

**PRASAR BHARATI  
(BROADCASTING CORPORATION OF INDIA)  
DIRECTORATE GENERAL;ALL INDIA RADIO  
(PLANNING & DEVELOPMENT UNIT)**

**SPECIFICATION DOCUMENT FOR MEDIUM FREQUENCY ANTENNA**

|                       |   |                     |
|-----------------------|---|---------------------|
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**SUUMMARY:**

These specifications give details of various technical parameters, accessories and spares required for a Self Radiating Triangular Lattice Structure MF Band Mast.

Section I,II & III are generic specifications whereas Section-IV is for a particular place wherein the frequency of operation, height, power and other special technical requirements along with spares as well as optional items required for self radiating mast have been indicated for a particular place.

As per enclosed specification requirement is for a **156.25 metre** high, vertical, self radiating, series fed mast, capable of radiating **1000KW** Carrier power in MF band at **AIR SPT RAJKOT**, the details of which has been indicated in Section-IV.

**N.B:**

1. **The tenderer should go through all the sections of the specifications carefully and confirm clause by clause compliance to all sections clearly. Tenders without clause by clause compliance shall be rejected outrightly.**
2. **The tenderer should also indicate the list of items offered as per schedule of requirements of Section-IV in the technical bid without cost to assess the completeness of requirements.**
3. **The tenderer should visit the site before submitting the tender for realistic offer. A certificate along with report duly signed by station authority and tenderer representative in this regard is to be enclosed with the tender. Station authority are requested to coordinate the representative of tenderer as and when approached for site visit.**

**(M.R.BHARARA)  
Dy. DIRECTOR ENGG.(TD)**

**SECTION – I**

**DETAILED TECHNICAL SPECIFICATIONS FOR MEDIUM FREQUENCY ANTENNA**

**I. INTRODUCTION:**

This specification covers the design, fabrication, supply and erection of medium frequency antenna for use as self radiating mast with broadcast transmitter, operating in the frequency range 531-1605 KHz.

**II. ELECTRICAL CHARACTERISTICS:**

- i) Frequency Range : 531 - 1605 KHz.
- ii) Polarisation : vertical
- iii) Height of Antenna : As given in the schedule of requirements.
- iv) Power handling capacity : As given in the schedule of requirements.
- v) Feeding arrangement : The antenna shall be suitable for being series fed at the base, the power being fed between the base of the antenna and ground.
- vi) Input Impedance : The input impedance at the feeding point should have flat characteristic within 10 KHz at any operating frequency in the range specified in (i) above. (An impedance curve for the entire frequency range will be supplied by tenderer.

**III. MECHANICAL DESIGN:**

**1. General:**

The structure shall be designed to withstand the mechanical / electrical stresses encountered in the Transportation, installation, operation and maintenance of the mast even under the worst wind and Ice loading conditions detailed in this specification. The antenna shall be provided with ladders to enable persons to go up in complete safety, rest platforms at the top and intermediate levels and Aviation obstruction lights as required under the regulations.

**2. Type of structure:**

The antenna structure shall be a guyed, lattice faced, steel structure of uniform triangular cross section throughout its height.

A typical antenna of this type is shown in the attached drawing No. TF-8832 Mod. 1.

### **3.DESIGN DATA:**

#### **(a) Wind and Ice Loading:**

The antenna structure shall be designed taking into account wind loading as below:

i) Basic wind pressure may be taken as per IS:875-1987 with latest amendments, taking into consideration the importance of structure as it is to provide uninterrupted broadcast during all season and will be designed for use anywhere in India. For the purpose of design calculations, therefore, basic wind pressure has to be taken as that of coastal areas in India. For heights more than 150 metres, the basic wind pressure shall vary with respect to the height as per formula  $P \propto H^{0.2}$

ii) The overall wind forces may be computed using the coefficient as given in BIS = CP-3, Chapter V, Para 2 with latest amendments.

#### **(b) Material and type of construction:**

Tower members shall be of standard structural steel (open hearth) conforming to IS-226-1969 (with latest amendments).

