

**Technical Specifications and Requirements of Emergency
Restoration System (ERS) for 400 kV Transmission Lines for Parbati
Koldam Transmission Company Limited**

SECTION-II

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1. Introduction

PrKTCL invites bids for procurement of Emergency Restoration System (ERS) suitable for its 400kV Transmission Lines as detailed below:

The ERS shall be suitable for the following lines:

- 400 kV Single Circuit Lines - Parbati to Koldam 2X400Kv S/C with Quad Moose Conductor.
- 400 kV Double Circuit Lines - Koldam to Ludhiana 400KV D/C With triple snow bird conductor.

Emergency Restoration System (ERS) shall consist of all necessary **Aluminium** restoration structures, anchors, hardware, insulators, construction tools, spare parts, computer software and training etc. essential for restoration of 400kV transmission lines.

2. Technical Description

The Emergency Restoration System (ERS) shall generally conform to IEEE-1070. However, other ERS supplying equipment's, materials, workmanship and other requirements such as design, geometry, fabrication and testing that provide performance in accordance with the functional specifications of the bidding documents will also be accepted.

2.1 Modular Restoration Structures

2.1.1 The ERS structure shall be of modular construction allowing easy adoption to various line designs/ configuration. To ensure uniform compatibility of the ERS supplied under the contract all components of modular restoration structures shall be geometrically identical/ mutually compatible.

2.1.2 The structure components shall be of light weight, made of high strength Aluminum Alloy. The ERS with structures made of all these materials shall be considered equivalent. The shape, size, dimensions and weight of individual components shall be such that manual handling of the components is possible. The ERS structure shall facilitate tower climbing. The structure column section shall not be more than 4.2m (14 feet) in length. Also, weight of the structure column section shall not exceed 200 kgs. The weight of any other individual component of ERS shall not exceed 260 kgs.

2.1.3 ERS towers shall be of following configuration types: -

- (i) Suspension ERS towers with horizontal V insulator assembly (Refer Table 1). These towers can also be used as running angle towers at reduced span using suspension insulator string of insulator assembly.
- (ii) Tension/Dead end towers (Refer Table 1) with tension insulator assembly and horizontal V insulator assembly for jumper. These towers can also be used as suspension/running angle towers with provision of horizontal insulator assy./suspension insulator string.

Each ERS suspension tower shall accommodate three phases of one circuit for circuit-wise restoration of D/C lines.

Table 1: Table showing; Voltage Level of ERS Structures with Conductor Bundling.

Sl. No.	Existing Line Voltage & Conductor configuration	Restoration of Conductors Per Phase on ERS Line	ERS type Based on Conductor Bundle	Angle Limitation Based on conductor Bundle	Span (m)	Wind speed (m/s)
1	400KV Quad Moose /Triple Snowbird	400KV Quad Moose/Triple Snowbird	C1- Quad Suspension Vertical configuration	0° to 10°- Quad 0° to 20° - Triple	400	47
2	400KV Quad Moose /Triple Snowbird	400KV Quad Moose/Triple Snowbird	C2-Quad Tension Vertical configuration	0° to 60°	400	

As per the proposed requirements mentioned in Table 1, the Bidder shall workout for below ERS combination.

- i) For Hilly Terrain: (All Tension ERS)
C2 X 12 = Total 12 ERS
- ii) For Normal Terrain: (Tension & Suspension ERS)
8 x C1 + 4 x C2 = Total 12 ERS

Insulator Hardware to be procured (Refer BOQ)

- i) Tension Insulator for Quad Moose conductor with Hardware's – 12 Sets
- ii) Suspension Insulator for Quad Moose conductor with Hardware's – 8 Sets

2.1.4 The tower structures, composite insulators and hardware components shall be designed for circuit-wise restoration of 400KV Double circuit transmission lines as per data provided in Table-1.

2.1.5 The structures shall be designed to withstand the loads that results from the load cases.

2.1.6 Locating pins and alignment holes may be provided in each structure to simplify assembly and erection.

2.2 Foundation/ Base Plates

The foundation/ base plates shall be designed to rest on the ground surface with anchors or metal stakes to avoid sliding. They shall be made of light weight, high strength material. The foundation/ base plates shall be designed for loads on foundation/ base plates under

specified loading conditions considered for design of ERS structures. The detailed designs shall be submitted by the Supplier during detailed engineering. The bearing capacity shall be considered as 27,350 kg/sqm for normal soil and 10,000 kg/sqm for low bearing capacity soil.

