Annexure – 2

Technical Specifications
for
Mono Pole Structure Material

TECHNICAL SPECIFICATION for DOUBLE / MULTI CIRCUIT HOT DIP GALVANIZED TRANSMISSION LINE POLYGONAL MONO POLES 220 KV LINES)

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1.0 CODES AND STANDARDS

The specified material and services shall be furnished in accordance with, but not limited to, the relevant Indian/international standards, including all addenda, in effect at the time of purchase order, unless otherwise stated in this specification:

In case Indian standards are not available for any of the items, relevant ASTM codes as mentioned shall be adhered to manufacturing and installation.

ASTM – American Society for Testing and Materials (OR Equivalent Indian & international Standards)

A 36 / 36 M Standard Specification for Structural Steel, Book 01.04

A 123. Specification for Zinc (Hot-Dip Galvanized) Coatings on iron and Steel Products, Book 01.06, 15.08.

A 153. Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware, Book01.06.15.08.

A 572/572M Specification for High-Strength Low Alloy Columbium Vanadium Steels of Structural Quality.

A 780 Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

AWS – American Welding Society.

D1.1-92 Structural Welding Code – Steel. Specification for Carbon Steel Covered Arc-Welding Electrodes.

A5.17-89. Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc-Welding

ASCE – American Society of Civil Engineers.

ASCE SEI 48-11 - Design of Steel Transmission Pole Structures.

ISO – International Standards Organization.

ISO 9001 - Quality System Model for Quality Assurance in Design/Development, Manufacture and Testing.

ISO 9002 - Quality System Model for Quality Assurance in Production, I installation and Servicing.

ISO 3834-2 - Quality requirement for Welding of Metallic Materials.

Indian Standards.

IS 5613:1985(or latest version) - for determining the clearance diagrams for the pole.

IS 802:2015(or latest version) - for sag tension and loading calculation.

CBIP Manual.

Full scale testing

IEC 60652 – 2002

These codes and standards set forth the minimum requirements which may be exceeded by Contractor, if in Contractor's judgment and with PURCHASERS acceptance, superior or more economical designs and materials are available for successful and continuous operation of Contractor's equipment as required by this specification.

2.0 TECHNICAL REQUIREMENTS FOR POLES

2.1. DESIGN.

2.1.1. Line parameters to be considered for Pole design.

(a) Voltage Level - 220 kV

(b) No. of circuits - 2 Nos. for Double Circuit
- 4 Nos. for Multi Circuit

(c) Conductor - 220 kV Line - Single AAAC Zebra / HTLS Drake

(d) Basic wind velocity for design - As per IS 802:2015 –Wind Zone-3
Depending on the location line.
- Reliability level Poles - As per latest IS 802:2015.
Terrain Category - As per latest IS 802:2015.

(e) Clearances - As per IS 5613:1985.

(f) Pole types to be used - DA / MA - 0-2 Degree, (D-Double Ckt / M-Multi Ckt)
- DB / MB - 2-15Degree,
- DC / MC - 15-30 Degree,
- DD / MD - 30-60 Degree/DE,
- DE / ME - 90 Degree/DE with Aux Xarms (if required).

(g) Normal Span - 132 kV DC & MC Poles @ 320 Mtrs.
220 kV DC & MC Poles @ 350 Mtrs.
- 400 kV DC Poles-300 Mtrs @ MC Poles- 250 Mtrs.

(Note - Extension poles required as per the survey may be designed like +0, +1.5, +3, +4.5. +6, etc.)

2.1.2 Deflection Limit (As per CBIP Manual)

Ultimate load condition 5.0% of the height of pole for design consideration.
Safety Normal condition 2.0% of the height of pole for design consideration.

2.1.3 W/T Ratio for Design

While designing the D/T Ratio and the W/T Ratio should be maintained at an adequate level to avoid buckling under load and ovality of the individual sections (without any additional internal supports) of the pole while storing. The allowable stress of Steel should not get reduced more than 10% of its designated strength (ASCE/SEI 48-11, Code for Design of Steel Transmission Pole Structures).

