POWER GRID COMPANY OF BANGLADESH LIMITED

BIDDING DOCUMENT

FOR THE PROCUREMENT OF

PACKAGE-1: DESIGN, SUPPLY, ERECTION, TESTING & COMMISSIONING OF 132KV TRANSMISSION LINES AND SUBSTATIONS ON TURNKEY BASIS

LOT-1: TRANSMISSION LINES

SECTION 11

CONDUCTORS

SECTION 11

CONDUCTORS

11.1 SCOPE

11.1.1 Types and Uses

The type and configuration of the phase conductor and earthwire shall be in accordance with the requirement of this Specification. For types of conductor reference should be made to Appendix 11.A1.

11.1.2 Definition

The following	definitions are used throughout this Specification.
AAC	All Aluminium Conductor
AAAC	All Aluminium Alloy Conductors
ACSR	Aluminium Conductor Steel Reinforced
ACAR	Aluminium Conductor Alloy Reinforced
AACSR	Aluminium Alloy Conductor Steel Reinforced
ACSR/AW	Aluminium Conductor Aluminium clad Steel Reinforced
S	Galvanised Steel Conductor
SA	Aluminium clad steel conductor

11.1.3 Sub conductor Configuration

For details of sub conductor configuration and spacing reference should be made to Appendix 11.A2.

11.1.4 Optical Fibre Cable

For details of embedded optical fibre cable reference should be made Section 14.0 of this Specification.

11.2 DESIGN

11.2.1 General

All AAC, AAAC, ACSR, AACSR and ACSR/AW conductors shall comply with the requirements of IEC 61089. Where applicable the selection of parameters not quantified nor specified in IEC 61089, reference shall be made to the appropriate standard Specification stated in Appendix 11.A.1.

The design of non-standard conductors including thermal resistant, fibre optic earthwire and those incorporating shaped wire sections shall be submitted to the Engineer. This is a **Hold Point.**

11.2.2 Joints in Wires

11.2.2 (a) Aluminium Wires

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

(ii) No joints shall be permitted in the individual wires in the outer most layer of the finished conductor. However joints are permitted in inner layer of Aluminium, unavoidably broken during stranding, provided such breaks are not associated with either inherently defective wire or with the use of short lengths of aluminium wires. Such joints shall not be more than four (4) per conductor length and shall not be closer than 15 meters from joint in the same wire or in any other aluminium wire of the completed conductor.

(iii) 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.

11.2.2(b) 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.

11.2.2(c) Alluminium Alloy Wires

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

(ii) No joints shall be permitted in the individual wires in the outer most layer of the finished conductor. However joints are permitted in the 12 wire inner layer of **AAAC** unavoidably broken during stranding, provided such breaks are not associated with either inherently defective wire or with the use of short lengths of aluminium alloy wires. Such joints shall not be more than four (4) per conductor length and shall not be closer than 15 meters from joint in the same wire or in any other aluminium alloy wire of the completed conductor.

(iii) 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.

11.2.3 Tolerances

The manufacturing tolerances to the extent of the following limits only shall be permitted in the diameter of individual aluminium and steel strands and lay-ratio of the conductor:

ACSR GROSSBEAK

a)	**Diameter of Aluminium and Steel Strands**			
		Standard	Minimum	Maximum
	Aluminium	3.973 mm	3.933 mm	4.013 mm
	Steel	3.089 mm	3.058 mm	3.12 mm
b)	**Lay ratio of Conductor**			
			Maximum	Minimum
	Steel	6 wire layer	26	16
		12 wire layer	22	14
	Aluminium	12 wire layer	16	10
		18 wire layer	16	10
		24 wire layer	14	10

ACSR MALLARD

a)	**Diameter of Aluminium and Steel Strands**			
		Standard	Minimum	Maximum
	Aluminium	Al 30/4.135	As per relevant standard	As per relevant standard
	Steel	St 19/2.482	As per relevant standard	As per relevant standard
b)	**Lay ratio of Conductor**			
			Maximum	Minimum
	Steel	6 wire layer	26	16
		12 wire layer	22	14
	Aluminium	12 wire layer	16	10
		18 wire layer	16	10
		24 wire layer	14	10

Earthwires

For 7/3.25 mm size Earthwire			
	Standard	**Maximum**	**Minimum**
Diameter	3.25 mm	3.2175 mm	3.2825 mm

Earthwires

For 7/4.25 mm size Earthwire			
	Standard	**Maximum**	**Minimum**
Diameter	4.25 mm	As per relevant standard	As per relevant standard

11.3 MATERIALS

11.3.1 Conductors

Aluminium wire used for AAC, ACSR, ACAR, ACSR/AW or incorporated in fibre optic earthwire shall comply with the requirements of IEC 60889.

Aluminium alloy wire used for AAAC, ACAR, AACSR or incorporated in fibre optic earthwire shall comply with the requirements of IEC 60104. The copper content shall not exceed 0.05 percent. Galvanised steel core wire used for ACSR and AACSR shall comply with the requirements of IEC 60888. Aluminium clad steel wire for ACSR/AW, SA or incorporated in fibre optic earthwire shall comply with the requirements of IEC 61232.

Shaped aluminium or aluminium alloy wire sections shall conform to the requirements of the appropriate IEC standard. Galvanised steel earthwire shall comply with the requirements of IEC 60888.

11.3.1.1 Aluminium for ACSR `GROSSBEAK'

The aluminium strands shall be hard drawn from electrolytic aluminium rods having purity not less than 99.6%. The aluminium shall be of the highest purity commercially obtainable, the copper content shall not exceed 0.04 percent. They shall have the same properties and characteristics as prescribed in ASTM B233

11.3.1.2 Steel

For ACSR

The steel wire strands shall be drawn from high carbon steel wire rods produced by either the acid or the basic open-hearth process, the electric furnace process, or the basic oxygen process and shall conform to the following requirements as to the chemical composition :

Element	% Composition
Carbon	0.50 to 0.85
Manganese	0.50 to 1.10
Phosphorous	Not more than 0.035
Sulphur	Not more than 0.045
Silicon	0.10 to 0.35

The Steel wire strands shall have the same properties and characteristics as prescribed for regular strength steel wire in ASTM B 498 for ACSR GROSSBEAK conductor.

For earthwire

The steel wire strands shall be drawn from high carbon steel rods and shall conform to the following requirements as to the chemical composition :

Element	% Composition
Carbon	Not more than 0.55
Manganese	0.4 to 0.9
Phosphorous	Not more than 0.04
Sulphur	Not more than 0.04
Silicon	0. 15 to 0.35

11.3.1.3 Zinc

For ACSR

The zinc used for galvanising shall be electrolytic High Grade Zinc of 99.95% purity. It shall conform to and satisfy all the requirements of ASTM B 6 for ACSR 'GROSSBEAK' Conductor.

For Earthwire

The zinc used for galvanising shall be electrolytic High Grade Zinc of 99.95% purity. It shall conform to and satisfy all the requirements of relevant IEC or BS standard.

11.3.1.4 Aluminium alloy for AAAC

The aluminium alloy strands shall be hard drawn from hear treated aluminium alloy redraw rods confirming to type B as per IEC:104-1987. Following shall be the chemical composition of redraw rods:-

Element	**Percent**
Si	0.50-0.90
Mg	0.60-0.90
Fe	0.50 Max
Cu	0.10 Max
Mn	0.03 Max
Cr	0.10 Max
Zn	0.10 Max
B	0.06 Max
Other element (each)	0.03 Max
Other element (total)	0.10 Max
Al	Remainder

The strands shall be of Aluminum-Magnesium-Silicon alloy of electrical conductivity of minimum 53 % of IACS. The Aluminium alloy wires shall be subjected to artificial aging (precipitation treatment) in order to attain the specified tensile properties and conductivity.

11.3.1.5 Standard Length

Conductor

(i) The standard length of the conductor shall be 3500 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. Not less than 90% total quantity of the conductor shall be supplied in standard lengths.

(ii) 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. When one number random length has been manufactured at any time, five (5) more individual lengths each equivalent to the above random length with a tolerance of +/- 5% shall also be manufactured and all the above six random lengths shall be despatched in the same shipment. At no point, the cumulative quantity supplied of such random lengths shall not be more than 12.5% of the total cumulative quantity supplied including such random lengths. However, the last 20% of the quantity ordered shall be supplied only in standard lengths as specified.

(iii) 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 Purchaser 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.

Earthwire

(i) The standard length of the earthwire shall be 2000 meters. The tolerance on length shall be ± 5% on the standard length.

(ii) Random length will be accepted provided no length is less than 70% of standard length and the total quantity of random lengths is not more than ten (10) percent of the total quantity in each shipment.

11.3.2 Grease

All grease applied to the specified inner aluminium, aluminium alloy or steel strands of the conductor shall be of a neutral type and shall have the following properties:

(a) The grease shall protect the conductors from corrosion in service which may include operation in atmospheres containing salt spray or industrial pollution.

(b) The grease shall not corrode steel, aluminium or aluminium alloy wires or any combination of wires.

(c) The grease shall be compatible with any wire drawing lubricant present on the conductor wires.

(d) The grease or any component of the grease shall not flow within, nor exude from the conductor during storage, transport, erection or during service at temperatures up to 100° C.

(e) The grease shall retain its properties at all operating temperatures specified in Appendix 11.A1.

(f) The grease shall not be damaged by storage or by the conductor manufacturing process (a hot applied grease shall be unimpaired after heating to 20°C above its dropping point for 150 hours, or 10°C above the temperature reached during the application of the grease to the conductor, whichever is greater).

(g) The grease shall have adequate resistance to oxidization.

(h) The grease shall not present a health hazard and shall conform to relevant current health and safety requirements.

11.4 WORKMANSHIP

For ACSR

11.4.1 All the Aluminium and steel strands shall be smooth, uniform and free from all imperfections, such as spills and splits, diemarks, scratches, abrasions, etc., after drawing and also after stranding.

11.4.2 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.

11.4.3 The steel strands shall be hot dip galvanised and shall have a minimum zinc coating of 260 gms/sq.m. The zinc coating shall be smooth, continuous, of uniform thickness, free from imperfections and shall withstand minimum three dips in standard Preece test. The steel wire rods shall be of such quality and purity that, when drawn to the size of the strands specified and coated with zinc, the finished strands and the individual wires shall be of uniform quality and have the same properties and characteristics as prescribed in ASTM B 498 for relevant conductor.

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

For AAAC

11.4..5 All the Aluminium alloy strands shall be smooth, uniform and free from all imperfections, such as spills and splits, diemarks, scratches, abrasions, etc., after drawing and also after stranding.

11.4.6 The finished conductor shall be smooth, compact, uniform and free from all imperfections including kinks (protusion 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.

For Steel Earthwire

11.4.7 All steel strands shall be smooth, uniform and free from all imperfections, such as spills and splits, die marks, scratches, abrasions and kinks after drawing and also after stranding.

11.4.8 The finished material shall have minimum brittleness as it will be subjected to appreciable vibration while in use .

11.4.9 The steel strands shall be hot dip qalvanised and shall have minimum, Zinc coating of 275 gms/sqm after stranding. The zinc coating shall be smooth, continuous, of uniform thickness, free form imperfections and shall withstand three and a half dips after stranding in standard Preece test. The steel wire rod shall be of such quality and purity that, when drawn to the size of the strands specified and coated with zinc, the finished strands shall be of uniform quality and have the same properties and characteristics as prescribed in ASTM designation B498-M.

11.4.10 The steel strands shall be preformed and postformed in order to prevent spreading of strands while cutting of composite earthwire. Care shall be taken to avoid damage to galvanisation during preforming and postforming operation.

11.4.11 To avoid susceptibility towards wet storage stains (white rust), the finished material shall be provided with a protective coating of boiled linseed oil.

Precautions shall be taken during the manufacture, storage and delivery of conductors to prevent contamination by copper or other materials which may adversely affect the aluminium or aluminium alloy.

Where permitted in IEC 61089 for aluminium or aluminium alloy wires the preferred method of jointing single wires is cold pressure welding.

11.5 PROTECTIVE TREATMENT

All steel core wires unless specified to the contrary shall be hot-dipped galvanised to comply with the requirements of IEC 60888.

Aluminium clad steel shall comply with the requirements of IEC 61232.

Unless specified to the contrary all conductors shall be uniformly covered with a neutral grease (i.e as case 2 appendix C IEC 61089). The minimum fill factor of the grease shall not be less than 70 percent. Each layer of wire except the outer layer shall have, both lengthwise and peripherally, an even and continuous coating of grease. Wax thickened greases shall be applied at a temperature above the dropping point, and shall be substantially free from contaminants. No grease must be visible on the exterior of the conductor and every effort should be made to minimise the presence of drawing oil on the surface of the finished conductor.

11.6 CONDUCTOR ERECTION

11.6.1 Method Statement

The contractor shall provide the Engineer with a method statement giving sequential details of the conductor stringing, sagging, jointing, clamping-in etc. methods and including his intended programme. Full tension stringing shall be undertaken, if agreed in writing by the Engineer.

The method statement shall be submitted to the Engineer for acceptance the requisite period before conductor stringing commences. This is a **Hold Point.**

11.6.2 Conductor Lengths and Joints

The fullest possible use shall be made of the maximum conductor lengths in order to reduce to a minimum the number of mid-span joints. The number, span and location of any phase conductor or earthwire mid-span joints used on the line shall be approved by the Engineer. There shall not be more than one such joint per conductor in any one span. A conductor schedule detailing the lengths of conductors and positions of mid-span joints in the section, shall be submitted to the Engineer for approval; this requisite period before conductor stringing commences. This is a **Hold Point.**

Mid -span joints shall not be used:

(a) Within 10m of the conductor suspension clamp or tension joint (dead end).

(b) In sections between tension towers of less than three spans unless specifically approved.

(c) In spans over railways, navigable rivers, main roads, trunk routes, buildings or spans covered by special wayleave conditions. A line shall be deemed to be over a building when, at the specified maximum conductor temperature with an assumed conductor swing of 45 degrees from the vertical, any part of the building is vertically below any conductor.

(d) In any span immediately adjacent to a span as described in (c), unless the tower between such span and adjacent spans is fitted with tension insulator sets.

11.6.3 Repair Sleeves

In the case of local damage to individual wires of a conductor during erection, repair sleeves may be permitted with the approval of the Engineer and subject to no repair sleeve being nearer than 1.2 m from any conductor fitting other than spacer dampers. This is a **Hold Point**.

11.6.4 Line Terminations

Line termination fittings either bimetallic or aluminium shall be fitted as specified at line terminations, to provide the connection interface between the downleads and/or downdroppers and the substation equipment and/or cable sealing ends.

11.6.5 Inelastic Extensions of Conductors

The contractor shall be responsible for evaluating the inelastic extension which is likely to occur in the conductor over the defined period of years. Reference shall be made to the recommendations contained in CIGRE Electra No. 75 for the evaluation. Compensation for the inelastic extensions so determined shall be made by the selection and use of an optimum pretension and time period and over tensioning the conductor at the time of erection. Over tensioning of the conductor shall be made by an allowance in the erection temperature i.e. Sagging temperature equals conductor temperature minus equivalent temperature correction. However, it should be noted that the maximum conductor tension under the defined system loading must not be exceeded at the time the transmission line is handed over.

The Contractor shall ensure that the erection tensions do not exceed the appropriate system loading on the supports. The Contractor's proposals shall be submitted to the Engineer in conjunction with the erection sags and tensions.

11.6.6 Sags and Tensions

The Contractor shall prepare sag and tension calculations and schedules (see also Clause 4.7) for the phase conductor and earthwire for every span at the proposed range of sagging operations, the design loading condition and at the maximum conductor operating temperature.

Due allowance shall be made for any severe gradient in the transmission line route, in addition the suspension insulator sets shall be vertical at the specified temperature immediately after stringing.

These schedules shall be submitted to the Engineer the requisite period prior to the commencement of conductor stringing and for inclusion within the supply and install manual. This is a **Hold Point.**

11.6.7 Conductor Stringing

The Contractor shall take special care that during the stringing of the phase conductor and earthwire to ensure that no contact is made with the ground or any obstacles such as walls, fences, or buildings etc., nor shall they be over-strained during this process.

Drum battens shall not be removed until conductor drums are properly mounted at the drum station on the line and the battens shall be immediately refitted to the drums if any surplus conductor is left thereon. Drums will be transported and positioned on station with the least possible amount of rolling.

Approved means shall be provided to prevent any damage to conductors where they are run over temporary supports.

The conductors, joints and clamps shall be erected in such a manner that no bird caging, over-tensioning of individual wires or layers, or other deformation, or damage to the conductors shall occur.

Clamps or hauling devices shall, under erection conditions, allow no relative movement of strands or layers of the conductor. If required by the Engineer, this property shall be demonstrated by actual tests.

The Contractor shall at his own expense make suitable arrangements for temporary guying of supports where necessary. Suitable plates (detachable or otherwise) shall be provided on the supports for the attachment of any temporary guys. The additional loads imposed on specific support during conductor stringing by the use of temporary guys shall be calculated and submitted to the Engineer for appraisal prior to conductor stringing commencing. This is a **Hold Point.**

Each conductor shall be clamped in at suspension points and the adjacent spans fitted with spacer dampers or vibration dampers at a concurrent operation, after having been sagged and tensioned off at section supports. The maximum time period between clamping-in and fitting of spacer dampers or vibration dampers shall not exceed 36 hours, or such other time agreed with the Engineer.

If this period is exceeded the Engineer reserves the right to undertake a random inspection of the unclamped and lowered conductor and if necessary the cutting out and replacement of any suspect conductor. All expenses involved in the unclamping, conductor lowering, conductor replacement and re-sagging of the conductor shall be borne by the Contractor, whether or not any damage is found.

11.6.8 Running Out Blocks

Conductor running out blocks shall be free running on ball or roller bearings and of an approved design to avoid damage to the conductor. The blocks shall have an electrical conducting path between their suspension fittings and the conductors supported by the blocks.

If conductors are being erected on one circuit of a double circuit line with the other circuit live or in other situations likely to induce a voltage into the conductor all running-out blocks shall be bonded to the support steelwork by means of flexible connections approved by the Engineer.

The diameter of the running out block shall not be less than 20 times the diameter of the respective conductor. Alternatively, where a group of smaller blocks are used these shall be arranged such that the conductor passes over an equivalent radius of not less than 20 times the conductor diameter.

The hangers for the running out blocks should be of a uniform length so that the conductors and the sheaves are held at a uniform distance, not exceeding 500 mm above, or below their final position when clamped in.

11.6.9 Sagging

The Contractor shall use approved dynamometers, accurate sighting and/or other apparatus necessary for the proper checking of the work. Every section shall be offered to the Engineer for inspection of the results before sagging equipment, dynamometers, sighting or other apparatus is removed from that portion of the Works. This is a **Notification Point.**

The assumed temperature of the conductor for the purposes of sagging, will be determined from an accurate thermometer basket suspended clear of the support steelwork at a point adjacent to the bottom crossarm level of one support at one end of the span being used to control sagging. The basket shall have been in position 15 minutes before temperature reading is taken.

11.6.10 Earthing of Conductor During Erection (Safety)

During the erection of conductors and subsequently when any work is being carried out on the support above the anti-climbing device level, the Contractor shall ensure the conductors are adequately earthed at points not more than three spans apart, or such other spacing as may be necessary or directed by the Engineer.

The earthing equipment shall be approved by the Engineer and shall be designed to be clearly visible from the ground.

