TITLE : TECHNICAL SPECIFICATION FOR BOUGHT OUT ITEM FOR ESP

ITEM : HIGH FREQUENCY HIGH VOLTAGE TRANSFORMER RECTIFIER (HFTR)

PROJECT : M/S NATIONAL THERMAL POWER CORPORATION LTD (NTPC)

NAME		DESIGNATION	SIGNATURE	DATE
PREPARED	K S S MANIAN SRAVAN KUMAR	SAE 1 SA 1		04.08.2014
CHECKED	S RANGA RAJAN G S NAIK	SDGM SR MGR		04.08.2014
APPROVED	S JAYAPRAKASAM	AGM		04.08.2014

ISSUED BY

EDC – ECI

Revision No	Date	Description Of Revision

Revision No: 00 **Initial Release : 30.07.2014**

1.0.0 Scope

1.1.0 Design, Manufacture, Test, Pack & supply Switch mode High Frequency Transformer Rectifier(HFTR) for Electrostatic Precipitator (ESP)with **400mm electrode spacing**, complete with Switch mode power supply (IGBT type) based Electronic controller Panel (ECP), Microcontroller/Digital Signal Processor(DSP) based controller and Remote Terminal Unit(RTU) with all fittings and accessories as required to make the system complete. **The scope also includes Erection Supervision and Commissioning of the HFTR unit at Thermal Power Station.**

1.2.0 All sections of HFTR unit like Input power isolator & filter, input rectification section, Pre-changing & Capacitor bank section, IGBT based Inverter section, Controller section, Transformer section and High voltage rectification section, Integral disconnect or cum earthing etc. shall be integrated to single module of enclosure in the case of high frequency transformer rectifier for 10KHz and higher and may be with separate standalone power supply panel housing Power isolator switch, Rectifiers, capacitors, IGBT and DSP controller where the operating frequency is range of 300Hz-1000Hz. In the case of separate power supply panel, maximum distance between the power panel and the High frequency transformer shall be specified in the offer.

1.3.0 BHEL will decide the requirement of HFTR unit either 10KHz (and above) OR (300-1000Hz) during placement of order.

1.4.0 It is the responsibility of the bidder to know all aspects of ESP & take care, which decides the design & performance of the HFTR unit. The HFTR unit to be supplied shall be field proven, type tested and tropicalized.

1.5.0 The bidder shall provide sufficient experience data and operating experience in switch mode HFTR which is in successful operation at least for a period of one year as on the date of bid opening in one coal fired thermal power plant for review and approval.

1.6.0 Transformer shall be filled with **Silicone oil**.

1.7.0 Special tool & tackles if any required to be indicated & included in the scope.

2.0.0 Project Information:

2.0.0 Ambient conditions

2.1.1	Ambient temperature	:	5°C to 50°C.
2.1.2	Humidity	:	Up to 95%. Non condensing.
2.1.0	Location	:	Outdoor, on top of ESP
2.2.0	Altitude from mean sea level	:	Less than 1000m
2.3.0	Quantity & Rating	:	As per enquiry.
2.4.0	Environment	:	The atmosphere is very dusty and of very high abrasive in nature, conducive to fungus growth.

3.0.0 Applicable Standards:

3.1.0 **General**

The equipment shall be designed, manufactured and tested (including type test) as per applicable standards and as per this technical specification.

If there is any contradiction between the specification and standards, the specification shall apply. If there is any contradiction between standards listed or between various clauses, the most onerous condition shall apply. Further to above, the HFTR shall meet local statutory regulation as applicable.

3.1.1 Transformer, SMPS Power and control components & all other equipment/ accessories shall confirm to relevant Indian Standards/ equivalent International Standard like IEC. The transformer oil shall meet the fire safety requirement specified in paragraph 450-23 of National Electrical Code.

3.1.2. **Standards:**

- Bidder to specify all applicable Indian Standards / International standards for the HFTR Unit offered.
- Following standards requirement shall be taken care
- EMC conformity : EN 61000-6-4 Emission, EN 61000-6-2 Immunity
- Low Voltage directive : EN 50178 2006/95/EC
- Degree of protections, Enclosure. : IEC 529 /1989/2/73, EN 60529
- Electronic equipment for use in power installations : EN 50178
- Transformer oil Fire safety requirement specified in paragraph 450-23 of National Electric Code

4.0.0 Terminal Conditions:

4.1.1 Power supply Input : 3 Phase, 415V, 50Hz AC.

4.1.2 Power supply variation

4.1.2.1 Voltage. : + / - 10%.

4.1.2.2 Frequency. : + / - 5%.

4.1.2.3 Combined variation of Voltage & Frequency : 10% (Absolute sum).

4.1.2.4 Any other voltage required for HFTR unit to be arranged internally by the vendor.

4.2.0 Capacitance of precipitator (PF) : 200 X rated output current in mA. (approx.)

4.2.1 Form factor to be considered for HVR : 1.4 MAX FOR “Input Current” &1.15 for “input voltage”

4.3.1 High voltage Negative Output terminal : Through single horizontal bushing.

4.3.2 Rated output voltage, output current and quantity shall be as per Enquiry/PO.

5.0.0 Design& Operational Requirements:

5.1.0 The HFTR consist of (a) Power supply Module (b) Transformer module, (c) Microcontroller/DSP Controller Module and RTU. **The Bidder shall furnish control principle details under non sparking and sparking mode for review.**

5.1.1 The Power supply module consists of 3 Phase diode converter, AC & DC filter, DC Bus, IGBT stack and Capacitor bank.

