification of Polymer insulators. The paint shall not have any deteriorating effect on the insulator performance.

Following codes shall be used as identification mark:

For 90KN Polymer insulator : Blue

For 120KN Polymer insulator : Yellow

6.8 BID DRAWINGS

6.8.1 The Bidder shall furnish full description and illustration of the material offered.

6.8.2 The Bidder shall furnish along with the bid the outline drawing of each insulator unit along with grading rings including a cross sectional view of the long rod insulator unit. The drawing shall include but not limited to the following information:

(a) Major Dimensions with manufacturing tolerances

(b) Minimum Creepage distance with positive tolerance

(c) Protected creepage distance

(d) Unit mechanical and electrical characteristics

(e) Size and weight of ball and socket parts

(f) Weight of composite long rod units

(g) Materials

6.8.3 After placement of award, the Manufacturer/contractor shall submit full dimensioned insulator drawings containing all the details as given in Clause No. 6.8.2 above, in four (4) copies to KSEBL for approval. After getting approval from

KSEBL and successful completion of all the type tests, the Manufacturer/contractor shall submit 10 more copies of the same drawing along with a soft copy to the KSEBL for further distribution and field use at KSEBL's end.

6.8.4 After placement of award the Manufacturer/contractor shall also submit fully dimensioned insulator crate drawing for different type of insulators.

7 MATERIAL DESIGN AND WORKMANSHIP

7.1 GENERAL

(i) All raw materials to be used in the manufacture of these insulators shall be subject to strict raw material quality control and to stage testing/quality control during manufacturing stage to ensure the quality of the final end product. Manufacturing shall conform to the best engineering practices adopted in the field of high voltage transmission. Bidders shall therefore offer insulators as are guaranteed by them for satisfactory performance on 110kV and 220kV Transmission lines.

(ii) The design, manufacturing, process and material control at various stages be such as to give maximum working load, highest mobility, best resistance to corrosion, good finish, elimination of sharp edges and corners to limit corona and radio interference voltages.

7.2 GALVANISING

All ferrous parts shall be hot dip galvanized in accordance with the latest edition of IS: 2629. The zinc to be used for galvanizing shall conform to grade Zn 99.5 as per IS: 209. The Zinc coating shall be uniform, smoothly adherent, reasonably bright, continuous and free from impurities such as flux, ash, rust stains, bulky white deposits and blisters. Before ball fittings are galvanized, all die flashing on the shank and on the bearing surface of the ball shall be carefully removed without reducing the designed dimensional requirements**.**

7.3 INTERCHANGEABILITY

The Polymer insulators inclusive of the ball and socket fittings shall be of standard design suitable for use with hardware fittings of any make conforming to relevant Indian Standards.

7.4 CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) PERFORMANCE

All surfaces shall be even, smooth, without cuts, abrasions or projections. No part shall be subjected to excessive localized pressure. The metal parts shall not produce any noise generating corona under all operating conditions.

7.5 SUITABILITY FOR LIVE LINE MAINTENANCE

7.5.1 The Polymer insulators shall be compatible for use with hot line or live line maintenance techniques so that usual hot line operations can be carried out with ease, speed and safety.

7.5.2 Suppliers shall indicate the methods generally adopted in routine hot and cold line maintenance of EHV lines for similar Polymer insulators supplied by them. Suppliers shall also indicate the recommended periodicity of such maintenance.

8 TEST ON INSULATORS

The following tests shall be carried out on the Composite Polymer insulator:

8.1 TYPE TESTS

This shall mean those tests which are to be carried out to prove the design, process of manufacture and general conformity of the material and product with the intents of this specification. These tests shall be conducted on a representative number of samples prior to commencement of commercial production.

8.2 ACCEPTANCE TESTS

This shall mean those tests which are to be carried out on samples taken from each lot offered for pre-dispatch inspection for the purpose of acceptance of the lot.

8.3 ROUTINE TESTS

This shall mean those tests, which are to be carried out on each Polymer insulator to check the requirements, which are likely to vary during production.

8.4 STAGE TESTS DURING MANUFACTURE

Stage tests during manufacture shall mean those tests, which are to be carried out during the process of manufacture to ensure quality control such that the end product is of the designed quality conforming to the intent of this specification.

8.5 TEST VALUES

For all type and acceptance tests, the acceptance values shall be the value guaranteed by the Supplier in the guaranteed technical particulars or the acceptance value specified in this specification or the relevant standard whichever is more stringent for that particular test.

8.6 TEST PROCEDURES AND SAMPLING NORMS

The norms and procedure of sampling for the above tests shall be as per the relevant Indian Standard or other internationally accepted standards. This will be discussed and mutually agreed to between the successful Supplier and Purchaser before placement of order. The standards and norms according to which these tests are to be carried out are listed against each test. Where a particular test is a specific requirement of this specification the norms and procedure for the same shall be as mutually agreed to between the successful supplier and purchaser in the quality assurance programme. The supplier shall offer at least three times the quantity of material required for conducting all the type tests for sample selection.

Before sample selection, the supplier shall be required to conduct the entire acceptance test successfully in presence of purchaser's representative.

8.6.1 TYPE TESTS

(A) The following type tests shall be conducted on all types of the Polymer insulator with hardware fittings:

Power frequency voltage withstand test with corona control rings and arcing horn under (dry/wet) conditions

a) Power frequency voltage flash over test with corona control rings and arcing horn under (dry/wet) conditions

b) Power frequency voltage flash over test without corona control rings and arcing horn under (dry/wet) conditions

c) Switching surge voltage withstand test under wet condition.

d) Impulse voltage withstand test under dry condition.

e) Voltage Distribution test

f) Impulse voltage flash over test under dry condition

g) Corona and RIV Test under dry condition.

h) Mechanical strength test

i) Vibration test.

j) Power Arc Test

k) Salt fog pollution withstand Test

(B) On composite Insulator Unit: -

1. Tests on interface and connection of metal fittings

(a) Dry Power Frequency Voltage Test

(b) Sudden Load Release Test

(c) Thermal Mechanical Test

(d) Steep Front Impulse Voltage Test

(e) Dry Power Frequency Voltage Test

2. Assembled Core Load Time Test

(a) Determination of the Average failing load of the core of the assembled unit

(b) Control of slope of the strength time curve of the insulator

3. Accelerated Ageing Test of 5000 hours

4. Flammability Test

5. Recovery of Hydrophobic Test

6. Mechanical Load Time Test

7. Brittle Fracture resistance test

8. Test of Housing, Tracking and Erosion Test

9. Test for the Core Material

- Dye Penetration Test

- Water Diffusion Test

8.6.2 ACCEPTANCE AND ROUTINE TESTS

On Polymer Insulators following Acceptance & Routine tests shall be conducted:

(A) Acceptance tests:

a) Verification of dimensions	IEC: 61109-1992
b) Verification of Locking System	-
c) Galvanizing test	IS-731
d) Verification of specified Mechanical Load	IEC: 575
e) Recovery of Hydrophobicity	As per annex-A

(B) Routine tests:

a) Visual Inspection	IS-731
b) Mechanical routine test	IS-731
c) Electrical routine test	IEC: 383

8.6.3 TESTS DURING MANUFACTURE (STAGE TESTS)

On all components as applicable

a) Chemical analysis of Zinc used for galvanizing

b) Chemical analysis, mechanical and metallographic test and magnetic particle inspection for malleable castings

c) Chemical analysis, hardness test and magnetic particle inspection for forgings

d) Crack detection test for metal parts

8.6.4 ADDITIONAL TESTS

The purchaser reserves the right for carrying out any other tests of a reasonable nature at the works of the Supplier/laboratory or at any other recognized laboratory / research institute in addition to the above-mentioned type, acceptance and routine tests at the cost of the Purchaser to satisfy that the material complies with the intent of this specification.

8.6.5 COORDINATION FOR TESTING:

For polymer insulator strings, the Supplier is required to produce type test reports to the satisfaction of the Purchaser. However, in case the Purchaser desires, the Supplier shall conduct all the type tests on the complete string with relevant hardware fittings. Responsibility of arranging required hardwares for the purpose of type testing will remain with the insulator Supplier.

8.7 TEST SCHEDULE

8.7.1 TYPE TESTS

The material offered shall be fully type tested as per this specification and the Supplier shall furnish four sets of type test reports along with the offer. These tests must not have been conducted earlier than five years.

For any change in the design/type, already type tested and the design/type offered against this bid, the purchaser reserves the right to demand repetition of some or all type tests without any extra cost.

8.7.2 ACCEPTANCE AND ROUTINE TESTS

All Acceptance and Routine tests as stipulated herein shall be carried out by the Supplier in the presence of Purchaser’s (Board's) representative.

8.7.3 Immediately after finalization of the programme of acceptance/ routine testing, the Supplier shall give sufficient advance intimation to the Purchaser, to enable him to depute his representative for witnessing the test.

8.8 INSPECTION

i) Purchaser and its representatives shall at all times be entitled to have access to the works and to all places of manufactures where insulators are manufactured, and the successful Supplier shall afford all facilities to them for unrestricted inspection of the works, inspection of material, inspection of manufacturing process of insulators and for conducting necessary tests as specified herein.

ii) The successful Supplier shall keep the Purchaser informed in advance of the time of starting and progress of manufacture of insulators in its various stages so that arrangements could be made for inspection.

iii) No material shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested.

iv) The acceptance of any quantity of insulators shall in no way relieve the successful Supplier of his responsibility for meeting all the requirement of this specification and shall not prevent subsequent rejection, if such insulators are later found to be defective.

8.9 QUALITY ASSURANCE PLAN

8.9.1 The Supplier hereunder shall invariably furnish following information alongwith his offer, failing which the offer shall be liable for rejection. Information shall be separately given for individual type of material offered.

i) Statement giving list of important raw materials, names of sub-suppliers for the raw material, list of standards according to which the raw material are tested, list of tests, normally carried out on raw material in presence of Supplier's representative, copies of test certificates.

ii) Information and copies of test certificates as in (i) above in respect of bought out items.

iii) List of manufacturing facilities available.

iv) Level of automation achieved and list of areas where manual processing exists.

v) List of areas in manufacturing process, where stage inspections are normally carried out in quality control and details of such test and inspections.

vi) Special features provided in Polymer insulators to make it maintenance free.

vii) List of testing equipment available with the Supplier for final testing of Polymer insulators specified and test plant limitation, if any, vis-a-vis the type, special, acceptance and routine tests specified in the relevant standards.

8.9.2 The successful Supplier shall within 30 days of placement of order submit the following information to the Purchaser.

i) List of raw material as well as bought out accessories and the name of material as well as bought out accessories and the names of sub-suppliers selected from those furnished along with the offer.

ii) Type test certificates of the raw material and bought out accessories.

iii) Quality assurance plan (QAP) withhold points for Purchaser's inspection. The QAP and Purchaser's hold points shall be discussed between the Purchaser and the Supplier before the QAP is finalized.

The successful Supplier shall submit the routine test certificates of bought out items and raw material at the time of routine testing of the insulator.

8.10 DOCUMENTATION

The Supplier shall furnish full description and illustrated catalogues of insulators offered, along with the bid. The supplier shall also furnish along with the bid the outline drawing of Polymer insulator unit including cross-sectional view. The drawing shall include the following information:

i) Shed diameter and unit spacing with manufacturing tolerance.

ii) Creepage distance.

iii) Unit mechanical and electrical characteristics for the complete string-suspension and tension. Unit

iv) Size and weight of ball and socket part.

v) Weight of Polymer unit.

vi) Materials for the cap and pin.

vii) Identification mark.

viii) Manufacturer's catalogue number.

ix) Brief installation instructions.

x) Relevant technical details of significance.

8.11 TEST REPORTS

i) Four copies of type test reports shall be furnished to the Purchaser within one month of conducting the tests. One copy will be returned duly certified by the Purchaser to the Supplier within three weeks thereafter and on receipt of the same Supplier shall commence with the commercial production of the Polymer insulators.

ii) Four copies of acceptance test reports shall be furnished to the Purchaser. One copy will be returned, duly certified by the Purchaser and only thereafter shall the materials be dispatched.

iii) All records of routine test reports shall be maintained by the Supplier at his works for periodic inspection by the Purchaser.

iv) All test reports of tests conducted during manufacture shall be maintained by the Supplier. These shall be produced for verification as and when requested for by the Purchaser.

8.12 GUARANTEED PARTICULARS AND PERFORMANCE GUARANTEE:

(i) The bidder shall furnish all relevant technical guaranteed particulars of the long rod Polymer Insulators offered. Offers without such details may not be considered.

(ii) The Polymer Insulators shall be guaranteed for satisfactory performance for a period of 24 months from the date of commissioning of line. Any defect due to faulty material or workmanship found during guarantee period shall be rectified free of cost to the KSEBL. The replacement will have to be organized expeditiously and within one month from the date of intimation.

(iii)The contractor must ensure that the material supplied from specific vendor also guaranteed for the period specified in the bid against the manufacturing defect.

9 PACKING & FORWARDING

i) All Polymer insulators shall be packed in suitable PVC/Plastic tubes/any other suitable packing. The packing shall provide protection against rodents. The supplier shall furnish detailed design of the packing. For marine transportation crates shall be paletted.

ii) The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field.

iii) Suitable cushioning, protective padding, or dunnage or spacers shall be provided to prevent damage or deformation during transit and handling.

iv) All packing cases shall be marked legibly and correctly so as to ensure safe arrival at their destination and avoid the possibility of goods being lost or wrongly dispatched on account of faulty packing and faulty or illegible markings.

Each case/crate shall have all the markings stenciled on it in indelible ink.

The supplier shall guarantee the adequacy of the packing and shall be responsible for any loss or damage during transportation handling, storage and installation due to improper packing indelible ink.

10 GUARANTEED TECHNICAL SPECIFICATIONS OF POLYMERIC INSULATORS & ACCESSORIES

(The following sets of GTP are required to be filled up by the bidders to aid in the evaluation process. The response shall be brief and to the point and shall be supported by the printed product description and other literature. The same GTP format duly filled and the relevant drawings shall also be submitted

during the detailed engineering along with the relevant technical brochures. The bidder shall fill in the guaranteed technical particulars in the Proforma given in this section and submit the same with his tender, without which bid will not be considered.)

TABLE OF CONTENTS

GTP- 1 **110kV 90KN Tension Type Silicone Rubber Housed long rod composite polymer insulator**				
Sl. No.	Description	Unit	110kV:90KN Tension type	To be filled by the bidder
1.	Manufacturer			
2.	Country of Origin		India	
3.	Insulator type Origin		110kV:90KN Tension type composite long rod insulators	
4.	Standard according to which the insulators will be manufactured and tested		IEC – 61109	
5.	Name of material used in manufacture of insulator with class/ grade		Silicone Rubber	
6a.	Material of core (FRP rod)		ECR boron free	
	i) E-glass of ECR glass			
	ii) Boron content			
6b	Material of Housing & weather – sheds (Silicon content by weight)		Silicon Rubber (40%)	
6c	Material End Fitting		MCI/SGI/Forged steel	
6d	Sealing compound for end fittingsq		Silicon Sealant	
6e	Colour		Blue	
7	Electrical Characteristic			

GTP- 1 110kV 90KN Tension Type Silicone Rubber Housed long rod composite polymer insulator				
Sl. No.	Description	Unit	110kV:90KN Tension type	To be filled by the bidder
7a	Nominal system voltage	KV	110	
7b	Highest system voltage	KV	125	
7c	Dry power frequency withstand voltage	kV (rms)	325	
7d	Wet power frequency withstand voltage	kV (rms)	275	
7e	Dry Flashover Voltage	kV (rms)	350	
7f	Wet Flashover voltage	kV (rms)	300	
7g	Dry lighting impuse withstand voltage	kV (rms)		
	I) Positive		650	
	ii) Negative		650	
7h	RIV at 1 MHz when energised at 10kV/30kV/110kV (rms under dry condition	kV (rms)	<500 micro volts	
7i	Creepage Distance (Minimum)	Mm	4495	
8	Mechanical Characteristics			
8a	Minimum failing load	KN	90	
9	Dimensions of insulators			
9a	Weight	Kgs		
9b	Diameter of FRP rod	mm		

GTP- 1 110kV 90KN Tension Type Silicone Rubber Housed long rod composite polymer insulator				
Sl. No.	Description	Unit	110kV:90KN Tension type	To be filled by the bidder
9c	Length of FRP rod	mm		
9d	Dia Weather – Shed	mm		
9e	Thickness of Housing	Mm		
9f	Dry arc distance	Mm		
10	Method of fixing of sheds to housing			
	i) Single mould			
	ii) Modular construction			
	(injection moulding/compression moulding)			
11	No of weather sheds	Nos		
12	Type of sheds			
12a	Aerodynamic			
12b	With under-rubs			
13	Packing details			
13a	Type of packing			
13b	No of insulator in each pack			
13c	Gross weight of package	Kgs		

GTP- 1 **110kV 90KN Tension Type Silicone Rubber Housed long rod composite polymer insulator**				
Sl. No.	Description	Unit	110kV:90KN Tension type	To be filled by the bidder
14	Dimensioned drawings of the insulator (including weight with tolerance in weight)			

GTP- 2 110kV 70 KN Suspension Type Silicone Rubber Housed long rod composite polymer insulator				
Sl. No.	Description	Unit	110kV:70 KN	To be filled by the bidder
1.	Manufacturer			
2	Country of Origin		India	
3.	Insulator type Origin		110kV:70KN type composite long rod insulators	
4.	Standard according to which the insulators will be manufactured and tested		IEC - 61109	
5.	Name of material used in manufacture of insulator with class/ grade		Silicone Rubber	
6a.	Material of core (FRP rod)		ECR Boron free	
	i) E-glass of ECR glass			
	ii) Boron content			
6b	Material of Housing & weather – sheds (Silicon content by weight)		Silicon Rubber (40%)	
6c	Material End Fitting		MCI / SGI /Forged steel	
6d	Sealing compound for end fittingsq		Silicon Sealant	
6e	Colour		Yellow	
7	Electrical Characteristic			
7a	Nominal system voltage	KV	110	
7b	Highest system voltage	KV	125	

GTP- 2 110kV 70 KN Suspension Type Silicone Rubber Housed long rod composite polymer insulator				
Sl. No.	Description	Unit	110kV:70 KN	To be filled by the bidder
7c	Dry power frequency withstand voltage	kV (rms)	325	
7d	Wet power frequency withstand voltage	kV (rms)	275	
7e	Dry Flashover Voltage	kV (rms)	350	
7f	Wet Flashover voltage	kV (rms)	300	
7g	Dry lighting impuse withstand voltage	kV (rms)		
	I) Positive		650	
	ii) Negative		650	
7h	RIV at 1 MHz when energised at 10kV/30kV/110kV (rms under dry condition	kV (rms	<500 micro volts	
7i	Creepage Distance (Minimum)	Mm	4495	
8	Mechanical Characteristics			
8a	Minimum failing load	KN	70	
9	Dimensions of insulators			
9a	Weight	Kgs		
9b	Diameter of FRP rod	mm		
9c	Length of FRP rod	mm		
9d	Dia Weather – Shed	mm		
9e	Thickness of Housing	Mm		
9f	Dry arc distance	Mm		

GTP- 2 **110kV 70 KN Suspension Type Silicone Rubber Housed long rod composite polymer insulator**				
Sl. No.	Description	Unit	110kV:70 KN	To be filled by the bidder
10	Method of fixing of sheds to housing			
	i) Single mould			
	ii) Modular construction			
	(injection moulding/compression moulding)			
11	No of weather sheds	Nos		
12	Type of sheds			
12a	Aerodynamic			
12b	With under-rubs			
13	Packing details			
13a	Type of packing			
13b	No of insulator in each pack			
13c	Gross weight of package	Kgs		
14	Dimensioned drawings of the insulator (including weight with tolerance in weight)			

GTP- 3 220 kV 120KN Tension Type Silicone Rubber Housed long rod composite polymer insulator				
Sl. No.	Description	Unit	220kV:120KN Tension type	To be filled by the bidder
1.	Manufacturer			
2.	Country of Origin		India	
3.	Insulator type Origin		220kV:120KN Tension type composite long rod insulators	
4.	Standard according to which the insulators will be manufactured and tested		IEC – 61109	
5.	Name of material used in manufacture of insulator with class/ grade		Silicone Rubber	
6a.	Material of core (FRP rod)		ECR boron free	
	i) E-glass of ECR glass			
	ii) Boron content			
6b	Material of Housing & weather – sheds (Silicon content by weight)		Silicon Rubber (40%)	
6c	Material End Fitting		MCI/SGI/Forged steel	
6d	Sealing compound for end fittings		Silicon Sealant	
6e	Colour		Yellow	
7	Electrical Characteristic			

GTP- 3 220 kV 120KN Tension Type Silicone Rubber Housed long rod composite polymer insulator				
Sl. No.	Description	Unit	220kV:120KN Tension type	To be filled by the bidder
7a	Nominal system voltage	KV	220	
7b	Highest system voltage	KV	245	
7c	Dry power frequency withstand voltage	kV (rms)	510	
7d	Wet power frequency withstand voltage	kV (rms)	460	
7e	Dry Flashover Voltage	kV (rms)		
7f	Wet Flashover voltage	kV (rms)		
7g	Dry lighting impuse withstand voltage	kV (rms)		
	I) Positive		1050	
	ii) Negative		1050	
7h	RIV at 1 MHz when energised at 10kV/30kV/110kV (rms under dry condition	kV (rms)	<500 micro volts	
7i	Creepage Distance (Minimum)	Mm	7595	
8	Mechanical Characteristics			
8a	Minimum failing load	KN		
9	Dimensions of insulators			
9a	Weight	Kgs		

GTP- 3 220 kV 120KN Tension Type Silicone Rubber Housed long rod composite polymer insulator				
Sl. No.	Description	Unit	220kV:120KN Tension type	To be filled by the bidder
9b	Diameter of FRP rod	mm		
9c	Length of FRP rod	mm		
9d	Dia Weather – Shed	mm		
9e	Thickness of Housing	Mm		
9f	Dry arc distance	Mm		
10	Method of fixing of sheds to housing			
	i) Single mould			
	ii) Modular construction			
	(injection moulding/compression moulding)			
11	No of weather sheds	Nos		
12	Type of sheds			
12a	Aerodynamic			
12b	With under-rubs			
13	Packing details			
13a	Type of packing			
13b	No of insulator in each pack			
13c	Gross weight of package	Kgs		

GTP- 3 220 kV 120KN Tension Type Silicone Rubber Housed long rod composite polymer insulator				
Sl. No.	Description	Unit	220kV:120KN Tension type	To be filled by the bidder
14	Dimensioned drawings of the insulator (including weight with tolerance in weight)			

GTP- 4 220kV 90 KN Suspension Type Silicone Rubber Housed long rod composite polymer insulator				
Sl. No.	Description	Unit	220kV:90 KN	To be filled by the bidder
1.	Manufacturer			
2	Country of Origin		India	
3.	Insulator type Origin		220kV:90KN type composite long rod insulators	
4.	Standard according to which the insulators will be manufactured and tested		IEC - 61109	
5.	Name of material used in manufacture of insulator with class/ grade		Silicone Rubber	
6a.	Material of core (FRP rod)		ECR Boron free	
	i) E-glass of ECR glass			
	ii) Boron content			
6b	Material of Housing & weather – sheds (Silicon content by weight)		Silicon Rubber (40%)	
6c	Material End Fitting		MCI / SGI /Forged steel	
6d	Sealing compound for end fittingsq		Silicon Sealant	
6e	Colour		Blue	
7	Electrical Characteristic			
7a	Nominal system voltage	KV	220	
7b	Highest system voltage	KV	245	

GTP- 4 220kV 90 KN Suspension Type Silicone Rubber Housed long rod composite polymer insulator				
Sl. No.	Description	Unit	220kV:90 KN	To be filled by the bidder
7c	Dry power frequency withstand voltage	kV (rms)	510	
7d	Wet power frequency withstand voltage	kV (rms)	460	
7e	Dry Flashover Voltage	kV (rms)		
7f	Wet Flashover voltage	kV (rms)		
7g	Dry lighting impuse withstand voltage	kV (rms)		
	I) Positive		1050	
	ii) Negative		1050	
7h	RIV at 1 MHz when energised at 10kV/30kV/110kV/220kV (rms under dry condition	kV (rms	<1000 micro volts	
7i	Creepage Distance (Minimum)	Mm	7595	
8	Mechanical Characteristics			
8a	Minimum failing load	KN		
9	Dimensions of insulators			
9a	Weight	Kgs		
9b	Diameter of FRP rod	mm		
9c	Length of FRP rod	mm		
9d	Dia Weather – Shed	mm		
9e	Thickness of Housing	Mm		
9f	Dry arc distance	Mm		

GTP- 4 220kV 90 KN Suspension Type Silicone Rubber Housed long rod composite polymer insulator				
Sl. No.	Description	Unit	220kV:90 KN	To be filled by the bidder
10	Method of fixing of sheds to housing			
	i) Single mould			
	ii) Modular construction			
	(injection moulding/compression moulding)			
11	No of weather sheds	Nos		
12	Type of sheds			
12a	Aerodynamic			
12b	With under-rubs			
13	Packing details			
13a	Type of packing			
13b	No of insulator in each pack			
13c	Gross weight of package	Kgs		
14	Dimensioned drawings of the insulator (including weight with tolerance in weight)			

GTP- 5 400 kV 160KN Tension Type Silicone Rubber Housed long rod composite polymer insulator				
Sl. No.	Description	Unit	400kV:160KN Tension type	To be filled by the bidder
1.	Manufacturer			
2.	Country of Origin		India	
3.	Insulator type Origin		400kV:160KN Tension type composite long rod insulators	
4.	Standard according to which the insulators will be manufactured and tested		IEC – 61109	
5.	Name of material used in manufacture of insulator with class/ grade		Silicone Rubber	
6a.	Material of core (FRP rod)		ECR boron free	
	i) E-glass of ECR glass			
	ii) Boron content			
6b	Material of Housing & weather – sheds (Silicon content by weight)		Silicon Rubber (40%)	
6c	Material End Fitting		MCI/SGI/Forged steel	
6d	Sealing compound for end fittings		Silicon Sealant	
6e	Colour		Yellow	
7	Electrical Characteristic			

GTP- 5 400 kV 160KN Tension Type Silicone Rubber Housed long rod composite polymer insulator				
Sl. No.	Description	Unit	400kV:160KN Tension type	To be filled by the bidder
7a	Nominal system voltage	KV	220	
7b	Highest system voltage	KV	245	
7c	Dry power frequency withstand voltage	kV (rms)	510	
7d	Wet power frequency withstand voltage	kV (rms)	460	
7e	Dry Flashover Voltage	kV (rms)		
7f	Wet Flashover voltage	kV (rms)		
7g	Dry lighting impuse withstand voltage	kV (rms)		
	I) Positive		1050	
	ii) Negative		1050	
7h	RIV at 1 MHz when energised at 10kV/30kV/110kV (rms under dry condition	kV (rms)	<500 micro volts	
7i	Creepage Distance (Minimum)	Mm	7595	
8	Mechanical Characteristics			
8a	Minimum failing load	KN		
9	Dimensions of insulators			
9a	Weight	Kgs		

GTP- 5 400 kV 160KN Tension Type Silicone Rubber Housed long rod composite polymer insulator				
Sl. No.	Description	Unit	400kV:160KN Tension type	To be filled by the bidder
9b	Diameter of FRP rod	mm		
9c	Length of FRP rod	mm		
9d	Dia Weather – Shed	mm		
9e	Thickness of Housing	Mm		
9f	Dry arc distance	Mm		
10	Method of fixing of sheds to housing			
	i) Single mould			
	ii) Modular construction			
	(injection moulding/compression moulding)			
11	No of weather sheds	Nos		
12	Type of sheds			
12a	Aerodynamic			
12b	With under-rubs			
13	Packing details			
13a	Type of packing			
13b	No of insulator in each pack			
13c	Gross weight of package	Kgs		

GTP- 5 400 kV 160KN Tension Type Silicone Rubber Housed long rod composite polymer insulator				
Sl. No.	Description	Unit	400kV:160KN Tension type	To be filled by the bidder
14	Dimensioned drawings of the insulator (including weight with tolerance in weight)			

GTP - 6 400kV 120 KN Suspension Type Silicone Rubber Housed long rod composite polymer insulator				
Sl. No.	Description	Unit	400kV:120 KN	To be filled by the bidder
1.	Manufacturer			
2	Country of Origin		India	
3.	Insulator type Origin		400kV:120KN type composite long rod insulators	
4.	Standard according to which the insulators will be manufactured and tested		IEC - 61109	
5.	Name of material used in manufacture of insulator with class/ grade		Silicone Rubber	
6a.	Material of core (FRP rod)		ECR Boron free	
	i) E-glass of ECR glass			
	ii) Boron content			
6b	Material of Housing & weather – sheds (Silicon content by weight)		Silicon Rubber (40%)	
6c	Material End Fitting		MCI / SGI /Forged steel	
6d	Sealing compound for end fittingsq		Silicon Sealant	
6e	Colour		Blue	
7	Electrical Characteristic			
7a	Nominal system voltage	KV	220	
7b	Highest system voltage	KV	245	

GTP - 6 400kV 120 KN Suspension Type Silicone Rubber Housed long rod composite polymer insulator				
Sl. No.	Description	Unit	400kV:120 KN	To be filled by the bidder
7c	Dry power frequency withstand voltage	kV (rms)	510	
7d	Wet power frequency withstand voltage	kV (rms)	460	
7e	Dry Flashover Voltage	kV (rms)		
7f	Wet Flashover voltage	kV (rms)		
7g	Dry lighting impuse withstand voltage	kV (rms)		
	I) Positive		1050	
	ii) Negative		1050	
7h	RIV at 1 MHz when energised at 10kV/30kV/110kV/220kV (rms under dry condition	kV (rms	<1000 micro volts	
7i	Creepage Distance (Minimum)	Mm	7595	
8	Mechanical Characteristics			
8a	Minimum failing load	KN		
9	Dimensions of insulators			
9a	Weight	Kgs		
9b	Diameter of FRP rod	mm		
9c	Length of FRP rod	mm		
9d	Dia Weather – Shed	mm		
9e	Thickness of Housing	Mm		
9f	Dry arc distance	Mm		

GTP - 6 400kV 120 KN Suspension Type Silicone Rubber Housed long rod composite polymer insulator				
Sl. No.	Description	Unit	400kV:120 KN	To be filled by the bidder
10	Method of fixing of sheds to housing			
	i) Single mould			
	ii) Modular construction			
	(injection moulding/compression moulding)			
11	No of weather sheds	Nos		
12	Type of sheds			
12a	Aerodynamic			
12b	With under-rubs			
13	Packing details			
13a	Type of packing			
13b	No of insulator in each pack			
13c	Gross weight of package	Kgs		
14	Dimensioned drawings of the insulator (including weight with tolerance in weight)			

ANNEXURE-7A

TESTS ON COMPLETE COMPOSITE INSULATOR WITH HARDWARE FITTINGS

1 CORONA EXTINCTION VOLTAGE TEST (DRY)

The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not less than 154kV (rms) line to ground under dry condition for 220kV line. There shall be no evidence of corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulated in IEC: 60383.

2 RIV TEST (DRY)

Under the conditions as specified under (1.2) above, the insulator string along with complete hardware fittings shall have a radio interference voltage level below 1000 micro volts at one MHz when subjected to 50 Hz AC voltage of 305kV line to ground under dry condition for 220kV AC line. The test procedure shall be in accordance with IS: 8263/ IEC: 60437.

3 MECHANICAL STRENGTH TEST

The complete insulator string along with its hardware fitting excluding arcing horn, corona control ring, grading ring and suspension assembly/dead end assembly shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. The load shall be held for five minutes and then removed. After removal of the load, the string components shall not show any visual deformation and it shall be possible to disassemble them by hand. Hand tools may be used to, remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached, and the value recorded.

4 VIBRATION TEST

The suspension string shall be tested in suspension mode, and tension string in tension mode itself in laboratory span of minimum 30 meters. In the case of suspension string, a load equal to 600 kg shall be applied along the axis of the suspension string by means of turn buckle. The insulator string along with hardware fittings and the each sub-conductor (each tensioned at 35KN for 220kV) shall be secured with clamps. The system shall be suitable to maintain constant tension on each sub-conductor throughout the duration of the test. Vibration dampers shall not be used on the test span. All the sub-conductors shall be vertically vibrated simultaneously at one of the resonance frequencies of the insulators string (more than 10 Hz) by means of vibration inducing equipment. The peak to peak displacement in mm of vibration at the antinode point, nearest to the string, shall be measured and the same shall not be less than

$1000/f^{1.8}$ where f is the frequency of vibration in cycles/sec. The insulator string shall be vibrated for not less than 10 million cycles without any failure. After the test, the insulators shall be examined for looseness of pins and cap or any crack. The hardware shall be examined for looseness, fatigue failure and mechanical strength test. There shall be no deterioration of properties of hardware components and insulators after the vibration test. The insulators shall be subjected to the Mechanical performance test followed by mechanical strength test as per relevant standards.

5 SALT - FOG POLLUTION WITHSTAND TEST

This test shall be carried out in accordance with IEC-60507. The salinity level for composite long rod insulators shall be 80 Kg/m^3 NACL.

6 COMPOSITE LONG ROD INSULATOR UNITS

6.1 BRITTLE FRACTURE RESISTANCE TEST

Assembled core load time test with container that contains in HNO_3 concentric acid this is applied at the naked FRP rod. The rod should be held at 80% of SML for the duration of the test. The rod should not fail within the 96-hour test duration.

6.2 RECOVERY OF HYDROPHOBICITY TEST

(i) The surface of selected samples shall be cleaned with isopropyl alcohol. Allow the surface to dry and spray with water. Record the HC classification. Dry the sample surface

(ii) Treat the surface with corona discharges to destroy the hydrophobicity. This can be done utilizing a high frequency corona tester. Holding the electrode approximately 3 mm from the sample surface slowly move the electrode over an area approximately 1'' x 1''. Continue treating this area for 2-3 minutes, operating the tester at maximum output.

(iii) Immediately after the corona treatment, spray the surface with water and record the HC classification. The surface should be hydrophilic with an HC value of 6 to 7. If not, dry the surface and repeat the corona treatment for a longer time until an HC of 6 or 7 is obtained. Dry the sample surface.

(iv) Allow the sample to recover and repeat the Hydrophobicity measurement at several time intervals. Silicone rubber should recover to HC 1 – HC 2 within 24 to 48 hours, depending on the material and the intensity of the corona treatment

6.3 SILICONE CONTENT TEST

Minimum content of silicone as guaranteed by supplier shall be verified through FT-IR spectroscopy & TGA analysis or any other suitable method mutually agreed between Owner & Supplier in Quality Assurance Programme.

7 HIGH PRESSURE WASHING TEST

The washing of a complete insulator of each E&M rating is to be carried out at 3800 KPa with nozzles of 6mm diameter at a distance of 3m from nozzles to the insulator. The washing shall be carried out for 10minutes. There shall be no damage to the sheath or metal fitting to housing interface. The verification shall be 1 minute wet power frequency withstand test at 460 kV r.m.s for 220KV.

8 TORSION TEST

Three complete insulators of each E&M rating shall be subjected to a torsional load of 55Nm. The torsional strength test shall be made with test specimen adequately secured to the testing machine. The torsional load shall be applied to the test specimen through a torque member so constructed that the test specimen is not subjected to any cantilever stress. The insulator after torsion test must pass the Dye Penetration Test as per IEC 61109.

9 TESTS ON ALL COMPONENTS (AS APPLICABLE)

9.1 CHEMICAL ANALYSIS OF ZINC USED FOR GALVANIZING

Samples taken from the zinc ingot shall be chemically analyzed as per IS 209-1979. The purity of zinc shall not be less than 99.95%.

9.2 TESTS FOR FORGINGS

The chemical analysis hardness tests and magnetic particle inspection for forgings, will be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Supplier and Owner in Quality Assurance Programme.

9.3 TESTS ON CASTINGS

The chemical analysis, mechanical and metallographic tests and magnetic, particle inspection for castings will be as per the internationally recognized Procedures for these tests. The samplings will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Supplier and Owner in Quality Assurance Programme.

10 POWER ARC TEST:

Three insulators having any one design of end fittings shall be tested for power arc endurance while tensioned horizontally at 3000lb. An arc shall be initiated across the insulator by means of a Copper shorting fuse wire. The arc shall burn 15 to 30 cycles and its current magnitude is determined by ampere- time product (IxT) equal to a minimum of 150kA cycles. Each insulator is only acceptable if there is no exposure of the core, no mechanical separation of the insulator, and no cracks in the housing.

SECTION - 8

TECHNICAL SPECIFICATION OF HARDWARE & ACCESSORIES FOR CONDUCTOR, INSULATOR & EARTH WIRE

TABLE OF CONTENT

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16	QUALITY ASSURANCE PROGRAM
	ANNEXURE-8A - TESTS ON HARDWARE FITTINGS
	ANNEXURE-8B - ACCEPTANCE TESTS

SECTION - 8

TECHNICAL SPECIFICATION OF HARDWARE & ACCESSORIES FOR CONDUCTOR, INSULATOR & EARTH WIRE

1 SCOPE

This section provides the technical details of Hardware fittings & Accessories suitable for Insulator string, Conductor and Earth wire for use on 220kV/110kV MCMV transmission lines. The material and services under this specification shall be performed as per the requirements of the latest revisions and amendments available at the time of placement of order of all the relevant Indian Standards/Codes listed in Clause-2 STANDARDS here under or equivalent International Standards, except as modified in this document.

The materials covered here under this specification shall be supplied complete in all respects, including all components, fittings and accessories which are necessary or are usual for their efficient performance and satisfactory maintenance under the various operating and atmospheric conditions. Such parts shall be deemed to be within the scope of the Contract, whether specifically included or not in the Specification or in the Contract Schedules.

2 STANDARDS

Sl. No.	Indian Standard	Title
1	IS:206	Tee and Strap Hinges
2	IS:209	Specification for Zinc
3	IS:1367	Technical supply conditions for threaded fasteners
4	IS:1385	Phosphor Bronze Rods & Bar Sheet and Strips and Wire
5	IS:1570 (part-I)	Schedules for wrought steels for general engineering purposes steel specified by tensile and/or yield properties
6	IS:1573	Electroplated coatings of zinc on iron and steel
7	IS:2002	Steel plates for pressure vessels for intermediate and high temperature
8	IS:2004	Specification for carbon steel forgings the general engineering purposes
9	IS 2062-2011	Specification for steel for general purpose
10	IS:2071	Method of high voltage testing
11	IS:2121 (all parts)	Specification of conductors and earthwire accessories for over-head power lines

Sl. No.	Indian Standard	Title
12	IS:2486 (all parts)	Specification for insulator fittings for overhead power lines with nominal voltage greater than 1000V
13	IS:2629	Recommended practice for Hot Dip galvanizing of iron & steel
14	IS:2633	Methods of testing uniformity of coating on zinc coated articles
15	IS:3138	Hexagon Bolts and Nuts
16	IS:3188	Characteristic of String Insulators Units
17	IS:4759	Hot Dip Zinc Coatings on Structural Steel and other Allied Products
18	IS: 4826-1979	Hot Dip Galvanised Coating on Round Steel Wires
19	IS 6639	Specification for Hexagonal bolts for steel structures
20	IS:6745	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles
21	IS:7814-1985	Phosphor Bronze Sheet and Strip
22	IS: 8263	Method of Radio Interference Tests on High Voltage Insulators
23	IS: 9708	Stockbridge Vibration Dampers for Overhead Power lines.
24	IS:10162	Spacers and Spacer Dampers for twin horizontal bundle Conductors.
25	BS:970 (Part-I)	General Instructions and Testing Procedures Specific Requirements for Carbon and Carbon Manganese Alloy and Stainless Steels.
26		Ozone test on Elastomer
27		Composite string insulator units for overhead lines with a nominal voltage above 1000V: i) Standard strength classes and end fittings ii) Dimensional and electrical characteristics

The standards mentioned above are available from:

Reference Abbreviation	Name and Address
BS	British Standards, British Standards Institution 101, Pentonvile Road, N - 19-ND, UK
IEC/CISPR	International Electro Technical Commission, Bureau Central de la Commission, electro Technique international, 1 Rue de verembe, Geneva, SWITZERLAND
BIS/IS	Bureau of Indian Standards. Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi – 110001, INDIA
ISO	International Organisation for Standardization. Danish Board of Standardization Danish Standardizing Sraat, Aurehoegvej-12 DK-2900, Heeleprup, DENMARK.
NEMA	National Electric Manufacture Association, 155, East 44th Street. New York, NY 10017, U.S.A.

3 LINE REQUIREMENT

3.1 INSULATOR STRING CHARACTERISTICS

Insulator string characteristics are furnished in clause 4.1, section 1, part A of volume II.

3.2 CONDUCTORS CHARACTERISTICS

Conductor characteristics are furnished in clause 4.1, section 1, part A of volume II.

3.3 OPGW CHARACTERISTICS

OPGW characteristics are furnished in clause 4.1, section 1, part A of volume II.

4 TECHNICAL DESCRIPTION OF HARDWARE FITTINGS

4.1 General

The Hardware fittings & Accessories shall meet the technical requirement as per standards. Hardware fittings & Accessories shall be suitable for single/double suspension V-string Insulator and single/double tension Insulator strings.

Each Hardware fitting shall be supplied complete in all respect and shall include all components, which are required for making complete set.

The hardware fittings shall be suitable for use with Composite Long Rod insulators having ball and socket fittings.

Corona control rings/grading ring with fittings for attachment to line side yoke plate.

Sag adjustment plate for Double tension hardware fittings and turn buckle for single tension hardware fittings.

Suspension and dead-end assembly to suit conductor size as detailed in clause 4.6 & 4.7 hereinafter.

Other necessary fittings viz D-shackles, eye links, extension links, ball clevis, socket clevis, clevis eye, U clevis and chain link etc. to make the hardware fittings complete.

The fittings shall be suitable for attachment to suspension and tension insulator strings along with hardware fittings and shall include 2.5 % extra fasteners, Aluminium filler plugs & retaining rods. Indicative drawings of complete insulator strings along with hardware fittings as well as indicative drawings for suspension clamps and dead end clamps are enclosed in Section-VII of this specification. The supplier shall be responsible for satisfactory performance of complete conductor system along with fittings offered by them for continuous operation at the maximum temperature specified by them for the conductor.

4.2 Interchangeability

The hardware for insulator strings with Composite long rod insulators together with ball and socket fittings shall be of standard design, so that these hardware are inter- changeable with each other and suitable for use with insulators of any make conforming to relevant Indian/International Standard.

4.3 Corona and RI Performance

Sharp edges and scratches on all the hardware fittings shall be avoided. All surfaces must be clean, smooth, without cuts and abrasions or projections. The Supplier shall be responsible for satisfactory corona and radio interference performance of the materials offered by him.

4.4 Maintenance

The hardware fittings offered shall be suitable for employment of hot line maintenance technique so that usual hot line operations can be carried out with ease, speed and safety. The technique adopted for hot line maintenance shall be generally bare hand method & hot stick method. The Bidder should clearly establish in the bid, the suitability of his fittings for hot line maintenance.

The line side yoke plate shall have a notch & a working hole of suitable size. The design of corona control rings/grading ring shall be such that it can be easily replaced by employing hot line maintenance technique.

4.5 Split Pins

Split pins shall be used with bolts & nuts.

4.6 SUSPENSION ASSEMBLY

4.6.1 The suspension assembly shall be suitable for the ACSR Panther conductor

4.6.2 The suspension assembly shall include either free centre type suspension clamp along with standard preformed armour rods or armour grip suspension clamp.