11.6.11 Crossings Over Roads, Railways, Buildings, Structures, Rivers etc.

Where the transmission line crosses over roads or tracks liable to be used by traffic of any description, or railways, buildings, structures and obstacles of any kind the Contractor shall provide temporary scaffolding during stringing operations. Scaffolding in accordance with this clause and Clause 5.5.3 shall be of adequate construction and height. Drawings and supporting calculations shall be submitted to the Engineer and governmental or statutory bodies. This is a **Hold Point.**

11.6.12 Live Line Scaffolds

Where it is possible only to have a restricted outage on a distribution or a transmission line sufficient only to erect the upper portion and 'net' the scaffold a live-line scaffold shall be used. Live line scaffolds shall be in accordance with the requirements of Clause 5.5.5. Drawings and supporting calculations shall be submitted to the Engineer and governmental or other statutory bodies. This is a **Hold Point.**

11.6.13 Downleads

Downlead spans between terminal supports and substation anchor points shall be erected at reduced tensions in accordance with Clause 8.2.10. Downleads shall be considered as slack span.

The exact tension between the downlead spans shall be calculated by the Contractor before executing.

The Contractor shall include within his Method Statement details of his proposal for tensioning downleads.

11.6.14 Conductor Cutting

Conductor joints shall be made over protective sheeting and waste materials shall be removed from site. Cutting of layers of conductors shall be carried out with tools designed to prevent damage to underlying strands. Preparation prior to jointing shall be carried out in accordance with Clause 11.6.15.

11.6.15 Jointing

Before the conductor is inserted into compression type joints, clamps, connectors, compression spacers or repair sleeves, it shall be prepared in the following manner, using an approved grease for phase conductors and earthwires.

The Contractor shall include within his Method Statement full details of his proposed jointing procedures, including where necessary appropriate diagrams.

(a) New Conductor: The outer layer of the conductor throughout the whole length of the joint shall be wiped clean, coated with grease, wire brushed (stainless steel) through the grease which shall be left on and assembled in the fitting after a further liberal application of grease.

(b) Old Conductor: Where a compression joint is to be made on to old conductor the Engineer shall be given the requisite period of notice. This is a **Notification Point.**

Unless otherwise agreed with the Engineer who will take account of the degree of corrosion of the conductor, all the aluminium layers, after preliminary cleaning of the individual aluminium wires with a fine grade of abrasive paper or cloth, shall be coated with grease, wire brushed through the grease which shall be left on and assembled in the fitting after a further liberal application of grease. The innermost layer of aluminium wires should not be unlaid but treated on their external surfaces only. Care shall be taken to avoid damage to the wires especially by kinking or excessive removal of metal. If however, damage does occur the whole conductor shall be cut clear of the damage and as a fresh joint prepared.

All compression joints shall be fitted strictly in accordance with the manufacturer's instructions. During compression all dies shall fully close at each end of the bite and the bites shall overlap by a minimum of 5 mm. All flashes shall be removed.

11.6.16 Surface Greasing of Conductor

Except where specified to the contrary, the conductor shall be coated with an approved grease at the point of attachment of fittings immediately before the final assembly of any fittings and all surplus grease shall be removed after assembly.

11.6.17 Greasing of Bolted Interfaces

For bolted jumper connections, non-tension joints, tee connectors and bonding leads, the lug and clevis contact faces shall be greased with an approved grease, wire brushed through the grease liberally before assembly. All nuts and bolts shall be tightened to the supplier's recommended torque.

Where jumper or non-tension joint bolts are found to be loose the Contractor shall dismantle and re-assemble the joint as above before re-bolting and tightening.

All bolts shall face towards the centre line of each conductor bundle.

11.6.18 Inspection Holes

Where a tension joint is supplied with an inspection hole the aluminium alloy drive screw shall be hammered in firmly until smooth and flush with the surface of the aluminium sleeve using the flat face of a hammer. Final smoothing over may be carried out using a flat file if necessary.

11.6.19 Tension Support Jumpers

All tension support jumper loops shall be erected complete with all fittings in accordance with the approved wire clearance diagram.

Where 2 bundle sub conductors are specified spacer for the jumper sub conductors shall be fitted necessarily. They shall be adjusted on site to give the best possible clearance to prevent contact between the phase and jumper sub-conductors.

Where specified bonding spacers shall be located at a point suitable for the application of temporary earthing bonds, normally near the middle of the jumper. In the case of non-tension joint bonding spacer the conductors must butt in the centre. Jointing shall be in accordance with the requirements of Clause 11.6.14 and resistance measurement in accordance with Clause 11.7.9.

Where tubular jumpers, if used, are fitted, the earthing bar shall be arranged as near as practical to a step-bolt of the support.

11.6.20 Spacer Dampers

Spacer dampers where specified shall be fitted to the phase conductors strictly in accordance with the manufacturer's instructions. The configuration of 2 bundle conductors in a phase and the spacing between them is 450mm.

Where there is a midspan joint or repair sleeve on a conductor, the adjacent spacer damper must not be closer than 2 m, or further away than 12 m from the midspan joint or repair sleeve. If possible, this should be achieved using the correct configuration of spacer damper positions. This configuration can be used in reverse by taking the measurement from the other support. Where the configuration given does not allow a spacer damper to be in the correct juxtaposition with the midspan joint or repair sleeve an additional spacer damper should be fitted.

11.6.21 Vibration Dampers

Vibration dampers shall be fitted to the ACSR Conductor, earthwires and OPGW strictly in accordance with the manufacturer's instructions.

11.6.22 Aircraft Warning Spheres

Where specified aircraft warning spheres shall be fitted to the earthwires and OPGW, complete with factory formed helical armour rods. The spheres shall, be located in accordance with the requirements of ICAO Annex 14 unless specified to the contrary.

11.6.23 Earthwire Bonds

Flexible earthwire bonds in accordance with the requirements of Clause 10.2.20 shall be fitted between all earthwire suspension and tension sets and the support. Where OPGW is used the connection to the earthwire shall if necessary be via a 'C' type connector (Ref. Clause 10.2.19).

No bond is required at terminal support positions where the earthwire jumper shall be attached directly to the support. At other tension positions the earthwire shall be continuously jumpered through. Where OPGW is used the jumper shall be formed from a short length of equivalent conductor attached to the earthwire via a 'C' type connector.

11.7 QUALITY CONTROL

Type and sample tests shall be undertaken on the conductor in accordance with the requirements of this specification.

Contract drawings previously submitted to the Employer shall be available at the time of testing.

The Contractor/Supplier shall give the Employer the requisite period of notice prior to undertaking the tests, and shall submit to the Employer a test program and procedures. This is a Hold Point.

For Conductor

11.7.1 Type Tests

The following tests shall be conducted once on a sample/samples of conductor for every 1500 Kms. of production from each manufacturing facility:

a)	DC resistance test on stranded conductor	As per Appendix 11.A4
b)	UTS test on stranded conductor	

11.7.2 Acceptance/Sample Tests

a)	Visual and dimensional check on drum	As per Appendix 11.A4
b)	Visual check for joints scratches etc. And length measurement of conductor by rewinding	
c)	Dimensional check on steel and aluminium/ Aluminium alloy strands	
d)	Check for lay-ratios of various layers	
e)	Galvanising test on steel strands	
f)	Torsion and Elongation tests on steel strands	
g)	Breaking load test on steel and Aluminium / Aluminium alloy strands	
h)	Wrap test on steel & Aluminium/ Aluminium alloy strands	IEC : 60888 & 60889

i)	DC resistance test on Aluminium/ Aluminium alloy strands	IEC : 60889
j)	Procedure qualification test on welded joint of Aluminium/ Aluminium alloy strands	As per Appendix 11.A4
k)	Barrel Batten strength test	As per Appendix 11.A4
l)	Drop point of grease	

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

Verification of Conductor Length

The Employer reserves the right to verity the length of conductor after unreeling at least Five percent (5%) to ten percent (10%)of the drums in a lot offered for inspection. The actual quantity will be discussed and mutually agreed to by the Supplier & Employer in the Quality Assurance Programme.

11.7.3 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 each coil

11.7.4 Tests During Manufacture

a)	Chemical analysis of zinc used for galvanizing	As per Appendix 11.A4
b)	Chemical analysis of Aluminium/ Aluminium Alloy used for making Aluminium strands	
c)	Chemical analysis of steel used for making steel strands	

For Earthwire

11.7.5 Type Tests on Earthwire

a) UTS test :As per Appendix 11.A4

b) DC resistance test : As per Appendix 11.A4

11.7.6 Acceptance/Sample Tests on Earthwire

a) Visual and dimensional check on drum : As per Appendix 11.A4

b) Visual check for joints scratches etc. and lengths of earthwire : As per Appendix 11.A4

c) Dimensional check : As per Appendix 11.A4

d) Lay length check : As per Appendix 11.A4

e)	Galvanising test	: As per Appendix 11.A4
f)	Torsion test	: As per Appendix 11.A4
g)	Elongation test	: As per relevant IEC or BS standard
h)	Wrap test	: As per relevant IEC or BS standard
i)	DC resistance test	: As per relevant IEC or BS standard
j)	Breaking load test	: As per relevant IEC or BS standard
k)	Chemical Analysis of steel	: As per Appendix 11.A4

Verification of Conductor Length

The Employer reserves the right to verity the length of earthwire after unreeling at least Five percent (5%) to ten percent (10%)of the drums in a lot offered for inspection. The actual quantity will be discussed and mutually agreed to by the Supplier & Employer in the Quality Assurance Programme.

11.7.7 Routine Tests on Earthwire

a)	Check for correctness of stranding	: As per Appendix 11.A4
b)	Check that there are no cuts, fins etc. on the strands.	: As per Appendix 11.A4
c)	Check that drums are as per Specification.	: As per Appendix 11.A4

11.7.7 Tests During Manufacture Earthwire

a)	Chemical analysis of zinc used for galvanising	: As per Appendix 11.A4
b)	Chemical analysis of steel	: As per Appendix 11.A4

11.7.5 Testing Expenses

11..7.5.1 Not used.

11..7.5.2 Not used.

11.7.5.3 Not used.

11.7.5.4 The entire cost of testing for the acceptance and routine tests and Tests during manufacture specified herein shall be treated as included in the quoted unit price of conductor.

11.7.5..5 In case of failure in any test, if repeat tests are required to be conducted, then all the expenses for deputation of Inspector/Purchaser's representative shall be borne by the contractor.

11.7.6 Additional Tests

11.7.6.1 The Purchaser reserves the right of having at his own expenses any other test(s) of reasonable nature carried out at Supplier's premises, at site or in any other place in addition to the aforesaid type, acceptance and routine tests to satisfy himself that the materials comply with the Specifications.

11.7.6.2 The Purchaser 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 Supplier's premises or at any other test centre. In case of evidence of non compliance, it shall be binding on the part of Supplier 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 Purchaser.

11.8 Sample Batch For Type Testing

Not used.

11.9 Test Reports

11.9.1 Not used.

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

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

11.10 Inspection

Please refer to Section 18, Volume 2 of 3 (Volume 2 of 2 in case the bidding documet consisting of two Volumes) in this regard.

11.10.1 The Employer'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.

11.10.2 The Supplier shall keep the Employer 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.

11.10.3 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 Employer in writing. In the latter case also the conductor shall be dispatched only after satisfactory testing for all tests specified herein have been completed.

11.10.4 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.

11.11 Test Facilities

11.11.**1** The following additional test facilities shall be available at the Supplier's works:

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

b) Standard resistance for calibration of resistance bridges.

c) 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.

11.12 Electrical Resistance of Joints and Clamps

The maximum resistance, measured overall (primary measurement), of all joints shall not exceed 75 percent of the resistance of an equivalent length of conductor.

11.13 Records

During the course of the Work, the SIMM document (reference Clause 4.7) shall be updated with details of the actual phase conductor and earthwire erection sags, location of phase conductor and earthwire tension joints including repair sleeves and the electrical resistance of all joints and clamps including the name of the linesman responsible and the date of assembly.

APPENDIX 11.A1/1

CONDUCTOR - TYPES AND USES

132kV Overhead Portion

Conductor	**Phase**	**Earthwire**	**OPGW**
Designation (Code Name)	Grosbeak	G.S.Earthwire	Equaivalent of 7x3.25 mm Earthwire
Type	ACSR		
Standard	ASTM B232	BS 183 Grade 850	
Conductor Operating Temperature Range(°C)	5-80	4-53	
Minimum mass of grease (kg/km)	41	-	
Creep period of conductor to be considered (years)	20	-	
No. and diameter of Aluminum wire (No./mm)	26/3.973	-	
No. and diameter of Steel wire (No./mm)	7/3.089	7/ 3.25	
Overall diameter of wire (mm)	25.16	9.75	
Sectional Area of Aluminium (sq.mm)	322.3	-	
Total sectional area (sq.mm)	374.8	58.07	
Calculated DC resistamce at 20 deg. Celsius (ohm/km)	0.08959	-	
Overall section area of wire (㎟)	374.8	58.07	
Nominal breaking load (kN)	112	58	
Weight (kg/Km)	1,303	460	
Direction of external lay	Right hand	Right hand	
Details of Aluminium Strand:			
Min. Breaking load of strand before stranding (kN)	1.98		
Min. Breaking load of strand after stranding (kN)	1.88		
Min. DC resistamce of strand at 20 deg. Celsius (ohm/km)	2.25		
Details of Steel Strand:			
Min. Breaking load of strand before stranding (kN)	10.86		
Min. Breaking load of strand after stranding (kN)	10.3		
Min. Number of twists to be withstood in torsion test when tested on a gauge length of 100 times diameter of wire	18 (before stranding) and 16 (after stranding)		

APPENDIX 11.A1/2

CONDUCTOR - TYPES AND USES

132kV River crossing Portion

Conductor	Phase	Earthwire	OPGW
Designation (Code Name)	Mallard	G.S. Earthwire	Equaivalent of 7x4.25 mm Earthwire
Type	ACSR		
Standard	ASTM B232	BS 183 Grade 1150	
Conductor Operating Temperature Range(°C)	5-80	4-53	
Minimum mass of grease (kg/km)	51	-	
Creep period of conductor to be considered (years)	20	-	
No. and diameter of Aluminum wire (No./mm)	Al 30/4.135	-	
No. and diameter of Steel wire (No./mm)	St 19/2.482	7/ 4.25	
Overall diameter of wire (mm)	28.95	-	
Sectional Area of Aluminium (sq.mm)	-	-	
Total sectional area (sq.mm)	-	-	
Calculated DC resistance at 20 deg. Celsius (ohm/km)	-	-	
Overall section area of wire (㎟)	-	-	
Nominal breaking load (kN)	171.25	-	
Weight (kg/Km)	1,888	-	
Direction of external lay	Right hand	Right hand	
Details of Aluminium Strand:			
Min. Breaking load of strand before stranding (kN)	1.98		
Min. Breaking load of strand after stranding (kN)	1.88		
Min. DC resistamce of strand at 20 deg. Celsius (ohm/km)	2.25		
Details of Steel Strand:			
Min. Breaking load of strand before stranding (kN)	10.86		
Min. Breaking load of strand after stranding (kN)	10.3		
Min. Number of twists to be withstood in torsion test when tested on a gauge length of 100 times diameter of wire	18 (before stranding) and 16 (after stranding)		

APPENDIX 11.A2

SUB CONDUCTOR - CONFIGURATION

NOT APPLICABLE

APPENDIX 11.A3

CONDUCTOR SYSTEM LOADING

APPENDIX 11.A3/1

132kV Tower Line

Conductor		Phase	Earth-wire	Earthwire OPGW
Code name		**ACSR Grosbeak**	**7X3.25**	
Maximum Working Tension Condition				
Maximum horizontal tension	kN	56	29	50% of B.L.
Wind pressure	N/m²	1952	2147	2147
Temperature	°C	5	5	5
Everyday condition (still air)				
Maximum horizontal tension	kN	22	11	20% of B.L.
Temperature	°C	30	30	30
Erection Condition (still air)				
Maximum tangential tension	kN	N/A	N/A	N/A
Temperature	°C			
Sagging Limits of earthwire				
Sagging Limits of earthwire as a percentage of conductor sag	%	N/A	90	90
Conductor temperature	°C		5	5

Notes:

1. Wind pressures stated have been adjusted to take account of height and spatial effects.
2. B.L. is minimum breaking strength of OPGW.
3. OPGW to be sag matched to earthwire.

APPENDIX 11.A3/1

132kV Pole Line

Conductor		Phase	Earth-wire	Earthwire OPGW
Code name		**ACSR Grosbeak**	**7X3.25**	
Maximum Working Tension Condition				
Maximum horizontal tension	kN	35% of BL	-	-
Wind pressure	N/m²	1952	2147	2147
Temperature	°C	5	5	5
Everyday condition (still air)				
Maximum horizontal tension	kN	-	-	-
Temperature	°C	30	30	30
Erection Condition (still air)				
Maximum tangential tension	kN	N/A	N/A	N/A
Temperature	°C			
Sagging Limits of earthwire				
Sagging Limits of earthwire as a percentage of conductor sag	%	N/A	90	90
Conductor temperature	°C		5	5

Notes:

1. Wind pressures stated have been adjusted to take account of height and spatial effects.
2. B.L. is minimum breaking strength of OPGW.
3. OPGW to be sag matched to earthwire.

APPENDIX 11.A4/1

TEST PROCEDURE OF CONDUCTOR

ACSR

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 on a tensile testing machine. The load shall be increased at a steady rate upto 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 100% of the 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 this value shall be recorded.

1.2 Corona Extinction Voltage Test

NOT APPLICABLE

1.3 Radio Interference Voltage Test

NOT APPLICABLE

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 by placing the clamps initially zero metre and subsequently one metre 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 relevant IEC/BS/equivalent standard. The resistance corrected at 20^0C shall conform to the requirements indicated in the STP.

1.5 Chemical Analysis of Aluminium and Steel

Samples taken from the Aluminium and steel ingots/coils/strands shall be chemically/spectrographically analysed. The same shall be in conformity to the requirements stated in this Specification.

1.6 Visual and Dimensional Check on Drums

The drums shall be visually and dimensionally checked to ensure that they conform to the requirements of this Specification.

1.7 Visual Check for Joints, Scratches etc.

Conductor drums shall be rewound in the presence of the Purchaser. The Purchaser shall visually check for scratches, joints etc. and that the conductor generally conform to the requirements of this Specification. Five percent (5%) to ten percent (10%) drums from each lot shall be rewound in the presence of the Purchaser's representative. The actual quantity will be discussed and mutually agreed to by the Supplier & Purchaser in the Quality Assurance Programme.

1.8 Dimensional Check on Steel and Aluminium Strands

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

1.9 Check for Lay-ratios of Various Layers

The lay-ratios of various layers shall be checked to ensure that they conform to the requirements of this Specification.

1.10 Procedure Qualification test on welded Aluminium strands.

Two Aluminium/ 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 breaking strength of individual strands.

1.11 Chemical Analysis of Zinc

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

1.12 Galvanising Test

The test procedure shall be as specified in IEC: 60888. 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.

1.13 Torsion and Elongation Tests on Steel Strands

The test procedures shall be as per clause No. 10.3 of IEC : 60888. In torsion test, the number of complete twists before fracture shall not be less than that indicated in the STP. 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 4% for a gauge length of 250 mm.

1.14 Check on Barrel Batten strength of Drums

The details regarding barrel batten strength test will be discussed and mutually agreed to by the Supplier & Purchaser in the Quality Assurance Programme.