5.1.2 The transformer module consists of Line reactor, Step up transformer, Full wave diode rectifier and High frequency Choke.

5.1.3 The DSP controller module shall consist of Controller with accessories and supplied with RTU.

5.1.4 Integral HV disconnector with earth switch shall be provided to isolate HT supply to field and to earth the ESP field.

6.0.0 The tentative details of Individual sections are as follows.

6.1.0 **Input rectifier**:

a) Three phase diode full wave bridge rectifier.
b) Input AC voltage & frequency : 415V +/- 10%, 50Hz +/- 5%
c) Output DC Voltage : 600V OR suitable for bidder overall configuration.
d) Output DC Current : Bidder to specify as per Inverter loss requirement
e) Output Power : Bidder to specify KW + total losses.
f) Power over load : 150% of rated KW for 60 sec. for every 10 minutes.

6.1.1 **Capacitor Bank:**

Equivalent Inductor & capacitance value, Harmonics current rating shall be suitable for rated KW inverter, operating at (a) 10 KHz and higher. (b) 300Hz -1000Hz and lower as applicable for the type and rating indicated in the enquiry.

6.1.2 **Pre-charging Circuit:**

The capacitor bank is charged in a controlled way to limit the inrush current at start. At the start command, the start relay connects the line voltage via resistors to the main rectifier bridge and charges the capacitor bank with a limited current. The start relay is also provided with a timer function that starts the main contactor.

6.1.3 **Inverter:**

a) Configuration	: Single phase, IGBT based, PWM inverter.
b) Input DC Voltage	: 550V +/- 10% OR as per vendor design
c) Output A/C Voltage	: 1Ph, 0 to 415V
d) Output A/C current	: As required. Bidder to specify.
e) Output frequency/ Switching frequency	: More than (a) 10 KHz. (b) 500Hz as applicable. Bidder to specify.
f) Output Power	: Bidder to specify KW
g) Output Power factor	: 0.9 minimum.(Bidder to specify).
h) Natural/Forced air cooling	(Bidder to specify).
i) Power overload	:150% of rated KW for 60 sec. for every 10minutes.

6.1.4 **Switching:**

The switching topology shall be of **Soft switching type/ Hard switching.** Suitable inductor and capacitor value shall be considered to enable soft switching at operating frequency.

6.1.5 **High frequency High Voltage Transformer rectifier.**

a) Number of Phase	: Single Phase.
b) KVA Rating	: Bidder to specify.
c) Input power supply	: 415V A/C, +/- 10%, Single Phase, at switching frequency.
d) DC Output Voltage	: 95KV (Full wave rectified)
e) DC output current	: As per Enquiry / PO.
f) Core material	: Nano crystalline / Amorphous Silicon OR equivalent.
g) Type of cooling	: Silicone Oil Force cooling.

6.2.0 All sections of HFTR unit like input rectification section, Capacitor bank section, IGBT based Inverter section, Controller section, Transformer section and High voltage rectification section, HV disconnector cum earth switch etc. shall be **integrated to single module of enclosure in the case of high frequency transformer rectifier for 10KHz and higher and may be with separate power supply panel housing DSP/micro controller where the frequency is 500Hz to 1000Hz. In the case of separate power supply panel, maximum distance between the power panel and the High frequency transformer shall be specified in the offer. Tentative run length of cable between ESP field and Control room is as specified in the enquiry.**

6.2.1 The vendor may propose their own field proven module arrangement meeting the above requirement for 10KHz and above and/or 500Hz to 1000Hz.

6.3.0 The HFTR unit is meant as automatic constant current source of power to the ESP. The HFTR unit shall be suitable for 24 hours a day operation continuously, with frequent sparking in the precipitator load, occasionally having 200 sparks per minute. HFTR is to operate throughout the year in all climatic condition in ESP application.

6.3.1 The HFTR unit shall be suitable for operation with charge ratio 1: 1 to 1: 255 and base current at higher charge ratio shall have range of 0 – 49 % of set current. ESP Current wave forms for various charge ratios are attached with this specification as Annexure-I for information. The controller shall limit current peaks to 204 % under intermittent charging mode.

6.4.0 DSP Controller/microcontroller shall regulate the output current to the set value within + / - 5 % for any non-Sparking load conditions between 10 to 100% of the rated output current for any / all of the following conditions:

1. Variation in impedance of EP load.

2. Variation in input supply voltage between 415 + 10 % to 415 – 10 %.

3. The Unit shall deliver the rated secondary voltage and current with load connected, when the Power supply input volt is 415V.