4.6.3 The suspension clamp along with standard preformed armour rods set shall be designed to have maximum mobility in any direction and minimum moment of inertia so as to have minimum stress on the conductor in the case of oscillation of the same.

4.6.4 The suspension clamp suitable for various type of Conductor along with standard preformed armour rods/armour grip suspension clamp set shall have a slip strength between 8% to 15% of ultimate strength of conductor.

4.6.5 The suspension clamp shall be designed for continuous operation at the temperature according to the temp of required conductor.

4.6.6 The suspension assembly shall be designed, manufactured and finished to give it a suitable shape, so as to avoid any possibility of hammering between suspension assembly and conductor due to vibration. The suspension assembly shall be smooth without any cuts, grooves, abrasions, projections, ridges or excrescence which might damage the conductor.

4.6.7 The suspension assembly/clamp shall be designed so that it shall minimise the static & dynamic stress developed in the conductor under various loading conditions as well as during wind induced conductor vibrations. It shall also withstand power arcs & have required level of Corona/RIV performance.

4.6.8 Free Centre Type Suspension Clamp

For the Free Centre Suspension Clamp seat shall be smoothly rounded and curved into a bell mouth at the ends. The lip edges shall have rounded bead. There shall be at least two U-bolts for tightening of clamp body and keeper pieces together.

4.6.9 Standard Preformed Armour Rod Set

4.6.9.1 The Preformed Armour Rods Set shall be used to minimize the stress developed in the sub-conductor due to different static and dynamic loads because of vibration due to wind, slipping of conductor from the suspension clamp as a result of unbalanced conductor tension in adjacent spans and broken wire condition. It shall also withstand power arcs, chafing and abrasion from suspension clamp and localized heating effect due to magnetic power losses from suspension clamps as well as resistance losses of the conductor.

4.6.9.2 The preformed armour rods set shall have right hand lay and the inside diameter of the helics shall be less than the outside diameter of the conductor to have gentle but permanent grip on the conductor. The surface of the armour rod when fitted on the conductor shall be smooth and free from projections, cuts and abrasions etc.

4.6.9.3 The pitch length of the rods shall be determined by the Bidder but shall be less than that of the outer layer of conductor and the same shall be accurately controlled to maintain uniformity and consistently reproducible characteristic wholly independent of the skill of linemen.

4.6.9.4 The tolerance in length of the rods in complete set should be within 13 mm between the longest and shortest rod. The ends of armour rod shall be parrot billed.

4.6.9.5 The number of armour rods in each set shall be eleven. Each rod shall be marked in the middle with paint for easy application on the line.

4.6.9.6 The armour rod shall not lose their resilience even after five applications. The conductivity of each rod of the set shall not be less than 40% of the conductivity of the International Annealed Copper Standard (IACS).

4.6.10 Armour Grip Suspension Clamp

4.6.10.1 The armour grip suspension clamp shall comprise of retaining strap, support housing, elastomer inserts with aluminium reinforcements and AGS preformed rod set.

4.6.10.2 Elastomer insert shall be resistant to the effects of temperature up to maximum conductor temperature guaranteed by the bidder corresponding to peak current, Ozone, ultraviolet radiations and other atmospheric contaminants likely to be encountered in service. The physical properties of the elastomer shall be of approved standard. It shall be electrically shielded by a cage of AGS performed rod set. The elastomer insert shall be so designed that the curvature of the AGS rod shall follow the contour of the neoprene insert.

4.6.10.3 The length of the AGS preformed rods shall be such that it shall ensure sufficient slipping strength and shall not introduce unfavorable stress on the conductor under all operating conditions.

4.7 DEAD END ASSEMBLY

4.7.1 The dead-end assembly shall be suitable for the ACSR Panther Conductor.

4.7.2 The dead-end assembly shall be of compression type with provision for compressing jumper terminal at one end. The angle of jumper terminal to be mounted should be 30° with respect to the vertical line. The area of bearing surface on all the connections shall be sufficient to ensure positive electrical and mechanical contact and avoid local heating due to I^2R losses.

The resistance of the clamp when compressed on Conductor shall not be more than 75% of the resistance of equivalent length of Conductor.

4.7.3 Die compression areas shall be clearly marked on each dead-end assembly designed for continuous die compressions and shall bear the words 'COMPRESS FIRST' suitably inscribed near the point on each assembly where the compression begins. If the dead-end assembly is designed for intermittent die compressions it shall bear identification marks 'COMPRESSION ZONE' and 'NON-COMPRESSION ZONE' distinctly with arrow marks showing the direction of compressions and knurling marks showing the end of the zones. Tapered aluminium filler plugs shall also be provided at the line of demarcation between compression & non-compression zone. The letters, number and other markings on the finished clamp shall be distinct and legible. The dimensions of dead end assembly before & after compression along with tolerances shall be shall be guaranteed in the relevant schedules of the bid and shall be decided by the manufacturer so as to suit the conductor size & conform to electrical & mechanical requirement stipulated in the specification.

4.7.4 The assembly shall not permit slipping of, damage to, or failure of the complete conductor or any part thereof at a load less than 95% of the ultimate tensile strength of the conductor.

4.8 OTHER HARDWARE FITTINGS

4.8.1 BALL AND SOCKET

The Ball and Socket for Hardware fittings shall necessarily conform to the dimensions as stipulated in the Indian Standards. The Ball and Socket dimensions of the Hardware sets to be used with 90KN Electro Mechanical strength of

Polymeric Insulators shall be of 16mm. The Ball and Socket dimensions of the Hardware sets to be used with 120KN Electro Mechanical strength of Polymeric Insulators shall be of 20mm. The Bidder shall offer full detail of locking device in accordance with IS 2486:(Part-III) or equivalent International Standard along with test reports, gauges and adherence to Standards for Tests on Locking Devices in line with IS:2486 (Part-IV) or equivalent International Standard.

4.8.1.1 Ball fittings

Ball fittings shall be made of class IV steel as per IS:2004 or steel of equivalent grade and shall be forged in one piece. They shall be normalized to achieve the minimum breaking strength specified on the respective drawings. Before galvanization of ball fittings, all die flashing on the shank and on the bearing surface of the ball shall be carefully removed without reducing the dimensions below the requirements.

4.8.1.2 Socket fittings

Socket fittings shall be made of class IV steel as per IS:2004 or steel of equivalent grade and shall be forged in one piece. They shall be normalized to achieve the minimum breaking strength specified on the respective drawings.

4.8.1.3 Security clips for socket fittings

Socket fittings shall be provided with R-shaped security clip in accordance with IS:2486 (parts III & IV) to provide positive locking against unintentional disengagement of socket from the ball of the insulator. The security clip shall be humped to maintain the clip in the locked position and shall have both prongs spread to prevent template withdrawal from the socket. The clip end shall not project outside the recess of socket when the clip in locked position.

The hole for the security clip shall be on the side of the socket opposite to the socket opening. The hole for the clip shall be counter sunk. The clip eye shall be of such design that the same may be engaged by a hotline clip puller to provide for disengagement under energized conditions.

The security clip shall be made of stainless steel of type AISI 302 or 304 or phosphor bronze as per IS:7814.

4.8.2 YOKE PLATE/LINK PLATE

The strength of yoke plates shall be adequate to withstand the minimum ultimate tensile strength suits to Insulators mentioned in Section 7 of Volume II.

The plates shall be either triangular or rectangular in shape as may be necessary. The design of yoke plate shall take into account the most unfavorable loading conditions likely to be experienced as a result of dimensional tolerances for Composite insulators as well as components of hardware fittings within the specified range. The plates shall have suitable holes for fixing corona control rings/grading ring/arcing horn. All the corners and edges should be rounded off with a radius of atleast 3 mm. Design calculations i.e. for bearing & tensile strength, for deciding the dimensions of yoke plate shall be furnished by the bidder.

The yoke plate/link plate shall be made of steel plate as per IS: 226 or equivalent standards. Shearing/cutting of the plate shall be clean without drawn or ragged

edges. If the plates are flame cut, mechanical guides shall be used. It shall be ensured that the grain flow of the yoke plate shall be in the direction of the tensile load.

Holes shall be cylindrical, clean cut and perpendicular to the plane of the material. The periphery of the holes shall be free from burrs.

4.8.3 ANCHOR SHACKLE

Anchor shackle shall be made of forged steel complete with G.I. rivets and stainless-steel split pin, minimum breaking strength shall be 240KN for double tension string.

4.8.4 BALL CLEVIS, SOCKET CLEVIS

The Ball clevis shall be made of forged steel and socket clevis from malleable cast iron complete with G.I. rivet and stainless-steel split pins. Ball and socket clevis shall be suitable for insulator string for appropriate fitting to which they are connected. All ball and clevis shall be a minimum breaking strength of 120KN.

4.8.5 CLEVIS – CLEVIS

Clevis fittings shall be made of malleable cast iron, complete with G.I. rivet and stainless-steel split pins. Clevis shall be suitable for connecting to yoke plate on sub-station structure side. Minimum breaking strength of the clevis shall be 120KN

4.8.6 TURN BUCKLE

The turn buckle is to be provided with single tension hardware fitting. The threads shall be of sufficient strength to remain unaffected under the specified tensile load.

It shall be made of forged steel. The minimum adjustment in the movement facilitated by the turn buckle shall be 175mm. The minimum breaking strength of the turn buckle shall be 160KN and requisite locking arrangement shall be provided for safe guarding shearing of threads under working conditions. The same shall be specifically indicated in the drawings.

4.8.7 SAG ADJUSTMENT PLATE

The Sag adjustment plate shall be made of steel plate as per IS:226 or equivalent standards. Shearing/cutting of the plate shall be clean without drawn or ragged edges. If the plates are flame cut, mechanical guides shall be used.

Sag adjustment plate for Dead End Assembly having adjustment of upto 150mm minimum at the interval of 6 mm.

The sag-adjustment plate to be provided with the Double tension hardware fitting shall be of three plate type. The sag adjustment plate shall be provided with a safety locking arrangement. The device shall be of such design that the adjustment is done with ease, speed and safety.

Design calculations for deciding the dimensions of sag adjustment plate shall be furnished by bidder

4.8.8 ARCING HORN

220/110kV Insulator strings for transmission line shall be provided with Arcing Horns of different type at suitable position for each insulator. In case of 220kV Insulator strings, the Arcing Horn shall be provided on both line side & tower side. The dimension of the Arcing Horn shall be as per standard. However, the height of the Arcing Horn may be changed depending upon the length of Socket Eye, Yoke Plate etc. The arrangement for fixing of Arcing Horn shall be such that they do not get loose while in service. To achieve this, they should have proper seat for the Arcing Horn and heat-treated Belleville washers should be provided with the bolts.

5 PARTICULARS OF HARDWARE FITTINGS

Each Hardware fitting for the transmission line shall be complete in all respect and Bidder should furnish complete drawings and technical particulars of the items of hardware fittings. The Hardware fittings should normally comprise items mentioned below:

5.1 SINGLE SUSPENSION V-STRING HARDWARE FITTING

Single suspension Hardware string shall comprise of one Ball Hook, one Socket Eye Horn holder, one-line side Arcing Horn and one Suspension Clamp of AGS type with armour rod suitable for respective sizes of Conductors. The Complete string shall have ultimate breaking strength of not less than 90KN for 220kV.

5.2 SINGLE TENSION STRING HARDWARE FITTINGS

Single tension string Hardware shall comprise of one `D' Shackle, one Ball Link, one Forged Steel Socket, Socket Clevis Horn holder, Arcing Horn and one Tension Clamp of compression type. The Complete string shall have ultimate breaking strength of not less than 120KN for 220kV.

5.3 DOUBLE TENSION STRING HARDWARE FITTINGS

The double tension string Hardware shall comprise of two `D' shackle, one chain link one top yoke plate, two ball clevis, two socket clevis, one bottom yoke plate, Arcing horn, one clevis and a compression type dead-end Clamp. The Complete string shall have ultimate breaking strength of not less than 240KN for 220kV.

6 GENERAL SPECIFICATIONS

6.1 All the materials shall be of the latest design and conform to the best modern practice adopted in the extra high voltage field. The manufacturer shall supply only such material as guaranteed by him to be satisfactory and suitable for 220/110kV Transmission lines.

6.2 The design, manufacturing process and quality control of all the materials shall be such as to give maximum factor of safety, maximum possible working load, highest mobility, elimination of sharp edges and corners, best resistance to corrosion and a good finish.

6.3 All ferrous parts shall be hot dip galvanised, after all machining has been completed. Nuts may, however, be tapped (threaded) after galvanizing and the threads oiled. Spring washers shall be electro galvanised. The bolts threads shall be undercut to take care of increase in diameter due to galvanizing. Galvanizing shall be done in accordance with IS:2629-1990 or equivalent International Standard and satisfy the tests mentioned in IS:2633- 1992 or equivalent International Standard. Fasteners shall withstand four dips while spring washers shall be

guaranteed to withstand at least six dips each lasting one minute under the standard preece test for galvanizing.

6.4 The Zinc coating shall be perfectly adhere, of uniform thickness, smooth, reasonably bright, continuous and free from imperfections such as flux, ash, rust stains, bulky while deposits and blisters. The Zinc used for galvanizing shall be grade Zn. 99.95 as per IS: 209-1992 or equivalent International Standard.

6.5 In case of castings, the same shall be free from all internal defects like shrinkage, inclusion, blowholes, cracks etc.

6.6 All current carrying parts shall be so designed and manufactured that contact resistance is reduced to minimum.

6.7 No item which would produce high electrical and mechanical stresses in normal working shall have sharp ends or edges, abrasions or projections and shall not cause any damage to the Conductor in any way during erection or during continuous operation. The design of adjacent metal parts and mating surfaces shall be such as to prevent corrosion of the contact surface and no maintain good electrical contact under service conditions.

6.8 Particular care shall be taken during manufacturing and subsequent handling to ensure smooth surface free from abrasion or dents.

6.9 The fasteners shall conform to the requirement of IS: 6639-1972 or equivalent International Standard. All fasteners and clamps shall have locking arrangements to guard against vibration loosening.

7 BID DRAWINGS

7.1 The Bidder shall furnish full description and illustrations of materials offered.

7.2 Fully dimensioned drawings of the complete insulator string hard wares and their component parts showing clearly the following arrangements shall be furnished along with the bid. Weight, material and fabrication details of all the components should be included in the drawings.

(i) Attachment of the hanger or strain plate.

(ii) Suspension or dead-end assembly.

(iii) Arcing horn attachment to the string as specified in clause 4.8.8 of this technical Specification.

(iv) Yoke plates

(v) Hardware fittings of ball and socket type for inter connecting units to the top and bottom Yoke plates.

(vi) Corona control rings/grading ring attachment to conductor and other small accessories.

(vii) Links with suitable fittings.

(viii) Details of balancing weights and arrangements for their attachment in the single suspension pilot insulator string.

7.3 All drawings shall be identified by a drawing number and contract number. All drawings shall be neatly arranged. All drafting & lettering shall be legible. The

minimum size of lettering shall be 3 mm. All dimensions & dimensional tolerances shall be mentioned in mm.

The drawings shall include:

(i) Dimensions and dimensional tolerance.

(ii) Material, fabrication details including any weld details & any specified finishes & coatings. Regarding material designation & reference of standards are to be indicated.

(iii) Catalogue No.

(iv) Marking

(v) Weight of assembly

(vi) Installation instructions

(vii) Design installation torque for the bolt or cap screw.

(viii) Withstand torque that may be applied to the bolt or cap screw without failure of component parts.

(ix) The compression die number with recommended compression pressure.

(x) All other relevant terminal details.

7.4 After placement of award, the Contractor/Manufacturer shall submit fully dimensioned drawing including all the components in four (4) copies to the KSEBL for approval. After getting approval from the KSEBL and successful completion of all the type tests, the Contractor/Manufacturer shall submit thirty (30) more copies of the same drawings to the KSEBL for further distribution and field use at KSEBL's end.

8 DIMENSIONS & TOLERANCES:

8.1 The dimensions and tolerances of pin balls and socket ends shall conform to IS 2486 Part-II/IEC-120 and shall be checked by the gauge therein after galvanizing.

8.2 The pin balls shall be checked with the applicable “GO” gauges in at least two directions, one of which shall be across the line of die flashing and the other 90 deg. to this line. “NO GO” gauges shall not pass in any direction.

8.3 The bearing surfaces of balls and machined sockets, before galvanizing shall not have surface roughness more than 250 micro inches.

8.4 The bearing surface of socket ends shall be uniform about the entire circumference without depressions or high spots. The internal contour of the socket ends shall be concentric with the axis of fittings. The axis of the bearing surface of socket ends shall be coaxial with the axis of fittings with no appreciable tilting.

9 IMPORTANT CONDITIONS:

9.1 All Hardware items shall be complete with minor items such as security clip, bolts, nuts, washer, split pins and inners etc.

9.2 The Contractor shall be responsible for satisfying him that the Insulator fittings offered are entirely suitable for the proposed attachments and for the sizes of the Conductor specified.

9.3 All ferrous fittings (except those specified otherwise) shall be hot dip galvanized, after all machining and fitting has been completed, in accordance with relevant Indian Standard. All Hardware items (other than clamps) and those specified otherwise should be made of Drop Forged Steel. Socket items in forged steel must be forged. All forgings supplied should be stress relieved and this treatment should be done at the Contractor works. Forgings, which are not stress relieved, will not be acceptable. The items like Yoke Plate, Arcing Horn, Bolts and Nuts shall be of mild steel and rest of the items shall be of forged steel.

9.4 All Bolts, Nuts and Screw heads shall have only wide worth standard thread and of sizes indicated in the enclosed drawing. Bolts head and Nuts shall be hexagonal. Where required, nuts shall be locked in approved manner. The thread in Nuts shall be over tapped after galvanizing and shall be cut before galvanizing. The threads shall not be undercut. The Nuts should be tapped such that they are fit on the bolt threads i.e. these should not have loose fitting.

9.5 Compression Markings

Die compression areas shall be clearly marked on each equipment designed for continuous die compressions and shall bear the words 'COMPRESS FIRST' 'suitably inscribed on each equipment where the compression begins. If the equipment is designed for intermittent die compressions, it shall bear the identification marks 'COMPRESSION ZONE' and 'NONCOMPRESSION ZONE' distinctly with arrow marks showing the direction of compression and knurling marks showing the end of the zones. The letters, number and other markings on finished equipment shall be distinct and legible.

10 GALVANISING:

10.1 Hot dip galvanizing shall conform to Indian Standard specification IS-2633 or equivalent International Standard.

10.2 Galvanizing shall be uniform, free from blisters, and shall not peel off due to abrasion, Zinc coating shall be thick enough to withstand 6 one minute dips in Copper Sulphate solution (preece test) for all ferrous parts except for threaded portions which shall withstand at least 4 one minute dips.

10.3 The Contractor must emboss/engrave their name in each forged steel item and Aluminium castings such as Ball Hook, Yoke Plate, Socket Clevis, Clevis Eye, Clevis-Clevis, Anchor Shackle/D-Shackle, Chain Link, Suspension Clamps of AGS type, Tension Clamps and Arcing Horns.

11 TESTS

11.1 All the specified type tests on Hardware Fittings and Accessories for ACSR Conductors offered by the bidder shall not be required to be carried out if valid test certificate is available i.e., tests conducted within last five years from the date of bid opening in an accredited laboratory or witnessed by the representative (s) of a Utility.

11.2 In the event of any discrepancy in the test report (i.e., any test report not applicable due to any design / material/manufacturing process change including substitution of components or due to non-compliance with the requirement stipulated in the Technical Specification) the tests shall be conducted by the Contractor at no extra cost to the KSEBL. The hardware fittings offered shall be

type tested as per the relevant standards. Further the acceptance, routine tests and tests during manufacture shall be carried out on the conductor.

11.3 Acceptance tests shall mean those tests, which are to be carried out on samples taken from each lot offered for pre-dispatch inspection, for the purpose of acceptance of that lot.

11.4 Routine tests shall mean those tests which are to be carried out on each and every product so as to check with requirements which are likely to vary during production.

11.5 Tests during manufacture shall mean those tests, which are to be carried out during the process of manufacture and end inspection by the Contractor to ensure the desired quality of the end product to be supplied by him.

11.6 The norms and procedure of sampling for these tests will be as per the Quality Assurance Programme to be mutually agreed to by the Contractor and the KSEBL.

11.7 For all type and acceptance tests, the acceptance values shall be the values guaranteed by the Contractor in the "Technical Questionnaire" or the acceptance value specified in this specification, whichever is more stringent for that particular test.

11.8 Type Tests (Type tests should have been completed during last five years)

11.8.1 On Suspension Clamp

a)	Magnetic power loss test	:	As per Annexure-8A
b)	Clamp slip strength Vs torque test	:	As per Annexure-8A
c)	Ozone Test on elastomer	:	As per Annexure-8A

11.8.2 On Dead End Tension Assembly

a)	Electrical resistance test for dead end Assembly:		As per IS:2486- (Part-I)
b)	Heating cycle test for dead end Assembly	:	As per IS:2486-(Part-I)
c)	Slip strength test for dead end assembly	:	As per IS:2486-(Part-I)
d)	Ageing test on filler (if applicable)	:	As per Annexure-8A

11.8.3 Mid Span Compression Joint for Conductor

a)	Chemical analysis of materials	:	As per Annexure-8A
b)	Electrical resistance test	:	As per IS: 2121(Part-II)
c)	Heating cycle test	:	As per IS: 2121(Part-II)
d)	Slip strength test	:	As per Annexure-8A
e)	Corona extinction voltage test (dry)	:	As per Annexure-8A
f)	Radio interference voltage test (dry)	:	As per Annexure-8A

Note: Tests mentioned at (c), (e) & (f) are not applicable to mid span compression joints for earth wire

11.8.4 Repair Sleeve for Conductor

a)	Chemical analysis of materials	:	As per Annexure-8A

b)	Corona extinction voltage test (dry)	:	As per Annexure-8A
c)	Radio interference voltage test (dry)	:	As per Annexure-8A

11.8.5 Connector for Conductor

a)	Chemical analysis of materials	:	As per Annexure-8A
b)	Electrical resistance test	:	As per IS: 2121(Part-II) Clause 6.5 & 6.6
c)	Heating cycle test	:	As per IS: 2121 (Part-II)
d)	Axial tensile load test on welded portion	:	As per Annexure-8A
e)	Corona extinction voltage test (dry)	:	As per Annexure-8A
f)	Radio interference voltage test (dry)	:	As per Annexure-8A

11.8.6 Vibration Damper for Conductor

a)	Chemical analysis of materials	:	As per Annexure-8A
b)	Dynamic characteristics test*	:	As per Annexure-8A
c)	Vibration analysis	:	As per Annexure-8A
d)	Clamp slip test	:	As per Annexure-8A
e)	Fatigue tests	:	As per Annexure-8A
f)	Magnetic power loss test	:	As per Annexure-8A
g)	Corona extinction voltage test (dry)	:	As per Annexure-8A
h)	Radio interference voltage test (dry)	:	As per Annexure-8A
i)	Damper efficiency test	:	As per IS: 9708

* Applicable for 4 R stock bridge dampers. For alternate type of vibration dampers (permitted as per clause 2.5.2), as an alternative to dynamic characteristic test, damper efficiency test as per IEEE-664 Power Manual may be proposed/ carried out by the supplier.

11.8.7 Acceptance Tests

On Both Suspension Clamp and Tension Assembly

a)	Visual Examination	:	As per IS: 2486-(Part-I)
b)	Verification of dimensions	:	As per IS: 2486-(Part-I)
c)	Galvanising/Electroplating test	:	As per IS: 2486-(Part-I)
d)	Mechanical strength test of each component:		As per Annexure-8A
e)	Mechanical Strength test of welded joint	:	As per Annexure-8A
f)	Mechanical strength test for corona control ring/ grading ring and arcing horn	:	BS:3288 - (Part-I)
g)	Test on locking device for ball and socket coupling	:	As per IEC:372 (2)
h)	Chemical analysis, hardness tests,		

	grain size, inclusion rating & magnetic particle inspection for forgings/castings	:	As per Annexure-8A

On Suspension Clamp only

a)	Clamp Slip Strength Vs Torque test for suspension clamp	:	As per Annexure-8A
b)	Shore hardness test of elastomer cushion for AG suspension clamp	:	As per Annexure-8A
c)	Bend test for armour rod set	:	As per IS: 2121(Part-I), Clause 7.5,7,10 &7.11
d)	Resilience test for armour rod set	:	As per IS: 2121(Part-I), Clause 7.5,7,10 & 7.11
e)	Conductivity test for armour rods set	:	As per IS: 2121(Part-I), Clause 7.5,7,10 & 7.11

On Tension Hardware Fittings only

a)	Slip strength test for dead end assembly	:	As per IS: 2486 (Part-I) Clause 5.4
d)	Ageing test on filler (if applicable)	:	As per Annexure-8A

On Mid Span Compression Joint for Conductor & Earth wire

a)	Visual examination and dimensional verification:		As per IS: 2121 (Part-II), Clause 6.2, 6.3 7 6.7
b)	Galvanizing test	:	As per Annexure-8A
c)	Hardness test	:	As per Annexure-8A
d)	Ageing test on filler (if applicable)	:	As per Annexure-8A

Connector for Conductor

a)	Visual examination and dimensional verification:		As per IS:2121 (Part-II)
b)	Axial tensile load test for welded portion	:	As per Annexure-8A

Repair Sleeve for Conductor

a)	Visual examination and dimensional verification:		As per IS:2121(Part-II) Clause 6.2, 6.3

Vibration Damper for Conductor

a)	Visual examination and dimensional verification:		As per IS: 2121(Part-II) Clause 6.2, 6.3 7 6.7
b)	Galvanizing test	:	As per Annexure-8A
	i) On damper masses	:	As per Annexure-8A

	ii) On messenger cable	:	As per Annexure-8A
c)	Verification of resonance frequencies	:	As per Annexure-8A
d)	Clamp slip test	:	As per Annexure-8A
e)	Clamp bolt torque test	:	As per Annexure-8A
f)	Strength of the messenger cable	:	As per Annexure-8A
g)	Mass pull off test	:	As per Annexure-8A
h)	Dynamic characteristics test*	:	As per Annexure-8A

* Applicable for 4R Stockbridge dampers. For alternate type of vibration dampers (permitted as per clause 2.5.2), as an alternative to dynamic characteristic test, damper efficiency test as per IEEE-664 Power Manual may be proposed/ carried out by the supplier.

Routine Tests

For Hardware Fittings

a)	Visual examination	:	IS:2486-(Part-I)
b)	Proof Load Test	:	As per Annexure-8A

For Conductor

a)	Visual examination and dimensional verification	:	As per IS: 2121(Part-II) Clause 6.2, 6.3 7 6.7

Tests During Manufacture on all components as applicable

a)	Chemical analysis of Zinc used for galvanizing:		IS:2486-(Part-I)
b)	Chemical analysis mechanical metallographic test and magnetic particle inspection for malleable castings	:	As per Annexure-8A
c)	Chemical analysis, hardness tests and magnetic particle inspection for forging	:	As per Annexure-8A

12 TESTING EXPENSES

12.1 In case of failure in any type test, the Bidder whose material has failed is either required to modify the design of the material & successfully carryout all the type tests as has been detailed out in Clause 11 of this specification or to repeat that particular type test at least three times successfully at his own expenses.

12.2 In case of type test on the complete insulator string, the Contractor/Manufacturer has to arrange similar insulators at his own cost.

12.3 Bidder shall indicate the laboratories in which they propose to conduct the type tests. They shall ensure that adequate facilities for conducting the tests are available in the laboratory and the tests can be completed in these laboratories within the time schedule guaranteed by them in the appropriate schedule.

12.4 The entire cost of testing for acceptance and routine tests and tests during manufacture specified herein shall be treated as included in the quoted Ex-works/CIF Price.

12.5 In case of failure in any type test, repeat type tests are required to be conducted, then, all the expenses for deputation of Inspector/KSEBL's representative shall be deducted from the contract price. Also if on receipt of the Contractor/Manufacturer's notice of testing, the KSEBL's representative/Inspector does not find 'plant' to be ready for testing the expenses incurred by the KSEBL for re-deputation shall be deducted from contract price.

12.6 The Contractor/Manufacturer shall intimate the KSEBL about carrying out of the type tests along with detailed testing programme at least 3 weeks in advance (in case of Domestic Contractor/Manufacturer and at least 6 weeks advance in case of Foreign Contractor/Manufacturer) of the scheduled date of testing during which the KSEBL will arrange to depute his representative to be present at the time of carrying out the tests.

12.7 Sample Batch For Type Testing

12.7.1 The Contractor/Manufacturer shall offer material for sample selection for type testing only after getting Quality Assurance Programme approved by the KSEBL. The Contractor/Manufacturer shall offer at least three times the quantity of materials required for conducting all the type tests for sample selection. The sample for type testing will be manufactured strictly in accordance with the Quality Assurance Programme approved by the KSEBL.

12.7.2 Before sample selection for type testing the Contractor/Manufacturer shall be required to conduct all the acceptance tests successfully in presence of KSEBL's representative.

12.8 Schedule of Testing and Additional Tests

12.8.1 The Bidder has to indicate the schedule of following activities in their bids

(a) Submission of drawing for approval.

(b) Submission of Quality Assurance programme for approval.

(c) Offering of material for sample selection for type tests.

(d) Type testing.

12.8.2 The KSEBL reserves the right of having at his own expense any other test(s) of reasonable nature carried out at Manufacturer’s premises, at site, or in any other place in addition to the aforesaid type, acceptance and routine tests to satisfy himself that the material complies with the specifications.

12.8.3 The KSEBL also reserves the right to conduct all the tests mentioned in this specification at his own expense on the samples drawn from the site at Manufacturer’s premises or at any other test center. In case of evidence of noncompliance, it shall be binding on the part of Contractor/Manufacturer to prove the compliance of the items to the technical specifications by repeat tests, or correction of deficiencies, or replacement of defective items, all without any extra cost to the KSEBL.

13 TEST REPORTS

13.1 Copies of type test reports shall be furnished in at least six copies along with one original. One copy shall be returned duly certified by the KSEBL, only after which the commercial production of the concerned material shall start.

13.2 Copies of acceptance test report shall be furnished in at least six copies. One copy shall be returned, duly certified by the KSEBL, only after which the materials will be dispatched.

13.3 Record of routine test report shall be maintained by the Manufacturer at his works for periodic inspection by the KSEBL 's representative.

13.4 Test certificates of tests during manufacture shall be maintained by the Manufacturer. These shall be produced for verification as and when desired by the KSEBL.

14 INSPECTION

14.1 The Owner's representative shall at all times be entitled to have access to the works and all places of manufacture, where the material and/or its component parts shall be manufactured, and the representatives shall have full facilities for unrestricted inspection of the Contractor's, sub- Contractor's works raw materials. Manufacturers of all the material and for conducting necessary tests as detailed herein.

14.2 The material for final inspection shall be offered by the Contractor only under packed condition. The engineer shall select samples at random from the packed lot for carrying out acceptance tests.

14.3 The Contractor shall keep the Owner informed in advance of the time of starting and of the progress of manufacture of material in its various stages so that arrangements could be made for inspection.

14.4 Material shall not be dispatched from its point of manufacture before it has been satisfactorily inspected and tested unless the inspection is waived off by the Owner in writing. In the latter case also, the material shall be dispatched only after all tests specified herein have been satisfactorily completed.

14.5 The acceptance of any quantity of material shall in no way relieve the Contractor of his responsibility for meeting all the requirements of the Specification, and shall not prevent subsequent rejection, if such material is later found to be defective.

15 PACKING AND MARKING

15.1 All material shall be packed in strong and weather resistant wooden cases/crates. The gross weight of the packing shall not normally exceed 200 Kg to avoid handling problems.

15.2 The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field.

15.3 Suitable cushioning, protective padding, dunnage or spacers shall be provided to prevent damage or deformation during transit and handling.

15.4 Bolts, nuts, washers, cotter pins, security clips and split pins etc. shall be packed duly installed and assembled with the respective parts and suitable measures shall be used to prevent their loss.

15.5 Each component part shall be legibly and indelibly marked with trade mark of the manufacturer and year of manufacture.

15.6 All the packing cases shall be marked legibly and correctly so as to ensure safe arrival at their destination and to avoid the possibility of goods being lost or wrongly dispatched on account of faulty packing and faulty or illegible markings. Each wooden case/crate shall have all the markings stenciled on it in indelible ink.

15.7 Each consignment shall be accompanied by a detailed packing list showing following details: -

(i) The name of the consignees

(ii) Details of consignment.

(iii) Destination.

(iv)Total weight of consignment.

(v) Handling and unpacking instrumentation.

(vi)Bill of material indicating content of each package.

16 QUALITY ASSURANCE PROGRAM

The contractor shall submit the Quality Assurance Programme. A copy of the accepted Quality Assurance Plan must be available at the manufacturer's works of the Plant for reviewing by inspecting officer of the KSEBL.

ANNEXURE - 8A

TESTS ON HARDWARE FITTINGS

1.1 Magnetic Power Loss Test for Suspension Assembly

Two hollow aluminium tubes of 32 mm diameter for the conductor shall be placed 450 mm apart respectively. An alternating current over the range of 1500 to 2000 amps shall be passed through each tube. The reading of the wattmeter with and without suspension assemblies alongwith line side yoke plate, clevis eye shall be recorded. Not less than three suspension assemblies shall be tested. The average power loss for suspension assembly shall be plotted for each value of current. The value of the loss corresponding to 2456 amperes per phase shall be read off from the graph and the same shall not be more than the value guaranteed by the supplier.

1.2 Galvanizing/Electroplating Test

The test shall be carried out as per Clause no. 5.9 of IS:2486-(Part-1) except that both uniformity of zinc coating and standard preece test shall be carried out and the results obtained shall satisfy the requirements of this specification.

1.3 Mechanical Strength Test of Each Component

Each component shall be subjected to a load equal to the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. The load shall be held for five minutes and then removed. The component shall then again be loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified UTS and held for one minute. No fracture should occur. The applied load shall then be increased until the failing load is reached, and the value recorded.

1.4 Mechanical Strength Test of Welded Joint

The welded portion of the component shall be subjected to a Load of 2000 kgs for one minute. Thereafter, it shall be subjected to die-penetration/ultrasonic test. There shall not be any crack at the welded portion.

1.5 Mechanical Strength Test for Suspension/Tension Hardware Fittings

The complete string without insulators excluding arcing horn, corona control rings/grading ring and suspension assembly/dead end assembly shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. This load shall be held for five minutes and then removed. After removal of the load, the string component shall not show any visual deformation and it shall be possible to disassemble them by hand. Hand tools may be used to remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS is reached and held for the one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached, and the value recorded.

1.6 Clamp Slip Strength Vs Torque Test for Suspension Clamp

The suspension assembly shall be vertically suspended by means of a flexible attachment. A suitable length of conductor shall be fixed in the clamp. The clamp

slip strength at various tightening torques shall be obtained by gradually applying the load at one end of the conductor. The Clamp slip strength vs torque curve shall be drawn. The above procedure is applicable only for free centre type suspension clamp. For AG suspension clamp only, clamp slip strength after assembly shall be found out. The clamp slip strength at the recommended tightening torque shall be more than 20 KN but less than 29 KN.

1.7 Heating Cycle Test

Heating cycle test shall be performed in accordance with IS 2486 (Part-I) with following modifications: -

i) Temperature of conductor during each cycle: 40 deg. C above designed maximum operating temperature of the conductor.

ii) Number of cycle: 100 Slip strength tests shall also be carried out after heating cycle test.

1.8 Shore Hardness Test for Elastomer Cushion for AG Suspension Assembly

The shore hardness at various points on the surface of the elastomer cushion shall be measured by a shore hardness meter and the shore hardness number shall be between 65 to 80.

1.9 Proof Load Test

Each component shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength which shall be increased at a steady rate to 67% of the UTS specified. The load shall be held for one minute and then removed. After removal of the load the component shall not show any visual deformation.

1.10 Tests for Forging Casting and Fabricated Hardware

The chemical analysis, hardness test, grain size, inclusion rating and magnetic particle inspection for forging, castings and chemical analysis and proof load test for fabricated hardware shall be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding test will be as in the Quality Assurance programme.

1.11 Ozone Test for Elastomer

This test shall be performed in accordance with ASTM D-1171 by the Ozone chamber exposure method (method B). The test duration shall be 500 hours and the ozone concentration 50 PPHM. At the test completion, there shall be no visible crack under a 2 x magnification.

2. TESTS ON ACCESSORIES FOR CONDUCTOR

2.1 Mid Span Compression Joint for Conductor

(a) Slip Strength Test: The fitting compressed on conductor shall not be less than one meter in length. The test shall be carried out as per IS:2121 (Part-ii)-1981 clause 6-4 except that the load shall be steadily increased to 95% of minimum ultimate tensile strength of conductor/earth wire and retained for one minute at this load. There shall be no movement of the conductor/ earth wire relative to the fittings and no failure of the fit tings during this one minute period.

2.2 Connector for Conductor

Axial Tensile Load Test for Welded Portion: - The sleeve portion of the T-Connector shall be compressed on conductor. The compressed portion shall be held rigidly on some fixtures and axial load shall be applied along with the jumper terminal the load shall be increased gradually till breaking of welded joint occurs. The breaking load should be above 30 KN.

2.3 Vibration damper for conductor

Clamp Slip and Fatigue Tests

(i) Test Set Up: The clamp slip and fatigue tests shall be conducted on a laboratory set up with a minimum effective span length of 30 m. The conductor shall be tensioned at tension corresponding to 0 deg & no wind condition and ruling span 400 from sag –tension calculation and shall not be equipped with protective armour rods at any point. Constant tension shall be maintained within the span by means of lever arm arrangement. After the conductor has been tensioned, clamps shall be installed to support the conductor at both ends and thus influence of connecting hardware fittings are eliminated from the free span. The clamps shall not be used for holding the tension on the conductor. There shall be no loose parts, such as suspension clamps, U bolts on the test span supported between clamps mentioned above. The span shall be equipped with vibration inducing equipment suitable for producing steady standing vibration. The inducing equipment shall have facilities for step less speed control as well as step less amplitude arrangement. Equipment shall be available for measuring the frequency, cumulative number of cycles and amplitude of vibration at any point along the span.

(ii) Clamp Slip test: The vibration damper shall be installed on the test span. The damper clamp, after lightning with the manufacturer's specified tightening torque, when subjected to a longitudinal pull of 2.5 KN parallel to the axis of conductor for a minimum duration of one minute shall not slip i.e. the permanent displacement between conductor and clamp measured after removal of the load shall not exceed 1.0 mm. The load shall be further increased till the clamp starts slipping. The load at which the clamp slips shall not be more than 5 KN.

2.4 Mechanical Strength Test for Earth wire Suspension/Tension Clamp

(a) The suspension assembly/tension assembly (excluding tension clamp) shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. This load shall be held for five minutes and then removed. After removal of the load, the components shall not show any visual deformation and it shall be possible to disassemble them by hand. Hand tools may be used to loosen the nuts initially. The assembly shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS is reached and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached, and the value recorded.

(b) Clamp Slip Strength Vs Torque Test for Suspension Assembly: The suspension assembly shall be vertically suspended by means of a flexible attachment. A suitable length of Earth wire shall be fixed in the clamps. The clamp slip

strength at various tightening torques shall be obtained by gradually applying the load at one end of the earth wire. The clamp slip strength Vs torque curve shall be drawn. The clamp slip strength at the recommended tightening torque shall be as per the values stipulated in the Standard Technical Particulars.

(c) Slip Strength Test of Tension Clamp: Tension clamps shall be compressed on a 5 m length of earth wire on both ends. The assembly shall be mounted on a tensile testing machine and anchored in a manner similar to the arrangement to be used in service. A tensile load of 50% of the specified breaking load of the earth wire shall be applied & the sample shall be marked in such a way that movement relative to the fitting can easily be detected. Without any subsequent adjustment of the fitting, the load shall be steadily increased to 95% of the specified breaking load and maintained for one minute. There shall be no movement of the earth wire relative to the fitting during this one minute period and no failure of the fitting also.

(d) Electrical Resistance Test of Tension Clamp: The tension clamp and the jumper shall be compressed on two suitable lengths of earth wire. The electrical resistance shall be measured between points on earth wire near the clamp and near the jumper mouth keeping 25 mm clearance of the fitting and should not exceed 75% of the measured resistance of equivalent length of earth wire. The test shall be conducted with direct current. The current connections shall be at a distance not less than 50 times the diameter of earth wire from the fitting and shall be made so that effective contact is ensured with all those strands of the earth wire which would be taken into account in calculating its equivalent resistance. The test shall be repeated with the polarity reversed and the average of the two results considered as the measured value.

2.5 Chemical Analysis Test

Chemical analysis of the material used for manufacture of items shall be conducted to check the conformity of the same with Technical Specification and approved drawing.

3. TESTS ON ALL COMPONENTS (AS APPLICABLE)

3.1 Chemical Analysis of Zinc used for Galvanizing

Samples taken from the zinc ingot shall be chemically analysed as per IS-209-1979. The purity of zinc shall not be less than 99.95%.

3.2 Tests for Forgings: The chemical analysis hardness tests and magnetic particle inspection for forgings will be as per the internationally recognized procedures for these tests. The, sampling will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Contractor and Owner in Quality Assurance Programme.

3.3 Tests on Castings: The chemical analysis, mechanical and metallographic tests and magnetic particle inspection for castings will be as per the internationally recognized procedures for these tests. The samplings will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Contractor and Owner in Quality Assurance Programme.

ANNEXURE-8B

ACCEPTANCE TESTS

1 Mid Span Compression Joint for Conductor

Hardness Test: - The Brinnel hardness at various points on the steel sleeve of conductor core and tension clamp shall be measured.

2 Connector for Conductor

Axial Tensile Load Test for Welded Portion: - Same as clause 2.2 of Annexure – 8A

3 Vibration Damper for Conductor

a) Verification of Resonance Frequencies: - The damper shall be mounted on a shaker table and vibrate at damper clamp displacement of +/-0.5 mm to determine the resonance frequencies. The resonance shall be visually identified as the frequency at which damper mass vibrates with maximum displacement on itself. The resonance frequency thus identified shall be compared with the guaranteed value. A tolerance of ± 1 Hz at a frequency lower than 15 Hz and ± 2 Hz at a frequency higher than 15 Hz only shall be allowed.

b) Clamp Slip Test: - Same as Clause 2.3 (ii) of Annexure – 8A.

c) Clamp Bolt Torque Test: - The clamp shall be attached to a section of the conductor/earth wire. A torque of 150 percent of the manufacturer's specified torque shall be applied to the bolt. There shall be no failure of component parts. The test set up is as described in Clause 2.4 (c), Annexure-8A.

d) Strength of the Messenger Cable: - The messenger cable shall be fixed in a suitable tensile testing machine and the tensile load shall be gradually applied until yield point is reached. Alternatively, each strand of messenger cable may be fixed in a suitable tensile testing machine and the tensile load shall be gradually applied until yield point is reached. In such a case, the 95% of yield strength of each wire shall be added to get the total strength of the cable. The load shall be not less than the value guaranteed by the Contractor

e) Mass Pull off Test: - Each mass shall be pulled off in turn by fixing the mass in one jaw and the clamp in the other of a suitable tensile testing machine. The longitudinal pull shall be applied gradually until the mass begins to pull out of the messenger cable. The pull off loads shall not be less than the value guaranteed by the Contractor.