APPENDIX 11.A4/2

TEST PROCEDURE OF CONDUCTOR

AAAC

NOT APPLICABLE

APPENDIX 11.A4/2

TEST PROCEDURE OF STEEL EARTHWIRE

1.1 UTS Test

Circles perpendicular to the axis of the earthwire shall be marked at two places on a sample of earthwire of minimum 5 m length suitably compressed with dead end clamps at either end. The load shall be increased at a steady rate upto 50% of 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 100% of UTS and held for one minute. The earthwire 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 D.C. Resistance Test

On a earthwire 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 by placing the clamps initially at zero metre and subsequently one metre 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. The resistance corrected at 20^0C shall conform to the requirements of this Specification.

1.3 Chemical Analysis of Zinc

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

1.4 Chemical Analysis of Steel

Samples taken from the steel ingots/coils/strands shall be chemically,/ spectrographically analysed. The same shall be in conformity to the requirements stated in this Specification.

1.5 Visual and Dimensional Check on Drums and its barrel strength test.

The drums shall be visually and dimensionally checked to ensure that they conform to the requirements of this Specification. The details regarding barrel strength test will be discussed and mutually agreed to by Contractor and Purchaser in the quality assurance programme.

1.6 Visual Check for Joints, Scratches etc. and Length of Earthwire

Ten percent drums from each lot shall be rewound in the presence of the Purchaser. The Purchaser shall visually check for scratches, joints etc. and see that the earthwire generally conforms to the requirements of this Specification. The length of earthwire wound on the drum shall be measured with the help of counter meter during rewinding.

1.7 Dimensional Check

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

1.8 Lay Length Check

The lay length shall be checked to ensure that they conform to the requirements of this Specification.

1.9 Galvanising Test

The test procedure shall be as per relevant IEC/BS/equivalent standard. 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.

1.10 Torsion Test

The minimum number of twists which a single steel strand shall withstand during torsion test shall be eighteen for 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.

APPENDIX 11.Bl

ENGINEERING DOCUMENTS TO BE SUBMITTED BY CONTRACTOR

Clause Reference	Document Description	Comment
	As per requirement.	

APPENDIX 11.Cl

NOTIFICATION AND HOLD POINTS

Clause Reference.	Notification Point	Hold Point
11.2.1		Non standard conductor
11.6.1		Method statement
11.6.2		Conductor joint schedule
11.6.3		Repair Sleeves

APPENDIX 11.Dl

REFERENCE STANDARDS

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

IEC 60104: Aluminium-magnesium-silicon alloy wire for overhead line conductors
IEC 60888: Zinc coated steel wires for stranded conductors
IEC 60889: Hard drawn aluminium wire for overhead line conductors
IEC 61089: Round wire concentric lay overhead electrical stranded conductor
IEC 61232: Aluminium-clad steel wires for electrical purposes.

Cigre Electra No. 75 ' Permanent elongation of conductors. Predictor equation and evaluation method'. SC22 WG05.

ICAO - Aerodrome Annex 14 Volume 1 'Aerodrome Design and Operation'.

POWER GRID COMPANY OF BANGLADESH LIMITED

BIDDING DOCUMENT
FOR THE PROCUREMENT OF
PACKAGE-1: DESIGN, SUPPLY, ERECTION, TESTING & COMMISSIONING OF 132KV TRANSMISSION LINES AND SUBSTATIONS ON TURNKEY BASIS

LOT-1: TRANSMISSION LINES

SECTION 12

VIBRATION DAMPERS

SECTION 12 VIBRATION DAMPERS

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APPENDIX

SECTION 12 VIBRATION DAMPERS

12.1 SCOPE

12.1.1 General

Vibration dampers shall be either of the Stockbridge type comprising two weights attached via a messenger cable to a conductor clamp, or spiral type (SVD) for installation on the conductor, OPGW or all dielectric self supporting (ADSS) optical fibre cable for which the damper is designed.

12.1.2 Types and Uses

Reference shall be made to Appendix 12.A1 for details of the specified requirements.

12.2 DESIGN

12.2.1 When installed in accordance with the manufacturer's recommendations the vibration damper(s) shall limit the aeolian vibration levels so that the conductor bending strain in the surface of the outer wires, determined in accordance with the Cigre/IEEE recommendations, shall not exceed 300 micro-strains peak to peak at the vibration damper clamp and at the adjacent suspension clamp or tension joint (dead end). This requirement shall be met for all frequencies up to f=1480/d Hz, where d is the conductor diameter in mm. The manufacturer shall provide either suitable laboratory test results, field test results or calculations to demonstrate to the Employer's satisfaction that this requirement is met for each damper/conductor combination.

12.2.2 The vibration damper shall be designed to perform satisfactorily under the environmental factors, including conductor temperature variations, ultra-violet radiation, ozone and atmospheric pollutants applicable to the Site. The vibration damper shall not damage or cause corrosion to the conductor or individual strands when installed or during service.

12.2.3 The weights for Stockbridge type dampers can be of equal or unequal weight and can have symmetrical or unsymmetrical shape. They can also be symmetrically or asymmetrically located on the messenger cable.

12.2.4 SVD's shall be manufactured from solid poly-vinyl-chloride (PVC) rod.

12.2.5 Vibration damper clamps shall be designed to ensure that it is not possible for the vibration damper to be removed from the conductor, without initially undoing the clamp bolt. The clamp design shall also ensure that after the bolt has been correctly tightened, no slackening of the clamp can occur in service.

The clamp bolt shall be suitably modified to prevent them being completely removed inadvertently. Any nut shall be captive.

12.2.6 For OPGW and ADSS optical fibre cable, the transmission properties of the optical fibres shall be unaffected by the vibration damper. During installation the interface between the clamp and the conductor shall be filled with grease to exclude moisture and this fact shall be taken into account in the design.

12.2.7 The messenger cable shall comprise a suitable number of high tensile steel wire strands, (minimum number 19), shall be straight and sufficiently stiff to remain straight when the vibration damper is suspended by it's clamp. The attachment points of the cable to the clamp and to the weights shall be protected from water ingress. No relative movement shall be permitted between the clamp and the cable.

12.2.8 Damper weights shall be of a ferrous or zinc material and the design shall ensure that there is no contact between the weight and the conductor or the messenger cable when in service. Drain holes (minimum diameter 6mm) shall be provided where applicable to ensure that any water entering the weights can escape.

12.2.9 The active part length of SVD's must capture one loop length of vibration.

12.2.10 Dampers shall be free from visible and audible corona discharge and radio interference at the voltage levels specified except those designed exclusively for use on earthwires.

12.2.11 No audible noise shall be induced by the wind under any weather conditions.

12.3 MATERIALS

12.3.1 Materials used in the manufacture of vibration dampers shall be of:

(a) Adequate strength for the intended application, service life requirements and free from defects which would affect their performance;

(b) Shall not be liable to intergranular or stress corrosion;

(c) Compatible with the conductor material, such that there can be no deleterious effects on the conductor or vibration damper resulting from their use;

(d) The material shall not adversely be affected in the long term by a coating applied for corrosion protection.

12.3.2 Vibration damper clamps shall be made from aluminium or aluminium alloy of a suitable grade complying with the requirements of BS EN 1559, 1676 and 1706.

12.3.3 Messenger wires shall be made from high tensile steel wire having a minimum tensile strength of 1220 N/mm^2.

12.3.4 Malleable cast iron weights shall be made of a suitable grade complying with either BS EN 1562 or BS EN 1563. Grey cast iron weights shall be made of a suitable grade complying with BS EN 1561.

12.3.5 Cast zinc weights shall be made of a suitable grade complying with BS EN 1774 and 12844.

12.3.6 Bolts and nuts shall be ISO Metric Precision Hexagon to BS 3692. Metal washers shall be ISO Metric to BS 4320 "Bright Series", and spring washers shall be ISO Metric to BS 4464.

12.3.7 Non-metallic materials used shall have:

(a) A good resistance to ageing;

(b) Capable of withstanding service temperatures and voltages without detrimental change of properties;

(c) Adequate resistance to the effects of nitrogen oxides, ozone, ultra-violet radiation and air pollution over the whole range of service temperatures.

12.4 WORKMANSHIP

12.4.1 General

The dimensions of the vibration dampers shall be shown on the contract drawings, together with material types and grades, protective treatment and any other pertinent information. Contract drawings shall be submitted to the Employer for approval. **This is a Hold Point.**

12.4.2 Identification

All vibration dampers shall be marked to ensure a system of traceability. Where practicable, and unless otherwise agreed between the Employer and the manufacturer, vibration dampers shall be clearly and indelibly marked with 3mm minimum high characters as follows:

(a) Identification of vibration damper (reference number);

(b) Manufacturer's identification;

(c) Date of manufacture (month and year);

(d) Conductor diameter range, or designation;

(e) Clamp bolt installation torque.

In the case of SVD's the information required above shall be provided on tear-off labels.

12.4.3 Installation Criteria

The supplier shall be responsible for determining (a) the exact number of vibration dampers required for each individual phase in each span of the transmission line, (b) distance of the vibration damper from the suspension clamp or mouth of the tension joint (dead end), (c) in-span separation and (d) clamp bolt installation torque. The rate for supply of vibration damper shall be quoted accordingly.

12.5 PROTECTIVE TREATMENT

12.5.1 Vibration dampers shall either be inherently resistant to atmospheric corrosion, or suitably protected against corrosion, such as may occur in transit, storage and in service. All ferrous parts which will be exposed to the atmosphere in service except steel wire, shall be protected by hot-dipped galvanising to comply with the requirements of BS ISO 1461.

12.5.2 Steel messenger wires shall be hot-dipped galvanised to comply with the requirements of BS EN 10244-2.

12.5.3 The ingot zinc used for galvanising shall comply with the requirements of BS EN 1179.

12.5.4 All external threads shall be cut or rolled before hot-dipped galvanising. Nuts to be galvanised shall be subsequently tapped 0.4 mm oversize and threads oiled.

12.5.5 All galvanised materials shall be stored on packing, clear of the ground and away from all material that might stain or corrode the galvanising. Black steel packing or bins shall not be used.

12.6 QUALITY CONTROL

12.6.1 General

Type and sample tests shall be undertaken on the vibration dampers in accordance with the requirements of this specification.

Type tests specified in Clauses 12.6.2 to 12.6.8 shall be undertaken on a minimum of three samples which shall be identical in all essential details with the vibration dampers to be supplied.

Contract drawings previously submitted to the Employer shall be available at the time of testing.

The Contractor/Supplier shall give the Employer the requisite period of notice prior to undertaking the tests, and shall submit to the Employer a test program and procedures. **This is a Hold Point.**

12.6.2 Conductor Damage

An undamaged length of conductor shall be tensioned to approximately 20% of its nominal breaking load and the vibration damper clamp shall be installed using the recommended torque. The position of the clamp shall be marked and then removed from the conductors. No indentations in the outer strands of the conductor shall be present in the area of the clamp.

For vibration dampers used on fibre optic earthwire, to check for any degradation in the optical fibre signal strength, the above test set-up shall be reused, except that the clamp installation torque shall be twice the recommended value. The degradation of the optical fibre signal shall be measured using an optical power metre.

Using a similar test set-up to that described above a spiral vibration damper shall be installed. The position of the SVD shall be marked and then removed from the conductor. No indentations in the outer strands of the conductor shall be present in the area of contact of the SVD.

12.6.3 Clamp Grip

The axial grip of the clamp shall be measured on a 4m sample of greased conductor, Tensioned at 20% of its nominal breaking load. The end fixings of the tensioned Conductor shall be such as to prevent bird caging or slipping of the individual strands. With the vibration damper clamped at the recommended torque, a co-axial force of 2.5kN shall be applied to the clamp. The relative movement of the clamp shall not exceed 0.5mm after the 2.5kN has been held for one minute. The force shall then be increased until the manufacturer's design value has been reached, no additional movement should occur.

With a test set-up identical to that described above, the clamp bolt shall be tightened to twice the recommended installation torque. Where aluminium alloy shear head clamp bolts are used, they shall be replaced by high tensile steel bolts for this test. However, the aluminium alloy shear head clamp bolts shall be capable of withstanding 1.5 times the recommended installation torque. No damage shall occur to the clamp or its fasteners.

The axial grip of the SVD shall be measured using a similar test set-up described above. A co-axial tension of 2.5kN shall be applied to the SVD, the relative movement of the SVD shall not exceed 0.5mm after the 2.5kN tensile force has been applied for one minute.

12.6.4 Slip Test

On an assembled vibration damper an axial tensile force of 10kN (for conductor diameters up to 25mm) or 15kN (for conductor diameters greater than 25mm) shall be applied between the weights for one minute and the distance between the weights shall not increase by more than 2mm. The force shall then be increased until the manufacturers design value has been reached, no additional movement should occur.

12.6.5 Corona

All vibration dampers, other than those used exclusively for earthwire applications shall be erected as in service (which may necessitate representation of the tower body) and subjected to a visible corona test. Corona tests shall be undertaken in accordance with the recommendations of IEC 61284. The visible corona extinction voltage shall not be less than 0.8 times the nominal system voltage plus 5%. One sample shall be retained for reference purposes.

12.6.6 Vibration Damper Characteristics

This test is required to establish the characteristics of the vibration dampers used in the Damping Effectiveness test and the Fatigue test. Characteristics obtained before and after the Fatigue test shall be used as one of the acceptance criteria for the Fatigue test.

The vibration damper shall be mounted vertically on a shaker table and driven with constant table velocities of 0.05m/s and 0.10m/s over a given frequency range of 165/D to 1480/D where D is the conductor diameter in mm. The frequency shall be varied either continuously with a maximum 0.2 decade per minute, or step by step with a maximum interval of 1 Hz. When measuring using the step by step procedures the vibration must be stable at each step.

The following values shall be measured and plotted against frequency over the defined frequency range:

(a) Reaction Force (F_v)

(b) Phase shift between the reaction force and the velocity (Q)

(c) Damper power absorption, $Pw = 0.5F_vV\cos Q$

where F_v = reaction force (rms)

V= velocity (rms)

Q = phase shift

12.6.7 Damping Effectiveness

This test is intended to verify that the damping system i.e. the vibration damper installed on the conductor is efficient in protecting the conductor from fatigue damage. The test shall be carried out in accordance with IEC 61897 or equivalent standards.

The same damper which has been subjected to the test in accordance with Clause 12.6.6 shall be used.

This test shall also be undertaken using spiral vibration dampers.

The test shall be conducted on a laboratory span with a minimum length of 30 m. The test span shall be arranged in accordance with CIGRE guides Electra No. 62 and IEEE Std. 664. The conductor shall be tensioned to 20± 1 % of its nominal breaking load.

After the conductor has been tensioned, a square faced clamp shall be installed to rigidly support (but not to tension) the conductor at the same end of the span where the damper is to be rigidly installed. The vibration damper shall be installed on the conductor at the distance recommended by the Supplier from the clamp. If strain gauges are used they shall be mounted on the conductor outside of the square faced clamp and on either side of the vibration damper clamp or SVD. The strain gauges, at least two at each point, shall be mounted on the two uppermost strands, and within 2mm of the clamp to measure the highest stress at each point on the conductor. Alternatively, if bending amplitude of the conductor is measured this shall be undertaken at the same three points in span.

The test span shall be vibrated in steady waves within a given frequency range of 185/D, but not less than 8 Hz, to 1295/D, where D is the conductor diameter in mm. The power input for each tuneable harmonic shall be regulated to a strain of 150µm/m, peak-to-peak, at the most stressed point. Alternatively when bending amplitude is measured, the power input for each tuneable harmonic shall be regulated to a bending amplitude corresponding to a strain of 150µm/m, peak-to-peak, at the most stressed point. The bending amplitude at a distance of 89mm outside the last contact between the clamp and the conductor shall be determined in accordance with IEEE Standard 664.

The following values shall be measured at each tuneable harmonic:

(a) The power input from the shaker;

(b) The conductor antinode amplitude peak-to-peak in one of the first four loops nearest the vibration damper;

(c) The strain at the three measuring points of the test span or the bending amplitude at the same points.

The wind power input shall be calculated from the equation:

$$P = D^4 f^3 \text{ fnc } (Y/D)\ L$$

where P = calculated wind input (Watts)

D = conductor diameter (mm)

F = tuneable harmonic frequency (Hz)

Y = conductor antinode amplitude peak-to-peak (metres)

fnc (Y/D) = a function of conductor antinode amplitude peak-to peak, expressed in terms of conductor meter given in Figure 12-1.

L = span length defined in Appendix 12.A1

Diagrams with the following data plotted against the frequency for each tuneable harmonic within the given frequency shall be presented:

(a) Strain at all three measuring points or, bending amplitude at all three measuring points;

(b) Conductor antinode amplitude peak-to-peak;

(c) Power input from the shaker;

d) Calculated wind power input.

The acceptance criteria for this test, shall be that the measured input from the shaker must be greater than the calculated wind power input at all tuneable harmonics within the given frequency range.

12.6.8 Fatigue

The same vibration damper previously used for the Vibration Damper Characteristics and Damping Effectiveness tests shall be used.

The damper shall be attached to a shaker and driven in a vertical direction for 10^7 cycles. The frequency shall be the tuneable harmonic found in the damping effectiveness test, nearest to the frequency 555/D, where D is the conductor diameter in mm. The minimum peak-to-peak amplitude at the damper clamp shall be equal to the conductor antinode amplitude peak-to-peak measured at the corresponding harmonic.

After the fatigue test, the vibration damper shall again be subjected to the vibration damper characteristic test, to ensure that the dynamic behaviour of the vibration damper is maintained. The test shall be performed in an identical manner to that previously undertaken and the results shall be resented accordingly.

The acceptance criteria for this test, shall be that the characteristics of the vibration damper must not show any significant divergence's before and after the test. In addition a (destructive) examination of the messenger wires shall show none to be broken.

12.6.9 Sample Tests

The clamp grip and slip type tests shall be repeated as sample tests. In addition, verification of compliance with the "contract drawings" and that their shape and surface finish compares satisfactorily with the corona test reference sample shall also form part of the sample test.

The Supplier shall give the Employer the requisite period of notice prior to undertaking sample tests. **This is a Notification Point.**

The number of samples selected for test shall be in accordance with the following requirements, where "p" is the number of fittings to be tested, and "n" is the number of fittings produced in a batch:

$p = 4$ when $n \leq 500$

$$p = 4 + \frac{1.5n}{1000} \text{ when } n > 500$$

In addition to the sample tests defined above, a vibration damper characteristic test in accordance with Clause 12.6.6 shall be undertaken when requested by the Employer.

The reaction force and the phase angle between the reaction force and the velocity shall be measured and plotted against the frequency over the given frequency range. The corresponding curves for the type test shall also be plotted on the same graph.

If the randomly selected samples meet the test requirements, the batch(s) shall be deemed to comply with this Specification. In the event of any samples not meeting the requirements, a further set of "p" samples shall be tested. Should any further failure occur the whole batch(es) from which the samples have been selected shall be liable to rejection.

12.6.10 Galvanising

Tests for galvanised components of vibration dampers, shall be carried out at the works to ensure compliance with the requirements of BS ISO 1461 and BS EN 10244-2. Details of the test results shall be made available to the Employer.

Certificates relating to the ingot zinc used for galvanising shall also be made available to the Employer.

12.6.11 Test Certificates

All metallic materials used in the manufacture of vibration dampers shall be covered by test certificates stating their mechanical and chemical properties to show compliance with this Specification and IEC 61897, BS EN 1559, 1676, 1706, BS EN 1562, BS EN 1563, BS EN 1561, BS EN 1774, 12844 and BS EN 1676 as appropriate. Bolts and nuts shall be covered by the appropriate test certificate in respect of the test requirements of BS 3692.

