

**PRASAR BHARATI  
DIRECTORATE GENERAL: ALL INDIA RADIO  
PLANNING & DEVELOPMENT UNIT**

SPECIFICATION DOCUMENT FOR SUPPLY, TESTING & COMMISSIONING OF  
300 KW SOLID STATE AMPLITUDE  
MODULATED-DRM MEDIUM WAVE TRANSMITTER

SPECIFICATION NO.	: XTE-209/1
DATE OF REVISION	: 07.06.2010
DATE OF APPROVAL	: 08.06.2010
DATE OF ISSUE	: 08.06.2010
APPROVAL FILE NO.	: 14(11)2010-D (TD/MW)-300kW
NO. OF PAGES	: 32

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**N.B:**1. The tenderer should go through all the sections of this specification document carefully and should confirm clause-by-clause compliance of all the sections clearly. Tenders received without clause by clause compliance are liable to be rejected.

2. The tenderer should indicate the items offered as per schedule of requirements, Section-IV, without cost details in technical bid to assess the completeness of offer against AIR's requirement.

(R.K.SAINI)  
DY. DIRECTOR ENGG. (TD)

## SECTION - I GENERAL CONDITIONS OF TENDER / CONTRACT

### 1.0 GENERAL SCOPE

The scope of the tender covers the design, supply, testing and commissioning of 300 KW fully Solid-state AM-DRM Medium Wave transmitter along with all its associated equipments and installation material at AIR Stations. The transmitter shall have AM/DRM/Simulcast broadcast capabilities. The essential requirements of the tender are:

(i) The transmitter shall be capable of being operated in AM/DRM/simulcast mode and the change-over from one mode to another shall be effected by a press of button/soft key/touch screen. (ii) All the components and sub-assemblies of the transmitter shall be assembled by the Transmitter Manufacturer in his factory (iii) All the associated equipments and installation materials should be complete in all respects and fully sourced from their respective O.E.Ms and they shall be supplied along with the transmitter as per the schedule of supply mentioned in the Section IV of this document (iv) The transmitter shall be fully integrated with all its associated equipments as per the AIR specifications by the transmitter manufacturer in his factory (v) An acceptance test shall be carried out by AIR on the transmitter, fully integrated with all its associated equipments in the transmitter manufacturer's works, before the ordered equipments are dispatched to AIR (vi) Optional items, such as spares, etc shall be tested and discrete components ordered as spares shall be physically inspected during the pre-dispatch acceptance test in the transmitter manufacturer's works and (vii) The installation, testing and commissioning Manuals along with Operation, Servicing and Trouble-shooting Manuals of the transmitter as well as associated equipments and accessories shall be supplied by the tenderer/OEM of the equipment.

### 1.1 BROAD SCOPE OF SUPPLIES/ SERVICES:

#### (a) Items to be included:

- (i) 300KW Solid State AM-DRM MW Transmitter along with DRM Equipments.
- (ii) Dummy load.
- (iii) Antenna/Dummy load RF change over switch.
- (iv) 120 Ohm Over Head Screened (Duct) Feeder / 120 Ohm rigid line. (For interconnection between Transmitter output, RF change over switch & Dummy Load inside Transmitter building upto feeder out-let assembly)
- (v) Feeder out-let assembly at Transmitter building for connection to 120 Ohm open wire Feeder Line external to transmitter building.
- (vi) Antenna Tuning Unit with feeder Lead in & Lead out Bowl Insulators assemblies. (For Suratgarh phasing networks is to be supplied as prescribed in the Bill of Material in this Document)
- (vii) Extended / Remote Control & monitoring facility (OPTIONAL).
- (viii) Installation materials for the above.
- (ix) Technical Manuals for above equipments.
- (x) Testing and Commissioning of the transmitter along with it's associated equipments.
- (xi) Optional items such as spares, etc.

#### (b) Items not to be included:

The following works/services will be carried out by All India Radio. These are not to be quoted by the tenderer.

- (i) Construction of necessary buildings, including all works and materials connected there with (i.e. masonry, foundations, cable trenches etc.) as per the details/ dimensions furnished by the transmitter supplier.

- (ii) Electric (mains) supply cable connection up to main Power Supply Distribution of Transmitter.
- (iii) All furniture and fittings, which do not form part of the transmitter equipment.
- (iv) Installation of Transmitter and it's associated equipment at AIR site.
- (v) Over-head feeder lines external to Transmitter Building.
- (vi) All works connected with the mast/antenna including laying of earth radials and modification/renovation of masts etc.
- (vii) Provision and laying of of R.F. Grounding by copper strips inside and projecting outside the Transmitter building Ground plane & A.C. Power Earthing outside the Transmitter building
- (viii) Provision and fixing of Copper sheets for inner shielding of Feeder Hut.

## **1.2 LANGUAGE AND SYSTEM OF MEASURES:**

All information supplied by the tenderer and all markings, notes, designations on the drawings and associated write-ups etc. shall be in "English" language.

All dimensions and units on drawings and all references to weights, measures and quantities shall be in "Metric" Units.

## **1.3 DOCUMENTS TO BE SUPPLIED ALONGWITH TENDER:**

The tender and associated information shall be submitted in duplicate. Following information shall be furnished to enable AIR to adjudge the full merit of the offer.

1.3.1. Compliance statement on each and every clause of these specifications (quoting the para number in the order in which they appear in these specifications) indicating clearly whether or not the equipment and accessories offered conforms to these specifications.

***Tender without clause by clause compliance to these specifications is liable to be rejected.***

1.3.2. All documents like pamphlets, data sheets, write-ups, drawings, block schematic etc. for the transmitter, associated equipment and accessories etc. in support of compliance statement will be furnished in printed form.

1.3.3. Descriptive functional information giving complete details and salient features of the transmitter.

1.3.4. Detailed typical layout plan clearly indicating dimensions for main transmitting equipment, associated equipments like stand-alone AHU, Dummy load & HV/LV panels, RF Change over switch etc. and installation material like R.F. screened(duct) feeders/ Rigid lines, ducts of the air-cooling system etc.

1.3.5. An overall schematic of the transmitter circuitry, including the power supply distribution.

1.3.6. A comprehensive schedule of materials offered along with quantity of each item.

1.3.7. A general undertaking to accept / furnish the guarantees, which will be required to be complied by the contractor as listed under Clause 1.10. of Section- I.

1.3.8. A supply record giving the names of the broadcasting organizations, countries, locations, year of supply at site, type and other details of the similar type of 300 kW transmitter supplied by the tenderer.

1.3.9 A complete set of performance figures taken on the similar type and make transmitter for: (i) AM DSB at full as well as reduced power (ii) Pure DRM at full DRM power, MER measurement and spectrum mask as per ETSI standard. (iii) AM DSB and DRM in SCS/MCS mode, MER measurement and spectrum mask as per ETSI Standard, as specified under Section-III, offered by the manufacturer to be furnished along with the tender.

1.3.10 Any other information, which the tenderer feels relevant to his offer.

#### **1.4 DOCUMENTS TO BE SUPPLIED AFTER PLACEMENT OF ORDER:**

1.4.1 The following documents in duplicate in hard copies as well as CD shall be supplied within **two months** of the date of placement order, to the Director Engineering (Transmitter Design), P&D Unit, DG: AIR, New Delhi-110 001, for approval

- a) Installation Manual containing detailed procedure along with drawings in plan, elevation, section and photographs, for the assembly/ installation of the transmitter, associated equipments and accessories.
- b) Testing and Commissioning Manual containing detailed procedural steps required for various adjustments, settings along with schematic and drawings of the transmitter circuits and all the associated equipments, as deemed essential for the testing and commissioning.
- c) Draft "Inspection and Acceptance Test Procedure" (ATP) as per guidelines given in Annexure-I for approval by AIR. This ATP after due approval by AIR will form the basis for final Inspection and testing at the transmitter manufacturer's works as part of pre-dispatch inspection.

1.4.2 One set each of the above mentioned documents duly approved by AIR shall be supplied to the Director Engineering (Transmitter Design), P&D Unit, DG: AIR, New Delhi-110 001 and concerned Zonal Chief Engineer (Project), and to Installation Officer at site (Total 3 sets per transmitter.)

1.4.3 Above requirement shall not be linked to supply schedule of Equipments.

#### **1.5 DOCUMENTS TO PRECEDE DISPATCH OF TRANSMITTER AND OTHER SUB SYSTEMS:**

The following documents shall be supplied, one month prior to the dispatch of equipment. One set of these shall be sent to Director Engineering (TD), P&D Unit, Akashvani Bhavan, New Delhi, one set each to the respective Zonal Chief Engineer and one set to the consignee.

- a) Detailed list of equipments under dispatch vis-a-vis supply order.
- b) Drawings showing location of various components indicating their part numbers in the various units/sub assemblies.

#### **1.6 DOCUMENTS TO BE SUPPLIED ALONG WITH THE TRANSMITTER AND OTHER SUB-SYSTEMS:**

1.6.1 Along with each equipment following documents shall be supplied.

- i. Technical Manuals covering detailed circuit descriptions, schematic/circuit drawings for operation & maintenance, in printed as well as electronic format.
- ii. Technical Manuals for fault location and Troubleshooting of the Transmitter as well as auxiliary equipments and accessories in printed as well as electronic format.

1.6.2 i. Test Reports of each sub-system of transmitter and associated equipments and the measurements conducted during Pre-dispatch Inspection of these equipment at the transmitter manufacturer's works shall form a part of these Manuals.