2.3 Gimbal Joints/Articulation

The Gimbal joint/ Articulation shall be of such design that it can be fixed on the foundation plate and it shall allow assembly of structures over itself. It shall allow leaning and rotation in all directions. It shall minimise column eccentricity and eliminate torsional loading on structures due to its rotational capability. It shall be made of light weight, high strength material. To facilitate temporary fixing & alignment of gimbal/ articulation joint during erection of ERS structures, suitable arrangement with turn buckles or alternate means shall be provided.

2.4 Guy Plates/ Swivels, Box section/ Connecting Box & Provisions for Earthwire

The design of Guy plates shall be such that they shall allow attachment of insulators and guy wires to the structure. It shall be assembled between two column structures and have predetermined holes to allow attachment of insulators and guy wires. Depending upon the requirement, the angle of guy plates shall be 0/0, 0/45 or 45/45. It shall be made of light weight, high strength material.

Box section (if required) shall be of such design that it allows attachment/mounting of insulators and guy wires to the structure. It shall be assembled between column structures and shall have predetermined holes on sides to allow attachment of insulators and guy wires. It shall be made of light weight, high strength material.

Alternatively, swivels or other means of attachment of insulators and guy wires to the structure in various directions simultaneously shall also be acceptable.

Suitable provisions shall be provided on the ERS tower for installation of earth wire, as required.

Actual number of guy plates/ swivels for attachment of guys shall be finalised based on design analysis of ERS towers during detailed engineering.

2.5 Anchoring Assembly

Depending on the prevailing soil conditions, following different anchoring arrangement shall be supplied, the details of which are given in Bid Proposal Sheet of Bidding Documents:

- (i) Cross plate assembly for normal soil
- (ii) Manta Ray or equivalent anchor assembly for normal soil
- (iii) Triple Helix anchor assembly for loose/ marshy soil
- (iv) Large plate anchor assembly for loose/ marshy soil
- (v) Rock anchor assembly for rocky soil

Anchor assemblies shall be of minimum 150 kN UTS and shall include guy adaptor, extension rod & associated fittings as per specified requirements

- 2.5.1** The quantity for anchor assemblies in the Bill of Quantities has been kept corresponding to the estimated number of guys required. Actual number of anchors shall be finalised based on design analysis of ERS towers during detailed engineering.

2.6 Guy Wires and Guy Hardwares

- 2.6.1** Guy wires having minimum 150kN UTS (14.3mm dia) and made of high strength galvanised steel shall be supplied in standard lengths of 70m. Preformed guy grips and guy wire thimbles to be used along with the guy wires for attachment to the tower and anchoring assembly shall have minimum ultimate strength greater than that of guy wire.
- 2.6.2** Other Guy hardware comprising of turn buckle, anchor shackles, extension link/ plates (as per requirements) as indicated in the BOQ of bidding documents shall also be supplied. The minimum UTS of guy hardware & components shall be 150 kN.
- 2.6.3** Actual number of guy wires & guy hardware's shall be finalised based on design analysis of ERS towers during detailed engineering.
- 2.6.4** In case, length of guy wire is more than standard length of 70 m, such guy wires have to be supplied based on actual requirement.

Such guy wires can be supplied in one length or in multiples of standard lengths to the extent required. In addition, jointing arrangements (using additional thimble, preformed grips, shackles, etc.) have to be supplied.

The payment for such lengths & jointing arrangements, if any, shall be restricted to one standard length i.e. 70 m.

In case requirement of guy wire is less than standard length of 70 m, such guy wires shall be supplied in standard length.

2.7 Composite Insulator Strings, Hardware Fittings & Guy insulators

- 2.7.1** All necessary composite insulator assemblies and corresponding hardware required for proposed structures shall be supplied with each set of ERS. The hardware fittings shall include end attachment, yoke plate, suspension clamps, tension clamps, extension links, turn buckles, corona control rings, etc.
- 2.7.2** The insulator strings/assemblies shall be of following types:
- i. Horizontal V (single braced, double post) suspension insulator assembly along with hardware fittings comprising of:
 - a) Composite long rod suspension insulator (3.5 m length, 160 kN tensile strength)
 - b) Composite long rod post insulator (3.5 m length, minimum 90mm core dia, 120 kN tensile strength, 90 kN compressive strength)
 - c) Hardware fittings including end attachment, yoke plates, suspension clamps, extension links, turnbuckles, corona/grading rings other fittings & components as per requirement
 - ii. Double tension insulator string assembly along with hardware fittings comprising of:
 - a) Composite long rod suspension insulator (3.5 m length, 160 kN tensile strength)
 - b) Hardware fittings including end attachment, yoke plates, tension clamps,

- extension links, turnbuckles, corona/grading rings other fittings & components as per requirement
- iii. Horizontal V (single braced, single post) pilot suspension insulator assembly along with hardware fittings comprising of:
- a) Composite long rod suspension insulator (3.5 m length, 160 kN tensile strength)
 - b) Composite long rod post insulator (3.5 m length, minimum 90mm core dia, 120 kN tensile strength, 90 kN compressive strength)
 - c) Hardware fittings including end attachment, yoke plates, suspension clamps, extension links, turnbuckles, corona/grading rings other fittings & components as per requirement

The hardware fittings shall be supplied for Quad Moose conductor as per Table 1.