2.1.4 Conductor Tension for Design

The final conductor tension at 32°C and without wind shall be 22% of the ultimate tensile strength of the conductor as per IS:802 Part-1, Section-1, 2015.

2.1.5 Minimum wind gust response factor for Design

Wind Gust response factor on pole structure shall be as per IS:802 Part-1, Section-1, 2015.

2.1.5 Normal Span

The normal ruling span of the line shall be as mentioned above.

2.1.6 Wind Span

The wind span is the sum of two half spans adjacent to the support under consideration. For normal horizontal spans this equals to normal ruling span. For pole design maxim wind span 1.1 times normal ruling span shall be considered.

2.1.7 Weight Span

The weight span is the horizontal distance between the lowest points of the conductors on the two spans adjacent to the tower. Negative weight span, wherever required for the design of the pole has to be considered based on the survey or as mentioned in the tender tech spec.

The final sag tension calculations, clearance diagrams and loadings trees suitable for actual requirement based on field survey & above line parameters shall be generated by the contractor using lesser umber of structures. These details shall be got approved by purchaser after placement of order.

2.2 GENERAL

2.2.1. General Requirement

All designs are to be made in accordance with the information provided herein and on the accompanying outline drawings. All outline dimensions are fixed but where no dimensions are given, the framing, may be modified to suit the Contractor's design, subject to compliance with all the requirements of the specification.

The manufacturer should have a manufacturing as well as a galvanizing plant of its own in India. And the steel pole manufacturer should have proven experience at least 5 years in design, manufacturing, supply and testing of above voltage class steel poles. To ensure quality, the pole manufacturer should have in house capacity to manufacturer poles of such voltage grade and offered poles types without outsourcing any of the key processes of the pole manufacturing like, steel sheet bending, seam welding of sections, base plate welding & galvanizing.

The steel poles design shall be the responsibility of the pole manufacturer. It shall be designed & manufactured for the configuration, loadings and limitations provided elsewhere in the tender documents. The contractor, at purchaser's request, shall explain and provide all the necessary information pertaining to the design of any or all elements of the structure.

Structures shall be designed so that member unit stress does not exceed the yield point stress of the material. The ratio of major axis of tubular diameter to wall thickness shall be such that local buckling does not govern member design. Structure deflection under maximum load condition including over load factors shall be no more than 5 % of the structure height.

Cross section of the pole shall be 12 sided polygons and shall be tapered from top to the base.

Cross arm member, if required in the Bid Drawings shall be of polygonal cross section with taper and shall conform to purchaser's general arrangement drawings. The strength of the attachment of cross arms to the columns shall be sufficient to develop the full capability of the cross arm.

Members requiring more than one length of tubular section shall be constructed by telescoping the sections together with sufficient overlap to develop the full strength of the member. Minimum overlap shall be 1.5 times the maximum inside diameter of outer section at the telescopic joint or as per design calculations, whichever is higher.

Rigging accessories, insulator attachment plates, ladder, lugs for bolted steps and lighting brackets, and hand line attachment shall be welded to the structure.

2.2.2. Structural Analysis.
Elastic methods of analysis shall be used. Stability shall be provided for the structure as a whole and for each structural element. The load effects resulting from the deflected shape of the structure and individual elements shall be considered during design.

The analysis shall include all structural members (including inter pole ties, bracings and guys, if required) in their actual, manufactured geometry and sizes.

When values for the following are specified in the tender documents, the analysis shall include: differences in support elevation, support movement and erection tolerances.

The structural design of the pole shall be done using proper internationally accepted design software.

2.2.3. Clearance.
Poles shall maintain the minimum clearances between conductors and steel structures as per the standards/codes/rules.

2.2.4. Design Loads.
The steel pole shall be designed to withstand the loading conditions and loading input data provided by the PURCHASER in the tender. These loads are to be factored in while preparing the loading trees.

The specified/calculated wind load on the steel pole shall be applied on projected steel area of the pole. The wind load shall be applied throughout the exposed length of steel pole. The Contractor shall indicate on the design drawings the magnitude and the location of the wind forces assumed in the design.