- ii. These Manuals shall include manufacturer's part numbers with generic description of semiconductors and active devices. These Manuals shall include data sheet on various Electrical Switch gear etc. used in the equipment supplied.

1.6.3 Three sets each of the above [one set for Transmitter Design Section, one set for Maintenance Wing and one set for Staff Training Institute (Tech.) i. e. STI(T) shall be packed separately and supplied to the Director Engineering (TD) P&D Unit, Directorate General, All India Radio, New Delhi. One set each shall be supplied to Zonal Chief Engineer (Projects), Zonal Chief Engineer (Maintenance), and two sets shall be supplied to the consignee. (Total 7 sets per transmitter.)

## **1.7 DELIVERY OF EQUIPMENT:**

### **(A) Supply of Equipment:**

The delivery of the entire equipment at AIR's transmitter site shall be completed within **12 (twelve )** months from the date of placement of order in case of FOR destination INR Quote/ date of opening of letter of credit (LC) in case of FOB quote, in two phases as per Section IV: Schedule of Requirements. The delivery of the equipment in first phase shall be completed within **06 (six)** months, followed by second phase in next **06(six)** month.

### **(B) The Testing & Commissioning of the Transmitter**

The testing & commissioning of the transmitters and their associated equipments shall be completed by the contractor/O.E.M. within one month after the installation is completed by AIR.

AIR, however, reserves the right to test and commission the transmitter if the situation demands.

## **1.8 PACKING & MARKING DETAILS:**

Please refer to the relevant para in the booklet "Instruction to bidders"

## **1.9 INSURANCE AGAINST WAR AND MARINE RISK:**

Please refer to Commercial terms for transportation by Sea and Land up to site.

## **1.10 COMPLETENESS OF SUPPLIES, QUALITY & WORKMANSHIP OF MATERIAL USED, WARRANTEE AND GUARANTEE, AVAILABILITY OF SPARES:**

An undertaking to accept the following terms and conditions along with those contained in para 8, P-49 of the Booklet "Instruction to bidders" with the exception of para 8.2.2 of the Annexure II (General terms and conditions), shall be submitted along with tender.

### **1.10.1 Correctness, completeness, shortages and damages of stores:**

- (a) The stores will be complete in every respect with mountings, fittings, fixtures and standard accessories which are normally supplied even though not specifically mentioned in these specifications. The Contractor shall not be eligible for any additional payment in respect of such mounting, fitting and fixtures and accessories which are needed for safe and efficient operation of the equipment and completeness of the system at the AIR site.
- (b) The Contractor shall arrange to replenish/repair all the items reported as shortage/damages free of cost to AIR and send the same to the ultimate consignee at the earliest, but not later than a period of one month from the date of such intimation from AIR. Payments for freight, insurance and other incidentals for such items shall be made by the Contractor. AIR shall not pay anything extra on this account.

### **1.10.2 Free replacement of components:**

The Contractor shall furnish guarantee to make good, at his own expense, any component which becomes defective within 18 months from the date of receipt of last consignment at site or 12 months from the date of commissioning of the equipment at site, whichever is earlier. Manufacturer shall offer an exchange program to ship replacement equipment in advance from a service centre in exchange of defective equipment. This supersedes the para 8.2.2 of the Annexure II (General Terms and Conditions) of the "Instruction to Bidders".

### **1.10.3. Materials & workmanship:**

- i) Should any defect be noticed in the design, material and /or workmanship of any equipment, within a period of 18 months from the date of receipt of last consignment at site or within a period of 12 months from

the date of commissioning of the equipment, whichever is earlier, it shall be replaced by the supplier free of cost, freight and insurance paid, to the ultimate consignee. All India Radio shall inform the supplier about any defects noticed. On receipt of such intimation, the supplier shall investigate the cause of defects and submit a report within 14 days and arrange rectification/replacement / modification of the defective equipment at AIR site without any cost to All India Radio. All such rectifications / replacements modification of the defective equipment based on report shall be done immediately, within a period not exceeding one month from the date of receipt of information by the supplier at no cost to AIR. If the supplier fails to take proper corrective action to repair/ replace the defective item/items satisfactorily within the period of one month as stated above, All India Radio shall be free to take such corrective action as may be deemed necessary, after giving notice to the supplier, at the risk and cost of the supplier. This supercedes para 8.2.2. of the Annexure II (General Terms and Conditions) of the "Instruction to bidders"

- ii) In case the equipment falls short of the guaranteed performance level, All India Radio will also be free to either reject the equipment completely or impose penalty on the supplier so as to recover the cost of the deficiency. However this does not entitle the supplier to deliberately supply substandard equipment or conceal the defects of the equipment supplied by Firm.

#### **1.10.4 Availability of major/critical spares:**

- (i) The supplier / manufacturer shall submit an undertaking for supply of spare parts, for a period of ten years from date of commissioning.
- (ii) The manufacturer of transmitter shall ensure that components used like MOSFETS, semiconductors, capacitors, transducers etc. as well as other critical items of spares , can be easily procured by AIR whenever such need arises and shall make available the information, in his tender, about the firms/agencies where from these items can be procured.
- (iii) If at any stage during next 10 years from the date of commissioning, the manufacturer stops production of this model of transmitter or any of the spare parts, the supplier is required to submit an undertaking for giving an adequate advance notice to AIR so that the latter can procure, if necessary, the balance of the life time spare parts and critical items.

#### **1.11 INSPECTION/ ACCEPTANCE:**

##### **1.11.1 Pre-dispatch Inspection / Acceptance Tests at manufacturer's Works:**

- a) AIR will depute 2(two) engineers and carry out the inspection of the Transmitter at Station's frequency, fully integrated with all it's associated equipments like Dummy load, Air-Ventilation Unit, etc, by the Transmitter Manufacturer at his works, as per Acceptance Test Procedure (ATP) approved by AIR. The various tests to be performed and the measurements to be done will be to check the conformity of the equipment offered to these specifications and the various conditions of the A/T. Rate for Pre-dispatch Inspection for five (05) days per transmitter shall be quoted by tenderer in his price bid.
- b) The contractor shall give at least 8 (eight) weeks notice to AIR to carry-out the inspection, before the consignment is ready for inspection.
- c) The transmitter manufacturer shall put up the transmitter along with its associated equipments on the test bench, at his works, before AIR inspectors and shall provide, without any extra charge, other than that indicated in 1.11.1 (g), the power supply,

consumable materials, tools, testing instruments and labour etc. as considered necessary for the tests to be carried out at the transmitter manufacturer's premises.

- d) The equipment shall be tested at the Mains Input Voltage and frequency specified against the various equipment in Section - III. Alternatively, the equipment shall be tested at the voltage prescribed in Section III, at supply frequency available at the manufacturer's works subject to an undertaking by the tenderer that the equipment shall be successfully tested and commissioned by the OEM at AIR site at the Mains Input Voltage and frequency specified in this Document in Section – III.
- e) The inspection and testing period shall be of 05 (five) working days for each transmitter along with its associated equipments at the transmitter manufacturer's works.
- f) The supplier shall ensure safety of AIR's Inspectors, while on inspection at the transmitter manufacturer's works, against any accidental injury, accidents, death etc, at no cost to AIR.
- g) The expenditure towards To & Fro Air Journey, lodging, boarding & Daily Allowance of the inspecting Officers shall be borne by AIR.

#### **1.11.2 Inspection/Acceptance Tests at AIR site (In India):**

AIR will carry-out the following inspections/tests at AIR site, in India.

- a) Physical inspection, after receipt of the equipment at AIR site, for reporting any shortages or damages for free replacements / repairs by the transmitter manufacturer/contractor.
- b) Testing & commissioning by the tenderer as per the ATP to confirm the performance of the equipment to Contract specifications, before finally taking-over/accepting the equipment by AIR.
- c) If any component fails or is found defective on receipt at site as well as during the installation/testing/commissioning these will be supplied free of cost to AIR site by the transmitter manufacturer / contractor. The Contractor will be bound to make free replacements even if the transmitter is commissioned by AIR as per the testing / commissioning procedure specified by the contractor/ transmitter manufacturer.
- d) A heat run test for a continuous period of 24 hours with rated carrier power and modulation as per the ATP shall be done keeping in view the modulation capability specified in the specifications and as per the claims made by the tenderer. Should this test get interrupted for any reason connected with the failure of any component or power failure, for a period exceeding 20 minutes a further period of 24 hours must be commenced. In essence, AIR has to be satisfied that the equipment supplied is capable of operating continuously for a period of 24 hours.
- e) Any other tests which may be found necessary to prove the performance of the equipment as a result of the preceding tests or as a result of the inspection by the inspecting authority.

#### **1.12 TRAINING OF AIR ENGINEERS:**

##### **1.12.1 At AIR Site:**

- a) The tenderer shall organize to train a group of about 10 AIR engineers free of cost to AIR, for a period of 5 (five) working days after the testing and commissioning of the transmitter equipment at AIR site. The training will be imparted for operation, maintenance and trouble shooting of the equipment. The Training will also include practical demonstration of circuits, fault finding, circuit tracing, major part replacements and also for the use of the various test and measuring equipment, jigs and tools etc. This is required to be done with a view to develop necessary skills for efficient operation and maintenance of the equipment by AIR staff. Training charges, if any, for the trainer, materials and logistics shall be

quoted in the tender separately.

(The expenditure towards to & fro Journey, lodging, boarding & Daily Allowance for the trainees as per Govt. of India norms shall be borne by AIR.)

