



**BHARAT HEAVY ELECTRICALS LIMITED**  
**TRANSMISSION BUSINESS ENGINEERING MANAGEMENT**  
**NOIDA**

|   |  |          |              |              |               |          |
|---|--|----------|--------------|--------------|---------------|----------|
| BHEL DOCUMENT No.                                   | TB-374-510-033   | Rev.     | 00           | Prepared     | Checked       | Approved |
| Customer Doc. No.                                   |  | NAME     | BA           | VK           | RS            |          |
| TYPE OF DOC.  | TECHNICAL SPECIFICATION  | SIGN     | <i>Brady</i> | <i>Brady</i> | <i>Rakesh</i> |          |
| TITLE<br>POWER LINE CARRIER COMMUNICATION<br>(PLCC) | DATE   | 13.05.14 | 13.05.14     | 13.05.14     |               |          |
|   | GROUP  | TBEM     |              |              |               |          |
|   | W.O. No  | 83009    |              |              |               |          |
| CUSTOMER  | Bihar State Power Generation Company Ltd.                          |          |              |              |               |          |
| PROJECT   | 2 * 250 MW BARAUNI THERMAL POWER STATION EXTENSION<br>UNIT # 8 & 9 |          |              |              |               |          |

CONTENTS

| Section No. | Description   | No. of Pages |
|-------------|---|--------------|
| SECTION-1   | Bill of Material: As per Annexure-1   | 01           |
| SECTION-2   | SCOPE, SPECIFIC TECHNICAL REQUIREMENTS<br>As per standard spec TB-235-510-034 | 40           |
| SECTION-3   | PROJECT DETAILS AND GENERAL SPECIFICATION                                     | 24           |

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|--------------|------|---------|---------|----------|------------------|------|------|
| Rev No.      | Date | Altered | Checked | Approved | REVISION DETAILS |      |      |
| Distribution |      |         |         | To       | TBPM             | TBMM | TBQM |
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**2 X250 MW Barauni Thermal Power Station (Extension Project)**

**ANNEXURE 1 of PLCC PI  
Bill of Material (Rev.00)**

| S.No.    | Description   | Barauni S/S | Remote S/S | Total      |
|----------|---|-------------|------------|------------|
| <b>A</b> | <b>Main Item</b>  |             |            |            |
| 1        | Coupling Device (ph-ph)   | 4 Sets      | 4 Sets     | 8 Sets     |
| 2        | Coupling Device (ph-E)  | 1 Set       | 1 Set      | 2 Sets     |
| 3        | Twin Channel Carrier Equipment<br>(Speech+ Protection and Speech + data ) | 10 Nos.     | 10 Nos.    | 20 Nos.    |
| 4        | Protection Coupler  | 10 Nos.     | 10 Nos.    | 20 Nos.    |
| 5        | VFT Modem   | 3 Nos.      | 3 Nos.     | 6 Nos.     |
| 6        | EPAX (24/8)   | 2 Nos.      | 2 Nos.     | 4 Nos.     |
| 7        | 2 Wire telephone sets   | 15 Nos.     | 15 Nos.    | 30 Nos.    |
| 8        | 4 Wire telephone sets   | 15 Nos.     | 15 Nos.    | 30 Nos.    |
| 9        | H.F. Cable  | 1000 meter  | 3000 meter | 4000 meter |
| 10       | 5-Pair armored Telephone cable  | 1000 meter  | 3000 meter | 4000 meter |
| 11       | Single pair unarmored telephone cable                                     | 500 meter   | 500 meter  | 1000 meter |
| <b>B</b> | <b>Services</b>   |             |            |            |
| 1        | System Engineering  | 1 Lot       |            |            |
| 2        | Supervision of commissioning & site testing                               |             |            |            |
| a        | Supervision of Installation and Pre<br>commissioning (Panel wise)         | 20 Nos.     |            |            |
| b        | Commissioning & Testing (Link wise)                                       | 5 Nos.      |            |            |

**Note:**

1. *The above quantities are tentative and subject to a change of  $\pm 50\%$  before placement of order.*
2. *Some of the items may not be ordered by BHEL during contract stage.*
3. *EPAX for PLCC system shall be suitable for 24 Subscribers and 8 Trunk lines.*
4. *230kV Coupling Devices are Ph-Ph type whereas 132kV Coupling devices are Ph-E type.*
5. *HF coaxial cable is 75 Ohms Un-balanced and is to be supplied in drum lengths of 1000m  $\pm 5\%$ .*
6. *There may be a quantity variation of up to -10% to +30% in the Bill of Quantity of Cables.*