Sd/-
ED (Unit –4&5)

PFC Consulting Limited

PART C

EXECUTION OF THE PACKAGE

SECTION - 9

TOWER FOUNDATION, ERECTION, STRINGING AND INSTALLATION OF LINE MATERIALS

TABLE OF CONTENT

SECTION – 9

TOWER FOUNDATION, ERECTION, STRINGING AND INSTALLATION OF LINE MATERIALS

PART – I TOWER FOUNDATION

(A) SCOPE OF WORK

This section covers the scope of the work to be executed for various items of works coming under foundations of self-supporting galvanized lattice towers for 400kV/ 220kV/ 110kV MCMV Transmission Lines under the scope of this contract.

The contractor shall complete the works as per the detailed design and drawings furnished by KSEBL for foundations for all types of normal towers with extensions as detailed in the design drawings.

The execution of works for foundation shall be as per relevant IS and in accordance with the CBI&P Publication No. 323 (Transmission Line Manual). Reference to any code/publication shall always mean reference to the latest revised edition of the code/publication including all its amendments upto date, unless otherwise specified. In the event of any conflict between the requirements of this specification and those of the referred codes, the former shall govern.

1. GEOTECHNICAL INVESTIGATION:

1.1. Item Description: Soil test, wherever found neccessary for asertaining type of foundation including taking pits/bore holes, collecting soil samples and testing at approved laboratories as per relevant IS codes, including cost of testing, all labour and transportion charges etc. as directed by KSEB Officers complete in all respects as per scope & technical specifications of following types: Except in River/Lake.

This item is applicable for all locations wherever soil testing is required to be carried out as directed by the engineer in charge. The Contractor shall perform a detailed soil investigation to arrive at sufficientlyaccurate conclusion regarding general as well as specific information about the soil profile and the necessary soil parameters of the site, in order to design and construct the foundation of the structures safely and rationally wherever required by the Engineer-in-charge. The procedures and result submissions as in compliance to the IS 1892 and CPWD manuals. A report by a qualified Geo-technical engineer to the effect shall be submitted by the Contractor for KSEBL's specific approval giving details regarding data proposed to be utilized for the design. The Contractor shall submit the detailed report as specified in IS: 1892 wherein information regarding the geological detail of the site, summarised observations and test data, bore logs, and conclusions and recommendations on the type of foundations with supporting calculations for the recommendations. Initially the Contractor shall submit draft report and after the draft report is approved, the final report in five (5) copies shall be submitted. The site test data shall bear the signatures of the Investigation Agency, Vendor and also site representative of KSEBL.

1.2. Item Description: Soil test, wherever found neccessary for asertaining type of foundation including taking pits/bore holes, collecting soil samples and testing at approved laboratories as per relevant IS codes, including cost of testing, all labour and transportion charges etc. as directed by KSEB Officers complete in all respects as per scope & technical specifications of following types: Except in River/Lake. In River/Lake

This item is applicable for the soil testing for the location coming in lake. Wherever location of River/Lake is mentioned it refers to the tower location at the middle of the National waterway near Nerukadau.

2. .Earthwork Excavation

2.1. **Item Description:** Excavation by mechanical means (Hydraulic excavator) / manual means in foundation trenches or drains (not exceeding 1.5m in width or 10 sqm on plan), including dressing of sides and ramming of bottoms, lift upto 1.5 m, including disposal of surplus excavated soil as directed, including pumping out water from all sources wherever necessary within a lead of 50m.

This item is applicable for excavation works of not exceeding 1.5m in width or 10 sqm on plan under various soil classification as detailed below

2.1.1. CLASSIFICATION OF SOILS

The earthwork shall be classified under the following categories and measured separately for each category:

(a) All kind of soils: Generally any strata, such as sand, gravel, loam, clay, mud, black cotton moorum, shingle, river or nallah bed boulders, siding of roads, paths etc. and hard core, macadam surface of any description (water bound, grouted tarmac etc.), lime concrete mud concrete and their mixtures which for excavation yields to application of picks, showels, jumper, sacrifiers, ripper and other manual digging implements.

(b) Ordinary rock: Generally any rock which can be excavated by splitting with crow bars or picks and does not require blasting, wedging or similar means for excavation such as lime stone, sand stone, hard laterite, hard conglomerate and un-reinforced cement concrete below ground level. If required light blasting may be resorted to for loosening the materials but this will not in any way entitle the material to be classified as 'Hard rock'.

(c) Hard rock: Generally any rock or boulder for the excavation of which blasting is required such as quartzite, granite, basalt, reinforced cement concrete (reinforcement to be cut through but not separated from concrete) below ground level and the like.

2.2. **Item Description:** Excavation by mechanical means (Hydraulic excavator) / manual means over areas (exceeding 30cm in depth. 1.5 m in width as well as 10 sqm on plan) including disposal of excavated earth, lead upto 50m and lift as specified, including pumping out water from all sources wherever necessary disposed earth to be levelled and neatly dressed.

This item is applicable for excavation works of exceeding 30cm in depth. 1.5 m in width as well as 10 sqm on plan under various soil classification as detailed above.

2.3. **Item Description:** Excavation in hard rock using non explosive agent (Chemical) without resorting to the use of conventional explosive materials etc in all lifts and conveying and depositing the excavated rock etc. at places with in a distance of 50m including pumping out water from all sources wherever necessary.

This item is applicable for excavation works of any width or area where blasting is not possible by the conventional methods and breaking of rock to be resorted using chemical. The locations where chemical blasting is to be carried out will be as directed by the Engineer in charge and the decision of the Engineer in charge shall be final. The quantity under removal by 'Chemical blasting' shall be restricted to the minimum as decided by the Engineer in charge.

3. Protection of excavated side slopes

3.1. **Item Description:** Close timbering in trenches including strutting, shoring and packing cavities (wherever required) complete. (Measurements to be taken of the face area timbered) complete in all respects as per scope & technical specifications:

This item is applicable for protection of the sides of excavated earth and to be executed on specific direction from the Engineer-in-charge.

3.2. **Item Description:** Open timbering in trenches including strutting and shoring complete (measurements to be taken of the face area timbered). Complete in all respects as per scope & specification of work & technical specifications:

This item is applicable for protection of the sides of excavated earth and to be executed on specific direction from the Engineer-in-charge.

4. Pumping

4.1. Item Description: Pumping out water caused by springs, tidal or river seepage, broken water mains or drains and the like. Complete in all respects as per scope & specification of work & technical specifications.

This item is applicable for pumping water that may accumulate in locations where no excavation is required to be executed as decided by the engineer-in charge during the progress of the work from springs, tidal or river seepage, broken water mains or drains (not due to the negligence of the contractor), and seepage from subsoil aquifer shall be bailed, pumped out or otherwise removed and to be executed on specific direction from the Engineer-in-charge.

5. Earthwork excavation under water

5.1. Item Description: Extra for Earth work in excavation in soil (Under water) by mechanical means (Hydraulic excavator) / manual means over areas (exceeding 30cm in depth, 1.5 m in width as well as 10 sqm on plan) including disposal of excavated earth, lead upto 50m and lift as specified, disposed earth to be levelled

and neatly dressed, in or under water and/or liquid mud, including pumping out water as required, complete in all respects as per scope & technical specifications:

This item is applicable for excavation works coming in fully submerged soil conditions like paddy fields, wet land etc as decided by the Engineer-in-charge. No pumping will be paid separately on these locations. The contractor shall take adequate measures for bailing and/or pumping out water from excavations and/or pumping out water from excavations and construct diversion channels, bunds, sumps, coffer dams etc. as may be required.

6. Concreting

6.1. Item Description: Providing and laying in position plain/reinforced cement concrete of specified grade excluding the cost of centering and shuttering up to plinth level complete in all respects as per scope & specification of work & technical specifications including dewatering wherever required.

Concreting works are to be carried out at tower locations as per design drawings. Cement content considered in each item is as per DSR specifications. Cement content considered in the specific item is mentioned. Excess/less cement used as per design mix is payable/recoverable separately. Generally design mix/ Ready mix concrete is preferred for the work. In exceptional cases where the access is limited engineer-in-charge may permit usage of the item of 1:1.5:3. The method of concreting is decided soley by the Engineer-in-charge. Concreting works in pile pile foundations also comes under this item except for the River/lake location. The cement content considered in this item is specified. Excess/less cement used as per design mix is payable/recoverable separately as per rates quoted for the item for providing extra cement. The quoted rate is inclusive of cost of admixtures in recommended proportions as per IS : 9103 to accelerate/ retard setting of concrete,improve workability without impairing strength and durability for the specified mix. Additional payment will be made on account of variation in cement content only and not for the admixture/other contents.

6.2. **Item Description:** Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete above plinth level with Thermo-Mechanically Treated bars.

This item to be carried as per approved barbending schedule and drawings.

6.3. **Item Description:** Centering and shuttering including strutting, propping etc. and removal following complete in all respects as per scope & technical specifications:

This item to be executed as per design drawings.

7. Revetment

7.1. **Item Description:** Random rubble masonry with hard stone in foundation and superstructure at all levels with cement mortar 1:6 (1 cement : 6 coarse sand) complete in all respects as per scope & technical specifications:

Rubble masonry used for the protection of sides of tower locations will come under this item.

7.2. **Item Description:** Flush/ Ruled pointing on stone work with cement mortar 1:3 (1 cement : 3 fine sand)

This item is applicable for the pointing works coming in rubble masonry works.

7.3. **Item Description:** 12 mm cement plaster of mix 1:4 (1 cement: 4 fine sand)

Plastering works wherever required as specifically ordered by the Engineer-in-charge will come under this category.

8. Back Filling

8.1. **Item Description:** Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and in all lifts complete in all respects as per scope & technical specifications.

The available excavated earth to be used for backfilling the foundation trenches

8.2. **Item Description:** Supplying and Filling good quality earth brought from out side in the revetment and pits of towers in layers for consolidation including stacking for measurements watering, ramming, etc, complete as directed.

If earth available is not sufficient the contractor has to bring earth from outside and fill in the tower locations including all leads and lifts.

9. Demolishing

9.1. **Item Description:** Demolishing stone rubble masonry In cement mortar manually/by mechanical means including stacking of serviceable material and disposal of unserviceable material within 50 metres lead as per direction of KSEB engineer complete in all respects as per scope & technical specifications.

When existing revetments/any nearby structure as specifically ordered by Engineer-in-charge are required to be demolished this item will be used.

9.2. **Item Description:** Demolishing R.C.C. work manually/ by mechanical means including stacking of steel bars and disposal of unserviceable material within 50 metres lead as per direction of KSEB.

When existing structure as specifically ordered by Engineer-in-charge are required to be demolished this item will be used.

10. Bunds

10.1. **Item Description:** Construction of earthen ring bunds for bailing out water for excavation and stub setting with coconut cadjan and bamboos etc complete in all respects as per scope & technical specifications (provisional qty)

For the construction of revetments this item will be executed wherever necessary. This item will not be included for works in fully submerged soil conditions.

11. Piling

11.1. **Item Description:** Boring and installation bored cast-in-situ reinforced cement concrete piles of specified grade of specified diameter and length below the pile cap, to carry a safe working load not less than specified, excluding the cost of steel reinforcement and cost of concrete but including the cost of boring with bentonite solution and temporary casing of appropriate length for setting out and removal of same and the length of the pile to be embedded in the pile cap etc. by percussion drilling using Direct mud circulation (DMC) or Bailer and chisel technique by tripod and mechanical Winch Machine all complete, including removal of excavated earth with all its lifts and leads (length of pile for payment shall be measured up to bottom of pile cap). Note: Truck Mounted rotary/TMR/Tubewell boring machine shall not be used . For all diameters of pile including charges for structural design of piles,all costs towards shifting , making ring bunds, access bunds, dewatering etc complete except for piles in river/lake as per the direction of KSEBL Engineer complete in all respects as per scope & technical specifications.

Piling process has been split into two items boring & installation and concreting. Since the diameter of pile can be ascertained only after detailed geo-technical investigation contractor has to submit the calculations and approval of pile diameter to KSEBL. Contractor has to execute the pile in the specified diameter and to the specified depth in this item. The rate quoted by the contractor is inclusive of structural design of piles,all costs towards shifting , making ring bunds, access bunds, dewatering etc complete for all diameter of piles. All piling coming in weak soil,fully submerged locations, partially submerged locations, dry land will come under this item except for piling in river/lake.

11.2. Item Description: Hire charges for providing floating platform required for piling, concreting etc (Pontoon in steel work using 2 Nos. x 12.00 x 5.55x1.75 meter size one for providing machineries and the other for handling materials for form work etc, fabricating and hoisting in position with MS plate 6mm thick for bottom and sides, 10mm for top and stiffening both ways with 65mm x 65mm x 6mm Ms angle at 50cm c/c supporting over by ISMB - 150 200mm & 3 Nos., 6m long MS pipe is used for supporting the pontoon. 1 meter dia circular barrels having length 6.40 meter and 5.00 meter each is used on either side and 3.75 meter long is used in front side) or of equivalent size and approved materials. Necessary charges are included for sot and hire charges of anchorages, pontoon, mobilization charges including painting with iron primer etc. complete for piling works in river/lake as per the directions of the departmental officers at site

This item is applicable for arranging a floating platform anchored at the middle of the river/lake with approximate water depth of 12m. The platform provided should be of sufficient size and strength so as to carry out boring,concreting works of piles and pile cap. The platform provided should be able to accommodate excavated earth and the bentonite solution mixture as per requirement. Further the platform should be kept in place for all operations required to complete the erection, stringing, testing and commisioning of the line and no sepa-

rate/additional payment for the other works will be given on account of rermoval of platform. The platform provided should in no way cause disturbance to the navigational/fishing activities currently undergoing. The waterway is under the control of Inland waterways authority and all statutory clearences required will be taken care of by KSEBL. However contractor has to abide by the rules and regulations set forth by Inland waterway authority for the work. Rates include the erection, anchoring,providing warning signs, removal after completion etc complete.

11.3. **Item Description:** Fabricating, casing pipe of specified diameter with specified thick MS plate used for cast in situ pile including cost and conveyance of all materials, all related charges for fixing anchorages etc with all leads and lifts etc. complete for piles in river/lake according to the specification and as directed by the departmental officers complete in all respects as per scope & technical specifications.

This item is required for the permanent casing required for the piles coming in lake/river. Internal diameter of pile casing will be the diameter of pile. Rate shall be inclusive of the design of the casing pipe.

11.4. **Item Description:** Conveying pre fabricated, casing pipe of specified diameter with specified thickness MS plate used for cast in situ pile and erecting at site in lines and levels and driven down into a required depth including cost and conveyance of all materials, all related charges for anchoring etc with all leads and lifts etc.complete for piles in river/lake according to the specification and as directed by the departmental officers**.**

This item is required for the permanent casing for the piles coming in lake/river. Rates shall be inclusive of conveyance to site, driving, welding at site etc complete.

11.5. **Item Description:** Boring and installation of cast-in-situ reinforced cement concrete piles of specified grade of specified diameter and length below the pile cap, to carry a safe working load not less than specified, excluding the cost of steel reinforcement and cost of concrete but including the cost of boring with bentonite solution and the length of the pile to be embedded in the pile cap etc. by percussion drilling using Direct mud circulation (DMC) or Bailer and chisel technique by tripod and mechanical Winch Machine all complete, including removal of excavated earth with all its lifts and leads and disposal of earth as per local regulations for Piles and pile cap coming in river/lake(away from water bodies) (length of pile for payment shall be measured up to bottom of pile cap). Note: Truck Mounted rotary/TMR/Tubewell boring machine shall not be used . For all diameters of pile including charges for structural design of piles and pile cap,all costs towards shifting , making ring bunds, access bunds, dewatering etc complete as per the direction of KSEBL Engineer complete in all respects as per scope & technical specifications.

This item is applicable for Boring and installation of cast-in-situ reinforced cement concrete piles coming in river/lake. Disposal of excavated earth and bentonite mixture shall be disposed off away from the water body as per the prevail-

ing local regulations. The work to be carried out on the working platform set for the purpose.

11.6. **Item Description**: Conveyance to site and Driving precast vertical specified grade R.C.C. Piles (Guard piles) excluding cost of cement concrete and Reinforcement complete as per Drawing and & Technical Specification Size of pile - as specified in river/lake. For all diameters / size of pile including charges for structural design of piles, all costs towards shifting , driving, jointing wherever required, etc complete as per the direction of KSEBL Engineer complete in all respects as per scope & technical specifications.

This item is applicable for the conveyance,driving of precast RCC piles with necessary jointing for guard piles around the tower foundation coming in river/lake. The cement concrete required for precast piles will be measured in the item of concreting for piles coming in submerged/ground locations. The quoted rate shall be inclusive of cost of structural design of piles, all costs towards shifting , driving, jointing wherever required. Rate shall further include painting, providing warning signs etc as per Inland waterway authority specifications.

11.7. **Item Description**: Providing and laying in position ready mixed specified grade concrete for reinforced cement concrete work, using cement content as per approved design mix, manufactured in fully automatic batching plant and transported to site of work in transit mixer for all leads, having continuous agitated mixer, manufactured as per mix design of specified grade for reinforced cement concrete work, including pumping of R.M.C. from transit mixer to site of laying and with necessary floating arrangements to keep the pipes floating , excluding the cost of centering, shuttering finishing and reinforcement, including cost of admixtures in recommended proportions as per IS : 9103 to accelerate/ retard setting of concrete,improve workability without impairing strength and durability as per direction of KSEB for Piles and pile cap coming in river/lake, complete in all respects as per scope & technical specifications.(Note :- Cement content considered in this item is @ 400 kg/cum. Excess/less cement used as per design mix is payable/recoverable separately)

This item is applicable for concreting works for piles coming in river/lake. The cement content considered in this item is 400 kg/m3. Excess/less cement used as per design mix is payable/recoverable separately as per rates quoted for the item for providing extra cement. The quoted rate is inclusive of cost of admixtures in recommended proportions as per IS : 9103 to accelerate/ retard setting of concrete,improve workability without impairing strength and durability for the specified mix. Additional payment will be made on account of variation in cement content only and not for the admixture/other contents.

12. Cement content

12.1. Item Description: Add for using extra cement in the items of design mix over and above the specified cement content therein.(This rate will be used for making deductions in case of usage of lesser cement content as directed)

Cement content is fixed based on releant IS codes and standards. Excess/less cement used as per design mix or if directed by Engineer-in-charge is payable/recoverable separately as per rates quoted for this item.

13. Under Reamed piles

13.1. Item Description: Boring with hydraulic piling rigs with power units, and installing cast in situ single under reamed piles of specified diameter and length below pile cap in cement concrete, to carry a safe working load not less than specified, excluding the cost of steel reinforcement and concrete but including the cost of boring with bentonite solution and the length of the pile to be embedded in pile cap etc. (Length of pile for payment shall be measured upto to the bottom of pile cap) For all diameters of pile including charges for structural design of piles,all costs towards shifting , making ring bunds, access bunds, dewatering etc complete as per the direction of KSEBL Engineer complete in all respects as per scope & technical specifications.

13.2. Under-reamed piling process has been split into two items boring & installation and concreting. Since the diameter of pile can be ascertained only after detailed geo-technical investigation contractor has to submit the calculations and approval of pile diameter to KSEBL. Contractor has to execute the pile in the specified diameter with single bulb and to the specified depth in this item. The rate quoted by the contractor is inclusive of structural design of piles,all costs towards shifting , making ring bunds, access bunds, dewatering etc complete for all diameter of piles. All under-reamed piling coming in weak soil,fully submerged locations, partially submerged locations, dry land will come under this item. The cement concrete required for under-reamed piles will be measured in the item of concreting for piles coming in submerged/ground locations. The quoted rate shall be inclusive of cost of structural design of piles and pile cap, all costs towards shifting , driving,etc.

13.3. Item Description: Extra for providing additional bulb in under reamed piles.

If the structural design specifies more than one bulb for the under reamed pile this item will be operated for boring and installation. Concreting quantity will be given as specified in the item for under reamed pile with single bulb.

14. Pile load tests

14.1. Item Description: Vertical load testing of piles in accordance with IS 2911 (Part IV) including installation of loading platform by Kentledge/Anchor piles method and preparation of pile head or construction of test cap and dismantling of test cap after test etc. complete as per specification & the direction of Engineer in-charge for Single pile of various tone capacities. Initial test (Test Load 2.5 times the Safe capacity) Note: 1. Initial and Routine Load Test shall not be carried out by Dynamic method of testing. Note: 2. Testing agency shall submit the design of loading platform for KSEB approval complete in all respects as per scope & technical specifications:

This item is applicable for testing of piling works coming in various locations. Initial and routine test to be carried out as per IS specifications. Various loads at

which tests are to be conducted are specified and contractor has to quote all inclusive rate for each type of test.

14.2. Item Description: Integrity testing of Pile using Low Strain/ Sonic Integrity Test/ Sonic Echo Test method in accordance with IS 14893 including surface preparation of pile top by removing soil, mud, dust & chipping lean concrete lumps etc. and use of computerised equipment and high skill trained personal for conducting the test & submission of results, all complete at all locations as per direction of Engineer-in-charge.

This item is applicable for testing of piling works coming in various locations. This is to check the quality of piling like concreting, diameter of pile, depth of pile, etc

14.3. Item Description: High-Strain Dynamic Testing of pile using method in accordance with ASTM D 4945 including surface preparation of pile top by removing soil, mud, dust & chipping lean concrete lumps etc. and use of computerised equipment and high skill trained personal for conducting the test & submission of results, except in river/lake all complete as per direction of Engineer-in-charge.

This item is applicable for testing of piling works coming in various locations. Based on the measurements from strain or force, and acceleration, velocity, or displacement transducers, this test method obtains the force and velocity induced in a pile during an axial impact event . The Engineer-in-charge may analyze the acquired data using engineering principles and judgment to evaluate the integrity of the pile, the performance of the impact system, and the maximum compressive and tensile stresses occurring in the pile and to estimate the ultimate axial static compression capacity of the pile. Rate quoted shall be inclusive of all works associated with the test for the successful interpretation of the axial bearing capacity of the pile.

15. Anchoring in hard rock foundations

Item Description: Boring holes of dia 100mm or nearest size dia on hard rock where anchoring is found necessary to accommodate anchor bars including hire charges of machinery, T&P, pilot vehicle to carry other materials, grouting charges etc. Complete in all respects as per scope & technical specifications.

This item is applicable for making anchoring for foundations coming entirely on hard rockRates shall be inclusive of drilling, including hire charges of machinery, T&P, pilot vehicle to carry other materials, grouting charges etc. but excluding cost of anchor bars to be placed.

16. **CLASSIFICATION OF FOUNDATIONS**

Depending on the location of water table and the presence of surface water, the following types of foundation designs shall be used for each type of tower:

(i)Normal dry type:

To be used for locations in normal cohesive or non-cohesive soils; where water table is expected to be below foundation level.

(ii) Wet type:

To be used for locations in normal cohesive or non-cohesive soil and

1. Where sub-soil water is met at 1.5 m or more below the ground level at or above foundation level.
2. Which are in surface water for long period with water penetration not exceeding one meter below the ground level e.g. the paddy fields.

(iii) Fully submerged type:

To be used at locations in normal cohesive or non-cohesive soil and where sub-soil water is met at or less than 0.75 m below the ground level.

(iv) Wet Black Cotton Soil

To be used at locations where soil is clayey type, not necessarily black in colour, which shrinks when dry and swells when wet, resulting in differential movement. For designing the foundation for such locations, where sub-soil water is met between 1.5 meters and the depth of foundation below the ground level.

(v) Fissured – Rock

To be used at locations, where decomposed or fissured rock, hard gravel, kankar, limestone, laterite or any other soil of similar nature is met. Under cut type foundation is to be used for fissured rock locations.

In case of fissured rock locations, where water table is met at 1.5M or more below ground level, wet fissured rock foundations shall be adopted. Where fissured rock is encountered with subsoil water table less than 1.5 meter below ground level, submerged fissured rock foundations shall be adopted. In case of dry locations dry fissured rock foundations shall be adopted.

(vi)Hard Rock

The locations where chiseling, drilling and blasting is required for excavation for monolithic rock for a particular leg/tower, hard rock type foundations are to be used. For these locations rock anchoring is to be provided to resist uplift forces.

The contractor shall be paid for the actual volume of concrete, excavation and weight of reinforcement executed as per Schedule of prices.

In addition to the above, depending on the site conditions more varieties of foundations may be introduced for suitable intermediate conditions under the above classifications to affect more economy.

The relevant characteristics of various types of soils are as given under this section. It shall be the responsibility of the contractor to draw the attention and obtain approval of KSEBL for any departure necessitated in these design data, based on geotechnical investigation at tower location, results of trial pits, etc.

(B) TECHNICAL SPECIFICATION FOR FOUNDATION OF TOWERS

The Technical specification and measurement of various items under this contract, unless otherwise mentioned hereunder specifically, will be governed by the CPWD specifications 2009 vol. 1&2 and latest amendments thereafter published by Director General of works, CPWD, Nirman Bhawan, New Delhi.

1. GEOTECHNICAL INVESTIGATION

The Contractor shall perform a detailed soil investigation to arrive at sufficient-lyaccurate conclusion regarding general as well as specific information about the soil profile and the necessary soil parameters of the site, in order to design and construct the foundation of the structures safely and rationally wherever re-quired by the Engineer-in-charge. The procedures and result submissions as in compliance to the IS 1892 and CPWD manuals. A report by a qualified Geo-technical engineer to the effect shall be submitted by the Contractor for KSEBL's specific approval giving details regarding data proposed to be utilized for the de-sign. The Contractor shall submit the detailed report as specified in IS: 1892 wherein information regarding the geological detail of the site, summarised ob-servations and test data, bore logs, and conclusions and recommendations on the type of foundations with supporting calculations for the recommendations. Initial-ly the Contractor shall submit draft report and after the draft report is approved, the final report in five (5) copies shall be submitted. The site test data shall bear the signatures of the Investigation Agency, Vendor and also site representative of KSEBL.

1. EARTH WORK EXCAVATION

This item of work to be executed as per CPWD specifications and includes dewatering from all sources wherever necessary. Dewatering to be executed as per CPWD specifications without any additional claims.

2. EARTH WORK EXCAVATION IN BLASTING PROHIBHITED LOCATIONS

Excavation in hard rock or rock boulders of size more than 0.5m^3 in volume to be carried out by wedging, barring, picking using rock drills, hammer, rock breaking tools attached to excavator etc. without resorting to the use of conventional explosive methods at locations where such excavation is specifically ordered by the Engineer in charge in lifts as specified and conveying and depositing the excavated rock etc. at places with in a distance of 50m as directed by the Engineer in Charge.

3. ROCK EXCAVATION USING NON-EXPLOSIVE AGENTS (CHEMICAL)

Excavation in hard rock or rock boulders of size more than 0.5m^3 in volume by use of non- explosives methods using specified chemical without resorting to the use of conventional explosive methods at locations where such excavation is specifically ordered by the Engineer in charge in all lifts and conveying and depositing the excavated rock etc. at places with in a distance of 50m as directed by the Engineer in Charge. Necessity of usage of chemical will be decided by Engineer-in-charge. The location where the rock excavation is to be carried out by

non- explosives methods (Chemical) will be decided by the Engineer in charge depending upon site conditions.

4. **CONCRETING**

This item of work to be executed as per CPWD specifications and includes dewatering from all sources wherever necessary.

5. **EARTHERN BUNDS**

Putting up ring bund as per approved shape using empty gunny/polythene bags filled with earth placed in 2 rows at 0.6m apart and filled in between with puddle clay to form bund for an average height as specified including labour dismantling the bund after completion of the work etc. complete.

6. **PILING**

Piling process has been split into two items boring & installation and concreting. Since the diameter of pile can be ascertained only after detailed geo-technical investigation contractor has to submit the calculations and approval of pile diameter to KSEBL. Contractor has to execute the pile in the specified diameter and to the specified depth in this item. The rate quoted by the contractor is inclusive of structural design of piles,all costs towards shifting , making ring bunds, access bunds, dewatering etc complete for all diameter of piles. The work has to be carried out as per latest IS specifications/ CPWD specifications.

7. **CONSTRUCTION AND INSTALLATION OF RCC BORED/ Driven CAST-IN-SITU / Pre-cast PILES**

Following LIST OF BUREAU OF INDIAN STANDARD CODES are to be followed for the Design, construction and installation of RCC bored cast in situ piles.
1. IS-1200 (Part 23) Method of measurement of building and Civil Engineering Works – Piling.
2. IS-2911 (Part 1/Sec. 1) Code of practice for Design and Construction of pile foundation. Driven cast-in-situ piles.
3. IS-2911 (Part 1/Sec. 2) Code of practice of Design and Construction of pile foundation. Bored Cast-in-situ piles.
4. IS-2911 (Part 1/Sec. 3) Code of practice for Design and Construction of pile foundation. Driven pre-cast concrete piles.
5. IS-2911 (Part 1/Sec. 4) Code of practice for Design and Construction of pile foundation. Bored pre-cast concrete piles.
6. IS-2911 (Part 3) Code of practice for Design and Construction of pile foundation. Under reamed piles.
7. IS-2911 (Part 4) Code of practice for design and Construction of pile foundation. Load test on piles.
8. IS-5112 Safety Code for piling and other deep foundations.
9. IS-6426 Specification for pile driving hammer.
10. IS-6427 Glossary of terms relating to pile driving.
11. IS-6428 Specification for pile frame.
12. IS-9716 Guide for lateral dynamic load test on piles.
13. IS-14362 Pile boring equipments. General requirements.

The work has to be carried out in accordance with CPWD specifications Volume-2 20.0 to 20.5.5.6

The design of pile foundations and pile cap as per the relevant IS codes is in contractor's scope. The rated quoted shall be inclusive for all diameters of pile including charges for structural design of piles,all costs towards shifting , making ring bunds, access bunds, dewatering etc complete as per the direction of Engineer-in-charge.

8. VERTICAL LOAD TESTING OF PILES

The bearing capacity of a single or group of piles shall be determined from test loading. It is most direct method for determining safe load on pile and it is more reliable on account of its being in-situ test. The load test on a concrete pile shall not be carried out earlier than 28 days of its casting. Initial test shall be carried on test pile which is not used as working pile and Routine tests shall be carried out as a check on working pile. Routine test shall be one-half percent to two percent of total number of piles or as specified, applicable to vertical and lateral load. Load Test shall generally conform to provision made in IS 2911 (Part IV) which provides guidelines for determination of safe loads and conducting of different types of tests.

9. MEASUREMENT AND PAYMENT

9.1. In general an average lead of 50m is considered for depositing spoil/excavated earth but in rare cases if the situation at site warrants additional lead the contractor has to execute the work without any additional financial commitment to KSEBL**.**

9.2. The locations where chemical blasting is to be carried out will be as directed by the Engineer in charge and the decision of the Engineer in charge shall be final. The quantity under removal by 'Chemical blasting' shall be restricted to the minimum as decided by the Engineer in charge.

9.3. The quoted rates for excavation of respective items in the schedule shall include cost of removal, handling and the disposal of all excavated materials wet or dry as the case may be. The rates shall further include hire and operational charges of all machinery involved, fencing, protection, care and diversion works, conveyance of excavated soil to dump yard and all other operations and incidental works necessary for the execution of works. The rates in the schedule shall include the entire cost of transporting the materials directly or indirectly from the excavation to the points of the final disposal including temporary stock piling and re-handling, if required.

9.4. Measurement for excavation by chemical blasting will be based on the actual quantity of rock in solid removed by the process. The unit rate will include all cost of excavation and of conveying and depositing the spoil at site pointed out by the Engineer in charge including all lifts.

9.5. The payment will be made at the agreed rate for the relevant items in the accepted schedule.

(C) CONSTRUCTION OF TOWER FOUNDATION

1. SETTING OF STUBS

The stubs shall be set correctly and precisely in accordance with approved method at the exact location, alignment and levels with the help of stub setting templates and levelling instruments. Minimum clearance between chimney concrete level and ground level shall be ensured as per foundation drawing. Stubs setting shall be done in the presence of KSEBL's representative available at site where required and for which adequate advance intimation shall be given to KSEBL by Contractor. Tolerances as per provisions of IS: 5613 shall be allowed for stub setting.

Setting of stubs at each location shall be approved by KSEBL.

However, towers with unequal leg extensions for Multi circuit tower, Extensions for raised chimney foundations, for river crossing towers, Anchor tower and for foundations in highly collapsible soils, props may be used with complete accuracy and high skilled supervision, subject to prior approval from KSEBL. No recovery shall be made on account of using Props for stub setting.

2. STUB SETTING TEMPLATES

Stub setting templates shall be arranged by the Contractor at his own cost for all heights of towers as per KSEBL's supplied drawings. Stub templates shall be of adjustable type. Stub templates should be painted.

The Contractor shall deploy sufficient number of templates for timely completion of the line without any extra cost to KSEBL.

However, the number of template to be deployed shall depend upon type of terrain condition, number & type of towers etc. Hence the quantity of template to be deployed for timely completion of the line shall be finalized in consultation with site in-charge without any extra cost to the KSEBL. **One set of stubs setting template (if used) shall be supplied to the KSEBL, on completion of the project, at no extra cost to KSEBL.**

3. BENCHING

When the line passes through hilly / undulated terrain, levelling the ground may be required for casting of tower footings. All such activities shall be termed benching and shall include cutting of excess earth and removing the same to a suitable point of disposal as required by KSEBL. Benching shall be resorted to only after approval from KSEBL. Volume of the earth to be cut shall be measured before cutting and approved by KSEBL for payment purposes. Further, to minimize benching, unequal leg extensions shall be considered and provided if found economical. If the levels of the pit centres be in sharp contrast with the level of tower centre, suitable leg extensions may be deployed as required. The proposal shall be submitted by the Contractor with detailed justification to the KSEBL.

4. PROTECTION OF TOWER AND TOWER FOOTING

Tower shall be spotted such that the quantity of revetment is optimum. For tower locations in undulated terrain such as hill / mountain slopes, options like use of

unequal leg extensions for towers, unequal chimney extensions etc. shall be explored by the contractor for optimizing the need for revetment & benching.

The work shall include all necessary stone revetments, concreting and earth filling above ground level, the clearing from site of all surplus excavated soil, special measures for protection of foundation close to or in small water streams (Nalas), river bank / bed, undulated terrain, protection of uphill / downhill slopes required for protection of tower etc., including suitable revetment or galvanized wire netting and meshing packed with boulders. Contractor shall recommend protection at such locations wherever required. Details of protection of tower/tower footing are given in drawing enclosed with these specifications for reference purpose only.

In protection of tower footings works the back filling shall generally be done using soil excavated at site unless deemed unsuitable for back filling. In the latter case, back filling shall be done with contractor's earth for which provision is given in the tender schedule. The unit rate for back filling quoted in Price Schedules shall include the required lead and consolidation and levelling of earth after back filling.

The provisional quantities for protection work of foundations are furnished in Price Schedule of Bid. The unit rates shall also be applicable for adjusting the actual quantities of protection works done. These unit rates shall hold good for protection work carried out on down hills or up hills slopes applicable for the tower locations.

No deduction shall be made for the volume enclosed by weep holes. The locations where both benching and protection of tower footing are envisaged, an economy got to be established against providing unequal leg extension.

PART - II TOWER ERECTION, STRINGING AND INSTALLATION OF LINE MATERIALS

2.0 GENERAL

2.0.1 The scope of erection work shall include the cost of all labour, tools and plant such as tension stringing equipment and all other incidental expenses in connection with erection and stringing work. The stringing equipment shall be of sufficient capacity to string the bundle conductors of specified size.

2.0.2 The Contractor shall be responsible for transportation to site of all the materials to be supplied by the Contractor as well as proper storage and preservation of the same at his own cost, till such time the erected line is taken over by the Owner. Similarly, the Contractor shall be responsible for transportation, proper storage, safe custody, and loss or damage of all Owner’s supplied items for incorporation in the lines and shall maintain and render proper account of all such materials at all times. The Contractor shall reimburse the cost of any of the materials lost or damaged during storage and erection.

2.0.3 Contractor shall set up required number of stores along the line and the exact location of such stores shall be discussed and agreed upon with the Owner.

Owner supplied items shall be dispatched to the railway stations situated nearest to the stores set up by the Contractor. From the railway stations, receipt,

unloading and transportation to the stores shall be the entire responsibility of the Contractor.

2.0.4 Payment for stringing shall be done on the basis of per kilometer and irrespective of number of tension/suspension towers. However, stringing for river crossing spans have been given separately in the BPS. The units of measurement for tower erection and other line materials, like, earth wire, Hard ware fittings and Accessories for conductor & earth wire are indicated in the BPS.

2.0.5 **TREATMENT OF MINOR GALVANISATION DAMAGE**

Minor defects in hot-dip galvanised members shall be repaired by applying zinc rich primer and two coats of enamel paint to the satisfaction of the Owner before erection.

2.1 TOWER ERECTION

2.1.1 The towers shall be erected on the foundations not less than 14 days after concreting or till such time the concrete has acquired sufficient strength. The towers are erected as per the erection drawings furnished by the designer to facilitate erection.

2.1.2 For the convenience of assembling the tower parts during erection operations, each member is marked in the factory to correspond with a number shown in the erection drawing. Any damage to the steel and injuring of galvanizing shall be avoided. No member shall be subjected to any undue over stress, during erection

2.1.3 The contractor shall give complete details of the erection procedures.

The method for the erection of towers shall ensure the following:

a) Straining of the members shall not be permitted for positioning. It may, however, be necessary to match hole positions at joints using tommy bars not more than 450mm in length;

b) Prior to erection of an upper section, the lower sections shall be completely braced, and all bolts provided tightened adequately in accordance with approved drawings to prevent any mishap during tower erection;

c) All plan diagonals, oblique bracings etc for relevant section of tower shall be in place prior to assembly of an upper Section;

d) The bolt positions in assembled towers shall be as per IS-5613 (Part II/Section 2);

e) Tower shall be fitted with number, danger and phase plates as well as anti-climbing device, as described;

f) After complete erection of the tower, all blank holes, if any, are to be filled by bolts and nuts of correct size.

g) Before starting erection of an upper section, the lower section shall be completely braced and all bolts provided in accordance with approved drawings.

2.1.4 The contractor shall be entirely responsible for correct erection for all towers as per the approved drawings and their correct setting on the alignment finally approved by the purchaser. The towers must be truly vertical after erection, the permitted tolerance in verticality being 1 in 360 of the tower height. No straining will be permitted to make the towers vertical.

2.1.5 A reasonable amount of drifting as permissible in IS:5613 (Part 3, section-2)-1989 shall be allowed in assembling but reaming for correction of mismatched holes due to shop errors will not be permitted. If any shop errors are discovered, the contractor shall notify the purchaser, who will decide whether the errors may be corrected in the field or members returned to tower fabricator for correction or replacement.

All galvanized surfaces damaged as a result of correction shall be made good to the satisfaction of the department.

2.1.6 Tower shall be fitted with number plate, danger plate, phase plates, circuit plates and anti-climbing device as described. After complete erection of tower, all blank holes, if any, are to be filled by Bolts and nuts of correct size. Suspension towers shall be fitted with Bird guards.

2.1.7 TIGHTENING OF BOLTS AND NUTS

2.1.7.1 All nuts shall be tightened properly using correct size spanner and torque wrench. Before tightening, it will be verified that filler washers and plates are placed in relevant gap between members, bolts of proper size and length are inserted, and one spring washer is inserted under each nut. In case of step bolts, spring washers shall be placed under the outer nuts. The tightening shall progressively be carried out from the top downwards, care being taken that all bolts at every level are tightened simultaneously. The threads of bolts projecting outside the nuts shall be punched at their position on the diameter to ensure that the nuts are not loosened in course of time. If, during tightening, a nut is found to be slipping or running over the bolt threads, the bolt together with the nut shall be replaced.

2.1.7.2 The threads of all the bolts except for Anti-theft bolts projected outside the nuts shall be welded at two diametrically opposite places, the circular length of each welding shall be at least 10mm. The welding shall be provided from ground level to waist level for single circuit towers and to bottom cross arm for double circuit towers. However, for towers, with +18-meter, +25 meter extensions and river crossing towers, the welding shall be provided from ground level to 30m height from stub level. After welding zinc-rich primer having approximately 90% zinc content shall be applied. to the welded portion. At least two coats of the paint shall be applied. The surface coated with zinc rich primer shall be further applied with two finish coats of high build enamel of the grade recommended by the manufacturer of the zinc rich primer. The cost of welding and paint including application of paint shall be deemed to be included in the erection price.

STRINGING OF CONDUCTORS AND EARTH WIRE

2.2 INSULATOR HOISTING

Suspension insulator strings shall be used on Suspension towers (A/DA) and tension insulator strings on angle and dead-end towers. These shall be fixed on all the towers just prior to the stringing. Damaged insulators and strings, if any, shall not be employed in the assemblies. Prior to hoisting, all insulators shall be cleaned in a manner that will not spoil, injure or scratch the surface of the insulator, but in no case shall any oil be used for that purpose. For checking the soundness of insulators, IR measurement using 10kV (DC) Meager shall be carried out on 100% insulators. Corona control rings/arcing horn shall be fitted in an approved manner. Torque wrench shall be used for fixing various line materials and components, such as suspension clamp for conductor and earth wire, etc., whenever recommended by the manufacturer of the same.

2.3 HANDLING OF CONDUCTOR AND EARTH WIRE

2.3.1 RUNNING OUT OF THE CONDUCTORS

2.3.1.1 The conductors shall be run out of the drums form the top in order to avoid damage. The Contractor shall be entirely responsible for any damage to tower or conductors during stringing.

2.3.1.2 A suitable braking device shall be provided to avoid damaging, loose running out and kinking of the conductors. Care shall be taken that the conductors do not touch and rub against the ground or objects which could scratch or damage the strands.

2.3.1.3 The sequence of running out shall be from the top down i.e. the earth wire/OPGW shall be run out first followed in succession by the conductors. Unbalanced loads on towers shall be avoided as far as possible. Inner phase of line conductors shall be strung before the stringing of the outer phases is taken up.

2.3.1.4 The Contractor shall take adequate steps to prevent clashing of sub conductors until installation of the spacers/spacer dampers. Care shall be taken that sub conductors of a bundle are from the same Contractor and preferably from the same batch so that creep behavior of sub conductors remains identical. During sagging, care shall be taken to eliminate differential sag in sub-conductors as far as possible. However, in no case shall sag mismatch be more than 25mm.

2.3.1.5 Towers not designed for one sided stringing shall be well guyed and steps taken by the Contractor to avoid damage. Guying proposal along with necessary calculations shall be submitted by the Contractor to Owner for approval. All expenditure related to this work is deemed to be included in the bid price and no extra payment shall be made for the same.

2.3.1.6 When the transmission lines runs parallel to existing energised power lines, the Contractor shall take adequate safety precautions to protect personnel; from the potentially dangerous voltage built up due to electromagnetic and electrostatic coupling in the pulling wire, conductors and earth wires during stringing operations.

2.3.1.7 The Contractor shall also take adequate safety precautions to protect personnel from potentially dangerous voltage build up due to distant electrical storms.

2.3.2 RUNNING BLOCKS

2.3.2.1 The groove of the running blocks shall be of such a design that the seat is semicircular and larger than the diameter of the conductor/earth wire and it does not slip over or rub against the slides. The grooves shall be lined with hard rubber or neoprene to avoid damage to conductor and shall be mounted on properly lubricated bearings.

2.3.2.2 The running blocks shall be suspended in a manner to suit the design of the cross-arm. All running blocks, especially at the tensioning end will be fitted on the cross-arms with jute cloth wrapped over the steel work and under the slings to avoid damage to the slings as well as to the protective surface finish of the steel work.