#### **(c) Design**

Design, fabrication and other details shall be in accordance with IS-806-1962 (with its latest amendments).

#### **(d) Galvanizing:**

To prevent corrosion, all steel members, accessories and hardware shall be galvanized after fabrication by the "Hot Dip Method" and shall conform to IS-4759-1968 with latest amendments. The fastener shall be galvanized as per IS-5388-69. The galvanizing shall be tested as per test procedure laid down in the relevant specification with latest amendments.

#### **(e) Guys:**

The triangular antenna structure shall be guyed in three planes, 120 degrees apart and at suitable levels. The top most guy level shall be one or two sections below the top of the mast. The mast must have minimum four guy level points except in the case of 40 mtr masts for which 3 guy levels can be accepted. The guys shall be of stainless steel/galvanized steel wire of appropriate size and grade and shall be chosen with adequate factor of safety. The guy ropes shall conform to IS-2266/1970 and IS-3326/1966 (with latest amendments). The guys shall be designed in such a way so that the initial tension in the guys should not be more than 15 percent of the breaking strength of the guys under still air conditions. 1st Insulator / Insulators of adequate rating should be connected as near as possible to the point of attachment of each guy to the tower. The guys shall be broken up (electrically) by the inserting slip in type of insulators of sufficient electrical and mechanical strength for sectional length of

less than one tenth of operating wave length to avoid parastic radiation. the next insulator on each guy section shall not be more than 15 mtrs. away and the spacing between the succeeding insulators shall not be more than 24 mtrs. Both these conditions should be full filled.

The guys shall be prefabricated to enable easy assembly at site. Provision shall be available to adjust at site, the total length of each guy to take care of relative variations in the ground level at the mast base and guy anchor points to the extent of 3 meters.

Provision shall be made for adjustment of the tension of each guy. The tensioning device shall form an integral part of the guy attachment assembly at the anchor end. The guy attachment at the anchor block shall also include arrangements for easy and accurate measurements of the guy tensions.

**(f) Cable connection:**

Ferruling/sleeving or socketing used in each guy section including the straining screw should be designed to withstand atleast 80% breaking load strength of main guy rope. Suitable locking arrangement also is to be made to avoid the slipping of sleeving/socketing and guy straining screw under storm conditions by providing U-clamps as backup measures in addition to ferruling/ socketing. If felt necessary, a sample breaking load test for a guy section may be taken in the presence of AIR inspector.

**(g) Ladder and Rest Platform:**

There shall be an interior ladder surrounded by a cage of about 70 cms diameter for the personnel to climb the structure with safety. Rungs of ladder shall be clear of any obstruction to the climber's toe etc and shall be equally spaced not more than 22.5 cms apart. However, in the case of masts having heights upto 60 M, an outside ladder can be accepted provided a fool proof safety climbing system is incorporated. The rest platform with hand-rails of sufficient size & 750mm high shall be provided at the top of the mast and at other intermediate levels at suitable heights.

**IV. INSULATOR RATING:**

As required under clause II(v) of this specification, the antenna is to be fed at the base. For this purpose, the base of antenna is to be suitably insulated from the ground. This is to be achieved by interposing an insulator of adequate electrical as well as mechanical strength between the antenna base and its foundation block. The base insulator or insulators shall be capable of withstanding the electrical stressess as given in the schedule of requirements. In addition, it shall also withstand voltage stress that may be built up due to lightning and other static charges. The electrical rating of the base insulator / insulators shall be chosen to have a margin of safety of 2.5. Not withstanding the rating imposed by the above conditions, the base insulator shall have a wet flash over rating of not less than 90KV at 50 Hz. The insulators shall also have as low capacitance as possible and low loss ratings at 1 MHz.

A carbon spark ball gap arrangement shall be provided across the base insulator for it's safety in the event of lightening/ thunder storms etc.

Mechanically the base insulator shall be strong enough to withstand the loadings

imposed by the antenna structure under worst conditions. A margin of safety of 3 may be taken while choosing mechanical rating of insulator.