**BHARAT HEAVY ELECTRICALS LIMITED**  
**TRANSMISSION PROJECTS ENGINEERING MANAGEMENT**  
**NEW DELHI**

|                               |   |        |      |         |      |
|-------------------------------|---|--------|------|---------|------|
| DOCUMENT No.                  | <b>TB-235-510-034</b>                   | Rev 00 | Prep | Checked | Appd |
| TYPE OF DOC.                  | <b>TECHNICAL DOCUMENT</b>               | NAME   | SKS  | GC      | DD   |
| TITLE                         | <b>POWER LINE CARRIER COMMUNICATION</b> | SIGN   |      |         |      |
|                               |   | DATE   |      |         |      |
|                               |   | GROUP  | TBEM | TBEM    | TBEM |
| <b>STANDARD SPECIFICATION</b> |   |        |      |         |      |

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**Contents:**

| <b>SI No.</b> | <b>Description</b>                            | <b>No. Sheet</b> |
|---------------|---|------------------|
| 1             | Technical Specification                       | 21               |
| 2             | Annexure-A (NO DEVIATION Certificate)         | 1                |
| 3             | Annexure-B (Guaranteed Technical Particulars) | 15               |
| 4             | Annexure-C (Blank Format for MQP)             | 1                |
| 5             | Annexure-D (CHECKLIST)                        | 1                |

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## 1.0 SCOPE

1.1 This technical specification covers the requirements of design, manufacture, testing at works, packing and dispatch of PLCC equipment. No deviation from the requirements specified in various clauses of this specification shall be allowed. A certificate to this effect shall have to be furnished alongwith the offer as per attached Annexure-A. In case this annexure is not submitted, it will be presumed that the equipment/ material to be supplied under this contract shall be in compliance with the specification requirements.

## 1.2 SPECIFIC TECHNICAL REQUIREMENTS

|   |  |
|---|--|
| Mode of transmission  | Amplitude modulation Single side band with suppressed carrier or reduced carrier |
| Carrier frequency   | 40 to 500kHz range   |
| Nominal carrier frequency band<br>In either direction of transmission | 4.0kHz   |
| Power output  | 20/ 40W  |
| Supply voltage  | 48V DC +15%, -10%  |

## 1.3 EQUIPMENT DESCRIPTION

| Type No. | EQUIPMENTS  |
|----------|---|
| PLC-1    | Ph to Ph Coupling device                          |
| PLC-2    | Ph to Earth Coupling device                       |
| PLC-3a   | 75 ohms Unbalanced High Frequency Co-axial Cable  |
| PLC-3b   | 125 ohms Unbalanced High Frequency Co-axial Cable |
| PLC-4a   | Single Channel PLC Terminal- 20W                  |
| PLC-4b   | Double Channel PLC Terminal- 20W                  |
| PLC-4c   | Single Channel PLC Terminal- 40W                  |
| PLC-4d   | Double Channel PLC Terminal- 40W                  |
| PLC-5a   | Protection Coupler suitable for 2 commands        |
| PLC-5b   | Protection Coupler suitable for 4 commands        |
| PLC-6    | VFT Equipment                                     |
| PLC-7a   | EPAX (24/8)                                       |
| PLC-7b   | EPAX (48/8)                                       |
| PLC-7c   | EPAX (4/4)  |
| PLC-8a   | 4 wire telephone sets with connecting cables      |

|        |   |
|--------|---|
| PLC-8b | 2 wire telephone sets with connecting cables  |
| PLC-9  | Selective Level Meter including impedance & return loss measuring attachments compatible with level generator |
| PLC-10 | Level Generator including facility for synchronisation with SLM   |
| PLC-11 | 4 1/2 digit time interval meter & 8 digit Frequency counter   |
| PLC-12 | Dual trace Oscilloscope.  |
| PLC-13 | 4 1/2 digit Digital Multimeter.   |
| PLC-14 | Print Test Kit (as per clause 1.14)   |
| PLC-15 | Set of prints for carrier equipments  |
| PLC-16 | Set of prints for protection coupler  |
| PLC-17 | Set of prints for EPAX (24/8)   |
| PLC-18 | Set of prints for EPAX (48/8)   |
| PLC-19 | Set of prints for EPAX (4/4)  |
| PLC-20 | Co-axial connector  |

#### **1.4 SUPERVISION OF COMMISSIONING & SITE TESTING**

Supervision of commissioning & site testing of PLCC is in the scope of bidder.

#### **1.5 STANDARD**

All the PLCC equipment covered under the package shall conform to the requirements of the latest edition of the relevant IEC/IS Specifications or equivalent National Standards.

