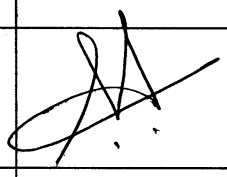
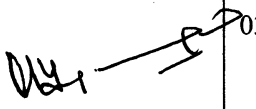
TITLE : TECHNICAL SPECIFICATION FOR BOUGHT OUT ITEM FOR ESP

ITEM : THREE PHASE HIGH VOLTAGE TRANSFORMER RECTIFIER (3PH HVTR)

PROJECT : STANDARD

NAME		DESIGNATION	SIGNATURE	DATE
PREPARED	K. S .S. MANIAN	SAE 1		03.01.2015
CHECKED	M.JAYAMURUGANAND	DGM		03.01.2015
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ISSUED BY
EDC – ECI

REVISION 01

Revision No: 00 **Initial Release : 05.01.2015**

1.0.0 **Scope**

1.1.0 Design, Manufacture, test, inspect, Pack & supply 3 Phase Transformer Rectifier (3Ph HVTR) for Electrostatic Precipitator (ESP)with **400mm electrode spacing**, complete with Electronic controller Panel (ECP), Controller , Remote Terminal Unit (RTU)(if applicable) and 3Phase High voltage rectifier transformer with all fittings and accessories as required to make the system complete. **The scope also includes Erection Supervision and Commissioning of the 3Ph HVTR set at Thermal Power Station.**

1.2.0 It is the responsibility of the bidder to know all aspects of ESP& take care, With operations requirement which decides the design & performance of the 3Ph HVTR set. The 3Ph HVTR set to be supplied shall be field proven, type tested and tropicalized.

1.3.0 The bidder shall provide sufficient experience data and operating experience in supply of 3Ph HVTR which is in successful operation in coal fired thermal power plant ESP for review and approval.

1.4.0 Transformer shall be filled with Mineral oil.

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

1.6.0 "HVTR" mentioned further in this specification shall be read as **Three phase transformer rectifier**

2.0.0 Project Information:

2.1.0	Ambient conditions		
2.1.1	Ambient temperature	:	5°C to 50°C.
2.1.2	Humidity	:	Up to 95%. Non condensing.
2.2.0	Location	:	Outdoor, on top of ESP
2.3.0	Altitude from mean sea level	:	Less than 1000m
2.4.0	Quantity & Rating	:	As per enquiry.
2.5.0	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 HVTR shall meet local statutory regulation as applicable.

3.1.1 Transformer, Power and control components & all other accessories shall confirm to relevant Indian Standards/ equivalent International Standard like IEC. The transformer oil shall meet IS 335.

3.1.2. **Standards:**

Bidder to specify all applicable Indian Standards / International standards for the 3Ph HVTR set 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 : IEC / IS2026
Control panel : IEC 13947

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 3Ph HVTR set 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 HVTR consist of (a) Power &control supply Panel (b) 3Phase oil filled delta star Transformer, (c) 3 Phase Thyristor Controller and RTU. **The Bidder shall furnish control principle details under non -sparking and sparking mode for review.**

5.1.1 The Power and control supply panel consists of power switch with fuse, power contactor, Thyristor bank, Controller and all components as required for trouble free operation to feed 3 phase power to 3Ph HVTR.

5.1.2 The HVTR consists of 3 Nos. each Line reactor, Step up transformer, Full wave diode rectifier, High frequency Choke, mA and kV Feed back circuits along with associated control accessories shall be suitable for single negative voltage output. The step up

transformer primary shall be connected in Delta and that of secondary shall be connected in Star.

5.1.3 The 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 **3 Phase High Voltage Transformer rectifier.**

a) Number of Phase: Three Phase.
b) KVA Rating: Bidder to specify.
c) Input power supply: 415V A/C, +/- 10%, 3 Phase, 50Hz.
d) DC Output Voltage: As per enquiry/ PO (Full wave rectified)
e) DC output current: As per Enquiry / PO.
f) Core material: CRGO or equivalent.
g) Type of cooling: ONAN

6.1.1 Limitation if any on the maximum distance between the power panel and the High voltage transformer shall be specified in the offer. Tentative run length of cable between ESP field and Control room is 200m approx.

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

6.1.3 The vendor shall inform whether the HVTR set 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 rated current field settable. ESP Current wave forms for various charge ratios are attached with this specification as Annexure-I for information. The current peaks under intermittent charge mode is 204 % of rated current.

7.0.0 Controller

The Controller 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,50 Hz.