**1.12.2 At transmitter manufacturer's Works: (OPTIONAL)**

- (a) The contractor shall be required to train Six (6) AIR Engineers for a period of 10 (ten) working days at transmitter manufacturer's works to enable them to become acquainted with all particulars in respect of installation, testing/ commissioning, operation, maintenance, trouble-shooting of the complete transmitter equipment . This training shall be imparted on same type of transmitter including associated equipments.
- (b) The training programme will be structured so as to cover theory of operation of transmitter, installation, maintenance, practical demonstrations of circuits, maintenance demonstrations, fault finding, testing, commissioning, operation, circuit tracing exercises and major part replacements.
- (c) The supplier shall ensure safety of AIR's trainees, while on training at the transmitter manufacturer's works, against any accidental injury, accidents, death etc, at no cost to AIR.
- (d) The tenderer shall quote separately for the Training charges in his price bid. (The expenditure towards to & fro Air Journey, lodging, boarding & Daily Allowance for the trainees shall be borne by AIR)

**1.13 INSTALLATION, TESTING AND COMMISSIONING:**

- (a) The transmitter equipment will be installed by All India Radio in accordance with the instructions, drawings and other details supplied by the transmitter manufacturer.
- (b) The Transmitter manufacturer shall have to carry-out the Testing and, Commissioning of the transmitter along with it's associated equipments at site as per the terms and conditions duly approved by AIR. Testing/commissioning charges shall be quoted separately.
- (c) All test and measuring instruments, special tools and any consumables required for the purpose shall be provided by the supplier, without any extra charge or liability to AIR.
- (d) The tenderer shall ensure safety of the testing and commissioning personnel of O.E.M., while engaged in testing and commissioning of the transmitter at the AIR site against any accidental injury, accidents, death etc, at no cost to AIR.

**1.14 AFTER-SALES SUPPORT:**

The transmitter manufacturer/contractor shall guarantee for the after-sales support for all the equipment offered under the contract for a minimum period of 10 years, after commissioning of the equipment. The details of the type of after-sales support and list of the various after-sales support centers in India and elsewhere shall be indicated in the tender.

## SECTION - II DESIGN FEATURES OF THE EQUIPMENT

### 2.0 300KW MW TRANSMITTER:

**Type & Configuration:** Fully solid state, modular design, field proven technology with MOSFETs delivering full carrier power as defined in under clause 3.2.4 of Section - III of the specification for AM / DRM / Simulcast operation modes. Change of mode shall be by press of button / soft key / touch screen.

### 2.1 DESIGN FEATURES:

#### 2.1.1 General:

- a) The architecture of the Transmitter should be simple and all the devices ergonomically placed for fatigue- less operation, ease in identification of components, adequate accessibility for maintenance / repair/ replacement. The transmitter shall have adequate redundancy in equipment to ensure a reliable broadcast service with minimum interruption.
- b) The transmitter shall be capable of continuous operation (24x7 Hrs).
- c) The transmitter will be in modular design with plug in modules for easy and quick replacement.
- d) The operating sequences will be properly enunciated and designed in logical steps for convenience of the operator.
- e) The transmitter shall have built-in supervisory, monitoring and fault diagnostic system, which should be user friendly & placed ergonomically for the ease in troubleshooting.
- f) An efficient air cooling system for close loop or open loop operation shall be provided to dissipate the heat generated wherever required for ensuring safe operation and long life of the transmitter components.
- g) The transmitter shall conform to latest safety standards applicable to radio broadcast equipment for Electrical Safety, Electromagnetic compatibility and Interference and should meet the relevant ETSI Standard for DRM transmission.
- h) Drawings: Station wiring drawing showing electrical interconnection between each system of transmitter plant shall be part of Manual.
- i) Manual: For each equipment system of transmitter plant, Manuals shall be provided for operation, maintenance, troubleshooting, Installation, adjustment, testing and commissioning in English language as per clause 1.2. Manuals shall be supplied in hard copy and in electronic format.

#### 2.1.2 Constructional Features:

- a) Various components and sub-assemblies will be housed in a rugged mechanical enclosure to withstand impacts, vibrations or abrasions encountered during the transportation, installation, and maintenance of the equipment.
- b) Proper arrangements shall be provided for fixing/grouting of the enclosures/components. The mounting arrangements for the various components / sub- assemblies shall be designed taking care of their weight and to withstand transit / transportation hazards.
- c) The Layout of the components shall be as per technical standards to have sufficient space for carrying out the repair and maintenance in the field. For maintenance, all components shall be accessible through interlocked doors.
- d) The material used shall be non- inflammable and fire-proof /fire- retardant.
- e) The various metal parts shall be painted to prevent rusting or corrosion. The transmitter panels shall be painted in non-glossy, mat finish color.
- f) The various assemblies and components shall be labeled liberally for easy

identification.

- g) **Electrical Wiring:** Various wires/cables switches etc. used in the equipment shall be as per international standard and shall have atleast a factor of safety of 1.5 for both voltage and current. Their termination shall be done as per the standard practice used for broadcast equipment. The various cables and terminations will be ferule numbered with cross-reference in circuit diagrams / drawings for ease in identification. Provision for cable entry shall be kept from top as well as bottom. All the wiring shall be routed through cable troughs duly harnessed and fastened. Suitable provision for preventing the entry of rodents through left over Cable entry routes is to be made.
- h) **Size:** The size of the equipment will be optimized for economy in space required for installation and convenience of maintenance. Typical equipment layout drawings showing the shape and size of the various equipment in plan and elevation shall be enclosed with the offer.
- i) **Weight:** The weight of the equipment shall be optimized to have the required ruggedness and ease in handling. The weight of various equipment shall be specified in the tender.

### 2.1.3 R.F. Section:

RF Section shall consist of three stages namely RF source, a driver/buffer/distribution stage supplying R.F. drive to Power amplifier consisting of multiple RF modules, followed by combiner, Filter & matching network. For DRM and Simulcast operation DRM exciter in 1+1 configuration shall be provided.

#### 2.1.3.1 R.F. Source:

The RF Drive Unit having two independent RF sources shall be suitably located in transmitter cubicle having following provisions:

- (a) RF frequency shall be generated by DDS (Direct Digital Synthesis)/PLL (Phase Locked Loop) having required spectral purity in AM band as defined in Section III of the technical specifications. Both the RF sources should be fully interchangeable/ programmable.
- (b) Each source shall be self-contained in all respects including arrangement for varying the frequency to a few cycles in field for having stability as per Section - III.
- (c) Automatic as well as manual change over arrangement shall be provided for selecting the healthy RF Source.
- (d) Provision for visual indication of active RF source shall be provided.

#### 2.1.3.2 Low – Level R.F. Buffer/Driver/ Distribution Amplifiers:

This unit shall be self-contained and shall function to split and provide the RF feed to PA Modules at adequate level. Alternatively, the low level R.F. signal can be first applied to a Modulation Encoder which can in turn provide low level R.F. drive and control Signals to all Power Amplifier modules to amplify drive as required when the module is enabled. The tenderer shall furnish complete details with schematic diagram to assess the specified provision.

#### 2.1.3.3 Design Criteria of P.A. Modules:

The transmitter shall have multiple R.F. P.A Modules of identical design and completely interchangeable and capable of delivering 10% higher output than it's rated power with 100 % modulation at normal supply voltage. PA modules shall be wired in suitable combination for plug-in connection/disconnection for ease in maintenance. In case a PA Module fails, it should be possible to identify the failed module. The P.A. Modules shall be based on MOSFETs with adequate safety margins to work under extreme ambient conditions in tropical regions as specified under Section – III. PA Module shall be broad band (in MF band) without any tuning elements / frequency dependent components.

- (b) **Arrangement of P.A. Modules:** A number of R.F. PA Modules shall be wired in

series/parallel, combinations to provide required rated power output. Detailed configuration of RF modules in the transmitter along with the type of combiner used shall be given.

**(c) Protection of P.A. Modules:** Effective and adequate arrangements will be provided for protection of P.A. modules against the risk of failure due to:

- i. Excessive Heating;
- ii. Voltage Surges/Spikes.
- iii. Load Mismatch/High VSWRs with automatic power fold back as specified in Section III
- iv. Excessive Load Currents/Short Circuits/ Sparks
- v. Lightning/Static
- vi. Power fold back as per VSWR indicated in Section III shall be provided but shall not diminish the protection of PA module.

**(d) Isolation of defective PA modules:** Arrangements shall be provided for isolation of defective PA modules to prevent deterioration of technical performance of the transmitter.

**(e) Information to be submitted with the tender:**

- i) Total no. of P.A. Modules used in the transmitter required for 300 KW carrier power with 10% overrating at 100% modulation.
- ii) Minimum No. of P.A. Modules required for 100% Modulation at rated carrier power.
- iii) Maximum number of modules which can fail without affecting the broadcast service
- iv) In the event of PA module failure state whether any balancing in the corresponding section of PA module to which the defective PA Module belongs to, is required to maintain technical performance? If so details to be provided.
- v) Peak & Average power output of each PA module at full carrier power with 0% and 100 % modulation.
- vi) Details of protection devices provided against failure of PA modules, which should include item mentioned in Para 2.1.3.3(c) above.
- vii) Safety margins adopted in the design criteria of the PA modules.
- viii) Circuit Diagram of the P.A Module.
- ix) Make, model and details of supplier for MOSFETs used in the PA Modules. In case the MOSFETS are proprietary items of the OEM of the transmitter, details of Part Number, make and model.
- x) Make, model & source of other special components /devices used in P.A.
- xi) Type and details of the arrangements provided for isolation of defective modules and whether a defective module will impact the broadcast quality.
- xii) Five most critical components in descending order.
- xiii) Efficiency of PA Module.