6.5.0 The HFTR unit shall regulate and control the electric power input to the Electrostatic Precipitators. The HFTR shall regulate the power supply in such a way, that current through Electrostatic Precipitator is corrected as the conditions for sparking are changed. The HFTR shall maintain the spark rate at a set level for great variations of gas temperature, dust composition, gas flow etc.

6.6.0 It shall be noted that the precipitator is a dead load. The electrodes inside the Precipitator keep swinging slightly with frequency of 5 to 10 Hz. Since the precipitator can be regarded as a capacitive load, under certain conditions, the precipitator may act like a tuned circuit. A critically adjusted controller may be completely stable when connected to a resistive load but not necessarily when connected to a Precipitator load; such regulator instability will not be accepted. The unit shall be capable of operating at any secondary current provided the primary current is not exceeded. The unit shall be capable of operating under accidental no load, which may occur during startup, maintenance and operation, without damage. The unit may be subjected to short circuit condition when the ESP Electrodes gets snapped during operation. The HFTR unit shall be suitable for the above operating conditions.

7.0.0 Construction& Design Features of Transformer Rectifier:

7.1.0 The HV transformer rectifier shall consists of suitably rated single phase high voltage step-up transformer, the secondary of which is connected to a full wave bridge connected rectifier. The transformer windings, magnetic circuit and other associated components and rectifier stack shall be housed in a common transformer tank made of robust, leak proof tank and shall have adequate cooling. (Preferably Oil Natural cooling type. Proven vendor design acceptable with justifying details).

7.2.0 Transformer shall be filled with Silicone oil, nontoxic and shall have high flash point (above 300 Deg. C).Maximum temperature rise is 50 Deg. C above an ambient of 50 Deg. C.

7.3.0 The tank shall be **sealed** type construction without breather and sized to take care of the oil expansion due to operating and ambient conditions. Access shall be provided for ease of maintenance and repairs.

7.4.0 The winding shall be of Electrolytic grade copper.

7.5.0 The High voltage rectifier shall be made of Fast silicon diode stacks. The diodes shall have adequate safety factor and protections and shall be mounted on printed circuit / molded discs. Bidder to specify.

7.6.0 A suitably rated line reactor with adequate impedance to limit short circuit current 2.5 to 3 times rated current shall be located inside the tank. The reactor shall be designed to generate minimum vibration and noise.

7.7.0 A suitably rated Radio Frequency Choke shall be located inside the Transformer Tank to protect the HFTR from the sparking that may occur in the ESP.

7.8.0 The positive lead of rectifier output shall be taken through an earth bushing. The earth bushing shall be located on the transformer tank. The negative lead of the rectifier output shall be brought out through side mounted horizontal high voltage bushing insulator. This bushing shall be provided on the side wall of the transformer. The terminal side of the bushing shall have M10 threading.

7.9.0 Integral disconnector cum earth shall be provided. The disconnector is to isolate HV output and earth the ESP field.

7.10.0 A suitable metallic duct enclosing the output negative bushing shall be provided with flange for the protection of the Bushing Insulator against adverse condition such as rain and accumulation of dust. This flange shall match with the flange provided in the Disconnecting Switch (Not in vendor scope, supplied by BHEL). The metallic duct shall have square flange of dimension 650 mm X 650 mm with 24 nos. 9.5 mm dia. holes, to connect the duct with purchaser's equipment. An opening to clean the insulator shall be provided in the duct.

7.11.0 There shall be two separate grounding terminals (M12 bolt, nut and washers) for Positive grounding of tank. The positive busing terminal shall be connected by tinned copper strips to the earth terminal, externally. The positive terminal shall also be earthed, internally within the TR set.

7.12.0 Power connections for LT supply shall be extended with adequate support such that power cables can be terminated vertically without bending the cable cores.

7.13.0 The feedback DC current shunt shall be located outside the transformer tank. A high voltage resistor column for measurement of DC output voltage shall be located inside the transformer tank. Measuring terminals shall be brought out for external termination. Necessary protections in the form of glow tube and voltage clamping devices shall be provided.

7.14.0 There shall be a weather proof Marshaling box mounted on the HFTR unit. The marshaling box shall house current shunt & voltage measurement terminals along with protections, terminations of protection, control and monitoring equipment etc. for safe &reliable operation of the HFTR unit.

7.15.0 The wheels of HFTR shall be separated at a distance of 900 mm (along the Output Horizontal Bushing) and at a distance of 550 mm (across the Bushing). The wheels shall have approximate thickness of 50 mm. The distance between Bushing center line and the wheel bottom shall be 700 mm. Other dimensions of the HFTR Unit shall be decided by the vendor to suit the rating.