Spiral vibration dampers shall be covered by the appropriate test certificate stating their mechanical and chemical properties. Test certificates for metallic, non-metallic materials and bolt and nuts shall be made available to the Employer. Test records, covering Type and Sample tests shall be made available to the Employer.

12.6.12 Certificate of Conformity

Copies of the following certificates/records shall also be forwarded:

(a) Metallic and non-metallic material test certificates

(b) Bolt and nut test certificates

(c) Galvanising test records

(d) Ingot zinc certificate

SECTION 12 VIBRATION DAMPERS

12.1 SCOPE

12.1.1 General

Vibration dampers shall be either of the Stockbridge type comprising two weights attached via a messenger cable to a conductor clamp, or spiral type (SVD) for installation on the conductor, OPGW or all dielectric self supporting (ADSS) optical fibre cable for which the damper is designed.

12.1.2 Types and Uses

Reference shall be made to Appendix 12.A1 for details of the specified requirements.

12.2 DESIGN

12.2.1 When installed in accordance with the manufacturer's recommendations the vibration damper(s) shall limit the aeolian vibration levels so that the conductor bending strain in the surface of the outer wires, determined in accordance with the Cigre/IEEE recommendations, shall not exceed 300 micro-strains peak to peak at the vibration damper clamp and at the adjacent suspension clamp or tension joint (dead end). This requirement shall be met for all frequencies up to f=1480/d Hz, where d is the conductor diameter in mm. The manufacturer shall provide either suitable laboratory test results, field test results or calculations to demonstrate to the Employer's satisfaction that this requirement is met for each damper/conductor combination.

12.2.2 The vibration damper shall be designed to perform satisfactorily under the environmental factors, including conductor temperature variations, ultra-violet radiation, ozone and atmospheric pollutants applicable to the Site. The vibration damper shall not damage or cause corrosion to the conductor or individual strands when installed or during service.

12.2.3 The weights for Stockbridge type dampers can be of equal or unequal weight and can have symmetrical or unsymmetrical shape. They can also be symmetrically or asymmetrically located on the messenger cable.

12.2.4 SVD's shall be manufactured from solid poly-vinyl-chloride (PVC) rod.

12.2.5 Vibration damper clamps shall be designed to ensure that it is not possible for the vibration damper to be removed from the conductor, without initially undoing the clamp bolt. The clamp design shall also ensure that after the bolt has been correctly tightened, no slackening of the clamp can occur in service.

The clamp bolt shall be suitably modified to prevent them being completely removed inadvertently. Any nut shall be captive.

12.2.6 For OPGW and ADSS optical fibre cable, the transmission properties of the optical fibres shall be unaffected by the vibration damper. During installation the interface between the clamp and the conductor shall be filled with grease to exclude moisture and this fact shall be taken into account in the design.

12.2.7 The messenger cable shall comprise a suitable number of high tensile steel wire strands, (minimum number 19), shall be straight and sufficiently stiff to remain straight when the vibration damper is suspended by it's clamp. The attachment points of the cable to the clamp and to the weights shall be protected from water ingress. No relative movement shall be permitted between the clamp and the cable.

12.2.8 Damper weights shall be of a ferrous or zinc material and the design shall ensure that there is no contact between the weight and the conductor or the messenger cable when in service. Drain holes (minimum diameter 6mm) shall be provided where applicable to ensure that any water entering the weights can escape.

12.2.9 The active part length of SVD's must capture one loop length of vibration.

12.2.10 Dampers shall be free from visible and audible corona discharge and radio interference at the voltage levels specified except those designed exclusively for use on earthwires.

12.2.11 No audible noise shall be induced by the wind under any weather conditions.

12.3 MATERIALS

12.3.1 Materials used in the manufacture of vibration dampers shall be of:

(a) Adequate strength for the intended application, service life requirements and free from defects which would affect their performance;

(b) Shall not be liable to intergranular or stress corrosion;

(c) Compatible with the conductor material, such that there can be no deleterious effects on the conductor or vibration damper resulting from their use;

(d) The material shall not adversely be affected in the long term by a coating applied for corrosion protection.

12.3.2 Vibration damper clamps shall be made from aluminium or aluminium alloy of a suitable grade complying with the requirements of BS EN 1559, 1676 and 1706.

12.3.3 Messenger wires shall be made from high tensile steel wire having a minimum tensile strength of 1220 N/mm².

12.3.4 Malleable cast iron weights shall be made of a suitable grade complying with either BS EN 1562 or BS EN 1563. Grey cast iron weights shall be made of a suitable grade complying with BS EN 1561.

12.3.5 Cast zinc weights shall be made of a suitable grade complying with BS EN 1774 and 12844.

12.3.6 Bolts and nuts shall be ISO Metric Precision Hexagon to BS 3692. Metal washers shall be ISO Metric to BS 4320 "Bright Series", and spring washers shall be ISO Metric to BS 4464.

12.3.7 Non-metallic materials used shall have:

(a) A good resistance to ageing;

(b) Capable of withstanding service temperatures and voltages without detrimental change of properties;

(c) Adequate resistance to the effects of nitrogen oxides, ozone, ultra-violet radiation and air pollution over the whole range of service temperatures.

12.4 WORKMANSHIP

12.4.1 General

The dimensions of the vibration dampers shall be shown on the contract drawings, together with material types and grades, protective treatment and any other pertinent information. Contract drawings shall be submitted to the Employer for approval. **This is a Hold Point.**

12.4.2 Identification

All vibration dampers shall be marked to ensure a system of traceability. Where practicable, and unless otherwise agreed between the Employer and the manufacturer, vibration dampers shall be clearly and indelibly marked with 3mm minimum high characters as follows:

(a) Identification of vibration damper (reference number);

(b) Manufacturer's identification;

(c) Date of manufacture (month and year);

(d) Conductor diameter range, or designation;

(e) Clamp bolt installation torque.

In the case of SVD's the information required above shall be provided on tear-off labels.

12.4.3 Installation Criteria

The supplier shall be responsible for determining (a) the exact number of vibration dampers required for each individual phase in each span of the transmission line, (b) distance of the vibration damper from the suspension clamp or mouth of the tension joint (dead end), (c) in-span separation and (d) clamp bolt installation torque. The rate for supply of vibration damper shall be quoted accordingly.

12.5 PROTECTIVE TREATMENT

12.5.1 Vibration dampers shall either be inherently resistant to atmospheric corrosion, or suitably protected against corrosion, such as may occur in transit, storage and in service. All ferrous parts which will be exposed to the atmosphere in service except steel wire, shall be protected by hot-dipped galvanising to comply with the requirements of BS ISO 1461.

12.5.2 Steel messenger wires shall be hot-dipped galvanised to comply with the requirements of BS EN 10244-2.

12.5.3 The ingot zinc used for galvanising shall comply with the requirements of BS EN 1179.

12.5.4 All external threads shall be cut or rolled before hot-dipped galvanising. Nuts to be galvanised shall be subsequently tapped 0.4 mm oversize and threads oiled.

12.5.5 All galvanised materials shall be stored on packing, clear of the ground and away from all material that might stain or corrode the galvanising. Black steel packing or bins shall not be used.

12.6 QUALITY CONTROL

12.6.1 General

Type and sample tests shall be undertaken on the vibration dampers in accordance with the requirements of this specification.

Type tests specified in Clauses 12.6.2 to 12.6.8 shall be undertaken on a minimum of three samples which shall be identical in all essential details with the vibration dampers to be supplied.

Contract drawings previously submitted to the Employer shall be available at the time of testing.

The Contractor/Supplier shall give the Employer the requisite period of notice prior to undertaking the tests, and shall submit to the Employer a test program and procedures. **This is a Hold Point.**

12.6.2 Conductor Damage

An undamaged length of conductor shall be tensioned to approximately 20% of its nominal breaking load and the vibration damper clamp shall be installed using the recommended torque. The position of the clamp shall be marked and then removed from the conductors. No indentations in the outer strands of the conductor shall be present in the area of the clamp.

For vibration dampers used on fibre optic earthwire, to check for any degradation in the optical fibre signal strength, the above test set-up shall be reused, except that the clamp installation torque shall be twice the recommended value. The degradation of the optical fibre signal shall be measured using an optical power metre.

Using a similar test set-up to that described above a spiral vibration damper shall be installed. The position of the SVD shall be marked and then removed from the conductor. No indentations in the outer strands of the conductor shall be present in the area of contact of the SVD.

12.6.3 Clamp Grip

The axial grip of the clamp shall be measured on a 4m sample of greased conductor, Tensioned at 20% of its nominal breaking load. The end fixings of the tensioned Conductor shall be such as to prevent bird caging or slipping of the individual strands. With the vibration damper clamped at the recommended torque, a co-axial force of 2.5kN shall be applied to the clamp. The relative movement of the clamp shall not exceed 0.5mm after the 2.5kN has been held for one minute. The force shall then be increased until the manufacturer's design value has been reached, no additional movement should occur.

With a test set-up identical to that described above, the clamp bolt shall be tightened to twice the recommended installation torque. Where aluminium alloy shear head clamp bolts are used, they shall be replaced by high tensile steel bolts for this test. However, the aluminium alloy shear head clamp bolts shall be capable of withstanding 1.5 times the recommended installation torque. No damage shall occur to the clamp or its fasteners.

The axial grip of the SVD shall be measured using a similar test set-up described above. A co-axial tension of 2.5kN shall be applied to the SVD, the relative movement of the SVD shall not exceed 0.5mm after the 2.5kN tensile force has been applied for one minute.

12.6.4 Slip Test

On an assembled vibration damper an axial tensile force of 10kN (for conductor diameters up to 25mm) or 15kN (for conductor diameters greater than 25mm) shall be applied between the weights for one minute and the distance between the weights shall not increase by more than 2mm. The force shall then be increased until the manufacturers design value has been reached, no additional movement should occur.

12.6.5 Corona

All vibration dampers, other than those used exclusively for earthwire applications shall be erected as in service (which may necessitate representation of the tower body) and subjected to a visible corona test. Corona tests shall be undertaken in accordance with the recommendations of IEC 61284. The visible corona extinction voltage shall not be less than 0.8 times the nominal system voltage plus 5%. One sample shall be retained for reference purposes.

12.6.6 Vibration Damper Characteristics

This test is required to establish the characteristics of the vibration dampers used in the Damping Effectiveness test and the Fatigue test. Characteristics obtained before and after the Fatigue test shall be used as one of the acceptance criteria for the Fatigue test.

The vibration damper shall be mounted vertically on a shaker table and driven with constant table velocities of 0.05m/s and 0.10m/s over a given frequency range of 165/D to 1480/D where D is the conductor diameter in mm. The frequency shall be varied either continuously with a maximum 0.2 decade per minute, or step by step with a maximum interval of 1 Hz. When measuring using the step by step procedures the vibration must be stable at each step.

The following values shall be measured and plotted against frequency over the defined frequency range:

(a) Reaction Force (F_v)

(b) Phase shift between the reaction force and the velocity (Q)

(c) Damper power absorption, $Pw = 0.5F_vV\cos Q$

where F_v = reaction force (rms)

V= velocity (rms)

Q = phase shift

12.6.7 Damping Effectiveness

This test is intended to verify that the damping system i.e. the vibration damper installed on the conductor is efficient in protecting the conductor from fatigue damage. The test shall be carried out in accordance with IEC 61897 or equivalent standards.

The same damper which has been subjected to the test in accordance with Clause 12.6.6 shall be used.

This test shall also be undertaken using spiral vibration dampers.

The test shall be conducted on a laboratory span with a minimum length of 30 m. The test span shall be arranged in accordance with CIGRE guides Electra No. 62 and IEEE Std. 664. The conductor shall be tensioned to 20± 1 % of its nominal breaking load.

After the conductor has been tensioned, a square faced clamp shall be installed to rigidly support (but not to tension) the conductor at the same end of the span where the damper is to be rigidly installed. The vibration damper shall be installed on the conductor at the distance recommended by the Supplier from the clamp. If strain gauges are used they shall be mounted on the conductor outside of the square faced clamp and on either side of the vibration damper clamp or SVD. The strain gauges, at least two at each point, shall be mounted on the two uppermost strands, and within 2mm of the clamp to measure the highest stress at each point on the conductor. Alternatively, if bending amplitude of the conductor is measured this shall be undertaken at the same three points in span.

The test span shall be vibrated in steady waves within a given frequency range of 185/D, but not less than 8 Hz, to 1295/D, where D is the conductor diameter in mm. The power input for each tuneable harmonic shall be regulated to a strain of 150µm/m, peak-to-peak, at the most stressed point. Alternatively when bending amplitude is measured, the power input for each tuneable harmonic shall be regulated to a bending amplitude corresponding to a strain of 150µm/m, peak-to-peak, at the most stressed point. The bending amplitude at a distance of 89mm outside the last contact between the clamp and the conductor shall be determined in accordance with IEEE Standard 664.

The following values shall be measured at each tuneable harmonic:

(a) The power input from the shaker;

(b) The conductor antinode amplitude peak-to-peak in one of the first four loops nearest the vibration damper;

(c) The strain at the three measuring points of the test span or the bending amplitude at the same points.

The wind power input shall be calculated from the equation:

$$P = D^4 f^3 \text{ fnc } (Y/D)\ L$$

where P = calculated wind input (Watts)

D = conductor diameter (mm)

F = tuneable harmonic frequency (Hz)

Y = conductor antinode amplitude peak-to-peak (metres)

fnc (Y/D) = a function of conductor antinode amplitude peak-to peak, expressed in terms of conductor meter given in Figure 12-1.

L = span length defined in Appendix 12.A1

Diagrams with the following data plotted against the frequency for each tuneable harmonic within the given frequency shall be presented:

(a) Strain at all three measuring points or, bending amplitude at all three measuring points;

(b) Conductor antinode amplitude peak-to-peak;

(c) Power input from the shaker;

d) Calculated wind power input.

The acceptance criteria for this test, shall be that the measured input from the shaker must be greater than the calculated wind power input at all tuneable harmonics within the given frequency range.

12.6.8 Fatigue

The same vibration damper previously used for the Vibration Damper Characteristics and Damping Effectiveness tests shall be used.

The damper shall be attached to a shaker and driven in a vertical direction for 10^7 cycles. The frequency shall be the tuneable harmonic found in the damping effectiveness test, nearest to the frequency 555/D, where D is the conductor diameter in mm. The minimum peak-to-peak amplitude at the damper clamp shall be equal to the conductor antinode amplitude peak-to-peak measured at the corresponding harmonic.

After the fatigue test, the vibration damper shall again be subjected to the vibration damper characteristic test, to ensure that the dynamic behaviour of the vibration damper is maintained. The test shall be performed in an identical manner to that previously undertaken and the results shall be resented accordingly.

The acceptance criteria for this test, shall be that the characteristics of the vibration damper must not show any significant divergence's before and after the test. In addition a (destructive) examination of the messenger wires shall show none to be broken.

12.6.9 Sample Tests

The clamp grip and slip type tests shall be repeated as sample tests. In addition, verification of compliance with the "contract drawings" and that their shape and surface finish compares satisfactorily with the corona test reference sample shall also form part of the sample test.

The Supplier shall give the Employer the requisite period of notice prior to undertaking sample tests. **This is a Notification Point.**

The number of samples selected for test shall be in accordance with the following requirements, where "p" is the number of fittings to be tested, and "n" is the number of fittings produced in a batch:

$p = 4$ when $n \leq 500$

$$p = 4 + \frac{1.5n}{1000} \text{ when } n > 500$$

In addition to the sample tests defined above, a vibration damper characteristic test in accordance with Clause 12.6.6 shall be undertaken when requested by the Employer.

The reaction force and the phase angle between the reaction force and the velocity shall be measured and plotted against the frequency over the given frequency range. The corresponding curves for the type test shall also be plotted on the same graph.

If the randomly selected samples meet the test requirements, the batch(s) shall be deemed to comply with this Specification. In the event of any samples not meeting the requirements, a further set of "p" samples shall be tested. Should any further failure occur the whole batch(es) from which the samples have been selected shall be liable to rejection.

12.6.10 Galvanising

Tests for galvanised components of vibration dampers, shall be carried out at the works to ensure compliance with the requirements of BS ISO 1461 and BS EN 10244-2. Details of the test results shall be made available to the Employer.

Certificates relating to the ingot zinc used for galvanising shall also be made available to the Employer.

12.6.11 Test Certificates

All metallic materials used in the manufacture of vibration dampers shall be covered by test certificates stating their mechanical and chemical properties to show compliance with this Specification and IEC 61897, BS EN 1559, 1676, 1706, BS EN 1562, BS EN 1563, BS EN 1561, BS EN 1774, 12844 and BS EN 1676 as appropriate. Bolts and nuts shall be covered by the appropriate test certificate in respect of the test requirements of BS 3692.

Spiral vibration dampers shall be covered by the appropriate test certificate stating their mechanical and chemical properties. Test certificates for metallic, non-metallic materials and bolt and nuts shall be made available to the Employer. Test records, covering Type and Sample tests shall be made available to the Employer.

12.6.12 Certificate of Conformity

Copies of the following certificates/records shall also be forwarded:

(a) Metallic and non-metallic material test certificates

(b) Bolt and nut test certificates

(c) Galvanising test records

(d) Ingot zinc certificate

APPENDIX 12.A1

VIBRATION DAMPERS TYPES & USES

132kV RIVER CROSSING PORTION

Parameters	CONDUCTOR TYPE		
	Phase	Earthwire	OPGW
Conductor Designation	ACSR Mallard	7 x 4.25	To match with 7x4.25 steel earthwire
Conductor Material	ACSR	Steel	-
Armour Rods Fitted	YES	YES	YES
Standard Span (m)	100-750-250 250-500-100	100-750-250 250-500-100	100-750-250 250-500-100
Everyday Temperature (°C) Everyday Tension (kN)	30 33.76	30 22.8	30 Sag matched to 7x4.25 steel eartwire
Vibration Damper Type	Stockbridge	Stockbridge	Stockbridge

APPENDIX 12.A2

VIBRATION DAMPERS TYPES & USES

132KV OVERLAND PORTION

Parameters	**CONDUCTOR TYPE**		
	Phase	**Earthwire**	**OPGW**
Conductor Designation	636 Grosbeak	7x 3.25	To match 7 x 3.25
Conductor Material	ACSR	S	S
Armour Rods Fitted	YES	NO	YES
Standard Span (m)	330	330	330
Everyday Temperature (°C) Everyday Tension (kN)	30 22	30 11	30 Sag matched to 7 x 3.25
Vibration Damper Type	Stockbridge	Stockbridge	Stockbridge

APPENDIX 12.B1

ENGINEERING DOCUMENTS TO BE SUBMITTED BY CONTRACTOR

Clause Ref.	Document Description	Comments
12.4.1	Vibration dampers - Contract drawings	
12.4.3	Installation procedures	
12.6.1	Type Test programme and procedures	
12.6.1	Vibration dampers - Type Test Certificates	
12.6.10	Galvanising test results	
12.6.10	Ingot zinc certificates	
12.6.11	Metallic material test certificates	
12.6.11	Bolts and nut material type test certificates	
12.6.11	Vibration dampers - Type test results	
12.6.11	Vibration dampers - Sample test results	
12.6.12	Certificate of Conformity	

APPENDIX 12.C1

NOTIFICATION AND HOLD POINTS

Clause Ref.	**Notification Points**	**Hold Points**
12.4.1		Contract drawings
12.6.1		Vibration dampers-type tests.
12.6.9	Vibration Dampers-Sample Tests	

APPENDIX 12.Dl

REFERENCE STANDARDS

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

IEC 61284:	Overhead lines - Requirements and tests for fittings
IEC 61897:	Overhead lines – Requirements and tests for stockbridge dampers
BS EN 10244-2:	Testing zinc coatings on steel wire for quality requirements
BS EN ISO 1461:	Specification for hot-dipped galvanising coating on iron and steel articles
BS EN 1774:	Specification for zinc alloys for die castings and zinc alloy die castings
BS EN 12844	
BS EN 1561:	Specification for flake graphite cast iron
BS EN 1559:	Specification for aluminium and aluminium alloy ingots and castings for general engineering purposes
BS EN 1676	
BS EN 1706	
BS EN 1563:	Specification for spherodical graphite cast iron
BS EN 1179:	Specification for ingot zinc
BS 3692:	Specification for ISO Metric hexagon bolts, screws and nuts
BS 4320:	Specification for metal washers for general engineering purposes. Metric series.
BS 4464:	Specification for Spring Washers for general engineering and automobile purposes. Metric series.
BS EN 1562:	Specification for Malleable cast iron
BS EN 1676:	Aluminium and aluminium alloys - Alloyed ingots for remelting

IEEE Trans Vol. PAS-85 (1966) No. 1 "Standardisation of Conductor Vibration Measurement"
IEEE Std. 664: "Guide to Laboratory Measurement of the Power Dissipation Characteristics for Aeolian Vibration Dampers for Single Conductors".