#### **2.1.3.4 P.A. Combiner / Output Network and Filter:**

- (a) Combiner: The mechanical assembly of combiner will be designed for plugged connection/disconnection of PA modules for ease in maintenance. Details of sub/ main combiner are required to be submitted.
- (b) Output Filter: A suitably designed filter to remove the spikes due to switching in/out of the P.A. Modules shall be provided in the output network.
- (c) Harmonic filter: Necessary tuned circuit / circuits for filtering out unwanted harmonics and undesired spectral components below the limits specified in Section- III shall be provided in output circuit. Details of filter are to be indicated.
- (d) Output Impedance Matching Network : Details of matching network to obtain an output impedance of the transmitter specified in Section-III as well as isolation from load side disturbances like very high continuous VSWR resulting from any fault in Transmission line, ATU, Mast etc. shall be provided.

- (e) Output Network Protection : The output network of the transmitter should incorporate UV arc sensors, spark gaps and required VSWR detecting devices for effective protection against :
- a) High VSWR / Load mismatch (Instantaneous & Long term).
  - b) Sparking/ flash over/ arcing
  - c) Lightning
  - d) High voltage discharge / Static
- (f) Frequency change kit: A complete list of additional components, or frequency determined chart of components required, along with circuit / schematic diagrams, detailed procedure required for change of frequency over the entire MW band specified in Section-III are to be submitted. AIR will have the option to purchase these kits.

#### **2.1.4 Modulation Technique:**

The transmitter should be capable of operation in AM/DRM/simulcast mode and the change-over from one mode to another shall be by a press of button/soft key/touch screen menu.

- (a) Analogue Mode: Amplitude Modulation shall be generated with digital techniques. Detailed description of modulation technique along with audio chain and the principle and system of modulation employed with schematic/block diagram etc shall be furnished.
- (b) Dynamic Carrier Control (DCC)/ ACC+ (Adaptive Carrier Control): The transmitter shall be having built-in arrangement for operation in DCC/ ACC+ as per ITU-R.
- (c) DRM Mode: The transmitter shall be capable of DRM and AM-DRM simulcast operation as per DRM ETSI standard. No change or addition of components should be required for DRM operation.
- (i) DRM encoder and multiplexer and DRM modulator/Exciter shall be stand-alone units mounted in a rack or alternatively integrated with the main transmitter and shall be supplied along with the transmitter for DRM operation. DRM encoder and multiplexer and DRM modulator/Exciter shall be designed to have selectable setting of audio encoding i.e. AAC, AAC+SBR, HVXC, HVXC+SBR, CELP, CELP+SBR, Parametric Stereo, AAC+SBR stereo, generation of MSC, SDC & FAC, selection of robustness modes and modulation bandwidth (4.5/5kHz), Nominal Bandwidth (9/10kHz), Double Bandwidth (18/20kHz), 64/16 QAM MSC with all code rates, 16/4 QAM SDC, standard modulation, hierarchical modulation, Equal Error Protection, Unequal Error Protection Long/Short Interleaving, Service Reconfiguration, Channel Reconfiguration etc.
  - (ii) AM-DRM Simulcast Mode: The transmitter shall be having built-in arrangement for Single Channel Simulcast (SCS) and Multi Channel Simulcast (MCS) operation with Half Bandwidth (4.5/5 kHz), Nominal Bandwidth (9/10 kHz), and Double Bandwidth (18/20 kHz) with spectrum shaping provision as per ETSI.

##### **2.1.4.1 DRM Encoder Multi-Program Multiplexer:**

The DRM Encoder Multi-Program Multiplexer shall be designed to meet all the demands of DRM broadcast with provision of triple functionality i.e. DRM audio encoding, Data service, generating of full digital DRM multiplexed stream (MDI) with following key features.

- Capable of handling up to 4 audio and/or data services to generate multiplexed Stream for providing DRM/DI MDI as well as MDI+MCI stream for the modulator of broadcast transmitter.
- Graphical user interface to guide the user to create and configure stream and source encoder as well as creation and configuration of input hardware.
- The equipment shall be equipped with an MPEG-4 AAC real time audio encoder, with MPEG-4 CELP as well as MPEG-4 HVXC real time speech

encoders along with the utilization of bandwidth enhancement SBR technology for all the three types of audio encoders. Audio input shall include mono, stereo and Parametric Stereo Modes.

- The equipment shall be capable of inserting text messages/pictures and multi-media object transfer Data (MOT) for slide show or broadcast web site format.

#### **2.1.4.2 DRM Digital Modulator / RF Exciter:**

DRM Digital RF Exciter /Modulator shall be designed to meet requirements of all broadcasting modes, to provide easy switchover between Analogue AM (DSB), pure DRM, single channel or multi channel Simulcast (SCS/MCS) with following key features.

- Real time Channel Coder / Modulator for coding and modulation functions by means of powerful embedded digital processing and shall deliver all the standardized DRM digital modes with signal bandwidth up to 20 kHz.
- Digital Integrated Synthesizer to generate RF.
- Ethernet Ports for DRM/MDI input.
- One AES/EBU Digital Audio Input, One Analogue Audio Input.
- SFN/MFN Operation Capability with internal GPS and/or through external NTP server.
- Spectral Shaping as per ETSI standard for meeting the requirement of providing good AM signal reception in Simulcast mode of operation of the transmitter.

**2.1.5 Power Supply:** AIR will extend 11kV (Phase to Phase) 3 phases, 50 Hz power supply connection for feeding to entire transmitter equipments system at the mains input, for normal operation of the transmitter with the power supply variations specified under Section-III. All main and sub power supply required for operation of transmitter and it's all accessories shall be derived from this main connection by supplier by providing step down transformers & distribution panel etc. Power supply system (main & sub) shall be capable to withstand various overloads including transients encountered during the operation of the transmitter without undue heating of any power supply components as specified in Section-III. Protection for under- voltage, over-voltage, and phase-loss and phase rotation shall be provided.

- a) Power supply equipments :** There will be a 11kV, (phase to phase) 3 phase, 50Hz mains input provided by AIR for transmitter equipments as specified under Section-III. The associated power distribution panel for supplying power to different sections of the transmitter/associated equipments of the transmitter (under scope of the supply of this Tender) as well as step down/step up transformers and the associated distribution and control switch gear /panel along with necessary protective circuits for taking care of over-load, shall be provided by the O.E.M. of the transmitter as a part of Transmitter power supply equipments.
- b) Mains isolation switch :** A suitably rated Vacuum Circuit breaker (VCB) will be provided for isolation of mains input to the transmitter.
- c) Emergency off:** A Push Button (Red in color) shall be mounted on the front panel as well as back panel of the transmitter to isolate the Mains supply to the Transmitter or shut down operation by opening the safety interlock of the transmitter in case of any Emergency.
- d) Transient Protection:** Metal Oxide Varistors (MOVs) or similar fast acting devices will be provided at the input of Power Supply system of the Transmitter and all sub systems to protect the equipment from voltage surges/transients encountered on the mains input line as specified under Section-III.
- e)** A block schematic of Power Supply distribution shall be enclosed with tender.

#### **2.1.6 Transmitter Control System:**

The Transmitter control system shall be the integrated into the main transmitter and shall be designed using user friendly digital control techniques. Control system shall be

having self diagnostic, supervising & monitoring facilities along with visual display as well as re-settable aural alarm.

- i) Switching Sequence & Interlocking: The "Switching-ON" and "Switching-OFF" of the transmitter will be interlocked to ensure the desired operational sequence for the safety of the equipment and operating personnel. This shall also be interlocked with dummy load and Antenna change over switch.
- ii) Control and Indications: Following visual indications of the status of the transmitter will be provided in the Local and Remote mode on Tx. Front Panel/GUI:
  - a) Transmitter-on/off
  - b) Type of modulation: AM/DRM/simulcast
  - c) Power level
  - d) Local/remote mode of operation
  - e) Forward Power, Reverse Power
  - f) Fault

All faults shall be supplemented with reset-able audible alarm.

- iii) Fault Diagnostics: Indications as required and procedures will be provided for fault diagnostics in the various circuits of the transmitter up to module level.
- iv) Metering: Necessary metering will be provided to have a close monitoring of the following vital operating parameters of the transmitter (in 'Local' and 'Remote').
  - a) Mains input voltage
  - b) Stage DC Voltages
  - c) Stage DC load currents
  - d) Audio input level /percentage modulation.
  - e) Forward RF power
  - f) Reverse RF power
  - g) Transmission hours / Comprehensive event logging.

#### **2.1.7 Protection of equipment and operating personnel:**

- i) Safety of operating personnel: Adequate and fool-proof arrangements shall be provided for protection of the operating personnel against hazards of any nature involved in operation and maintenance of the equipment covered under this specification as per IEC 215.
- ii) The Operating Personnel shall be protected against following hazards by providing suitable interlocking through door key inter-locks, ground hooks or mechanical locks having electrical loops etc. (provision to be confirmed by enclosing a schematic indicating type of device)
  - a) Against high RF voltages;
  - b) High voltage Power Supplies;
  - c) Energy storing components requiring discharge time
  - d) Access to moving machinery, hot / live components.
- iii) Protection of components: The Equipment and its various components will be protected by providing suitable devices like UV detectors, arc gaps corona rings (provision to be confirmed by enclosing a schematic indicating type of device and their locations) against the following:
  - a) Electrical Flash over;
  - b) Deep Voltage fluctuations/transients;
  - c) Lightning on or near the Antenna
  - d) Fire due to sparking etc.
- iv) Output RF circuit of the transmitter shall be provided with a protective device in order to by - pass/ ground the lightning strikes entering through feeder line.
- v) EM/ RF Radiations: The radiation shall be within the safe limits prescribed under the relevant standards to avoid risk to operating personnel.
- vi) Earthing Rods: Earthing rods wherever required shall be provided.

