

प्रसार भारती / Prasar Bharati
(India's Public Service Broadcaster)
आकाशवाणी महानिदेशालय/ Directorate General: All India Radio
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ट्रान्समिटर डिज़ाइन/ Transmitter Design




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No. 11/1/-Specs/D (TD/SW)-2019

Dated 28-12-2020

Subject: Draft Revised Technical Specifications for STC of 50 kW AM DRM SW Transmitter at AIR Kurseong (WB) for feedback and Budgetary Cost Estimation from Vendors/ OEMs.

A tender is likely to be floated for STC of 50 kW AM DRM SW Transmitter at AIR Kurseong (WB) transmitter site.

Draft Revised Technical Specification for STC of 50 kW AM DRM SW Transmitter at AIR Kurseong (WB) (40 Pages) is uploaded on Prasar Bharati website <http://prasarbharati.gov.in/> under link **Information**  **Tenders**  **All India Radio**  **Engineering** to invite comments/feedback and Budgetary Cost Estimation from the Vendors/OEMs, dealing with supply of such equipment. The interested parties are requested to provide comments/feedback on the technical specifications.

Vendors are requested to provide Comments/Feedback & Budgetary Cost Estimation for the STC as per Schedule of Requirement (Section-IV) given in the specification. The Comments/Feedback & Budgetary Cost Estimation may be provided by E-mail to pruthi@prasarbharati.gov.in latest by 18/01/2021.

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Director General

Encl.: Draft Specification as above (40 Pages)

PRASAR BHARATI
(India's Public Sector Broadcaster)
DIRECTORATE GENERAL: ALL INDIA RADIO
PLANNING & DEVELOPMENT UNIT

**SPECIFICATION DOCUMENT FOR SUPPLY, TESTING & COMMISSIONING OF 50 kW AM-
 DRM SHORT WAVE TRANSMITTER AT AIR KURSEONG (WB)**

SPECIFICATION No	: XTE- SW/1002-1
DATE OF REVISION	: 24 /12/2020
DATE OF APPROVAL	:27/12/2020
DATE OF ISSUE	: 28/12/2020
APPROVAL FILE No	: 11/1/Spec/D (TD)/SW/2019
NO. OF PAGES	: 39

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N.B:

- 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.
- 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.

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SECTION - I

GENERAL CONDITIONS OF TENDER / CONTRACT

1.0 GENERAL SCOPE

The scope of the tender covers:-

- a. Supply, Testing and Commissioning of 50 kW AM-DRM Short Wave Transmitter along with all its associated equipment and installation material, at AIR Kurseong (West Bengal). The Transmitter shall have AM/DRM broadcast capabilities.
- b. Supply, Installation, Testing and Commissioning of NVIS antennas to provide Skip Zone free coverage for Day & Night time.
- c. Supply, Installation, Testing and Commissioning of 300 Ω balanced Feeder line from Transmitter Hall to NVIS antennas & Antenna Selector switches.

The essential requirements of the tender are:

- i. The transmitter shall be capable of being operated in AM/DRM mode and the change-over from one mode to another shall be executed by a press of button/soft key/touch screen.
- ii. All the associated equipment, NVIS Antenna, Feeder Line and related installation materials should be complete in all respects and shall be supplied along with the transmitter as per the schedule of supply mentioned in the Section IV of this document.
- iii. Transmitter, Antenna, Feeder Line with their associated equipment and optional items such as spares shall be dispatched on the basis of OEM Test certificates. The final testing of the equipment shall be done during Site Inspection Testing (SAT).

1.1 BROAD SCOPE OF SUPPLIES/ SERVICES:

(a) Items to be included:-

- i. 50kW AM-DRM SW Transmitter along with DRM Equipment.
- ii. Dummy load
- iii. IP based Remote Control & monitoring facility.
- iv. Antenna & Dummy load selector switches.
- v. Supply, Installation, Testing & Commissioning of NVIS Antennas along with suitable frequencies of operation for both Day time and Night time Transmission for different seasons to provide Skip Zone Free coverage.
- vi. Supply, Installation, Testing & Commissioning of Feeder Lines
- vii. Installation materials for the Transmitter, Antenna and feeder line.
- viii. Technical Manuals for above equipment in Searchable PDF file format.
- ix. Testing and Commissioning of the transmitter along with its associated equipment.
- x. Power supply distribution panel.

- xi. Online acceptance test as per ATP approved by AIR.
- xii. Site Acceptance Test of the Transmitter (complete with Feeder line and Antenna system) after installation of Transmitter at AIR site at Kurseong(WB)
- xiii. Optional items such as spares, etc.
- xiv. Signal Strength measurement/Monitoring survey at 1 km, 10 km, 100 km, 300 km& 500 km in all possible directions both during daytime and night time

(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/ Modification of Transmitter 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/Contractor.
- 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 equipment at AIR site.
- v. Necessary RF, Electrical and Audio Earth required for installation of SW Transmitter.

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:

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.
- 1.3.2 All documents like pamphlets, data sheets, write-ups, drawings, block schematic etc. for the Transmitter, Antenna, feeder line & associated equipment and accessories etc. in support of compliance statement will be furnished.
- 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, Feeder line, Antenna, associated equipment like stand-alone AHU, Dummy load, HV/LV panels etc. and installation material like 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 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 SW/MW transmitters of 50 kW or more power, NVIS antenna & Feeder Line supplied by the Tenderer/OEM.
- 1.3.8 Coverage map of NVIS antenna showing Omni directional coverage (in azimuth plane) with skip Zone at frequencies suggested by contactor/OEM for both Day & Night time. The coverage must also include MER contours.
- 1.3.9 A complete set of performance figures taken on the similar make & type transmitter, is to be furnished along with the tender with following operating conditions:
 - i) AM DSB at full as well as reduced power
 - ii) Pure DRM with single service transmission at full DRM power, MER measurement and spectrum mask as per ETSI standard.
 - iii) Pure DRM with more than one Service transmission at full DRM Power, MER measurement and spectrum mask as per ETSI Standard, offered by the manufacturer, is to be furnished along with the tender.
- 1.3.10 Any other information, which the Tenderer feels relevant to this offer.

1.4 DOCUMENTS TO BE SUPPLIED AFTER PLACEMENT OF ORDER:-

- 1.4.1 The soft copy of following documents shall be supplied within **Two months** of the date of placement order, to the Deputy Director General (E)(TD/MW), 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 equipment 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 equipment, as deemed essential for the testing and commissioning.
 - c. Draft Testing & Commissioning Procedure for SAT (Site Acceptance Test) as per Guidelines given in Annexure-I for approval by AIR. This SAT after due approval by AIR will form the basis for final Testing and commissioning of Transmitter, NVIS antenna & Feeder Line at Kurseong.
 - d. Detailed installation drawing of NVIS Antenna at suggested frequency with design criterion.
 - e. Detailed installation design drawing for Feeder Line
- 1.4.2 The above mentioned Documents shall be amended to satisfaction of AIR before their approval by AIR. After the above mentioned documents are approved by AIR,

One set each of the above mentioned documents duly approved by AIR shall be supplied to the Deputy Director General (E) (TD/MW), P&D Unit, DG: AIR, New Delhi-110 001 and East Zonal Additional Director General (E) (Project), and to Installation Officer at site.

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

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 Deputy Director General (E) (TD/MW), P&D Unit, Akashvani Bhavan, New Delhi, one set each to the East Zonal Additional Director General (E) (Project) and one set to the consignee:-

- a. Detailed list of equipment under dispatch vis-a-vis Supply Order.
- b. Drawings showing location of various components indicating their part numbers in the various units/subassemblies.
- f. OEM Test certificate for Transmitter associated equipment and spare parts.

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

1.6.1 Technical Manuals as per Section II Para 2.7 shall be supplied.

1.6.2 Three sets of the above [one set for Transmitter Design Section, one set for Maintenance Wing and one set for NABM (Tech.) Delhi, shall be supplied to the Deputy Director General (E) (TD/MW), P&D Unit, Directorate General, All India Radio, New Delhi. One set each shall be supplied to concerned Zonal Additional Director General (E) (Project), East Zonal Additional Director General (E) (Project), East Zonal Additional Director General (E) (Maintenance), and two sets shall be supplied to the consignee. (Total 7 sets.)