7.16.0 The HFTR unit shall be provided with bi-directional wheels, skids, lifting lugs and jacking pads.

7.17.0 The HFTR unit shall be provided with Danger Plate and Name plate.

7.18.0 The Transformer shall be designed to pass the Double voltage Double frequency testing.

8.0.0 Electronic Controller panel (ECP):

8.1.0 The Electronic control Panel/Cabinet (ECP) mounted with Microcontroller/DSP Controller shall be suitable for operation with HFTR. It shall be mounted suitably with HFTR having opening from front. The panel shall be suitable for continued trouble free operation in dusty atmosphere. The construction of panel shall be such that free access is possible to all components for ease of troubleshooting and maintenance.

8.2.0 The General Arrangement of the HFTR unit, Components, lay out inside the EC panels, Electrical power and control Scheme is subject to BHEL approval.

8.3.0 The panel shall be preferably made of 2 mm thick (if free standing)/1.6mm (if part of HFTR) steel sheet & the door shall be rigid enough to avoid wobbling. The front door of cubicle shall be interlocked to ensure that the interior of panel cannot be reached until the mains supply is made OFF.

8.4.0 Cutouts as per the sketch indicated in the Annexure-II shall be provided on the door for mounting a special rotary interlock, (supply &mounting by buyer at site) to de–energise the rectifier when the key of the special interlock is removed. This facility is intended for interlocking of the HFTR unit with the Precipitator for safety of operating personnel and equipment. Necessary wiring and terminations shall be made to include the NC contact of this key interlock in the Main Power contactor coil circuit.

8.5.0 Anti-vibration pads, if required for the HFTR unit shall be provided.

8.6.0 All controls and instrumentation shall be insensitive to vibration, dust & humidity and shall be fully tropicalized**.**

8.7.0 The bus bar support shall be of molded type, non-hygroscopic, anti-tracking and non-inflammable. The location of power terminals shall be sufficiently above gland plate for ease of cable termination. Bus-bar shall be tinned copper bus suitable to terminate four runs each incoming power & outgoing power cable. All power wiring shall be done with bars of suitable size to withstand 50 KA for 1 Sec.

8.8.0 All internal wiring shall be neatly laid out. Interlocking type or colour coded ferrules of proper size shall be used for control and signal wiring. Ferrule numbering shall be adopted for wiring. Inter component wiring shall be done with extra flexible stranded copper conductor PVC insulated wires. More than two wires shall not be terminated in a terminal block. Each wire shall be provided with a separate lug for termination. Suitable pre-insulated Annealed Tinned Copper (ATC) lugs and clip on type terminals shall be used in wiring. For CT, shorting link shall be provided. All the wires shall be laid down through cable tray channel. For control and signal wiring, 1Sq. mm copper PVC insulated stranded wires to be used.

8.9.0 20% spare control terminal blocks shall be provided in the panel for each row / group of terminal. Terminal block of phenolic, polyethylene or hylam are not acceptable. It shall be made of melamine. The insulating material of epoxy or fibreglass shall be preferred. The current rating of terminal blocks shall be at least twice that of terminated wires.

8.10.0 Heavy Duty brass double compression cable glands and insulated Annealed tinned Copper lugs shall be provided for terminating external power, control and screened cables.

8.11.0 <u>Grounding:</u>

8.12.0 A tinned copper ground bus of minimum 150 Sq. mm cross section shall be run along the entire width of the panel. Two external grounding points with M12 bolts, nuts and washer for connecting purchaser's safety ground conductor (50 x 6 GI) shall be provided. All ground points inside the panel shall be connected to the Panel ground bus separately. The Earth Bus shall be provided with adequate number of lugs to receive screening of external cables.

8.13.0 Measuring Instruments:

Separate control transformers (C.T) shall be provided for metering and protection. All instrument transformers required for metering shall be of class 1 accuracy and those for protection shall have class 5P3 accuracy. Adequate burden shall be provided for the CTs. The indicating meters shall be of flush mounting type. The dial range shall be such that it shall read rated value at 75% deflection of indicator. Ammeter and current coil of meters shall continuously withstand 120% of rated current and 5 times rated current for 0.5 sec without loss of accuracy. Voltmeters and potential coils shall withstand 120% of rated voltage continuously and twice the rated voltage for 0.5 sec.

Instrument dial shall be white with black numerals and lettering. Knife-edge pointers are preferred. There shall be red mark on dial corresponding to rated value. The measuring instruments shall be identified as follows. All indicating meters shall be of reputed make.

i. AC ammeter to measure primary current labeled as “AC PRIMARY CURRENT” and AC Voltmeter to measure primary voltage labeled as “AC PRIMARY VOLTAGE”.
ii. DC milli-ammeter to measure precipitator voltage labeled as “PRECIPITATIOR CURRENT”. (The signal to meter shall be from shunt resister. The meter shall be of moving coil type giving arithmetic mean reading).

iii. DC kilo voltmeter to measure precipitator voltage shall be labeled as "PRECIPITATOR VOLTAGE". (The meter shall be of moving coil type giving arithmetic mean reading).

iv. 5 digit time totalizer labeled as "POWER SUPPLY OPERATION". This shall be non-resettable type. The time totalizer shall indicate the cumulative time in hours up to last digit. At the time of dispatch the initial reading of time totalizer shall not exceed two digits.

v. Apart from the above meters, the Microcontroller/DSP controller shall have adequate alpha numeric display to read various parameters like set & actual values, alarm and trip conditions, etc. required for ease and efficient operation of the equipment.