- vii) Earth terminals: for connecting client's earth to the transmitter shall be provided at appropriate locations as per standard practice.

The above details along with the schematic diagram and location of the various provisions made for protection of equipment and operating personnel shall be furnished with tender.

#### **2.1.8 Extended/Remote Control & Monitoring Facility (Optional):**

Extended/ Remote control & monitoring facility for remote ON/OFF, reduced power operation and monitoring of vital parameters, percentage modulation Meters, logging facility etc. shall be provided in addition to the transmitter control system as mentioned at 2.1.6 for working within the transmitter building up to a distance of 100 meters from the transmitter .

#### **2.1.9 Cooling System:**

##### **(i) Main Features of cooling / Heat extracting arrangement:**

- a. The transmitter should have air / liquid cooling system or combination of both and it should be an integral part of the transmitter to be provided by O.E.M. of the transmitter to take away the heat generated in the equipment for ensuring a safe operation and long life of the transmitter components.
- b. In case of liquid cooled transmitter, the liquid to air heat exchanger shall be outdoor type. If it is indoor type it should be specifically indicated in the tender.
- c. The air-cooling system shall be designed for both closed air and open(fresh) air loop operation. In case the AHU is external to the transmitter, the transmitter manufacturer shall provide duplicated fans to meet the exigencies of blower (100% redundancy). In case, the blowers are located inside the transmitter, the transmitter manufacturer shall provide 100% redundant blowers ready to meet the exigencies of failure of internal blowers. The transmitter manufacturer shall provide motorized louvers (for closed air and open loop operation) and air ducts (wherever required). The tenderer shall quote the Air Handling Units (internal or external), Air Filters/ weather proof louvers etc. from the OEM of the transmitter, in his offer.
- d. The cooling fans / blowers shall be designed for acoustic noise as specified in Section-III to minimize the fatigue to the operator.
- e. Dust filters: Fine filters of washable and re-usable type of sufficient surface area shall be provided at the cooling air inlet to the transmitter. Details, size and filtering efficiency of the filters may be furnished in the tender for tropical environments.
- f. The operation of fans/blowers/motors should be monitored by providing suitable detectors. Fans/blowers/motors should be protected for any abnormality by providing suitable detectors. Protective devices should be provided to fold back the Power of the transmitter up to a safe operating level in case of insufficient / deficient cooling.
- g. The transmitter building layout plan shall be supplied by AIR to OEM for optimization of cooling system after placement of the order.

##### **(ii) Air cooling System features:**

- a. The capacity and static pressure of blower/blowers should be as per ventilation requirement of the transmitter. The blowers shall be statically & dynamically balanced.
- b. Air filters shall be of synthetic material, non woven washable type with efficiency 90 % down to 10 microns.
- c. The duct (where ever required) shall be fabricated with standard rust proof sheets suitable with joining collars and smooth bend. Requisite supports and anti- vibration duct hangers shall be provided.

- ##### **(iii) Liquid Cooling System:** Water circulating pumps, pressure equalizing chamber, water reservoir, heat exchanger etc. for water cooling circuits shall be sourced by OEM of the transmitter. De-ionizer (on- line type) shall be part of liquid cooling

system with its own monitoring unit. The liquid cooling system shall be complete in all respect with water flow switches, meters, sensors, pressure gauge, and temperature gauge etc with status monitoring and interlocking features. Water pump of suitable rating, for meeting the total liquid cooling requirements of transmitter in feed line from water reservoir to water cooling circuit for feeding the water at required pressure, shall be part of supply. A standby pump set also shall be part of standard supply. The heat-exchanger shall have redundant fan motors.

**(iv) Following data shall be supplied with tender:**

- a. Detailed schematic of cooling system indicating number and capacity of the pumps/cooling fans/blowers used.
- b. Total amount of heat generated (in KW/ Kcal per hour) by the transmitter equipment and ancillaries including D/L to be extracted shall be specified separately.
- c. Details of size and filtering efficiency of the filters may be furnished in the tender.

**2.1.10 Input/output connections from Transmitter Cabinet:** The transmitter cubicle shall be designed for connection of the R.F. output from top and for entry of power supply cables, audio cables, control cables & other monitoring cables from top of the cubicle through overhead mounted cable trays / bottom of the cubicle through underground trenches as per site suitability.

The following Input / Output Connections will be provided:

**(i) Input connections:**

- a) Mains input through suitable industry standard connectors with suitable termination.
- b) Audio input shall be through suitable industry standard connectors.
- c) Remote control connections: The remote control command connections shall be through suitable terminal blocks / standard connectors.

**The mating connectors shall be supplied along with the equipment.**

**(ii) Output connections :**

- a) RF output: RF output shall be terminated suitably for connecting a screened (duct) over-head feeder or rigid line.
- b) RF o/p for performance measurement: One sample RF output shall be provided by terminating in a BNC connector with output level of 5 to 15 volt RMS, suitable for connecting modulation monitor of standard make which shall be used for performance measurement purposes.

**2.2 DUMMY LOAD:**

**2.2.1 Type:** Dummy load shall be of standard make soda water circulation type or water - cooled resistance type and all the accessories like Heat Exchanger, Pump, Flow meter, liquid storage tank, Motor controlled automatic flow control etc. shall be included in the offer as part of the Dummy Load, all sourced from the O.E.M. of the Dummy Load. Make & Model of the dummy load offered along with its literatures shall be enclosed with the tender.

**2.2.2 RF Input Impedance & connection type:** Impedance shall be as indicated in Section-III. The termination arrangement will be as per internal feeder system.

**2.2.3 RF Power Measurement:** Direct reading type RF Power measurement shall be provided.

**2.2.4 Electrical/Thermal Protection:** The dummy load shall be protected against over heating, electrical overloads. Necessary protection shall also be provided for any over loads occurring in any component of the dummy load.

**2.2.5 Electrical input:** The dummy load shall work on mains input voltage specified under Section - III.

**2.2.6 Interlocking:** In addition to it's internal interlocking, the dummy load shall be interlocked with the transmitter. The interlock connection shall switch-off the transmitter R.F. Power or would prevent switching-ON of the transmitter RF power for the following conditions of the Dummy

load:

- a. The R.F. Connection between the Dummy Load and the transmitter is not through.
- b. The Dummy Load impedance is outside the permissible variation.
- c. The cooling system of the Dummy Load is not functioning properly.
- d. There are any overloads or abnormal working conditions of the dummy load.

### **2.3 RF CHANGES OVER SWITCH:**

Standard make four (04) port R.F. change over switch shall be manually operated motorized switch for 120 Ohms Screened (duct) feeder or 120 ohms rigid line for connecting output of the new transmitter and existing old standby transmitter to either antenna during normal transmission or to dummy load for testing the transmitter. The switch shall provide the necessary R.F. isolation between the input and output ports and also between two output ports.

The switch shall be housed in a suitable rugged enclosure with proper isolation of live terminals / points. It shall be suitable for overhead mounting but shall be operated from the ground level with suitable indication provided/extended at the operating point to clearly indicate the position of the switch. The details of mounting arrangements shall be included in the installation manuals of the transmitter. The enclosure shall be painted/treated to prevent rusting/corrosion, in a color to match the transmitter equipment.

- i. Interlocking connections shall be provided from the antenna change over switch, wired into the transmitter controls, so as to ensure that the transmitter RF power can be switched on only when the transmitter is connected either to the antenna or to the dummy load.
- ii. The switch shall be adequately rated for the power handling capacity mentioned under Section-III.
- iii. The switch shall be designed to present a very low VSWR as mentioned under Section-III.

### **2.4 ANTENNA TUNING UNIT (ATU) & PHASING NETWORKS:**

- (I) **ATU:** The unit shall be supplied in the form of floor mounted components/assemblies supported on post insulators inside a shielded hut near the antenna base. ATU shall be designed to present a minimum VSWR to the transmitter and to provide approximately flat impedance up to 20 kHz bandwidth to allow transmission on the highest-quality DRM signal. A guard net fixed to the floor to deny access to operator when Transmitter is 'ON' also shall be provided.
- (II) **The input & output impedances:** As specified in Section - III.
- (III) **For Suratgarh:** An inductor ( with capacitance for fine tuning) for providing required phasing to reflector mast to obtain desired directional Radiation Pattern (Annexure II) to be mounted on floor shall be supplied.
- (IV) **Input/output connections:** Shall be through bowl insulators mounted on the plates to be fixed in the walls openings of the ATU hut having provision for connection of the earthed limb of the feeder at the inlet side.
- (V) **Metering:** Meters shall be provided for measuring the Feeder RF current and the Antenna RF current. The meters shall be provided with suitable shorting switches. It will be possible to read the meters with the ATU enclosure door closed and with the transmitter on.
- (VI) **Static leak coil:** Static leak coil of adequate rating shall be provided for discharging the lightning current safely to the ground.
- (VII) **Spark gaps:** Adjustable spark gaps shall be provided at the input as well as output points of the ATU. Necessary voltage break-down strength

characteristics of the spark gaps shall be included in the technical literature.

- (VIII) **Earthing / Isolation arrangements:** Necessary earthing & isolation arrangements shall be made for isolating input and Output side as well as to groundings of Controls.
- (IX) The measured base impedance of the masts with the other mast shorted alternatively to calculate the mutual impedance shall be supplied by AIR at the time of placement of order.