2.2.5. Allowable Stresses.
The allowable stresses for tubular members, guys (if applicable) and connection bolts shall comply with the requirements of ASCE SEI 48-11, Design of Steel Transmission Pole Structures.

2.3 MATERIALS.
2.3.1. General.
All materials shall comply with the requirements of an ASTM specification unless otherwise specified. Material to be welded shall comply with the requirements of ANSI/AWS D1.1.

2.3.2. Structural Plates.
Plate and "product of a coil" that is used to produce load carrying components shall be considered structural plate. Material used for grounding plates, identification plates, pole caps, disposable cage plates and similar components does not need to be classified as structural plates.

Structural plate less than or equal to 31.75 mm (1.25 in.) in thickness shall conform to ASTM A36, ASTM A572, ASTM A 633 or ASTM A871.

Yield strength of Plates used for manufacturing the shafts & cross arms shall be confirming to Gr 65 of ASTM A572 or equivalent grades. Yield strength of Plates used for manufacturing the Base Plates shall be confirming to Gr 50 of ASTM A572 or equivalent grades. The silicon content of plates used for the pole shaft shall be limited to less than 0.06 % to have a better quality of Galvanizing.

MATERIAL SPECIFICATIONS for Shaft & Base Plate

Pole Shaft ASTM A572-65 or Equivalent
Arm & Arm Bracket ASTM A572-65 or Equivalent
Base Plate ASTM A572-50 or Equivalent

2.3.3. Bolts and Nuts.

Material for anchor bolts shall conform to grade 6.8 or 8.8 as per the requirement. Exposed portion of the Anchor bolts shall be galvanized in accordance with ASTM A 153.

Material for headed bolts shall be of grade 6.8 or 8.8 and shall be galvanized in accordance with ASTM A 153. When inch size bolts are used, they shall conform to: ASTM A307, ASTM A325, ASTM A490 or ASTM A449 when bolt diameter exceeds 38.1 mm (1.5 in.) Threaded rod shall be of grade 6.8 or 8.8. When inch size threaded rods are used, they shall conform to ASTM A36, ASTM A354,ASTM A449, ASTM A588 or ASTM A687.

2.3.4. Weld Material.

The material used for making welds shall be compatible with the parent material, as defined by ANSI/AWS D1.1-92 and shall meet the impact requirements specified in 3.2.4 for the lowest toughness requirements of the plates being joined.

2.4 DETAILING.

2.4.1. Typical Details.

Telescoping splices joining sections (slip joints) shall be designed to assure a minimum overlap of 1.5 times the largest inside diameter of the outer section. Anchor bolts for the pole shall be provided with top and bottom templates to form a cage at job site. This is to get a proper alignment of bolts during casting of foundation.

2.4.2. Circumferential welds.

Shaft-to-shaft, pole shaft-to-base plate, and pole shaft-to-flange shall be full penetration welds.

Arm shaft-to-arm bracket shall be partial penetration groove weld with fillet overlay, sized to develop the full strength of the shaft.

Other accessories (Lugs and plates for grounding, jacking, climbing and identification) shall be fillet and/or groove welds sized to develop the loading requirements of the attachment.

2.4.3. Longitudinal Welds.
Longitudinal welds in outer section of slip joints and within 76.2 mm (3") of a full penetration weld shall be full penetration. Longitudinal welds shall be a minimum of 60% penetration in other locations.

2.4.4. Plate Bends.
The minimum inside radius of plate bends shall be such that cracking does not occur. Care must be taken to prevent the steel from cracking especially at the free ends of the bend either during the bending operation or subsequently due to residual stresses.

2.5 FABRICATION.
2.5.1. General.
The Pole manufacturer shall prepare a detailed drawing of the pole and submit it to PURCHASER for approval. Fabrication shall be performed in strict compliance with PURCHASER's approved detail drawings. Material substitution or deviations from the final approved drawings shall not be made without written approval from PURCHASER. The manufacturer shall accurately identify all material to assure proper usage.