7.1.0 The HVTR set shall regulate and control the electric power input to the Electrostatic Precipitators. The HVTR shall regulate the power supply in such a way, that current through Electrostatic Precipitator is corrected as the conditions for sparking are changed.

The HVTR shall maintain the spark rate at set level for great variations of gas temperature, dust composition, gas flow etc.

7.1.1 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 for longer duration when the ESP Electrodes gets snapped during operation. The HVTR unit shall be suitable for the above operating conditions.

8.0.0 **Construction & Design Features of 3 Phase step up Delta/Star Transformer Rectifier:**

8.1.0 The HV transformer rectifier shall consists of suitably rated three phase high voltage step-up transformer, the Three phase secondary connected to a full wave bridge 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.

8.1.1 Transformer shall be filled with Mineral oil. Maximum temperature rise is 50 Deg. C above an ambient of 50 Deg. C.

8.1.2 The tank construction shall have adequate cooling fins, conservator tank, 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 of internal and external components.

8.1.3 The winding shall be of Electrolytic grade copper.

8.1.4 The 3 phase High voltage rectifier shall be made of silicon diode stacks. The diodes shall have adequate safety factor and protections and shall be mounted on printed circuit / molded discs. Bidder to specify.

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

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

8.3.0 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.

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

9.0.0 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. 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 provision to clean the insulator shall be provided in the duct.

9.1.0 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.

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

9.2.0 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.

9.3.0 There shall be a weather proof Marshaling box mounted on the HVTR 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 HVTR unit.

9.4.0 The wheels of HVTR shall be separated preferably 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 preferably 700 mm. Other dimensions of the HVTR Unit shall be decided by the vendor to suit the rating.

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

9.6.0 The HVTR unit shall be provided with Danger Plate and Name plate.

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

10.0.0 **Electronic Controller panel (ECP):**

10.1.0 The Electronic control Panel (ECP) mounted with Controller shall be suitable for operation with HVTR. The panel shall have door opening at the front and rear. The panel shall be

suitable for continued trouble free operation in ventilated room atmosphere. The construction of panel shall be such that free access is possible to all components for ease of trouble shooting and maintenance.

10.1.1 The General Arrangement of the HVTR set, Components, lay out inside the EC panels, Electrical power and control Scheme, controller details & operation is subject to BHEL approval.

10.1.2 The panel shall be preferably made of 2 mm thick sheet steel & free standing. 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.

10.1.3 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 HVTR set 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.

10.2 Anti-vibration pads , if required for the Panel unit shall be provided.

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

10.4 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 in coming power & outgoing power cable. All power wiring shall be done with bars of suitable size to withstand 50 KA for 1 Sec.

10.5 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.

10.6 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 fibre glass shall be preferred. The current rating of terminal blocks shall be at least twice that of terminated wires.

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

11.0.0 **Controller**

11.1.1 The controller supplied by vendor shall be an advanced, latest version with high degree of flexibility, process the signals 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 of faults for diagnosis. List of alarm & Trip condition for trouble free operation of the HVTR shall be provided and subject to approval. Operating modes shall be selected manually from local OR remote terminal unit (RTU).

11.1.2 Following alarms/trip shall be provided as minimum.

i) Oil temperature, oil level
ii) Thyristor power pack temperature
iv) Over load, over voltage

11.1.3 The Controller consists of Power supply, logic circuits, Display, Peripherals, buffers, opto-couplers, analogue circuits etc. The RTU consists of key boards and LCD display with connector to interface with controller. **Details of the controller & RTU to be furnished in the offer.**

11.1.4 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 for each phase:	Vendor to specify.

11.1.5 Digital Inputs: Potential free contacts, Normally Open,5A at 230V AC.

11.1.6 Digital outputs: Potential free Contacts rated 5A at 230V AC.

11.1.7 Analogue outputs: 4 to 20 mA corresponding to rated mA DC output , rated KVp.

11.1.8 Communication: RS-485 Modbus RTU, 2wire. User friendly operator interface with communication in message form and in engineering units.

11.1.9 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.

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

12 **Back corona**

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

13.0 **Grounding:**

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.

14.0 Measuring Instruments:

14.1.1 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 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.

14.1.2 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.

14.1.3 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 HVTR from Remote.

15.0 Component Identification and Labelling:

All the components of HVTR set shall be identified. Door mounted components shall be identified by fixing anodized Aluminium labels & for components mounted inside the panel / marshaling box shall be identified with Aluminium foil sticker or approved equivalent.