## 2.5 FEEDER OUTLET:

The bowl insulators assembly shall be complete in all respect including mounting Plates etc.

- a) For transmitter Building Outlet : It shall be designed to be mounted in a wall opening, suitable for termination of an overhead 120 Ohm screened(duct) feeder/ 120 ohm rigid lines, unbalanced feeder inside the building and an overhead 16 wire,120 Ohm unbalanced feeder outside the building. Along with live terminals this shall be having provision for ground terminal.
- b) Feeder Hut Inlet : It shall be mounted in a wall opening, suitable for termination of an overhead 16 wire,120 Ohm unbalanced feeder outside the ATU hut and copper pipe connection to the ATU inside the feeder hut. Along with live terminal this shall be having provision for ground terminal.
- c) Feeder Hut Outlet: It shall be mounted in a wall opening suitable for termination of a copper pipe connection to self radiating mast.

## 2.6 PROFESSIONAL DRM MONITORING RECEIVER:

This professional grade stand alone DRM Monitoring receiver shall be used for DRM reception and transmitter monitoring & measurement. The receiver shall be capable of continuous (24x7Hrs) operation. The receiver shall have well tested DRM receiver software updateable via built-in DVD drive, fully remote controlled via LAN and Ethernet. It should have following key features:

- Applications:  
DRM/AM/SSB Reception, Modulation quality measurements, Modulation parameter measurements, two configurable alarm signals to trigger conditions (e.g. audio dropouts or field strength), Spectrum monitoring, logging of RSCI, RSCI output (compatible to ETSI TS 102 349 V1.2.1) via LAN, QoS(Quality of Service) monitoring, high accuracy field strength measurement.
- Monitoring
  - Display, recording and online UDP output (RSCI) of
  - Field strength (antenna factor can be specified)
  - Estimated signal-to-noise ratio
  - Estimated delay spread
  - Estimated Doppler spread
  - Audio quality
  - Frequency offset
  - Location information via external NMEA-complaint GPS receiver interface
  - Display of power spectrum, channel impulse response, field strength, Signal-to-noise ratio.
- Alarm: Two independent alarms(associated with relays) configurable to multiple trigger conditions:
  - Spectrum mask violated above specified level
  - RF level below specified value.
  - S/N level below specified value
  - Audio dropouts above specified ratio
  - Audio level below specified value

- MDI errors above specified rate
- Frequency offset above specified value
- Interfaces
  - Headphones output with volume control
  - Built-in loudspeaker with volume control
  - Line output
  - Two relays output
  - Ethernet 100 Base T-port
  - Two RS 232 connectors
  - Two USB 2.0 connectors
  - Antenna input N type female connector with 50 Ohm
  - External loudspeaker output
- Remote Control via
  - Graphical user interface
  - RSCI (Receiver Status and Control Interface)
  - Web interface

## SECTION – III

## TECHNICAL SPECIFICATIONS OF TRANSMITTER AND ASSOCIATED EQUIPMENTS

## 3.1 AMBIENT CONDITIONS:

The equipment covered by these specifications shall be required to work at various AIR sites under the Ambient Conditions as follows:

- a) Ambient Temperature : 0 to 45°C
- b) Humidity : 0 to 95% Non-condensing.
- c) Altitude : 0 to 1000 Mt.

## 3.2.0 300KW MW TRANSMITTER:

S. No.	Parameters	Specifications
3.2.1	Type of Emission	A3E (Double side Band, full Carrier B'casting), DRM -all modes and AM-DRM Simulcast modes.
3.2.2	R.F. Range	525 – 1605 kHz.
3.2.3	Carrier Frequency stability	Within $\pm 10$ Hz as per the latest ITU-R Radio Regulations in force at the time of Delivery of the Transmitter equipment.
3.2.4	Carrier Output Power at the A.C. Mains input specified under para 3.2.25.	(i) 300KW nominal with 100% modulation for AM-DSB (ii) 120kW for pure DRM (10dB below analogue PEP) (iii) 292.5kW analog and 7.5kW DRM (16dB back-off) for MCS and 295.25kW analog and 4.75kW DRM (18dB back-off) for SCS Simulcast- as per ETSI Standard
3.2.5	Reduced power operation	Down to 75 kW carrier power with at least 3 preset power levels for AM DSB mode and corresponding power level in DRM and Simulcast modes. <b>N.B.:</b> The performance figures of the transmitter shall be as specified in this section even at the reduced power levels. Typical figures to be enclosed with the Tender.
3.2.6	Spurious and Harmonic Radiation	As per the latest Radio Regulation in force at the time of delivery of the equipment. Please specify the figures. As per ITU-R the harmonic contents should be less than 50mW. For DRM, out of band emission limits shall be as per ETSI EN302 245-2 (amended upto date).

3.2.7	Carrier Level Shift	1 % or less (Mains voltage variation excluded)
3.2.8	Noise Level	- 60dB (Un-weighted) or less at 100% modulation.
3.2.9	Output R.F. Impedance	120 Ohm $\pm$ 2% (Unbalanced)
3.2.10	Load mismatch / VSWR withstand Capacity	<ol style="list-style-type: none"> <li>1. Full rated R.F. output up to a VSWR of 1:1.2</li> <li>2. Reduced R.F. output (within safe limits) for VSWR from 1:1.2 to 1:1.5.</li> <li>3. At VSWR greater than 1:1.5 <ol style="list-style-type: none"> <li>i. The transmitter should trip-off for a predetermined period, after three attempts of switching on automatically.</li> <li>ii. After the predetermined period, the transmitter should make an attempt to switch-on automatically. In case the high VSWR still exists, the transmitter should switch-off automatically.</li> <li>iii. For switching-on the transmitter again, Manual Intervention shall be required.</li> </ol> </li> </ol> <p><b>NB:</b> Safe R.F. Output power vs. VSWR relationship for equipment offered should be specified by the tenderer.</p>
3.2.11	Type of Modulation	<p>(a)Analogue: Amplitude modulation. The modulated waveform for Sine, Triangular and Square will be seen on CRO for proof of fidelity of modulation.</p> <p>(b)Digital: DRM modulation. ETSI standards would strictly apply as per clause 2.1.4 (c) of Sec. II.</p> <ol style="list-style-type: none"> <li>i) Pure DRM</li> <li>ii)Simulcast (SCS&amp;MCS): Analogue(AM) and digital (DRM) with selectable Half Bandwidth (4.5/5kHz), Nominal Bandwidth (9/10kHz), Double Bandwidth (18/20kHz)</li> </ol> <p>NB: Type of modulation i.e. AM/DRM/ Simulcast (SCS/MCS) shall be operator selectable.</p>
3.2.12	Modulation capability	Continuous 70% Sine Wave Tone modulation 30 Hz to 10kHz.
3.2.13	Peak Modulation capability	Up to 110% positive peak programme
3.2.14	Audio input level range	<p>(a)Analogue: 0dBu to +10dBu Nominal for 100% modulation, adjustable from -10 to +10dBu.</p> <p>(b) AES-EBU Digital: -10dBFS to 0dBFS for 100%modulation</p>
3.2.15	Audio Input Overload Protection	The Audio Input level will be protected up to 10dB higher level over the nominal audio level required for 100% modulation.
3.2.16	Audio input impedance	<p>(a)Analogue: 600 Ohms</p> <p>(b) AES-EBU Digital: 110 Ohm</p>

3.2.17	Audio Frequency Response	$\pm 1.0$ dB from 30 Hz to 10 kHz w.r.t 70% modulation at 1kHz.
3.2.18	Total Harmonic Distortion	1.0 % or less up to 80% modulation in case of analogue transmission
3.2.19	Modulation Error Ratio (MER)	30dB minimum as per ETSI 302 245
3.2.20	Inter Modulation Distortion	1.0 % or less at 60/7000 Hz at 85% Modulation as per SMPTE standards
3.2.21	Mode of Operation	NORMAL: 1) AM DSB without DCC/ACC+ 2) AM DSB with DCC/ACC+ up to 3/6 dB carrier reduction DRM: i. DRM mode only ii. Simulcast mode DRM with Analogue transmission. 3. Mode of operation shall be easily selectable by operator 4. DRM mode audio coding and bandwidth(full/half) as per clause 2.1.4 (c) of Sec. II should be easily selectable by operator 5. In Simulcast mode MCS/SCS with half/full/double (4.5KHz/9KHz/18KHz) bandwidth as per clause 2.1.4 (c) of Sec. II shall be easily selectable by operator:
3.2.22	Performance parameters for DCC/ACC+ and DRM mode of operation	Technical performance in DCC/ACC+ and DRM mode shall be within the parameters specified for AM mode.
3.2.23	A.C. Mains input	1. 11kV (Phase to Phase) $\pm 5\%$ , 3 phase, 50 Hz, for the Transmitter system (without AVR). 2. The various loads within the transmitter shall be evenly distributed on the three phases of AC mains. The transmitter load shall not cause an unbalance more than of $\pm 5\%$ between the three phases.
3.2.24	Power Factor	Better than 0.90
3.2.25	Overall Efficiency (AC input to RF output)	80% or Better <u>Calculation to be enclosed.</u>
3.2.26	Acoustic Noise due to rotating machinery	65dBA or less at 1.5 meters from the Transmitter panel.
3.2.27	Transmitter protection	MOVs or any other fast acting device will be provided on AC input line to prevent damage to any component of the transmitter against voltage surges/ transients on AC Mains.