POWER GRID COMPANY OF BANGLADESH LIMITED

BIDDING DOCUMENT
FOR THE PROCUREMENT OF
PACKAGE-1: DESIGN, SUPPLY, ERECTION, TESTING & COMMISSIONING OF 132KV TRANSMISSION LINES AND SUBSTATIONS ON TURNKEY BASIS

LOT-1: TRANSMISSION LINES

SECTION 13

SPACER DAMPERS

SECTION 13 SPACER DAMPERS

(NOT USED)

POWER GRID COMPANY OF BANGLADESH LIMITED

BIDDING DOCUMENT
FOR THE PROCUREMENT OF
PACKAGE-1: DESIGN, SUPPLY, ERECTION, TESTING & COMMISSIONING OF 132KV TRANSMISSION LINES AND SUBSTATIONS ON TURNKEY BASIS

LOT-1: TRANSMISSION LINES

SECTION 14

OPTICAL FIBRE CABLE AND FITTINGS

SECTION 14 OPTICAL FIBRE CABLE AND FITTINGS

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APPENDIX

SECTION 14 OPTICAL FIBRE CABLE AND FITTINGS

14.1 SCOPE

14.1.1 General

This section of the specification covers optical fibre cable suitable for incorporation into the earthwire (OPGW), associated fittings and non-metallic underground fibre optic cable.

14.1.2 Types and Uses

For details of the specified requirements reference shall be made to Appendices 14.Al to 14.A3.

14.2 DESIGN

14.2.1 Reliability

The overall system design of the fibre optic system shall meet the following minimum requirements:

(a) Single failure or degradation in any optical fibre not more than one per year averaged over five years;

(b) Failures or degradations affecting more than one optical fibre, not more than one in ten years;

(c) Increase in optical system transmission attenuation due to accumulated ageing and other effects at the end of five years not more than 0.05 dB/km.

14.2.2 Fibre Optic Earthwire (OPGW)

The fibre optic earthwire to be supplied shall be suitable for installation on transmission lines, and shall be supplied complete with all necessary fittings and optical joint boxes. The earthwire, fittings and optical joint boxes shall be type approved.

The fibre optic earthwire shall comprise an optical sub-unit containing optical fibres, over which shall be laid aluminium, aluminium alloy or aluminium coated steel strands. Reference should be made to Section 11 for pertinent details of the overall earthwire.

The optical sub-unit shall withstand the temperature rise associated with the specified lightning fault current flowing in the earthwire without damage. The fibre optic earthwire shall be manufactured in continuous lengths of not less than 3km.

14.2.2 Optical Fibres

Optical fibres shall be single mode fibre. The fibres shall be coded for ready identification at each end. Single mode fibres shall conform to CCITT G652 or to IEC 60793-2-B1 and Appendix 14.A3.

The optical fibre coating material shall be mechanically strippable. The optical fibres shall be capable of being joined by fusion splicing techniques.

There shall be no measurable long term or short term optical attenuation change due to the temperature rise associated with a fault current flowing in an earthwire, or a lightning strike on the earthwire.

The optical fibres shall not be subjected to any critical stresses when the cable is at its maximum system loading, reference Appendix 11.A3/1.

After finalisation of the drum lengths, the Contractor/Supplier shall submit calculations for the expected overall attenuation and dispersion. **This is a Hold Point.** This will be compared with the actual values measured after a completion of the installation.

14.2.3 OPGW Fittings

The fibre optic earthwire shall be used with approved conductor fittings in accordance with Section 10 & 12 of the Specification. The application of these fittings shall not damage the earthwire or the fibres, either mechanically or optically.

At each support, a bypass device shall be provided to guide the cable around the earthwire fittings associated with the support.

Earthwire bonds similar to those specified in Section 10 of the specification shall be provided.

The cable run from the earthwire to the splice enclosure shall be secured to the support and suitable protection shall be provided to prevent damage from shotgun attack or other accidental means.

14.2.4 Optical Joint Boxes

Optical joint boxes shall be provided to protect the splice joints of optical fibres, either when individual lengths of fibre optic OPGW, are jointed, or between the fibre optic earthwire and the underground fibre optic cable. The optical joint boxes shall protect the splice joint from both mechanical and environmental damage.

The optical joint boxes shall preferably be of hood/dome type with single end plate in bottom and shall be fitted to the support immediately above the anti-climbing device.

The joint boxes shall consist of an external steel or die cast aluminium housing and provide protection to IEC 60529 IP447, and an internal die cast aluminium or high impact plastic ABS box to IEC 60529 IP54.

The external housing shall be designed so that rain water is directed-away from the door, and there shall be no water ingress when the door is opened.

The door of the box shall be fitted with captive hinges and shall be fastened shut by screw fixings. A hasp shall be provided on the door capable of taking a 10mm padlock.

The bottom of the box shall be fitted with two gland plates, each gland plate shall have two entry points. The gland plates shall be interchangeable, one style shall be used for fibre optic earthwire, the other for underground fibre optic cable. The joint boxes shall be supplied complete with all fittings to secure and seal the cable in the gland plates or blank the unused spigots. Cable cleats to secure the fibre optic OPGW or underground cable shall be fitted inside the box. The cleats shall not have a detrimental effect on the performance of the optical fibres when tightened to the recommended torque.

The top and bottom of the joint box shall be vented, and the vents provided with vermin shields.

An M12 earthing boss complete with an M12 galvanised nut and lock washers shall be provided on the outside of the box.

The interior box shall be mounted on brackets inside the external housing and shall be capable of easy removal, complete with the optical fibre tails. The seal around the box shall be capable of withstanding specified temperatures.

The box shall be supplied complete with internal splice cassettes to accommodate the required number of splices. Glands shall be fitted to accommodate either the fibre optic OPGW, or underground fibre optic cable.

14.2.5 Fixing Clamps

A bolted clamping system shall be used to attach the OPGW to the inside of the support without drilling or modifications to the support steelwork. The clamping system shall be capable of use with galvanised steel angle sections varying between 40 and 200mm wide and accommodating either single, double or multiple lengths of OPGW.

The attachment clamps shall be capable of being attached and detached from the support, without affecting the OPGW.

14.2.6 Non-Metallic Underground Fibre Optic Cable

The fibre optic cable shall be circular in cross section and shall be designed so that any cable strain is not directly imported on the optical fibres. The cables shall not include any metallic components, to prevent high induced voltages when used in switching or substation compounds.

Optical fibres shall be in accordance with Clause 14.2.5 and shall match the OPGW, fibres in type and colour.

14.3 MATERIALS

14.3.1 Fibre Optic Earthwire

External aluminium, aluminium alloy or aluminium coated steel strands shall be in accordance with the requirements of Section 11 of the specification.

14.3.2 Optical Joint Boxes

Optical joint boxes shall be made from either a suitable grade of aluminium alloy complying with the requirement of BS EN 1559, 1676, 1706 and/or BS EN 1676, or steel complying with requirements of BS 3100.

14.3.3 Fixing Clamps

Fixing clamps shall be made from a suitable grade of aluminium alloy comprising with the requirements of BS EN 1559, 1676, 1706 and/or BS EN 1676. Bolt quality shall be grade 4.6 according to ISO 898-1. Bolts and nuts shall be ISO Metric Black Hexagon to BS 4190, and shall unless otherwise specified be threaded ISO Metric Coarse Pitch to BS 3643: Part2, Tolerance Class 7h/8g.

14.4 WORKMANSHIP

14.4.1 Contract Drawings

Contract drawings for fixing clamps and optical joint boxes shall in addition to the dimension show material types and grades, protective treatment and any other pertinent information. Contract drawings shall be submitted to the Employer. **This is a Hold Point**.

14.5 PROTECTIVE TREATMENT

14.5.1 Fibre Optic Earthwire

Where two layers of wire strands are provided over the optical sub-unit, the external surface of the optical sub-unit and the inner strand layer shall be greased, using an approved conductor grease (Ref.: Section 11 of the Specification).

14.5.2 Ingress of Moisture

The cable shall be capped before shipment to prevent the ingress of water.

14.5.3 Optical Joint Boxes

Optical joint boxes (steel exterior housings) shall be hot dipped galvanised after manufacture to meet the requirements of BS ISO 1461. The boxes shall be sufficiently rigid so that there is no distortion of either the box or its door after galvanising.

14.6 INSTALLATION

14.6.1 General

The supplier of the OPGW, will be responsible for the supervision of installation by the Contractor, to ensure that overall system reliability requirements are met. To ensure that this is undertaken, the supplier will provide the services of a suitably qualified/experienced installation supervisor, who shall supervise the installation of the Works and shall advise the Engineer and the Contractor in matters of methods procedures and precautions to be followed and will be responsible for all matters pertaining to the quality of the installation. The supplier's installation supervisor shall make at least four visits of 2(two) weeks each during progress of OPGW installation work for the purpose.

The Contractor shall provide the Employer with a method statement giving sequential details of the stripping procedure and the optical fibre jointing (splicing) procedure. The method statement shall take full cognisance of the manufacturer's installation instructions.

The method statement shall be submitted to the Employer for acceptance the requisite period prior to stringing or optical fibre jointing commences. **This a Hold Point.**

14.6.2 Workmanship

The Contractor shall ensure that the fibre optic cables are not strained or damaged either mechanically or optically during stringing and/or jointing. If necessary the Contractor shall demonstrate the suitability of his proposed method, including the choice of running blocks prior to the commencement of stringing operations.

14.6.3 Optical Fibre Joints

Optical fibre joints either in the OPGW, or between the OPGW, and the non-metallic underground fibre optic able shall be housed in optical joint boxes. The joint boxes shall be located immediately above the anti-climbing device for convenient access by technical personnel. All joint boxes shall be earthed to the support steelwork using approved multi-wire/multi-strand flexible aluminium earthing bonds.

14.7 QUALITY CONTROL

14.7.1 General

Type, sample and routine tests shall be undertaken on OPGW, their associated fittings, non metallic underground fibre optic cable and the optical fibres in accordance with the requirements of this Specification, CCITT G652, IEC 60793 and IEC 60794 as appropriate. Contract drawings previously submitted to the Employer shall be available at the time of testing.

The Contractor/Supplier shall give the Employer the requisite period of notice prior to undertaking the tests, and shall submit to the Employer a test programme and procedures for approval. **This is a Hold Point.**

14.7.2 OPGW

14.7.2.1 Type Test

(a) Stress-strain

A sample of OPGW not less than 10m length, complete with the proposed end fittings shall be subject to a stress-strain test. The test shall be undertaken in accordance with IEC 61089 Annex B and the measuring techniques in accordance with IEC 60794-1-El. There shall be no visual change to the OPGW strands after the test and that the fibre strain must be less than 0.05% at 85% of the UTS of the cable.

(b) Tensile Performance

The test shall be undertaken in accordance with the load conditions specified in IEC 61089 Annex B and the measuring techniques in accordance with IEC 60794-1 El. There shall be no permanent change in the fibre attenuation at the specified wavelength after the test, while the change in attenuation during the test shall be less than 0.05db/km from zero load to 85% of the UTS of the cable.

(c) Crush and Impact

The tests shall be undertaken in accordance with the recommendations of IEC 60794 - 1 -E3 and IEC-60794 - 1 -E4.

The crush test shall be undertaken by applying a 10kN load for 1min to the OPGW via two 50 x 50 mm flat plates. There shall be no measurable permanent change in the fibre attenuation at the specified wavelength, while any temporary change in attenuation shall be less than 0.1db.

The impact test shall be undertaken by dropping a 4kg weight from a height of 150mm onto the end of a 20mm diameter steel mandrel placed on the OPGW. After 20 repeated applications, there shall be no measurable change in fibre attenuation at the specified wavelength, while any temporary change in attenuation shall be less than 0.1db.

(d) Temperature Cycling

The optical performance under temperature cycling shall be tested in accordance with IEC 60794-1-F1 with T_A and T_B as specified in Appendix 14.A1 and the duration of 4 hours. The test should be undertaken twice.

(e) Water Ingress

The optical sub-unit shall be tested for water ingress in accordance with IEC 60794-1-F5.

(f) Fault Current

A sample of OPGW not less than 2m in length shall be subject to a fault current pulse. The fault current pulse specified in Appendix 14.A1 shall be supplied in less than 1s after the conductor has been raised to the specified initial temperature. During the test the temperature of the optical sub-unit shall be measured, the temperature immediately after the current pulse shall be less than the specified temperatures. The test shall be performed twice with an interval of 30min between tests. After the second impulse the OPGW shall be dismantled and the optical cable examined throughout its length for any signs of deterioration.

(i) Lightning Strike

The Contractor shall submit his proposals to the Employer to demonstrate the effectiveness of the OPGW to withstand the effects of a lightning strike. The test shall consider both an initial stroke and a power follow through. The initial peak current shall be as specified in Appendix 14.A1. The test shall be carried out on a sample of OPGW not less than 2m long. The acceptance criteria shall be that earthwire's calculated residual strength is not less than 90% of the original stated ultimate tensile strength. Any damaged strands shall be assumed to be broken.

14.7.2.2 Routine Test

OPGW on all drums shall be tested for mechanical Tests including measurement of dimensions of steel and aluminium (Al) wires and overall diameter of OPGW, measurements of thickness of Al on ACS wires, twist test of steel & Al wires, torsion test of steel wires, checking of lay length & lay ratio of layers, checking of lay directions, breaking load test of steel and Al wires and DC resistance measurement of Al and ACS wires at the factory by the manufacturer as routine tests.

In addition, attenuation shall be measured on each fibre of all OPGW with OTDR at the factory by the manufacturer as routine test.

The test results shall be available with the manufacturer and shall be submitted to the Employer, if requested.

14.7.2.3 Sample Test

Samples taken on random sampling basis from the OPGW drums ready for shipment against each batch shall be tested for mechanical tests including measurement of dimensions of steel and aluminium (Al) wires and overall diameter of OPGW, measurements of thickness of Al on ACS wires, twist test of steel & Al wires, torsion test of steel wires, checking of lay length & lay ratio of layers, checking of lay directions, breaking load test of steel and Al wires and DC resistance measurement of Al and ACS wires at the factory by the manufacturer which may be witnessed by the Employer’s representative.

In addition, attenuation shall also be measured on each fibre of above mentioned sample drums of OPGW with OTDR.

14.7.3 Optical Fibres

Optical fibres shall be tested in accordance with the requirements of CCITT G652 and IEC 60793 as appropriate.

14.7.4 Optical Joint Boxes

Optical joint boxes shall be visually inspected to ensure they meet the specified requirements. If the external housing or its door shows any signs of distortion or any galvanising damage then the box shall be rejected. Details of the inspection shall be recorded and shall be made available to the Engineer upon request.

14.7.5 Non-metallic Underground Fibre Optic Cable

Non metallic underground fibre optic cable and the optical fibres shall be tested in accordance with the requirements of CCITT G652, IEC 60793 and IEC 60794 as appropriate.

14.7.6 Fibre Optic Cables

All fibre optic cables shall be tested prior to despatch using an OTDR on each fibre.

14.7.7 Test Certificates

Test records, covering Type and Sample tests shall be made available to the Employer.

14.7.8 Certificates of Conformity

When requested copies of the following certificates/records shall also be forwarded:

(a) Optical joint boxes visual inspection records;

(b) Routine test records;

(c) The records of the OTDR test results.

14.7.9 Installation

The following tests shall be undertaken by the Contractor:

(a) Prior to installation the fibre optic cable shall be tested with an OTDR on each fibre to ensure that no physical damage has occurred to the fibre during, delivery and shall be compared with the results prior to despatch;

(b) After installation the above test shall be repeated to ensure that no damage has occurred to the fibre during installation;

(c) An end to end attenuation measurement shall be taken in each direction on each fibre using an optical source and optical power meter.

The overall attenuation of the installed cable shall not exceed that calculated using the attenuation and splice loss values specified in Appendix 14.A3.

The Contractor shall give the Engineer the requisite period of notice prior to commencing the tests. **This is a Notification Point**. Details of the test results shall be submitted to the Employer.

The supplier of the OPGW is requested to co-operate with the Fibre Optic Terminal Equipment Supplier (if this is under a separate contract) and shall supply all technical data requested.

14.8 TEST EQUIPMENT

Reference should be made to Appendix 14.A4 for details of the test equipment required.