1.7 DELIVERY OF EQUIPMENT:

(A) Supply of Equipment:

The delivery of the entire equipment at AIR's transmitter site shall have be completed within 12 (Twelve) months from the date of acceptance of tender.

(B) Installation of Feeder-line and Antenna System:

Installation activity related to Feeder-line and Antenna system can be started by vendor any time after acceptance of tender.

(C) Testing and Commissioning of the Transmitter, NVIS antenna & Feeder Line.

- i. The testing and commissioning of the Transmitter (along with antenna and feeder line) shall be completed within 6 (Six) Weeks of the handing over of the transmitter

- to the Contractor/OEM, after the installation of the Transmitter at the AIR site is completed by AIR. AIR shall take about three months for completion of installation of equipment after completion of supply of equipment at AIR Site.
- ii. The Contractor/O.E.M. shall insure his men while working at AIR site, against any accidental injury, death etc. Similarly the equipment, instruments, tools etc., belonging to the contractor shall be insured against damage, loss, theft etc. AIR will not be responsible in any way for the safety and security of the Contractor's Men and equipment etc.

1.8 COMPLETENESS OF SUPPLIES:

- a. The stores should 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 Three (03) 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.

1.9 WARRANTY AND GUARANTEE/ QUALITY & WORKMANSHIP OF MATERIAL USED:

Should any component become defective or any defect be noticed in the design, material and /or workmanship of any equipment, within a period of 36 months from the date of commissioning of the equipment, it shall be replaced by the contractor free of cost, freight and insurance paid, to the ultimate consignee. All India Radio shall inform the contractor about any defects noticed. On receipt of such intimation, the contractor 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 contractor at no cost to AIR. If the contractor 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 contractor, at the risk and cost of the contractor.

Tenderer may quote additional charges for extended warranty for fourth and fifth Year also. However, these charges shall not be considered for decision of L1 tenderer.

1.10 AVAILABILITY OF SPARES:

- a. The contractor / manufacturer shall submit an undertaking for supply of spare parts, for a period of ten years from date of commissioning.
- b. The manufacturer of Transmitter shall ensure that transmitting tubes, 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.
- c. 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 contractor 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.
- d. In case the equipment falls short of the guaranteed performance level, All India Radio will be free to either reject the equipment completely or impose penalty on the contractor so as to recover the cost of the deficiency. However this does not entitle the contractor to deliberately supply substandard equipment or conceal the defects of the equipment supplied by Firm.

1.11 INSTALLATION, TESTING, COMMISSIONING & SITE ACCEPTANCE TESTS AT AIR SITE (KURSEONG (WB) IN INDIA):

- a. The Transmitter and its associated equipment will be installed by All India Radio in accordance with the instructions, drawings and other details supplied by the transmitter manufacturer.
- b. NVIS antenna, Feeder Line shall be installed by Contractor/OEM.
- c. The Transmitter manufacturer/Contractor shall have to carry-out the testing and commissioning of the Transmitter, NVIS antenna, Feeder Line along with its associated equipment at site as per the terms and conditions duly approved by AIR.
- d. All manpower, resources, tools and tackles, test and measuring instruments, special tools and any consumables required for the testing and commissioning shall be provided by the Contractor, without any extra charge or liability to AIR.
- e. The Contractor shall ensure safety of the testing and commissioning personnel of O.E.M., while engaged in testing and commissioning of the transmitter and its associated equipment at the AIR site against any accidental injury, accidents, death etc. at no cost to AIR
- f. Guidelines for SAT (Site Acceptance Test) are given in Annexure-I.

1.12 TRAINING OF AIR ENGINEERS:

The Contractor 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 by experts from OEM of Transmitter 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.

1.13 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.

1.12 Payment Schedule:

The following shall various Project Milestones and Payment schedule linked to those milestones.

SNo	Mile Stone	Payment to be made after completion of Milestone
1.	Supply of Equipment at site after Online Testing and acceptance by AIR	80% of Cost of equipment as mentioned at Sr. No. 1 of section IV.
2	Successful Testing and commissioning of Transmitter, Antenna and Feeder Line at site	20% of Cost of equipment as mentioned at Sr. No. 1 of section IV. + 100% of Cost of Items as mentioned at Sr. No. 2 of section IV.

SECTION - II

DESIGN FEATURES OF THE EQUIPMENT

2.0 50 kW AM-DRM SW TRANSMITTER:

Type & Configuration: Preferably Fully Solid State, using State-of-Art, field proven technology Solid State Modulator, delivering full carrier power (as per this specification) for AM / DRM 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 shall have Solid-State Modulator, Solid-state/tube Driver circuit and solid state/single-tube final stage. Transmitter shall accept Envelope, phase modulated R.F. or I.Q. Baseband signal from DRM modulator/ Exciter for DRM operation.
- 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 ease in troubleshooting.
- f. An efficient air /liquid cooling system 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. Manuals shall be supplied in electronic format (searchable PDF Format). The manual should contain Circuit Details along with full functional description of each stage

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 colour.
- 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 at least 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 different 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 different equipment shall be specified in the tender.
- j. **RF shielding:** The Transmitter construction shall ensure complete shielding of high power radio frequency circuits to minimize spurious/ interfering and harmful radiation from the transmitter cabinets in accordance with the recommendations of-latest IEC 60215. Suitable measures shall be incorporated to keep the radio frequency energy from leaking into power supply circuits.
- k. UPS shall be provided for DRM Content server, Modulator/Exciter & Control Circuit of Transmitter so that equipment is safe from voltage fluctuation during Power supply failure.

2.1.3 **R.F. Section:**

RF Section shall consist of three stages namely Modulator with Preamplifier (capable of working both in AM & DRM Mode), driver stage and Power amplifier, Filter & matching network. The Driver unit shall be tunable to 3.2-17.9 MHz Band. . The design of RF section should be such as to permit a quick wave change of any frequency in the desired range of shortwave band. Facilities shall be provided for the rapid and accurate tuning and matching of all the stages on full power. Special attention shall be paid to the design of moveable contacts in case variable inductance tuning is used as to ensure freedom from sparking and long trouble free service. The tuning and matching circuits in the final stage shall be designed for optimum operating conditions leading to the highest efficiency and lowest voltage and current stresses on the components in the tuning circuits.

2.1.4 **Modulator :**

Digital RF Exciter /Modulator shall be designed to meet requirements of all broadcasting modes, to provide easy switchover between Analogue AM (DSB) and pure DRM. RF Exciter/Modulator should have in built 100% redundancy, in 1+1 configuration having the feature of Hot Standby as well as manual selection. RF Modulator shall have 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 having spectral purity in AM band with a high degree of Stability.
- Ethernet Ports for DRM/MDI input.
- It shall offer automatic delay adjustment between phase and envelope paths (if required).
- It shall have one AES/EBU Digital Audio Input, One Analogue Audio Input.
- SFN/MFN Operation Capability through external NTP server/GPS.
- 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 **Tubes:**

Transmitter having only one tube in final PA stage may also be considered. The tube replacement procedure should involve minimum removal of components. Means for easy and quick replacement of tubes shall be provided. The tube removal device comprising of a lifting hook and a crane should be offered along with transmitter. Suitable device (tube-trolley) for safe transportation of the heavy tubes within the Transmitter building shall be included in the supply.

The tube being used in PA stage of Transmitter must be capable of delivering the specified power. The tube requiring black heating will not be preferred.

2.1.6 Tuning and wave changes:

The transmitter shall be designed for, and equipped with automatic tuning facility with a small frequency change time in the desired frequency range. In addition, it should also be possible to resort to manual tuning with motorized control of tuning elements.

The automatic frequency selection and tuning control system settings should be stored in programmable storage.