15.1.1 HVTR, ECP & Controller shall be dust and vermin proof with enclosure meeting IP55 &IP 43 degree of protection respectively. Neoprene gaskets / natural rubber shall be provided for all metal-to-metal joints. CFL light with door operated switches shall be provided. All hard wares such as bolts, nuts and be nickel / cadmium plated / zinc passivated.

16.0.0 Painting

16.1.0 **Painting for Transformer.**

The internal and external surfaces including fluids filled chambers and structural steel work of 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 epoxy paint of shade as per Enquiry / PO shall be provided. Minimum thickness of paint shall be 50 microns.

16.1.1 **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 of panel shall be per Enquiry / PO. Peelable 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.**

17.0.0 **Makes of Components:**

The makes of components are subject to BHEL review & Customer approval. Only the Make of components which are approved during drawing approval shall be used in the supply.

18.0.0 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 HVTR set.
e) Power and control scheme(Typical)
f) Bill of materials of Major components with make.

g) List of customers where similar/identical HVTR supplied, year of supply & commissioning, Quantity, country and application like Thermal power /cement etc, Customer feedback if any on the performance(typical)

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

19.1.1 General arrangement of HVTR, ECP & Marshaling box, inside major component layout, Wiring drawing, Bill of material, Power and control scheme, Rating and Diagram plate and technical particulars of High voltage transformer rectifier , Make of components.

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

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

20.1.1 Interconnection diagram between HVTR and EC panel, Controller, Marshaling box, and external equipment interface requirements / other panels.

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

20.1.3 Quality plan with customer check points.

20.1.4 Packing procedure and drawing.

20.1.5 Three sets of the above drawings shall be submitted to BHEL for approval, before taking up manufacture in hard copy and also in soft copy.

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

20.1.7 Packing details for HVTR,EC panel , controller , loose items if any.

21.0.0 O& M Manual:

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

21.1.1 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.

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

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

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

22.0.0 **Testing**:

The HVTR 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: 109: (latest revision).
(v) BHEL/Customer approved vendor drawings.

23.0.0 **Packing:**

23.1.0 The equipment shall be properly packed with sea worthy packing, as applicable 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.

23.1.1 Each HVTR unit, Electronic control panel and controller shall be packed separately. Loose Items related to each HVTR set shall be packed along with the HVTR/ECP for ease of identification.

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

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

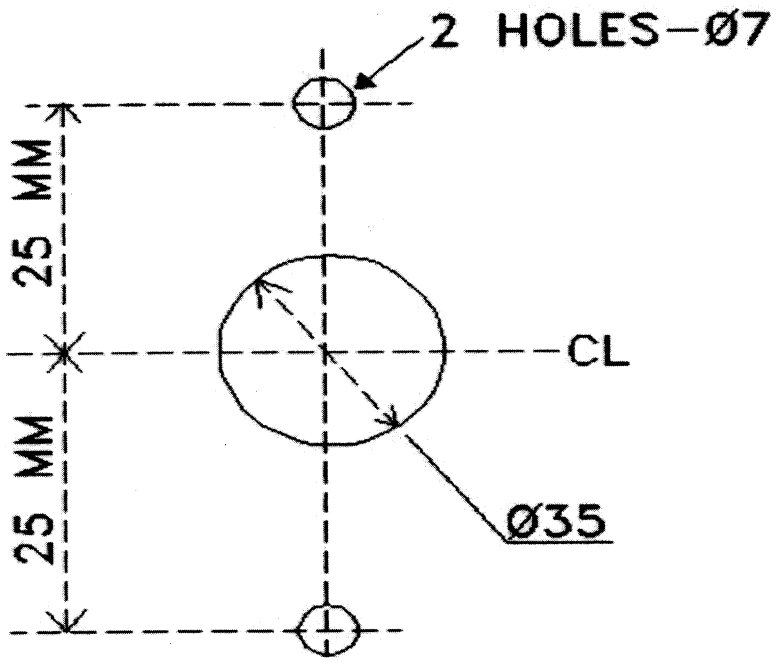
Sl. No	Requirement / Details	Requirement to be met by Bidder	Bidder detail	Remarks
01	Compliance to technical specification	Full compliance. Deviation if any to be brought out with justification.		
02	List of customers with details	To be attached		
03	Type, acceptance & routine test details	Typical for similar/identical rating & type		
04	Transport dimension & weight	To be furnished		
05	HT Negative bushing orientation	Horizontal, housed in duct		
06	Overall General arrangement	To be attached-Indicate dimension, clearance, weight		
07	Applicable standards for HVTR	Indian standards furnished in tech. spec. Vendor to confirm / indicate International standards as applicable		
08	Power and control scheme(Typical) & Major BOM	To be attached.		
09	Brief write up of equipment offered and it operation	To be attached		
10	HVTR wheel & Output requirement	Compliance preferable OR to be specified		
11	Transformer core	To be specified-CRGO & grade		
12	Transformer Tank material	Steel		
13	Protections provided	To be specified		
14	Major Make of components list	To be attached		
15	Measuring Instruments & Indications	To be furnished		
16	Make & Details of Controller	To be furnished		
17	Remote terminal unit details	To be furnished		
18	Communication	To be specified		
19	Transformer KV &mA signal level	To be furnished		
20	Details of painting & Process	To be furnished		
21	Typical O&M	To be attached		
22	Manufacturer Quality plan(Typical &proposed for the rating &type)	To be attached		
.23	List of Recommended spares	To be attached		