2.3.3 REPAIRS TO CONDUCTORS

2.3.3.1 The conductor shall be continuously observed for loose or broken strands or any other damage during the running out operations.

2.3.3.2 Repairs to conductor if accidentally damaged, shall be carried out with repair sleeve with the permission of the Engineer in charge.

2.3.3.3 Repairing of the conductor surface shall be carried out only in case of minor damage, scuff marks, etc. The final conductor surface shall be clean, smooth and free from projections, sharp points, cuts, abrasions, etc.

2.3.3.4 The Contractor shall be entirely responsible for any damage to the towers during stringing.

2.3.4 CROSSINGS

Derricks or other equivalent methods ensuring that normal services need not be interrupted, nor damage caused to property shall be used during stringing operations where roads, channels, telecommunication lines, power lines and railway lines have to be crossed. However, shut down shall be obtained when working at crossings of overhead power lines. The Contractor shall be entirely responsible for the proper handling of the conductor, earth wire and accessories in the field. The shutdown schedule and number of days will be intimated at the time of execution after consulting with Load Dispatch Center. The shutdown will be arranged by the KSEBL as per requirement.

2.4 STRINGING OF CONDUCTOR AND EARTH WIRE

2.4.1 The stringing of the conductor shall be done by the control tension method. The equipment shall be capable of maintaining a continuous tension per bundle such that the sag for each conductor is about twenty percent greater than the sags specified in the stringing sag table.

2.4.2 The bidder shall give complete details of the stringing methods he proposes to follow. Prior to stringing the Contractor shall submit the stringing charts for the

conductor and earth wire showing the initial and final sags and tension for various temperatures and spans alongwith equivalent spans in the lines for the approval of the Owner.

2.4.3 A controlled stringing method suitable for simultaneous stringing of the sub conductors shall be used. The two conductors making up one phase bundle shall be pulled in and paid out simultaneously. These conductors shall be of matched length. Conductors or earth wires shall not be allowed to hang in the stringing blocks for more than 96 hours before being pulled to the specified sag.

Conductor creep are to be compensated by over tensioning the conductor at a temperature of 26^{0}C lower than the ambient temperature or by using the initial sag and tensions indicated in the tables.

2.5 JOINTING

2.5.1 When approaching the end of a drum length at least three coils shall be left in place when the stringing operations are stopped. These coils are to be removed carefully, and if another length is required to be run out, a joint shall be made as per the specifications.

2.5.2 Conductor splices shall not crack or otherwise be susceptible to damage in the stringing operation. The Contractor shall use only such equipment/methods during conductor stringing which ensures complete compliance in this regard.

2.5.3 All the joints on the conductor and earth wire shall be of the compression type, in accordance with the recommendations of the manufacturer, for which all necessary tools and equipment like compressors, dies etc., shall be obtained by the Contractor. Each part of the joint shall be cleaned by wire brush till it is free of dust or dirt etc. and be properly greased with anti-corrosive compound. If required and as recommended by the manufacturer, before the final compression is carried out with the compressors.

2.5.4 All the joints of splices shall be made at least 30 meters away from the tower structures. No joints or splices shall be made in spans crossing over main roads, railways, power lines and small river spans up to 650m. Not more than one joint per sub conductor per span shall be allowed. The compression type fittings shall be of the self centering type or care shall be taken to mark the conductors to indicate when the fitting is centered properly. During compression or splicing operation; the conductor shall be handled in such a manner as to prevent lateral or vertical bearing against the dies. After compressing the joint the aluminium sleeve shall have all corners rounded, burrs and sharp edges removed and smoothened.

2.5.5 During stringing of conductor to avoid any damage to the joint, the Contractor shall use a suitable protector for mid span compression joints in case they are to be passed over pulley blocks/aerial rollers. The pulley groove size shall be such that the joint along with protection can be passed over it smoothly.

2.6 TENSIONING AND SAGGING OPERATIONS

2.6.1 The tensioning the sagging shall be done in accordance with the approved stringing charts or sag tables. The "initial" stringing chart shall be used for the conductor and final stringing chart for the earth wire. The conductors shall be pulled up to the desired sag and left in running blocks for at least one hour after which the sag shall be rechecked and adjusted, if necessary, before transferring the conductors from the running blocks to the suspension clamps. The conductor shall be clamped within 96 hours of sagging in.

2.6.2 The sag will be checked in the first and the last section span for sections up to eight spans, and in one additional intermediate span for sections with more than eight spans. The sag shall also be checked when the conductors have been drawn up and transferred from running blocks to the insulator clamps.

2.6.3 The running blocks, when suspended from the transmission structure for sagging, shall be so adjusted that the conductors on running blocks will be at the same height as the suspension clamp to which it is to be secured.

2.6.4 At sharp vertical angles, conductor and earth wire sags and tensions shall be checked for equality on both sides of the angle and running block. The suspension insulator assemblies will normally assume verticality when the conductor is clamped.

2.6.5 Tensioning and sagging operations shall be carried out in calm whether when rapid changes in temperature are not likely to occur.

2.6.6 CLIPPING IN

2.6.6.1 Clipping of the conductors into position shall be done in accordance with the manufacturer's recommendations.

2.6.6.2 Jumpers at section and angle towers shall be formed to parabolic shape to ensure maximum clearance requirements. Pilot suspension insulator strings shall be used, if found necessary, to restrict jumper swing to design values.

2.6.6.3 Fasteners in all fittings and accessories shall be secured in position. The security clip shall be properly opened and sprung into position.

2.7 FIXING OF CONDUCTORS AND EARTH WIRE ACCESSORIES

Conductor and earth wire accessories including spacers, spacer dampers (for bundle conductor) and vibration dampers shall be installed by the Contractor as per the design requirements and manufacturer's instruction within 24 hours of the conductor/earth wire clamping. While installing the conductor and earth wire accessories, proper care shall be taken to ensure that the surfaces are clean and smooth and that no damage occurs to any part of the accessories or of the conductors. Torque wrench shall be used for fixing the Dampers/Spacer Dampers, Suspension Clamps etc. and torque recommended by the manufacturer of the same shall be applied.

2.8 AERIAL MARKER BALLS & AVIATION SIGNAL

The line route shall be at a sufficient distance from the aerodromes / airports so that clearance from the aerodrome / airport authorities is not required or,

otherwise, can be obtained easily. Aviation obstruction fixtures / lights / painting have been provided, if required.

Aircraft warning sphere/ aerial marker ball will be provided where ever required, is designed to provide daytime visual warning or nighttime visual warning if comes with reflective tape, for electricity transmission line and overhead wire for aircraft pilots, especially cross river high voltage transmission lines. An aircraft warning marker should be of one color such as aviation orange, white and red. Generally, the marking spheres are placed on the highest line. Where there is more than one line at the highest level, white and red, or white and orange spheres should be displayed alternately. This alternating color scheme provides the most conspicuity against all back ground.

2.9 REPLACEMENT

If any replacement is to be affected after stringing and tensioning or during maintenance, leg member and bracing shall not be removed without first reducing the tension on the tower by proper guying techniques or releasing of the conductor. For replacement of cross arms, the conductor shall be suitably tied to the tower at tension points or transferred to suitable roller pulleys at suspension points.

2.10 PERMITTED EXTRA CONSUMPTION OF LINE MATERIALS

2.10.1 The quantity of conductor and earth wire to be incorporated in the line shall be worked as per the following norms.

Quantify of Conductor = Line length as per detailed survey x 3 phases x Nos. of conductor per bundle (for Single Circuit Line)

= Line Length as per detailed survey x 3 phases x Nos. of conductor per bundle x 2 (for Double Circuit Line)

Quantity of Earth wire = Line length as per detailed survey x nos. of ground wires

- For calculation of conductor & Earth wire requirement in hilly stretches, inclined distance between the towers may be considered instead of horizontal distance (considered for line length).

2.10.2 The Contractor shall make every effort to minimize breakage, losses and wastage of the line materials during erection. However, the Contractor shall be permitted and extra consumption of line materials up to the limits specified in Table 2.10.2.1 and shall be permitted to dispose of the scrap, if any at the end.

Table 2.10.2.1 Permitted extra consumption of line materials

Item	% of permitted extra consumption
Conductor & earth wire	1
Insulators	1

2.10.3 In case of conductor and earth wire, the permitted extra consumption limit of one percent is inclusive of sag, jumpering, damage, loss and wastage etc.

2.10.4 The Contractor shall not be required to return to the Owner empty conductor and earth wire drums and shall dispose of the same at his cost.

2.10.5 Any conductor and earth wire drum which has been opened by the Contractor shall not be taken back by Board and the unused conductor or earth wire in such drums may be treated as waste permissible within the overall limits specified in Table 2.10.2.1.

2.10.6 The Contractor shall return to the Board all Board supplied material not incorporated in the works, except those permitted by Board as scrap in terms of Table 2.10.2.1. Otherwise, the Contractor shall pay in respect of such excess materials which he is unable to return at rates corresponding to the actual cost of procurement plus 15% for OSM procured under domestically funded packages. The "cost of procurement" for the above purpose shall be F O R destination site cost of OSM as per LOA of the respective packages plus taxes & duties plus price variation (if positive) applicable as on the date of issuance of TOC for Tower Package.

2.10.7 For calculation of conductor & earth wire consumption in hilly (mountainous) stretches inclined distance between towers may be considered, instead of horizontal distance between them.

2.10.8 The quantities of line materials to be supplied by the contractor (i.e. earth wire, Hardware fittings & accessories) as indicated in the bill of quantities are provisional and the actual quantity shall depend upon detailed survey.

Contractor shall be responsible for regulating the supplies of contractor supplied materials in the basis of actual requirements. The Owner shall have right, not to take any surplus contractor supplied line materials.

2.11 FINAL CHECKING, TESTING AND COMMISSIONING

2.11.1 After completion of the works, final checking of the line shall be carried out by the Contractor to ensure that all foundation works, tower erection and stringing have been done strictly according to the specifications and as approved by the Owner. All the works shall be thoroughly inspected in order to ensure that:

a) Sufficient back filled earth covers each foundation pit and is adequately compacted;

b) Concrete chimneys and their copings are in good condition and finely shaped.

c) All tower members are used strictly according to final approved drawing and are free of any defect or damage whatsoever.

d) All bolts are properly tightened, punched, tack welded and painted with zinc rich paint;

e) The stringing of the conductors and earth wire has been done as per the approved sag and tension charts and desired clearances are clearly available;

f) All conductor and earth wire accessories are properly installed;

g) All other requirements for completion of works such as fixing of danger plate, phase plate, number plate, anti-climbing device, Aerial marker balls, aviation signal have been fulfilled.

h) Wherever required, that proper revetment (erosion protection) is provided;

i) The original tracings of profile and route alignment as well as tower design, structural drawings, bill of material and shop drawings of all towers are submitted to the Owner for reference and record.

j) The insulation of the line as a whole is tested by the Supplier through provision of his own equipment, labour etc., to the satisfaction of the Owner.

k) All towers are properly grounded.

l) The line is tested satisfactorily for commissioning purpose.

Sd/-
ED (Unit – 4&5)

PFC Consulting Limited

PART D
DOCUMENTATION AND DELIVERABLES

(To be submitted with the proposal of vendor approval by the successful bidder after placement of order)

PART D
DOCUMENTATION AND DELIVERABLES

This section describes the documentation requirements and provides a list of deliverable that the Contractor shall provide to the KSEBL. Complete documentation necessary for the operation and maintenance of the fibre optic cabling system is required. All the documentation shall be provided in hard copy and also on CD-ROMs in full compliance with the specification. Conditions pertaining to Document Review and Approval Rights and Document Submission Scheduling are specified in this section.

The documentation shall include the following:

(a) Detailed list of the deliverables
(b) Description of the products
(c) Technical particulars
(d) Installation manuals
(e) Maintenance manuals
(f) Quality assurance manuals, Manufacturing Quality Plan (MQP) & Field Quality Plan (FQP)
(g) Tests documentation

1. System Documentation

A detailed documentation plan and document submission schedule shall be prepared and submitted for approval. The guidelines specified in table 5-1 & table 5-2 shall be followed.

2. Supplementary Documentation

While performing maintenance during the warranty period, the KSEBL determines that additional information is required to perform the maintenance function, the Contractor and/or its subcontractors shall provide the specific supplemental information necessary to perform the maintenance function. This information shall be documented in a form suitable for incorporation into the appropriate maintenance document.

3. Test Documentation

The Contractor shall provide documentation for all Type tests, Factory Acceptance tests and site tests (SAT).

The test documentation shall include the following:

a. Type test Documents (Procedures & Reports)
b. Factory Acceptance Test Documents (Procedures & Reports)
c. Site Acceptance Test Documents (Procedures & Reports)

c) Drawings

All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, dimensions, material description, Bill of Materials, weight of each component, break-up for packing and shipment, shipping arrangement required, the

dimensions required for installation and any other information specifically requested in the Specifications.

Each drawing submitted by the Contractor shall be clearly marked with the KSEBL name, the unit designation, the specification title, the specification number and the name of the Project. All titles, notes, markings and writings on the drawing shall be in English. All the dimensions should be to the scale and in metric units. The drawing revision level/ issue no, issue date shall be marked on each drawing and the drawing shall carry issue history information and appropriate signatures (eg: originator, checker and approving authority).

4. Drawing and Document Approval Procedure

The drawings/documents submitted by the Contractor shall be reviewed by the KSEBL as far as practicable within stipulated duration and shall be modified by the Contractor if any modifications and/or corrections are required by the KSEBL in compliance with the Specifications. The Contractor shall incorporate such modifications and/or corrections and submit the final drawings for approval. Any delays arising out of failure by the Contractor to rectify the drawings in good time shall not alter the contract completions date.

The drawings/documents submitted for approval to the KSEBL shall be in quadruplicate. One print of such drawings shall be returned to the Contractor by the KSEBL marked with one of the categories as listed below: -

Category Inference

Cat I	Approved/Released for implementation.
Cat II	Approved/Released for implementation subject to incorporation of comments. Revised drawing required
Cat III	To be resubmitted for approval after incorporating comments.
Cat IV	For information and record.

The approval of the drawing/document conveyed vide above marked copy shall neither relieve the Contractor of its contractual obligations and its responsibilities towards weights, qualities, design details, assembly fits, performance particulars and conformity of supplies with the Indian Statutory Laws as may be applicable, nor shall it limit KSEBL's and/or KSEBL's right under the contract.

Depending upon the category of approval the Contractor shall resubmit the drawings/documents for review by KSEBL after incorporating all corrections.

Further work by the Contractor shall be strictly in accordance with the Cat-I, Cat-II or Cat-IV approved drawings and no deviation shall be permitted without the written approval of the KSEBL.

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

of his responsibilities and liabilities under the Contract.

5. Final Documentation

Final documentation shall consist of all the documents approved in Cat I and Cat IV. The documents will be used by the KSEBL personnel for operating and maintaining the equipment after acceptance.

Until acceptance of the equipment by the KSEBL, the Contractor shall be responsible for supplying documentation revisions or changes necessitated by inaccuracies, installation requirements, omissions determined by usage, and design or production alterations to the equipment. All changes shall be issued in the form of replacements for the affected drawings, diagrams, charts, graphs, tables, lists, and pages in the various documentation such that all documentation describes the equipment "as delivered".

For all the documents listed in Table D.1 (except Type, FAT & SAT related), five(5) sets of the final approved documentation shall be provided for the engineering office of the KSEBL in CD-ROM and two (2) sets in hard copy.

All final Contractor-supplied documentation shall be easily reproducible by the KSEBL.

Table D-1: Documentation Plan

S. No	Document	Applicable Equipment's/Item	Brief Description	Approval Category
1.	Documentation Plan and Schedule		This document shall contain the list of all documents to be submitted for approval and their submission/approval schedule.	Cat - I
2.	Survey guidelines & formats		As per technical specifications.	Cat - I
3.	Data Requirement Sheets (DRS) and Guaranteed Technical Parameters & Drawings	For each and every item to be supplied including fibre, OPGW cable, approach cable, joint box, FODP, All FO cable Hardware & fittings (suspension clamp assembly, tension clamp assembly, vibration damper etc.), test equipment.	These document(s) shall describe all the technical parameters of the item being offered. The formats for some items provided in the appendices shall be used, which may be expanded as required. The GTP shall be submitted for all items. The GTP shall be supported by technical brochures / product manuals.	Cat - I (for DRS) & Cat – IV (for brochure)
4.	Sag tension charts	For OPGW cable	Shall accompany the DRS	Cat - I

5.	Previous type test reports	For all items for which type testing is required. (fibre, OPGW cables, Hardware & fittings for OPGW cable, approach cable, joint box,)	Shall be complete in all respect including all test graphs, curves, calculations, photographs etc.	Acceptance e Letter
6	Manufacturing Quality Plan	For all items to be supplied	Refer technical specifications.	Cat- IV
7	Survey reports & engineering analysis	For FO cable link	Line wise survey reports, indicating tower schedules, drum schedules, crossing details, hardware & fitting requirements etc. Shall include line wise sag-tension charts and other engineering analysis etc.	Cat- I (for Drum Schedule) and Cat-IV for other detailed report
8	Link and survey reports & engineering analysis	For each Fibre Optic link and site	Link wise survey reports as per specifications, link calculations etc.	Cat- I
9	Numbering, Marking, labelling Document	As applicable.	Must include numbering, marking, labelling and naming conventions for channels, cables, connectors, sub racks, cubicles etc	Cat- I
10	Bill of Quantities	For each item and each line	Line wise survey reports, indicating tower schedules, drum schedules, crossing details, Hardware & fitting requirements etc. Shall include line wise sag-tension charts and other engineering analysis such as tower strengthening analysis etc. Shall include site wise	Cat- I

			detailed quantities of each equipment	
11.	Factory Acceptance tests: test plan, procedures and report format	For all items to be supplied	This document shall include the list of Factory acceptance tests, the administrative & functional test plans, test procedures and formats for recording & reporting factory acceptance test results.	Cat- I
12.	Factory acceptance test report	For all Factory acceptance tests	This document shall provide all factory acceptance reports for all materials used in this project.	Cat- IV
13.	Transportation& Handling Procedures	For OPGW cable	This document shall describe the procedures & precautions to be observed during overseas & inland transportation, cable & cable drum handling during transport, storage & pre-installation. It shall also include drum details and drum labelling details.	Cat- IV
14.	Jointing Manual	For each type of FO cable/ joint box to be supplied	This document shall describe the installation of joint box (In line splice enclosures) and other jointing gang activities	Cat- I
15.	Installation procedure	For OPGW cable & joint box	The expected content of this document are presented in table D-2 below.	Cat- IV

16.	Site Acceptance tests (SAT) test plan, procedures and report format	System document	This document shall include the list of Site acceptance tests, the administrative & functional test plans, test procedures and formats for recording & reporting site acceptance test results.	Cat- I
17.	Field Quality Plan	One Document with multiple subdocuments if required	Field Quality Plan shall describe the quality control to be exercised during the field activities. This document can include the following information: (a.) The list of performance & safety checks applied to installation equipment, tools & tackles, checks, check on physical health & training records of installation crew etc. (b.) The list of Site Acceptance tests (including statement of acceptance criteria). The inclusion of list of site acceptance tests in FQP is analogous to the inclusion of list of FAT in the MQP. The formats for recording & reporting Site acceptance tests can also be reproduced.	Cat- I
18	Field Safety Plan	Safe Execution procedures	Instructions and Procedures for safe practices at site.	Cat- I
19	Approach Cable & FODP layout document – site wise	For each site	To describe the layout of approach cable at each site and the floor plan of the FODP.	Cat - I
20	Site test records as per approved SAT procedures	Per Link and per Location		*

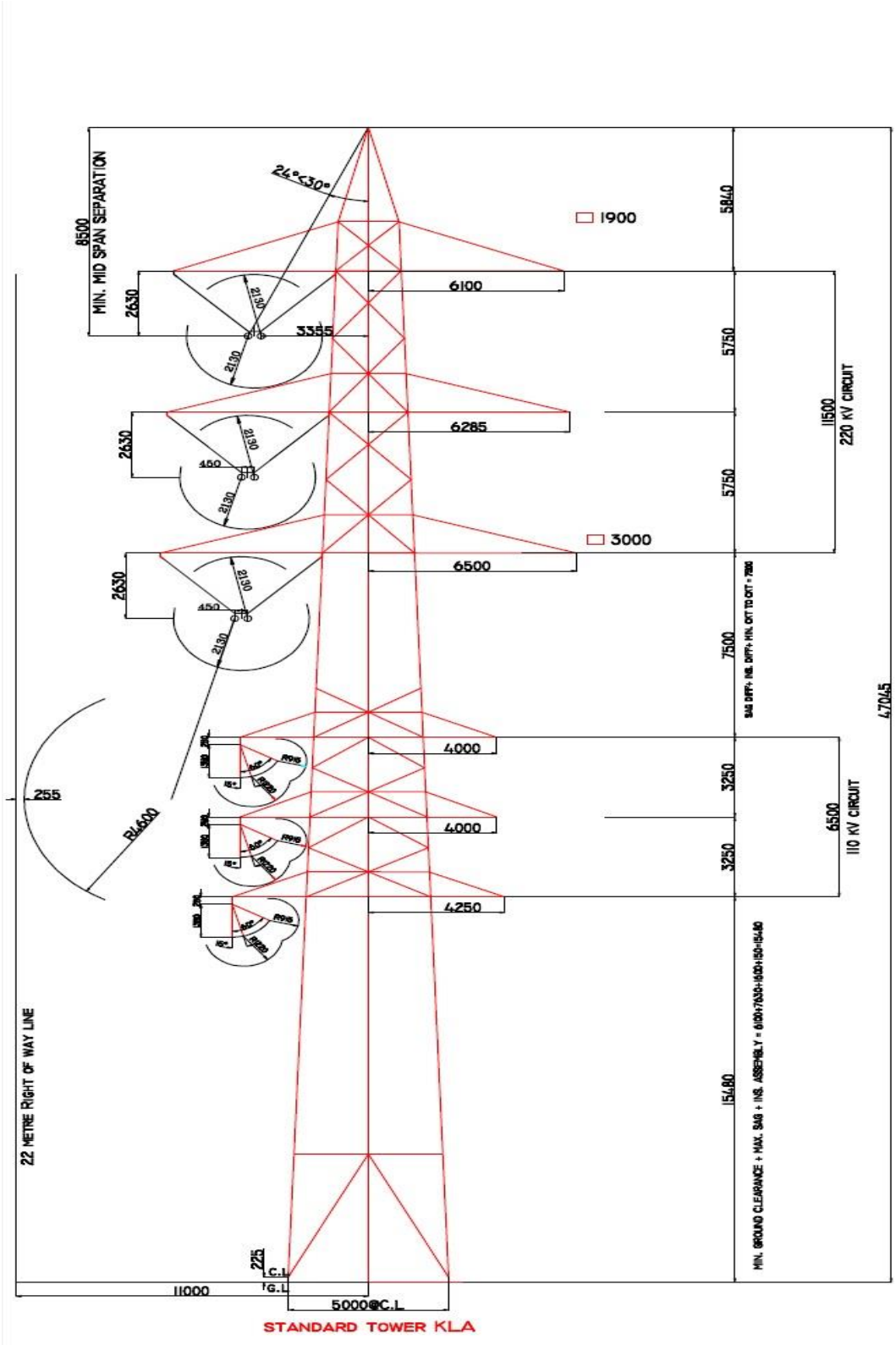
- To be reviewed & approved by the Site

Table D-2: Expected Contents & Structure of FO Cable / Equipment Installation Manual

1	Installation procedure	Description of activities of installation gangs: Preparation & Setting up, Stringing, sagging, attaching hardware, attaching down lead clamps & cable routing on the tower, securing cable ends (for protection before work by jointing gang). Precautions for preventing cable damage shall be highlighted.
2	Safety Instructions	Instructions & procedures related to ensuring installation crew safety: personnel grounding & safety, installation equipment safety, Safety for power system & environment (viz preventing accidental tripping, precaution for railway crossings etc)
3	Description of Installation Equipment	Sketches, drawings, photographs, safe working ratings of installation equipment, tools & tackles etc., handling instructions & precautions.
4	Cable routing	Illustrations of the positions of tower attachment clamps (down lead clamps), routing of FO cable on the tower, service loop(s), joint box position.
5	References	References to other related documents covering the installation, jointing & testing, like: SAT administrative & functional test plans & test procedures, Jointing Procedures, Field Quality Plan & Field Quality Audit, Storage & Handling Instructions, FO cable & hardware drawings, technical parameters, GTP etc. KSEBL & Statutory safety rules, safety manuals, standards, codes of practices etc.

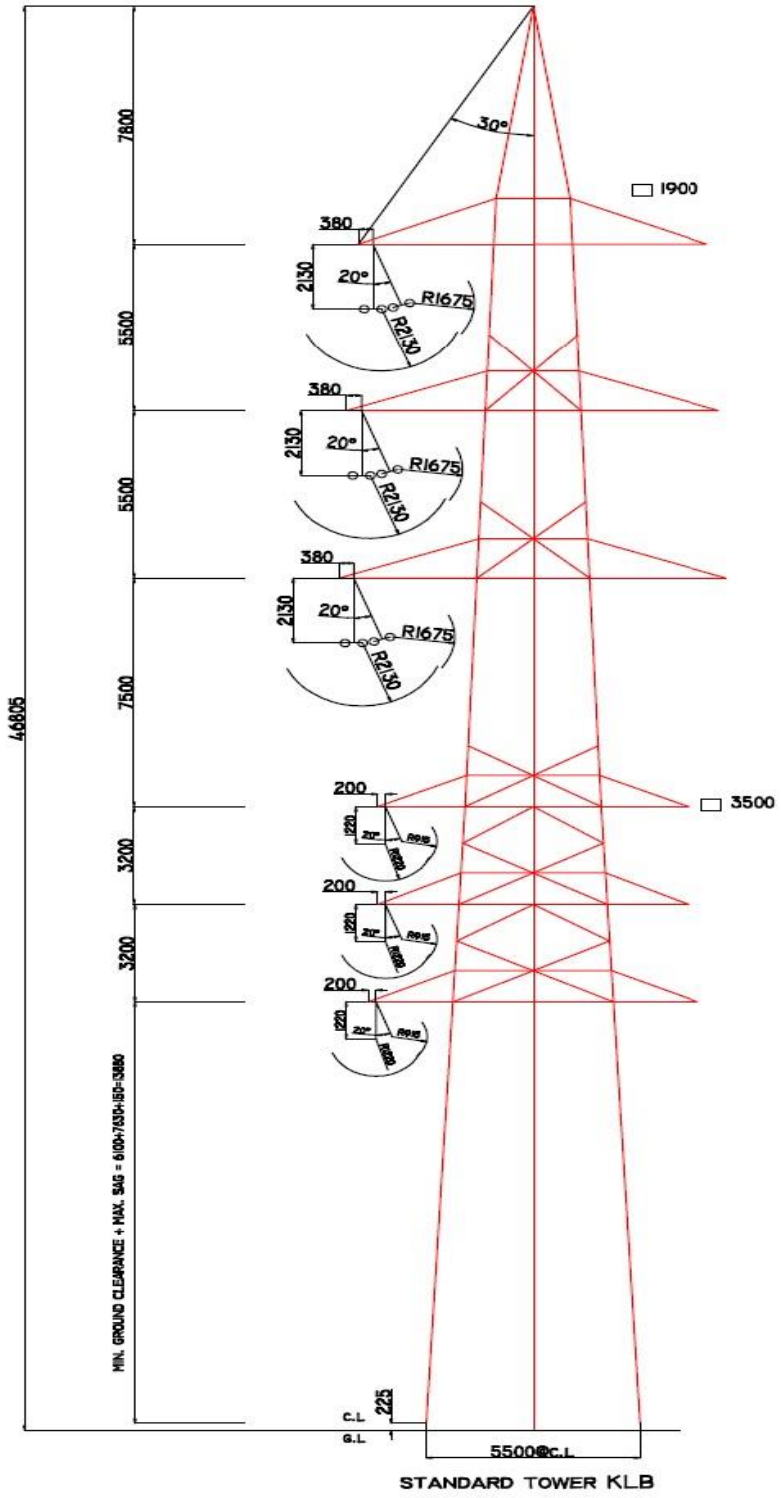
PART E
DRAWINGS

TABLE OF CONTENT



220/110kV MCMV TOWER - KLA

FOR TENDER PURPOSE ONLY



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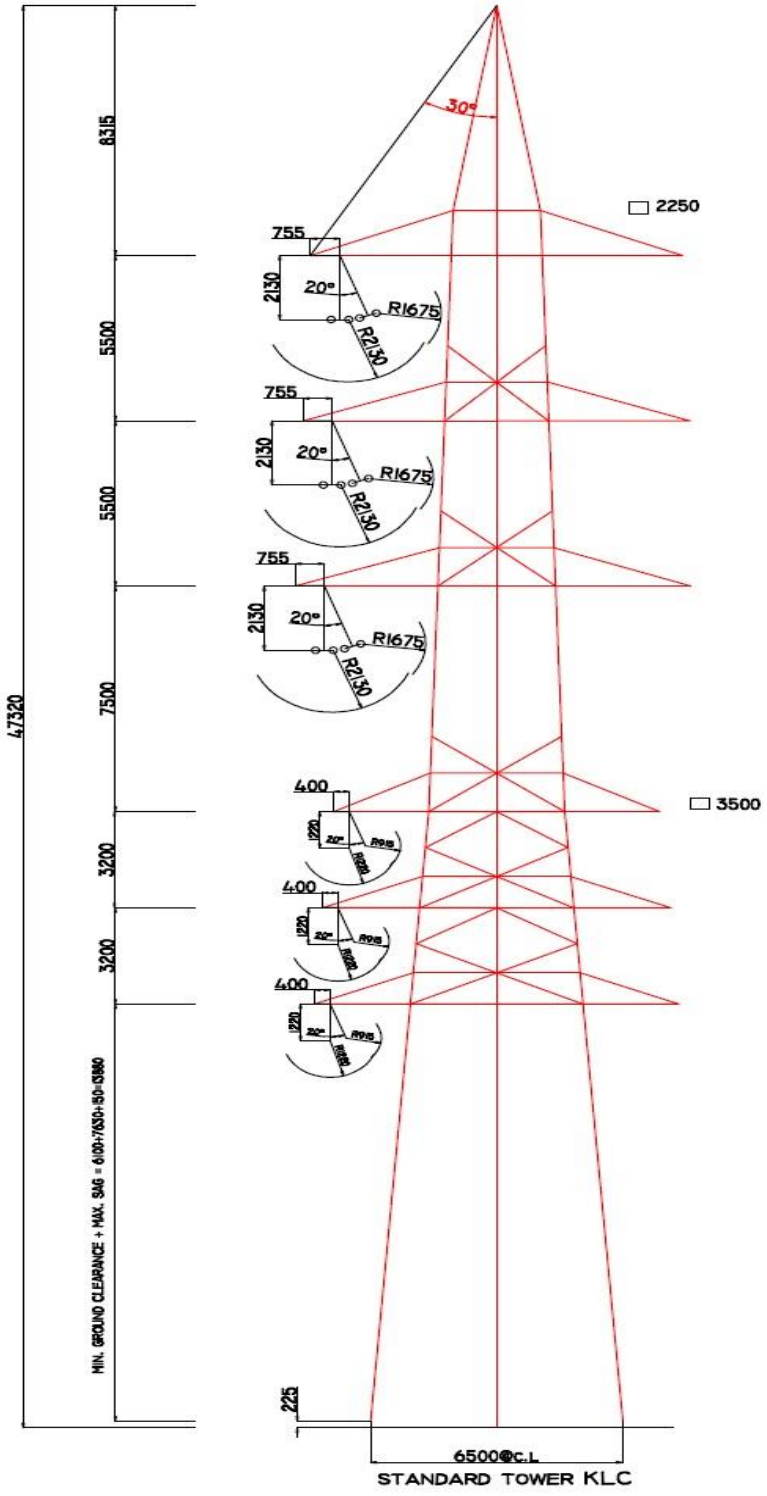

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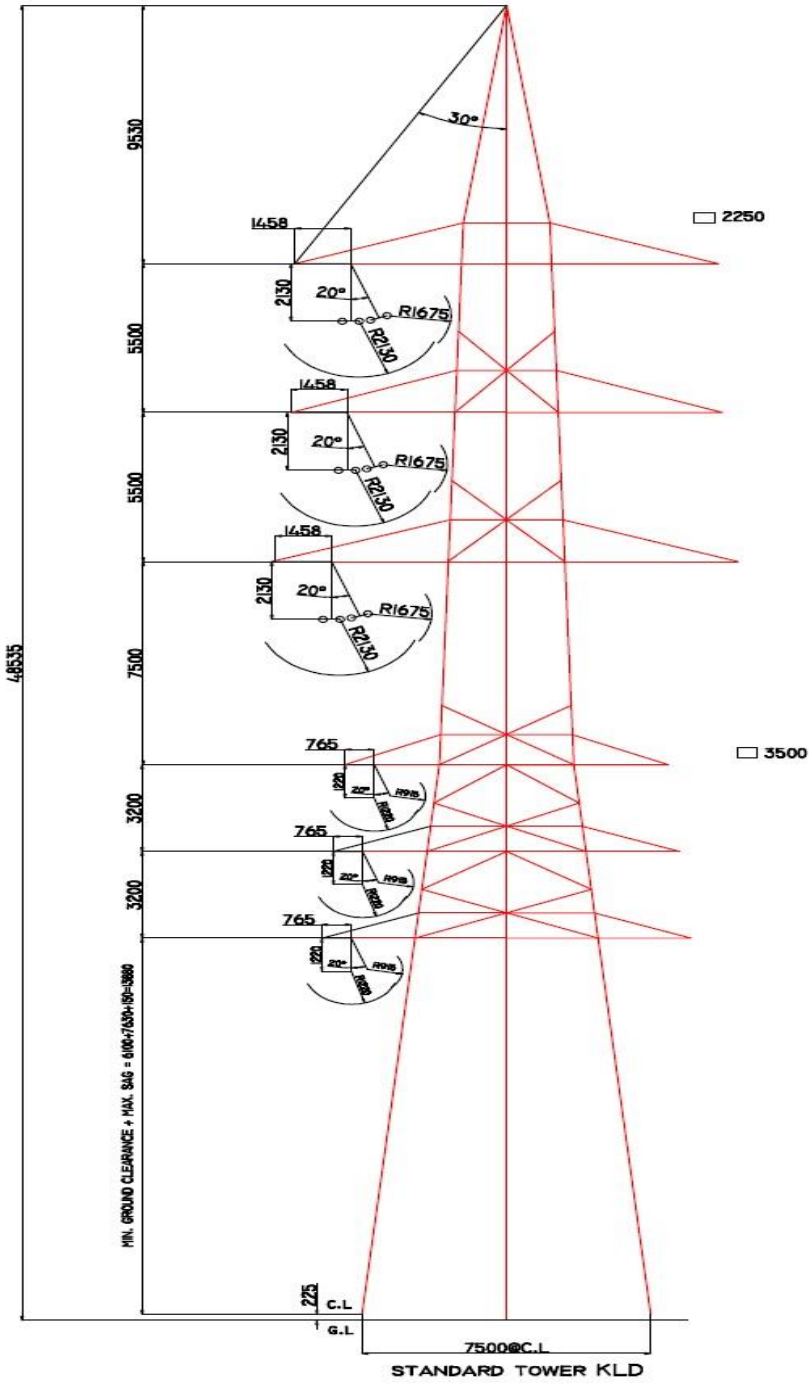

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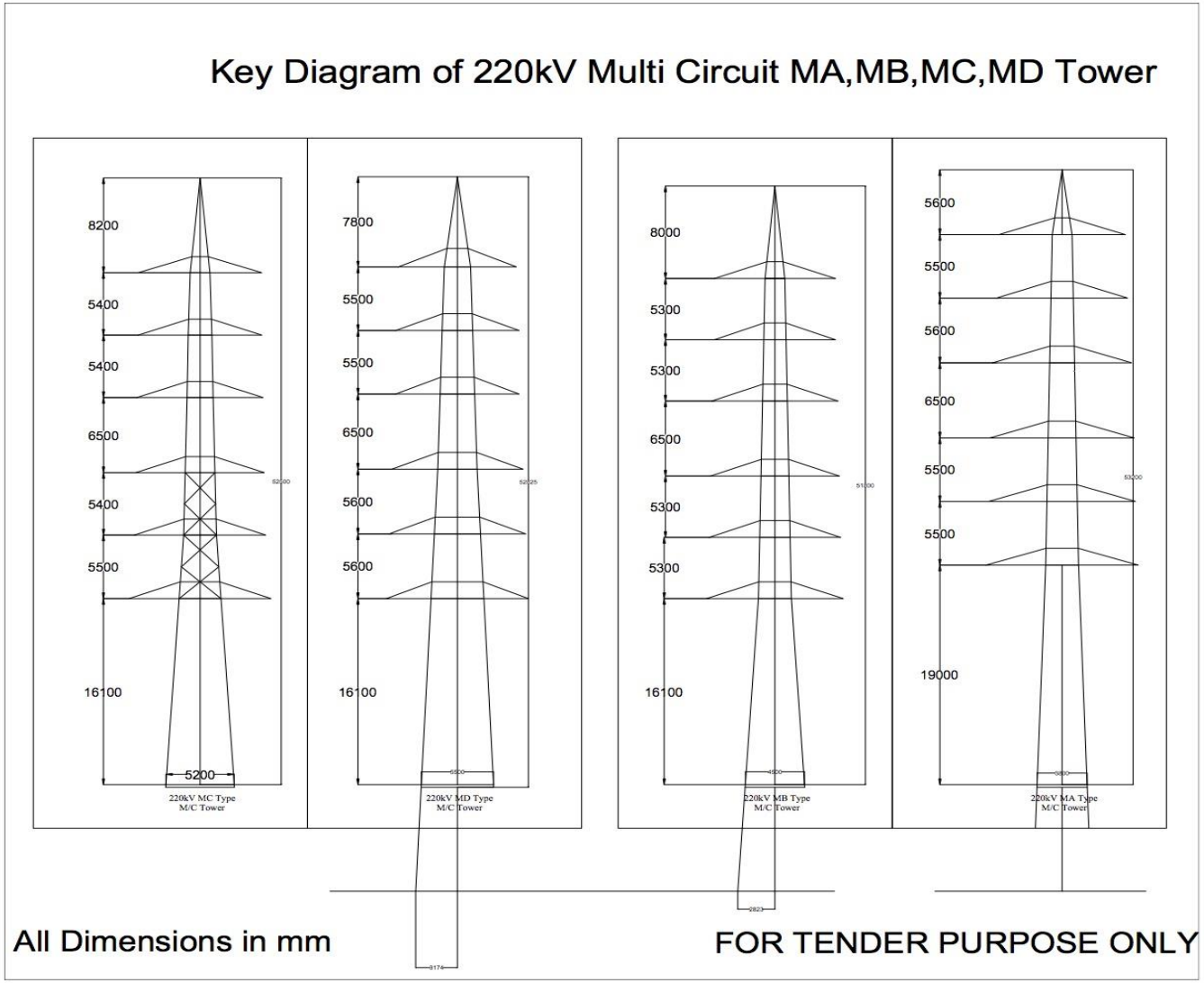

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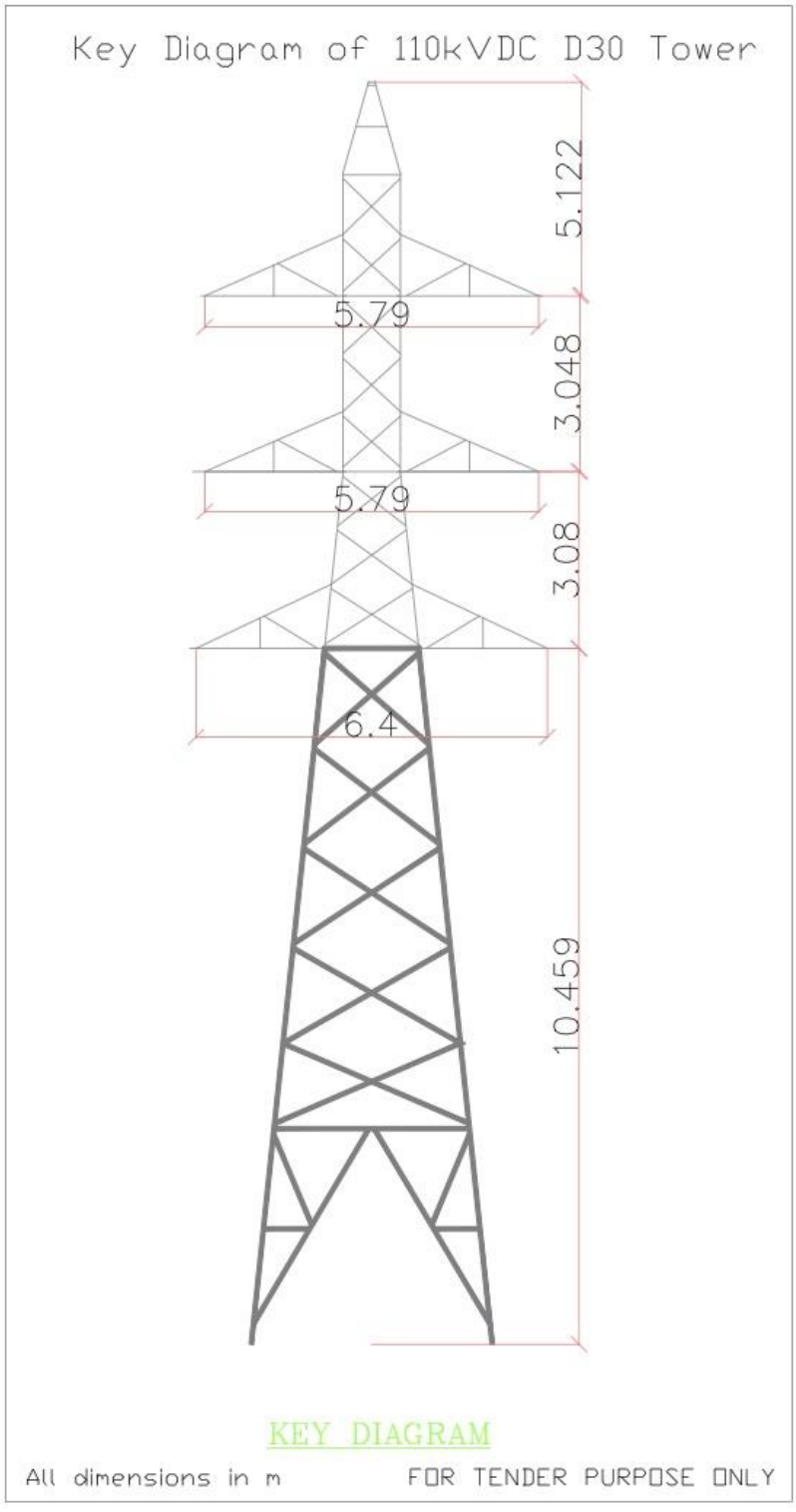