8.14.0 No loose component shall be terminated to any of the components. Potentiometers for calibration if any shall be provided in PCB's / Part of Electronic cards.

8.15.0 Potential free, 5A 230V AC rated, Normally Open (NO) contacts shall be provided for customer use for HT ON, HT OFF, Main supply ON, Alarm and Trip. Also provision shall be made in the panel to receive ON, OFF commands of HFTR from Remote.

8.16.0 Component Identification and Labelling:

All the components of HFTR unit shall be identified. Door mounted components shall be identified by fixing anodized Aluminum labels & for components mounted inside the panel / marshalling box shall be identified with Aluminum foil sticker or approved equivalent.

8.17.0 HFTR, ECP & DSP/microcontroller shall be dust and vermin proof with enclosure meeting **IP55 degree of protection.** Neoprene gaskets / natural rubber shall be provided for all metal-to-metal joints. CFL light with door operated switches shall be provided. All hardwares such as bolts, nuts and etc. shall be nickel / cadmium plated / zinc passivated.

9.0.0 Microcontroller/Digital Process Signal (DSP) Control module

9.1.0 The Microcontroller /DSP controller shall be an advanced, latest version with high degree of flexibility, converts the frequency to the required level, monitor, execute algorithms and adjust automatically the output to suit ESP operating conditions. Once programmed by the operator, it shall automatically adjust output without any manual intervention/adjustments. Adequate Alfa Numeric display shall be provided for operator information/trouble shooting. All parameter setting& editing shall be pass word protected. Controller shall detect failure of any phase. The controller shall have record log of sequence of faults for diagnosis. List of alarm & Trip condition for trouble free operation of the HFTR shall be provided and subject to approval. Operating modes shall be selected manually from local OR remote terminal unit (RTU).

9.1.1 Following alarms/trip shall be provided as minimum.
i) Oil temperature
ii) Capacitor bank temperature
iii) IGBT power pack temperature
iv) Over load, over voltage

9.1.2 The Controller consists of Power supply, logic circuits, DSP, Peripherals, buffers, opto-couplers/isolator, analogue circuits etc. The inputs like keyboard and output like LCD display can be in-built to controller or in Remote Terminal Unit (RTU). **Details of the DSP controller & RTU to be furnished in the offer.**

9.1.3 Feedback signals for operation:

(a) Output current feedback	: 1V DC at rated mA (average)
(b) Output Voltage Feedback	: 400Micro Amps DC at rated KVp.
(c) Input current signal for each phase	: 0 to 100mA A/C.CT ratio programmed for Measuring line currents.

9.1.4	Digital Inputs	: Potential free contacts Normally Open.
9.1.5	Digital outputs	: Potential free Contacts rated 5A at 230V AC.
9.1.6	Analogue outputs	: 4 to 20 mA corresponding to rated mA DC output rated KVp.
9.1.7	Communication	: R2-485 Modbus RTU, 2wire. Or Controller Area Network (CAN) or Ethernet with RJ45. User friendly operator interface with Communication in message form and in engineering units.
9.1.8	Gate driver	: Power requirement and interface to controller and IGBT to be Furnished by bidder.

9.1.9 Soft start shall be provided during initial energisation / switch on of the output. The soft start shall be effective till field current reaches set value.

9.1.10 Program settings are stored in **Flash** memory; no battery backup is required. Memory remains even after years without power. Watchdog &self-diagnostic shall be provided.

9.2.0 **Back corona**

Detection and optimization of operating parameters based on the VI characteristic of the field to be provided to avoid back corona.

10.0.0 Painting

10.1.0 **Painting for Transformer.**

The internal and external surfaces including fluids filled chambers and structural steel work of FHTR unit transformer shall be sand blasted / approved equivalent method, to remove all rust, scales or foreign adhering material. All steel surfaces in contact with insulating fluid shall be painted with two coats of heat resistant fluid insoluble in insulating fluid. All sheet steel surfaces exposed to weather shall be given a primary coat of zinc chromate, second coat of weather resistant epoxy paint of colour distinct from primary. Finally two coats of glossy fluid and weather resistant non fading paint of shade RAL 5012 (BLUE) shall be provided. Minimum thickness of paint shall be 50 microns. If the transformer tank is made of material other than steel, the same shall be clearly brought out along with the process followed for metal treatment &painting.