### 3.3 DUMMY LOAD:

S. No.	Parameters	Specifications
3.3.1	Capacity	500 KW

3.3.2	Input Impedance	120 Ohms $\pm 2\%$
3.3.3	Frequency Range	525 – 1605 kHz
3.3.4	Mains Input supply for Dummy Load system	400 V AC $\pm 5\%$ , 3 phase, 50 Hz

### 3.4 RF CHANGE OVER SWITCH:

S. No.	Parameters	Specifications
3.4.1	R.F. Power Handling Capacity	500 kW
3.4.2	Switch Impedance	120 Ohm $\pm 2\%$
3.4.3	Mismatch/VSWR due to switch	1.05 or less
3.4.4	Frequency range	525 – 1605 kHz
3.4.5	Mains Input for motor and Status/Indications etc.	230 V AC $\pm 5\%$ , 1 Phase/ 400 V $\pm 5\%$ , 3 phase, 50 Hz
3.4.6	R.F. Isolation between ports	Better than 40 dB
3.4.7	No. of Port	Four (04)

### 3.5 ANTENNA TUNING UNIT (ATU) & PHASING NETWORK:

S. No.	Parameters	Specifications
3.5.1	Details of Mast	(A) Single Mast at Jammu, Jalandhar, Dibrugarh, Lucknow & Rajkot (B) Double Masts at Suratgarh: one active mast and the other passive mast with a phasing network for DA
3.5.2	Details of Station Frequency	i) Jammu :990kHz ii) Jalandhar : 873kHz iii) Dibrugarh :567kHz iv) Lucknow :747kHz v) Rajkot :810kHz vi)Suratgarh :918kHz
3.5.3.	Antenna Tuning Unit	
3.5.3.1	Power Handling Capacity	300KW carrier + 110% Modulation
3.5.3.2.	Input Impedance	120 Ohms unbalanced
3.5.3.3	Output Impedance	To be designed to match Antenna Impedance in the following range : Resistance: 30 to 900 Ohms Reactance : +j 500 to –j 500 Ohms Measured value of Mast Base Impedance shall be supplied at the time of order.
3.5.4	Phasing Network for passive mast	For Suratgarh only

### 3.6 DRM ENCODER MULTI-PROGRAM MULTIPLEXER:

S. No.	Parameters	Specifications
3.6.1	Input Characteristics	
a)	Audio Input	(i) Analog Audio: Four (Stereo) (ii) Digital Audio AES/EBU: Four (Stereo)
b)	Impedance	(i) Analog Audio: 600 Ohm (ii) Digital Audio: 110 Ohm as per AES/EBU Standard

c)	Connector	XLR3 female
d)	Frequency	i) Digital Audio: sample standard from 22.05KHz. to 48 KHz. ii) Analog Audio: Maximum 20 KHz.
3.6.2	Output Characteristic	
a)	Output	MDI Ethernet
b)	Connector	RJ45 female
c)	Frequency	10/100 M bauds
d)	Remote Monitoring	Ethernet, RJ45 female 10/100 M bauds
3.6.3	General Characteristics	
a)	Standard	As per relevant ETSI Standard
b)	Single Frequency Network (SFN)	Internal GPS Receiver/ External NTP Server.
c)	Mounting	19" Rack Mounting or integrated with the transmitter
3.6.4	Mains Power Supply	230V AC $\pm$ 5%, 1 Phase, 50 Hz.

### 3.7 DRM DIGITAL MODULATOR / RF EXCITER:

S. No.	Parameters	Specifications
3.7.1	General Characteristics	
a)	Standard	As per relevant ETSI Standard.
b)	Transmission Structure	COFDM, Analog AM
c)	Signal Bandwidth	4.5, 5, 9, 10, 18 and 20 kHz.
d)	DRM Modes	Modes A, B, C and D.
e)	Single Frequency Network (SFN)	Either Internal or External GPS receiver Or through NTP Server & 1 PPS time reference.
3.7.2	Input Characteristics	
a)	Input	i) MDI Ethernet, ii) Digital Audio (stereo) AES/EBU. iii) Analog Audio (stereo), iv) RF GPS Analog v) RF Feed- back Analog.
b)	Input Connector	RJ45 female, XLR3 female, SMC, BNC
c)	Frequency	i) MDI Ethernet: 10/100 M bauds. ii) Digital Audio Stereo: Sample Standard from 22.05 KHz. to 48 KHz. iii) Analog Audio Stereo: 20KHz. maximum. iv) RF Feedback: 50KHz. to 26.1 MHz.
d)	Impedance	i) Digital Audio Stereo: As per AES3 Standards. ii) Analog Audio Stereo: 600 $\Omega$ . iii) RF Feedback: 50 $\Omega$ iv) RF GPS: 50 $\Omega$
3.7.3	Output Characteristics	
a)	Output	Envelope, Phase modulated RF (A, $\emptyset$ ) or I, Q Base Band signal.
b)	Frequency	525KHz to 1605KHz

c)	Connectors	Standard BNC and standard XLR connectors
3.7.4	Mains Power Supply	230V AC $\pm$ 5%, 1 Phase, 50 Hz
3.7.5	Mounting	19" Rack Mounting or integrated with the transmitter

### 3.8 PROFESSIONAL DRM MONITORING RECEIVER:

3.8.1	Applications:	DRM/AM/SSB Reception, Modulation quality measurements, Modulation parameter measurements, two configurable alarm signals to trigger conditions (e.g. audio dropouts or field strength), Spectrum monitoring, logging of RSCI, RSCI output (compatible to ETSI TS 102 349 V1.2.1) via LAN, QoS(Quality of Service) monitoring, high accuracy field strength measurement.
3.8.2	Reference Oscillator accuracy	< 5ppm
3.8.3	Input Freq. range	100KHz to 27.4 MHz
3.8.4	Level measurement accuracy	$\pm$ 1dB
3.8.5	RF Data Band width	40 KHz, ripple 0.2 dB
3.8.6	DRM spectrum mask monitoring	within $\pm$ 30 kHz
3.8.7	Input level	DRM decoding : – 110 to 20dBm In-channel IP3: + 15dBm (noise figure 15 dB) Out of band IP3; + 30dBm (noise figure 15 dB)
3.8.8	Phase noise at $\pm$ 20 Hz	-80dBc/Hz
3.8.9	Phase noise at $\pm$ 20 kHz	-130dBc/Hz
3.8.10	DRM Parameter according to ETSI ES 201 980 V2.1.1	4.5, 5.0, 9.0, 10, 18, & 20 kHz bandwidth Modes A, B, C and D, QAM 4, 16, 64, All code rates, EEP & UEP, Hierarchical modes and Simulcast modes.
3.8.11	Audio decoder	MPEG-4 AAC+SBR, HVXC+SBR, CELP+SBR
3.8.12	Monitoring	Field strength, Estimated signal-to-noise ratio Estimated delay spread, Estimated Doppler spread, Audio quality, Frequency offset
3.8.13	Display	Power spectrum, Channel impulse response, Field strength, Signal-to-noise ratio
3.8.14	Alarm	Two independent alarms(associated with relays) configurable to multiple trigger conditions: i) Spectrum mask violated above specified level ii) RF level below specified value. iii) S/N level below specified value

		<ul style="list-style-type: none"> <li>iv) Audio dropouts above specified ratio</li> <li>v) Audio level below specified value</li> <li>vi) MDI errors above specified rate</li> <li>vii) Frequency offset above specified value</li> </ul>
3.8.15	Interfaces	<ul style="list-style-type: none"> <li>i) Headphones output with volume control</li> <li>ii) Built-in loudspeaker with volume control</li> <li>iii) Line output</li> <li>iv) Two relays output</li> <li>v) Ethernet 100 Base T-port</li> <li>vi) Two RS 232 connectors</li> <li>vii) Two USB 2.0 connectors</li> <li>viii) Antenna input N type female connector 50 Ohm</li> <li>ix) External loudspeaker output</li> </ul>
3.8.16	Remote Control	GUI, RSCI & Web interface
3.8.17	Power Supply:	230V , 50Hz AC

**SECTION - IV****(SCHEDULE OF REQUIREMENTS / PRICES)**

AIR requires the following equipment / services as per technical specifications detailed under Sections I, II & III. The tenderer shall quote price of each item separately with necessary break-up details keeping in view the following:

- i. Make & Model of each item, to be indicated.
- ii. Indenter reserves the right to choose & decide the quantity of Equipments at the time of finalization of Tender.
- iii. All items mentioned in the Schedule from Sl. No. 4.1 to 4.14, will be taken in to consideration for ranking purpose where as all items mentioned in the Schedule under Optional items, from Sl. No. 5.1 to 5.8, will not be taken in to consideration for ranking purpose. However the tenderer must quote for all the items under the schedule of requirements.
- iv. Tenderers must comply with Para 1.0 of Section I of the Specifications while quoting for the schedule of requirements.
- v. Present requirement is for the following stations:  
Phase-I: i) Jammu (990kHz) ii) Jalandhar (873kHz) iii) Dibrugarh (567kHz)  
Phase-II: i) Lucknow (747kHz) ii) Rajkot (810kHz) iii) Suratgarh (918kHz)

<b>S. No.</b>	<b>Requirements for each site</b>	<b>Quantity</b>
<b>4.0</b>	<b>Transmitter and its associated equipments</b>	
<b>4.1</b>	Main Transmitter Equipment comprising of Solid state 300KW MW AM-DRM Transmitter with built in DCC/ACC+ complete with full set of associated equipments and installation material (to be indicated as per section II and III ) tuned to station frequency and matched to 120Ω open wire feeder line external to the transmitter building and consisting of following:	1 set
4.1.1	DRM Encoder Multi-Program Multiplexer	2Nos.
4.1.2	DRM Digital RF Exciter /Modulator	2Nos.
4.1.3	Air Ventilation Unit along with air ducts, motorized louvers for close/open loop arrangements etc for fixing to Air Ventilation Unit.	1set
4.1.4	Liquid Cooling System alongwith heat exchanger with standby pump and redundant fan motor for heat exchanger . Please refer to Para 2.1.9 (iii)	1set
<b>4.2</b>	Mains Power Supply Distribution Panel for complete system	1 No.
<b>4.3</b>	Dummy Load with heat exchanger and Control Panel as per specification Section-III para—3.3	1 No.
<b>4.4</b>	4 Port RF changeover switch ( Main Transmitter/ Antenna/ Dummy load/ Standby Tr. ) as per specification Section-III para—3.4	1 No.