24	Details of Packing	Typical drawing/details to be attached		
25	Provision for mounting & terminating castell type Interlock at site for HVTR switch ON permissive	To be Ensured in the supplies		
26	Harmonic suppressor	To be provided, if required		
27	Electronic Control Panel Ingress protection	To be specified		
28	Maximum Power cable length applicable in meters, if panel kept away	To be specified for each type and rating		
29	Input power requirement KVA	To be furnished		
30	Heat loss- HVTR, ECP, Controller	To be furnished		
31	Supervision of erection	To be quoted separately-lump sum		
32	Commissioning	To be quoted separately-Lump sum		
33	List of special tools	To be furnished		
34	Soft were Package required if any, for commissioning	To be specified and included in the scope		
35	Inspection at vendor works	To be specified-Location and duration		

MAKE OF COMPONENTS

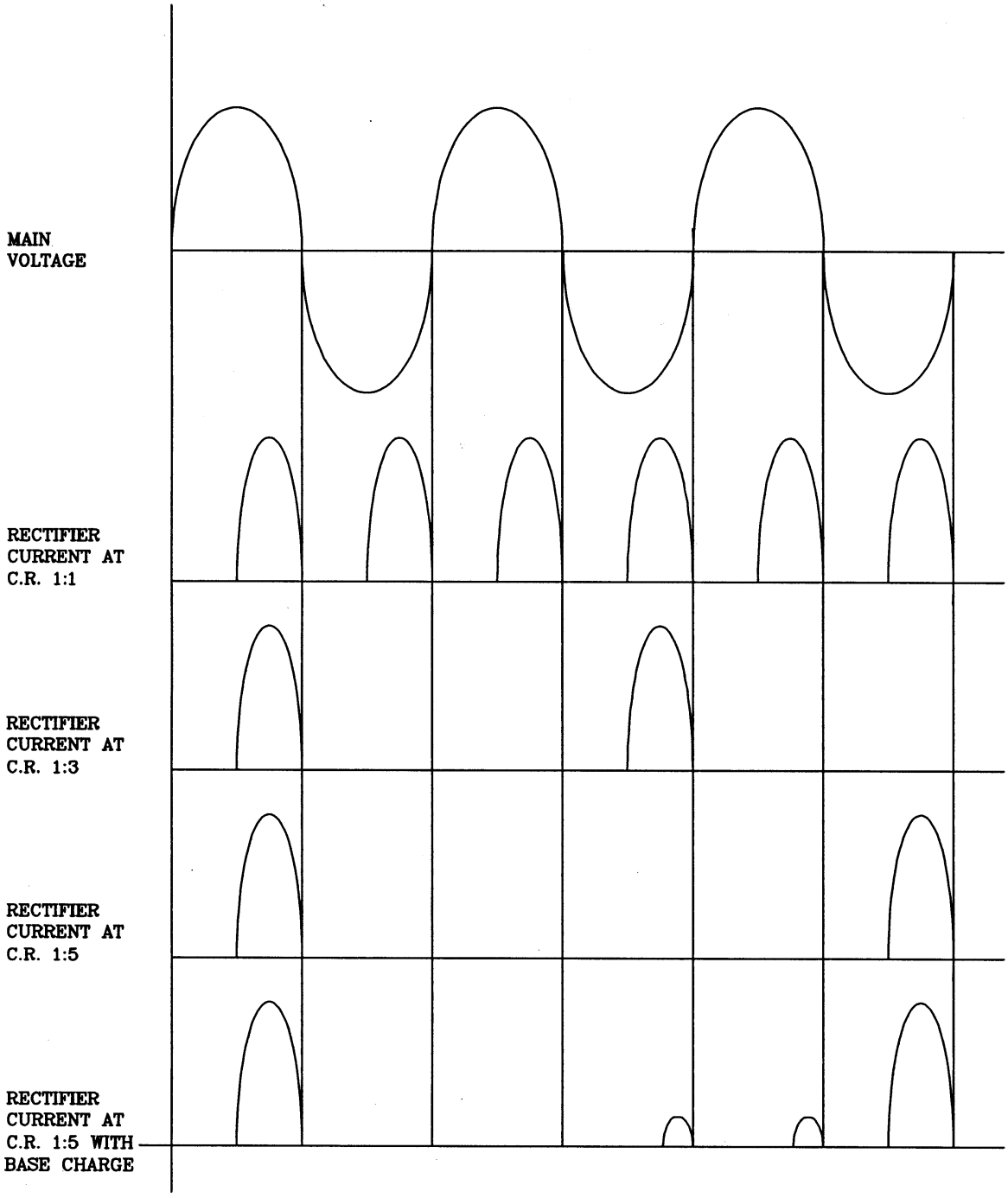
SI.NO	ITEM	MAKE
1	Fuse switch unit	L&T/SIEMENS/C&S/SCHENIDER/BCH/GE
2	Contactor	L&T/SIEMENS/C&S
3	THYRISTOR	RUTTONSHA/SEMICRON/ INFINECON (EUPEC) / ABB
4	L.T.HRC FUSE LINK	L&T/SIEMENS/C&S
5	THERMAL OVER LOAD RELAY	L&T/SIEMENS/C&S
6	CURRENT TRANSFORMER	G&M / AE/ MECO/KAPPA/IND COIL/PRAYAG/PRAGATI/AVK-SEG & CONTROLS(CONTROLS & SWITCHGEAR)/PRECISE/SOUTHERN ELECTRICAL/CANDS/G&M