Guy Insulators shall be rated - electrically and mechanically with factors of safety as 2.5 and 3 respectively. Damage to guy insulators due to lightning and other electrical disturbances and consequent interruption in transmitter operation are to be prevented by means of suitable devices such as RF chokes connected across the insulators. These devices should be so designed as to offer an easy leakage path for the unwanted electrical disturbances but at the same time not impairing the efficiency of insulators at the operating frequency of the transmitter. These devices shall be provided in the top two guys. For masts up to 60 mtr height, these will be provided only for top most guy.

#### **V. AVIATION OBSTRUCTION LIGHTING:**

The antenna structure shall be provided with beacon lights, aviation obstruction light fittings at the top of the mast and at intermediate levels respectively as per latest civil aviation rules. The lights shall be of solid state devices in conformity with international standards.

The intermediate lights should be spaced as equally as practicable between the top obstruction light and the mast base level. In no case the spacing shall be more than 45 metres. The first intermediate light may be provided at the height of 45 metres from the ground. The obstruction lights shall be fixed lights, red in colour, having an intensity sufficient to ensure that it is conspicuous, considering the intensity of the adjacent lights and the general level of illumination against which they would normally be viewed. In no case shall the intensity be less than 10 candles of red light.

Rest platforms with hand rails shall be provided at the levels where aviation obstruction lights are fixed to have easy access to these lights. The supply should include all necessary cables, water tight conduits of appropriate size from the bottom of the tower to the lights and other accessories.

#### **VI. ANTENNA LIGHTING TRANSFORMERS:**

The antenna lighting circuit shall be connected to 230 V, 50 Hz mains supply through a well designed isolation circuit which shall provide perfect isolation of the power mains circuit from the Radio Frequency voltages of the antenna. The isolation circuit may take the form of toroidal transformers with low coupling (Austin transformer shown in attached drawing TF-8832 Mod.I) or filter circuits with chokes and capacitors of adequate rating. The supply against this tender should include either of these and in the case of the transformer, it shall be water proof, outdoor type, complete with mounting brackets, insulators if any. The transformer primary shall have tappings for 5 percent and 10 % voltage variations from the normal 230 volts and the transformer and its fittings shall add negligible capacitance between the antenna base and the earth.

#### **VII. FOUNDATIONS:**

The casting of concrete foundations for the Antenna structure, guy anchors and isolation transformer will be done by the tenderer to suit the site requirements at each place. These foundations will be 750 mm (minimum) above the natural ground level. The supplies will include galvanised guy anchor assemblies, foundations bolts, re-enforcement etc., and the necessary material including cement etc. for casting of the

foundations.

The tenderer shall conduct the necessary soil testing for designing the foundations for erection of the tower and guy anchors at each place. However, for the purpose of quote the following typical values of the soil bearing parameters may be considered:

Bearing Pressure : 8.2 metric tons/Sq.m

Earth Weight : 1450 Kg/cubic meter

Angle of repose of soil : 30 degrees

Concrete : 2200 Kg/cubic meter

N.B : For a variation of 0.5 mt/sq.m in soil bearing capacity, additional amount required will be quoted.

The mast base and the isolation transformer foundations will be covered with 1.6mm thick copper sheets of electrical grade on the top and all sides of the foundation upto a depth of 1 foot below the natural ground level.

These sheets will be securely fastened to the foundation. The joints will be overlapping upto at least 1 inch and brazed continuously. The copper sheets, fixing and brazing material required for this work will be supplied by the tenderer.

#### **VIII. ERECTION:**

The complete erection of the antenna structure will be done by the tenderer. The tenderer shall, however, supply complete instructions with drawings for the assembly, erection procedure, adjustments of the antenna structure.

#### **IX. GUARANTEE**

(a) The tenderer shall certify and guarantee that the design, material used and fabrication of the antenna structure and accessories has been done to ensure the capacity of the antenna to withstand the electrical and mechanical stresses with margin of safety specified in this specification encountered under the conditions detailed in the specifications. The structure design details of the mast shall be approved by any of Govt of India structural Institute/IIT/IISc. For this purpose, a dynamic analysis is required to be performed against actual or standardized wind spectra and the successful tenderer shall provide the structural fitness certificate of the mast design within 3 months from the date of the acceptance of the tender.