2.5.2. Pole Shaft& Base Plate.
The pole shaft shall present the most pleasing appearance possible consistent with the strength requirements in the specification and drawings. Pole shall be continuously tapered from top to bottom with a uniform slope. No multi-ply steel plates will be allowed. For the pole structure fabrication shaft shall be made with number of sections specified in the Standard Drawings.

The cross section of the pole shall be as specified in the Standard Drawings with all sides equal.

Minimum requirement for Base Plate -

1) Edge Distance**:** minimum 1.5 times of the bolt diameter
2) Bolt to Bolt Spacing**:** minimum 2.5 times of the bolt diameter
3) Shaft to Bolt spacing**:** minimum 3 times of the bolt diameter
4) Base Plate should be welded to the Pole Base Section with a T-joint along with a Back-up Ring.

2.5.3. Pole Slip Joint.
Pole section shall be made with telescopic slip joints for easy assembly either in air or on the ground at the construction site. Overlapping shall not be less than 1.5 times the maximum inside diameter of outer section at the telescopic joint or as per design calculations, whichever is higher. Manufacturer to clearly mark “Minimum”& “Designed” slip positions on the pole sections in RED Paint.

At site, slip joints shall be done using proper devises of suitable capacity only to ensure proper joining of the sections.

The taper of each section at a slip joint should match the taper of the adjacent section to provide proper splice tolerances. No circumferential weld within a shaft section shall be permitted. Other type of connection will not be permitted.

2.5.4. Insulator String and Ground String.
Insulator string and ground string shall be provided and shall refer to the General Design for different type of structures.

2.5.5. Cross Arms.
Cross-arm shall be furnished with hoisting lugs to facilitate line construction and maintenance.

2.5.6. Other pole attachments.
2.5.6.1. Step Bolts or Climbing Devise.
Each pole shall be provided with the required set of Step Bolts & Ladders (Ladder Material: ASTM A572-36 or Equivalent) where maintenance personnel can climb on the pole face. The step bolts shall be approximately 2.5m above ground level for 2m and then the Ladders to the pole cross-arm and from there on to the ground wire peak.

Step bolts shall have suitable proven connection to the pole considering the safety of the maintenance personal.

The step bolts shall be not less than 16 mm dia, symmetrical head, spaced not more than 45 cm apart. The bolts or ladder rungs shall withstand without permanent deformation, a vertical load of at least 137 Kgs. applied at the bolt head and at the Centre of the ladder rung.

2.5.6.2. Grounding Provision.
Grounding clamps or nuts shall be provided near the top and base of each pole. The wire lug shall be welded to the exterior of tubular column sections near the top and the base for grounding, in addition to any other ground wire requirements shown on PURCHASERS's general arrangement drawing

2.6 MATERIAL PREPARATION.
Edges shall be in accordance with ANSI/AWS D1.1. Burrs or sharp notches that may be detrimental to the structure or that pose a safety hazard shall be removed. Re-entry cuts shall be rounded. Care shall be taken to prevent separation of the outer surface and reduction of the cross sectional properties below those required by design. If separation occurs during bending, it shall be repaired in accordance with ANSI/ AWS D1.1. Mill scale shall not be considered as the surface.

When hot bending is required, heating shall be done evenly over the entire bend area and shall be of sufficient temperature to minimize separation and necking down of the cross section. The temperature used in hot bending shall be such that the physical properties of the steel are not diminished.

2.7 WELDING.
Unless otherwise specified herein, or note on purchaser drawings, welding shall conform to the AISC Specification and weld procedure qualifications shall be in accordance with AWS D1.1, Section 5 "Qualifications". A written welding procedure specification as shown in Appendix E of AWS D1.1 (FormsE-1, E-2 orE-3 as applicable) shall be prepared for each procedure and submitted for review and acceptance by PURCHASERS when requested. Weld details on Contractor's shop detail drawings shall include identification of weld and method to be used for making the weld in accordance with AWS D1.1, Section 2,"Design of Welded Connections", and Section 4, Technique.