4.5	120 Ohm Over-Head Screened (DUCT) Feeder/ Rigid Line.	1 Lot of 10meter
4.6	Feeder out-let Bowl Insulator assembly with mounting plate at the transmitter building	1 Set
4.7	Antenna Tuning Unit	
4.7.1	Antenna Tuning Unit (ATU) with lead IN and lead OUT bowl insulator assembly with mounting plate.	One Set each
4.7.2	Phasing Network for Passive Mast for Suratgarh	One Set
4.8	Professional DRM Monitoring Receiver	1 No.
4.9	Complete installation material for all the above items (Sl. No. 4.1 to 4.8) including the cables etc. for the entire system including the extender cards. (List to be given)	1 Set.
4.10	Any other item/equipment required for the completeness of 300KW MW transmitter system(To be indicated with details)	1 set
4.11	Charges for factory inspection/Acceptance tests by two (02) AIR engineers including charges, if any, for arranging the power supply for testing the equipment- 5 working days/transmitter (Please refer para 1.11 of Section-I)	1 lot
4.12	Installation, Testing and Commissioning manuals for the Transmitter and all associated Equipments and accessories. (Please refer Para 1.4 of Section - I)	3 sets
4.13	Manuals for Operation, maintenance and trouble shooting for Transmitter and all associated Equipment (Please refer Para 1.6 of Section - I)	7 sets
4.14	Charges for Testing & commissioning of Transmitter along with its associated equipment at AIR site in India. (Please refer Para 1.13 of Section-I)	1 lot
5.0	<b>Optional items</b>	
5.1	Charges for training of 6 (six) AIR engineers for 10 working days at manufacturer's works. (Please refer Para 1.12 of Section - I)	1 lot
5.2	Frequency change kits to cover the entire frequency band from 525 to 1605 kHz for complete transmitter. The frequency range for each set of kits will be clearly stated by the tenderer.	One Full set
5.3	Extended/Remote control & monitoring facilities as per para 2.1.8 of Section II.	1 No.
5.4	Spares for the Transmitter Each set comprise of the following:	1 Set
5.4.1	P.A. Modules	To be specified later
5.4.2	PCBs for all R.F. stages from crystal oscillator upto P.A.	1 No. each
5.4.3	PCBs for all the Audio processing and modulation encoding stages.	1 No. each

5.4.4	Additional PCB for all DRM equipments	One each
5.4.5	Power supply transformers	1 No. each
5.4.6	Cooling Fans (if mounted inside transmitter cabinet)	2 Nos
5.4.7	Control circuit PCBs	2 No
5.4.8	Discrete components like power transistors (MOSFETs), main I.C's, Semi conductors & other special components.	1 set.
5.5	Spares for the dummy load	1 set.
5.6	Spares for R.F change over switch	1 set.
5.7	Spare for ATU	1set
5.8	Other items of spares recommended by the Transmitter manufacturer/ contractor <i>N.B.: The transmitter manufacturer / tenderer shall specify the recommended quantity of each item of major and minor spares, required for maintenance of the equipment for 2 years, along with their prices. AIR will take a final decision upon the quantity of spares to be purchased after the opening of the price bids.</i>	1 set

## ANNEXURE – I

## ACCEPTANCE TEST PROCEDURE FOR THE TRANSMITTER, ASSOCIATED EQUIPMENTS AND ACCESSORIES

### 1. General:

1.1 The Transmitter along with its associated equipments and installation materials ordered shall be accepted only after inspection and testing by All India Radio as per the "Acceptance Test Procedure" detailed in this Annexure.

1.2 The transmitter manufacturer/contractor shall put up the equipment for Inspection / Testing and Acceptance of the Inspectors deputed by All India Radio, only after being satisfied themselves first that the equipment offered meets the stipulated standards and specifications.

1.3 The contractor shall dispatch the equipment to AIR only after it has passed the various tests as per this ATP and certified to be acceptable (vide para-4 below) by the Inspectors of AIR.

### 2. Inspection/Testing of Equipment at Transmitter Manufacturer's Works:

AIR's inspectors shall carryout the following tests at the transmitter manufacturer's works:-

#### 2.1 Physical/Visual Inspection:

A physical/visual inspection of the equipment offered shall be carried-out to ascertain the following:

a) **Quality of Material:** The material used in the manufacture of the equipment and it's workmanship is of high quality.

b) **Standard Manufacturing Practice:** The various standard practices used for manufacture of high quality broadcast equipment have been adopted in manufacture of the equipment.

c) **Quality checks during manufacture:** The certificates issued by the transmitter manufacturer of the various items/sub assemblies on the quality checks done during manufacture will be put up by the contractor for perusal/scrutiny of the AIR inspectors.

d) **Identification / Labeling of Sub-Assemblies:** All the sub-assemblies have been identified and all the wiring has been labeled with corresponding numbers / references in the Installation / Technical Manuals.

e) **Conformation to AIR Specifications:** The various provisions in the equipment offered conform to Sections - I, II & III of AIR specifications.

#### 2.2 Control-circuit protection and interlocking:

a) **Control circuit:** The control circuits of the transmitter will be tested for proper switching-on and switching-off sequences. The various indications during the switching-on and switching-off process shall be checked against those specified in the Technical/Operation Manual.

b) **Protection and Overloads:** The settings of the various protective and over load circuits/devices will be checked against those specified in the technical manual and their operation will be checked by suitable simulations.

c) **Interlocking:** The various inter-locking for the safe and sequential operation of the transmitter will be checked as specified in the Technical Manual. The interlocking of the transmitter with the antenna changeover switch, dummy load and ATU / Antenna will also be checked for proper operation.

#### d) **Protective / Control Circuits of the Auxiliary Equipment:**

The protective, over load and interlocking circuits of the various auxiliary equipments like Dummy Load and Antenna Change over switch and ATU etc. will be checked for

proper operation.

### **2.3 Performance tests on the equipment:**

The methodology adopted for testing the equipment shall be as follows:-

a) The transmitter along with its associated equipment as well as optional items such as spares mentioned in Section –IV, Schedule of Requirements (excluding ATU, RF change over switch, air ducts, RF screen (Duct) feeder, power supply cables and other installation materials), shall be tested in the transmitter manufacturer's works, against the technical specifications stipulated under Section-III of these specifications or the technical parameters of the equipment claimed by the contractor whichever are better, as per ATP duly approved by AIR.

The equipment shall be tested at the Mains Input voltage and frequency specified for the various equipment under Section - III. Alternatively, the equipment shall be tested at the voltage prescribed in Section III, at supply frequency available at the manufacturer's works subject to an undertaking by the tenderer that the equipment shall be successfully tested and commissioned by the OEM at AIR site at the Mains Input Voltage and frequency specified in this Document in Section – III.

b) After successful testing of the technical performance of the transmitter and its associated equipments as specified under Para 2.3 (a) above, Heat run test for 24 hours shall be conducted on the transmitter and its associated equipments at the transmitter manufacturer's works as defined in per Para 1.11.2. (d) of Section-I of these specifications.

c) All the Sub assemblies / amplifiers / oscillators and modules etc, ordered as spares shall be tested in circuit at the transmitter manufacturers works and performance of the equipment shall be checked against the specifications. The various discrete components, ordered as spares, shall be checked physically / visually.

c) The remaining equipment (not covered under Para 2.3 (a) to 2.3 (c) shall be inspected for acceptance as per the specifications subject to successful testing of these equipments later at the AIR site against the technical parameters specified under Section - III of these specifications or the technical parameters claimed by the contractor whichever are better.

### **3. Testing of equipment at AIR site:**

After installation of the various equipment at the respective AIR sites, tests shall be carried out as per paras 2.3(a) to 2.3(c) above, and the above equipment shall be tested at the assigned station frequency at the particular AIR site.

### **4. Documentation of Inspection / Tests Results at transmitter manufacturers works:**

The results of the various tests conducted at the transmitter manufacturer's works as per para 2 above shall be documented neatly and signed by the AIR's inspectors and contractor's authorized representatives.

Three sets of these signed documents shall be handed over by the contractor to the AIR's inspector. The certificates mentioned under para 2.1 (c) above shall be attached along with the results of the Inspection / Tests Report.

### **5. Seal of inspection:**

AIR's inspector will affix a seal of inspection on each equipment which has passed the Acceptance Tests at the transmitter manufacturer's works. The equipment shall be shipped only after the inspection and acceptance of the same by the AIR's inspector.

### **6. Documentation of Inspection/Test Results at AIR site:**

The results of the various tests conducted at AIR site, as per para 3 above shall also be documented neatly and signed by AIR's representatives and the contractors representative.