7	Indicating instruments	RISHABH (L&T)/MECO
8	CLUSTER LED TYPE indicating lamp	L&T/SIEMENS/ TEKNIC/C&S/RAAS CONTROLS/BINAY/SCHENIDER/CANDS/BCH/ESSEN/VAISHNO/GE
9	AUXILIARY CONTACTOR	L&T/SIEMENS/ TEKNIC/C&S/CONTROLS & SWITCHGEAR(TC)/SCHENIDER/BCH/GE
10	MINIATURE CIRCUITBREAKER	L&T/SIEMENS/ C&S/HAGER
11	TIME TOTALISER	GIC/KAYCEE/TELEMECHANIQUE(SCHENIDER)/CONTROLS & SWGR(TC)/ L&T/SIEMENS/ALSTHOM(AREVA)/GE
12	SWITCH WITH 5 PIN SOCKET	VINAY/ANCHOR
13	PUSH BUTTON	L&T/SIEMENS/C&S/BCH/TEKNIC/CONTROLS / SWITCHGEAR(RAAS CONTROLS)/SCHENIDER/GE
14	SPACE HEATER , 100W	APT CONTROLS/VILECO/CANDS/PYROSYSTEM/CONTROLS & SWGR/SOPEHIA/CROMPTION GREAVES
15	THERMOSTAT	HONEST WELL/ASAVARI/TEMPTROL/SIEMENS/AI/RENUTROL/ANCO
16	AUDIO ALARM BUZZER OPERATING VOLTAGE 240V AC	RENAISSAINCE ELECT/INDU ELECT
17	METAL OXIDE VARISTORS	GUJARAT POLY /AVX
18	DOUBLECOMPRESSION CABLE GLANDS	COMET/JAINSON/CHETNA/COSMOS/ ATLAS
19	ATC LUG WITH FASTNERS	DOWEL/COMET/CHETNA/ 3 D BILLETS
20	LUG FOR CONTROLCABLE	DOWEL/COMET/CHETNA
21	MINIATURE CIRCUIT BREAKER	SIEMENS,C&S,L&T
22	GAS OLR-GOR	PRAYOG/ATVUS/YOGYA
23	LIMIT SWITCH	SIEMENS/BCH/L&T
24	LAMP	ANCHOR/VINAY/HAVELLS/PHILIPS

ANNEXURE - II



DRILLING DATA ON PANEL FRONT DOOR (FOR FIXING INTERLOCK)