APPENDIX 14.A1/1

OPGW DESIGN REQUIREMENTS

230KV PORTION

(NOT USED)

Number of fibres			48
Fault Current	(1 second)	(kA)	5
Initial Temperature		(°C)	40
Leading Edge		(µs)	1.2
Lightning Initial Peak Current		(kA)	100
Tail		(µs)	50
Power Follow Through		(Coulomb)	200
Temperature Cycling Test	T_A	(°C)	5
	T_B	(°C)	40

APPENDIX 14.A1/1

OPGW DESIGN REQUIREMENTS

132KV PORTION

Number of fibres			24
Fault Current	(1 second)	(kA)	5
Initial Temperature		(°C)	40
Leading Edge		(µs)	1.2
Lightning Initial Peak Current		(kA)	100
Tail		(µs)	50
Power Follow Through		(Coulomb)	200
Temperature Cycling Test	T_A	(°C)	5
	T_B	(°C)	40

APPENDIX 14.A2

NOT APPLICABLE

APPENDIX 14.A3

SINGLE MODE OPTICAL FIBRE CABLE REQUIREMENTS

Coating diameter				µm	250 ± 15
Cladding diameter				µm	125 ± 3
Cladding non-circularity				%	≤2
Mode field diameter				µm	9 ± 1
Mode field concentricity error				µm	≤ 1
Cut off wave length				nm	≤ 1270
Attenuation at (maximum average)	1285	nm	1330	dB/km	≤ 0.4
Attenuation at (maximum average)	1550	nm		dB/km	≤ 0.25
Zero dispersion wave length				nm	≤ 1321
Chromatic dispersion at	1285	nm	1330	ps/(km-nm)	≤ 3.5
Chromatic dispersion at	1550	nm		ps/(km-nm)	≤ 20
Individual splice loss				dB	≤ 0.15
Mean splice loss				dB	≤ 0.1

APPENDIX 14.A4

TEST EQUIPMENT

OTDR

APPENDIX 14.B1

ENGINEERING DOCUMENTS TO BE SUBMITTED BY CONTRACTOR

Clause Reference	Document Description	Comment
14.2.5	Expected overall attenuation and dispersion	
14.4.1	Optical Joint Boxes - Contract drawings Fixing clamps - contract drawings	
14.4.3	Installation instructions	
14.6.1	Method Statement	
14.7.1	OPGW fittings	
	Non-metallic underground fibre optic cable and optical fibres - Type test certificates	
14.7.1	Type test programme	
14.7.2	OPGW - Fatigue Life	Documentary evidence
14.7.2	OPGW - Lightning Strike	Test proposals
14.7.2	OPGW - Routine Tests	Test proposals
14.7.5	Optical joint boxes - visual inspection test records	
14.7.9	OPGW fittings and optical fibres - Type test records	
14.7.9	OPGW fitting & optical fibres - Routine test records	
14.7.10	Certificate of Conformity	
14.7.11	Installation test records	

APPENDIX 14.C1

NOTIFICATION AND HOLD POINTS

Clause Reference	Notification Point	Hold Point
14.2.9		Fixing clamps
14.4.1		Contract drawings
14.6.1		Method Statement
14.7.1		Type test programme
14.7.2		Lightning Strike-Test Proposals
14.7.2		Routine Test Proposal
14.7.3		Lightning Strike-Test Proposal
14.7.3		Routine Test Proposals
14.7.4		Type & Routine Test Proposal
14.7.11	Installation Tests	

APPENDIX 14.Dl

REFERENCE STANDARDS

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

IEC 60529:	Classification of decrees of protection provided by enclosures
IEC 61089:	Round wire concentric lay overhead electrical stranded conductors
IEC 60793- 1:	Optical Fibres Part 1: Generic Specification
IEC 60793-2:	Optical Fibres Part 2: Product Specification
IEC 60794-1:	Optical Fibre Cable Part 1: Generic Specification
IEC 60794-2:	Optical Fibre Cable Part 2: Product Specification
BS ISO 1461:	Specification for hot dip galvanised coatings on iron and steel articles
BS EN 1559:	Specification for Aluminium and aluminium alloy ingots and castings for general engineering purposes
BS EN 1676	
BS EN 1706	
BS 3100:	Specification for steel castings for general engineering purposes
BS 3643:	Ingot zinc
BS 4190:	Specification for ISO Metric hexagon bolts, screws and nuts
BS EN 1676:	Aluminium and aluminium alloys - Alloyed ingots for remelting
BS EN 10025:	Specification for hot rolled products of non-alloying structural steels and their technical delivery requirements.
ISO 898-1:	Mechanical properties of fasteners made of carbon steel and alloy steel
CCITT G652:	Characteristics of single mode optical fibre cable.

POWER GRID COMPANY OF BANGLADESH LIMITED

BIDDING DOCUMENT
FOR THE PROCUREMENT OF
PACKAGE-1: DESIGN, SUPPLY, ERECTION, TESTING & COMMISSIONING OF 132KV TRANSMISSION LINES AND SUBSTATIONS ON TURNKEY BASIS

LOT-1: TRANSMISSION LINES

SECTION 15

AIRCRAFT NAVIGATATION

SECTION 15

AIRCRAFT NAVIGATION (OBSTRUCTION AIDS)

15.1 SCOPE

15.1.1 Types and Uses

The type and arrangement of all aircraft navigation (obstruction aids) i.e. aircraft warning lights (solar or LV powered), solar arrays, batteries and aircraft warning spheres shall be approved.

Reference shall be made to Appendix 15.A1 for details of the specific requirements.

15.2 DESIGN

15.2.1 General

All aircraft navigation (obstruction aids) shall be so designed as to:

(a) Withstand the mechanical loads relevant to the installation-service-maintenance conditions and environmental effects;

(b) Minimise the number of parts and the possibility of incorrect assembly and installation;

(c) Ensure that individual components are secured against becoming loose in service; all threaded fasteners shall be locked;

(d) Utilise materials which have sufficient strength, ductility and environmental resistance to withstand the static dynamic loading;

(e) Avoid damaging the earthwire under all service conditions;

(f) Comply with the requirements of ICAO Aerodromes Annex 14 Volume 1 Aerodrome Design and Operation and Aerodroiiie Design Manual Part 4 unless stated to the contrary.

15.2.2 Obstruction Lights (Solar powered)

The complete solar powered obstruction light system i.e. obstruction lights, photovoltaic cells, storage batteries and control equipment, shall be designed to ensure maximum unattended operation with minimal maintenance, i.e. maximum once per year.

The obstruction lights shall consist of one main and one stand-by low intensity omnidirectional red lamps in compliance with local aviation requirements.

The light shall be equipped with Neon discharge lamps having a luminous intensity of approximately 320 candelas, and a rated life of at least 20,000 hours. Neon discharge lamps shall be of the cold cathode type and fitted with RF screens.

The light shall be designed to allow it to be directly installed on any vertical or horizontal surface on the peak of the tower. In case the power adapter cannot be installed at the lamp locations, an extension cable assembly with lampholder shall be provided.

The operation of the lights during darkness or poor visibility shall be controlled by a photoelectric switch. The levels of illuminance falling on a vertical surface for activating the lights shall be agreed with the Engineer.

15.2.3 Obstruction Lights (LV powered)

Obstruction lights shall consist of one main and one standby low intensity omni- directional red lamps in compliance with ICAO requirements.

The luminous intensity shall be approximately 320 candelas and have the longest possible rated life, which should not be less than 10,000 hours.

The light shall be designed to allow it to be directly installed on any vertical or horizontal surface on the tower. The operation of the light during darkness or poor visibility shall be controlled by a photo-electric switch. The level of illuminance falling on a vertical surface for activating the lights shall be agreed with the Engineer.

At the base of the tower immediately above the A.C.D. level a termination box shall be provided complete with isolator and other control gear as necessary.

The termination box shall be manufactured from either steel or die cast aluminium to provide protection to IEC 60529 IP 55.

15.2.4 Photo-Voltaic Cells (Solar array)

The photo-voltaic cells in conjunction with the storage batteries shall be designed to have the maximum system reliability and battery life. Solar panels shall not be designed to provide maximum power durinc, periods of peak solar radiation, but to provide power at an essentially constant rate over the annual solar cycle. The minimum charge state shall provide adequate reserve for weather anomalies which may comprise up to one month of continuous heavy cloud cover, whilst the maximum charge state achieved during favourable conditions shall not exceed the rated battery capacity to prevent the possibility of overcharging the battery causing electrolyte evaporation.

For protection of the solar array from reverse currents during darkness, a diode shall be placed in series with the array.

The complete solar panel shall be designed to ensure that the maximum electrical Output degradation shall not exceed 10 percent over a 10 year period.

The photo-voltaic cells shall be redundantly interconnected and provided with integral bypass diodes to prevent cell overheating due to localised shading and system continuity in the event of cell circuit failure.

The complete solar panel shall be suitably sealed in an aluminium frame which effectively isolates the cells from thermal and mechanical shock and-prevents the ingress of moisture.

15.2.5 Support Framework

The solar array support framework shall be designed to mount the complete solar panel at the optimum tilt angle, and to resist the imposed wind loading calculated in accordance with Section 8 of this Specification.

15.2.6 Storage Batteries

Vented lead acid electrolyte batteries of an extremely low self-discharging type shall be used in conjunction with photo-voltaic cells. Catalytic recombinator caps shall be used to reduce water loss to very low levels. The batteries shall have proven cycling abilities in conjunction with photo-voltaic operation and shall be designed to provide power during periods of low solar radiation, which shall not be less than a minimum of 5 days, reserve storage plus specified low solar storage calculated from the optimum storage array, size associated with the location.

A regulator shall be used to protect the battery from overcharging and a low voltage disconnecter from excessive discharge.

The batteries must have a stable voltage characteristic with less than 5 percent variation in nominal output voltage from fully charged to discharged.

15.2.7 Battery Enclosure

A suitably designed battery enclosure shall be provided for housing the batteries and control unit at the specified work platform level.

The enclosure shall have hinged access panels for ease of battery maintenance, vent holes in the base and ventilation at the top to provide adequate air through venting of gases from the batteries. Maximum and minimum electrolyte levels of all battery cells shall be clearly visible.

15.2.8 LV Cables

All LV cables and cabling shall be in accordance with the appropriate British Standards and local health and safety requirements.

15.2.9 Aircraft Warning Spheres

Aircraft warning spheres shall be a minimum of 600 mm diameter and shall be fitted to the earthwire.

Externally, the spheres shall be coloured red or orange to meet the local environmental conditions and installed alternatively with white spheres. All component bolts shall be captive and preference shall be given to use of shear-head clamp tightening bolts. Factory formed helical armour rods shall be fitted to protect the earthwire at aircraft warning sphere locations.

15.2.10 Tower Painting

Painting of towers to comply with the requirements of local aviation authorities, shall be undertaken when specified by the Engineer.

The paint system shall comprise an etch primer, under and gloss coat which shall be formulated to take into consideration the local environmental conditions. The paint shall not present a health hazard and shall conform to relevant current health and safety requirements.

Reference shall be made as appropriate to BS 5493. Details of the proposed painting system shall be submitted to the Engineer. **This is a Hold Point**.

For details of the extent of the painting requirements reference should be made to Appendix 15.Al.

In some areas where the tower may be under water during the rainy season, the tower (All members) shall be painted for navigation with reflecting paint upto 3 m from the ground level. The contractor has to submit the details specification of the reflecting paint and the location nos. of the towers which shall be painted, to the employer's engineer for approval before start of the painting.

15.3 MATERIALS

15.3.1 Materials used in the manufacture of aircraft navigation (obstruction aids) shall be of:

(a) Adequate strength for the intended application and service life requirements (including mechanical loads, vibrations, electrical currents and environmental effects) and free from defects which would affect the performance of the equipment.

(b) Shall not be liable to intergranular or stress corrosion.

(c) The material shall not be adversely affected in the long term by a coating applied for corrosion protection.

15.3.2 Photo-voltaic cells shall comprise matched monocrystalline silicon cells enclosed by a glass front surface and a rear composite layer to provide the optimum thermal and electrical performance.

The glass front surface shall have similar thermal expansion characteristics to the photovoltaic cell, shall be resistant to impact and abrasion by wind blown materials and shall be self-cleaning under the action of rain.

15.3.3 All mild steel used in the manufacture of the support framework shall comply with the requirements of BS EN 10025 or BS EN 10210. Minimum steel grade shall be S275JR and S275JOH respectively.

15.3.4 Aluminium or aluminium alloy used in the manufacture of the complete solar panel frame shall comply with the requirements of BS 1474.

15.3.5 Cast aluminium and aluminium alloy fittings shall be made from aluminium or aluminium alloy of a suitable grade, complying with the requirements of BS 1490 and/or BS EN 1676.

15.3.6 Aircraft warning spheres shall be made from either glass reinforced polyester resin or aluminium sheet, having a minimum specified thickness. Aluminium sheet shall comply with the requirements of BS EN 485

15.3.7 Bolts and nuts shall be either ISO Metric Black Hexagon to BS 4190 threaded ISO Metric Course Pitch to BS 3643 : Part 2 Tolerance Class 7H/8g, or ISO Metric Precision Hexagon to BS 3692. Metal washers shall be either to BS 4320, Form E, Grade 4.6 or 'bright series'. Spring Washers shall be ISO Metric to BS 4464.

If shear-head type bolts are used they shall be clearly marked so after the correct torque has been applied, the installed bolt may be clearly identifiable from the ground.

15.3.8 Non-metallic materials shall have good resistance to ageing and shall have adequate resistance to the effects of nitrogen oxide, ozone, ultra-violet radiation and air pollution.

Glass reinforced polyester resin mouldings for aircraft warning spheres shall be in accordance with BS 4549, Part 1.

15.3.9 All paints used shall be suitable for use with and not adversely effect galvanised steel.

15.4 WORKMANSHIP

15.4.1 The dimensions of all aircraft navigation (obstruction aids) equipment shall be shown on the contract drawings. Contract drawings including cabling layouts shall be submitted to the Engineer. **This is a Hold Point.**

All equipment shall be i-narked to ensure a system of traceability for each component of the equipment. Where practicable, and unless otherwise agreed between the Engineer and the Contractor/Supplier, equipment shall be clearly and indelibly marked with 6 mm high characters as follows:

(a) Identification of equipi-nent (reference number);
(b) Maker's identification;
(c) Date of manufacture (month and year);
(d) Cast code - if appropriate;
(e) Conductor diameter range - if appropriate;
(f) Fitting bolt installation torque - if appropriate.

15.5 PROTECTIVE TREATMENT

15.5.1 All parts of the aircraft navigation (obstruction aids) equipment shall either be inherently resistant to atmospheric corrosion or suitably protected against corrosion, such as may occur in transit, storage and service. All ferrous parts which will be exposed to the atmosphere in service shall be protected by hot-dipped galvanising to comply with the requirements of BS 729. All manufacturing processes shall be completed prior to galvanising.

15.5.2 The ingot zinc used for galvanising shall comply with the requirements of BS 3436.

15.5.3 All external threads shall be cut or rolled before hot-dipped galvanising. Nuts to be galvanised shall be subsequently tapped 0.4 mm oversize and the threads oiled.

15.6 INSTALLATION

15.6.1 Aircraft navigation (obstruction aids) shall be installed strictly in accordance with the Supplier's instructions.

15.6.2 The proposed means of paint application shall take full cognizance of local environmental requirements and shall be subject to the approval of the Engineer. **This is a Hold Point.**

15.7 QUALITY CONTROL

15.7.1 General

Type, sample and routine tests as appropriate shall be undertaken on both individual items and complete system, eg. obstruction lights, solar panels, storage batteries etc. in accordance with the requirements of this Specification. The test procedure must clearly demonstrate the suitability of the complete system to meet the environmental and operational conditions specified. The Contractor's proposals for these tests shall be submitted to the Engineer for approval before manufacture commences. **This is a Hold Point.**

Contract drawings previously submitted to the Engineer shall be available at the time of testing. The Contractor/Supplier shall give the Engineer the requisite period of notice prior to undertaking the type and sample tests, and shall submit to the Engineer for approval a test programme and procedures. **This is a Hold Point**.

15.7.2 Galvanising

Tests for galvanised equipment shall be carried out at the works to ensure compliance with the requirements of BS 729. Details of the test results shall be made available to the Engineer upon request.

15.7.3 Test Certificates

All metallic materials used in the manufacture of the equipment shall be covered by test certificates stating their mechanical and chemical properties to prove compliance with requirements of this Specification and BS EN 10210, BS EN 10025, BS EN 485, BS 3 1 00, BS 4190, BS 1474, BS 1470 as appropriate.

Bolts and nuts shall be covered by the appropriate test certificate in respect of either BS 4190 or BS 3692.

Tests certificates for metallic materials, bolts and nuts and where appropriate non-metallic materials shall be made available to the Engineer upon request.

Where Type and Sample tests are undertaken test certificates covering these tests shall be made available to the Engineer.

Where Routine tests are undertaken test certificates covering the tests shall be made available to the Engineer upon request.

15.7.4 Certificate of Conformity

Prior to despatch the Contractor/Supplier shall forward to the Engineer requisite copies of the completed Certificate of Conformity. The certificate shall be supported by copies of the appropriate test reports of any type and/or sample tests undertaken.

When requested copies of the following certificates/records shall also be forwarded:

(a) Metallic material test certificates
(b) Bolt and nut test certificates
(c) Non-metallic material test certificates
(d) Galvanising test records
(e) Routine test records.

15.7.5 Site Tests

Prior to commissioning the Contractor shall submit to the Engineer his proposals for checking/testing the complete installation. This is a **Hold Point**. The Contractor shall give the Engineer the requisite period of notice prior to undertaking the agreed comniissioning tests. This is a **Notification Point**.

15.7.6 Painting

Prior to the commencement of painting the Contractor shall submit to the Engineer his proposals for checking/testing the routine quality of the Painting. This is a **Hold Point.**

APPENDIX 15.Al

AIRCRAFT NAVIGATION (OBSTRUCTION AIDS)

Tower Painting as per ICAO requirements		Yes
Tower Painting as per local requirements		---
Obstruction Lights		Solar Powered
L.V. powered & supply voltage	V	---
Solar powered:		
Number and position of lights per support		3*
Height and position of work platform		Top Crossarm
Height and position of solar array		Earthwire
Diameter of aircraft warning spheres	mm	600
Spacing of aircraft warning spheres	m	30 between adjacent spheres on opposite earthwires

* One at the top of the tower and one each on both transverse faces of the tower at bottom crossarm level.

Tower Painting

All river crossings towers are to be painted in alternative bands of orange and white colour, starting from ground level to the top of the tower. Width of bands to be approximately 8 m, to conform to the requirements of ICAO.

APPENDIX 15.Bl

ENGINEERING DOCUMENTS TO BE SUBMITTED BY CONTRACTOR

Clause Reference	Document Description	Comments
15.2.10	Tower Painting – Painting system	
15.4.1	Obstruction Aids – Contract drawing	
15.6.2	Painting – Method Statement	
15.7.1	Test Proposals – type, sample, routine	
15.7.2	Galvanizing test results	If requested
15.7.3	Metalic material test certificates	If requested
15.7.3	Bolt and nuts test certificates	If requested
15.7.3	Non-metalic material test certificates	If requested
15.7.3	Type test records	
15.7.3	Sample test records	
15.7.3	Routine test records	If requested
15.7.4	Certificate of conformity	
15.7.5	Commissioning test proposals	
15.7.6	Painting – routine test procedure	

APPENDIX 15.Cl

NOTIFICATION AND HOLD POINTS

Clause Reference	Notification Points	Hold Points
15.2.10		Tower Painting System
15.4.1		Contract drawings
15.6.2		Painting – Method statement
15.7.1		Test Proposals
15.7.1		Type tests
15.7.5		Test Proposals
15.7.5	Commissioning tests	
15.7.6		Painting – Routine test proposals

APPENDIX 15.Dl

REFERENCE STANDARDS

The reference standards and other documents referred to in this Specification are listed below:

IEC 60529:	Classification of degrees of protection provided by enclosures.
BS 729:	Specification for hot-dipped galvanising coating on iron and steel articles.
BS 1474:	Specification for wrought aluminium and aluminium alloys for general engineering purposes bars, extruded round tubes and sections.
BS 1490:	Aluminium and aluminium alloy ingots and castincs for general engineering purposes.
BS 3463:	Specification for ingot zinc.
BS 3643:	ISO Metric threads.
Part 2:	Limits and tolerances for course pitch series threads.
BS 3692:	Specification for ISO Metric Precision hexagon bolts, screws and nuts.
BS 4190:	Specification for ISO Metric hexagon bolts, screws and nuts.
BS 4320:	Specification for metal washers for general engineering purposes Metric series.
BS 4549:	Guide to quality control requirements for reinforced plastic moulding.
Part 1:	Polyester resin mouldings reinforced with chopped strand mat or randomly deposited glass fibre.
BS 4464:	Specification for Spring washers for general engineering and automobile purposes. Metric Series.
BS 5493:	Protective coatings of iron and steel structures.
BS EN 485:	Aluminium and aluminium alloys sheet, strip and plate.
BS EN 1676:	Aluminium and aluminium alloys - Alloyed ingots for remelting,
BS EN 10025:	Specification for hot rolled products of non-alloy structural steels and their technical delivery requirements.
BS EN 10210:	Hot finished structural hollow sections of non-alloy and fine grain structural steels.