- 2.7.3** Composite insulators (Suspension, post) with silicone weather sheds shall be supplied along with the associated corona control rings at each end. These insulators shall be supplied from manufacturers whose similar product is in satisfactory operation for 345/400 kV or above voltage application for a minimum period of two years as on date of bid opening.
- 2.7.4** The insulation characteristics shall comply for the system parameters given in Clause 7.1 of SECTION-1 of Technical Specification.
- 2.7.5** The composite insulators shall comply with the electrical and mechanical test requirements specified in IEC-1109.
- 2.7.6** These composite insulators shall be supplied in PVC tubing of proper size to protect these insulators. The PVC tube shall have the provision of closing and opening at one end.
- 2.7.7** Guy strain insulators shall be supplied for insulating portion of guy wires in proximity to live parts. Guy insulators shall be either composite long rod suspension insulators or insulating rods of minimum ultimate tensile strength for conductor configuration given in Table-1. These insulators shall be provided with suitable end fittings for attachment to guy wires & ERS structures.

2.8 Earth wire/ OPGW fittings

Earth wire/ OPGW fittings as per requirements indicated in the Bid Proposal sheets of the bidding documents shall also be supplied. Each set of Earthwire/ OPGW Suspension assembly shall consist of one assembly each for earthwire and OPGW whereas Each set of Earthwire/ OPGW Tension/ Dead end assembly shall consist of two assemblies each for Earthwire and OPGW.

The suspension & tension/ dead end assemblies, fittings & components shall be suitable for 7/3.66 galvanised steel earthwire or equivalent OPGW having overall dia of max. 13.5 mm.

2.9 Detailed Design & Engineering

- 2.9.1** The Supplier shall be responsible for the design of ERS towers (based on the specified design parameters, loading criteria) and also analysis of their use under alternate tower configuration options specified in Table 1.

2.9.2 For various ERS components where type/rating/strength requirements are stipulated in item description of the Bill of Quantities, the design analysis to determine suitability/ extent of usage etc. shall also be carried out by the Supplier during detailed engineering stage.

2.9.3 Loading Criteria

2.9.3.1 The design of ERS towers shall be carried out by the Supplier considering loads, loading conditions as per IS 802.

2.9.3.2 Following conductor bundle & earth wire parameters shall be considered for design of ERS towers

- (i) Conductor Tension- 22 % (at Everyday Temperature after Creep)
- (ii) Earth Wire Tension- 17 % (at Everyday Temperature after Creep)
- (iii) Maximum Span Length- 400 m (Ruling Span as per tower design)
- (iv) Wind Speed- 47 m/s (Wind Zone-4)
- (v) Conductor Temperature- Hot 85° C
- (vi) Maximum Ambient Temperature +50° C
- (vii) Minimum Ambient Temperature -15° C
- (viii) Maximum Relative Humidity- 100 % with continuous raining
- (ix) Overload Vertical and Horizontal Factor- 1.0
- (x) Minimum Electrical clearance shall be maintained as per IS/IEC codes.

ERS Mast shall be designed for standard span of 400m. Span reduction from standard span due to accumulation of 15mm radial Ice condition on conductor to be worked out and separate load case shall be created during ERS model analysis for 400kVACSR Moose Conductor Line.

2.9.3.3 Loading Criteria adopted in Existing Transmission towers: (ERS towers shall be designed considering the loading parameters applied in Existing towers)

Existing tower	400kV D/C	400kV S/C	400kV D/C
Name	ACSR Moose	ACSR Moose	ACSR Snowbird
Total Dia (mm)	31.77	31.77	30.57
Bundle	2/4	2/4	3
Bundle spacing (mm)	457	457	457
Weight (Kg/m)	2.004	2.004	1.657
UTS (Kg)	16438	16438	12050

Earth wire	400kV	400kV	400kV
Name	GSW (7/3.66)	GSW (7/3.66)	GSW (7/3.66)
Total Dia (cm)	1.098	1.098	1.098
Weight (Kg/m)	0.583	0.583	0.583
UTS (Kg)	6975	6975	6975
Design Parameters/Loads	400kV D/C	400kV S/C	400kV D/C
Wind Span (m)	400	400	400