The IEC/IS Specifications and international publication relevant to the equipment covered under this specification shall include but not be limited to the list given below:

- IS-8997 - Coupling devices for PLC System
- IS-8998- Methods of test for coupling devices for PLC System
- IEC-481 - Coupling devices for power line carrier systems
- IEC-495- Single sideboard power line carrier terminal
- IEC-683- Planning of (single Side- band) power line carrier systems.
- CIGRE- Teleprotection report by committee 34 & 35
- CIGRE- Guide on power line carrier 1979.
- CCIR - International Radio Consultative Committee
- CCITT - International Telegraph & Telephone Consultative Committee
- EIA- Electric Industries Association

## **1.6 FREQUENCY PLANNING**

- 1.6.1 Frequency planning / computer study is in the scope of bidder. Frequency data for frequency planning may be made available by BHEL / Ultimate customer . In case, any additional data are required, the same shall be directly collected by bidder for which necessary assistance will be given by BHEL / Ultimate customer.
- 1.6.2 For planning frequency and output power of carrier terminals Bidders may plan for a minimum receive signal to noise ratio of 25 dB for the speech channels without companders. The noise power in 2.1 kHz band (300-2400 Hz) may be taken as - 13 dB referred to the coupling point of the H.T. line. An additional minus two and a half dB may be assumed for prophometric factor. As far as coupling loss (phase to phase) is concerned the Bidders may assume the same as 6dB at one coupling end for evaluating SNR. For protection channels the minimum SNR shall not be less than 15 dB under adverse weather. A safety margin of 9 dB shall be taken over and above these SNR values in order to cater for variations in line attenuation from the computed value as in hand reserve. Frequency and output power of PLCC terminals for protection shall be planned such that the protection signal is received with full reliability even when one of the phase is earthed or is on open circuit on the line side causing an additional minimum loss of 6 dB.

The Bidder shall indicate the noise power in the bandwidth used for protection signaling and shall submit the SNR calculations for speech as well as protection channels on all the line section given in at the proposed frequencies. Sample calculations for SNR requirement and power allocation over different channels must be furnished alongwith the bid. Maximum permissible line attenuation shall be clearly brought out in these calculations. Further, Bidder shall submit details of frequency planning done (including computer studies carried out and facilities available) for PLCC links on EHV lines in the past in the relevant schedule of DRS. Bidder must enclose one copy of computer study result done in the past along with the Bid.

- 1.6.3 Successful Bidder shall be fully responsible for the coordination required with concerned State Electricity Boards for finalising the frequency plan.
- 1.6.4 The frequency plan will be referred to wireless Adviser/DOP Department for clearance and in case any change in the bidder's recommended carrier frequency and power output is proposed by these authorities, the bidder shall have to modify his proposal accordingly. Change of power output shall, however, not involve repeater stations.

## **1.7 PROPOSED ARRANGEMENT**

- 1.7.1 The power line carrier communication equipment required by the OWNER is to provide primarily efficient, secure and reliable information link for carrier

aided distance protection and direct tripping of remote-end breaker and also for speech communication between 400/220 kV sub-stations. It shall include separate carrier terminals of multipurpose type for speech and protection purposes. All carrier/ terminals including those for protection shall be suitable for point-to-point speech communication also.

- 1.7.2 For security reasons each 400/220kV transmission line shall be protected by Main-I and Main-II protections as given below:

Main-I Numerical Distance protection with permissive inter-tripping.

Main-II Distance protection of a different measuring technique than that of relay under Main I.

132kV transmission lines shall have Main I protection same as above alongwith backup overcurrent and earth fault protections.

- 1.7.3 The requirement of carrier information on each link covered under this specification is as below:

a) One protection channel for Main-I and another for Main-II distance protection schemes. In case of 220 KV/132KV lines speech and data channel can also be used for protection wherever possible.

b) One speech channel with a facility to superimpose telex and data signals.

c) One main and one back-up protection channel for direct circuit breaker inter-tripping for 400kV lines.

- 1.7.4 The equipment for protection signals shall have high degree of reliability and speed. It shall be guaranteed to function reliably in the presence of noise impulse caused by isolator or breaker operation. The equipment shall be suitable for direct tripping of remote end breaker for fault in unswitched 400 kV Shunt Reactor & Operation of Buchholz relays of reactor etc. It shall also be possible to effect direct tripping of breaker at one end when the other end breaker opens out either manually or by relays such as Bus fault relay etc.

- 1.7.5 The time intervals between receipt of a trip command on the transmit side, its transmission over the carrier link, reception at the far end and giving command to the trip relays at the distant end shall not exceed 20 msec. for permissive intertripping and 30 m sec. for direct inter-tripping even for the longest line section. The above timings are inclusive of operating time for auxiliary relays and interposing relays, if any, included in the PLCC equipment.