The control system shall be so arranged that the coarse setting of tunable elements (Inductances and Capacitances) is pre-determined and stored positions are always carried out without applying H.T.D.C. to driver and final stages. Fine tuning is carried out only with reduced HT on the anodes/ reduced RF Drive.

2.1.7 Audio frequency Stages:

The AF Stages should be completely solid state including the modulator with digitized signal processing facility. Choice of various AF filters should be available to enable full range of audio processing in all modes of operation. The semiconductor switching devices being used in the solid state modulator is to be specified and its details made available along with tender.

2.1.8 Modulation Technique:-

The Transmitter shall be capable of providing Amplitude Modulation with Digital Techniques. The transmitter may be equipped with a Solid State Modulator comprising of solid state devices which shall deliver the A.F. modulated anode voltage to the R.F. final stage (If the Transmitter uses Tube). The modulator should have outstanding broadcast performance relating to **Total Harmonic Distortion** and **Signal-to-Noise Ratio** and it should have high **Efficiency** with high **Power Factor**. The modulation system shall have a proven design and should be fully compatible with technical specification enumerated in section III.

The Tenderer shall furnish the details of the Solid State Modulator along with the shelf life of electrolytic condensers used in the circuit.

The cooling system of the Solid State Modulator equipment should be adequate either with air or water. Its module arrangement should ensure equal loading of all modules as well as highest possible redundancy for reliable operation. Each module should be capable of switching on or off independently. Module capacity to contribute voltage and current should be indicated. The above modulation system should be compatible with all the technical specifications enumerated in section-III.

The transmitter should be capable of operation in AM/DRM 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 operation as per DRM ETSI 201980 V040102 System Specifications. No change or addition of components should be required for DRM operation. 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. xHE-AAC(extended High Efficiency Advanced Audio Encoding) encoder with SBR & Parametric 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, hierarchical modulation, standard modulation, Equal Error Protection, Unequal Error Protection Long/Short Interleaving, Service Reconfiguration, Channel Reconfiguration etc.

2.1.9 **DRM Encoder Multi-Program Multiplexer:**

The DRM Encoder Multi-Program Multiplexer shall be designed to meet all the demands of DRM -30 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 MDI 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 MPEG- xHE-AAC Encoder capable of real time encoding of Speech, Music and mixed audio along with the utilization of bandwidth enhancement SBR technology Audio input shall include analog, mono, stereo and Parametric Stereo Modes & AES/ EBU (Mono & Stereo).
- The equipment shall be capable of inserting text messages/pictures and multi-media object transfer (MOT) of size up to 256 Mbytes in accordance with latest version of ETSI TS 101 968 for slide show or broadcast web site format.
- The equipment shall be capable of handling hierarchal structured textual information- Journaline.
- The equipment shall be capable of handling traffic management/TPEG Traffic information & Electronic Programme Guide.
- Should have in built 100% redundancy, in 1+1 configuration having the feature of Hot Standby with option of manual selection.

2.1.10 Audio Leveler:

A two Source Audio Leveler shall be put in the circuit before DRM Encoder Multi-Program Multiplexer. Audio Leveler shall maintain the loudness level of both the channels so that listener doesn't perceive the level difference when he shifts from one channel to other channel on Pure DRM Multi-channel broadcast. Audio leveler should be able to provide Automatic Gain control during Pure Analog or Pure DRM single channel broadcast. Audio Leveler shall have following features:

- Should provide loudness control for two program sources.
- Should support AGC for individual channel with capture/correction range of $\pm 18\text{dB}$. The AGC correction rate should be programmable.
- Should support wideband loudness control on both sources using Digital Processing.
- Digital Processing should be in such a way that resulting audio is free of Noise, Distortion & modulation effect.

2.1.11 POWER SUPPLY:-

2.1.11.1 Primary AC circuits:

The user shall provide power supply for the transmitter (400 V, 3phase, 50Hz) at a single point. All the power supply required for the transmitter and its auxiliary equipment should be derived from this point. All the equipment and distribution board required should be included in the offer.

The transmitter shall have its own 400 V, 3Phase, and 50 Hz input Isolator & Surge Protector. There should be provision of Circuit breaker, and on-load isolator for auxiliary supply of adequate capacity for fully de-energizing the entire equipment and making the same safe for servicing and maintenance. In this condition, any exposed terminals or bare conductors should not exist with lethal voltage, anywhere in the transmitter and associated equipment.

- a. Circuit breaker/ contactor used for supplying the power to solid-state modulator transformer are likely to be operated 15 to 20 times a day. The device used should be such as to ensure 50,000 maintenance free operations.
- b. The transformer for auxiliary supplies (if provided) shall also have its own input isolator/breaker.
- c. 400V, 3Phase, 50Hz supply distribution switchgear details with schematic diagram and literature are to be made available by the Tenderer.
- d. Different sub units of 400V distribution switch gear shall be Mechanically & Electrically interlocked such that there is no access to high voltage side of any unit unless the input isolator is de-energized and earthed.
- e. HT distribution switch gear details with schematic diagrams and literature shall be made available by the Tenderer along with the offer.
- f. All the power supply equipment such as auxiliary transformer, LT distribution, Auxiliary power supply distribution and voltage regulator shall form an integral part of the transmitter and shall be separately and independently provided and shall be included in the offer.

2.1.11.2 HT (DC Supplies):-

- a. All rectifier circuits for providing DC supplies to the various stages including the final stage shall use semiconductor devices. During initial switching on, the surges should be kept well within limits to ensure smooth operation. Facility to increase/ decrease smoothly the output power shall be provided for the purpose of tuning and checking.
- b. It shall be possible for the system to remove HT instantaneously, under fault conditions.
- c. The average power consumption for the transmitter shall be indicated along with instantaneous power requirement on the transmitter panel. It shall be possible to operate the transmitter on reduced power if necessary. For this purpose the other potentials like bias etc. shall change along with HT with single operation only.

2.1.11.3 Filament supplies (If Applicable):-

- a. Filament supply circuits for high power tubes shall have built-in electronic control, preferably without any moving parts and wearing contacts for current limiting and gradual build-up of voltage, to ensure longer life for the tubes.
- b. Tenderer should specify the control incorporated for control of filament voltage.

2.1.12 Transmitter Control System:-

The Transmitter control system shall be integrated into the main transmitter and shall be designed using user friendly digital control techniques. Control system shall have 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 Transmitter Front Panel/GUI:-
 - a. Transmitter-On/Off
 - b. Type of modulation: AM/DRM
 - c. Power level
 - d. Local/remote mode of operation
 - e. Forward Power, Reverse Power
 - f. VSWR
 - g. 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. Output DC Voltages of every DC supply.
 - c. DC load currents of every DC supply.
 - d. Anode/ cathode voltage and current of every electron tube.
 - e. Grid and Screen Grid Voltage and current of every electron tube.
 - f. Filament voltage (1% accuracy)
 - g. Temperature and pressure indicator at cardinal points of tube cooling system.
 - h. Audio input level /percentage modulation.
 - i. Forward RF power
 - j. Reverse RF power
 - k. VSWR
 - l. Filament / Transmission hours and Comprehensive event logging.
- v. **Overall efficiency**: -It should also clearly indicate the loads accounted for calculating the efficiency. (R F output power to Mains input power)
- vi. **LAN System**:-The DRM Transmitter System comprises of three different Computers namely - Content Server, Modulator/ Exciter & Control System of the Transmitter, which may be connected in LAN. So suitable interface either integrated in the control system or as a separate PC shall be provided.

2.1.13 **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 latest IEC 60215.

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.
- ii. **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.
 - e) 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.

- iii. **EM/ RF Radiations:** The radiation shall be within the safe limits prescribed under the relevant standards to avoid risk to operating personnel.
- iv. **Earthing Rods:** Earthing rods wherever required shall be provided.
- v. **Earth terminals:** Earthing terminals shall be provided 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.

2.1.14 IP Based Remote Control & Monitoring Facility:-

IP based 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 for operating the Transmitter from any remote location.