Basic Wind load Parameters (IS-802)			
Wind Zone	2	2	4
Wind Speed (m/sec)	39	39	47
Wind Pressure (Kg/m ²)	50.29	50.29	73.1
Drag Co-efficient considered for conductor	1	1	1
Gust Response Factor considered for conductor	2.29	2.12	2.21
Drag Co-efficient considered for OPGW or EW	1.2	1.2	1.2
Gust Response Factor considered for OPGW or EW	2.36	2.21	2.28
Drag Co-efficient considered for Insulators	1.2	1.2	1.2
Gust Response Factor considered for Insulators	2.5	2.5	2.5
Minimum Creepage Distance in your Polymer/Porcelain Insulators (in mm)	13020	13020	13020

2.9.3.4 For calculation of vertical loads due to conductor weight span shall be considered as follows:

		Normal Condition (NC)	Broken Wire Condition (BWC)
Suspension Tower	Max.	600 m	360 m
	Min.	200 m	100 m
Tension Tower	Max.	600 m	360 m
	Min.	0	-300 m

2.9.3.5 Following criteria shall be considered for conductor & earth wire sag-tension calculations: -

- Conductor & earth wire tension at everyday temperature at no wind condition shall be considered as 22% & 17% of UTS respectively.
- Maximum sag shall be considered corresponding to 85 deg C conductor temperature & 53 deg C earth wire temperature.
- Maximum conductor/earth wire tension (for calculation of line deviation loads) shall be considered corresponding to 32 deg C & full wind pressure on conductor/earth wire on the entire wind span.
- 28% of design wind pressure at (-) 5deg C with 15 mm thick radial Ice - This will be applicable only for reduced span with snow load. Standard span of 400m shall be non-ice condition. **The reduced span shall be mentioned in the design document for Ice Condition.**

2.9.3.6 The Supplier shall furnish the limit loads as well as ultimate strengths of all components (along with calculations) during engineering stage. The Ultimate strengths finalized during detailed engineering stage shall be applicable for testing purposes.

2.9.4 Electrical parameters

2.9.4.1 Electrical system parameters for design of ERS shall be same as those indicated for existing transmission lines under clause 6.1 of Section-I of Technical Specification.

2.9.4.2 Electrical clearances to be considered for ERS shall be as follows: -

S.No.	ELECTRICAL CLEARANCES	
1.	Minimum Ground Clearance (m)	8.84
2.	Minimum Live-metal Clearance (m)	3.05
3.	Minimum Inter-phase/pole spacing (m)	8
4.	Minimum Mid-span clearance between conductor & earth wire (m)	9.0

2.9.4.3 Minimum total creepage distance (phase to ground) for insulators shall be 13020 mm

2.9.5 Erection & Stringing Equipment's, Tools & Tackles

The Erection & Stringing Equipment's, Tools & Tackles required for erection/assembly of structures as indicated in bill of quantities of the Bidding Documents shall be supplied with each set of ERS. **The bidders shall also consider erection & stringing equipment's, tools, and tackles which in their opinion are required for use & deployment of ERS in the BOQ.**

2.9.6 Containers for ERS

Required number of 20 feet containers shall be supplied for storage of all ERS components/material (except structure/ mast sections) as well as for transportation of the same to restoration site. The containers shall have suitable stacking arrangement for storage & provision (sliding stacks or alternate arrangements) for easy access & removal of material from stacks. Estimated quantity of containers has been indicated in the BOQ. Actual quantity shall be finalized during detailed engineering.

The containers shall be such that these can be loaded on separate trucks or flat bed trailers for transportation.

The containers supplied shall be suitable for indoor storage & outdoor storage under service conditions mentioned at 7.1 of Section-1 of Technical Specification.

2.9.7 Computer Programs

2.9.7.1 An extensive set of computer analysis programs to assist in determining the capabilities of the structures shall be supplied with each set of ERS. Two sets of such programs shall be supplied on CDs for compatible personnel computers using MS-DOS or WINDOWS. The computer program(s) shall be suitable for copying & multiple use by at least 2 (three) users simultaneously & independently.

2.9.7.2 The programs shall be easy to use, i.e., user friendly and shall be accompanied by a Technical Specification for ERS "Section-II"

thorough instruction manual.

- 2.9.7.3 The computer programme output data (for given load design scenario) shall include but not limited to guy wire tension, maximum span for a given conductor height, compressive loads for the foundation plate, right of way area requirement, total anchor load requirement ,graphic representations of the structures to be built.
- 2.9.7.4 The computer programme must have the capability to analyse all configuration of towers. Up-gradation of computer programme, if any, should be furnished free of cost for 5 years period.
- 2.9.7.5 In addition to the above computer programme, Supplier shall also supply PLS-CADD software package including tower spotting, tower design, mass/pole design modules (1 license) for line design using ERS structures, self supporting permanent towers, guyed towers, etc. including necessary software for thermal ratings of various conductors, sag tension calculations, tower loading trees, tower analysis, foundation loads, tower spotting, etc.