ANNEXURE-I



CHARGE RATIO FOR EC HVR

C.R.J

C.R.J

TESTING PROCEDURE
AIR QUALITY CONTROL SYSTEMS
BHEL : RANIPET

TP:109:REV 04
PAGE No. 01 OF 06

TITLE : FUNCTIONAL TEST PROCEDURE FOR ELECTRONIC CONTROLLER HIGH VOLTAGE TRANSFORMER RECTIFIER

ITEM : EC - HVR

	NAME	DESIGNATION	SIGNATURE	DATE
PREPARED	P. MOHANKUMAR	MANAGER		28.06.2004
CHECKED	C.R. JAYACHANDRAN	SR.MANAGER		28.06.2004
APPROVED	S. JAYAPRAKASAM	DGM		28.06.2004

ISSED BY

EDC – AQCS

REVISION :00	INITIAL RELEASE	DT : 25.07.96
REVISION :01	Test details elaborated	Dt. : 04.06.99
REVISION :02	Clause 2.7.0 updated	Dt. : 13.06.03
REVISION :03	Clause 2.6.0 revised	Dt. : 31.10.03
REVISION :04	TP revised based on feedback	Dt. : 28.06.04

BHEL EDC / EC & I Ranipet-632 406.
1. Approved 2. Approved as Noted
3. Revise & Resubmit 4. For Information
Approval Category
1
Sign : 15/8/04
This approval does not relieve the vendor from his responsibility regarding the correctness of design features like dimensions, weight, quantities. Vendor also has to ensure conformity to applicable Indian Statutory Laws

1.0.0 INTRODUCTION

This testing procedure describes the procedure for functional testing of ELECTRONIC CONTROLLER (EC) and HIGH VOLTAGE TRANSFORMER RECTIFIER (HVR). For testing all HVR's one EC can be used. Similarly for testing of all ECs, one HVR can be used.

2.1.0 OPEN CIRCUIT TEST (HVR)

This test shall be conducted on the HVRs with VARIAC. A fuse of suitable rating, shall be connected in series with HVR input terminals for protection purpose. A 0-500V voltmeter shall be connected across the input terminals of the HVR. An ammeter of suitable range shall be connected in series with the input terminals of the HVR. Initially the voltage at the output of VARIAC (Which is input to HVR), shall be kept at zero and shall be increased to the rated voltage at primary winding of the TRANSFORMER. Observe for no primary current shoot up in the HVR (current to be measure with the ammeter), during this test. If the primary current shoots up suddenly / the fuse blows, the HVR is considered to be defective. It shall be noted that during this open circuit test, the secondary of HVR shall be kept in 'OPEN CONDITION'. The no load loss and current shall be recorded at 0%, -10% and +10% of the rated primary voltage.

2.2.0 HIGH VOLTAGE AND INSULATION RESISTANCE TEST

2.2.1 INSULATION RESISTANCE TEST: (For HVR)

Short the input terminals of the HVR together.
Short the output terminals of the HVR together.

Measure the IR of HVR at the following groups, using 2000V DC MEGGER. The following shall be the acceptable values.

Between input & earth	:	Minimum 50 Meg. Ohms
Between output & earth	:	Minimum 500 Meg. Ohms
Between input & output	:	Minimum 500 Meg. Ohms

2.2.2 HIGH VOLTAGE TEST: (For HVR)

With secondary (output) terminals of HVR kept shorted, apply 3KV (rms) for 1 minute between the input (both terminals shorted) and earth terminals of HVR. The HVR shall withstand the above test.

2.2.3 INDUCED OVER VOLTAGE TEST : (For HVR)

With secondary (output) terminals of HVR kept open, apply a power supply having two times the rated Transformer primary voltage at twice the rated frequency, for 1 minute, between primary terminals of HVR. The HVR shall withstand this test.

2.2.4 INSULATION RESISTANCE TEST : (For EC)

The input & output Power terminals shall be shorted together. The secondary terminals of all the transformers shall be shorted together. The connections to Electronic Circuits like hooter, Firing Card & BAPCON/ Equivalent controller shall be removed.

Measure the IR between the following groups with 500V DC Megger and ensure that all the groups withstand this test.