2.1.15 Cooling System:

i. Main Features of cooling / Heat extracting arrangement

- i. An air/liquid cooling system or combination of both shall be provided to take away the heat generated at any component of the equipment for ensuring a safe operation and long life of the transmitter components.
- ii. The cooling system for the Vapotron/ condensed vapour cooled tubes, VVCs, Coils and moving contact etc. should preferably be a closed circuit system. The liquid to air heat exchanger shall be outdoor type.
- iii. The air-cooling system shall be designed for both closed and opened (fresh air) circuit operation in conjunction with AIR's Air-conditioning plants. The Tenderer shall include the blowers, motorized louvers (for closed and open circuit operation), Air ducts and Air Handling Units (AHU with duplicated blowers), Air Filters/ weatherproof louvers etc. in the offer.
- iv. The cooling fans / Blower shall be designed for acoustic noise as specified in Section-III to minimize the fatigue to the operator.
- v. **Dust filters:** Fine filters of washable and re-usable type having 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.
- vi. **Flow/ temperature detectors and protective devices for fans:** The operation of fans and pumps should be monitored by measuring airflow & temperature. 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.
- vii. The transmitter building layout plan shall be supplied by AIR to OEM/Contractor 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. shall be of reputed make for water cooling circuits. 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, pressure and temperature gauges, and water conductivity meter with status monitoring and interlocking features. Water pumps (duplicated) of suitable rating for meeting the total liquid cooling requirements of all RF equipment (PA valve, VVCs ,coils & moving contacts) 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 and a spare heat exchanger fan motor shall be part of standard supply.

iv. **Following data shall be supplied with tender:-**

- a. Detailed schematic of cooling system indicating number and capacity of the cooling fans / pumps used.
- b. Total amount of heat generated by the transmitter and its associated equipment including D/L to be extracted by Water System, & Air System shall be specified separately.
- c. Details of size and filtering efficiency of the filters may be furnished in the tender.
- d. The amount of heat load (in KW/ Kcal per hour) to be taken away by the air in CFM in case of closed loop operation of air-conditioned air and in case of open circuit by outside ambient air shall be specified, clearly.
- e. In case of built-in air ventilation units/ Fans, which suck air from Tr. Hall and require duct for letting out hot air: - Whether a Standby duplicated fan in the opening at the end of duct for letting IN/OUT the air is required? If yes then it has to be included in the offer including all the filters to be fixed in the wall along with motorized weather proof louvers and necessary control panel.

2.1.16 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.
- d. MDI input through suitable standard connectors.

The mating connectors shall be supplied along with the equipment.

ii. Output connections:

- a. **RF output:** - RF output shall be terminated suitably to **Balun** for connecting to 300Ω balanced rigid line in overhead screen duct.
- 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.
- c. **De-modulated output:** - A demodulated output by providing a suitable detector unit shall be provided/ terminated in a BNC connector/ XLR audio connector with a level of 1 volt RMS for aural monitoring.
- d. **MDI Monitoring:** - There should be a provision of monitoring MDI via MDI player integrated in the transmitter system. The audio Output of the MDI player should be available through Stereo connector / Speaker.
- e. Four Licenses of Software based MDI players capable of Playing MDI Stream on any Windows 10based PC/ Laptop, shall be included with DRM Encoder.

2.1.17 IMPEDANCE TRANSFORMATION NETWORK:-

The salient features of the Impedance Transformation Network shall be:-

- 2.1.17.1** This Network shall be used for transforming the output impedance of the transmitter to match with the feeder line impedance 300 Ω balanced.
- 2.1.17.2** It will be a self-contained, single cabinet and Network will be realized with inductors and capacitors. The components of Impedance transformation network shall be designed for adequate bandwidth, amplitude and phase linearity to allow AM/DRM.
- 2.1.17.3 Input/ output connections:**-It shall have One Input port and One Output Port each rated for the power output rating to be specified as per site requirements.
- 2.1.17.4** The design of the network shall be such that no forced ventilation is required.
- 2.1.17.5 Power handling capacity:**-As mentioned under Section-III.

2.1.17.6 Mounting & Safety switch: - The network shall be floor mounted fully enclosed. It shall be inaccessible to operator in ON condition with an interlocked access door. All other safety requirements as needed in a RF networks are to be provided.

2.1.18 RIGID LINE:-

A Box type rigid line having 300 Ω balanced Characteristic Impedance capable of handling 100 kW RF power at 100% modulation, for indoor connection of final Transmitter RF output to antenna selector switch assembly shall be provided. The inner conductor of the line should be of copper. All the material, insulators, parts etc, used in the rigid line must comply with latest IS/Broadcast standards.

2.1.19 ANTENNA SELECTOR SWITCH:-

- 2.1.19.1 The necessary Antenna Selector switches shall be provided for connecting Transmitter Output from Rigid Line to Dummy Load/ Feeder Lines feeding Power To NVIS Antennas.
- 2.1.19.2 The Motorized Antenna selector switches shall be designed for efficient and trouble free service for long period of continuous operation. All material used in the construction shall be of high quality in compliance with latest IS standards.
- 2.1.19.3 All works shall be carried out in accordance with standard electrical practice. The units shall be designed for easy maintenance and complete safety to operating personnel.

2.2 DUMMY LOAD:-

- 2.2.1 **Type:** - Dummy load shall be of standard make soda water 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 Display:-** Dummy Load shall have provision of displaying of RF Power directly.
- 2.2.4 **Electrical/Thermal Protection:** - The dummy load shall be protected against overheating, 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 **Mechanical construction:** The dummy load shall be grouted on the floor. It shall be rugged in construction with proper protection against mechanical impacts. The body of the dummy load shall be provided with a protection paint coating, galvanized nut bolts may be used to prevent rusting, corrosion etc.

2.2.7 Interlocking: In addition to its internal interlocking, the dummy load shall be interlocked with the transmitter. The interlock connection shall switch-off the transmitter R.F. Power automatically 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 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/USB Port, fully remote controlled via LAN and Ethernet. It should have following key features:

i. 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 latest ETSI TS 102 349 V1.2.1 or better) via LAN, QoS(Quality of Service) monitoring, high accuracy field strength measurement.

ii. Monitoring

Display, recording and online UDP output (RSCI) of:-

- Field Strength (antenna factor can be specified)
- MER
- DRM Mode
- Interleaving
- QAM/QPSK
- Constellation Diagram
- Capability to display AFS feature of DRM
- Estimated Signal-to-Noise Ratio
- Estimated Delay Spread
- Estimated Doppler Spread
- Audio quality
- Frequency & Frequency Offset

- Spectrum& Spectrum Mask
- Journaline & Text Messages
- MOT/ Slides
- EPG
- Emergency Warning Feature of DRM
- Location information via external NMEA-complaint GPS receiver interface
- Display of power spectrum, channel impulse response, field strength, Signal-To-Noise Ratio

iii. 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

iv. 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

v. Remote Control via

- Graphical user interface
- RSCI (Receiver Status and Control Interface)
- Web interface

2.4 SOFTWARE DEFINED DRM MONITORING RECEIVER WITH NECESSARY HEADEND &HARDWARE:

Software Defined Radio (AM & DRM) software along with Hardware Interface Units for receiving AIR transmission on computer shall be provided. The receiver should be able to receive& display all the Features & Value added services available in DRM -30.

2.5 NVIS ANTENNA

Tenderer shall Supply, Install , Test & Commission the NVIS Antenna system capable of handling 100 kW of carrier power at 100% modulation in SW Band. The antenna system shall be capable of handling 100kW of carrier power at 100% modulation in SW NVIS band viz – 5/6 MHz for Day Time & 3.2-4MHz for Night Time. The angle of elevation up to 90^0 should be achievable, in order to provide Skip Zone free Omni directional (in azimuth plane) NVIS coverage by this antenna system. The antenna shall be required to be connected to 300 Ω balanced feeder line.