2.9.8 List of Drawings and Documents

- 2.9.8.1 The Bidder, along with his Bid, shall furnish necessary description and illustration of the materials offered. Bidder shall also furnish a preliminary design of ERS structure considering design criteria stipulated in the specification.
- 2.9.8.2 The Bidder in his Bid shall furnish the drawings, calculations, test reports and literature pertaining to specified items which shall include but not be limited to the following information:
 - a) Name and location of the factory or company manufacturing the ERS components, Composite insulators, hardware's and all other equipment offered.
 - b) Technical standard, manufacturing technology and quality assurance system for ERS components.
 - c) Description of the ERS structure, including broad dimensions of each part, unit weight.
 - d) Technical standards of all other main elements used in ERS and other equipment offered.
 - e) Test reports and certificates showing compliance with the tests as listed in Section- II of Technical Specification.
 - f) Description of Quality Control/ Assurance Programme.
- 2.9.8.3 The Supplier shall also furnish 4 copies each of the following documents during detailed engineering in addition to drawings & documents specified in 2.9.8:
 - a) Detailed design of the ERS structure & all components considering design criteria stipulated in the specification.
 - b) Detailed description of the ERS structure, including dimensions of each part, unit weight and cross-section drawings.
 - c) Erection drawings

- d) Specific instructions for installation of ERS, maintenance and instruction manuals.
 - e) Drawings of each hardware item showing ultimate or breaking strength.
 - f) Details of packing and
 - g) Detailed drawings of jumper connections including electrical clearances.
- 2.9.8.4 After Purchaser's approval and successful completion of all type tests, the Supplier shall within three weeks, submit 10 prints, one set of good quality reproducible, one set of colour drawings in AutoCAD stored in CD/USB Drive of the approved drawings for Purchaser's use.
- 2.9.8.5 Ten (10) sets of nicely printed separate bound volumes of storage, maintenance, transportation & erection manuals in English for each equipment as well as stringing manuals shall be submitted by the Supplier for distribution, prior to the dispatch of the equipment.

The manual shall contain in separate sections all the drawings and information required for emergency restoration of the transmission lines. The manual shall also contain a set of all the approved drawings, type test reports/ performance test reports etc.

The Supplier shall also furnish six CDs/USB Drive demonstrating the procedure of installation/stringing of conductor and associated hardware and such other works and procedures (with slow motion sequences also) which would educate and guide the Purchaser's engineers in execution of work. The CDs shall be informative and self-explanatory and in English language only.

2.9.9 Workmanship

All works shall be performed using the best modern practices of the industry. All material should be new and free of defects or irregularities. All components of the same design and designation should be identical and like components should be interchangeable. All corners should be rounded, and sharp edges should be broken.

2.9.10 Galvanising

- 2.9.10.1 The structures and components of ERS made of steel shall be fully galvanised. Galvanising shall conform to IS: 2629 and IS:4759. Post treatment (chromating) recommended as per IS:2629 shall also be carried out after galvanising. All galvanised members shall withstand tests as per IS:2633. For fasteners, the galvanising shall conform to IS:1367 (Part-13). Spring washers shall be electrogalvanized as per Class-4 of IS:1573.
- 2.9.10.2 The steel strands of the guy wires shall be hot dip galvanised and shall have minimum zinc coating of 275 gms/sqmm after stranding. These shall withstand three & a half dips under the Standard Preece test.
- 2.9.10.3 Other ferrous components (of hardware fittings, etc.) shall be hot dip galvanised and shall have minimum average coating of zinc equivalent to 600 gms/sqmm. These shall withstand at least six dips of one minute duration under the Standard Preece test.

2.9.11 Quantities

- 1.0 Bill of Quantities (BOQ) of various items of ERS are given in the relevant schedule under this bidding documents. The quantities of various items of ERS may vary based on final requirement to be determined after completion of detailed engineering. The final quantities shall be supplied by the Supplier at the same terms & conditions and unit rates shall remain the same for any variation in quantities of items of ERS. For overall quantity variation, provisions stipulated in relevant clauses under Conditions of Contract of the Bidding Documents shall be applicable.

3. Tests

3.1 General

The Bidder along with his bid shall furnish performance test certificates for the equipment's/ material offered by him. If the Bidder is required to specially design the equipment to meet the Purchaser's Specification, then he should submit the performance test certificates for the equipment's/material which are similar to those offered by him.