(b) The tenderer shall ensure that the fabrication of the members of the antenna is done with such precision so that the main leg members of the antenna structure shall remain vertical within two minutes of the arc subtended at the base of structure. The twist of the mast members will not exceed 1/2 degree.

(c) The tenderer shall guarantee the safety of the antenna structure under the specified conditions of electrical operation and wind pressure for a period of one year from the date of the taking over, of the antenna system.

(d) In the event of structural or electrical failure of any component / part of the antenna structure within the guarantee period specified above, on account of manufacturing defects, the tenderer shall undertake to replace the component / parts which have failed and those which were damaged as a result thereof, free of cost and bear the expenditure to be incurred for re-erection of the tower.

#### **X. DRAWING AND TECHNICAL INFORMATION:**

(a) A drawing showing the general arrangement of the antenna offered alongwith the technical information shall be submitted alongwith the tender in the proforma given in Appendix. This will include the leaflet showing technical and physical details of base and guy insulators.

(b) The successful tenderer shall submit 4 sets of the following within 2 months of the date of acceptance of his tender.

1. Layout plan along with action plan erection bar chart
2. Foundation design data and drawings for the antenna base and guy anchor foundations based on soil data given in Para - VII above.
3. Complete instructions with General drawings for the assembly erection and adjustments of the antenna structure.

#### **XI. SPARES:**

(a) The tenderer should quote unit cost separately for the spares such as mast base insulator, guy insulators, RF chokes, light fittings and Austin transformer etc.

(b) The tenderer should quote separately for the kit comprising of Jig and fixture, Hydraulic Jacks etc required for the replacement of mast base insulator.

#### **XII. DELIVERY PERIOD:**

All the erection works including measurements and handing over shall be completed with in 12 months of acceptance of tender.

#### **XIII. PRE- DISPATCH INSPECTION:**

Pre dispatch inspection of stores by giving an advance notice of three weeks shall have to be got done by representative of DG:AIR , P&D Unit or resident inspector if any assigned for such purpose at the premises of manufacturer.

#### **XIV. PAYMENT TERMS:**

As per commercial terms.

#### **XV. INSURANCE**

The entire store will be comprehensively insured including during transit, for free delivery at site, till the mast is erected and handed over to the consignee.

**SECTION-II**

**TECHNICAL INFORMATION TO BE SUPPLIED ALONG WITH THE TENDER**

**1. ANTENNA STRUCTURE :**

- a. A drawing showing the general arrangement of the antenna structure offered.
- b. Dimension of the Cross-section of the antenna structure.
- c. Wind load adopted for the mast.

**2. Guy ropes:**

- (a) Type and specification reference.
- (b) Sizes of various guy ropes.
- (c) Maximum calculated working stress for each guy at the design load.
- (d) Calculated ultimate breaking strength of each guy rope (as modified by a factor depending on the type of connections).
- (e) Proof test load for each guy wire

**3. Base Insulator:**

- (a) Make/Manufacturer's name
- (b) Type number with sketch
- (c) Working load (as per design of antenna structure)
- (d) Proof test load
- (e) Breaking load
- (f) Wet flash over voltage at 50 Hz.(without & with rain shield)
- (g) Wet flash over voltage at 1 MHz.(without & with rain shield)
- (h) Capacitance. of base insulator with & without Austin transformer
- (i) Calculated Base and characteristic Impedance of mast.
- (j) Calculated Base Voltage across insulator under normal working condition.

**4. Guy break up insulators:**

- (a) No. and type of insulators in the chain near the tower attachment point.
- (b) Spacing of the insulators in each guy.
- (c) Type and make of guy insulators.
- (d) Breaking load
- (e) Wet flash over voltage of each insulator at 50 Hz.
- (f) Wet flash over voltage of each insulator at 1 MHz.
- (g) Capacitance of Insulator.
- (h) Distribution of voltage across guy insulators for each guy length.