Transmitter shall be installed at Kurseong. The Location details of Kurseong are as follows:

- i. Longitude 26° 88' N
- ii. Latitude 88° 28' E
- iii. Mean Height above Mean Sea Level 1500 Mtr
- iv. Two set of Steel Towers (for Hoisting Antenna Curtains) are existing at the site. A site layout drawing showing the location of Transmitter Building, Feeder Line Path, Location of Towers and feeder Poles is attached at Annexure II
- v. Steel Tower details are given below:

Tower (Pair 1)	
Height of Towers:	61 meters
Span of Towers:	68.6 meters
Tower (Pair 2)	
Height of Towers:	22 meters
Span of Towers:	45 meters
- vi. Existing Tower infrastructure (after necessary repairs and repainting) should be used as far as possible to cut down the cost.
- vii. Vendor may, if necessary, may visit the site to assess the possibility of reutilizing the existing Tower infrastructure.
- viii. Tenderer shall provide design Parameters of installed NVIS Antenna system.
- ix. Antenna design should preferably be made up of suitable Gauge Copper wires supported by Steel ropes and insulators.
- x. Tenderer will also have to suggest suitable frequencies of operation for both Day time and Night time Transmission for different seasons.
- xi. The angle of elevation up to 90^0 should be achievable, in order to provide Skip Zone free Omni directional (in azimuth plane) NVIS coverage by this antenna system.
- xii. The antenna shall be required to be connected to 300 Ω balanced feeder line.
- xiii. The any steel structure constructed for mounting the Antenna system should be of designed for wind load, temperature & sag during extreme weather conditions at the site. Such Steel structure should be designed for life of at least 25 Years. The material used in antenna must comply with latest relevant IS standards.

- xiv. The AIR site at Kuseong has hilly terrain. Site contour Diagram is given at Annexure-III. Locations of Transmitter Hall, Existing steel towers, Feeder Path etc. is shown in Site Layout Plan at Annexure-II.

2.6 FEEDER LINE FOR FEEDING NVIS ANTENNA

- i. Tenderer shall Supply, Install, Test & Commission the feeder line system capable of handling 100 kW of carrier power at 100% modulation in SW Band.
- ii. Tenderer shall provide design parameters of Feeder Line.
- iii. AIR shall prefer Open wire feeder line having Characteristic impedance of $300 \pm 10\% \Omega$, using copper wire.
- iv. It should be capable of feeding 100 kW RF power with 100% modulation in SW band of frequencies from newly installed SW transmitter to NVIS antenna.
- v. The output Impedance of the transmitter shall be $300 \pm j0 \Omega$ Balanced.
- vi. The design of the feeder line should take proper care of irregularities due to supporting structures like- poles & insulators, bends & kinks.
- vii. The design of feeder line should be such as to take proper care of wind pressure, temperature, span & sag during extreme weather conditions at site.
- viii. The feeder line should have minimum (almost negligible) loss & radiations.
- ix. The material used in feeder line must comply with relevant latest IS standards.

2.7 TECHNICAL MANUALS OF ALL THE SUPPLIED EQUIPMENT:

- i. Technical Manuals covering detailed circuit descriptions, schematic/circuit drawings for operation & maintenance for Transmitter and all Auxiliary equipment shall be supplied free of cost in Searchable PDF File format.
- ii. Technical Manuals should also have procedure for fault location and Troubleshooting of the Transmitter as well as auxiliary equipment and accessories.
- iii. These Manuals must include the Test Reports of each sub-system of Transmitter and associated equipment.
- iv. These Manuals should include Manufacturer's part numbers with generic description of semiconductors, tubes and active devices and Data sheet on various Electrical Switch gear etc. used in the equipment supplied.
- v. In case, Transmitter has a Unified Control System (UCS) with Single On Board Computer, copy of Software on the Flash Card should also be provided along with complete wiring drawing of the UCS.

SECTION – III**TECHNICAL SPECIFICATIONS OF TRANSMITTER, ASSOCIATED
EQUIPMENTS AND ACCESSORIES****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 1500 Mt.

3.2 50 kW AM-DRM SW TRANSMITTER:-

S. No.	Parameters	Specifications
3.2.1	Type of Emission	1. A3E - Double side Band for full carrier broadcasting. 2. DRM - DRM all modes. 3. AM-DRM - Simulcast
3.2.2	R.F. Range	3.20- 17.9 MHz
3.2.3	Carrier Frequency Tolerance	In accordance with the latest ITU-R Radio Regulations in force at the time of delivery of the Transmitter equipment; whichever is better.
3.2.4	Carrier Shift	≤ 5% for instantaneous application/ removal of 100% 1 KHz Sinusoidal Wave modulation.
3.2.5	Carrier Output Power	i. 50 kW (Nominal) with 100% modulation for AM-DSB ii. Any power in range of 20 kW to 40 kW in pure DRM Mode.
3.2.6	Reduced power operation	There will be a provision for operating the transmitter on reduced carrier power. The performance figures of the transmitter shall be as specified in this section even at the reduced levels. Typical figures to be enclosed with the Tender.
3.2.7	Harmonics	<p>a. RF Harmonics: Below 50 dBc; the absolute mean power level of 50 mW not to be exceeded (for the entire spurious domain), or better, as per latest ITU-R Radio Regulations at the time of delivery of the transmitter equipment For DRM out of band emission limit shall be as per ETSI EN302 245-2 (amended up to date)</p> <p>a. <u>A3E (Analog Mode)</u> i. RF Harmonics: ≤50 mW up to 40MHz ii. Spurious Emission: <1mW for A3E Emission</p> <p>b. <u>DRM MODE</u> Out of Band & Spurious Emission: Shall conform to ETSI EN302 245-2 (amended up to date) For DRM</p>

S. No.	Parameters	Specifications
3.2.8	R.F. Impedance	Final output impedance of transmitter System will be $300 \pm j0 \Omega$ balanced.
3.2.9	Load mismatch / VSWR withstand Capacity	<ol style="list-style-type: none"> 1. Full rated R.F. output up to a VSWR of 1.5:1 2. Reduced RF output (within safe limit) for VSWR greater than 2:1. <ol style="list-style-type: none"> i. The transmitter should trip-off on user selectable value ($<1.5:1$) of VSWR. ii. After VSWR trip the transmitter should automatically switch ON. iii. If high VSWR still persists, then after three attempts of switching on automatically on set power, the control system should be able to switch ON the transmitter on reduced power, safe for Transmitter in accordance with persisting VSWR. iv. In case of no more VSWR trips for a predetermined period the transmitter should be able to recover to full power automatically. v. In case the high VSWR condition still exists, the power should be reduced to a minimum level until it is switched to standby. vi. For switching-on the transmitter again, Manual Intervention shall be required. <p><i>R.F. output vs. VSWR relation for equipment offered would be specified by the Tenderer.</i></p>
3.2.10	Type of Modulation	<ol style="list-style-type: none"> a. Analogue: Amplitude modulation generated with digital techniques. The modulated waveform for Sine, Triangular/Saw Tooth, Square/Rectangular, will be seen on oscilloscope for proof of fidelity of modulation. i. Digital: DRM modulation as per latest ETSI relevant standards ES 201 980 would strictly apply for Pure DRM <p><i>NB: Type of modulation i.e. AM/DRM shall be operator selectable.</i></p>
3.2.11	Modulation capability	<p>Continuous modulation with frequencies between 50Hz – 7500Hz.</p> <ol style="list-style-type: none"> a. 100% -10 mts per hour. b. 70% - 50 mts per hour. <ol style="list-style-type: none"> i. Repeated in the sequence hour after hour. ii. Short period modulation with frequencies between 50 HZ to 7500Hz 100% positive and negative peaks.
3.2.12	Peak Modulation capability	Up to 100% Positive Peak Programme modulation at nominal carrier power for 1 minute from 50 Hz to 10 kHz.
3.2.13	Modulation Linearity	Within $\pm 0.5\text{dB}$ up to 12dB below the reference level at 95% modulation on 1 KHz.
3.2.14	a. Audio input level range	a. Analogue: 0 dBu to +10 dBu (Nominal for 100% modulation, adjustable from -10 to +10 dBu)
	b. Digital audio input range	b. AES-EBU Digital: -10 dBfs to 0dBfs for 100% modulation