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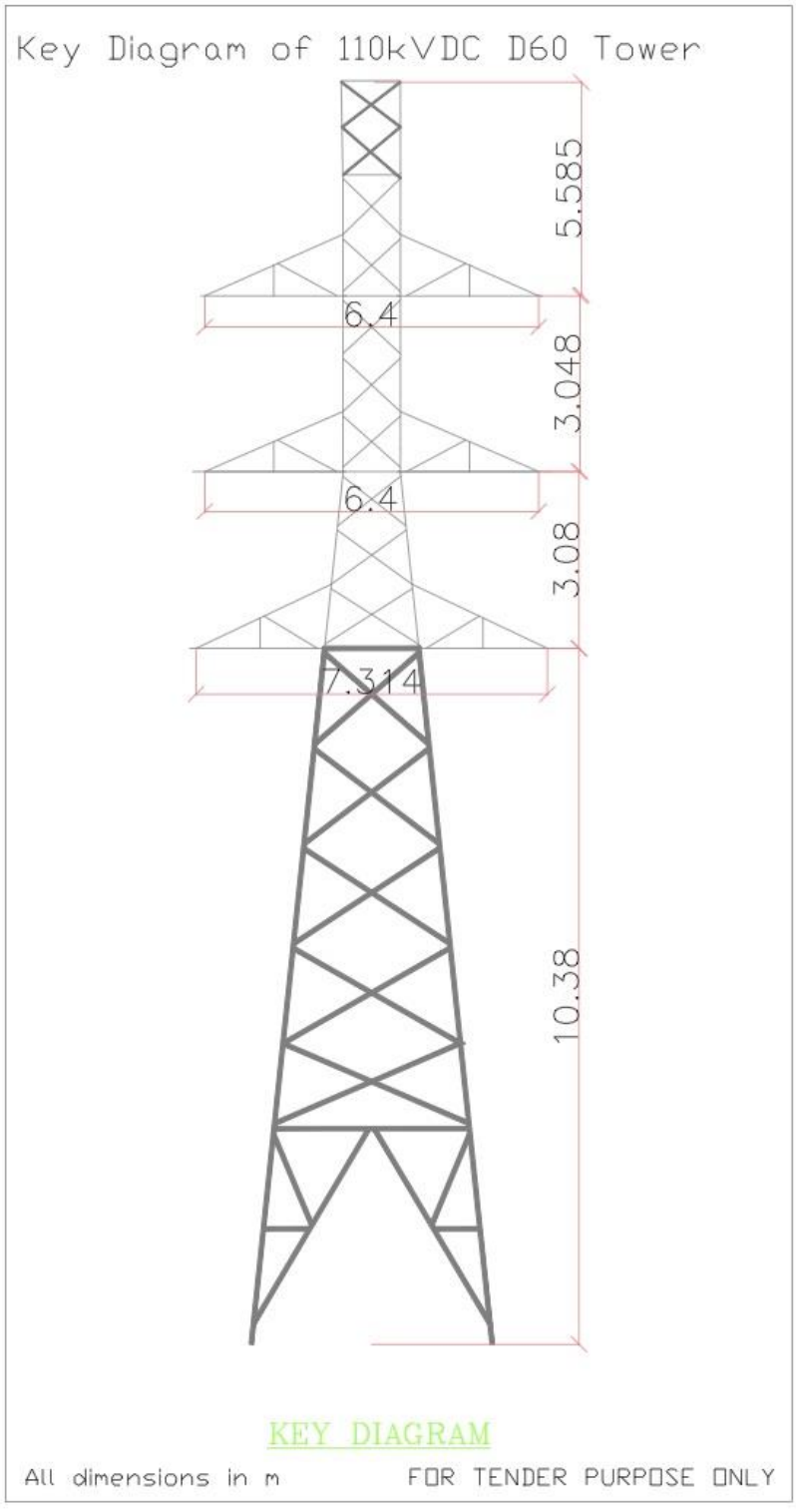

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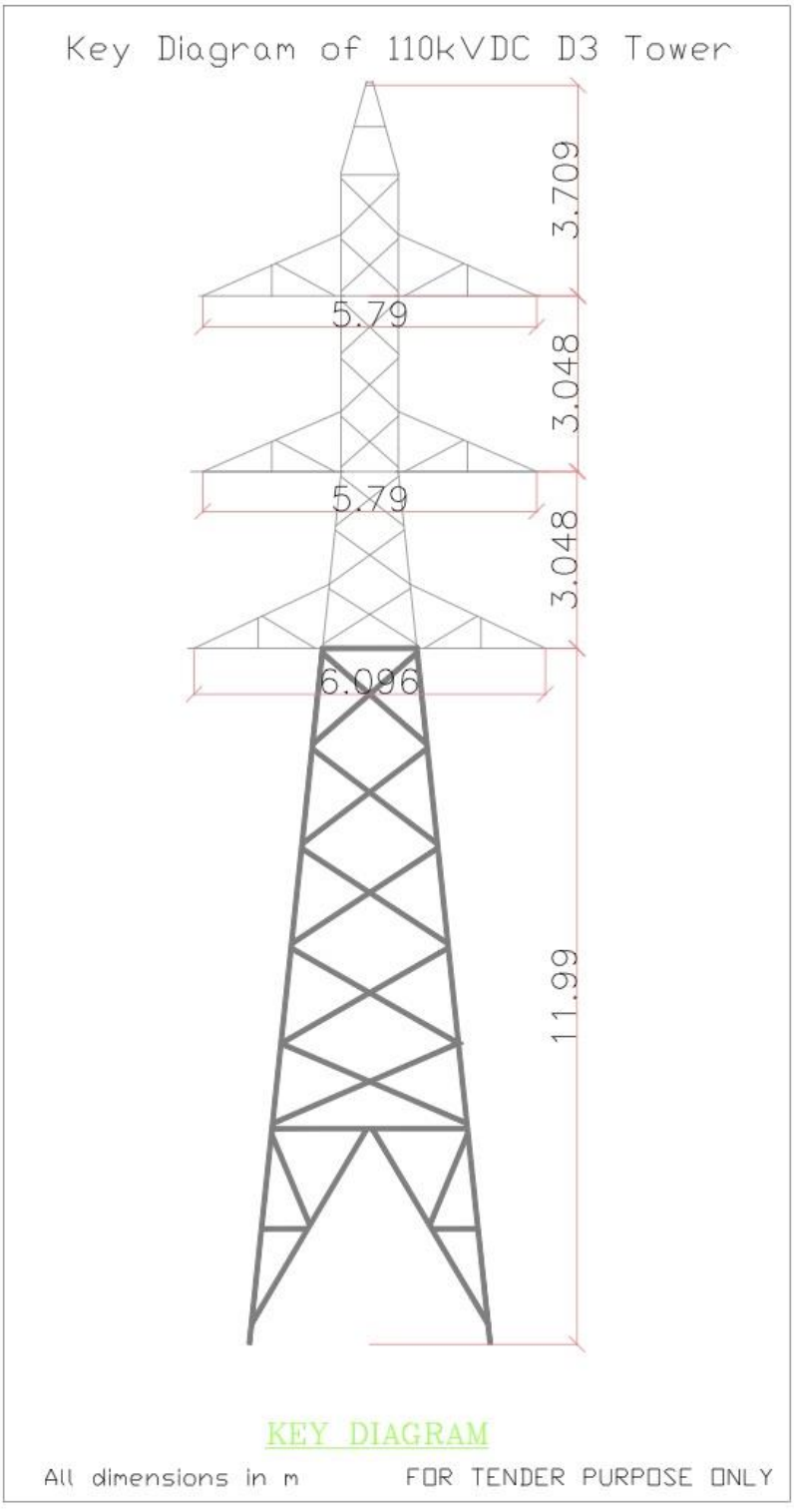

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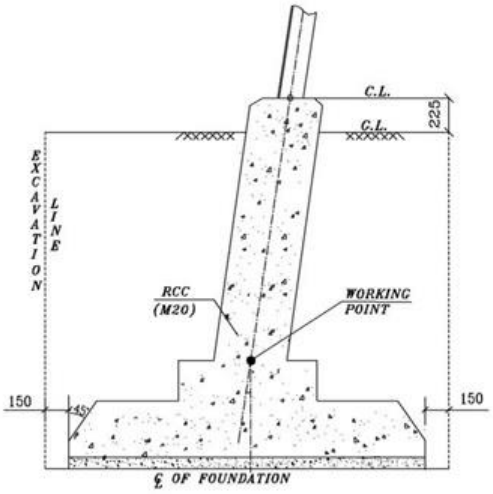
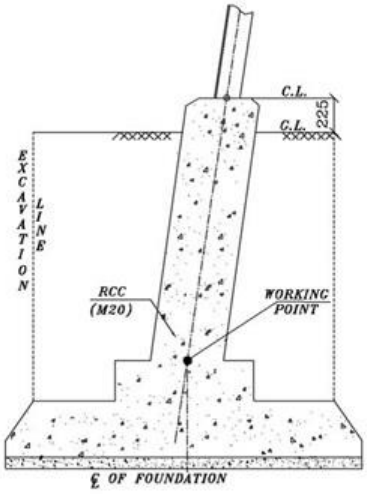


PAD & CHIMNEY FOUNDATION
FOR NORMAL DRY/WET/FS/WBC SOIL



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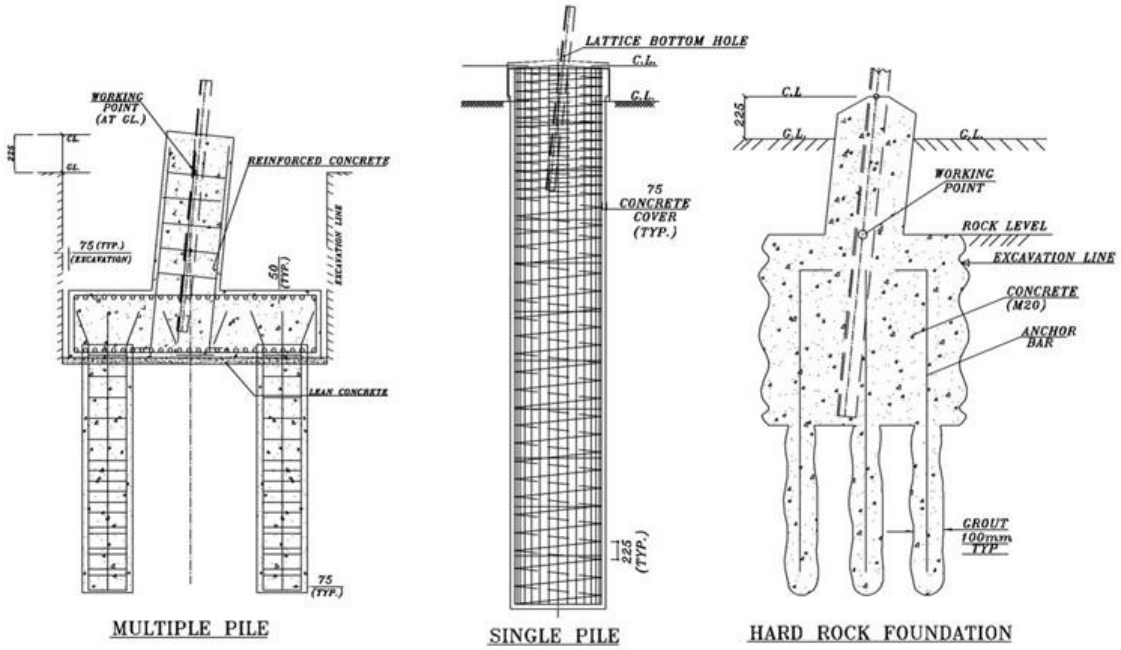
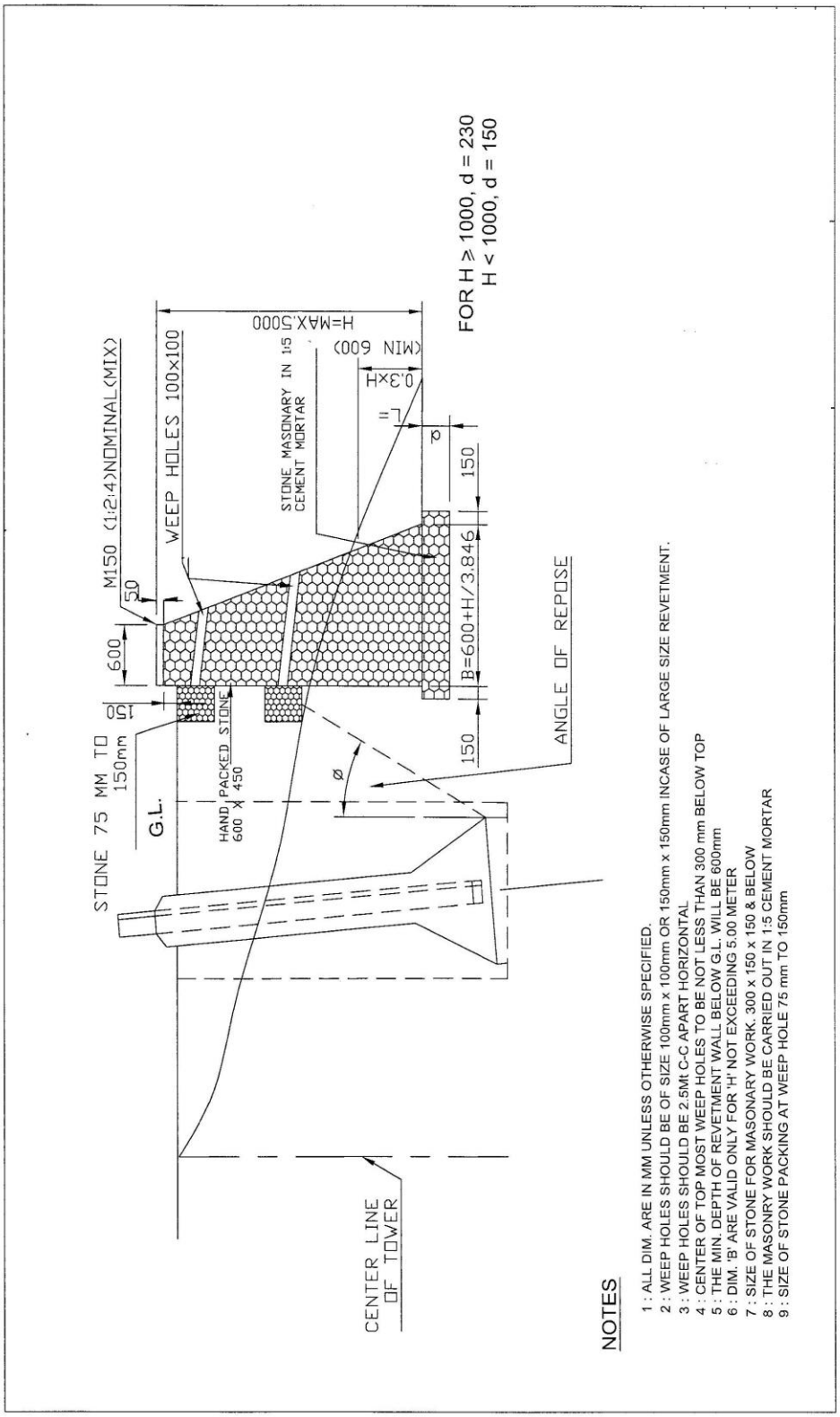
FOR SUBMERGED FISSURED ROCK

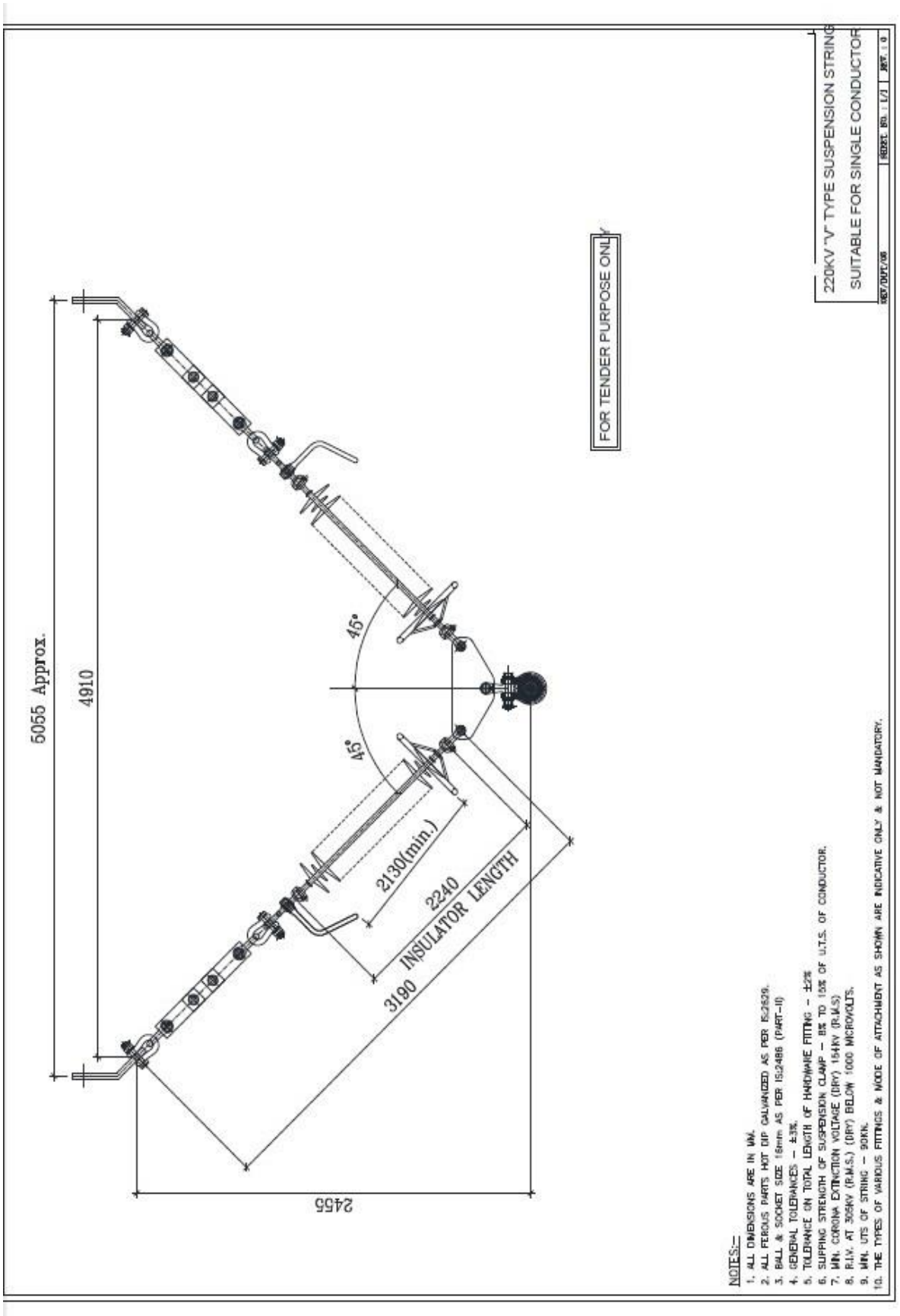


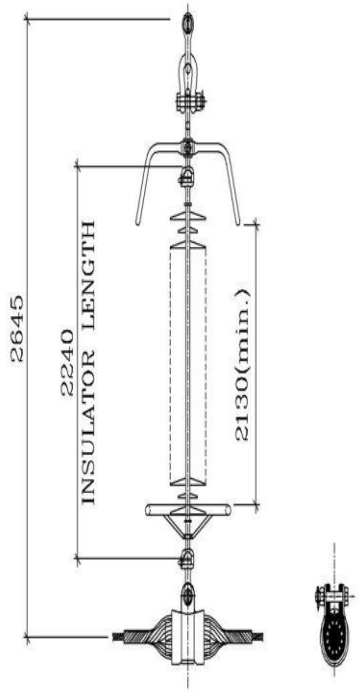
SPECIAL TYPE FOUNDATION

SAMPLE FOUNDATION DRAWINGS

FOR TENDER PURPOSE ONLY


FOR H ≥ 1000, d = 230
H < 1000, d = 150
H=MAX.5000
(MIN 600)
0.3×H
STONE MASONARY IN 1:5 CEMENT MORTAR
WEEP HOLES 100x100
M150 (1:2:4)NOMINAL(MIX)
50
600
150
B=600+H/3.846
150
ANGLE OF REPOSE
ø
STONE 75 MM TO 150mm
G.L.
HAND PACKED STONE 600 X 450
CENTER LINE OF TOWER
NOTES
1 : ALL DIM. ARE IN MM UNLESS OTHERWISE SPECIFIED.
2 : WEEP HOLES SHOULD BE OF SIZE 100mm x 100mm OR 150mm x 150mm INCASE OF LARGE SIZE REVETMENT.
3 : WEEP HOLES SHOULD BE 2.5Mt C-C APART HORIZONTAL
4 : CENTER OF TOP MOST WEEP HOLES TO BE NOT LESS THAN 300 mm BELOW TOP
5 : THE MIN. DEPTH OF REVETMENT WALL BELOW G.L. WILL BE 600mm
6 : DIM. 'B' ARE VALID ONLY FOR 'H' NOT EXCEEDING 5.00 METER
7 : SIZE OF STONE FOR MASONARY WORK. 300 x 150 x 150 & BELOW
8 : THE MASONRY WORK SHOULD BE CARRIED OUT IN 1:5 CEMENT MORTAR
9 : SIZE OF STONE PACKING AT WEEP HOLE 75 mm TO 150mm


FOR TENDER PURPOSE ONLY
220KV "V" TYPE SUSPENSION STRING
SUITABLE FOR SINGLE CONDUCTOR
5055 Approx.
4910
45°
45°
2130(min.)
2240
INSULATOR LENGTH
3190
2455
NOTES:-
1. ALL DIMENSIONS ARE IN MM.
2. ALL FERROUS PARTS HOT DIP GALVANIZED AS PER IS:2629.
3. BALL & SOCKET SIZE 16mm AS PER IS:2486 (PART-II)
4. GENERAL TOLERANCES - ±3%.
5. TOLERANCE ON TOTAL LENGTH OF HARDWARE FITTING - ±2%
6. SLIPPING STRENGTH OF SUSPENSION CLAMP - 8% TO 15% OF U.T.S. OF CONDUCTOR.
7. MIN. CORONA EXTINCTION VOLTAGE (DRY) 154KV (R.M.S)
8. R.I.V. AT 305KV (R.M.S.) (DRY) BELOW 1000 MICROVOLTS.
9. MIN. UTS OF STRING - 90KN.
10. THE TYPES OF VARIOUS FITTINGS & MODE OF ATTACHMENT AS SHOWN ARE INDICATIVE ONLY & NOT MANDATORY.



FOR TENDER PURPOSE ONLY

NOTES:-

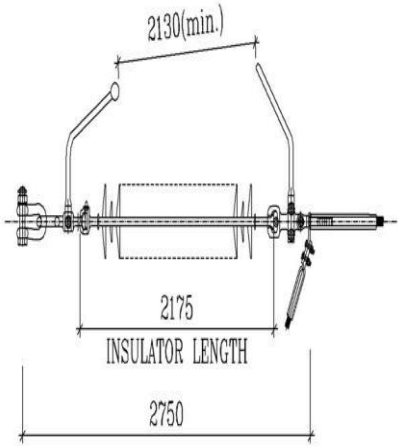
1. ALL DIMENSIONS ARE IN MM.
2. ALL FEROUS PARTS HOT DIP GALVANIZED AS PER IS:2629.
3. BALL & SOCKET SIZE 16mm AS PER IS:2486 (PART-II)
4. GENERAL TOLERANCES - ±3%.
5. TOLERANCE ON TOTAL LENGTH OF HARDWARE FITTING - ±2%
6. SLIPPING STRENGTH OF SUSPENSION CLAMP - 8% TO 15% OF U.T.S. OF CONDUCTOR.
7. MIN. CORONA EXTINCTION VOLTAGE (DRY) 154KV (R.M.S)
8. R.I.V. AT 305KV (R.M.S.) (DRY) BELOW 1000 MICROVOLTS.
9. MIN. UTS OF STRING - 90KN.
10. THE TYPES OF VARIOUS FITTINGS & MODE OF ATTACHMENT AS SHOWN ARE INDICATIVE ONLY & NOT MANDATORY.

KSEB KERALA STATE ELECTRICITY BOARD LTD.

220KV PILOT SUSPENSION STRING

SUITABLE FOR SINGLE CONDUCTOR

DRAWING NO : C228/KSEB/400-220KV/INPT/06	SHEET NO. : 1/1	REV. : 0



FOR TENDER PURPOSE ONLY

NOTES:-

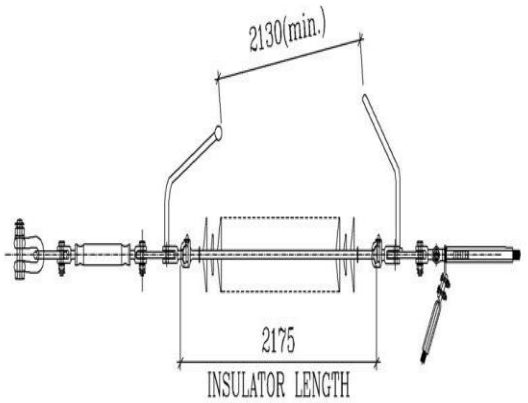
1. ALL DIMENSIONS ARE IN MM.
2. ALL FEROUS PARTS HOT DIP GALVANIZED AS PER IS:2629.
3. BALL & SOCKET SIZE 20mm AS PER IS:2486 (PART-II)
4. GENERAL TOLERANCES - ±3%.
5. TOLERANCE ON TOTAL LENGTH OF HARDWARE FITTING - ±2%
6. SLIPPING STRENGTH OF SUSPENSION CLAMP - 95% OF U.T.S. OF CONDUCTOR.
7. MIN. CORONA EXTINCTION VOLTAGE (DRY) 154KV (R.M.S)
8. R.I.V. AT 305KV (R.M.S.) (DRY) BELOW 1000 MICROVOLTS.
9. MIN. UTS OF STRING - 120KN.
10. THE TYPES OF VARIOUS FITTINGS & MODE OF ATTACHMENT AS SHOWN ARE INDICATIVE ONLY & NOT MANDATORY.

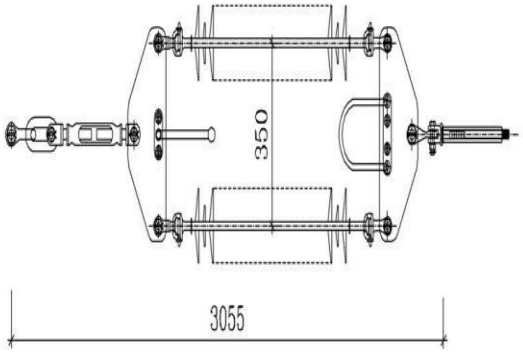
KSEB KERALA STATE ELECTRICITY BOARD LTD.

220KV SINGLE TENSION STRING

SUITABLE FOR SINGLE CONDUCTOR

SHEET NO. : 1/1 | REV. : 0





FOR TENDER PURPOSE ONLY

NOTES:-

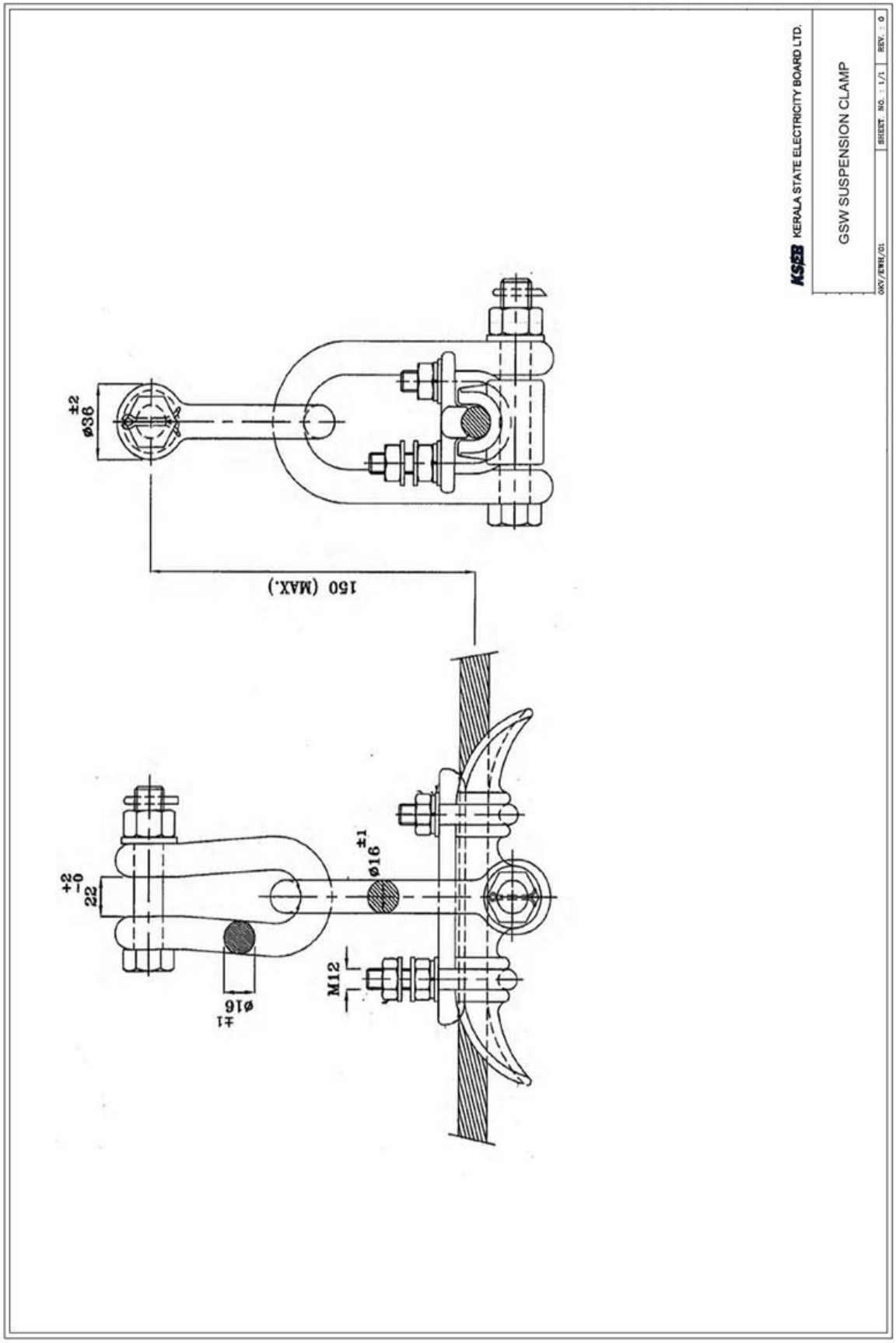
1. ALL DIMENSIONS ARE IN MM.
2. ALL FEROUS PARTS HOT DIP GALVANIZED AS PER IS:2629.
3. BALL & SOCKET SIZE 20mm AS PER IS:2486 (PART-II)
4. GENERAL TOLERANCES - ±3%.
5. TOLERANCE ON TOTAL LENGTH OF HARDWARE FITTING - ±2%
6. SLIPPING STRENGTH OF SUSPENSION CLAMP - 95% OF U.T.S. OF CONDUCTOR.
7. MIN. CORONA EXTINCTION VOLTAGE (DRY) 154KV (R.M.S)
8. R.I.V. AT 305KV (R.M.S.) (DRY) BELOW 1000 MICROVOLTS.
9. MIN. UTS OF STRING - 240KN.
10. THE TYPES OF VARIOUS FITTINGS & MODE OF ATTACHMENT AS SHOWN ARE INDICATIVE ONLY & NOT MANDATORY.

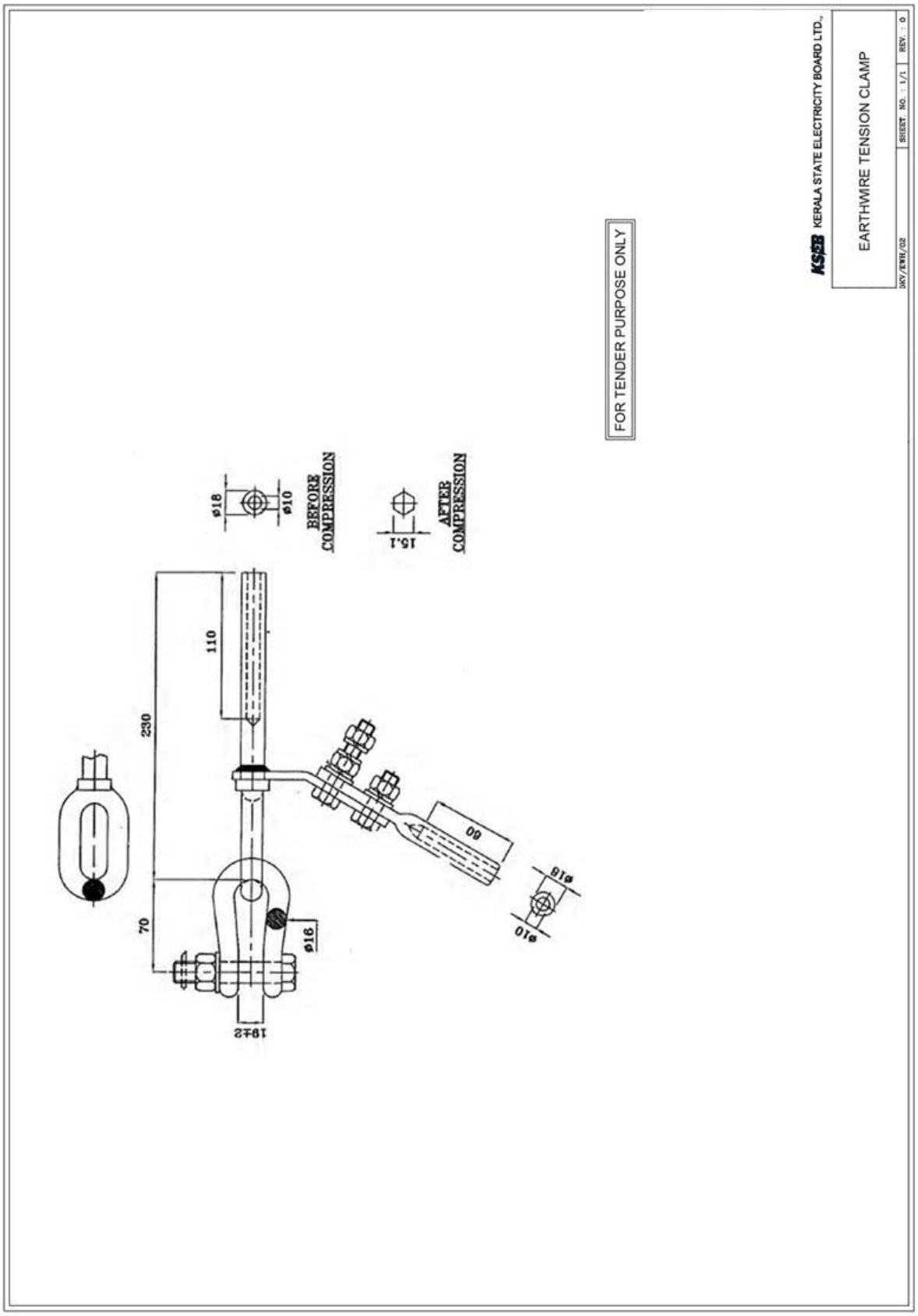
KSEB KERALA STATE ELECTRICITY BOARD LTD.

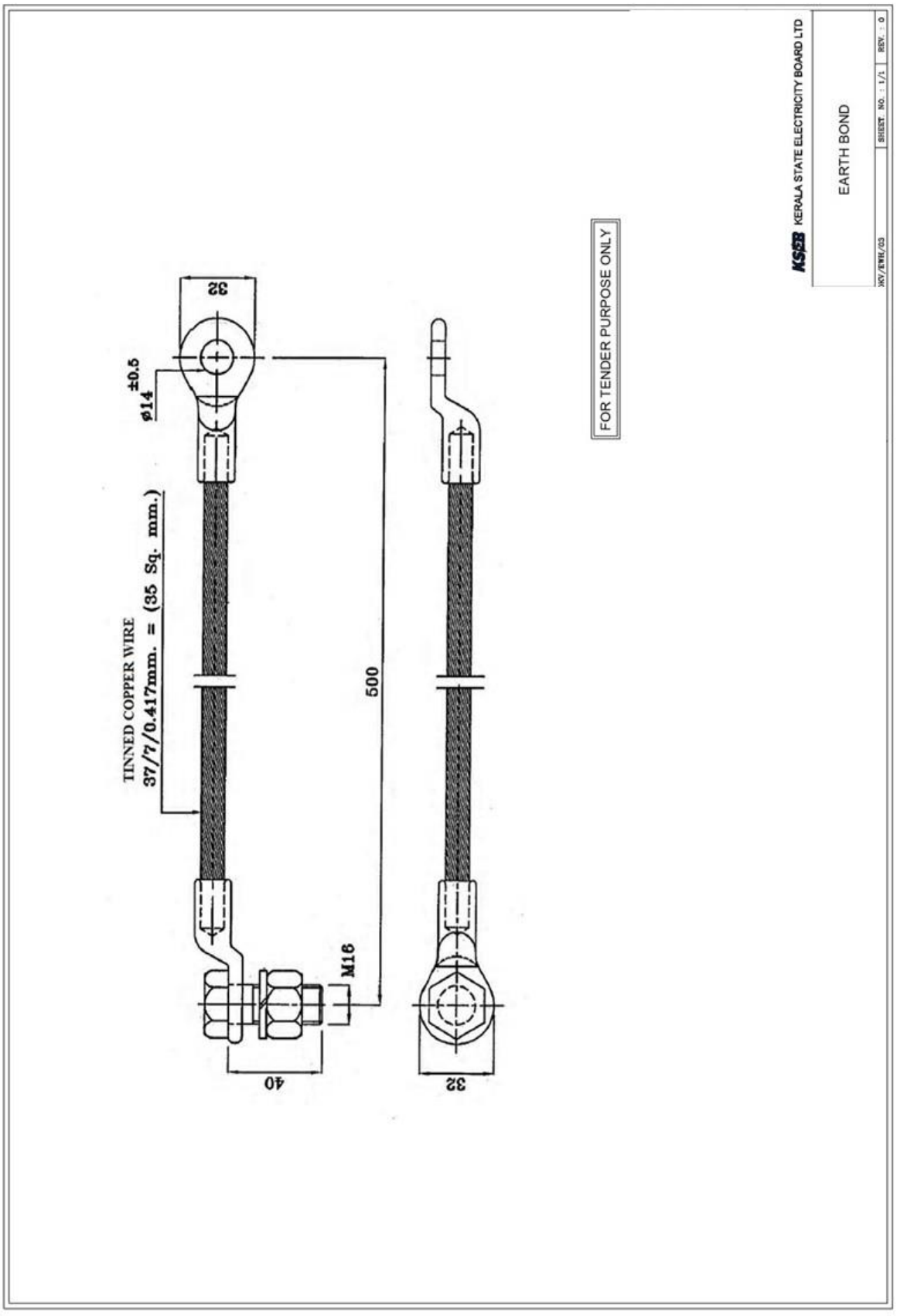
220KV DOUBLE TENSION STRING

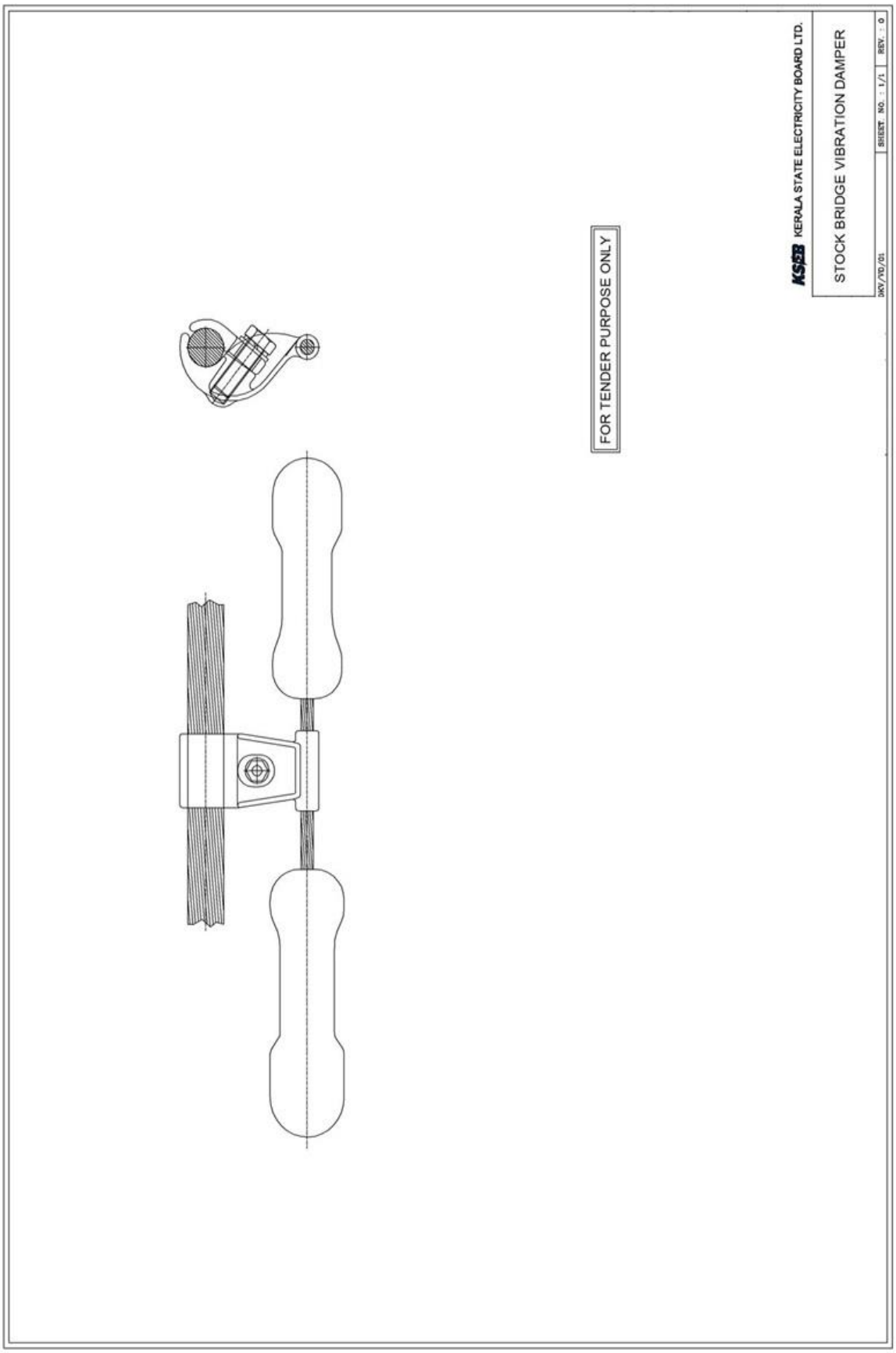
SUITABLE FOR SINGLE CONDUCTOR

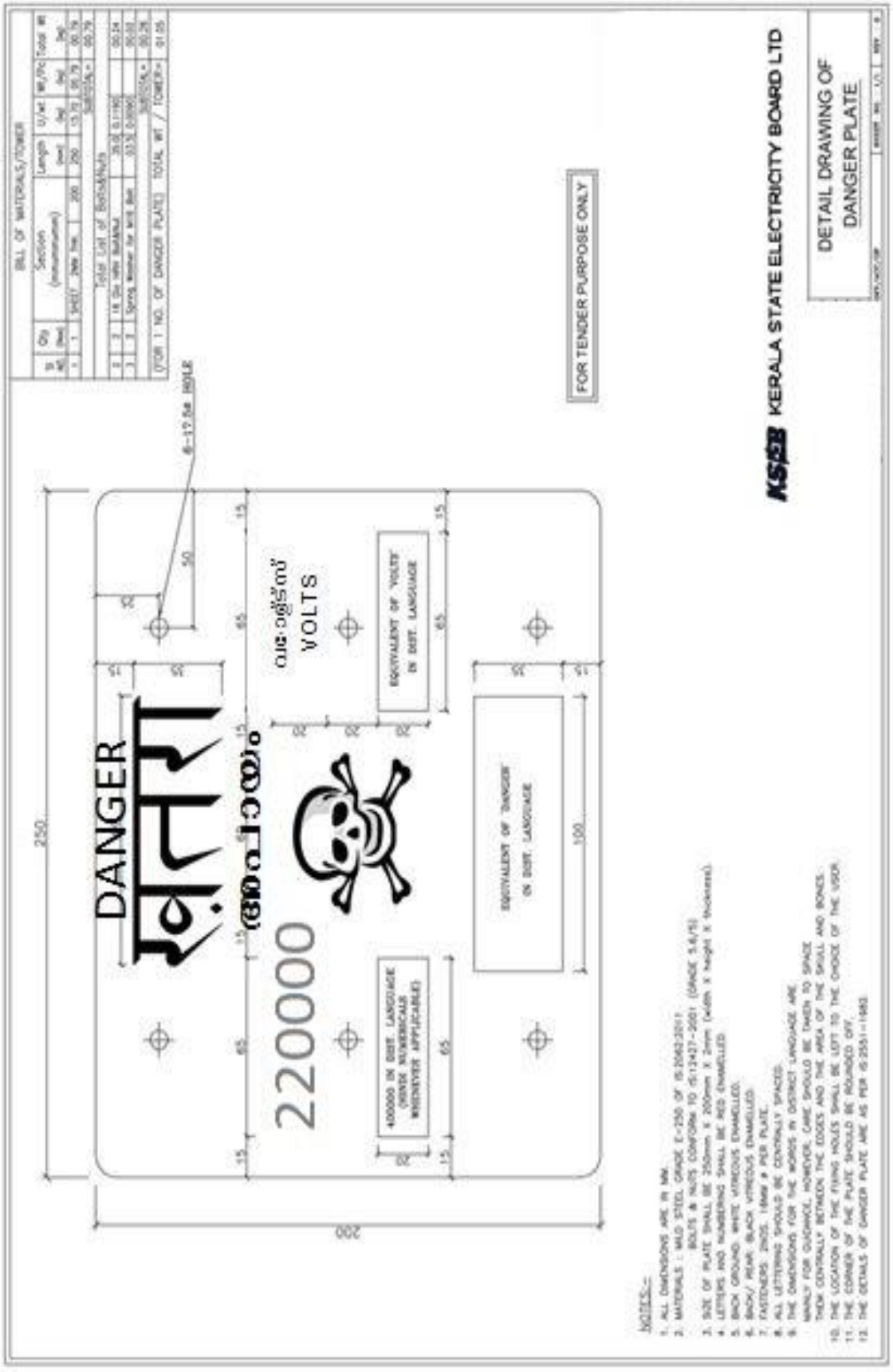
SHEET NO. : 1/1 REV. : 0

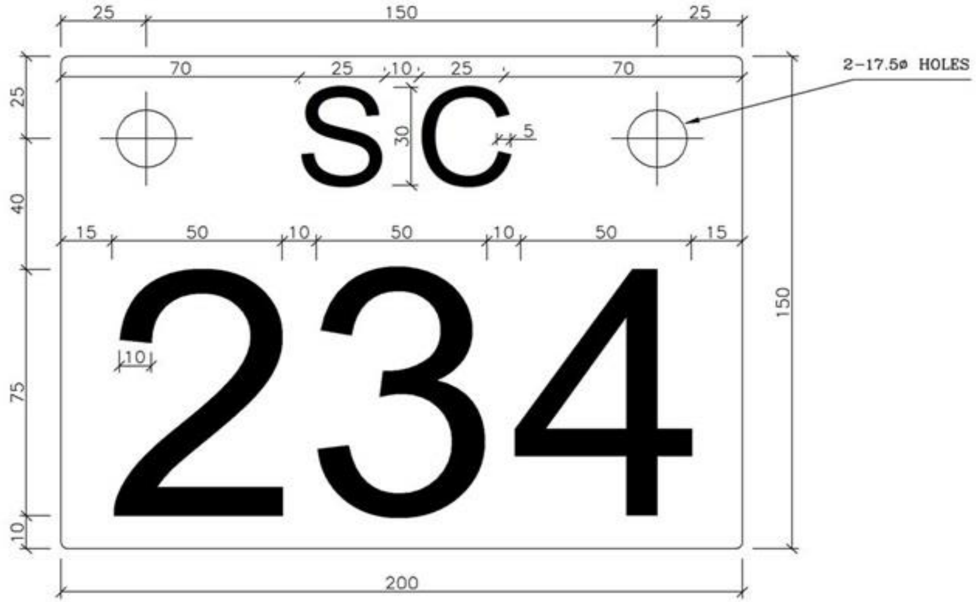

KERALA STATE ELECTRICITY BOARD LTD.
GSW SUSPENSION CLAMP
SHEET NO. : 1/1
REV. : 0
150 (MAX.)
±2
ø36
±1
ø16
+2
-0
22
±1
ø16
M12