3.2 Production Tests and Performance Tests

All equipment's covered under this Specification shall be subjected to Production and Performance tests during manufacturing, assembly and on completion. Cost of such tests shall be borne by the Supplier.

3.3 Production Tests

- 3.3.1** Production tests/Tests during Manufacture/ Routine tests of all major equipment/tools shall be conducted as per applicable standards/codes. In the absence of any Code/Standard, equipment shall be tested as per mutually agreed procedure between the Supplier and the Purchaser. These tests shall include all tests to be carried out at Supplier's works, works of his sub-vendor and at works where raw materials supplied for manufacture of equipment's are fabricated.

- 3.3.2** The tests to be carried out shall include but not be limited to the tests described as follows:

(i) For Column Sections/Structures, Box Sections, Gimbals & Guy Plates

- a) Strength proof test
- b) Dimensional test
- c) Material analysis and testing

The test values for strength proof test shall be maximum of those specified in IEEE- 1070 or 67 % of the ultimate strength values guaranteed by the Supplier and considered in the detailed design.

(ii) For Guy hardware's, insulator string hardware's & Anchor assembly hardware's

- a) Dimensional test
 - b) Material analysis and testing
 - c) Proof Load Test
- } As per Annexure-A

(iii) For Composite Insulators & Guy insulators

- a) Visual Examination } As per IEC:61109-2008
- b) Mechanical routine test } As per IEC:61109-2008
- c) Material analysis and testing of metal parts
- d) Insulation resistance test for guy insulators (of insulating rods)

3.4 Performance Tests

3.4.1 Following Performance tests shall be carried out once at Supplier's works/ works of his sub-vendor before dispatch of material.

3.4.2 Tests for the IEEE standardized system shall be according to IEEE Standard 1070: 2006 "Guide for the Design and Testing of Transmission Modular Restoration Structure Components". For other types of structures tests shall be carried out according the objectives of IEEE Standard but test parameters shall be mutually discussed and agreed.

3.4.3 The acceptance values for the tests to be carried out as per IEEE 1070 shall be maximum of those stipulated either in IEEE 1070 or those guaranteed by the Supplier and considered in the detailed design.

3.4.3.1 For Column Sections/Structures

- i) Compression test } As per IEEE 1070
- ii) Bending test } As per IEEE 1070
- iii) Torsion strength test } As per IEEE 1070
- iv) Combined bending and compression test } As per IEEE 1070
- v) Ultimate strength bending test-Bolts } As per IEEE 1070
- vi) Ultimate strength bending test-welds } As per IEEE 1070
- vii) Column Buckling test } As per IEEE 1070

3.4.3.2 For Box Sections

- i) Box Section load test } As per IEEE 1070

3.4.3.3 For Guy Plates

- i) Guy Plate load test } As per IEEE 1070

3.4.3.4 For Gimbals

- i) Gimbal articulation test } As per IEEE 1070
- ii) Gimbal compression test } As per IEEE 1070
- iii) Gimbal transverse test } As per IEEE 1070

3.4.3.5 For Bolts & Nut

- i) Ultimate strength test } As per IEEE 1070

3.4.3.6 Stainless steel washer / thaw test } As per IEEE 1070

3.4.3.7 For Composite Insulators & Composite Insulator strings

(i) Design & Type Tests on composite insulators } As per IEC 1109

(ii) Corona & RIV tests on composite insulator strings } As per Annexure-A

The above design & type tests on composite insulators indicated at i) & ii) above shall not be required to be carried out if a valid test certificate is available for a similar design, i.e., tests conducted earlier should have been conducted in accredited laboratory (accredited based on ISO/IEC guide 25/17025 or EN 45001 by the National Accreditation body of the country where laboratory is located) or witnessed by the representative (s) of INDIGRID or Utility.

(iii) Mechanical Strength Test on Composite insulators } As per Annexure-A

(iv) Mechanical Strength Test on Hardware fittings } As per Annexure-A
of insulator strings

3.4.3.8 For guy wires, guy hardware's, guy insulators (of insulating rods) & anchoring assemblies

(i) UTS/ Mechanical Strength Test } As per Annexure-A

3.4.4 The Purchaser's representative shall be given full access to all performance tests. The Supplier shall inform the Purchaser in accordance with clause no. 4.10.2 of Section-I of Technical Specification, so that, if the Purchaser so desires, his representative can witness the tests.

3.4.5 All test certificates and reports shall be submitted to the Purchaser for approval.

3.4.6 The entire cost of testing for the above production & performance tests shall be treated as included in the quoted Ex-works price.