- 1.7.6 The requirement of protection signaling channel is such that security against incorrect signals being received shall be at least two to three orders higher than reliability against a signal not being received.
- 1.7.7 For reasons of security and reliability, phase to phase coupling for 400 kV S/C, D/C & 220kV S/C lines shall be used. Inter-circuit coupling shall be used for 220/132kV D/C lines and phase to ground coupling shall be used for 132 KV S/C lines. Double differential coupling shall also be considered for double circuit lines. Bidders must furnish detailed write-up on methods of coupling and recommend suitable coupling mode for double-circuit lines along-with the bids. Coupling mode shall however, be fully confirmed by Contractor after conducting detailed computer study taking into account the transpositions of 400 kV lines for optimum coupling mode over these line sections. The coupling arrangement shall be fully optimised by the Contractor after conducting detailed study of every line section individually, taking into account the temperature variations, transpositions, earth resistivity, conductor configuration, carrier channels requirements, security and reliability criteria and other relevant details. The line attenuation shall be calculated for complete range of frequencies. The earth resistivity data, existing frequency networks and other relevant details of each line will be furnished to the Contractor for carrying out the computer studies and frequency planning. The Contractor shall complete the computer studies wherever required and submit the frequency plan and optimum coupling details within a period of one month from the date of receipt of above data.
- 1.7.8 The 400 kV transmission lines may be transposed.
- The transmission tower configuration and conductor details shall be forwarded after the award to enable the contractor to make his own computer study assessment of the carrier path based on wave propagation over transposed lines with each transposition point acting as "Model Converter".
- 1.7.9 The parameters of the equipment quoted shall be such that the mode of wave propagation on 400 kV power line (with transpositions indicated) shall not impose any limitation on the efficient and reliable performance of information link from protection or communication point of view.
- 1.7.10 The bidder shall have to check and prove through the results of his computer studies that attenuation due to transpositions in the EHV lines is within limits and the offered equipment will perform satisfactorily.
- 1.7.11 The Bidder shall submit curves illustrating 'incorrect tripping' and "Failure to trip" probability plotted against corona noise level, in the presence of impulse noise due to switching of isolator and circuit breaker etc. Details of field tests and laboratory tests for successful operation of his equipment, under such adverse conditions shall be furnished by the Bidder. These are to be related to end-to-end signaling and shall take into account the type of communication

link e.g. account shall be taken of transpositions in the phase-to-phase coupled H.T. line. Details of field tests and laboratory tests for successful operation of the equipment under the above circumstances shall be submitted by the Bidder illustrating the above parameters.

## **1.8 Power Line Carrier Terminal**

1.8.1 As already indicated the information link shall be provided for speech protection telex and data services.

1.8.2 PLCC terminal shall use Amplitude Modulation and shall have single side band transmission mode. These shall be equipped for fixed frequency duplex working.

Characteristic input and output parameters of the SSB PLCC terminals shall be as per IEC-495, unless otherwise specified.

1.8.3 The salient features are detailed out below:

- |    |  |   |
|----|--|---|
| a) | Mode of transmission   | Amplitude Modulation single side band with suppressed carrier or reduced carrier.   |
| b) | Carrier frequency  | 40 to 500 kHz range.  |
| c) | Nominal carrier frequency band in either direction of transmission | 4.0 kHz   |
| d) | Power output (PEP) at HF terminal                                  | 20/40 Watt  |
| e) | Frequency difference between a pair of PLCC terminals              | Frequency difference between VF signal at the transmitting and receiving ends will not exceed 2 Hz with suppressed carrier. With reduced carrier frequency difference shall be zero. This shall include permissible ambient temperature variation and supply frequency and voltage variation of (+) 15% and (-) 10% |
| f) | Automatic gain   | For 40 dB change in carrier frequency signal control level within the regulation range, change in VF receive levels of both speech and other signals shall be less than 1 dB.   |

g) Supply voltage 48 V DC + 15%, - 10% (Positive pole earthed)

1.8.4 All the PLCC terminals shall be of multipurpose type. The Bidder shall confirm that the total transmission time for teleprotection shall not exceed 20 ms for permissive and 30 ms for direct tripping signals. Speech and teleprotection channels shall independently fulfill the SNR requirements out of the power allocated to its channel from the total power of the PLCC terminals.

Detailed calculation for SNR requirement and power allocation over different channels should be furnished along with the bid.

1.8.5 In the input circuit of the PLCC terminal protective devices shall be provided in the form of zener diodes or surge suppressers in order to eliminate any surge transfer through the coupling device or the surge induced in the connecting path of H.F. cable.