KERALA STATE ELECTRICITY BOARD LTD.,
EARTHWIRE TENSION CLAMP
DKV/EWR/02
SHEET NO. : 1/1
REV. : 0
FOR TENDER PURPOSE ONLY
BEFORE COMPRESSION
AFTER COMPRESSION
ø18
ø10
15.1
230
110
70
ø16
60
ø18
ø10


KSEB KERALA STATE ELECTRICITY BOARD LTD
EARTH BOND
KV/EWR/03
SHEET NO. : 1/1
REV. : 0
FOR TENDER PURPOSE ONLY
32
ø14 ±0.5
TINNED COPPER WIRE
37/7/0.417mm. = (35 Sq. mm.)
500
M16
40
32


KERALA STATE ELECTRICITY BOARD LTD.
STOCK BRIDGE VIBRATION DAMPER
DKV/VD/01
SHEET NO. : 1/1
REV. : 0
FOR TENDER PURPOSE ONLY


DANGER
220000
VOLTS
FOR TENDER PURPOSE ONLY
KERALA STATE ELECTRICITY BOARD LTD
DETAIL DRAWING OF DANGER PLATE



BILL OF MATERIALS/TOWER

Sl NO.	Qty (Nos)	Section (mmxmmxmm)		Length (mm)	U/wt (kg)	Wt/Pc (kg)	Total Wt (kg)
1	1	SHEET 2MM THK.	150	200	15.70	00.47	00.47
						SUBTOTAL=	00.47
Total List of Bolts&Nuts							
2	2	16 Dia HRH Bolt&Nut		35.0	0.1190		00.24
3	2	Spring Washer for M16 Bolt		03.5	0.0090		00.02
						SUBTOTAL=	00.26
(FOR 1 NO. OF NUMBER PLATE) TOTAL WT / TOWER=							00.73

FOR TENDER PURPOSE ONLY

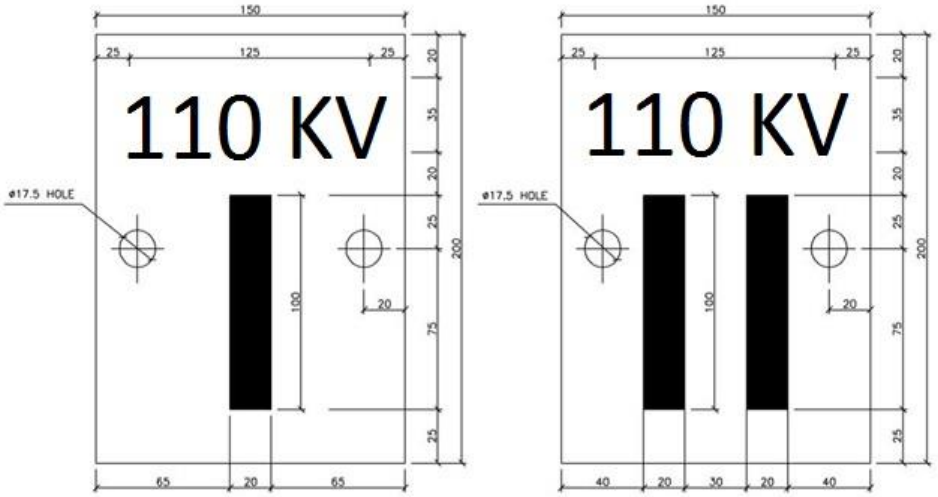
NOTES:-

1. ALL DIMENSIONS ARE IN MM.
2. MATERIALS : MILD STEEL GRADE E-250 OF IS:2062:2011
   BOLTS & NUTS CONFORM TO IS:12427-2001 (GRADE 5.6/5)
3. SIZE OF PLATE SHALL BE 200mm X 150mm X 2mm.
4. LETTERS AND NUMBERING SHALL BE RED ENAMELLED.
5. BACK GROUND: WHITE VITREOUS ENAMELLED.
6. BACK/ REAR: BLACK VITREOUS ENAMELLED.
7. FASTENERS: 2NOS. 16MM ø PER PLATE.
8. 'SC' REPRESENTS FIRST LETTER OF STARTING & ENDING PLACE OF LINE.
9. '234' REPRESENTS TOWER NOS.
10. THE CORNER OF THE PLATE SHOULD BE ROUNDED OFF.
11. DRAWING IS MADE AS PER IS:5613 (PART3/SEC I) -1989.

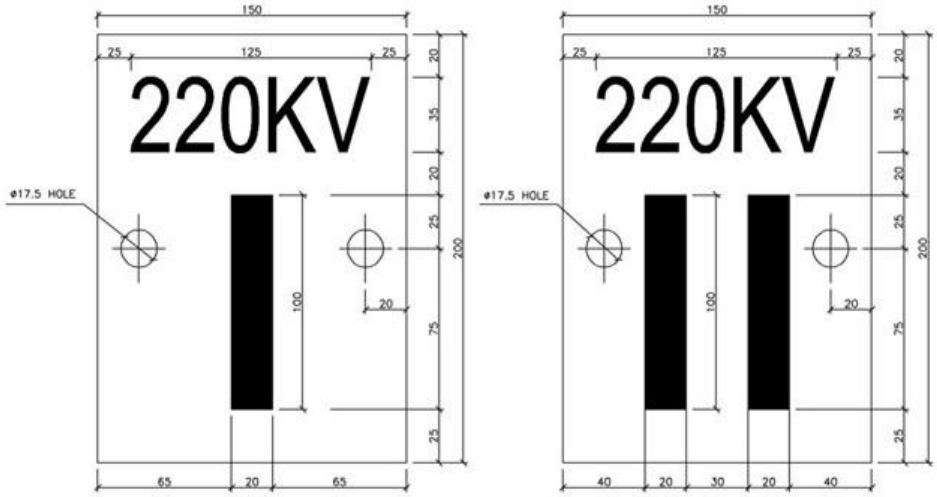
KSEB KERALA STATE ELECTRICITY BOARD LTD.

DETAIL DRAWING OF NUMBER PLATE

DKV/ACC/NP | SHEET NO. : 1/1 | REV. : 0



CIRCUIT PLATES FOR 110 KV



CIRCUIT PLATES FOR 220KV

BILL OF MATERIALS/TOWER							
Sl NO.	Qty (Nos)	Section (mmxmmxmm)	Length (mm)	U/wt (kg)	Wt/Pc (kg)	Total Wt (kg)
1	4	SHEET 2MM THK.	150 200	13.70	00.47	01.88
					SUBTOTAL=	01.88
Total List of Bolts&Nuts						
2	8	16 Dia HRH Bolt&Nut	35.0	0.1190		00.952
3	8	Spring Washer for M16 Bolt	03.5	0.0090		00.072
					SUBTOTAL=	01.024
(FOR 4 NOS. OF CIRCUIT PLATE) TOTAL WT / TOWER=						02.904

FOR TENDER PURPOSE ONLY

NOTES:-

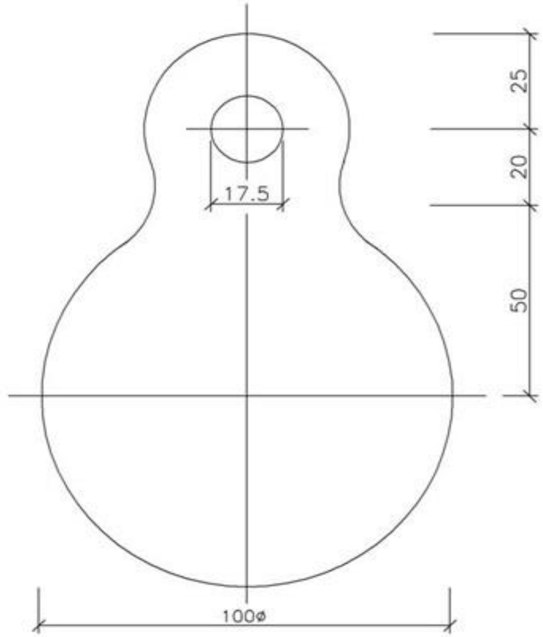
1. ALL DIMENSIONS ARE IN MM.
2. MATERIALS :
   MILD STEEL GRADE E-250 OF IS:2062:2011
   16ø BOLTS & NUTS CONFORM TO IS:12427-2001 (GRADE 5.6/S)
   BOLT SET: ONE BOLT+ONE NUT+ONE SPRING WASHER.
3. SIZE OF PLATE SHALL BE 200mm X 150mm X 2mm.
4. LETTERS SHALL BE RED ENAMELLED.
5. BACK GROUND: WHITE VITREOUS ENAMELLED.
6. BACK/REAR: BLACK VITREOUS ENAMELLED.
7. ALL LETTERS SHOULD BE CENTRALLY SPACED.
8. ONE SET CONSISTS OF 4 SUCH PLATES, TWO WITH MARKINGS 'I' & TWO WITH MARKING 'II' FOR 400 & 220kV CIRCUIT.
9. THE CORNER OF THE PLATE SHOULD BE ROUNDED OFF.

KSEB KERALA STATE ELECTRICITY BOARD LTD.

DETAIL DRAWING OF CIRCUIT PLATE

BILL OF MATERIALS/SET

Sl NO.	Qty (Nos)	Section (mmxmmxmm)		Length (mm)	U/wt (kg)	Wt/Pc (kg)	Total Wt (kg)
1	12	SHEET 2MM THK.	100	145	15.70	00.23	02.76
						SUBTOTAL=	02.76
Total List of Bolts&Nuts							
2	12	16 Dia HRH Bolt&Nut		35.0	0.1190		01.428
3	12	Spring Washer for M16 Bolt		03.5	0.0090		00.108
						SUBTOTAL=	01.536
(FOR 3 NOS. OF PHASE PLATES) TOTAL WT / SET =							04.29



FOR TENDER PURPOSE ONLY

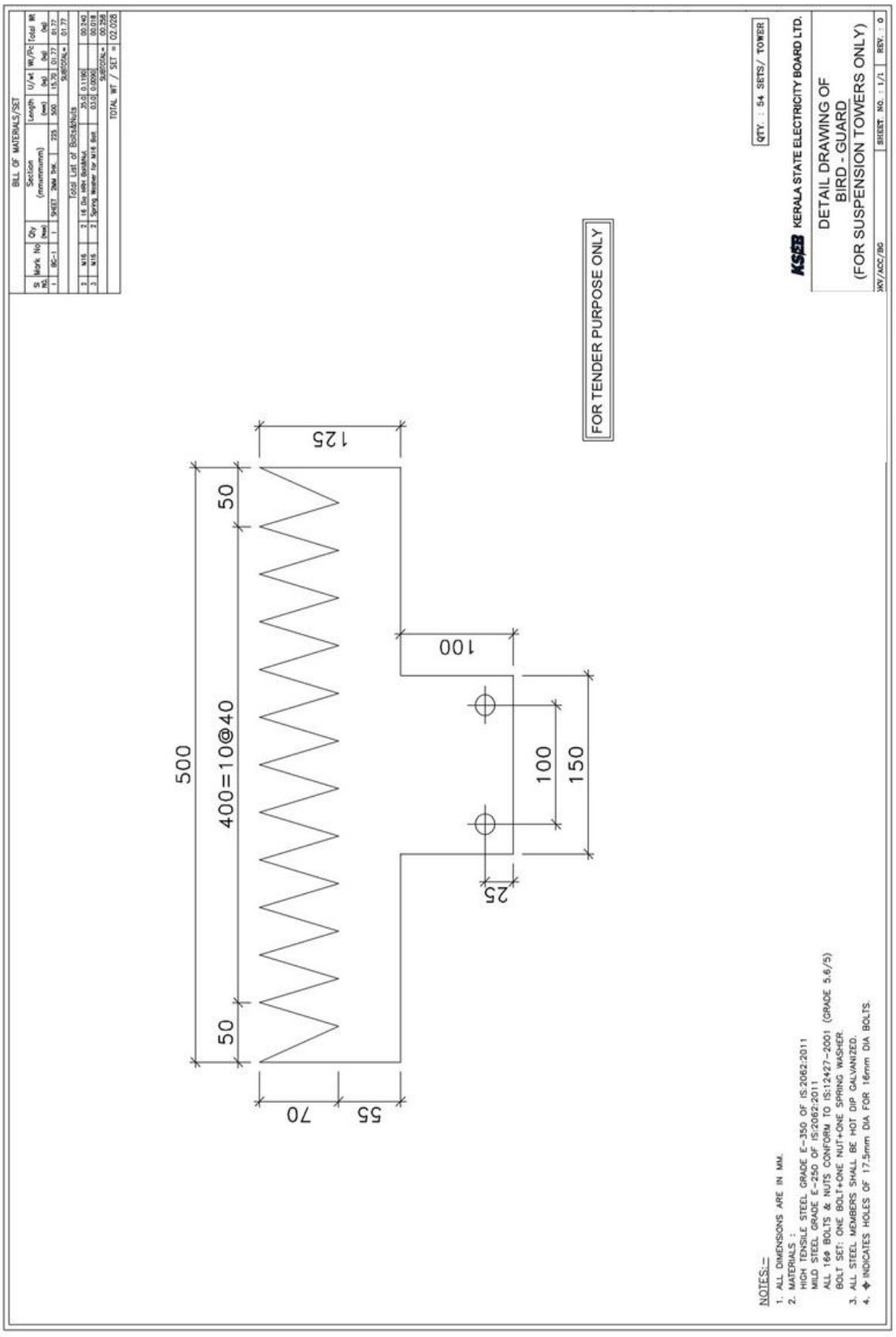
NOTES:-

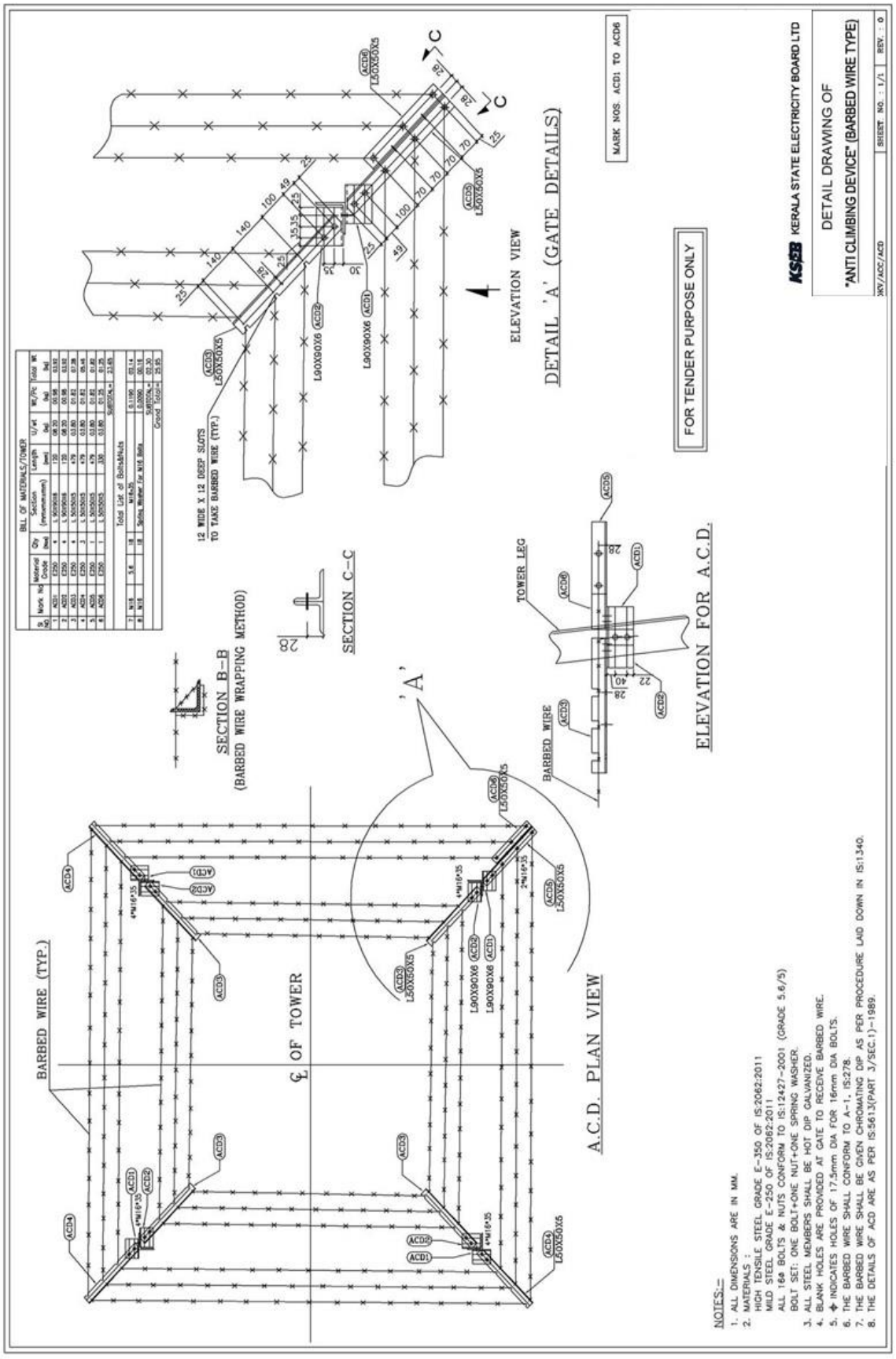
1. ALL DIMENSIONS ARE IN MM.
2. MATERIALS :
   MILD STEEL GRADE E-250 OF IS:2062:2011
   BOLTS & NUTS 16ø - GRADE 5.6/5 (IS: 12427-2001)
3. DRAWING IS MADE AS PER IS:5613 (PART3/SEC I) -1989.
4. SIZE OF PLATE SHALL BE 145mm X 100mm X 2mm.
5. FOUR SETS EACH CONSISTING OF 3 PLATES HAVING RED, BLUE & YELLOW COLOURS. TWO FOR 400KV & TWO FOR 220KV CKT.
6. FRONT: WITH COLOUR AS PER NOTE 5.
7. BACK/REAR: BLACK VITREOUS ENAMELLED.

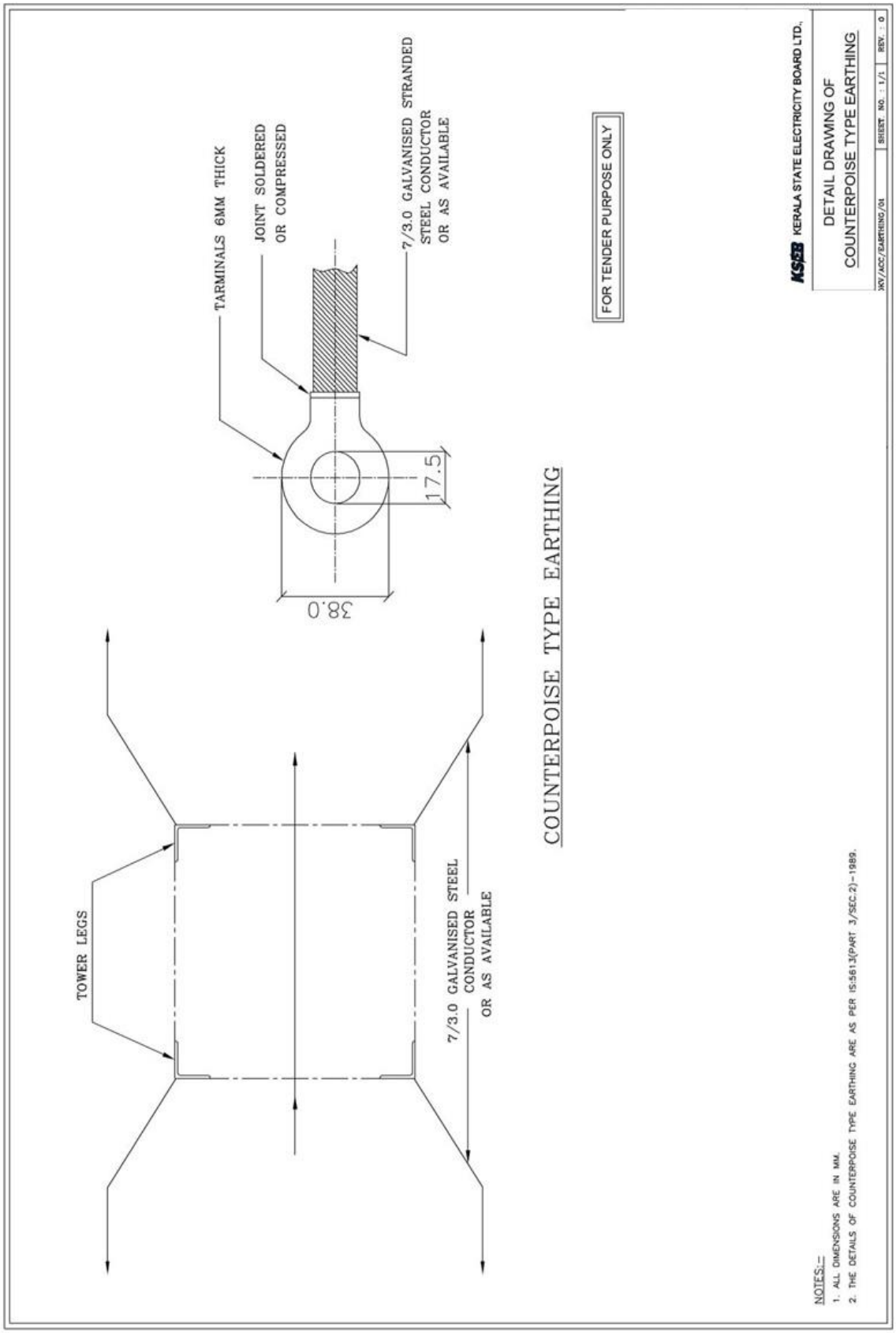
KSEB KERALA STATE ELECTRICITY BOARD LTD.,

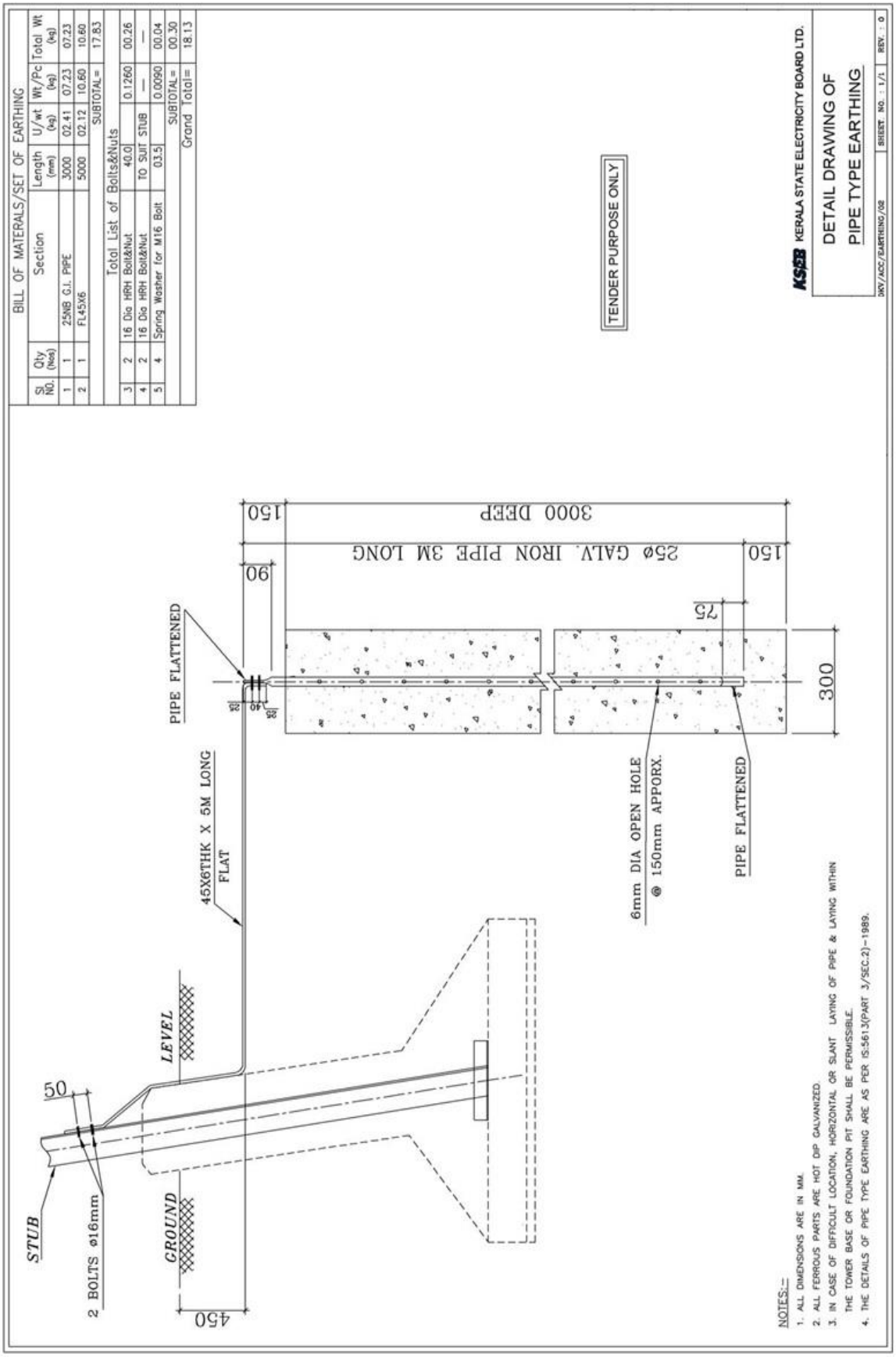
DETAIL DRAWING OF PHASE PLATE

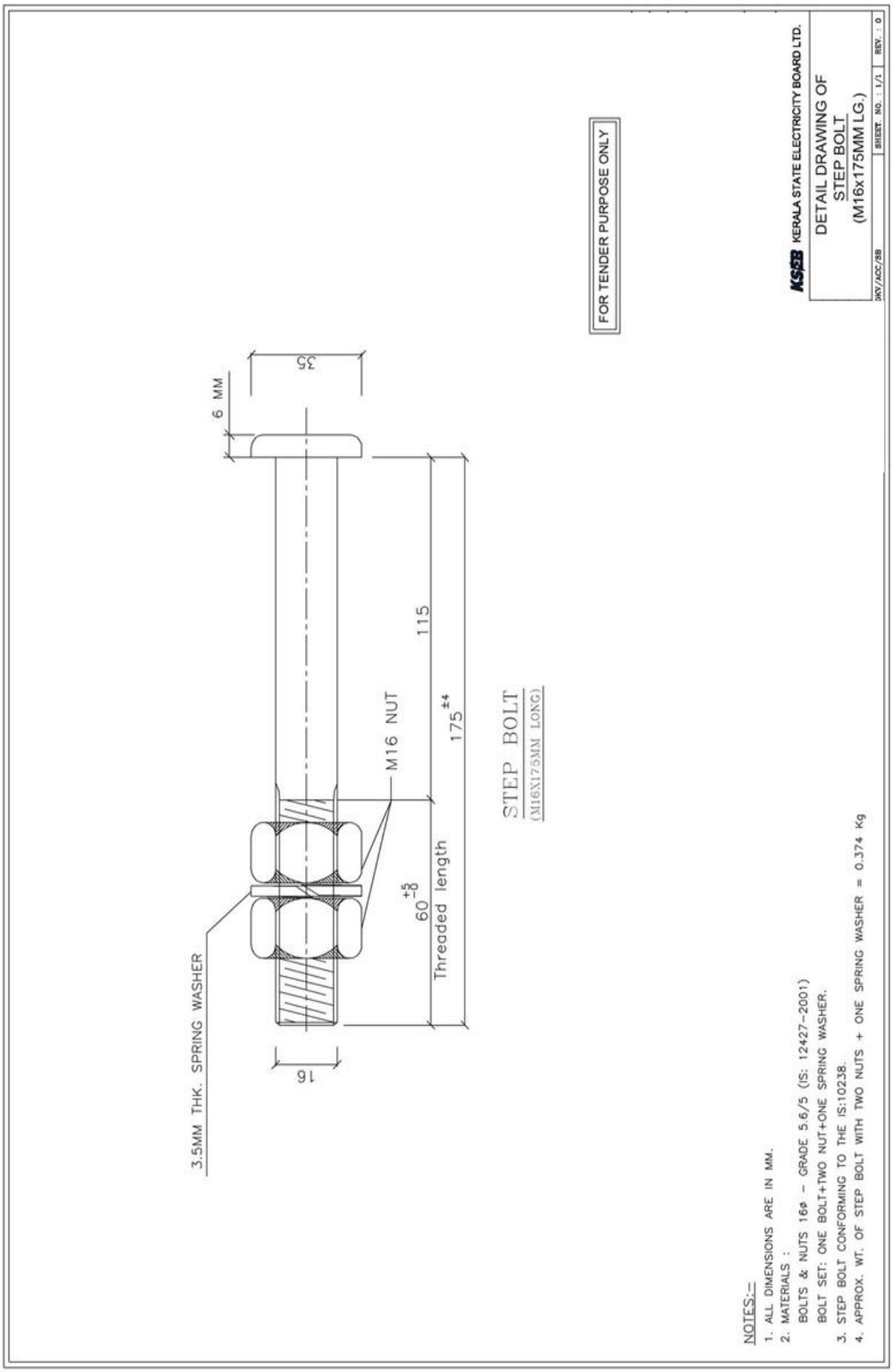
DKV/ACC/PP | SHEET. NO. : 1/1 | REV. : 0

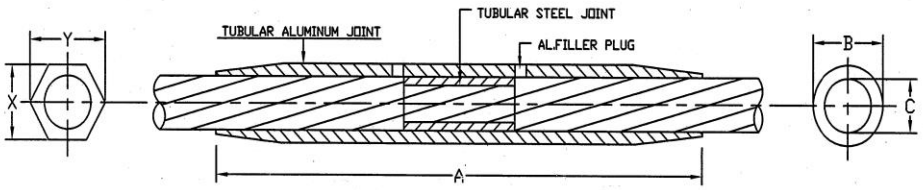

BILL OF MATERIALS/SET
Sl No.
Mark No
Qty (Nos)
Section (mmxmmxmm)
Length (mm)
U/wt (kg)
Wt./Pc (kg)
Total Wt (kg)
1 BC-1 1 SHEET 2MM THK. 225 500 15.75 01.77 01.77
SUBTOTAL= 01.77
Add Left of BOM&Nuts
2 M16 2 16 Dia WASHER PLATE 25 @ 0.1190 00.240
3 M16 1 Spring Washer for M16 Bolt 03.00 0.0090 00.018
SUBTOTAL= 00.258
TOTAL WT / SET = 02.028
FOR TENDER PURPOSE ONLY
QTY. : 54 SETS/ TOWER
KSEB KERALA STATE ELECTRICITY BOARD LTD.
DETAIL DRAWING OF BIRD - GUARD (FOR SUSPENSION TOWERS ONLY)
KKV/ACC/BG
SHEET NO. : 1/1
REV. : 0
NOTES:-
1. ALL DIMENSIONS ARE IN MM.
2. MATERIALS :
HIGH TENSILE STEEL GRADE E-350 OF IS:2062:2011
MILD STEEL GRADE E-250 OF IS:2062:2011
ALL 16ø BOLTS & NUTS CONFORM TO IS:12427-2001 (GRADE 5.6/5)
BOLT SET: ONE BOLT+ONE NUT+ONE SPRING WASHER.
3. ALL STEEL MEMBERS SHALL BE HOT DIP GALVANIZED.
4. ✣ INDICATES HOLES OF 17.5mm DIA FOR 16mm DIA BOLTS.
500
400=10@40
50
50
125
100
100
150
25
70
55


BILL OF MATERIALS/TOWER
Total List of Bolts&Nuts
MARK NOS. ACD1 TO ACD6
FOR TENDER PURPOSE ONLY
KERALA STATE ELECTRICITY BOARD LTD
DETAIL DRAWING OF
"ANTI CLIMBING DEVICE" (BARBED WIRE TYPE)
SKY/ACC/ACD
SHEET NO. : 1/1
REV. : 0
DETAIL 'A' (GATE DETAILS)
ELEVATION VIEW
12 WIDE X 12 DEEP SLOTS TO TAKE BARBED WIRE (TYP.)
L90X90X6 (ACD1)
L60X50X6 (ACD2)
L60X50X5 (ACD3)
L60X50X5 (ACD4)
L60X50X5 (ACD5)
L60X50X5 (ACD6)
SECTION B-B (BARBED WIRE WRAPPING METHOD)
SECTION C-C
ELEVATION FOR A.C.D.
TOWER LEG
BARBED WIRE
A.C.D. PLAN VIEW
BARBED WIRE (TYP.)
℄ OF TOWER
NOTES:-
1. ALL DIMENSIONS ARE IN MM.
2. MATERIALS :-
HIGH TENSILE STEEL GRADE E-350 OF IS:2062:2011
MILD STEEL GRADE E-250 OF IS:2062:2011
ALL 16ø BOLTS & NUTS CONFORM TO IS:12427-2001 (GRADE 5.6/5)
BOLT SET: ONE BOLT+ONE NUT+ONE SPRING WASHER.
3. ALL STEEL MEMBERS SHALL BE HOT DIP GALVANIZED.
4. BLANK HOLES ARE PROVIDED AT GATE TO RECEIVE BARBED WIRE.
5. ✚ INDICATES HOLES OF 17.5mm DIA FOR 16mm DIA BOLTS.
6. THE BARBED WIRE SHALL CONFORM TO A-1, IS:278.
7. THE BARBED WIRE SHALL BE GIVEN CHROMATING DIP AS PER PROCEDURE LAID DOWN IN IS:1340.
8. THE DETAILS OF ACD ARE AS PER IS:5613(PART 3/SEC.1)-1989.

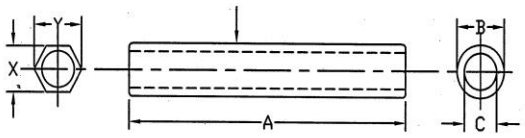

TARMINALS 6MM THICK
JOINT SOLDERED OR COMPRESSED
7/3.0 GALVANISED STRANDED STEEL CONDUCTOR OR AS AVAILABLE
17.5
38.0
TOWER LEGS
7/3.0 GALVANISED STEEL CONDUCTOR OR AS AVAILABLE
COUNTERPOISE TYPE EARTHING
FOR TENDER PURPOSE ONLY
KSEB KERALA STATE ELECTRICITY BOARD LTD.
DETAIL DRAWING OF COUNTERPOISE TYPE EARTHING
KKV/ACC/EARTHING/01
SHEET NO. : 1/1
REV. 0
NOTES:-
1. ALL DIMENSIONS ARE IN MM.
2. THE DETAILS OF COUNTERPOISE TYPE EARTHING ARE AS PER IS:5613(PART 3/SEC.2)-1989.


BILL OF MATERALS/SET OF EARTHING
Sl NO. | Qty (Nos) | Section | Length (mm) | U/wt (kg) | Wt/Pc (kg) | Total Wt (kg)
1 | 1 | 25NB G.I. PIPE | 3000 | 02.41 | 07.23 | 07.23
2 | 1 | FL45X6 | 5000 | 02.12 | 10.60 | 10.60
SUBTOTAL= 17.83
Total List of Bolts&Nuts
3 | 2 | 16 Dia HRH Bolt&Nut | 40.0 | 0.1260 | 00.26
4 | 2 | 16 Dia HRH Bolt&Nut | TO SUIT STUB | — | —
5 | 4 | Spring Washer for M16 Bolt | 03.5 | 0.0090 | 00.04
SUBTOTAL= 00.30
Grand Total= 18.13
TENDER PURPOSE ONLY
KSEB KERALA STATE ELECTRICITY BOARD LTD.
DETAIL DRAWING OF PIPE TYPE EARTHING
DKV/AOC/EARTHING/02 SHEET NO. : 1/1 REV. : 0
150
3000 DEEP
150
25ø GALV. IRON PIPE 3M LONG
90
75
PIPE FLATTENED
300
45X6THK X 5M LONG FLAT
6mm DIA OPEN HOLE @ 150mm APPORX.
PIPE FLATTENED
LEVEL
50
STUB
2 BOLTS ø16mm
GROUND
450
NOTES:-
1. ALL DIMENSIONS ARE IN MM.
2. ALL FERROUS PARTS ARE HOT DIP GALVANIZED.
3. IN CASE OF DIFFICULT LOCATION, HORIZONTAL OR SLANT LAYING OF PIPE & LAYING WITHIN THE TOWER BASE OR FOUNDATION PIT SHALL BE PERMISSIBLE.
4. THE DETAILS OF PIPE TYPE EARTHING ARE AS PER IS:561.3(PART 3/SEC.2)-1989.