S. No.	Parameters	Specifications
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	600 Ohms (Balanced) for Analogue Audio input. 110 ohm (Balanced) for Digital (AES-EBU) input.
3.2.17	i. Audio Frequency Response	± 1.0 dB from 50 Hz to 7.5 kHz w.r.t 70% modulation at 1kHz.
	ii. Audio Frequency Distortion	< 3.5% for a nominal power output at modulation of 20-90% for any frequency from 50- 7.5 KHz.
	iii. Noise level	<58 db at full rated \ transmitting power
3.2.18	MER	>30dB as per ETSI EN 302 245-2
3.2.19	Inter Modulation Distortion	<30 dB using SMPTE Inter-modulation test method (where two signals of frequency 60Hz and 7kHz, with 4:1 amplitude ratio are used as input) with Transmitter running at 80% modulation at full rated output power of Transmitter
3.2.20	Modes of operation	NORMAL: i. AM DSB without DCC/ACC+ ii. AM DSB with DCC/ACC+ up to 3/6dB carrier reduction DRM: i. DRM mode only ii. Mode of operation shall be easily selectable by operator. iii. DRM mode audio coding and bandwidth (full/half) should be easily selectable by operator
3.2.21	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.
3.2.22	A.C. Mains input	400 V (Phase to Phase) $\pm 5\%$, 3 phase, 50 Hz ± 2 Hz for the system (without AVR). 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 $\pm 5\%$ between the three phases.
3.2.23	Power Factor	> 0.9
3.2.24	Overall Efficiency	> 70% (including all the ancillary equipment of the transmitter) from 0 to 100% modulation at full rated power of transmitter. (Efficiency calculation to be enclosed)
3.2.25	Acoustic Noise due to rotating machinery in main Transmitter cubical.	All rotating machinery such as water cooling Pumps etc shall be installed in an enclosed cabinet.

3.3 DUMMY LOAD:

S. No.	Parameters	Specifications
3.3.1	Capacity	200 KW
3.3.2	Input Impedance	300 Ω \pm 2 % (Balanced)
3.3.3	Frequency Range	3.9-26.1 MHz
3.3.4	Mains Input supply for system	400 V AC \pm 10%, 3 phase, 50 Hz
3.3.5.	Type	Soda water

3.5 DRM ENCODER MULTI-PROGRAM MULTIPLEXER:-

S.No.	Parameters	Specifications
3.5.1	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 22.05 KHz to 48 KHz. ii. Analog Audio: Maximum 20 KHz.
3.5.2	Output Characteristics	
a)	Output	MDI Ethernet
b)	Connector	RJ45 female
c)	Frequency	10/100 M bauds
d)	Remote Monitoring	Ethernet, RJ45 female 10/100 M bauds
3.5.3	General characteristics	
a)	Standard	As per latest relevant ETSI Standards (TS102 820 & TS 102 821)
b)	Mounting	19" Rack Mounting or integrated with the transmitter
3.5.4	Mains power supply	230V AC \pm 5%, 1 Phase, 50 Hz.
3.5.5	Environmental conditions	
a)	Operating Temperature	0° C to 45° C
b)	Altitude	Up to 1500 Meters.

3.6 DRM DIGITAL MODULATOR / RF EXCITER:

S. No.	Parameters	Specifications
3.6.1	General Characteristics	
a)	Standard	As per latest relevant ETSI Standard (ES 201 980).
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.
3.6.2	Input characteristics	
a)	Input	i. MDI Ethernet ii. Digital Audio (stereo) AES/EBU iii. Analog Audio (stereo) iv. RF Feedback Analog (If required in transmitter)
b)	Input connector	RJ45 female, XLR3 female, SMA,
c)	Frequency	i. MDI Ethernet: 100 Mbits 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 (If required in transmitter)
d)	Impedance	i. Digital Audio Stereo: As per AES3 Standards. ii. Analog Audio Stereo: 600Ω. iii. RF Feedback: 50Ω iv. RF GPS: 50Ω
3.6.3	Output Characteristics	
a)	Output	i. RF- Envelope, Phase modulated RF (A, Ø) or I, Q Base Band signal. ii. Amplitude LVDS Analog Audio
b)	Frequency	i. 1-30 MHz 100 Mbaud 20 KHz Maximum
c)	Connectors	SMA, Standard BNC and standard XLR connectors
3.6.4	Environmental conditions	
a)	Operating temperature	0° C to 45° C
b)	Altitude	Up to 1500Mtrs.
3.6.5	Mains power supply	
	230V AC ± 5%, 1 Phase, 50 Hz	
3.6.6	Mounting	
	19" Rack Mounting or integrated with the transmitter	

3.7 PROFESSIONAL DRM MONITORING RECEIVER:

S.No.	Parameters	Specifications
3.7.1	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 latest ETSI TS 102 349) via LAN, QoS(Quality of Service) monitoring, high accuracy field strength measurement.
3.7.2	Reference Oscillator	Built in high accuracy OCXO (Oven Controlled Crystal Oscillator)
	i. Offset	< 0.1ppm
	ii. Aging	< 0.1ppm/year

3.7.3	Input Freq. range	100KHz to 27.4 MHz
3.7.4	Level measurement accuracy	± 1 dB
3.7.5	RF Data Band width	40 KHz, ripple 0.2 dB
3.7.6	DRM spectrum mask monitoring	within ± 30 kHz
3.7.7	Input level	DRM decoding : – 110 to 20dBm In-channel IP3: + 15dBm (noise figure 15 dB) Out of band IP3: + 30dBm (noise figure 15 dB)
3.7.8	Phase noise at ± 20 Hz	-80dBc/Hz
3.7.9	Phase noise at ± 20 kHz	-130dBc/Hz
3.7.10	DRM Parameter according to latest ETSI ES 201 980 standards	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.
3.7.11	Audio decoder	xHE-AAC with SBR, MPEG-4 AAC+SBR, HVXC+SBR, CELP+SBR, Parametric Stereo
3.7.12	Monitoring	Field strength, Estimated Signal-to-Noise Ratio, MER, AFS feature of DRM Estimated Delay Spread, Estimated Doppler spread, Audio quality, Frequency offset& all latest Value Added Services offered/ available in DRM.
3.7.13	Display	Power spectrum, Spectrum Mask, Channel Impulse Response, Field strength, Signal-to-noise ratio
3.7.14	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 iv) Audio dropouts above specified ratio v) Audio level below specified value vi) MDI errors above specified rate vii) Frequency offset above specified value
3.7.15	Interfaces	i) Headphones output with volume control ii) Built-in loudspeaker with volume control iii) Line output iv) Two relays output v) Ethernet 100 Base T-port vi) Two RS 232 connectors vii) Two USB 2.0 connectors viii) Antenna input N type female connector 50 Ohm

		ix) External loudspeaker output
3.7.16	Remote Control	GUI, RSCI & Web interface
3.7.17	Power Supply:	230V , 50Hz AC
3.7.18	Environmental Specification	Temperature range: 0-40 °C
3.7.19	Mechanical Dimensions	Should be 19" rack mounting Dimensions to be furnished by bidder.

3.8 ANTENNA SELECTOR SWITCHES (MOTORIZED)

S. No.	Parameters	Specifications
8.1	R F Carrier power	100 KW
8.2	Frequency range	3.2-17.9 MHz
8.3	Maximum permissible VSWR	1:2
8.4	Test voltage between each phase and earth	42 KV r.m.s.
8.5	Characteristics impedance	Balanced $300\Omega \pm 5\%$
8.6	For any switch position the matching error within a Switch block with $150+j0\Omega$ between each leg and earth, will produce a VSWR less than.	1:1.2
8.7	Cross talk within a switch block in any feeder line, Terminated at both its ends with $150+j0\Omega$ between each leg and earth, the symmetrical components of current and voltage induced from any other feeder line terminated at one end with $150+j0\Omega$ are less than.	-60dB
8.8	Motor drive:	
	i. Type	AC
	ii. Power supply three-phase four wire connection	400V
	iii. Main frequency	50Hz
	iv. Switching time	2 sec.
8.9	Manual Drive: A control lever may be installed to operate manually.	
8.10	Micro switches: These may be provided to give the feedback of antenna operation to transmitter control circuit and to Beam reversal Switches.	