10.2.0 **Painting for ECP, Marshaling Box, Enclosure box etc.**

All sheet steel shall be pretreated in seven tank process in accordance with IS 6005. Degreasing, de-rusting, phospating (Class C) shall be done for metal treatment. Stove lead oxide primer coating. After primer application, finishing synthetic enamel stoving paint shall be applied. Thickness of paint shall not be less than 50 microns. The final shade shall be RAL 9002(GREY) in front and rear and RAL 5012 (BLUE) in the extreme end covers of panel. Peel able coating shall be applied on panel after final painting. **If the approved drawing calls for any other painting process, then the same shall be followed.**

11.0.0 Makes of Components:

The makes of components are subject to BHEL review &NTPC approval. Only the Make of components which are approved by NTPC during drawing approval shall be used in the supply. There shall not be any commercial implication on account of such approvals.

12.0.0 Documents to be submitted along with offer:

a) Filled in data sheet forming part of the enquiry.
b) Over all General arrangement with dimensions, mounting details, weight, and external clearances required.
c) Compliance to the technical specification and list of specific deviations if any. Clarifications will be construed as compliance.
d) Brief operation /functioning of HFTR.
e) Power and control scheme(Typical)
f) Bill of materials of Major components with make & model number.
g) List of customers where similar/identical HFTR supplied, year of supply& commissioning, Quantity, country and application like Thermal power /cement etc., Customer feedback on the performance(typical)
h) Quality plan of vendor.
i) List of spares for 3 years trouble free operation. (O & M)

12.0 **Documents to be submitted on placement of Purchase order for NTPC review and approval:**

12.1.0 General arrangement of HFTR, ECP & Marshaling box, inside component layout, Wiring drawing, Bill of material, Power and control scheme, Rating and Diagram plate and technical particulars of High frequency high voltage transformer.

12.2.0 Detailed calculation for selection / sizing of KVA rating of transformer, Line reactor, RF choke, Diode stack, HV resistor column, IGBT etc. for review/information.

12.3.0 Data sheet for transformer, EC panel and DSP Controller, functional/operational write up and catalogue on EC.

12.4.0 Interconnection diagram between HFTR and EC panel, Marshalling box, and external equipment interface requirements / other panels.

12.5.0 Typical test certificate of similar /identical rating and test format for inspection.

12.6.0 Quality plan with customer check points.

12.7.0 Packing procedure and drawing.

12.8.0 Three sets of the above drawings shall be submitted to BHEL for approval, before taking up with manufacture. Soft copy is a single pdf shall be also submitted.

12.9.0 Typical operation and maintenance supplied for identical / similar rating recently to customers.

13.0.0 <u>O& M Manual</u>:

13.1.0 Operation &Maintenance manual in required numbers, as per Enquiry / Purchase order, shall be supplied along with the dispatch of the HFTR unit. The O&M manual shall be directly sent to BHEL / Ranipet Stores.

13.2.0 The O & M manual shall contain the following as minimum requirement. Relevant GA drawings, power & control schemes, operational write up, wiring drawings, Rating and diagram plate, Do's and Don'ts, details on storage, handling, Controller operating details, set parameters, pre commissioning checks, commissioning procedure, trouble shooting, manufacturer's catalogue for various bought out components etc., List of recommended spares for three years trouble free maintenance spares with Quantity shall be included.

13.3.0 The scheme drawings shall indicate all the components so that trouble shooting can be made easier.

13.4.0 Exhaustive Bill of Materials indicating description, rating, quantity, make, model number etc., for ordering components at a later date.

13.5.0 Typical test certificate shall be included for guidance for the operator information.

14.0.0 <u>Testing</u>:

The HFTR shall be tested based on the following documents:

(i) BHEL Purchase order (PO).
(ii) BHEL Technical specification/ordering specification as finalised &indicated in the PO.
(iii) Quality checklist / Quality Plan as finalised & indicated in the PO.
(iv) Test Procedure TP: 110: (latest revision).
(v) BHEL/NTPC approved vendor drawings.

15.0.0 <u>Packing:</u>

15.1.0 The equipment shall be properly packed with sea worthy packing to avoid any damage during transit / storage. The packing shall be weather proof and suitable for outdoor storage. Necessary provisions / marks for handling shall be provided. Each packing shall contain a packing slip showing all the components, supplier reference and Name, purchase order number, serial number of equipment, destination address, brief equipment description, one copy of instruction manual and relevant test certificates. Loose components if any, shall be clearly indicated in packing slip.

15.2.0 Each HFTR unit shall be packed separately. Loose Items related to each HFTR unit shall be packed along with the HFTR for ease of identification.

15.3.0 Each crate shall indicate the Purchase order number, Name and address of the consignee, approximate weight, Name of equipment (HFTR), Shipping marking etc.