KERALA STATE ELECTRICITY BOARD LTD.
DETAIL DRAWING OF
STEP BOLT
(M16x175MM LG.)
DRV/ACC/SB
SHEET NO. : 1/1
REV. : 0
FOR TENDER PURPOSE ONLY
STEP BOLT
(M16X175MM LONG)
6 MM
35
M16 NUT
115
175 ±4
60 +5 -8
Threaded length
16
3.5MM THK. SPRING WASHER
NOTES:-
1. ALL DIMENSIONS ARE IN MM.
2. MATERIALS :
BOLTS & NUTS 16ø - GRADE 5.6/5 (IS: 12427-2001)
BOLT SET: ONE BOLT+TWO NUT+ONE SPRING WASHER.
3. STEP BOLT CONFORMING TO THE IS:10238.
4. APPROX. WT. OF STEP BOLT WITH TWO NUTS + ONE SPRING WASHER = 0.374 Kg



S.No.	CONDUCTOR	DIA.	A	B	C	X	Y	APP.WT. IN KG.
1.	PANTHER	21.00	610	38	23	32	37	1.160

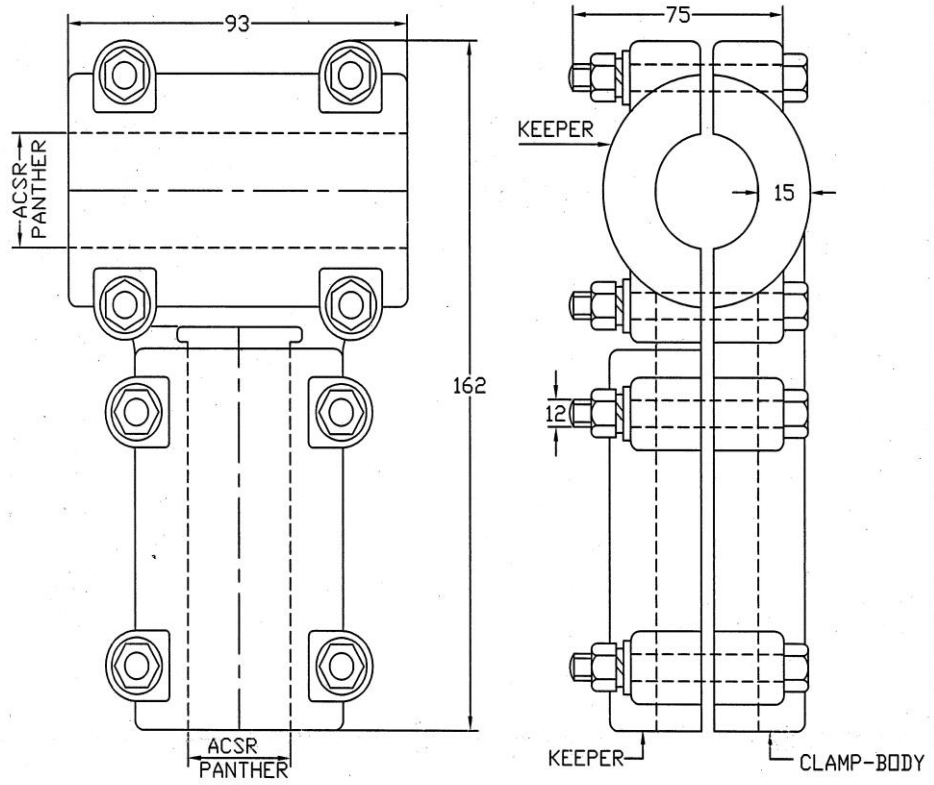


S.No.	CONDUCTOR	DIA.	A	B	C	X	Y	APP.WT. IN KG.
1.	PANTHER	9.0	200	18.0	9.3	15.1	17.4	0.280

NOTE:-

1. ALL DIMENSIONS ARE IN MM'S.
2. TOLERANCE:- ±2%.
3. STEEL JOINT IS H.D.G. AS PER IS:2633/1986.
4. BREAKING STTRENGTH:-100% OF U.T.S. OF THE CONDUCTOR.
5. MID SPAN JOINT CONFORMS TO AS PER IS:2121/Pt-II/1981.
6. MATERIAL:-EXTRUDED AL. PIPE & MILD STEEL.
7. RESISTANCE:-BELOW 75% OF THE EQUIVALENT LENGTH OF COND.
8. SLIP STRENGTH:-NOT LESS THAN 95% OF U.T.S. OF CONDUCTOR.

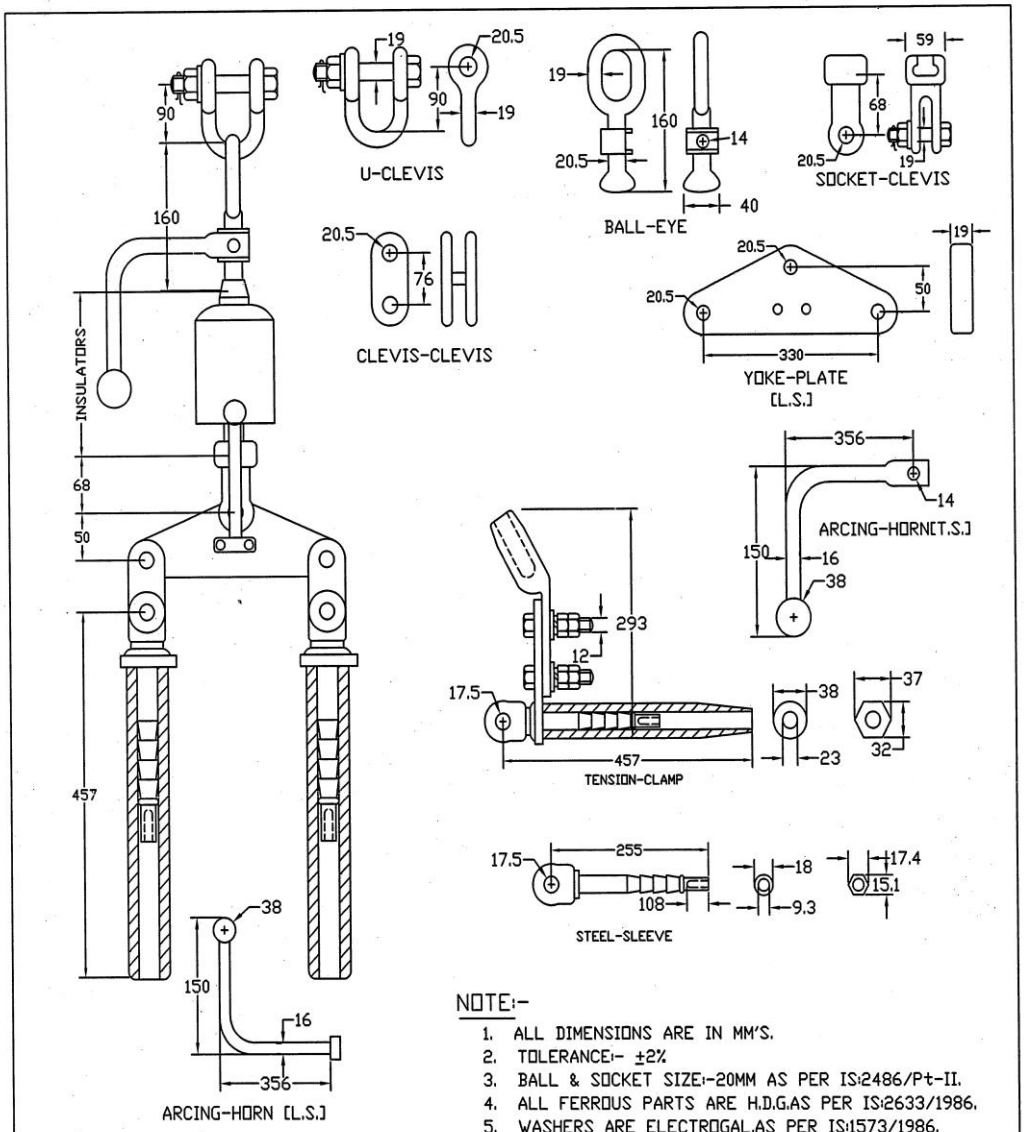
MID SPAN COMPRESION JOINT FOR ACSR PANTHER



1. ALL DIMENSIONS ARE IN MM'S.
2. TOLERANCE:- ±2%.
3. ALL FERROUS PARTS ARE H.D.G.AS PER IS:2633/1986.
4. SP. WASHERS ARE ELECTROGAL.AS PER IS:1573/1986.
5. CONNECTOR CONFORMS TO AS PER IS:5561/1970.
6. TOTAL APP.WEIGHT OF AL.ALLOY : 1.1 KG & STEEL : 0.8 KG..
7. MIN. THICKNESS OF CLAMP BODY & KEEPER : 15 MM.
8. BOLT TIGHTENING TORQUE : 3KG M.
9. MAX. TEMP. RISE : WITHIN 35 DEGREE C @ 50 DEGREE C AMBIENT. SHORT CIRCUIT CAPACITY : 31.5 KA FOR 1 SEC.

S.No.	DESCRIPTION	MATERIAL	QTY.
1.	CLAMP-BODY	AL-ALLOY-LM6	1
2.	KEEPER	AL-ALLOY-LM6	2
3.	BOLT & NUT	M.S.	8
4.	P. WASHER	M.S.	8
5.	SP.WASHER	SP.STEEL	8

TEE CLAMP SUITABLE FOR ACSR PANTHER TO ACSR PANTHER CONDUCTOR

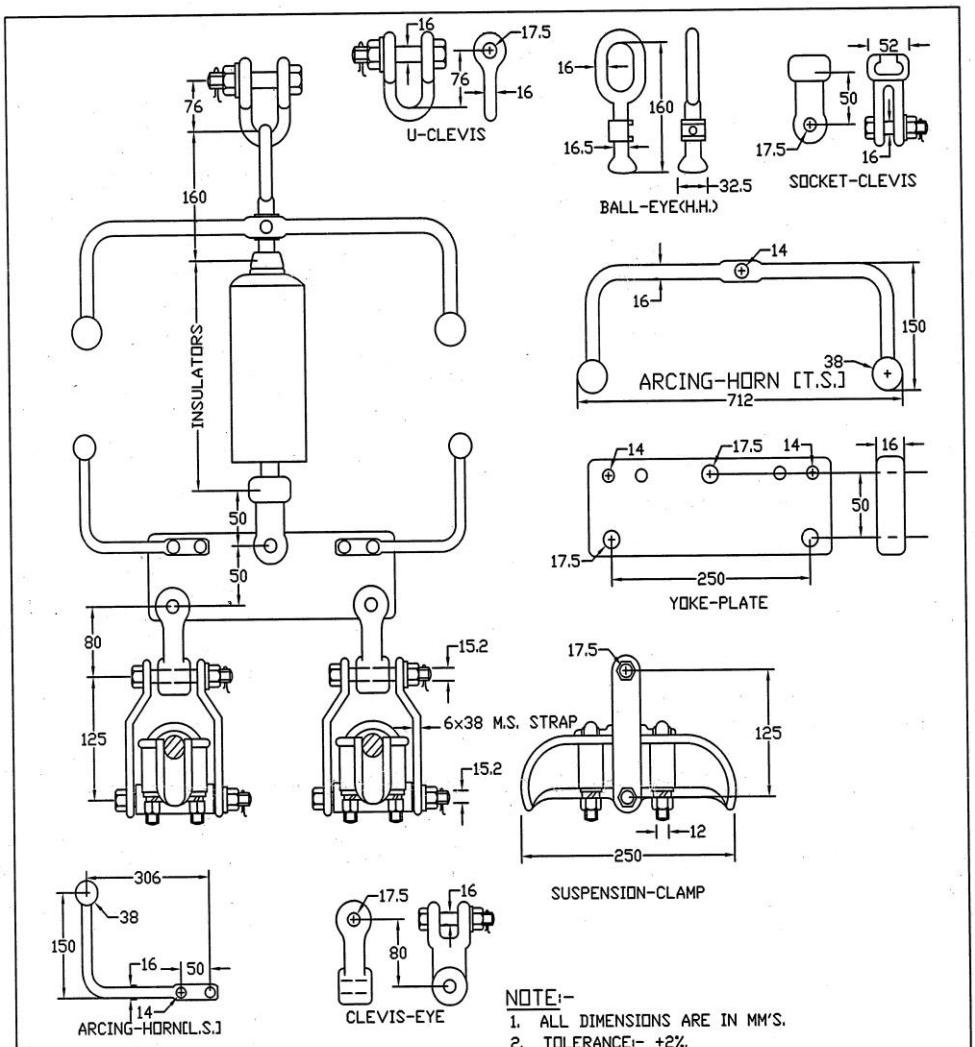


S.No.	DESCRIPTION	MATERIAL	QTY.
1.	U-CLEVIS	F.S.	1
2.	BALL-EYE(H.H.)	F.S.	1
3.	SOCKET-CLEVIS	F.S.	1
4.	YOKE-PLATE	M.S.	1
5.	CLEVIS-CLEVIS	M.S.	2
6.	TENSION-CLAMP	EXTD.ALUM.	2
7.	ARCING HORN	M.S.ROD	2
8.	R-TYPE SECURITY PIN	S.S.	1
9.	BOLT,NUT & P-WASHER	M.S.	-
10.	SPRING-WASHER	SP.STEEL	8
11.	SPLIT PIN	S.S.	6

NOTE:-

1. ALL DIMENSIONS ARE IN MM'S.
2. TOLERANCE:- ±2%
3. BALL & SOCKET SIZE:-20MM AS PER IS:2486/Pt-II.
4. ALL FERROUS PARTS ARE H.D.G.AS PER IS:2633/1986.
5. WASHERS ARE ELECTROGAL.AS PER IS:1573/1986.
6. BREAKING STRENGTH WITHOUT TENSION CLAMP :-120 KN.
7. SLIP STRENGTH:-95% OF UTS OF CONDUCTOR.

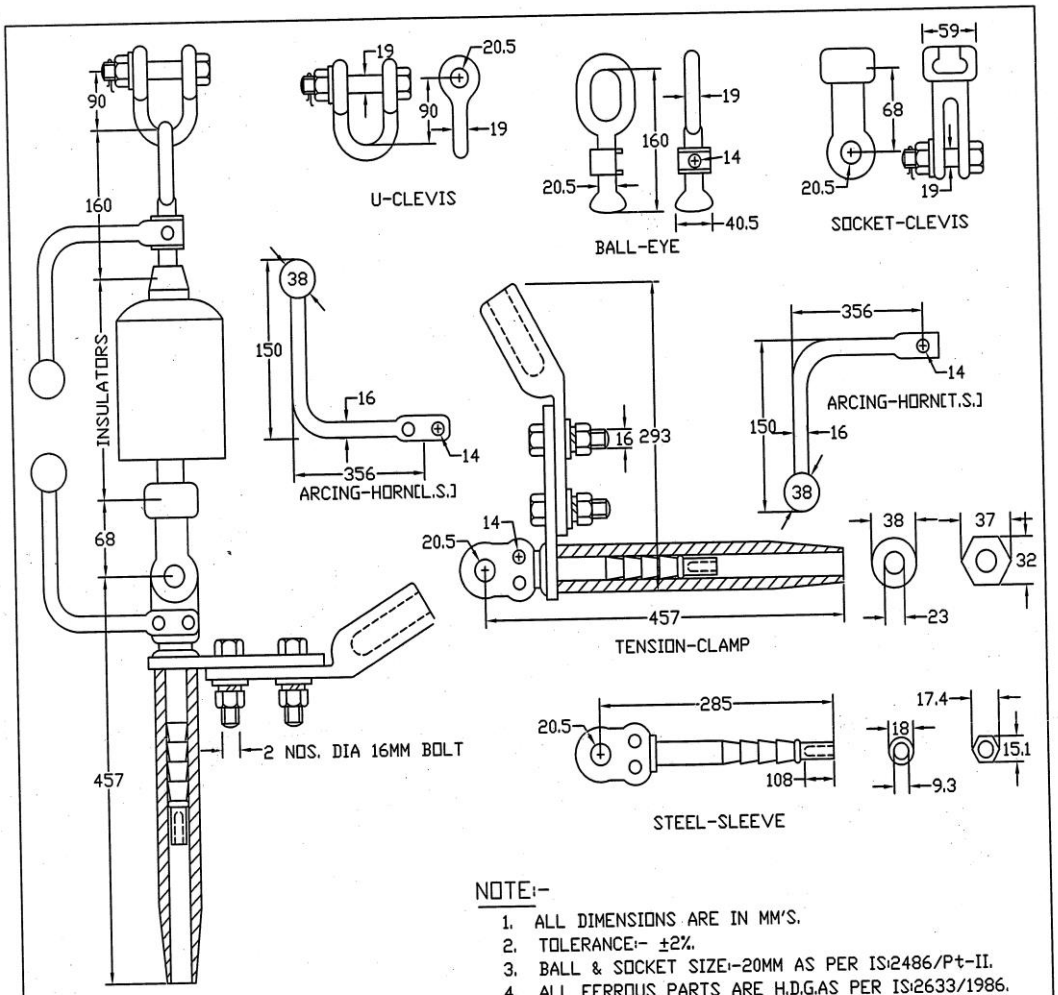
SINGLE TENSION HARDWARE FITTINGS
SUITABLE FOR ACSR TWIN PANTHER



S.No	DESCRIPTION	MATERIAL	QTY.
1.	U-CLEVIS	F.S.	1
2.	BALL-EYE(H.H.)	F.S.	1
3.	ARCING HORN(T.S.)	M.S.ROD	1
4.	SOCKET-CLEVIS	F.S.	1
5.	YOKE-PLATE	M.S.	1
6.	ARCING HORN(L.S.)	M.S.ROD	2
7.	CLEVIS-EYE	F.S.	2
8.	SUSPENSION-CLAMP	AL-ALLOY	2
9.	KEEPER	AL-ALLOY	2
10.	SIDE-STRAP	M.S.	2-SET
11.	U-BOLT,NUT,P-WASHER	M.S.	4,8,8
12.	SPRING-WASHER	SP. STEEL	8
13.	BOLT,NUT & P.WASHER	M.S.	-
14.	SECURITY-CLIP & SPLIT-PIN	SS & BRASS	1&8

NOTE:-
1. ALL DIMENSIONS ARE IN MM'S.
2. TOLERANCE:- ±2%.
3. ALL FERROUS PARTS ARE H.D.G. AS PER IS:2633.
4. WASHERS ARE ELECTROGAL. AS PER IS:1573/1986.
5. BALL & SOCKET SIZE:-16MM AS PER IS:2486/Pt-II.
6. BREAKING STRENGTH:- 7000 KG.
7. SLIP STRENGTH:-8 TO 15% OF U.T.S. OF CONDUCTOR.

SINGLE SUSPENSION HARDWARE FITTINGS SUITABLE FOR TWIN ACSR PANTHER

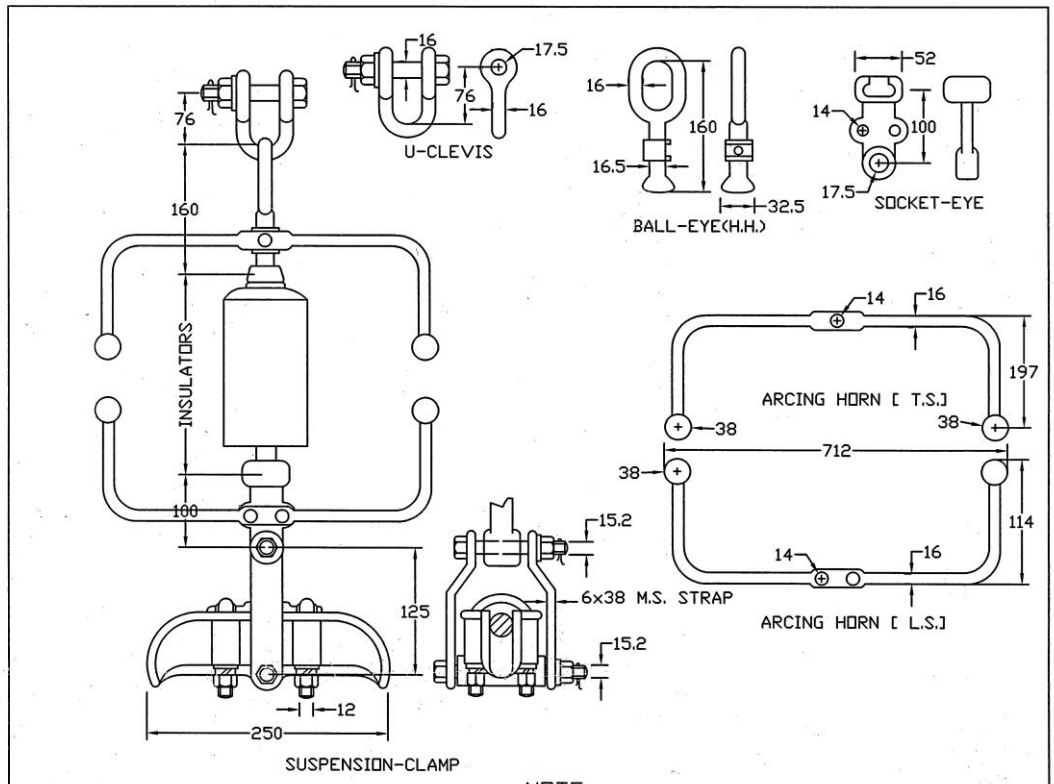


NOTE:-

1. ALL DIMENSIONS ARE IN MM'S.
2. TOLERANCE:- ±2%.
3. BALL & SOCKET SIZE:-20MM AS PER IS:2486/Pt-II.
4. ALL FERROUS PARTS ARE H.D.G.AS PER IS:2633/1986.
5. WASHERS ARE ELECTROGAL.AS PER IS:1573/1986.
6. BREAKING STRENGTH OF HARDWARES:-12000 KG.
7. SLIP STRENGTH:-95% OF U.T.S. OF THE COND.

S.No.	DESCRIPTION	MATERIAL	QTY.
1.	U-CLEVIS	F.S.	1
2.	BALL -EYE(H.H)	F.S.	1
3.	SOCKET-CLEVIS	F.S.	1
4.	TENSION-CLAMP	EXT.ALUM.	1
5.	STEEL-SLEEVE	F.S.	1
6.	ARCING-HORN	M.S.ROD	2
7.	R-TYPE SECURITY PIN	S.S.	1
8.	BOLT,NUT & P-WASHER	M.S.	-
9.	SPRING-WASHER	SP.STEEL	-
10.	SPLIT PIN	BRASS	1

SINGLE TENSION HARDWARE FITTING SUITABLE FOR ACSR PANTHER CONDUCTOR



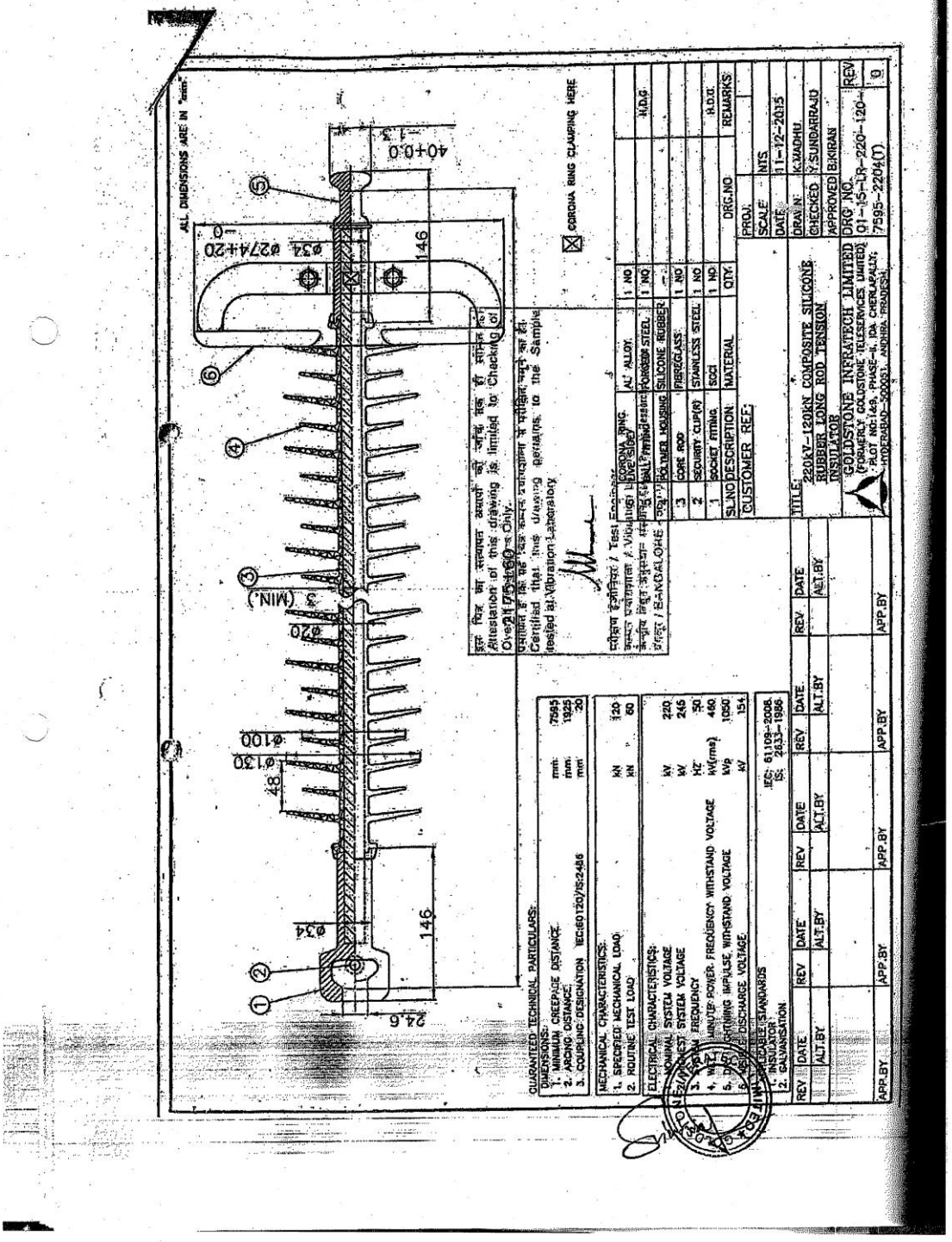
NOTE:-

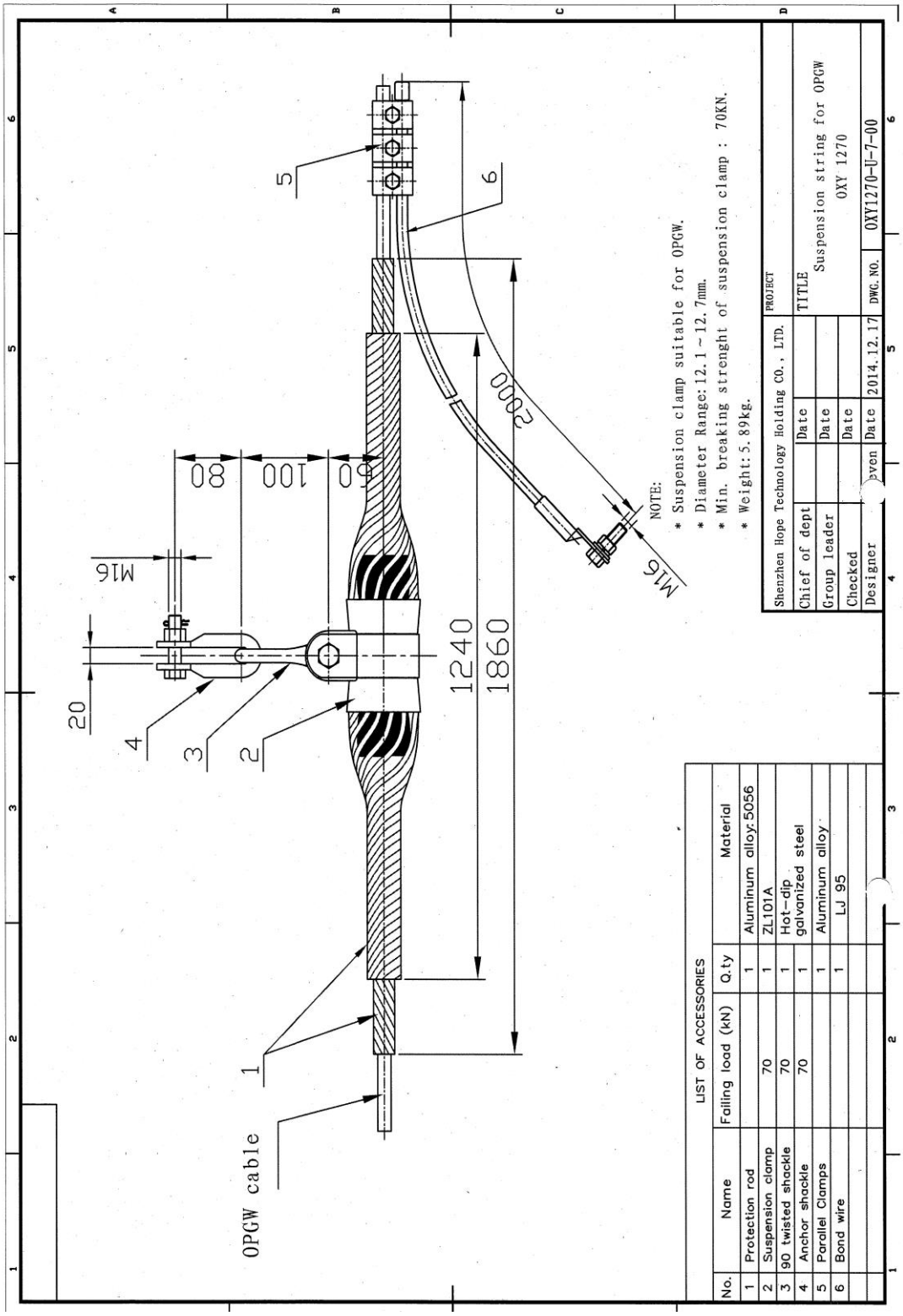
1. ALL DIMENSIONS ARE IN MM'S.
2. TOLERANCE:- ±2%.
3. ALL FERROUS PARTS ARE H.D.G. AS PER IS:2633.
4. WASHERS ARE ELECTROGAL. AS PER IS:1573/1986.
5. BALL & SOCKET SIZE:-16MM AS PER IS:2486/Pt-II.
6. BREAKING STRENGTH:- 7000 KG.
7. SLIP STRENGTH:-8 TO 15% OF U.T.S. OF CONDUCTOR.

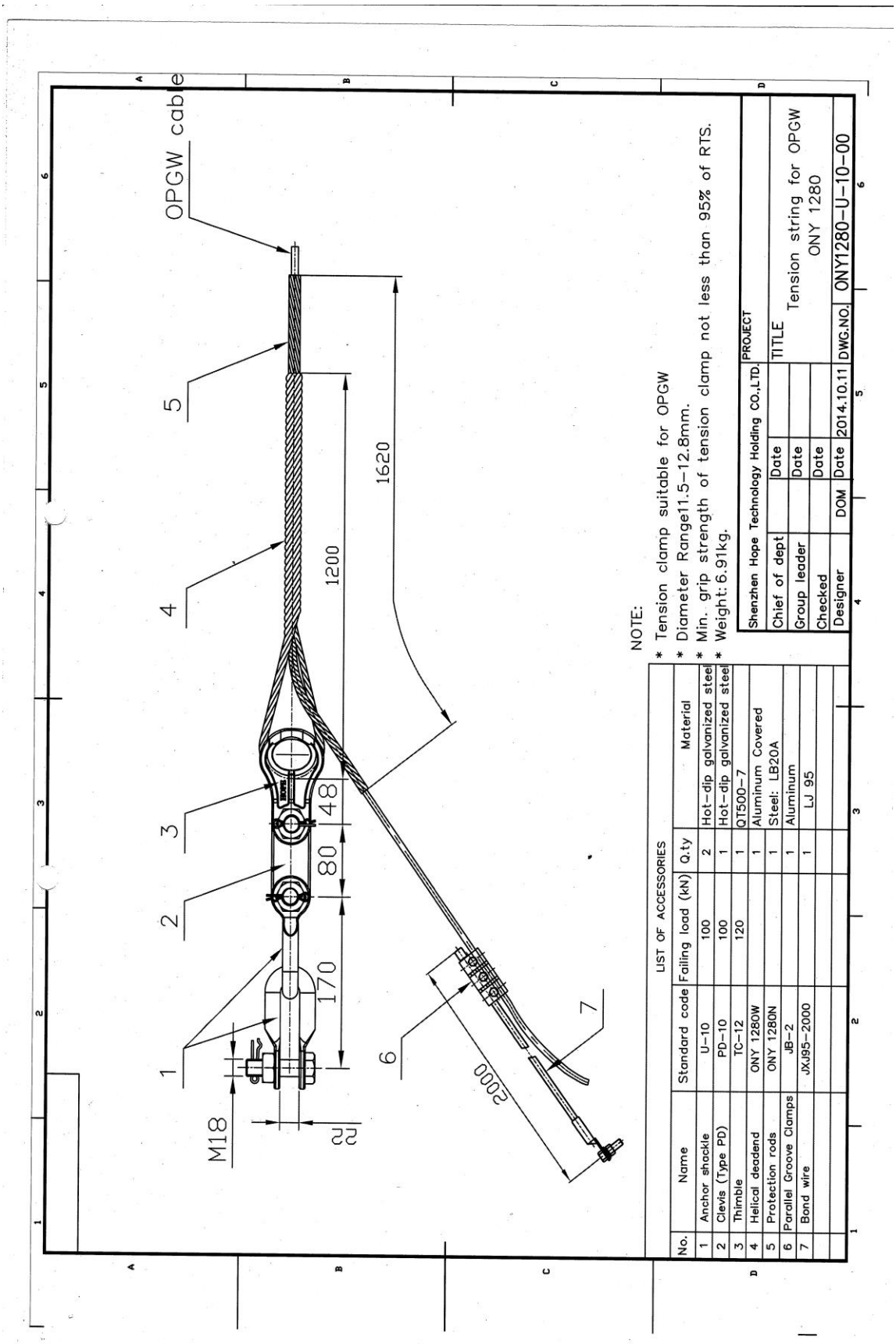
S.No	DESCRIPTION	MATERIAL	QTY.
1.	U-CLEVIS	F.S.	1
2.	BALL-EYE(H.H.)	F.S.	1
3.	ARCING-HORN	M.S. ROD	2-Sets
4.	SOCKET-EYE	F.S.	1
5.	SUSPENSION-CLAMP	AL-ALLOY	1
6.	KEEPER	AL-ALLOY	1
7.	SIDE-STRAP	M.S.	1-set
8.	U-BOLT,NUT,P-WASHER	M.S.	2,4,4
9.	SPRING-WASHER	SP. STEEL	4
10.	BOLT,NUT & P.WASHER	M.S.	-
11.	R-TYPE SECURITY PIN	S.S.	1
12.	SPLIT PIN	BRASS	3

SINGLE SUSPENSION HARDWARE FITTING SUITABLE FOR ACSR PANTHER CONDUCTOR

Test Report Number: VB.2940.T265.1516 Date: 18.01.2016




NOTE:
* Suspension clamp suitable for OPGW.
* Diameter Range:12.1-12.7mm.
* Min. breaking strenght of suspension clamp : 70KN.
* Weight:5.89kg.
OPGW cable
1240
1860
2000
M16
M16
20
80
100
60
LIST OF ACCESSORIES
No. Name Failing load (kN) Q.ty Material
1 Protection rod 1 Aluminum alloy:5056
2 Suspension clamp 70 1 ZL101A
3 90 twisted shackle 70 1 Hot-dip galvanized steel
4 Anchor shackle 70 1 Aluminum alloy
5 Parallel Clamps 1 LJ 95
6 Bond wire 1
Shenzhen Hope Technology Holding CO., LTD.
PROJECT
Chief of dept Date
Group leader Date
Checked Date
Designer Date 2014.12.17
TITLE
Suspension string for OPGW
OXY 1270
DWG. NO. OXY1270-U-7-00

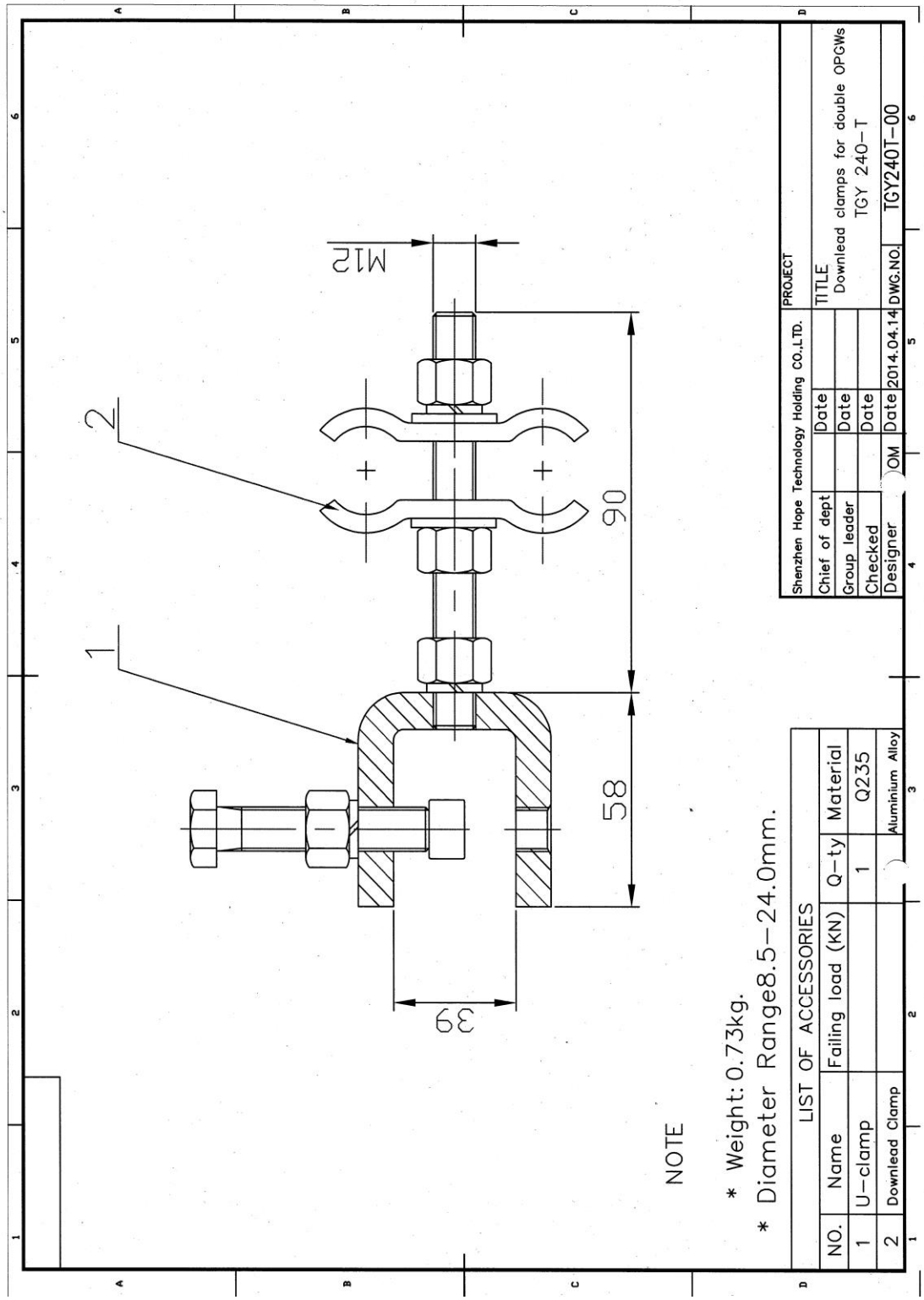


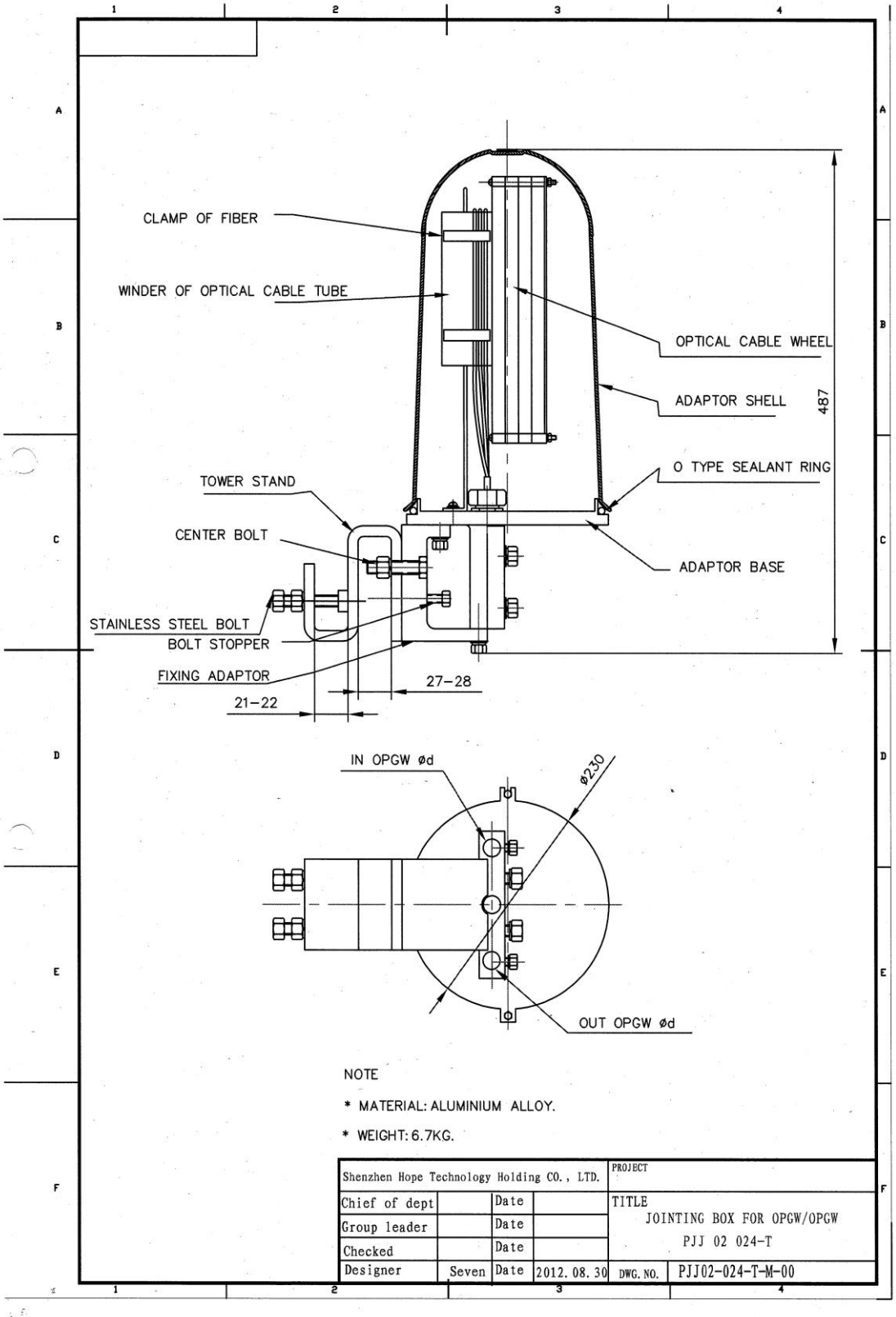
NOTE:
* Tension clamp suitable for OPGW
* Diameter Range11.5–12.8mm.
* Min. grip strength of tension clamp not less than 95% of RTS.
* Weight: 6.91kg.