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 Equipment at the time of finalization of Tender.
- iii. All items mentioned in the Schedule under Supply of Equipment (Items at Sl. No. 1) and under Works (Items at Sl. No. 2) , will be taken in consideration for ranking purpose whereas all items mentioned in the Schedule under Spares and Optional items, at Sl. No. 3 will not be taken in consideration for ranking purpose. However the Tenderer must quote for all the items under the schedule of requirements.

S. No.	Equipment	Quantity
1	Supply of Equipment	
(a)	50 kW AM-DRM-SW Transmitter	01Set
(b)	Antenna Selector Switches	1 Set
(c)	Box type Rigid Line	01 Set
(d)	DRM Encoder Multi-program multiplexer	02 Nos.
(e)	DRM digital RF Exciter/ Modulator	02No.
(f)	Air Ventilation Units.	01Set
(g)	Liquid Cooling System with standby pump	01Set
(h)	Air ducts, motorized close/open loop arrangements for fixing to AHU & weather proof Louvers for fixing on wall opening for inlet and outlet	01 Set
(i)	Self-contained RF Drive Unit.	01Set
(j)	Audio Leveler	01 Set
(k)	Spare PA Valve(If the transmitter has Valve in PA stage) (in addition to one in circuit)	01 No
(l)	MDI Player Software	

S. No.	Equipment	Quantity
(m)	Mains Power Supply Distribution Panel for complete system	01No.
(n)	Dummy Load, Soda Water type 200KW capacity with heat exchanger and Control Panel.	01 No.
(o)	Transmitter's coolant heat exchanger unit.	01Set
(p)	Professional DRM Monitoring Receiver	01 No.
(q)	Software Defined Radio (AM & DRM) along with Hardware Interface Units for receiving AIR transmission on computer.	10 Sets
(r)	Complete installation material for Transmitter	01Set
(s)	Any other Equipment/Material required for the completeness of 50kW SW transmitting system (To be indicated with details)	01 Set
(t)	Supply Material for NVIS Antenna system	01 Set
(u)	Supply Material for Feeder Line	01 Set
2	Works	
(a)	Installation, Testing and commissioning of Feeder Line	1 Lot
(b)	Installation, Testing and commissioning of NVIS Antenna System	1 Lot
(c)	Testing and commissioning of 50 kW SW Transmitter with proper interface with feeder line and NVIS Antenna system	1 Lot
(d)	Signal Strength / Radio Reception Monitoring	1 Lot
3	Optional Items & Spares:	
a	Charges for training of 6 AIR engineers for 10 working days at manufacturer's works.	01 lot
b	Solid state modulator transformer	01 No.
c	Driver tube socket(If tube used)	01 No.
d	PA tube socket (complete)	01 No
e	Solid state modulator modules	10 Nos.
f	Spares for all switching systems	01 Set.
g	Pre-driver RF amplifier module (Complete)	01Set
h	Motor for XTR. Water to air heat exchanger	01 No.
i	Breaker/ contactor for solid state mod. Transformer	01 No.
j	Driver spare tube (If tube used)	01 No.
k	PA spare tubes	01No.
l	Additional Cards of each type for Transmitter Control system (List to be enclosed)	01Set
m	Additional Cards of all type for all R.F stages.	01Set

S. No.	Equipment	Quantity
n	Additional Cards of all type for all Audio stages from Audio processing to modulation encoding. (list to be enclosed)	01 Set
o	Additional Ventilation Unit.	01 Set
p	All variable vacuum capacitors used in one transmitter	01 Each
q	All ceramic capacitors—25% of each type or minimum 1 each	01 Lot
r	Frequency Synthesizer	01 No.
s	Discrete components like power transistors (MOSFETs), main I.Cs, Semi-conductors & other special components.	01Set.
t	Spares for the dummy load	01 Set.
u	Other items of spares recommended by the Tenderer <i>N.B.: The manufacturer / contractor 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 decide upon the quantity of spares under optional to be purchased after the transmitter equipment system on lowest cost basis is decided.</i>	01 Set.



ANNEXURE - I**GUIDELINES FOR ATP (SITE ACCEPTANCE TEST) OF THE TRANSMITTER, ASSOCIATED EQUIPMENT AND ACCESSORIES****1. General:-**

- 1.1** The installation of Transmitter along with its associated equipment & sub-assemblies shall be carried out by AIR. However, Final Testing, Commissioning & Site Acceptance shall be carried out by representatives of Manufacturer/Contractor in presence of AIR Representatives.
- 1.2** AIR shall give at least 8 (eight) weeks' notice to Manufacturer/Contractor to carry-out the inspection, before the installation of Transmitter is complete.

2. Inspection/Testing of Equipment at Transmitter Site:

Representatives of Manufacturer/Contractor shall check the installation of Transmitter, associated equipment and sub-assemblies, Feeder Line & Antenna system. Any defect found in the installation shall be got rectified from AIR Installation team. The Transmitter shall then be put ON-AIR (on feeder line and Antenna) and various parameters shall be checked by Representatives of Manufacturer/Contractor. After being fully satisfied with functioning of Equipment, AIR Inspectors shall carryout the following tests at the transmitter site in presence of Manufacture/Contractor representatives:-

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 its workmanship is of high quality.
- b. 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 Erection / Technical Manuals.
- c. 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 and dummy load, 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 equipment like Dummy Load and Antenna Change over switch etc. will be checked for proper operation.

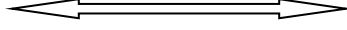
2.3 **Performance tests on the equipment:**

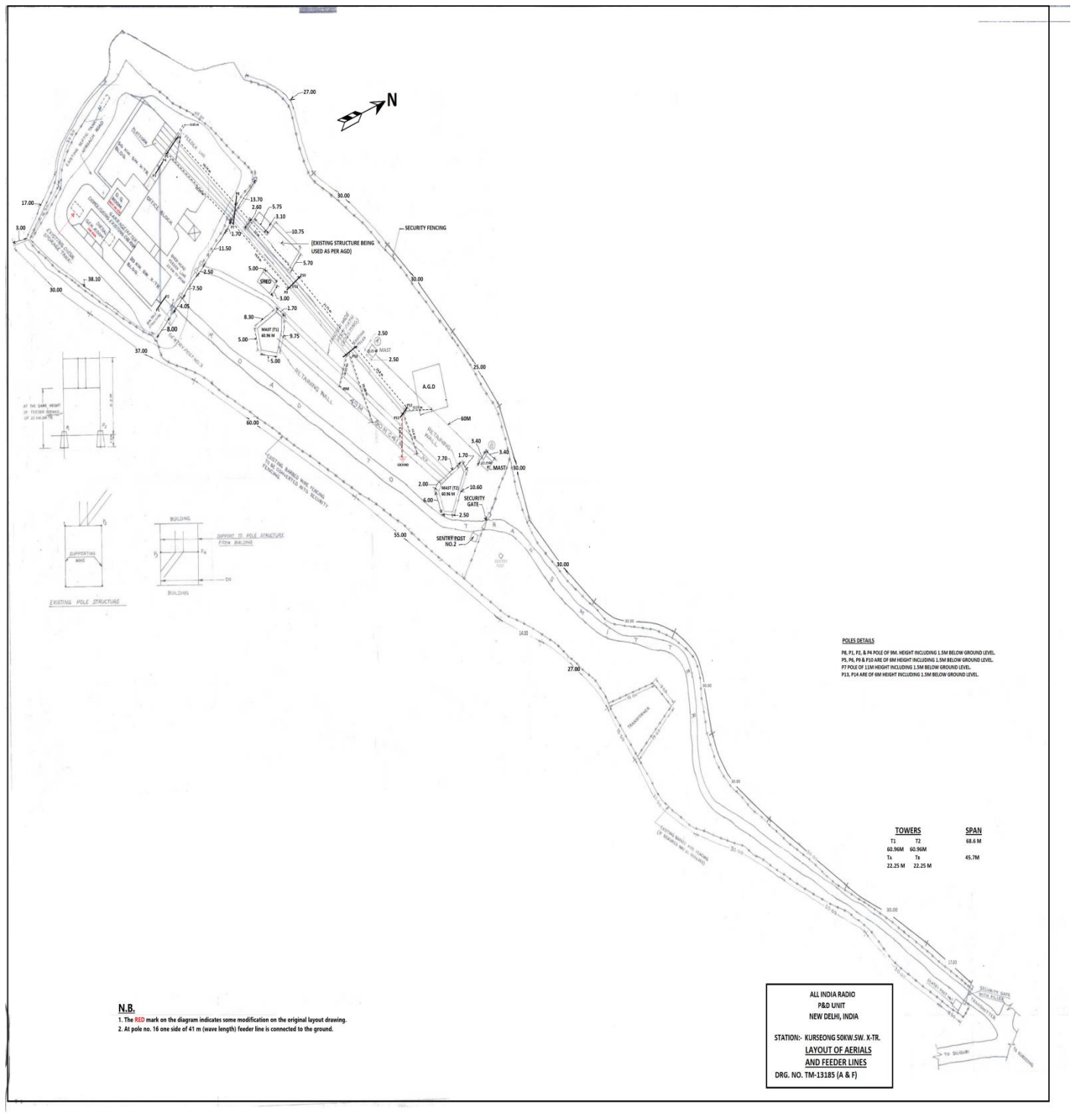
The methodology adopted for testing the equipment shall be as follows:-