16.0.0 <u>MAKE OF COMPONENTS:</u>

DESCRIPTION	MAKE
SWITCH FUSE UNIT	L & T / SIEMENS / CONTROLS & SWITCH GEAR(STROMBERG) / SCHENIDER / BCH / GE
MCB	L & T / SIEMENS / S & S / SCHENIDER / INDO-ASIAN / GE
MCCB	L & T / SCHENIDER / CONTROLS & SWITCHGEAR / SIEMENS / GE
CURRENT TRANSFORMER	A.E / KAPPA / IND COIL / PRAYAG / PRAGATI / AVK – SEG & CONTROLS (CONTROLS & SWITCHGER) / PRECISE / SOUTHERN ELECTRICAL / CANDS / G & M
INDICATING LAMP (CLUSTERED LED TYPE)	L & T / RAAS CONTROLS / BINAY / TEKNIC / SCHENIDER / CANDS / VAISHNO / BCH / ESSEN / SIEMENS / GE
CABLE GLAND	COMET / SIEMENS / SUNIL & CO / BRACCO / CONTROL & SWITCHGEAR / ARUP ENGINEERING / QUALITY PRECISION / LOTUS / CMI
CABLE LUG	DOWELLS / JAINSON / LOTUS / 3D
POWER CONTACTOR & AUX. CONTACTOR	L & T / SIEMENS / TELEMECHANIQUE(SCHNEIDER) / CONTROLS & SWITCHGEAR(TC) / SCHENIDER / BCH / GE
POWER FUSE	L & T / SIEMENS / CONTROLS & SWITCHGEAR / BUSMANN / GE
PUSH BUTTON	L & T / SIEMENS / BCH / TEKNIC / CONTROLS & SWITCHGEAR(RAAS CONTROLS) / SWITCHGEAR / GE

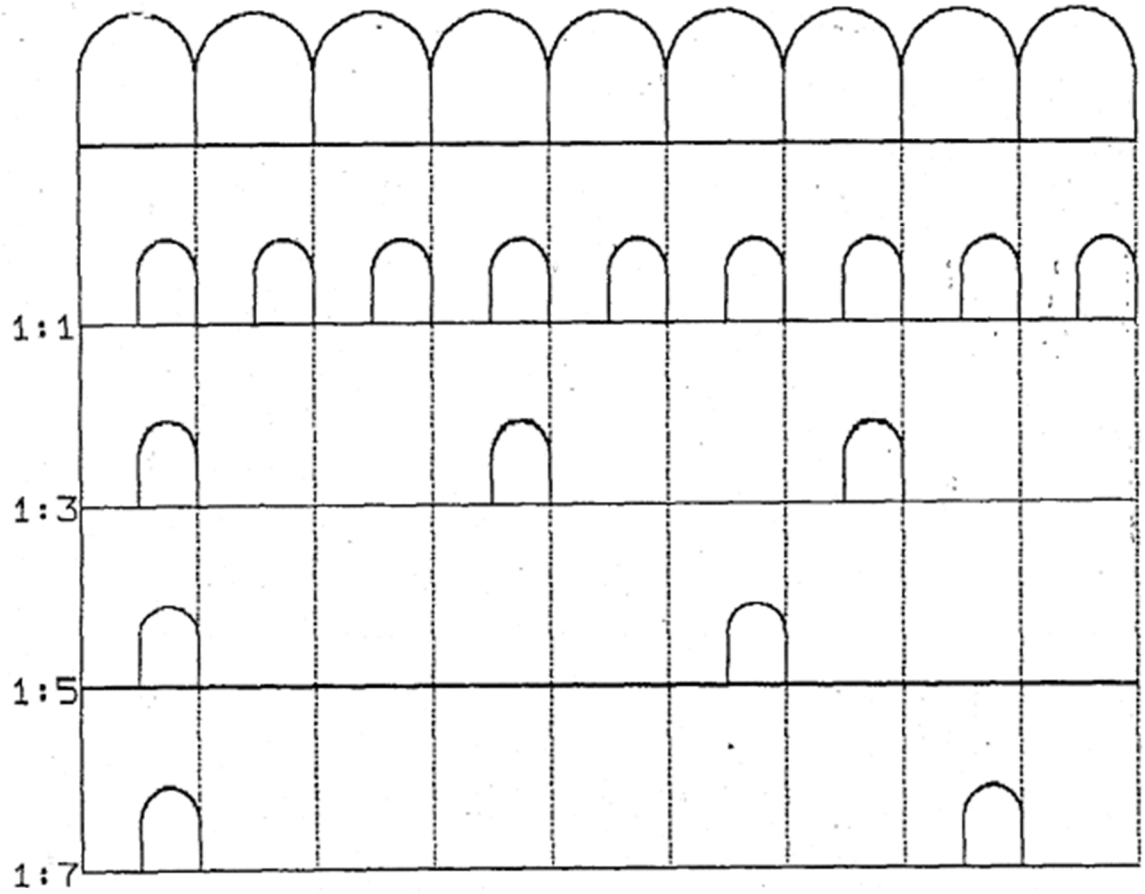
For items not mentioned above, make of components is subject to NTPC approval.