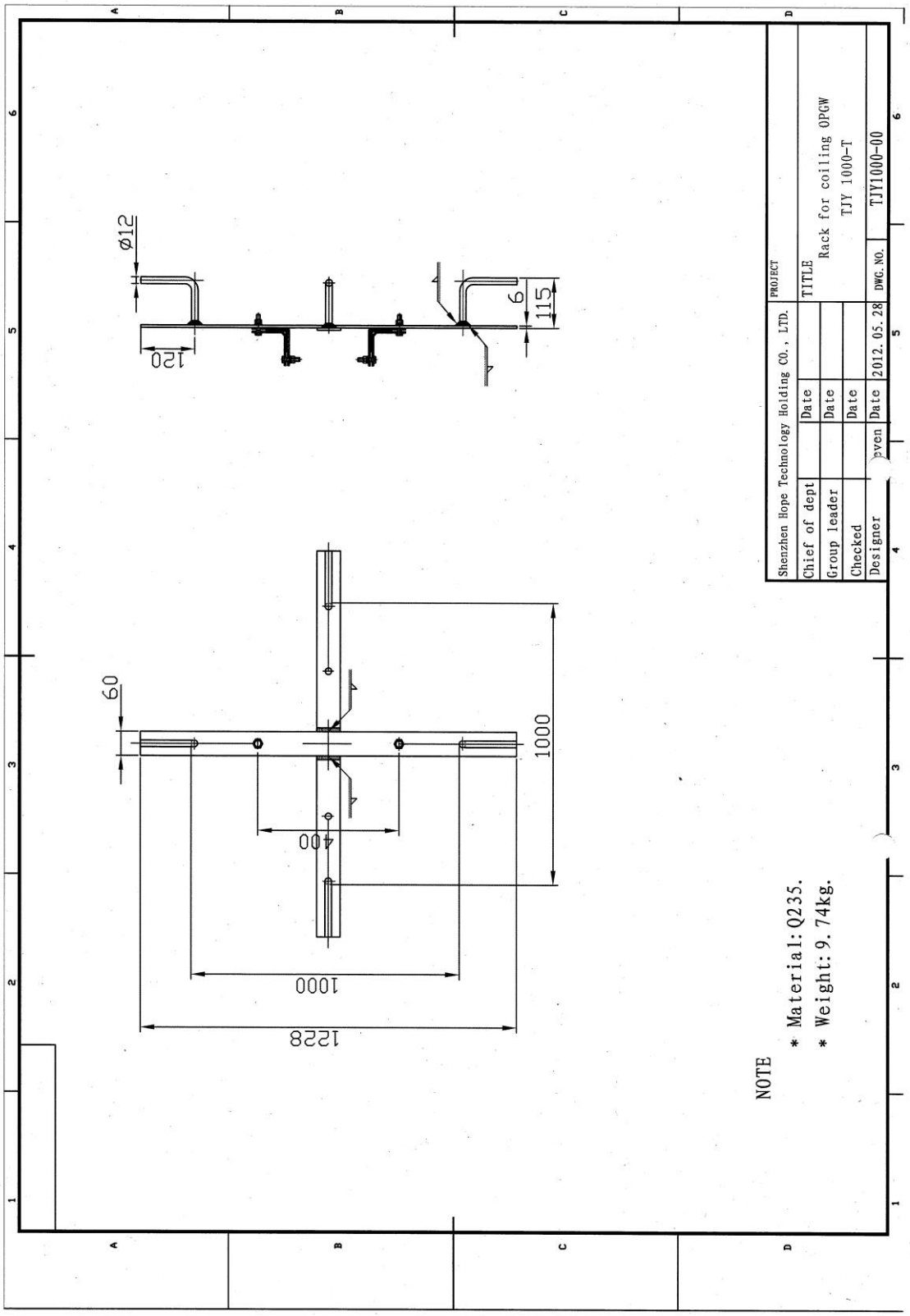
LIST OF ACCESSORIES

No.	Name	Standard code	Failing load (kN)	Q.ty	Material
1	Anchor shackle	U-10	100	2	Hot-dip galvanized steel
2	Clevis (Type PD)	PD-10	100	1	Hot-dip galvanized steel
3	Thimble	TC-12	120	1	QT500-7
4	Helical deadend	ONY 1280W		1	Aluminum Covered Steel: LB20A
5	Protection rods	ONY 1280N		1	
6	Parallel Groove Clamps	JB-2		1	Aluminum
7	Bond wire	JXJ95-2000		1	LJ 95

Shenzhen Hope Technology Holding CO.,LTD.			PROJECT
Chief of dept		Date	TITLE: Tension string for OPGW ONY 1280
Group leader		Date	
Checked		Date	
Designer	DOM	Date 2014.10.11	DWG.NO. ONY1280-U-10-00

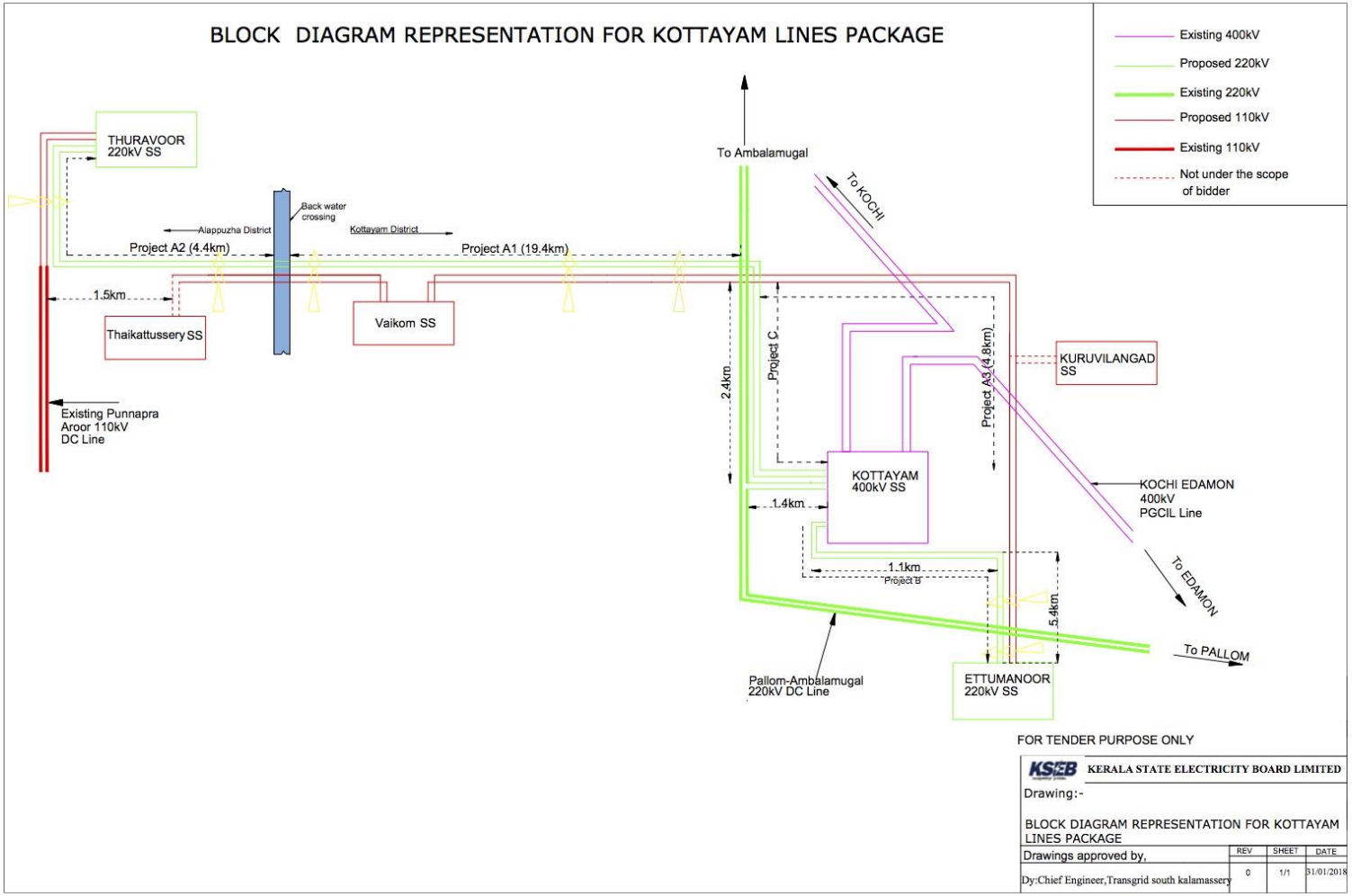

M12
90
58
39
2
1
NOTE
* Weight: 0.73kg.
* Diameter Range8.5–24.0mm.
LIST OF ACCESSORIES
NO. Name Failing load (KN) Q-ty Material
1 U-clamp 1 Q235
2 Downlead Clamp Aluminium Alloy
Shenzhen Hope Technology Co.,LTD.
PROJECT
Chief of dept Date
Group leader Date
Checked Date
Designer OM Date 2014.04.14
TITLE
Downlead clamps for double OPGWs
TGY 240-T
DWG.NO. TGY240T-00


CLAMP OF FIBER
WINDER OF OPTICAL CABLE TUBE
OPTICAL CABLE WHEEL
ADAPTOR SHELL
487
O TYPE SEALANT RING
TOWER STAND
CENTER BOLT
ADAPTOR BASE
STAINLESS STEEL BOLT
BOLT STOPPER
FIXING ADAPTOR
27-28
21-22
IN OPGW ød
ø230
OUT OPGW ød
NOTE
* MATERIAL: ALUMINIUM ALLOY.
* WEIGHT: 6.7KG.
Shenzhen Hope Technology Holding CO., LTD.
PROJECT
Chief of dept
Date
Group leader
Date
Checked
Date
Designer
Seven
Date
2012. 08. 30
TITLE
JOINTING BOX FOR OPGW/OPGW
PJJ 02 024-T
DWG. NO.
PJJ02-024-T-M-00

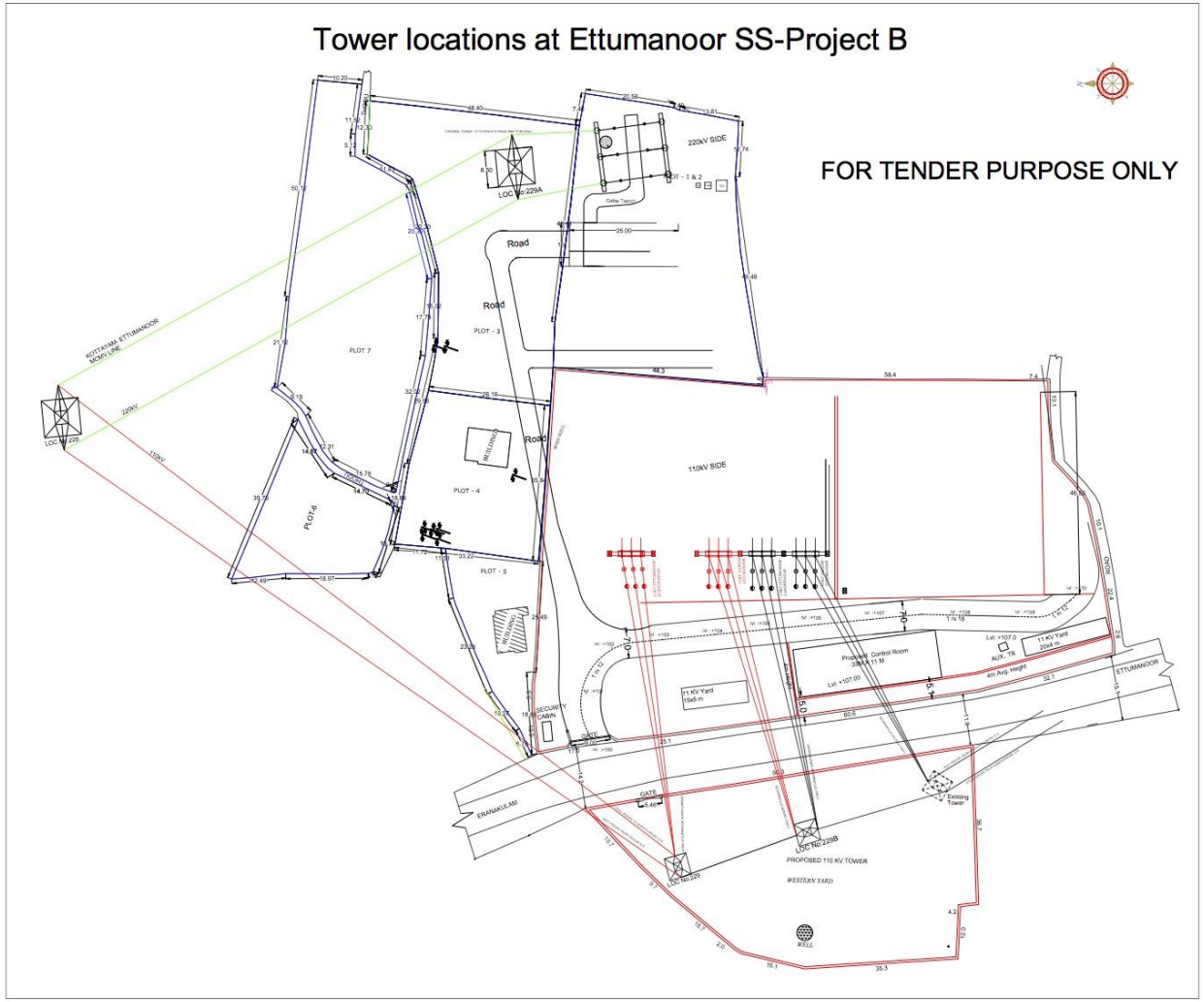

Ø12
120
6
115
60
1000
400
1000
1228
NOTE
* Material: Q235.
* Weight: 9.74kg.
Shenzhen Hope Technology Holding CO., LTD.
PROJECT
Chief of dept
Group leader
Checked
Designer
Date
Date
Date
Date
2012.05.28
TITLE
Rack for coiling OPGW
TJY 1000-T
DWG. NO.
TJY1000-00

ANNEXURE – A

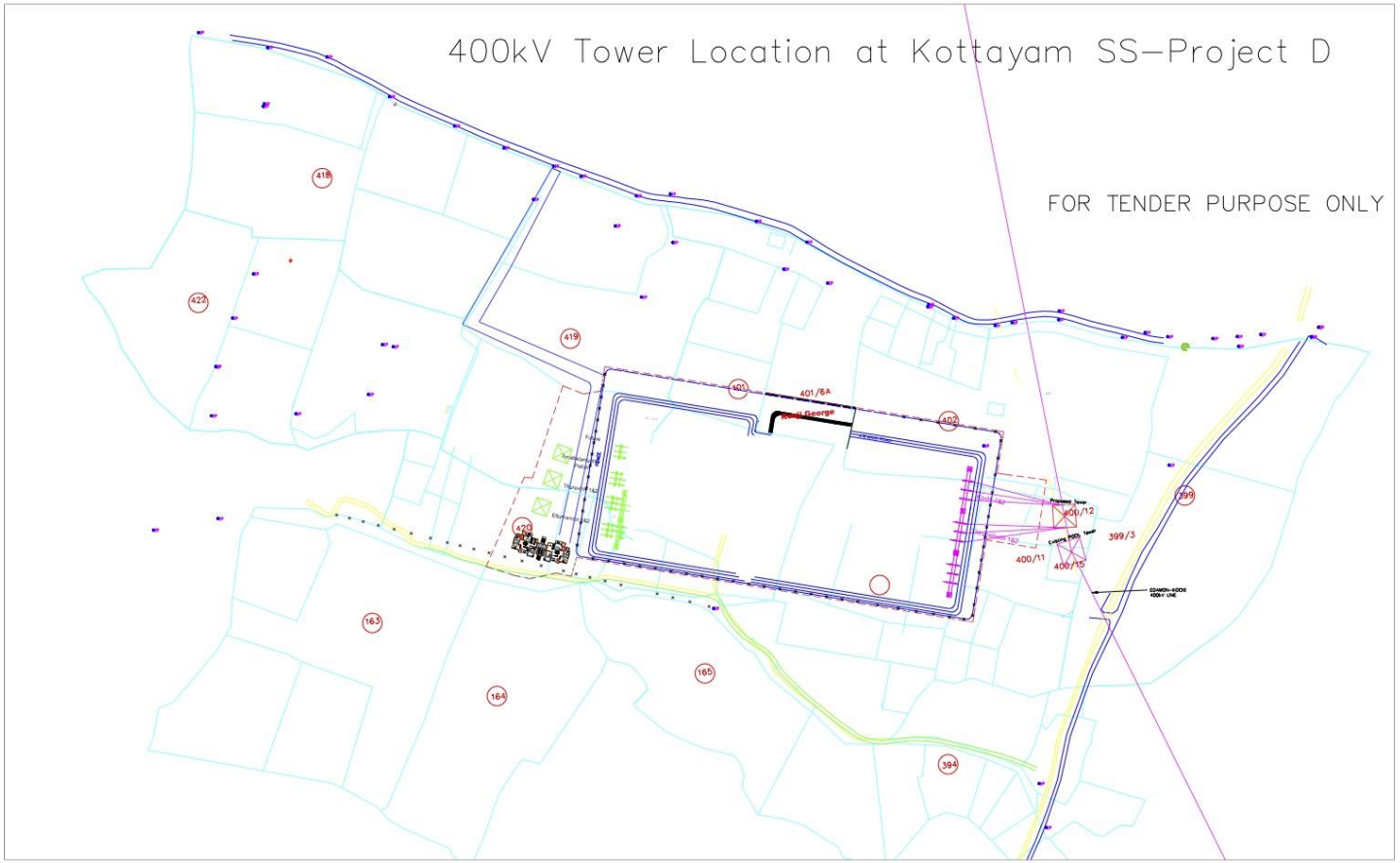
Block diagram representation of Kottayam Line Package (KLP), North – South Interlink Package (Phase – I) & Thrissivaperur Lines Package (Phase-I)

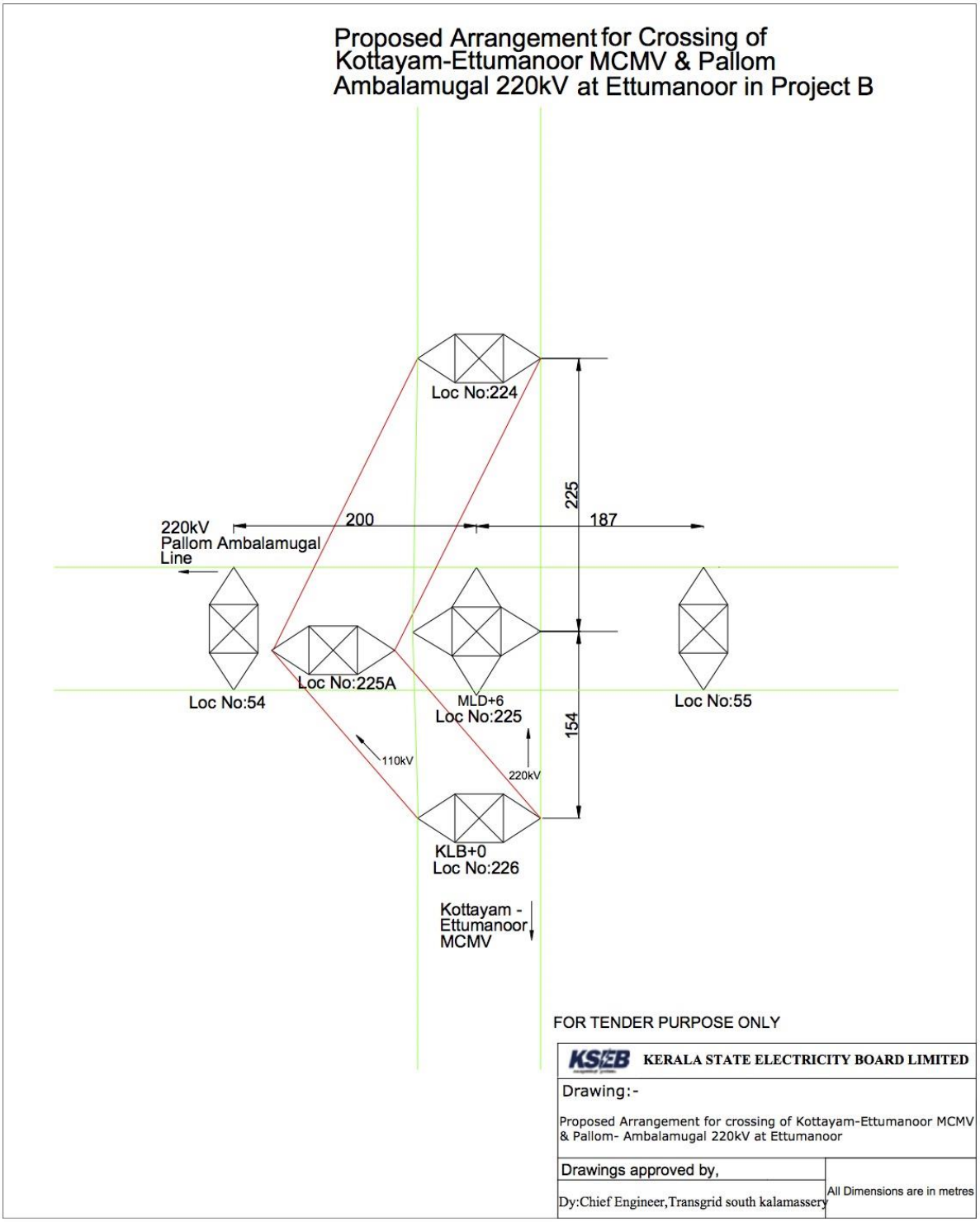

BLOCK DIAGRAM REPRESENTATION FOR KOTTAYAM LINES PACKAGE
Existing 400kV
Proposed 220kV
Existing 220kV
Proposed 110kV
Existing 110kV
Not under the scope of bidder
THURAVOOR 220kV SS
To Ambalamugal
To KOCHI
Back water crossing
Alappuzha District
Kottayam District
Project A2 (4.4km)
Project A1 (19.4km)
1.5km
Thaikattussery SS
Vaikom SS
Existing Punnapra Aroor 110kV DC Line
2.4km
Project C
Project A3 (4.8km)
KURUVILANGAD SS
KOTTAYAM 400kV SS
1.4km
KOCHI EDAMON 400kV PGCIL Line
To EDAMON
1.1km
Project B
5.4km
To PALLOM
Pallom-Ambalamugal 220kV DC Line
ETTUMANOOR 220kV SS
FOR TENDER PURPOSE ONLY
KSEB
KERALA STATE ELECTRICITY BOARD LIMITED
Drawing:-
BLOCK DIAGRAM REPRESENTATION FOR KOTTAYAM LINES PACKAGE
Drawings approved by,
Dy:Chief Engineer,Transgrid south kalamassery
REV
SHEET
DATE
0
1/1
31/01/2018

KEY LOCATION MAPS – KOTTAYAM LINES

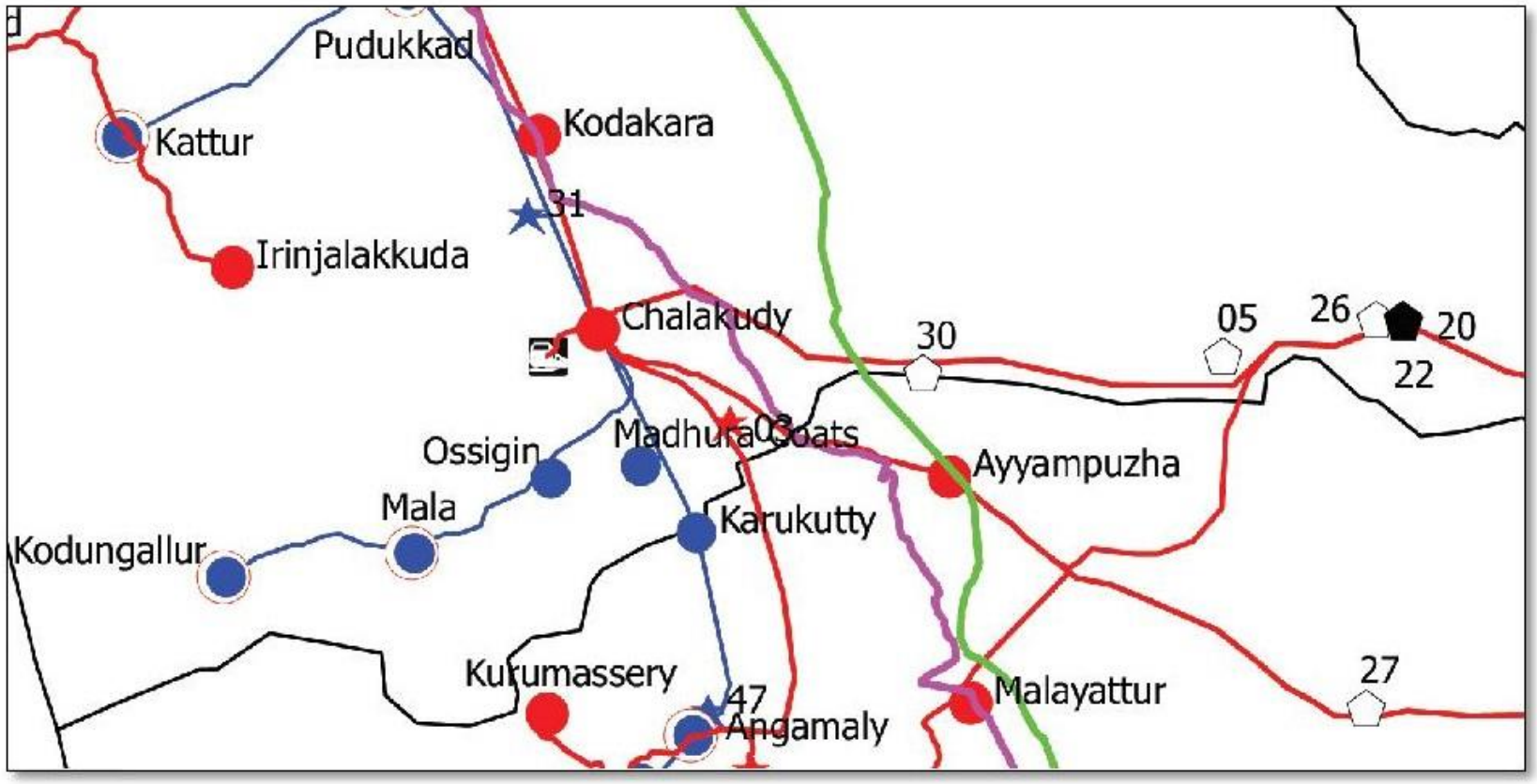


KEY LOCATION MAPS – KOTTAYAM LINES

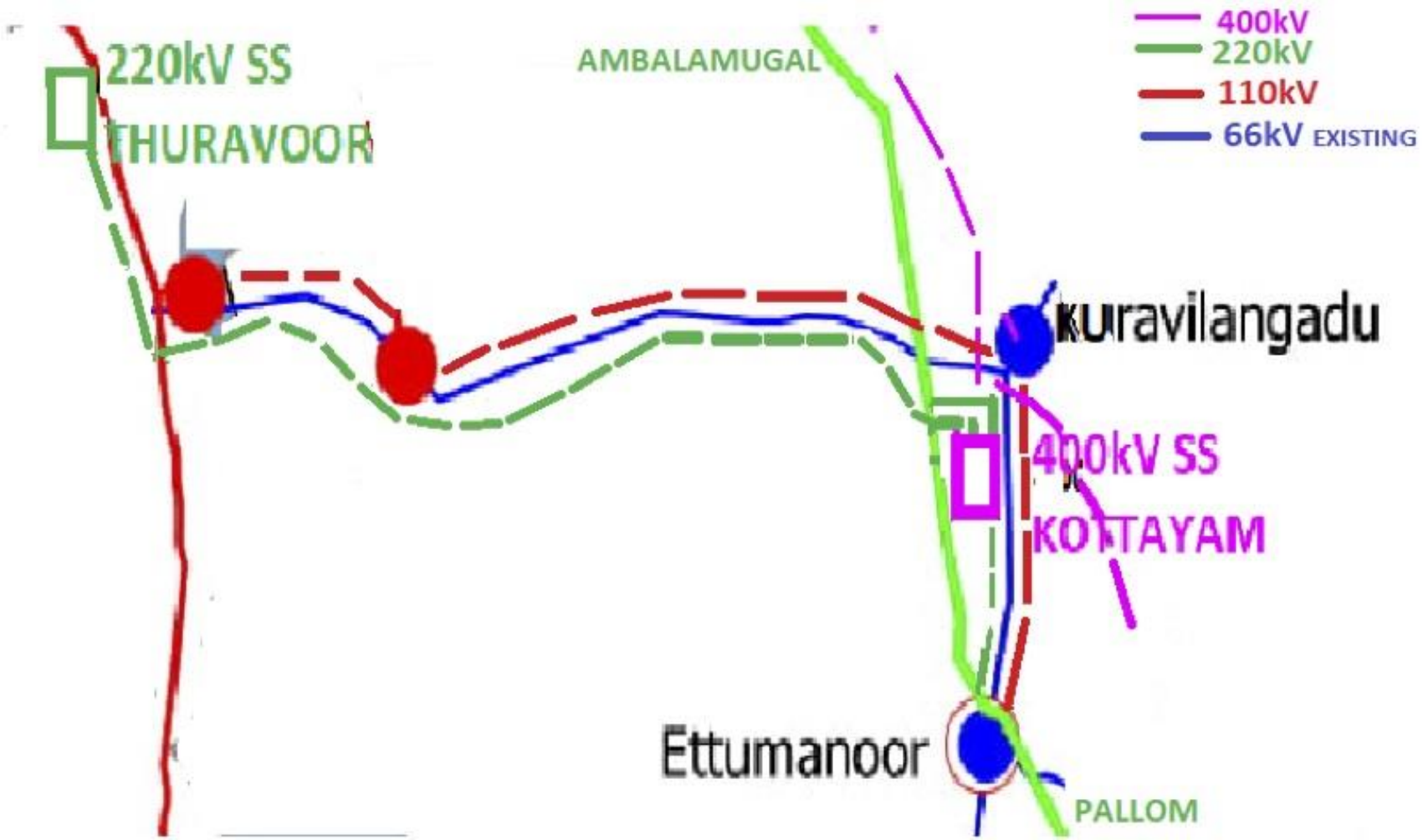



Proposed Arrangement for Crossing of
Kottayam-Ettumanoor MCMV & Pallom
Ambalamugal 220kV at Ettumanoor in Project B
Loc No:224
225
200
187
220kV
Pallom Ambalamugal
Line
Loc No:54
Loc No:225A
MLD+6
Loc No:225
Loc No:55
154
110kV
220kV
KLB+0
Loc No:226
Kottayam -
Ettumanoor
MCMV
FOR TENDER PURPOSE ONLY
KSEB
KERALA STATE ELECTRICITY BOARD LIMITED
Drawing:-
Proposed Arrangement for crossing of Kottayam-Ettumanoor MCMV & Pallom- Ambalamugal 220kV at Ettumanoor
Drawings approved by,
Dy:Chief Engineer,Transgrid south kalamassery
All Dimensions are in metres

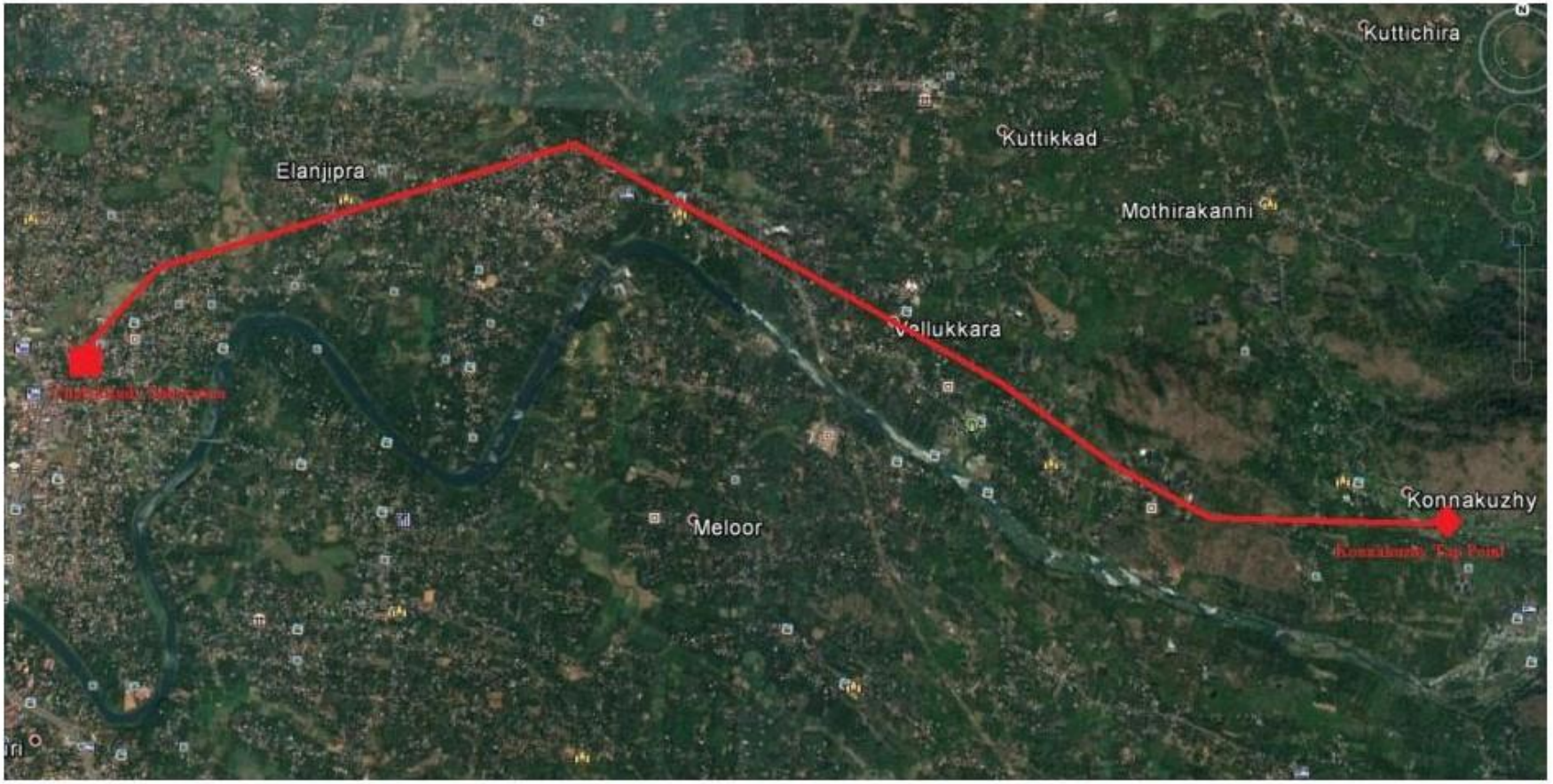
BLOCK DIAGRAM FOR NORTH-SOUTH INTERLINK LINE PACKAGE



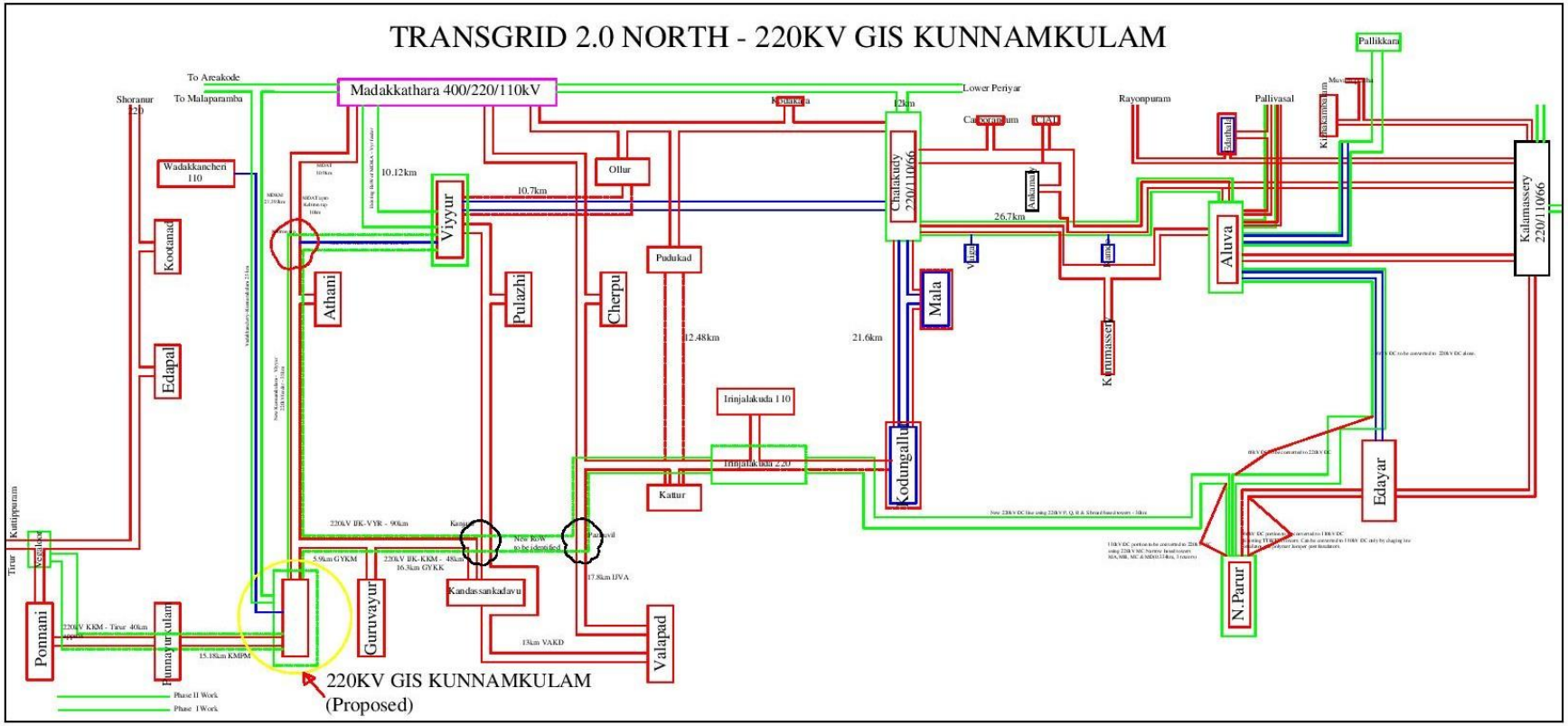
BLOCK DIAGRAM FOR NORTH-SOUTH INTERLINK LINE PACKAGE



BLOCK DIAGRAM FOR NORTH-SOUTH INTERLINK LINE PACKAGE

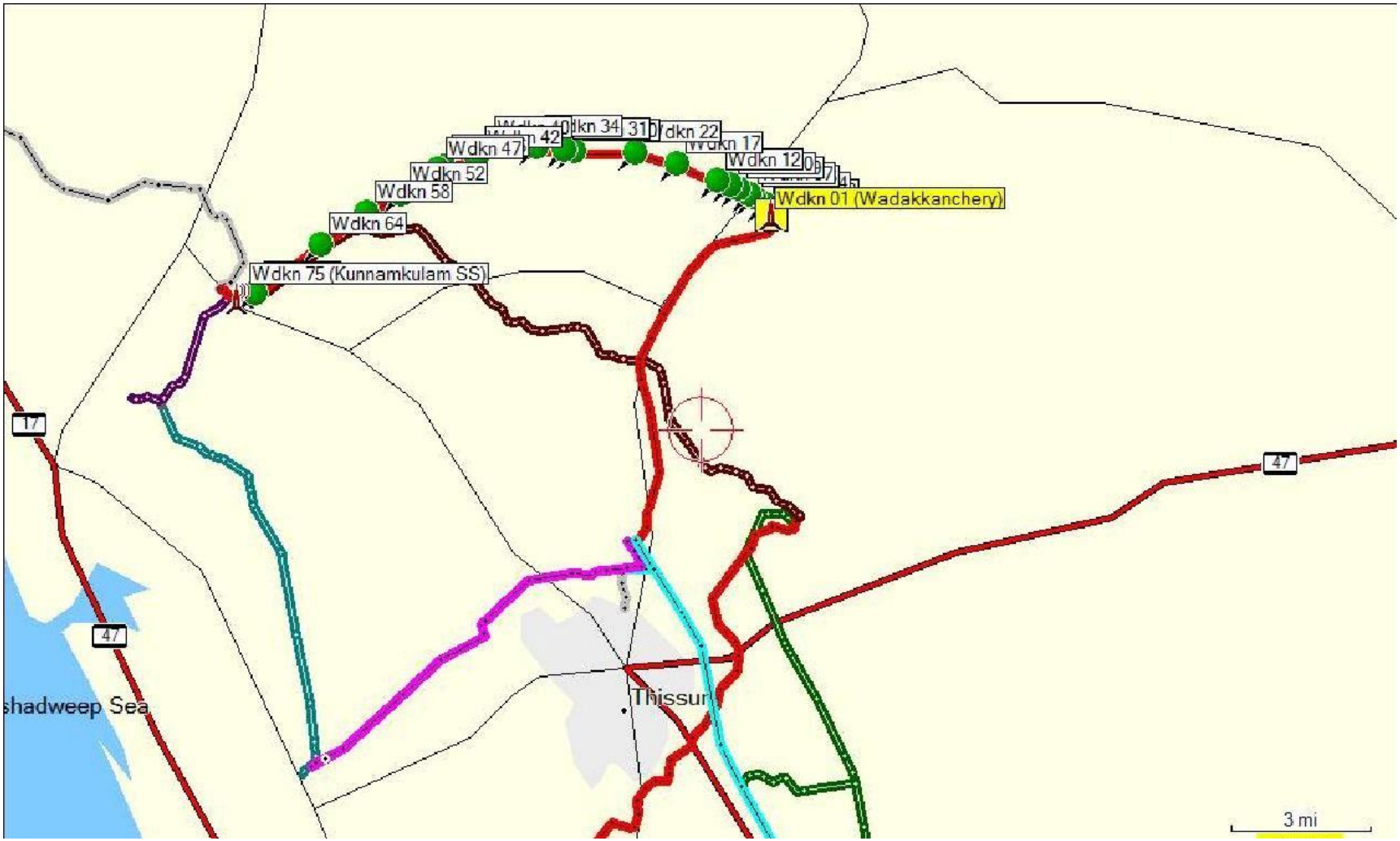


BLOCK DIAGRAM FOR THISSIVAPERUR LINE PACKAGE



BLOCK DIAGRAM FOR THISSIVAPERUR LINE PACKAGE

BLOCK DIAGRAM FOR THISSIVAPERUR LINE PACKAGE



ANNEXURE – B

LIST OF MATERIALS & SPARES FOR ALL LINE PACKAGE MATERIALS

AS PER SEPARATE ATTACHED SHEET

ANNEXURE - C
Approximate Tower Quantities

Kottayam Lines Package PROJECT A: Construction of 23.8 km 220/110kV MCMV and 4.8km of 110 kV DC line from Kottayam to Thuravoor Project A comprises of 3 parts • PART A1 : Construction of 19.4km 220/110kV MCMV lines from Kottayam to Thuravoor (in Kottayam district) • PART A2 : Construction of 4.4km 220/110kV MCMV lines from Kottayam to Thuravoor (in Alappuzha district) • PART A3 : Construction of 4.8 km 110kV DC portion through Kuravilangad Town PROJECT B: Construction of 6.5 km 220kV (5.4km 220/110kV MCMV and 1.1km 220kV DC) line from 400 kV Kottayam substation to Ettumanoor SS PROJECT C: Construction of 3.8 km 220kV Multi Circuit LILO from 220 kV Pallom – Ambalamugal feeder to Kottayam 400 kV SS. PROJECT D : Construction of 400 kV Multi Circuit/ Double Circuit Tower at Kottayam 400KV Substation (including tap line of approx. 100m)	**As per attached sheet below**
North South Interlink Package Phase-I PROJECT A: Construction of 11.726 km of 220/ 110kV MCMV line from Chalakudy to Konnakuzhy (Thrissur District) using 220/110kV MCMV Narrow/Broad based Towers. PROJECT B: Construction of 15.85 km of 220/ 110kV MCMV line from Irinjalakuda to Kodungallur (Thrissur District)	**As per attached sheet below**
Thrissivaperur Lines Package Phase-I PROJECT A: Construction of 23km of 220/ 110kV MCMV line from Wadakkanchery to Kunnamkulam (Thrissur District)	**As per attached sheet below**

Approximate Tower Quantity – Kottayam Lines Package

Tower Type	Sub project						Total
	A1	A2	A3	B	C	D	
KLA	21	4		5			30
KLB	25	4		11			40
KLC	6	1		3			10
KLD	8	5		5			18
D3			4	0			4
D30			11	0			11
D60			5	3			8
MA					3		3
MB					5		5
MD					6		6
MLD				1			1
New Design						1	1
Total	**60**	**14**	**20**	**28**	**14**	**1**	**137**

Approximate Tower Quantity – North South Interlink Lines Package

	Sub Project	
Tower Type	A	B
KLA	6	
KLB	9	
KLC	7	
KLD	10	
P	3	
X	7	
Y	3	
Z	7	
MA		14
MB		27
MC		3
MD		8

Approximate Tower Quantity – Thrissivaperur Line Strengthening Package

Tower Type	P	R	S	KLC	KLD
Quantity	51	14	5	1	9

Sd/-
ED (Unit –4&5),
PFC Consulting Limited