Preheat and inter pass temperature of AWS D1.1 shall be followed. Welding shall be done by the shield metal-arc, gas shielded flux core, gas shield metal arc or submerged-arc processes. Welding electrodes shall be AWS A5.1, low hydrogen classification E70XX-EXXX, for submerged arc welding, unless noted otherwise on purchaser's design drawings. Where steel other than ASTM is specified electrode selection will be subject to acceptance by purchaser.

The storage of welding consumables (welding wire, electrodes, fluxes and gases) shall be in accordance with AWS D1.1 and the welding consumables manufacturer's recommendations.

Care shall be taken in assembling and fitting and welding shall be controlled to minimize shrinkage stresses and distortion. AII finished work shall be of good quality and have a neat appearance without war page.

Caution shall be exercised to obtain full penetration welds where specified on purchaser's design drawings.

When inspection of a weld zone is called for on purchaser's design drawings, procedures shall be in accordance with non-destructive testing procedures of AWS D1.1 and the following additional requirements:

Circumferential and longitudinal welds within the slip joint area of tubular sections shall be shear wave ultrasonically inspected in accordance with AWSD1.1. Longitudinal welds in tubular sections, where visual inspection is not adequate, shall be magnetic particle or dye penetrate tested.

Attachment welds shall be examined by visual inspection. Magnetic particle or dye penetrate testing in accordance with AWS D1.1 shall be used at questionable area by visual inspection.

Contractor shall furnish a shop test report indicating complete test results of all non-destructive testing and inspection conducted.

Welding of pole sections shall be done using a SAW type welding and pole closing machine. The pole closing machine shall have the required dimensions so that pole sections shall move through it during the welding process. The machine shall have the required jigs from all directions to hold pole section intact while welding to get proper shape and welding quality.

Open arm type welding machines without automatic jigs for holding the pole during welding shall not be used for welding of pole sections as they will not provide the required strength and shape. Welding being the key process of the pole manufacturing, the manufacturer should have ISO 3834-2 certification of quality requirement for Welding of Metallic Materials.

2.8 SURFACE PREPARATION AND COATING

2.8.1 Galvanizing.

All structural steel shall be hot-dip galvanized after fabrication in accordance with ASTM A 123. Surface preparation by means of seven tank process shall be during galvanizing. Exposed welds shall be mechanically cleaned.

Fabrication and preparation of material for galvanizing shall conform to the requirements of ASTM A143. When specified in the drawings or specification, embrittlement test of designated galvanized material shall be performed in accordance with ASTM A 143.

All fabrication work on pole sections (including welding of base section with base plate) shall be completed in all respects before hot dip galvanizing. No cutting, grinding, welding, fabrication, etc. shall be allowed on any of the pole sections after hot dipped galvanizing.

Galvanizing shall be done with single dipping method. Cold galvanizing methods shall not be applied on any of the pole sections while manufacturing / galvanizing. The pole manufacturer has to submit a declaration of suitability of its own galvanizing facility for the work, where the poles are to be galvanized.
Lead content in the zinc solution should not be more than 0.001%. The bidder is required to indicate the size of galvanizing baths in Pre-qualification form as well as proof of ownership and test certificate from Govt. Accredited agency as proof of low lead zinc bath.

Bolts, nuts and washers shall be galvanized in accordance with ASTM A 153.Bolts and nuts shall be assembled after galvanizing and shall fit with finger pressure only and nuts shall be interchangeable on any bolts without shake. Wrench tightness or spinning fit shall be caused for rejection.

Only the exposed threaded portion shall be galvanized in case of foundation Anchor bolts.

Repair of damaged hot dip galvanized surfaces during shipping or handling shall be in accordance with ASTM A780.

Heavy runs or lumps of excess zinc will not be acceptable in any area where they will interfere with bolt hole alignment (such as the "drip end" of punched angle braces, etc.), with matching flat surfaces which are to be bolted together, or are of such size and location that normal handling or erection may cause them to be dislodged. Sharp, pointed, "stickers" of zinc which could cause injuries in handling shall be removed.