1.8.6 To improve voice transmission characteristics for the system, compressors and expanders shall be provided. The compressors shall have at least 2.1 compression ratio with a corresponding expansion ratio of 1:2. The operating range of compressor shall be compatible with the audio power levels specified for 4-wire operation. The improvement gained by compressors shall however not be taken into account for power allocation and shall be in-hand reserve.

1.8.7 Sudden changes in input level to the receiver shall not cause false tripping. The Bidder shall clearly indicate in his offer the methods adopted to ensure above phenomenon. The receiver design shall also provide protection against false tripping from random noise.

1.8.8 Fail-safe devices shall be provided, so that a malfunction in one unit or subassembly cannot cause damage elsewhere in the system. All plug-in equipment shall be fitted with features to prevent improper insertion. The electrical cables shall not be routed across sharp edges or near sources of high temperature. The adjustments, which are susceptible to misadjustment from accidental contact/vibration, shall be equipped with suitable locking devices.

1.8.9 The PLCC set shall be designed to give guaranteed performance from 0 deg. C to 50 deg. C ambient temperature. The thermal capability of the equipment shall be so designed that the equipment remains operational successfully upto 60 deg. C ambient temperature. Any ventilation fans provided for circulation of air inside the cabinets shall conform to relevant Indian Standards.

1.8.10 The terminals shall be provided with built-in indicating instrument to facilitate checking of important voltages and current values and signal levels in different parts of the PLCC Terminals. Protection fuses shall be provided in

all important circuits and fuses shall be so mounted as allow their easy inspection and replacement. All test points shall be easily accessible.

The carrier set shall be provided with suitable supervision and alarm facilities. Individual parts of the carrier set should be accessible from front, making it possible to place the carrier cabinets side-by-side. All components and parts of the carrier set shall be suitably tropicalised.

- 1.8.11 PLCC terminals shall be housed in floor mounting sheet metal cabinets, suitable for mounting on concrete plinth as well as channel frame by means of nuts and bolts. The cables shall be properly cleaned and spray-painted with two pant. Exterior of the cabinets shall be painted with glossy finish. Interior of the cabinets shall be painted with white enamel paint with glossy finish. All the panels shall be properly earthed to the OWNER's earthing grid by the Contractor. Contractor shall submit detailed drawings for earthing connections.
- 1.8.12 All the panels shall be protected against moisture ingress and corrosion during storage. Panels shall be properly dried before they are installed and energized. Bidder shall indicate measures adopted to prevent ingress of moisture during operation.
- 1.8.13 All cabinets having PLCC terminals shall be provided with lamps of sufficient wattage for interior illumination with switch. Each panel shall be provided with 240 V AC single-phase socket with switch to accept 5 & 15A standard Indian plugs.
- 1.8.14 A nameplate shall be provided on the front door of each cabinet indicating channel function, transmitter frequency and direction etc.

## **1.9 Speech Communication**

PLC equipment offered shall provide telephone communication between the stations where the transmission lines are terminating. The equipment shall be suitable for providing the following facilities :

- a) It shall be possible for subscriber at any of the stations to contact the stations to contact the subscriber at all other stations connected in the system as shown in the specification drawing by dialing his call number. To achieve this an EPAX with 4 wire interface & remote subscriber units shall be provided/ available at different stations.
- b) The equipment shall contain all normal facilities like ring back tone, dial tone, engage tone & priority tone, and suitable pulses to establish and disconnect communication between subscribers.
- c) The equipment shall be provided with necessary alarm circuits and fuses etc.

d) The equipment shall be of 4 kHz bandwidth on either direction and be suitable for providing superimposed data and teleprinter facilities at a later date without major modifications and high cost. The bidder shall clearly indicate in his bid the provision made in his proposal for future development and the extent to which such additional facilities can be added at a later date.

e) The system shall be completely automatic with definite number allocated for each telephone. The numbering scheme for telephones, exchange and tie lines shall be developed by the bidder and indicated in the bid. Final numbering scheme shall be fully coordinated with existing / proposed future systems by the bidder.

f) Arrangement for over-riding facilities shall be provided by means of priority keys wherever specified. The over-riding facility shall enable cutting -in ongoing calls with the priority key and ask the concerned parties to finish their conversation. The wanted number should then get automatically connected without having to redial the number.

g) All the carrier telephone conversations shall be secret and it should not be possible for anybody to over hear the conversation going on between any two parties excepting those provided with over-riding facilities.

h) The necessary cables for connecting all the telephones instruments ordered for at each sub-station (including wiring and termination) shall be provided by the bidder. These telephone instruments shall be located within control room building at respective sub-station.

i) The cabinets housing the equipment for EPAX, four wire E/M remote subscriber units (four wire) shall have mounting similar to that for PLCC terminals.