5. Guy insulator protective device type proposed to be used & if RF chokes then its details & inductance including the antiresonance impedance at carrier frequency.

6. Antenna lighting transformer/filter circuit details with KVA ratings and it's capacitance/inductance values.

7. Details of aviation lights.

8. Wiring diagram of mast lighting.

9. Details of mast climbing arrangement including the safety arrangements with drawings.

10. Details of kit for replacement of mast base insulator.

**SECTION III**  
**SPECIFICATION FOR PAINTING OF A GALVANISED MAST**

Painting is a accepted method of protection against corrosion, wear, decay and other factors which affect the durability of the structures. In addition, painting of the masts according to a specific colour scheme is obligatory as per "International Civil Aviation Regulations", which are reproduced as follows:

" The towers shall be painted in alternate bands of International Orange and White paints. The bands shall be perpendicular to the longest dimension and have a width of approximately 1/7 th of the longest dimension for towers of height upto 210 meters and 1/9th of the longest dimension for towers of height between 210 meters and 270 meters OR 30 meters (100 ft.) whichever is less. The Orange and White paints shall be of equal width terminating with Orange bands at both top and bottom."

The painting shall be done in the following sequence.

**A) Preparation of Surface:**

All dust, dirt, grease, rust add scale, if any, should be thoroughly removed. Degreasing is an essential preliminary for removing dirt and grease. Solutions of soap, or other detergents should be used. After the dirt has been removed, the work should be thoroughly rinsed off with plenty of clean water.

**B) Pre-treatment by Etching:**

After degreasing and cleaning, when the work is absolutely dried, the surface is to be prepared for receiving the paint by etching. For this purpose, a priming coat of wash/etch primer should be given. The etch primer shall be of a reputed make and of a composition specifically used for zinc surfaces.

**C) Priming under Coat:**

After the above coat is dried, but without too much delay, a coat of zinc chromate primer should be applied. The priming coat should be allowed to dry for a minimum period of 72 hours before application of the next coat.

**D) Final coats of paints:**

The finishing coats of high quality exterior class paint shall be applied. The first coat shall be allowed to dry for at least 48 hours before the second coat is applied. The paints, primers and thinner used must be of best quality and shall conform to the following specifications.

IS : 2074 - 1962 (Revised up to date) - Ready mixed paint ,redoxide zinc chrome priming.

IS : 2932 - 1964 (Revised up to date) - Enamel synthetic, exterior type.

IS : 1745 -1961 (Revised up to date) – Petroleum Hydrocarbon solvents (thinner).

The correct shade for International Orange corresponds to "592 - International Orange" as per IS : 5 - 1961 (Revised up to date).

**SECTION-IV**

**SCHEDULE OF REQUIREMENTS FOR VERTICAL MAST FOR 1000 Kw. MW TRANSMITTER AT AIR, SPT, RAJKOT (GUJARAT)**

**PART-1 : DETAILS & SPECIAL CONDITIONS**

(A) Design, fabrication, supply, erection, painting ,measurements of twist,verticality & functioning of aviation lights including handing over of 156.25Mts. High vertical mast (on ready-to-use basis) capable of radiating R.F.Carrier Power of 1000 KW in medium wave band as per the following details:

| No. | Item                        | Particulars                                 |
|-----|-----------------------------|---|
| 1.  | Power                       | 1000KW (Plus modulation upto 150%)          |
| 2.  | Freq. Of operation          | 1017 KHz                                    |
| 3.  | Mast Height                 | 156.25M                                     |
| 4.  | Height above mean sea level | 88M   |
| 5.  | Site coordinaties           | 22Degree -22' -00" N<br>70Degree-41' -30" E |

The supplies will be complete including the Tower superstructure with climbing arrangement, Guys with break-up insulators and RF Chokes, Mast-Base Insulator, Aviation-Obstruction lights with Isolation Transformer circuit and all necessary foundations for the Mast-Base, Guy-Anchors, Isolation Transformer etc including the copper-sheet covering for earthing of the Mast Base foundation and Isolation Transformer foundation etc alongwith paints, primers etc.