Straightening of steel after galvanizing shall be accomplished without the use of heat. Steel so straightened shall be inspected to assure no deformation or cracking of galvanizing layer.

All materials shall be cleaned or washed after galvanizing to remove traces of flux, flux inclusions, preflux slats, acid ash, dross or other extraneous materials. The presence of wet storage stain (White Rust) shall be caused for rejection.

2.9 PREPARATION FOR SHIPPING AND STORAGE

Each shipment shall include a detailed packing list identifying all items by part number, including hardware. Special care shall be exercised in the handling, packaging and shipping of the materials to prevent denting, bending, or any other damage of the sections, cross arms and anchor bolt cages. Suitable cushioning, protective padding, dun age or non-metallic spacers shall be used to prevent vangs and flanges welded to the tubular sections from damaging other tubular parts and to prevent damage and

shifting during transit.

Small parts and fasteners shall be carefully boxed, crated, bagged or otherwise containerized and protected for shipment. Small pieces shall be bundled, with all the pieces in any bundle having the same mark. All small pieces such as bolts, ground wire and insulator connections shall be packed in boxes. Bolts of different size or length shall be wrapped in separate sacks before boxing. Description, quantity and marks or description of contents shall be shown on the outside.

Shipping shall be as specified in the Purchase Order and shall be in complete structure lots. All identifications shown on bundles, boxes or other containers shall be included on Contractor's shipping and packaging lists.

All Materials shall be arranged to allow safe unloading at site.

Shop painted or galvanized steel will be stored in the field pending erection. Contractor shall provide storage and handling instructions to minimize damage to painted or galvanized surfaces.

2.10 MARKING.
All parts of poles shall be appropriately marked or numbered. All markings shall be indelible and clearly visible after galvanizing. Each pole shaft shall have a welded identification tag at 1.5m above ground level, which includes customer name, structure type, manufacturer name, year and month of fabrication.

Each pole shaft section, cross arm and other separate pieces of structure shall have a welded identification tag marked with part number and serial number. All letters and numbers on identification tags shall have a minimum height of 15mmand be legible after galvanizing.

3.0 INSTALLATION.
Experienced engineers of the pole manufacturer shall be available at site while conducting assembly & installation of poles. Pole manufacturer shall submit the installation procedure to the purchaser before starting the installation work.

Assembly of pole sections at site shall be conducted using hydraulic jacking devices and/or suitable chain pulley blocks to achieve proper jacking force.

4.0 TESTS.
4.1 GENERAL.
All materials shall comply with test criteria, and purchaser's acceptance of the steel poles and its components shall not relieve the Contractor of his responsibility for meeting all the requirements of this specification.

The steel poles and its components shall be given the manufacturer's routine shop tests and quality conformance tests. When specified, these tests shall be witnessed by purchaser or its representative. Tests results shall be submitted to purchaser. No steel poles shall be shipped until released for shipment by purchaser.

4.2 MATERIAL.
Contractor shall furnish four (4) copies of certified mill test reports covering chemical and mechanical properties of the structural steel. Stock material may be used with

purchaser's concurrence where stock can be satisfactorily identified with the specified ASTM specification.

Contractor shall furnish all shop test reports for purchaser's review and records.

4.3 QUALITY CONFORMANCE INSPECTION.

This is intended to eliminate defective materials and components of the steel poles. Each component shall be inspected for conformance to the approved drawings. This inspection shall include, but not limited to:

a) Ultrasonic inspection of base plate more than 50mm thick prior to welding for laminations.
b) Visual inspection of dimensions to assure that tolerances are met.
c) Visual inspection of cut edges to ANSI/AWS D.1.1 criteria.
d) Visual inspection of bent surfaces for surface separations(supplemented by magnetic particle in questionable areas);
e) visual inspection of bolt holes to assure that they are cylindrical, perpendicular, free of burrs and without torn or ragged edges;
f) visual inspection of all welds to ANSIIAWS D1.1 Section 8 criteria;
g) ultrasonic inspection of all full penetration welds
h) ultrasonic inspection of shaft to base plate weld after galvanizing for base plate thicker than 50mm (maybe waived if routine audits show no history of defects);
i) visual inspection of all structural partial penetration or fillet welds, in questionable area use magnetic particle inspection according to ANSI/AWS D1.1 Section 8 criteria;
j) visual inspection of finish;
k) Magnetic thickness measurement of finish coatings.