j) All the terminals for speech shall be supplied fully wired for addition of VFs and transit filters in future.

k) Equipment for speech communication must be fully compatible with OWNER's existing equipment. Any interfaces required for proper matching and connection with the OWNER's existing equipment shall be provided by the bidder.

l) Terminals for protection shall be suitable for speech between two ends of each transmission line or on tandem operation basis with back-to-back connection at the intermediate stations.

n) Each PLCC terminal for speech as well as protection purposes shall be provided with a plug-in type service telephone and buzzer. Further, 4 wire remote telephone instruments (parallel to service telephone) shall also be

provided on one PLCC terminal for protection for each link. These instruments shall be located in respective Switchyard control room to enable the operator .

### **1.10 Network Protection Equipment (Protection Coupler)**

- 1.10.1 The Bidder shall offer voice frequency transmission equipment, which shall work on frequency shift or coded signal principle for transmission/reception of protection signals as single purpose channel. The equipment shall be suitable for connection to the power line carrier terminal.
- 1.10.2 The voice frequency transmission equipment shall not only be insensitive to corona noise but shall also remain unaffected by impulse type noise which are generated by electrical discharge and by the opening and closing of circuit breakers, isolators, earthing switches etc. The equipment shall also be made immune to a field strength of 10.V/m expected to be caused by portable radio transmitters in the range of 20-1000 MHz. In his offer, bidder shall clearly explain as to what measures have been taken to make the equipment insensitive to corona noise, white noise and to impulse noise of an amplitude larger than the wanted signal and submit full field test and laboratory test reports. The guarantee on design data shall not be acceptable.
- 1.10.3 The equipment shall be unaffected by spurious tripping signals. The Bidder shall submit proof as to how this is achieved satisfactorily.
- 1.10.4 The equipment shall be suitable for transmission of direct and permissive trip signal as well as blocking signals for protective gear of power system. The equipment shall be operated in the audio frequency range in speech band or above speech band as superimposed channel in 4 kHz band of SSB carrier. The equipment shall operate with full duplex frequency shift mode of operation. The protection signaling equipment shall be of solid-state design, modular in construction and have a proven operating record in similar application over EHV systems. Details regarding application of the equipment over 400kV/220kV systems shall be submitted along with the bid. Each protection signaling equipment shall provide:
- i) Transmission facilities for minimum two protection signals.
  - ii) Reception facilities for minimum two protection signals.
- 1.10.5 The equipment shall be designed for remote tripping/ blocking on permissive basis and direct tripping for reactor fault and others. The overall time of PLCC, VFT an transmission path for permissive trip/blocking shall be 20m. Sec. or less and for direct tripping 30m. Sec. or less even for the longest line section.

Operating time lower than specified above may be preferred provided they fulfill the requirements of security and reliability as mentioned below

False - trip probability 10-5  
(Noise burst of any-amplitude)

Fail to trip probability 10-2  
for S/N 6 dB IN 3.1 kHz Band  
(White Noise Measurement)

1.10.6 It may be emphasized that specified time, as mentioned above is composed of the following:

- a) Back-to-back signal delay in frequency shift or coded signals protection equipment.
- a) Back-to-back delay in PLCC terminal.
- b) Delay in transmission line.
- c) Operation time of interposing relay, if any, in frequency shift or coding equipment.

Reference is invited in this regard to the guidelines expressed in CIGRE Publication "Teleprotection" report by Committee 34 and 35.

1.10.7 The following transfer criteria shall be provided by the equipment:

- a) Transmit side

One number potential free NO (normally open) contact of protective relays (To be supplied by the OWNER) of under noted rating for each of the following functions:

- i) Permissive trip command
  - ii) Direct trip command
- Contact Rating:
- |                        |   |           |
|------------------------|---|-----------|
| Maximum voltage        | : | 660 Volts |
| Maximum current rating | : | 5 amps    |
| Maximum power rating   | : | 1250 W/VA |

- b) Receive Side

Voice frequency transmission equipment for network protection shall be provided with one potential free NO (normally open) contact of the under noted rating for each of the following functions:

- i) Permissive trip command
  - ii) Direct trip command
- Contact Rating:
- |                  |   |                     |
|------------------|---|---------------------|
| Rated voltage    | : | 250 Volts DC        |
| Rated current    | : | 0.1 ADC             |
| Other Parameters | : | As per IEC-255-0-20 |

- c) Alarm

In addition, the voice frequency protection terminal shall provide at least one number potential free change over contact of the following rating for alarm purposes.

|                  |   |                     |
|------------------|---|---------------------|
| Rated voltage    | : | 250 volts DC        |
| Rated current    | : | 0.1 A DC            |
| Other Parameters | : | As per IEC-255-0-20 |

1.10.8 The Contractor shall submit drawings showing inter-connection between PLCC and protection panels for approval by the OWNER.