POWER GRID COMPANY OF BANGLADESH LIMITED

BIDDING DOCUMENT
FOR THE PROCUREMENT OF
PACKAGE-1: DESIGN, SUPPLY, ERECTION, TESTING & COMMISSIONING OF 132KV TRANSMISSION LINES AND SUBSTATIONS ON TURNKEY BASIS

LOT-1: TRANSMISSION LINES

SECTION 16

MISCELLANEOUS

SECTION 16 MISCELLANEOUS

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SECTION 16 MISCELLANEOUS

16.1 TOOLS AND APPLIANCES

Each tool or appliance shall be clearly marked with its size and/or purpose and is not to be used for erection purposes by the Contractor.

The tools and appliances with the appropriate boxes are to be handed over to the Employer at the Employer's stores depot at the time of arrival at Site.

The Contractor shall, where required, by the Engineer, provide test certificates and die-stamp or indelible mark on each piece of equipment in an approved manner.

For details of the tools and appliances to be supplied reference should be made to Appendix 16.A1.

APPENDIX 16.Al

TOOLS & APPLIANCES

(a) Sets of temporary earthing equipment shall consist of one, telescopic, Fibre glass rod 3m total length, complete with a screwing head together with 6 PVC covered 8m lengths of 150mm^2 pure aluminium conductor. Each length of conductor shall be equipped with an earth end clamp which shall have a hardened steel threaded point capable of piercing a galvanised or corroded steel surface to provide a good earth connection. In addition an alloy line end clamp shall be provided which shall be spring loaded and capable of being further tightened around a conductor of up to 32.4mm diameter, to provide a good electrical connection. The line end clamp and the screwing head of the pole shall be such that the latter is capable of holding, fixing and tightening the end clamp onto the conductor when attached to the temporary earth lead.

The leads are expected to withstand a fault current of 2.5kA for 10s.

(b) Elcometer for measuring galvanisation thickness.

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LOT-1: TRANSMISSION LINES

SECTION 17

PACKING, PROTECTION AND DESPATCH MARKING

SECTION 17

PACKING, PROTECTION AND DESPATCH MARKING

SCOPE OF WORK

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SECTION 17 PACKING, PROTECTION AND DESPATCH MARKING

17.1 GENERAL

The following minimum packing methods shall be adopted for suppliers external to the country of the transmission line installation, unless otherwise specified.

The Supplier shall be entirely responsible for ensuring that the packing is suitable for transit and storage and will be held responsible for any shortages or damage during transit.

Wherever possible, the Supplier shall utilise shipping by container vessels in the containers of the correct type for the item being shipped to reduce the likelihood of damage to the items. If containerisation is not possible the requirements of the following Clauses shall be applicable.

All materials shall be carefully packed in a manner suitable for transport to and storage under the climatic conditions present. Items packed in cases or crates shall be so secured that they are not free to move, and cannot work loose in transit.

Woodwool is to be avoided as a packaging material as far as possible.

Waterproof paper and felt lining are to overlap at the seams by at least 12mm, and the seams secured together in an approved manner, but the enclosure is to be provided with vermin proof screened openings to permit ventilation.

A packing note in a weatherproof plastic envelope is to be securely attached to the right hand lower corner of one side of all cases or crates. A copy of the packing list shall also be included inside.

All packing cases or crates shall be marked on the outside to show the correct way up and where relevant, where the weight is bearing and the correct positions for slings.

Shipping mark, numbers and symbols will be provided by the Employer. These marks shall be applied to conductor drums and cases either by the use of a waterproof stencil, flo-pen or any other permanent method. The use of tie-on tags is not permitted. Cases shall be marked on two opposite sides.

ALL MARKS SHALL BE CLEARLY LEGIBLE AT THE TIME OF DESPATCH.

17.2 LATTICE TOWER AND ASSOCIATED STEELWORK

(a) Main Legs Steel Poles, Heavy Sections

As loose items, or as below.

(b) Angle Bracings and Large Plates

Bundled in packages of less than 5ton and strap-bonded as follows:

Galvanised -Tensional Steel Stripping, either

i) Tension strapping 32mm x 0.8mm, minimum of two bands and at maximum centres of 2m; or

ii) Tension strapping 19mm x 0.8mm, minimum of three bands and at maximum centres of 1.25m.

Whichever method i) or ii) is adopted, bundles shall also have a layer of either hessian or polythene between the strap-bands and the galvanised steelwork.

One end of tie bundle shall also be wired in such a way as to prevent the removal of any single piece.

(c) Plates, Small Items

These shall be cased (maximum net mass 500kg).

Cases shall be of sturdy construction, made from new 25mm thick timber and constructed with annular (rag) nails. They shall have packing pieces on the underside to enable the use of fork-lift trucks.

(d) Bolts

Shall be double bagged and cased as above. A contents list shall be included in each bag. (Cases used both (c) and (d) shall be stored in dry areas both before and after packing.

Where required, materials shall be colour flashed to aid recognition.

17.3 CONTAINERISATION

Where materials shipped by the use of containers, a reduced level of packing, is acceptable as follows:

(a) Strap-band centres may be increased to 3m for 32mm x 0.8mm bands and 2.5m for 19mm x 0.8mm bands.

(b) The use of wire through bundle ends is not required.

(c) Cases may be 20mm thick timber.

17.4 CONDUCTOR

Conductors shall be supplied on drums of sufficient sturdiness to withstand overseas shipment, and the drums shall be securely battened to prevent damage to the conductor.

All wooden components shall be manufactured from sound defect-free seasoned softwood and suitable for prolonged storage without deterioration. Wood shall be either planed or finely sawn to facilitate accuracy in assembly. The thickness of each ply or component part shall be of reasonable uniformity.

The flanges of drums shall be constructed from two ply of wood laminated in such a manner to be cross-grain to each other. The boards shall be close butted to provide maximum support. Fastenings of the flanges shall be with suitable bright nails with the head countersunk on the inside flange. A flange conductor hole of sufficient diameter for the free passage of the conductor shall be cut in one flange. The exposed end of the conductor shall be protected by a suitable sheet metal plate.

Drainage holes shall be provided through each flange as close as possible to the underside of the barrel lagging. The inner checks of the drum shall be painted with an aluminium flake or bitumen based paint.

The spindle hole shall be round and cut through the centre of the centre board of each flange ply. The spindle holes, of not less than 80mm diameters, shall be reinforced by a 6mm mild steel plate bolted to each flange.

The drum barrel shall be of the segmented type, with supports and cross struts, with a diameter not less than 30 times the conductor diameter. The barrel lagging shall be closely butted and shall provide a smooth external finish to the conductor. The barrel and flanges shall be securely clamped together by not less than six M20 bolts.

The inner end of the conductor shall be brought through the drum flange and secured by staples. The outer end shall also be secured to the inner face of the flange in a similar manner painted with aluminium flake paint.

The outer layer of the conductor on the drum shall be covered by either a layer of sheet plastic or waxed paper secured immediately under the circumferential battens so that it is not in contact with the conductor.

Circumferential battens shall enclose the conductor space completely. They shall fit flush with the outer flanges and shall be securely fixed.

Drums shall be provided with a secure waterproof label displaying the maker's name, type, size and length of conductor on the drum. Drum serial number shall be either chiselled into one drum cheek or impressed onto a secure metallic label. Drums shall be painted on all outer surfaces in finishing colours to the option of the manufacturer.

Drums shall display an arrow and the words "Roll This Way" on each cheek to show the correct direction of rolling.

Steel conductor drums shall be used for any spare conductor supplied and shall comply with the requirements of the American Aluminium Association Standards or other equivalent National Standards.

17.5 INSULATORS

Insulators shall be crated, each crate shall contain insulators units of the same type. Crates shall be either hexagonal or rectangular cross section.

Crates shall be wooden and close boarded, manufactured from sound seasoned softwood a minimum of 20mm thick. They shall be tensioned strapped at not less than three positions along their length. All crates shall be marked with the batch number and insulator code number.

Special attention shall be paid to ensure that all insulators are complete with their security clip.

17.6 INSULATOR, CONDUCTOR AND ANCILLARY FITTINGS

Insulator, conductor and ancillary fittings shall be cased as per Clause 17.2(c).

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LOT-1: TRANSMISSION LINES

SECTION 18

METHOD OF MEASUREMENT & PAYMENT

SECTION 18 METHOD OF MEASUREMENT & PAYMENT

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SECTION 18 METHOD OF MEASUREMENT & PAYMENT

18.1 INTRODUCTION

18.1.1 General

Payment will be made in accordance with the unit prices and total prices set against the items in the Price Schedules as amplified in this section and against the final quantities approved by the Employer. These unit prices and total prices shall include all of the work, temporary and permanent, necessary to comply with the Contract. Where non-quantified unit prices are required in the Bid submission, they shall be so provided. Measurement for the purposes of payment shall where appropriate be made jointly by the representative of the Employer and the Contractor.

The Contractor when requested shall attend for purposes of measurement, or otherwise accept measurements made by the Employer alone.

Where applicable the Contractor shall indicate on each invoice the identification number of each support to which items in the invoice refer.

Unit prices in the Schedule where applicable shall be deemed to include for all work on site irrespective of access conditions, including slope of ground, nature of subsoil, presence of water or other obstacles adjacent to or across the line of the route.

The unit prices shall include all incidental expenses which the Contractor or specialist Subcontractor may incur in the preparation and maintenance of access, in the provision of site services and of all transportation for labour whether skilled or unskilled.

The unit prices in the Schedules shall include all out allowances or other supplementary payment to skilled or unskilled labour, customary, authorised or required by regulations in force at the date of the Bid.

The unit prices shall be deemed to include payment to labour, or other expenses incurred for idle time during which work on site is interrupted by weather conditions or flooding by storm overflow or the like.

Whilst every assistance will be provided to facilitate line construction activities in sequence in accordance with the Contractor's agreed programme of work, there could be occasions when this may not be possible. No claims for additional costs to the Contractor will be accepted solely for such discontinuity of working.

Only those prices shown in the miscellaneous unit prices will be accepted as additional to the Contract price where the use of such unit prices is authorised by the Employer.

18.1.2 Surplus Material

Surplus quantity or waste material of Goods and materials if any, collected from the Purchaser's Stores, are to be returned to the Employer. Surplus or waste material supplied by the Contractor will not be paid by the Employer.

18.1.3 Nominated Subcontractor/Supplier

NOT USED.

18.1.4 Specialist Subcontractors

NOT USED.

18.1.5 Quantities

The quantities set out in the schedules are unless otherwise defined estimated quantities of the Works. They are not to be assumed as the actual and correct quantities to be executed by the Contractor in fulfilment of his obligations under the Contract. The Contractor is presumed to have satisfied himself as to the relevance of the estimated quantities in the preparation of his Bid.

Final quantities shall be established and agreed upon between the Employer and Contractor immediately after the date of signing of the Contract.

18.1.6 CIF Price

The term CIF shall be governed by the rules prescribed in the Incoterms of cuurent edition published by the International Chamber of Commerce, Paris.

18.1.7 Freight and Insurance Prices

NOT USED.

18.1.8 Ex-works (EXW) Price

The term EXW shall be governed by the rules prescribed in the Incoterms of cuurent edition published by the International Chamber of Commerce, Paris.

18.1.9 Local Transportation & Erection Price

Not Used.

18.1.10 Drawings, Reference Standards and Records

The provision of all drawings, design calculations, records etc as specified in the Contract shall deemed to be included in the Contract price.

18.1.11 Witnessing of Tests by Employer

Not used

18.1.12 Overseas Training

Not used

18.1.13 Instruction of Employer's Staff

Not used

18.2 SURVEY

Full precision profile survey undertaken by the Contractor on the Employer's instruction shall be paid for as per unit prices in the Price Schedule and shall be measured to the nearest metre along the centre-line of the route. The unit price shall include for the establishment or re-establishment of the line route from terminal points and other such fixed points the Employer may define, full ground survey, preparation and submission of route maps, mouza maps, profile drawings with tower plotting, SIMMs document, tree marking and tree schedule and pegging of tower locations. During check survey, the route might need to be changed due to field requirements. Cost involved in such changes shall deemed to be included in the price indicated in the price Schedule. Payment shall be done considering the final length of the line route.

18.3 ROUTE CLEARANCE & ACCESS

Route clearance undertaken by the Contractor on the Employer's instruction shall be paid for at Schedule B unit prices and shall be measured to the nearest metre along the centre line of the route. The prices of route clearance shall include payment of compensation for crops, trees, houses, etc. and all kinds of damage compensation.

18.4 FOUNDATIONS

18.4.1 General

The prices quoted in Price Schedule for the supply and installation of a foundation refers to a foundation required in accordance with the Specification and 'Method of Measurement and payment’. Where additional work is required over and above that provided for in the Specification and 'Method of measurement and Payment' this will be paid on a measured basis at miscellaneous unit prices or unit prices to be agreed.

The unit prices for foundations shall include all necessary geotechnical investigation and geotechnical studies as defined in the Specification or as required by relevant authorities.

The unit prices for all foundations shall include for site clearing, excavating in any material and by any means, manual or mechanical, and for ensuring, stability and natural drainage inside the working area, for all back filling, compacting and disposal of surplus material, routine testing, site restoration and for all necessary supports to sides of excavations.

The complete foundations for a tower/pole shall be paid for at the appropriate Price Schedule unit prices.

The unit price shall include for all excavations, conventional pumping (including well-point de-watering), excavation supports, concrete work, formwork. reinforcing, stub steelwork, stub cutting, routine testing, backfilling, clearing up and all other work required to complete the foundation in accordance with the Specification.

The unit prices shall also include supply of weak-mix concrete or the importation of any back fill material necessary due to the excavated material being unsuitable as backfill.

The unit prices for foundations shall include the use of whichever type of cement is to he used and density of concrete necessary to meet the requirements of the Specification.

The unit prices for foundations shall include all stub steelwork installation and setting out including the use of templates, setting to any level and any excavation necessary for Setting out. The protective treatment to defined concrete faces or support steelwork and provision of site protection barriers shall be included in the rates for the foundations.

The unit prices for foundations shall include the cost for all earthing requirements.

Where site stabilisation outside the defined 'working area' is required this shall be undertaken at unit prices to be agreed.

Design tests on foundations to prove the foundation design shall be paid for at the unit prices quoted. The unit prices shall include for the removal of concrete and steel down to 1m below ground level where this is deemed necessary by the Employer.

All costs regarding making necessary arrangement for de-watering or whatsoever required starting the foundation inside river or water logged locations shall be included in the unit price of foundation.

18.4.2 Piled Foundations and Special Foundations

The complete foundations for each support shall be paid for at the appropriate Schedule B unit prices. The unit prices shall include for mobilisation and de-mobilisation of piling rig, setting out, cleaning, cutting, to length, reinforcement and pile cap connection, jointing of piles as necessary irrespective of number of piles, all excavations (including rock), conventional pumping (including well-point de-watering), excavation supports (including use of bentonite slurries), concrete work for piles, pile cap and tie beams, formwork, reinforcing stub steelwork, stub cutting, routine testing, backfilling, clearing up and all other work required to complete the foundation in accordance with the Specification.

The unit prices for piled foundations shall be based on the unit price for a complete tower foundation including piles, pile cap and tie beams etc.

18.4.3 Flood Protection Walls

NOT USED.

18.4.4 Miscellaneous Unit Prices

The miscellaneous unit price for additional excavation shall include for site clearing, excavating in any material and by any means manual or mechanical and for ensuring, stability and natural drainage, pumping, backfilling, compacting and disposal of surplus material, site restoration and for all necessary support to the sides of the excavation.

The miscellaneous unit price for additional concrete shall include for all design and preparation formwork and all other work necessary.

The miscellaneous unit price for reinforcement shall include for design and drawing preparation of bar bending schedules, cutting, bending, fixing and all other associated activities.

18.5 STEEL TOWERS

Steel towers normal extensions shall be paid for at Schedule B unit prices. The unit prices shall include for standard crossarms and shall include stub steelwork.

The unit prices for steel towers shall include for access facilities, anti-climbing devices, attachment plates, ancillary steelwork etc. used as standard fittings on the tower.

The unit prices shall include for all tower mounted notice plates.

Type tests, including prototype tests (if require by this specification) to structural failure, which shall be conducted at an independent testing facility or manufacturer's own testing facility on the specified contractor-designed lattice steel towers, shall be paid for at the unit prices quoted in Schedule B, but only if the test proves that the contractor-designed tower complies with the requirements of the specification (see Section 8).

Special Supports and additional steelwork to the approved design shall be paid for at Schedule B unit prices.

The unit price of towers shall include all supplies and all works associated with the towers which are specified in this bid document.

18.6 INSULATOR SETS AND ASSOCIATED FITTINGS

All Insulator sets shall be paid for at Schedule B unit prices. The unit prices for insulator sets shall include for all insulator units, links, sag adjusters, turnbuckles, weights, insulators protective devices (arc horns), tension joints (dead ends) and suspension clamps (Inclusive of helical armour rods), used as a standard between the support and the phase conductor and all others fittings specified to be supplied in this tender document.

Unit prices for earthwire tension and suspension sets shall where specified include for all earthwire bonding to the supports including all earthwire bonding clamps in accordance with the Specification and all others fittings specified to be supplied in this tender document.

All conductor tee-connectors and line termination fittings shall be paid for at Schedule B unit prices.

18.7 CONDUCTOR AND FITTINGS

Cost of phase conductors and earthwires including OPGW shall be paid for at Schedule B unit prices, and shall be measured to the nearest metre after stringing, along the centre of the route without allowance for sag, jumpers or scrap i.e. the cost of conductor, earthwire and OPGW shall be paid as per route length. The cost of conductor, earthwire and OPGW due to sag, jumper, joints etc. shall deem to be included in the relevant route-km cost. The supply and erection unit price shall include for all normal phase and earthwire jumpers including the jumpers at terminal supports between phase conductors or earthwires and downleads.

Downleads between terminal supports and anchorages and downdroppers between downleads and substation equipment shall be paid for at Schedule B unit prices. The unit prices shall include for conductors, jumpers and associated fittings.

The cost of fibre optic earthwire (OPGW) connections to the joint boxes, fixing clamps, joint boxes and fusion splicing of optical fibres shall be included in the erection unit price of OPGW.

The aforementioned erection unit prices shall include all joints, clamps and fittings other than insulator sets and their fittings, tension joints (dead ends) and/or earthwire, jumpers and downlead conductors.

All spacer dampers, vibration dampers and spacers including bonding and weighted jumper and/or spacer shall be paid for at Schedule unit prices.

18.8 AIRCRAFT NAVIGATION (OBSTRUCTION AIDS)

Aircraft warning light shall be paid for at Schedule B unit prices and shall be measured on a per support basis. The unit price shall include for the warning lights and as appropriate connection to the LV mains supply or solar panels, storage batteries etc., all power and control cables, solar light switches, support steel works as necessary.

The prices for aircraft warning lights shall include for all type, sample and routine tests.

18.9 MISCELLANEOUS

Tools and spares shall be paid for at the Schedule B unit prices.

18.10 PAYMENT FOR WORK CARRIED OUT AT TIME AND MATERIAL RATES

The Employer may, if in their opinion it is necessary or desirable, order that any additional or substituted work shall be executed on a Time and Material basis.

No work shall be carried out on a Time and Materials basis without written instructions of the Employer. All applications for payment for such work by the Contractor shall be accompanied by statements, authorising the undertaking of such work, duly signed by the Employer and shall be submitted within three months of completion of such work.

When the work is in progress the Contractor shall render daywork sheets in duplicate to the Employer showing the number of men so employed with the number of hours worked and detailed quantities of materials used. The Contractor shall obtain the Employer's certification of the daywork sheets at the end of each working week whilst the work is in progress and failure to do so shall render the Contractor liable to forfeiture of payment.