There will be process inspection by the purchaser at manufacturer's plant during key process like, steel sheet bending, seam welding of sections, base plate welding & galvanizing process as and when necessary. All galvanization to be done only after inspection of the completed poles in black condition. Further pre-manufacturing inspection & testing (Mechanical & Chemical) of Steel Sheets will be carried out as & when necessary to ensure the quality of the steel to be used.

4.4 FULL SCALE TESTS

If required by purchaser, the Contractor / pole manufacturer shall be in a position to conduct **type testing of the poles** to ensure the satisfactory design and manufacture of steel poles and its components in accordance with the applicable standards mentioned herein in the specification. This shall be on chargeable basis.

If the poles are being manufactured by using established internationally accepted software, all pole types need not be tested in full scale conditions. In any case, at least one pole type shall be full scale tested. While selecting the sample for testing, pole type having maximum quantity shall be selected for testing.

Full scale testing shall be conducted for 6 load cases up to ultimate (100 %) loading conditions as per IEC 60652-2002. Poles successfully tested up to 100 % load can be used in the line. Testing of poles shall be conducted in black conditions. Tested poles shall be fully hot dip galvanized in single dipping method before being supplied to the

site.

Full scale testing shall be conducted at either any Govt. Laboratory/Test Center or independent NABL accredited Laboratory/Test Centre. Contractor's / manufacturer's in house test center shall not be used for testing of poles. Selected test center must have previous experience of testing power transmission steel tubular/polygonal poles.
The pole shall be erected on a rigid foundation and the vertical axis through the center of gravity shall not be out of plumb by more than two tenths percent (0.2%) of the height at any level.

The pole structure shall sustain the load including overloads. These loads shall be applied in increments and shall be held constant for a period of five (5) minutes before increasing or removing the loads.

The Contractor shall submit for purchaser's approval his proposed method and facilities of applying and measuring the loads on the structure. The load measuring devices with appropriate numbering shall be suitably calibrated prior to and following the test in accordance with the manufacturer's recommendation at the presence of purchaser's Structural Design Engineer / Representative(s).

Structure deflections under load shall be measured by suitable procedure at points designated. Deflection readings shall be recorded for the "before- load" and "Load-off" conditions.

The Contractor shall submit, fifteen (15) days prior to the performance of the tests, his testing programs to purchaser for review and approval. These shall include test procedures, diagrams or test arrangements showing the points of location and magnitude of the loads to be applied, the designated points for deflection measurements, etc.

The pole to be tested shall be inspected in the presence of purchaser's Structural Design Engineer who shall conduct a visual check and evaluate all parts of the structure for sign of failure following the completion of each test.

After completion of test, the test structure can be considered failure if the structure experienced any of the following:

a) After the loads have been removed, the pole structure does not return to its original position within reasonable tolerance;
b) Failure (i.e. bending, yielding, breaking, etc.) of the material or weld is detected; and
c) Test structure does not pass all physical and dimensional checks as required in the test specified in this specification.

Such a failure shall be corrected and tested at the Contractor's expense. In case of no failure, tested poles can be used for installation in the line.

4.4.1 TEST REPORTS
The Contractor shall furnish two (2) copies of a test report in English Language and that shall include;

a) The designation and description of the pole tested;

b) The name of "PURCHASER";
c) The name of the person or organization (responsible engineer) that specified the loading, electrical clearances, technical requirements and general arrangement of the prototype;
d) The name of the Engineer from PURCHASER who attended the test.
e) The name of the Manufacturer.
f) A brief description and the location of the test facilities;
g) The names and affiliations of the test witnesses;
h) The dates of each test load case;
i) Design and detail drawings of the pole, including any changes made during the testing program;
j) A rigging diagram with details of the points of attachment to the pole;
k) Calibration records of the load-measuring devices;
l) A loading diagram for each load case tested;
m) A tabulation of deflections for each load case tested;
n) In case of failure; Photographs of failure: Loads at the time of failure; a brief description of the failure; The remedial action taken; The dimension of the failed members; and Test coupon reports of failed members;
o) Photographs of the overall testing arrangement and rigging;
p) Air temperature, wind speed and direction, any precipitation and any other pertinent meteorological data;
q) Mill test reports of poles used in the test report;
r) Test result of the test coupons taken following the completion of test.