To be filled in and submitted by bidder along with Offer for Each rating and Type of HFTR

Sl. No	Requirement / Details	Requirement to be met by Bidder	Detail by Bidder for 10KHz&Higher	Detail by Bidder for 500Hz – 1000Hz	Remarks
01	Compliance to technical specification	Full compliance: example 'Comply TECI:NTPC:HFTR:Rev.00'			
02	List of customers with details	To be attached with details on rating, quantity, year of supply & commissioning, Country, application			
03	Type, acceptance & routine test details	To furnish Details of identical rating & type			
04	Transport dimension & weight	To be furnished(LXBXH in mm, Wt. in Kg.)			
05	HT Negative bushing orientation	Horizontal, housed in duct			
06	Provision for mounting & terminating castell type Interlock at site for HFTR switch ON permissive	To be complied & Ensured in the supply			
07	Applicable standards for HFTR unit, ECP, DSP, RTU, HFHVR	Furnish Indian standards/ International standards as applicable			
08	Overall General arrangement drawings	To be attached-Indicate dimension, clearance, weight			
09	Power and control scheme (Typical)	To be attached.			
10	Brief write up of equipment offered and its operation	To be attached			
11	Control philosophy during Switch on, Non sparking and sparking conditions	Attach field output curves for Current, Voltage with reference to time			
12	Details of display & indications in ECP, DSP, RTU	To be furnished			
13	Major BOM	To be furnished indicating Item description, make, model no.			

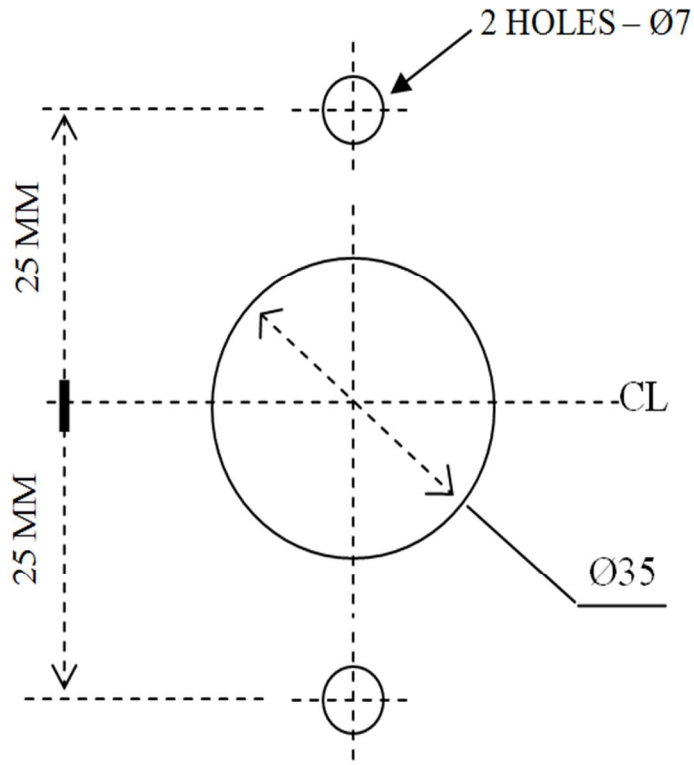
14	Protections provided	Specify list of alarm, trip & safety requirements			
15	List of Measuring Instruments	To be furnished			
16	Transformer output KV & mA, Primary voltage and current signal levels	To be furnished			
17	Harmonic suppressor	To be provided, if required			
18	Communication RS485 Modbus RTU or CAN any other microcontroller.	To comply			
19	Heat loss in KW-HVTR, ECP, Transformer rectifier	To be furnished			
20	Input power requirement KVA	To be furnished			
21	Electronic Control Panel	Part of Attached with HFTR or Separate			
22	HFTR wheel & HT Output dimension requirement	Compliance preferable OR to be specified			
23	Transformer core	To be specified- CRGO/ Nano crystalline / amorphous / others			
24	Transformer Tank material	To be specified - Steel or others			
25	List of Major Make of components	To be attached			
26	Make & Details of DSP	To be furnished			
27	Remote terminal unit details	Features To be furnished. Effective distance in meter for operation to be specified			
28	Specification of silicone oil	To be furnished including make of oil			
29	Details of painting & Process	To be furnished			
30	Typical O&M	To be attached with offer			
31	List of Recommended spares	To be attached			
32	Details of Packing	Typical drawing & details to be attached			

33	Maximum Power cable length applicable in meters, if EC panel kept away	To be specified for each type and rating.			
34	List of special tools	To be furnished separately and quoted			
35	Software Package required if any, for commissioning	To be specified and included in the scope			
36	**Manufacturer Quality plan (i)Typical & (ii) proposed for the rating & type**	To be attached			
37	Inspection at vendor works	To be specified-Location and duration			
38	Supervision of erection	To be quoted separately-lump sum			
39	Commissioning	To be quoted separately-Lump sum			
40	Intermittent/ charge Ratio implementation	Details to be furnished.			



ESP CURRENT WAVE FORMS FOR VARIOUS CHARGE RATIOS

ANNEXURE -I



DRILLING DATA ON PANEL FOR FIXING INTERLOCK

Annexure - II