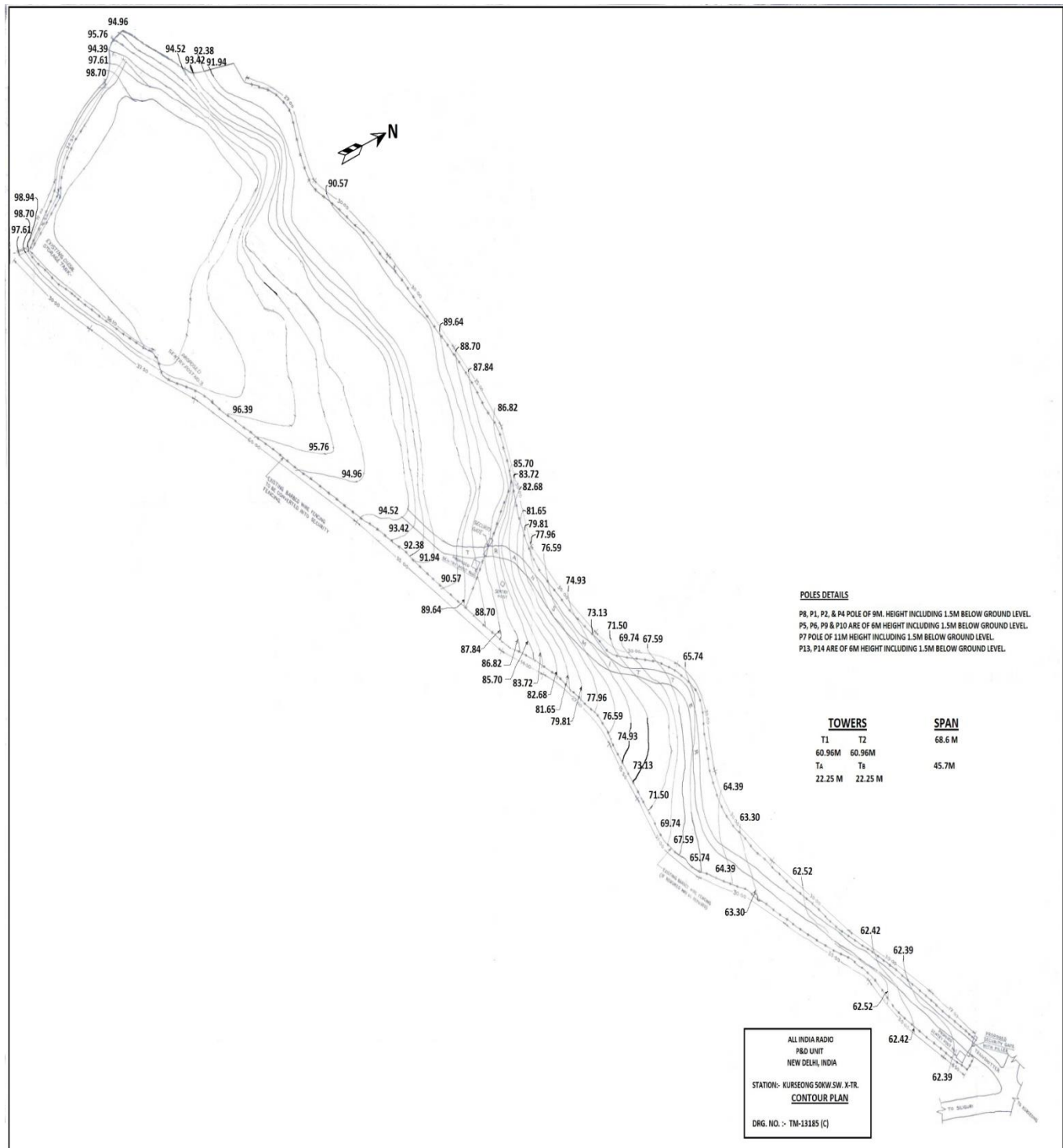
- a. The transmitter along with its associated equipment **as well as optional items such as spares/Cards mentioned in Section –IV, Schedule of Requirements** (excluding power supply cables and other installation materials), **shall be tested at site**, against the technical specifications stipulated 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.**
- b. The equipment shall be tested at the Mains Input voltage and frequency specified for the various equipment under Section - III i.e. 400 V AC $\pm 10\%$ (without AVR), 3 phase / 230 V AC (Nominal) 1 phase, 50 Hz.
- c. After successful testing of the technical performance of the transmitter and its associated equipment as specified under Para 2.3 (a) above, A heat run test for a continuous period of 24 hours with rated carrier power and modulation as per the ATP (SAT) shall be done keeping in view the modulation capability specified in the specifications and as per the claims made by the Tenderer.
- d. In case, this Heat Run test gets 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.
- e. If any component fails or is found defective on receipt at site as well as during the Erection/Testing/Commissioning these will be supplied free of cost to AIR site by the transmitter manufacturer / contractor.
- f. All the Sub-assemblies / amplifiers / oscillators and modules etc, ordered as spares shall be tested in circuit at the transmitter site and performance of the equipment shall be checked against the specifications. The various discrete components, ordered as spares, shall be checked physically / visually.
- g. I/P & O/P impedance of the feeder line for entire SW band should be in range of $300 \pm 10\% \Omega$.
- h. Testing of NVIS Antenna & Feeder Line shall be done by feeding Transmission on full Power of the Transmitter at 100% modulation via newly installed transmitter. NVIS Antenna Signal Strength measurement/Monitoring survey at 1 km, 10 km, 100 km , 300 km & 500 km in all possible directions both during daytime and night time at the frequencies suggested by Contractor for successful NVIS operation at Kurseong. NVIS antenna & Feeder Line shall be accepted by AIR only after being satisfied about the performance of Feeder Line & NVIS aerial & it is found to fulfill AIR requirements. The cost of monitoring & survey shall be borne by the contractor.
- i. The remaining equipment (not covered under Para 2.3 (a) to 2.3 (h) shall also integrated/ taken in circuit & be inspected for acceptance as per the specifications subject to successful

testing of these equipment at AIR site against the technical parameters specified under Section - III of these specifications or the technical parameters claimed by the contractor whichever are better.

- j. 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.



ANNEXURE - II**SITE LAYOUT PLAN 50 kW SW Tx. AIR KURSEONG (WB)**

ANNEXURE - III**CONTOUR DIAGRAM OF 50 kW SW Tx. AIR KURSEONG (WB) SITE**

*******END OF DOCUMENT*******