Between Power Terminal Group and earth : Minimum 5 Meg. ohms
Between Secondary Terminals of transformer and earth : Minimum 5 Meg. Ohms
Between Power Terminals and Secondary terminals of Transformer : Minimum 5 Meg. Ohms

2.2.5 HIGH VOLTAGE TEST : (For EC)

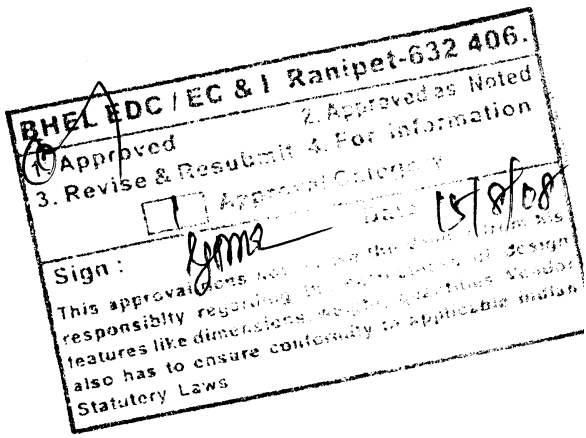
The input & output Power Terminals shall be shorted together. The secondary terminals of all the transformers shall be shorted together. The connections to electronic circuits like hooter, firing card & BAPCON / Equivalent controller shall be removed. Apply high voltage for 1 minute between the following groups and ensure that all the groups withstand this test.

Between Power Terminal Group and earth : 2 KV
Between Secondary Terminals of transformer and earth : 1.5KV
Between Power Terminals and secondary terminals of transformer : 1.5 KV

2.3.0 RESISTANCE AND CAPACITIVE LOAD TEST FROM 0 TO RATED LOAD

This test shall be conducted with HVR & EC fitted with BAPCON / Equivalent controller collected from BHEL / Ranipet. Ensure the following settings.

	PARAMETER DESCRIPTION		*SETTINGS AS SEEN IN DISPLAY*
0	Maximum Current	:	100%
1	Set Current	:	0%
2	Step Control	:	5%
3	T Control	:	20%
4	Stabilisation Time	:	30%
5	Under Voltage	:	10%
6	Charge Ratio	:	1
7	Pulse Current Limit	:	200%
8	Repetition Time	:	20%
9	Address	:	1
P	Base Charge	:	0%



Connect rated Resistive and rated Capacitive load to HVR (the rated

$$\text{Resistive load in M}\Omega = \frac{\text{RATED KV (AVERAGE)}}{\text{RATED mA (AVERAGE)}}$$

, The rated capacitance load in pf = K x rated average mA. (The value of K is between 100 to 200).

The value of the resistance and capacitance shall be recorded. The EC &HVR shall be tested with R separately and R+C load connected in parallel separately. The test shall be carried out at the Set currents 0%, 10%,25%,50%,75% &100% . In all cases, record the Primary voltage, Primary current, Secondary voltage & Secondary current.

2.4.0 TIME OVER RIDE TEST:

With the above set up, switch off power supply to EC. Connect 100% of Resistive load & 100% of Capacitance load at the Secondary of HVR. Keep the set current at 100 %. Apply 415 V at the input terminals of EC. Switch ON power supply to EC. Then press HT ON / OFF key provided in the BAPCON/ Equivalent controller Observe that, the secondary current increases initially at a faster rate for 5 seconds (approximate) and then the secondary current increases at a slower rate until the secondary current reaches the set current. During this test, there shall be no Tripping or Alarm occurs.

2.5.0 CURRENT REGULATION TEST

2.5.1 LINE REGULATION TEST

Switch off power to EC. Apply 373V at the EC input terminals. With the above set up and at 100% Set current, switch HT ON/OFF key to switch on power to HVR. Record the secondary DC current when it reaches the steady value. This value should not deviate from the value, when the input voltage was 415V< BY more than 5%.

Switch off EC and apply 457V at the EC input terminals. Now switch HT ON/OFF key to switch on power to HVR. Record the secondary DC current when it reaches steady value. This value should not deviate from the rated value, by more than 5%.

2.5.2 LOAD REGUALTION TEST

With the above set up, switch off supply to EC. Connect 10% of rated resistive load and rated capacitance at the secondary of HVR . Apply 415V at the input terminals of EC. Switch on power to EC and set the Set current at 100%. Then press HT ON/OFF key in BAPCON / Equivalent controller. When the secondary DC current reaches the steady value, record the same. It should not deviate by more than 5% from the rated secondary current.

2.6.0 SEMI USE OPERATION AT DIFFERENT CHARGE RATIO

Switch off power to EC. Connect 100% of rated resistive load and rated capacitive load. With above set up, apply 415V to EC and switch on power to EC. Press HT ON/OFF in

BAPCON to switch on power to HVR. Change the charge ratio to 3, 31 & 159 and observe, in each charge ratio, for any trip or primary current shoot up. During the charge ratio mode from 3 to 159, if no trip occurs or no primary current shoots up, the HVR is considered to be withstood this test. Now make the charge ratio as 1.