3.5 Additional Tests

3.5.1 The Purchaser reserves the right of having, at his own expense, 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 tests, performance tests and tests during manufacture so as to satisfy himself that the material comply with the Specification.

3.5.2 The Purchaser also reserves the right to conduct all the tests mentioned in this Specification at his own expense on the samples selected from lots supplied to the Purchaser at Supplier's premises or at any other test center. In case of evidence of noncompliance, it shall be binding on the part of Supplier to prove the compliance of the items to the Technical Specification by repeat tests or corrections of deficiencies or replacement of defective items, all without any extra cost to the Purchaser.

3.6 Test Reports

3.6.1 Copies of Performance test report shall be furnished in at least six copies. One copy shall
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be returned, duly certified by the Purchaser, only after which the materials will be dispatched.

- 3.6.2** Record of Production test report/ Tests during Manufacture shall be maintained by the Supplier/Sub-Vendor at his works for periodic inspection by the Purchaser's representative.

3.7 Inspection

- 3.7.1** The Purchaser's representative shall at all times be entitled to have access to the works and all places of manufacture, where materials shall be manufactured and the representatives shall have full facilities for unrestricted inspection of the Supplier's, sub-vendor's works, raw materials, manufacturers of all the materials and for conducting necessary tests as detailed herein.

- 3.7.2** The Supplier shall keep the Purchaser informed in advance of the time of starting and of the progress of manufacture of materials in its various stages so that arrangement could be made for inspection.

- 3.7.3** Materials shall not be dispatched from its point of manufacture before it has been satisfactorily inspected and tested unless the Purchaser in writing waives off the inspection. In the latter case also, the materials shall be dispatched only after all tests specified herein have been satisfactorily completed.

- 3.7.4** The acceptance of any quantity of materials shall in no way relieve the Supplier of his responsibility for meeting all the requirements of the Specification, and shall not prevent subsequent rejection, if such materials are later found to be defective.

4 Training & Demonstration

- 4.1** Upon receipt of the equipment at site, the Supplier is required to give field training & demonstrate installation of two typical types of suspension & one tension ERS structure using ERS structures & components supplied by the Supplier. All labor & other materials, equipment's, tools & tackles required for field training & demonstration shall be provided by the Supplier.

- 4.2** In case of evidence of noncompliance during demonstration, it shall be binding on the part of Supplier to prove the compliance of the items to the Technical Specification by replacement/modifications of relevant item(s)/components etc. or by providing additional item(s)/ components etc. and re-demonstrating compliance, all without any extra cost to the Purchaser.

- 4.3** The field training cum demonstration shall be carried out near to the designated destination store separately for each set of ERS supplied. The classroom training shall be provided by the Supplier to Purchaser's representatives anywhere in India for a period of 5 working days for each set of ERS supplied.

- 4.3.1** During field training, usage of each type of equipment, tools and tackles shall be clearly instructed and demonstrated to the Purchaser's representative. The training shall include the actual field training imparting firsthand knowledge about the assembly of modular structures (all type of tower configurations), fixing of foundation plates, erecting of

structures on the foundation, guying the tower with anchoring arrangement, etc.

- 4.3.2** The classroom training shall include classroom lectures, including training in computer analysis program to assist the Purchaser's personnel in determining the capabilities of the structures, analysis of failure scenarios, selection of suitable scheme of deployment, etc. The classroom training may also include explanation/demonstration of actual scenarios with scaled model. Special stress shall be given so as to ensure that the trained personnel acquire proficiency in restoring of failed structures so that they can take up this work independently. Training w.r.t storage & maintenance of ERS shall also be provided to Purchaser's Personnel.
- 4.3.3** Bidders are required to indicate training charges in the prescribed schedule of the bidding document. The training charges shall include the to and fro travel expenses, lodging and boarding charges, and any other miscellaneous charges.
- 4.3.4** The program of training shall be mutually discussed and finalized by the Purchaser with the Supplier.

5 Standards

- 5.1** The material shall conform to the following Indian/International Standards, which shall mean latest revisions, amendments/changes adopted and published unless otherwise specified herein above. International and Internationally recognized standards to which these standards generally correspond are also listed below.
- 5.2** In the event of the supply of material conforming to any standard other than Standards listed below, the salient features of comparison shall be brought out and furnished along with the bid.