**B. Special Conditions:**

- (i) The mast will be a triangular lattice structure having an equivalent cross sectional area equal to that of old 0.9m. dia circular/cylindrical structure for having an approximate base impedance of  $64 -j190$  ohms at 1017 KHz since it will be part of a 4 antenna array DA system. A sketch showing the location and other details of antenna array system layout at SPT, RAJKOT is enclosed herewith.
- (ii) The new mast will be erected at existing location, by removing the old base and guy anchor foundation blocks, as it is part of existing DA array system and physical separation w.r.t existing three masts is to be strictly maintained as per design for obtaining required radiation pattern.
- (iii) The location of foundation and erection activities shall be carried out in co-ordination with Zonal & station authorities after the Directorate approval.

**PART-II ; SHEDULE OF REQUIREMENTS :**

- Note:-**
- 1. The tenderer shall furnish the cost details of each of the following items separately under the commercial Bid.**
  - 2. The tenderer should visit the site before submitting the tender for realistic offer. A certificate along with report duly signed by station authority and tenderer representative in this regard is to be enclosed with the tender. Station authority are requested to coordinate the representative of tenderer as and when approached for site visit.**

| S. No. | Item Description   | Qty.                                      |
|--------|--|---|
| ( A )  | <b>SUPPLY PORTION material/stores</b>  |   |
| 1      | a) Design, Fabrication, Galvanizing, Supply of mast structure with Climbing arrangement,<br>b) Guy ropes including fasteners, thimbles, Pin washer etc.<br>c) Isolation transformer, AOL (Solid State), Cables, Conduit pipes, Junction boxes, Sunswitch,.<br>d) RF Chokes ( Nos. to be indicated by tender)<br>e) 1.6mm copper sheet covering for mast and isolation transformer foundation for RF Earthing of radials. | 1 Lot<br>1 Lot<br>1 Lot<br>1 Lot<br>1 Lot |
| 2      | Design, Supply, Integration of base insulators & Guy insulators  | 1 Lot                                     |
| 3      | Manuals incorporating all the drawings giving description, erection procedure & maintenance of mast including procedure for measuring twist, verticality & guy tention   | 4 sets                                    |
|        | NOTE:- The Supply shall include all the items which might have not been specifically mentioned above but are requisite & essential for mast on ready to use basis  |   |
| (B)    | <b>SERVICES/WORKS</b>  |   |
| 1      | Design & casting of concrete foundation for Mast base, Guy anchor and Austin transformer including all raw materials, labour, site clearance etc and covering of base and Austin transformer foundation block with 1.6mm copper sheet.   | 1 job                                     |
| 2      | Erection of Mast including fixing of Guy strain Insulators, Egg Insulators, Checking of vertically, Guy tension etc.   | 1 job                                     |
| 3      | Painting of triangular mast including supply of paints   | 1 job                                     |
| 4      | Additional charges for reduction of every 0.5 MT/sqm in soil bearing capacity of casting of Mast base, guy anchor, Isolation transformer foundation  | 1 job                                     |
| 5      | Removal of damaged old mast base & guy anchor concrete foundation block material & disposal outside  | 1 job (LS)                                |

|       |   |        |
|-------|---|--------|
|       | premises  |        |
| ( C ) | <b>OPTIONAL ITEMS</b>                           |        |
|       | 1. RF Chokes                                    | 2 Nos. |
|       | 2. AOL ( Solid state lamps)                     | 1 set  |
|       | 3. Guy Insulator                                | 2 Nos. |
|       | 4. Base insulator                               | 1 No.  |
|       | 5. Jig for replacement of Mast-Base insulator . | 1 set  |
|       | 6. Safety-kit for Mast climbing.                | 1 set  |
|       | 7. Shunt type tension dynmometer                | 1 No.  |

### ANNEXURE

List of drawings attached for reference;

1 Drawing No. TF-8832 General Antenna arrangement Mod-I

2 Drawing No. TM 15453 Antenna array system at SPT AIR Rajkot