2.7.0 S&T CONTROL TEST

Switch off power to EC. Connect spark gap across R+C load. Switch on power to EC. Change parameter 2 step control in BAPCON / Equivalent controller as 25% (approximate) and parameter 3 T control as 10% (approximate) by tuning corresponding potentiometer in the BAPCON / Equivalent controller. Press HT ON/OFF key in BAPCON / Equivalent controller to energize HVR. Spark will appear on load side of HVR as current rises. After each spark note that the secondary DC current drops by 25% (approximate) of maximum current before spark. Note the time between two consecutive sparks. It should be 15 seconds (approximate)

2.8.0 SPARK TEST

With the above set up, set parameter 2 step control and parameter 3 T control so that approximately 160 to 180 sparks per minute will appear on the load side of HVR. Continue this test for 3 minutes and ensure that the HVR withstand this test without any trip or primary current shoot up.

2.9.0 SPARK SIMULATION TEST

With the above set up change settings of parameter 2 S control at 5% and parameter 3 T control at 20%. Keep the DC secondary current at 25%, 50%, 75% and 100% each for 2 minutes, by tuning Is potentiometer and observe that no trip occurs.

2.10.0 FAULT ANNUNCIATION TEST ON HVR

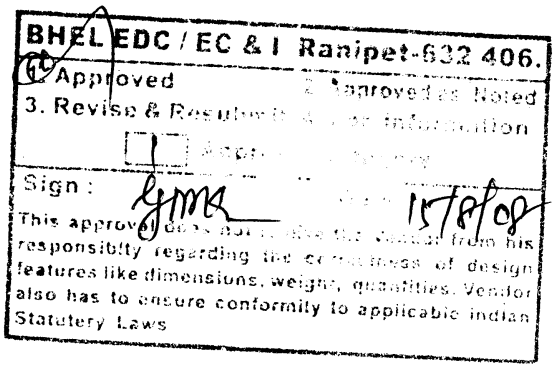
For the following components individual test records shall be verified. After assembling with HVR, wiring continuity shall be checked.

i) BUCHOLZ RELAY
ii) OIL TEMPERATURE INDICATOR
iii) MAGNETIC OIL LEVEL GAUGE

2.11.0 FAULT ANNUNCIATION TEST ON EC

Simulate the following faults by shorting the respective terminals in the EC and check for alarm / trip as the case may be

i) Bucholz top float	Alarm
ii) TR temperature high	Alarm
iii) Bucholz bottom float	Trip
iv) TR temperature very high	Trip



v) Primary current very high	Trip
vi) Safety line broken	Trip
vii) TR oil level low	Trip
viii) Ash level high	Alarm & Trip

2.12.0 RESISTIVE LOAD TEST FROM 0 TO RATED LOAD

Switch off power to EC & HVR. Disconnect the capacitive load and spark gap. Keep only the resistive load at the secondary of HVR. Set the Is Potentiometer at 100%.

Switch on power to EC. Press HT ON/OFF key in BAPCON / Equivalent controller to switch on power to HVR. Observe that the secondary DC current raises slowly and record the secondary current when it reaches steady value. This value should not deviate from the rated current by more 2%. Turn Is potentiometer fully counter clockwise. Now record the secondary DC current. This value should not be more than 5% of rated DC current.

3.0.0 QUANTUM OF TESTS

Test following are the quantum of tests to be conducted on EC & HVRs.

SL. NO.	*TEST DESCRIPTION*	*EC*	*HVR*
01	OPEN CIRCUIT TEST	-	100%
02	IR & HV TEST	100%	100%
03	RESISTIVE & CAPACITIVE LOAD TEST	100%	100%
04	T/O TEST	5%	5%
05	CURRENT REGULATION TEST	1/Lot	1/Lot
06	SEMI PULSE OPERATION FOR DIFF. CHARGE RATIOS	5%	100%
07	S&T CONTROL TEST	1/L0t	1/Lot
08	SPARK TEST	1/Lot	1/Lot
09	SPARK SIMULATION TEST	1/Lot	1/Lot
10	FAULT ANNUNCIATION TEST	100%	100%
11	RESISTIVE LOAD TEST FROM 0 TO RATED LOAD	1/Lot	1/Lot