1.10.9 It has to be ensured that under no circumstances protection channel should share the power. Each protection channel shall be able to transmit power for which system is designed. For example a.40 W PLCCC terminal shall transmit 40 Watt (max) for protection channel alone in the event of fault. Speech and super-imposed data channels, in the same protection terminal must get disconnected momentarily during the operation of protection channels.

1.10.10 The equipment shall be constructed such that in permissive line protection system operational reliability of the protection channel may be checked over the carrier link by means of a loop test. It shall be possible to carry out the above test from either end of the carrier link. During healthy condition of the transmission line the loop test shall not initiate a tripping command. In the event of a system fault, while loop test is in progress, protection signal shall over-ride the test signal.

1.10.11 The equipment shall be complete with built in counters for counting the number of trip commands sent and number of trip commands received.

## **1.11 COUPLING DEVICE**

1.11.1 The coupling devices shall be interposed between the capacitor voltage transformer and coaxial cable to the PLCC transmitter/receiver, and in conjunction with the capacitor voltage transformer shall ensure:

- d) Efficient transmission of carrier frequency signals between the carrier frequency connection and the power line.
- e) Safety of personnel and protection of the low voltage parts and installation, against the effects of power frequency voltage and transient over voltages.

1.11.2 The coupling device, in conjunction with the CVT shall form an electric filter of band pass type:

- a) It shall match characteristic impedance of H.T. line to impedance of the carrier frequency connection.

- b) Galvanic isolation between primary and secondary terminals of the coupling device shall be performed by the above mentioned transformer.
- c) Power frequency currents derived by the CVT may be drained to the earth by a separate inductance termed drain coil of suitable rating.
- d) Voltage surges coming from the power line at the terminals of the coupling device shall be limited by a non-linear surge arrester of suitable rating in the primary side. Requirement of a gas type voltage arrester in secondary side of the coupling device shall have to be fully justified, but in any case the input circuit of PLCC equipment shall have protective devices in the form of zener diodes and surge suppressers.

The surge arrester shall have power frequency spark over voltage coordinated with the equipment ahead of it.

- e) For direct and efficient earthing of its primary terminals, the coupling device shall be equipped with an earthing switch. The Earth Switch shall be available for earthing of CVT-HT terminals, when the coupling filter units are removed from circuit for maintenance/ replacement. The design shall take due regard of requirements for safety in accordance with the Indian Electricity Rules.

1.11.3 Two numbers 'phase to earth' type coupling filters shall be used to achieve 'phase to phase' / ' Inter-circuit coupling'. Connection between secondaries of the two phase to earth type coupling device shall be through a balancing transformer/hybrid such that reliable communication shall be ensured even when one of the coupled phase is earthed or open circuited on the line side.

1.11.4 Coupling device shall conform to IEC-481 and shall have the following carried frequency characteristics as applicable to a phase to earth type coupling device:

- |    |                                  |   |
|----|----------------------------------|---|
| a) | Nominal line side                | 320 ohms for 400 kV line impedance<br>400 ohms for 220./132 kV line impedance |
| b) | Nominal equipment side impedance | 75 ohms (unbalanced)  |
| c) | Composite loss                   | Not more than 2 dB  |
| d) | Return Loss                      | Not less than 12 dB   |

- |    |  |  |
|----|--|--|
| e) | Bandwidth  | Shall suit the frequency plan between 36 and 500 kHz |
| f) | Nominal peak envelope power<br>(for Inter-modulation product 80 dB down) | Not less than 650 Watt.                              |

1.11.5 The coupling device shall be suitable for outdoor mounting. Temperature of metallic equipment mounted outdoor is expected to rise upto 65 deg. C during the maximum ambient temperature of 50 deg. C specified. The equipment offered by the Bidder shall operate satisfactorily under these conditions.

1.11.6 The H.T. Terminal of coupling device shall be connected to H.F. Terminal of the CVT by means of 6 mm sq. copper wire with suitable lugs & taped with 11 kV insulation by the contractor.

1.11.7 Coupling device shall have at least two terminals for carrier equipment connection. Bidder shall confirm that such a parallel connection to coupling device directly will not result in any additional attenuation.

## **1.12 Electronic Private Automatic Exchange (EPAX)**

1.12.1 The 24 line Electronic Private Automatic Exchange (EPAX) wherever specified shall be connected to minimum six trunk routes through PLC channels (speech panel) with 4 four-wire E/M interface unit. This 4-wire interface unit either shall form an integral part of the 'EPAX' system or be suitable for mounting/housing in the carrier panel. The exchange will have its own ringing current and the generator etc. The exchange shall be suitable for working on 48 V DC Power Supply (positive pole earthed).