Sl. No.	Indian Standard	Title	International Standards
1		IEEE Guide for the Design and Testing of Transmission Modular Restoration Structure components	IEEE 1070-2006
2		Composite insulator units for overhead lines with a nominal voltage greater than 1000 V	IEC:61 466-1
3		Composite insulators for A.C. overhead lines with a nominal voltage greater than 1000 V: Definitions, test methods and acceptance criteria	IEC:601109
4		Loading test on overhead line towers	IEC:60852
5		Loading and strength of overhead transmission lines	IEC:60826
6		Specification for Aluminum alloy sheet and plate	ASTM B209

Sl. No.	Indian Standard	Title	International Standards
7	IS:802(Part-I)	Transmission Line towers: Materials, loads and permissible stresses	
8	Central Board of Irrigation and Power Publication No. 268	Transmission Line Manual	
9		IEEE Standard for Testing of Overhead Transmission and Distribution line Hardware	IEEE no.135.61-1997
10	IS:1367	Technical Supply conditions for Threaded Steel Fasteners	
11	IS:1573	Electro-plated coatings of Zinc or Iron & Steel	
12	IS:2629	Recommended Practice for Hot Dip Galvanising of Iron & Steel	
13	IS:2633	Method of Testing Uniformity of Coating of Zinc coated Articles	
14	IS:4759	Specification of Hot Zinc Coatings on Structural Steel and other Allied Products	

6 Experience and Credentials

Bidder shall submit documentary evidence / performance letters / certificates for the supply of **three sets** 400 kV ERS to reputed customers during last five years.

7 Warranty of ERS Structures and After Sale Service

Warranty for ERS Structures and all the associated Components, Accessories and Equipment shall be provided for minimum 24 months from the date of commissioning. In case of any difficulty while understanding, planning and execution of ERS; a qualified person of the Manufacturer/ Supplier shall be approachable / available for urgent clarifications or online support for the minimum period of 5 years. This is a very important from the point of view safe, optimum and effective planning of ERS under emergency conditions. **“Undertaking”** shall be submitted accordingly along with a bid. Further, a detail for “After Sales Support Network” if available in India shall be submitted along with the offer.

8 Guaranteed Technical Particulars (GTP)

Duly filled “Guaranteed Technical Parameters” (GTP) shall be submitted by a bidder for following group of items and requirements for ERS Structures.

- A. ERS Structure and Insulator Components.
- B. Insulator & Hardware Assembly.
- C. Guy Wire and its Components.
- D. Conductor and Guying Hardware.
- E. ERS Assembly and Erection Tools.
- F. Anchor Assembly and Installation Tools.

- G. Storage System.
- H. ERS Design back up files (PLS).
- I. Software & Training
- J. Field training on ERS Erection and stringing.

ANNEXURE-A

(i) Proof Load Test:

Each component shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength which shall be increased at a steady rate to 67% of the UTS specified. The load shall be held for one minute and then removed. After removal of the load the component shall not show any visual deformation.

(ii) Corona & RIV tests for composite insulator strings

- a) Corona Extinction Voltage Test (Dry): The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not less than 320 kV (rms) line to ground under dry condition for 400 kV line. There shall be no evidence of corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulated in IEC : 383.
- b) RIV Test (Dry): Under the conditions as specified under (1.2) above, the insulator string along with complete hardware fittings shall have a radio interference voltage level below 1000 micro volts at one MHz when subjected to 50 Hz AC voltage of 305 kV line to ground under dry condition for 400 kV line. The test procedure shall be in accordance with IS:8263/IEC : 437.

Corona & RIV tests are to be conducted on one suspension & one tension string (horizontal V suspension & double tension insulator string) along with hardware fittings.

(iii) Mechanical Strength Test on Composite insulators:

One sample of each type of composite insulators shall be subjected to 67% of UTS (for both suspension and post insulator) & to 67% of Ultimate compression strength (for post insulator only). This load shall be held for 5 min. The insulator shall not show any visual deformation. Subsequently the load shall be further increased at a steady rate till the specified minimum UTS/ Ultimate compression strength and held for one minute. No fracture should occur during this period.

(iv) Mechanical Strength test on Hardware fitting components of insulator strings/ Mechanical strength test on guy hardwares, guy insulators (of insulating rods) & anchor assemblies:-

One sample of each component of the hardware fittings/ guy hardwares & anchor assemblies shall be subjected to 67% of UTS / Ultimate compression strength. This load shall be held for 5 min. The sample shall not show any visual deformation. Subsequently the load shall be further increased at a steady rate till the specified minimum UTS/ Ultimate compression strength and held for one minute. No fracture should occur during this period.

(v) Mechanical Strength test on Guy Wires

Circles perpendicular to the axis of the guy wire shall be marked at two places on a sample of guy wire of minimum 5 m length suitably compressed with standard clamps at either end. The load shall be increased at a steady rate up to 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 guy wire sample shall not fail during this period. The applied load shall then be increased until the failing load is reached, and the value recorded.

ANNEXURE-B

(Separately Enclosed)

----- End of Technical Specification for ERS "Section-II"-----