5.0 DATA AND DOCUMENTATION REQUIREMENTS

5.1. GENERAL

Contractor shall furnish data and information on predicted performance, inter face requirements and construction features of all steel poles supplied by the contractor. The accuracy of such information and its compatibility with overall performance requirements specified by purchaser are the sole responsibility of the Contractor.

All information submitted as part of the Proposal Data will become part of contract data for successful bidder. Any deviation from such data requires purchaser's approval for such a deviation to be acceptable to purchaser.

5.2 DATA TO BE SUBMITTED ALONG WITH THE PROPOSAL

a) Description and outline drawings of proposed poles including configuration, material detail, shapes, sizes and representative connection details.
b) Description of design calculations to be performed and buckling criteria to be used;
c) Reference list of previous experience of the pole manufacturer and the contractor.
d) Proof of experience of the contractor as specified in clause no 1.2
e) Proof of previous experience of the pole manufacturer for manufacturing of poles as specified in clause no 1.3.
f) Certified sample mill test reports
g) Proposed time bar schedule to meet delivery, installation/erection date(s)of the steel poles and its components;
h) Copy of ISO 9001 Certification of the pole manufacturer.
i) Tentative Quality Control procedures and qualifications, and nondestructive testing to be performed.
j) Detailed list of all assumptions / exceptions and/or deviations taken by the

Bidder to the requirements of this specification or, if none are taken, a statement indicating that no exceptions or deviations are taken by the Bidder.

k) Details of equipments available with the manufacturer for making these poles.
l) Dimensions of the hot dip galvanizing facility of the manufacturer shall also be provided to ensure their capacity. This will be major qualifying criteria.

5.3. DATA TO BE SUBMITTED AFTER AWARD OF CONTRACT

a) Sag tension calculations, clearance diagrams and loading trees.
b) List of Drawings and schedules of submittals;
c) List of Codes used;
d) The final design calculations of all types of pole's showing design assumptions, analysis, joint fixity, foundation fixity, eccentricities induced to structure deflections and assumptions and computations used to determine radius of gyration and other critical sections;
e) Maximum moments, shears, axial loads and member section modules required and furnished for at least every 20 foot (6.09 m) length, and at ground level, joints, splices and other critical sections;
f) Detailed assembly and fabrication drawings;
g) Bill of materials and parts list for each type of poles;
h) Dimensions of each section and components of each type of poles including Bill of materials.
i) Test reports.
j) Calculations of stresses in the ground line, attachment connections, and moment connections;
k) Maximum horizontal and vertical deflection at top of pole, at shield wire and conductor attachments, and at cross arm joints.
l) Detailed QA Program based on ISO 9001 ;
m) Detailed Contract Schedule Activity for the steel poles;
n) As-built shop/erection drawings as finally approved.

Erection drawings shall show only one (1) pole each with its component parts, and shall have an identification mark. The number and length of bolts, with spring type of washer, nuts and locknut required for the assembly shall be shown at each connection.

A complete list of material listing quantities of all material required for the structure or part structure shown, including bolts, nuts, locknuts, washers shall be shown on Contractor's detail drawings. The bill of material shall include the quantity of pieces required, mark number, description, size, length, weight and total weight of material shown on the drawing, and the reference drawing on which the member is detailed.

Detail drawings shall show each individual member's dimensions and tolerances, welding requirements, connections, identification mark, quantities, material designation, surface treatment, and a bill of material.

The Contractor shall furnish in the manner, number of copies and within the time set forth in the Contract.