Where the Contractor is required to carry out work at the Time and Material unit prices, the Employer will furnish the Contractor with such particulars as necessary to enable the Contractor to prepare such drawings and schedules as required for such work. Unit prices for work executed on a Time and Material basis shall be agreed.

POWER GRID COMPANY OF BANGLADESH LIMITED

BIDDING DOCUMENT
FOR THE PROCUREMENT OF
PACKAGE-1: DESIGN, SUPPLY, ERECTION, TESTING & COMMISSIONING OF 132KV TRANSMISSION LINES AND SUBSTATIONS ON TURNKEY BASIS

LOT-1: TRANSMISSION LINES

SECTION 19

LIST OF BID DRAWINGS

SCOPE OF WORK

CONTENTS

CLAUSE NO.	TITLE	PAGE NO.

SECTION 19 1

SECTION 19

LIST OF BID DRAWINGS

Following drawings are enclosed for tender purpose:

Drawing Number		Title
PGCB/BS/2/02	:	1 DL Sheet No. 1
PGCB/BS/2/05	:	1 D1 Sheet No. 1
PGCB/BS/2/06	:	1 D1 Sheet No. 2
PGCB/BS/2/06	:	1 D1 Sheet No. 3
PGCB/BS/2/07	:	1 D25 Sheet No. 1
PGCB/BS/2/09	:	1 DT6 Sheet No. 1
PGCB/SC/02/TD-1DT6-148	:	1 DT6 Sheet No. 2
PGCB/BS/2/09		1DT6 Sheet No. 3
PGCB/132kV/SS	:	132kV Suspension Set (70kN)
PGCB/132kV/HSS	:	132kV Heavy Suspension Set (120kN)
PGCB/132kV/TS	:	132kV Tension Set (120kN)
PGCB/132kV/ULD	:	132kV Upright Low duty Tension Set (70kN)
PGCB/132kV/ILD	:	132kV Inverted Low duty Tension Set (70kN)
PGCB/132kV/OPGW/SS	:	132kV OPGW Suspension Set
PGCB/132kV/OPGW/TS	:	132kV OPGW Tension Set
PGCB/TL/INS	:	Cross section sketch of Insulator unit showing straight head portion.
PGCB/JSFK/132/RM	:	Route Map for 132kV Transmission Line
PGCB/TL/NP	:	Number Plate
PGCB/TL/DP	:	Danger Plate
PGCB/TL/EARTHING	:	Earthing Arrangement Drawing
PGCB/TL/AT	:	Anti-theft Nuts & Bolts Drawing

List of Tower Drawings is enclosed.

LIST OF AVAILABLE STRUCTURAL/ERECTION DRAWINGS OF TOWERS

NORMAL BASE WIDTH

TOWER TYPE 1DL

Sl.	Description	Drawing No.	Sheet No.	Rev
1	Outline drawing of 1DL std, +3, +9	PGCB/BS/2/02	1 of 1	0
2	Erection Drawing for Bottom part of ±0M	PGCB/SC/02/ED/1DL/23	1 of 4	1
3	Erection Drawing for Upper part-1 of ±0M	PGCB/SC/02/ED/1DL/23	2 of 4	1
4	Erection Drawing for Upper part-2 of ±0M	PGCB/SC/02/ED/1DL/23	3 of 4	0
5	Cross - Arm and Tie plan	PGCB/SC/02/ED/1DL/23	4 of 4	0
6	Erection Drawing for +1.5M body extention	PGCB/SC/02/ED/1DL/142	1 of 1	0
7	Erection Drawing for +9M body extention	PGCB/SC/02/ED/1DL/24	1 of 2	1
8	Erection Drawing for +3.0M body extention	PGCB/SC/02/ED/1DL/24	2 of 2	1
9	Erection Drawing for +4.5M body extention	PGCB/SC/02/ED/1DL/25	1 of 1	0
10	Erection Drawing for +6.0M body extention	PGCB/SC/02/ED/1DL/26	1 of 1	1
11	Step Bolt	PGCB/SC/02/ACC/55	1 of 1	1
12	Stub for pile	PGCB/SC/02/ED/1DL/27/PILE/4	1 of 1	1
13	Stub for pad & chimney	PGCB/BS/2/71	1 of 1	A

TOWER TYPE 1D1

Sl.	Description	Drawing No.	Sheet No.	Rev
1	Outline drawing of 1D1 std, +6, +12	PGCB/BS/2/05	1 of 1	0
2	Outline drawing of 1D1 +3	PGCB/BS/2/06	1 of 2	0
3	Outline drawing of 1D1 +9	PGCB/BS/2/06	2 of 2	0
4	Erection Drawing for Bottom part of ±0M	PGCB/SC/02/ED/1D1/30	1 of 4	0
5	Erection Drawing for Top part-1 of ±0M	PGCB/SC/02/ED/1D1/30	2 of 4	0
6	Erection Drawing for Top part-2 of ±0M	PGCB/SC/02/ED/1D1/30	3 of 4	0
7	Cross - Arm and Tie plan	PGCB/SC/02/ED/1D1/30	4 of 4	0
8	Erection Drawing for +6.0M body extention	PGCB/SC/02/ED/1D1/01/31	2 of 2	1
9	Erection Drawing for +9.0M body extention	PGCB/BS/2/80	1 of 2	0
10	Erection Drawing for +12.0M body extention	PGCB/SC/02/ED/1D1/31	1 of 2	1
11	Stub for pile Soil Category 3 & 4	PGCB/AS/1/32	1 of 1	0

LIST OF AVAILABLE STRUCTURAL/ERECTION DRAWINGS OF TOWERS

NORMAL BASE WIDTH

TOWER TYPE 1D25

Sl.	Description	Drawing No.	Sheet No.	Rev
1	Erection Drawing for Bottom part of (-)3M	PGCB/SC/02/ED/1D25/40	1 of 4	0
2	Erection Drawing for Top part-1 of (-)3M	PGCB/SC/02/ED/1D25/40	2 of 4	0
3	Erection Drawing for Top part-2 of (-)3M	PGCB/SC/02/ED/1D25/40	3 of 4	0
4	Cross - Arm and Tie plan	PGCB/SC/02/ED/1D25/40	4 of 4	1
5	Erection Drawing for (-)3M to ±0M portion	PGCB/SC/02/ED/1D25/42	1 of 2	0
6	Erection Drawing for +1.5M body extention	-	-	-
7	Erection Drawing for +3.0M body extention	PGCB/SC/02/ED/1D25/42	2 of 2	0
8	Erection Drawing for +4.5M body extention	PGCB/SC/02/ED/1D25/41	2 of 2	0
9	Erection Drawing for +6.0M body extention	PGCB/SC/02/ED/1D25/43	1 of 1	0
10	Erection Drawing for +9.0M body extention	PGCB/SC/02/ED/1D25/41	1 of 2	0

TOWER TYPE 1DT6 (Angle)

Sl.	Description	Drawing No.	Sheet No.	Rev
1	Erection Drawing for Bottom part of ±0M	PGCB/SC/02/ED/1DT6/47	1 of 5	0
2	Erection Drawing for Top part-1 of ±0M	PGCB/SC/02/ED/1DT6/47	2 of 5	0
3	Erection Drawing for Top part-2 of ±0M	PGCB/SC/02/ED1/1DT6/47	3 of 5	1
4	Erection Drawing for Cross - Arm plan	PGCB/SC/02/ED/1DT6/47	4 of 5	0
5	Erection Drawing for Tie plan	PGCB/SC/02/ED/1DT6/47	5 of 5	0

TOWER TYPE 1DT6 (Terminal)

Sl.	Description	Drawing No.	Sheet No.	Rev
1	Erection Drawing for Bottom part of ±0M	PGCB/SC/02/ED/1DT6/153	1 of 6	0
2	Erection Drawing for Top part-1 of ±0M	PGCB/SC/02/ED/1DT6/153	2 of 6	0
3	Erection Drawing for Top part-2 of ±0M	PGCB/SC/02/ED/1DT6/153	3 of 6	0
4	Erection Drawing for Cross - Arm plan with aux. Cross Arm	PGCB/SC/02/ED/1DT6/153	4 of 6	0
5	Erection Drawing for Cross - Arm plan with aux. Cross Arm	PGCB/SC/02/ED/1DT6/153	5 of 6	0
6	Erection Drawing for Tie plan with aux. Tie	PGCB/SC/02/ED/1DT6/153	6 of 6	0

LIST OF AVAILABLE STRUCTURAL/ERECTION DRAWINGS OF TOWERS

NORMAL BASE WIDTH

TOWER TYPE 1DT6 (Angle/Terminal)

Sl.	Description	Drawing No.	Sheet No.	Rev
1	Erection Drawing for +1.5M body extention	PGCB/SC/02/ED/1DT6/49	1 of 3	0
2	Erection Drawing for +3.0M body extention	PGCB/SC/02/ED/1DT6/49	2 of 3	0
3	Erection Drawing for +4.5M body extention	PGCB/SC/02/ED/1DT6/49	3 of 3	0
4	Erection Drawing for +6.0M body extention	PGCB/SC/02/ED1/1DT6/48	1 of 1	0
5	Erection Drawing for +9.0M body extention	PGCB/SC/02/ED/1DT6/50	1 of 1	0

TOWER TYPE 1DR

Sl.	Description	Drawing No.	Sheet No.	Rev
1	Structural drawing of Basic Body Part-II of River Crossing Tower Type 1DR	S-2424	1 of 2	0
2	Basic Body Part-II	S-2424	2 of 2	0
3	Basic Body Part-III	S-2425	1 of 2	**A**
4	Basic Body Part-III	S-2425	2 of 2	**A**
5	Basic Body Part-IV	S-2426	1 of 2	**B**
6	Basic Body Part-IV	S-2426	2 of 2	**B**
7	Basic Body Part-V	S-2427	1 of 1	A
8	Cage	S-2428	1 of 2	**B**
9	Peak	S-2428	2 of 2	**C**
10	Bottom, Middle & Top X-Arms	S-2429	-	**C**

TOWER TYPE 1DAX

Sl.	Description	Drawing No.	Sheet No.	Rev
1	Structural drawing of Body of Anchor Tower Type '1DAX'	S-2052	-	A
2	Cage & Peak	S-2436	1 of 1	B
3	Cross-arms	S-2054	-	-
4	Standard Tower	S-2434	1 of 1	A
5	+4.5m Body Extension of Tower Type 1DAX	S-2438	1 of 1	0

LIST OF AVAILABLE STRUCTURAL/ERECTION DRAWINGS OF TOWERS

NORMAL BASE WIDTH

TOWER TYPE 1QL

Sl.	Description	Drawing No.	Sheet No.	Rev
1	Structural drawing of Peak, Top X-Arm & X-Arm-4 & 3 of 1QL type tower	S-2288	1 of 1	3
2	X-Arm-1 & X-Arm-2 and bottom x-arm	S-2289	1 of 1	3
3	Cage-I	S-2290	1 of 1	1
4	Cage-II	S-2291	1 of 1	0
5	Body-I	S-2292	1 of 1	0
6	Body-II	S-2293	1 of 1	0
7	+0m Extension and plan at 'B-B'	S-2294	1 of 1	0
8	+9m Extension	S-2295	1 of 1	0
9	+0m Extension (view at 'F' and plan at 'A-A'	S-2296	1 of 1	1

TOWER TYPE 1Q15

Sl.	Description	Drawing No.	Sheet No.	Rev
1	Structural drawing of GW X-Arm & X-Arm-5 & 6 of 1Q15 type tower	S-2310	1 of 1	D
2	X-Arm-3 & X-Arm-4	S-2311	1 of 1	C
3	X-Arm-1 & X-Arm-2	S-2312	1 of 1	D
4	Cage-I	S-2313	1 of 1	E
5	Cage-II	S-2314	1 of 1	E
6	Body	S-2315	1 of 1	D
7	Basic body with plan 'B-B'	S-2316	1 of 1	D
8	0-Base	S-2317	1 of 1	D
9	+6m Extension (top part of +12m & +15m Extension)	S-2318	1 of 1	D
10	Plan view 'A-A' & Oblique view 'D'	S-2319	1 of 1	D
11	+15m Extension (bottom part of +15m Extension)	S-2320	1 of 1	D
12	Plan view 'C-C' & Oblique view 'H'	S-2321	1 of 1	D

LIST OF AVAILABLE STRUCTURAL/ERECTION DRAWINGS OF TOWERS

NORMAL BASE WIDTH

TOWER TYPE 1QT6

Sl.	Description	Drawing No.	Sheet No	Rev
1	Structural drawing of GW X-Arm & X-Arm-6 of 1QT6 type tower	S-2395	1 of 1	2
2	X-Arm-4 & X-Arm-5	S-2456	1 of 1	3
3	X-Arm-2 & X-Arm-3	S-2397	1 of 1	3
4	X-Arm-1	S-2398	1 of 1	3
5	Cage-I	S-2399	1 of 1	1
6	Cage-2	S-2400	1 of 1	2
7	Body	S-2401	1 of 1	2
8	Basic Body	S-2402	1 of 1	0
9	0 Base	S-2403	1 of 1	0
10	+9M Extension	S-2404	1 of 1	0
11	Plan A-A & B-B	S-2405	1 of 1	1
12	+6M Extension	S-2424	1 of 1	0
13	Aux. cross-arm GW & 6	S-2759	1 of 1	1
14	Aux. cross-arm 4 & 5	S-2760	1 of 1	0
15	Aux. cross-arm 2 & 3	S-2761	1 of 1	0
16	Aux. crooss-arm 1	S-2762	1 of 1	1

GENERAL ARRANGEMENT DRAWING OF ACD

Sl.	Description	Drawing No.	Sheet No.	Rev
1	1QL	A-5441	1 of 1	-
2	1Q15	A-5442	1 of 1	-
3	1QT6	A-5444	1 of 1	-
4	1DR	A-5445	1 of 1	-
5	1DAX	A-5446	1 of 1	-

LIST OF AVAILABLE STRUCTURAL/ERECTION DRAWINGS OF TOWERS

NORMAL BASE WIDTH

STRUCTURAL DRAWING OF STUB

Sl.	Description	Drawing No.	Sheet No.	Rev
1	1DL			
2	1D1			
3	1D25	PGCB/SC/02/ED/1D25/150	1 of 1	0
4	1DT6	PGCB/SC/02/ED/1DT6/151	1 of 1	0
5	1QL	S-2297	1 of 1	A
6	1Q15	S-2308	1 of 1	-
7	1QT6	S-2393	1 of 1	-
8	1DR	S-3032	1 of 1	-
9	1DAX	S-2990	1 of 1	1

LIST OF AVAILABLE STRUCTURAL/ERECTION DRAWINGS OF TOWERS

NORMAL BASE WIDTH

TOWER TYPE 1DL
NARROW BASE WIDTH

Sl.	Description	Drawing No.	Sheet No.	Rev
1	132kV Tower Type – 1DL, Top Part	T2005-1DL-01	1 of 1	A
2	132kV Tower Type – 1DL, Bottom Part	T2005-1DL-02	1 of 1	B
3	132kV Tower Type – 1DL, E0 Body	T2005-1DL-03	1 of 1	B
4	132kV Tower Type – 1DL, E1.5 Body	T2005-1DL-04	1 of 1	B
5	132kV Tower Type – 1DL, E3 Body	T2005-1DL-05	1 of 1	B
6	132kV Tower Type – 1DL, E4.5 Body	T2005-1DL-06	1 of 1	B
7	132kV Tower Type – 1DL, E6 Body	T2005-1DL-07	1 of 1	B
8	132kV Tower Type – 1DL, E9 Body	T2005-1DL-08	1 of 1	B
9	132kV Tower Type – 1DL, Stub (Except E9)	T2005-1DL-09	1 of 1	A
10	132kV Tower Type – 1DL, Stub (E9)	T2005-1DL-09A	1 of 1	0
11	132kV Tower Type – 1DL, Template	T2005-1DL-10	1 of 1	A

TOWER TYPE 1D1
NARROW BASE WIDTH

Sl.	Description	Drawing No.	Sheet No.	Rev
1	132kV Tower Type – 1D1, Top Part	T2005-1D1-01	1 of 1	B
2	132kV Tower Type – 1D1, Bottom Part	T2005-1D1-02	1 of 1	A
3	132kV Tower Type – 1D1, E0 Body	T2005-1D1-03	1 of 1	B
4	132kV Tower Type – 1D1, E1.5 Body	T2005-1D1-04	1 of 1	B
5	132kV Tower Type – 1D1, E3 Body	T2005-1D1-05	1 of 1	B
6	132kV Tower Type – 1D1, E4.5 Body	T2005-1D1-06	1 of 1	B
7	132kV Tower Type – 1D1, E6 Body	T2005-1D1-07	1 of 1	B
8	132kV Tower Type – 1D1, E9 Body	T2005-1D1-08	1 of 1	B
9	132kV Tower Type – 1D1, E12 Body	T2005-1D1-09	1 of 1	0
10	132kV Tower Type – 1D1, Stub (Except E12)	T2005-1D1-09	1 of 1	A
11	132kV Tower Type – 1D1, Stub (E12)	T2005-1D1-09A	1 of 1	0
12	132kV Tower Type – 1D1, Template	T2005-1D1-10	1 of 1	A

LIST OF AVAILABLE STRUCTURAL/ERECTION DRAWINGS OF TOWERS

NORMAL BASE WIDTH

TOWER TYPE 1D25
NARROW BASE WIDTH

Sl.	Description	Drawing No.	Sheet No.	Rev
1	132kV Tower Type – 1D25, Top Part	T2005-1D25-01	1 of 1	B
2	132kV Tower Type – 1D25, Bottom Part	T2005-1D25-02	1 of 1	B
3	132kV Tower Type – 1D25, E0 Body	T2005-1D25-03	1 of 1	A
4	132kV Tower Type – 1D25, E1.5 Body	T2005-1D25-04	1 of 1	A
5	132kV Tower Type – 1D25, E3 Body	T2005-1D25-05	1 of 1	C
6	132kV Tower Type – 1D25, E9 Body	T2005-1D25-05A	1 of 1	0
7	132kV Tower Type – 1D25, Stub (Except E9)	T2005-1D25-06	1 of 1	0
8	132kV Tower Type – 1D25, Stub (E9)	T2005-1D25-06A	1 of 1	0
9	132kV Tower Type – 1D25, Template	T2005-1D25-07	1 of 1	0
10	132kV Tower Type – 1D25, Template (E9)	T2005-1D25-08	1 of 1	0

TOWER TYPE 1DT6
NARROW BASE WIDTH

Sl.	Description	Drawing No.	Sheet No.	Rev
1	132kV Tower Type – 1DT6, Top Part	T2005-1DT6-01	1 of 1	0
2	132kV Tower Type – 1DT6, Bottom Part	T2005-1DT6-02	1 of 1	0
3	132kV Tower Type – 1DT6, E0 Body	T2005-1DT6-03	1 of 1	0
4	132kV Tower Type – 1DT6, E1.5 Body	T2005-1DT6-04	1 of 1	0
5	132kV Tower Type – 1DT6, E3 Body	T2005-1DT6-05	1 of 1	0
6	132kV Tower Type – 1DT6, E4.5 Body	T2005-1DT6-06	1 of 1	0
7	132kV Tower Type – 1DT6, E6 Body	T2005-1DT6-07	1 of 1	0
8	132kV Tower Type – 1DT6, E9 Body	T2005-1DT6-08	1 of 1	0
9	132kV Tower Type – 1DT6, Stub	T2005-1DT6-09	1 of 1	0