The exchange shall be fully automatic, solid state, and of modular construction and shall have multiple switching routes (minimum 4-routes).

1.12.1 'EPAX' shall also be provided with two (2) additional interface units and operate exclusively with OWNER's leased subscriber lines, of Department of Telecommunication (DOT) and compatible with 2 wire full duplex, voice grade mode of operation. The details of communication protocol, for interfacing of the 'DOT' leased lines, shall be coordinated by the Contractor, with the licensing authority (DOT).

## **1.13 Remote End Four Wire 'E/M' Interface & Subscriber Unit or Equivalent EPAX (4X4).**

1.13.1 The remote end four wire 'E/M' interface & subscriber units, wherever specified, shall be of electronic type and be suitable for working on fixed frequency power line carrier systems with E & M signaling. This shall be

housed in the carrier set and be fully wired to the power line carrier terminal equipment.

- 1.13.2 This unit shall receive and register various signals, on PLCC Channels, from remote end exchanges or other remote end subscriber units and associated four-wire interface unit.
- 1.13.3 The four wire interface unit shall be equipped for routing transit calls and shall be supplied pre-wired to handle calls for minimum eight directions, in a form suitable for transmission over PLCC.
- 1.13.4 The bidder shall also indicate the total number of trunk-line capacity, available with each four-wire interface unit.

The unit shall be suitable for connecting two-wire telephone sets. Further, the associated telephone cables for locating two subscriber lines, within the control room is in the scope of this specification.

#### **1.14 High Frequency Cable**

- 1.14.1 High frequency cable shall connect the coupling device installed in the switchyard to the PLCC terminal installed indoor.
- 1.14.2 The cable shall be steel armoured and its outer covering shall be protected against attack by termites. Bidder shall offer his comments on method employed by him for earthing of screen and submit full justification for the same with due regard to safety requirements.  
  
Bidder must enclose in his bid a detailed construction drawing of the cable being offered, with mechanical and electrical parameters.
- 1.14.3 Impedance of the cable shall be such as to match the impedance of the PLCC terminal on one side and to that of the coupling device on the other side over the entire carrier frequency range of 40-500 kHz.
- 1.14.4 Conductor resistance of cable shall not exceed 16 ohms per Km at 20<sup>0</sup>C.
- 1.14.5 The cable shall be designed to withstand test voltage of 4 kV between conductor and outer sheath for one minute.
- 1.14.6 Bidder shall specify attenuation per Km of the cable at various carrier frequencies in the range of 40 to 500 kHz. The typical attenuation figures for H.F. cable shall be in the range of 1 to 5 dB/km in the frequency range of 40-500 kHz.
- 1.14.7 All HF cables within the scope of this specification shall be laid and termination shall be carried out by the Contractor.

1.14.8 The cables shall be supplied wound on drums containing nominal length as specified. However, exact requirement of drum lengths shall be finalised during detailed engineering to avoid joint in HF cable and its wastage.

## **1.15 TESTS**

All equipment being supplied shall conform to type tests including additional type tests as per technical specification and shall be subject to routine tests in accordance with requirements stipulated under respective sections.

The reports for all type tests and additional type tests as per technical specification shall be furnished by the bidder along with equipment / material drawings. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited based on ISO/IEC Guide 25/ 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by the representative (s) of POWERGRID /NTPC/BHEL/Utility. The test reports submitted shall be of the tests conducted within last 5 (five) years prior to the date of bid opening. In case the test reports are of the test conducted earlier than 5 (five) years prior to the date of bid opening, the bidder shall repeat these (s) at no extra cost to purchaser.

In the event of any discrepancy in the test reports i.e. any test reports not acceptable due to any design / manufacturing changes (including substitution of components ) or due to non- compliance with the requirement stipulated in the technical specification or any / all additional type tests not carried out. Same shall be carried out without any additional cost implication to the purchaser.

Bidder shall also submit type test charges for conducting type tests on PLCC equipments in the event of these tests being conducted even after availability & approval of valid type tests reports.

### **A)Coupling device:**

The coupling device including the drainage coil, surge arrester and earthing switch shall conform to type tests and shall be subject to routine tests as per IEC-48I/IS: 8998.

Routine tests shall include but not be limited to the following:

- i) Composite loss and return loss tests on coupling device.
- ii) Turns ratio test and insulation tests on the balancing transformer.
- iii) Milli volt drop test, power frequency voltage test and mechanical operation test on earthing switch.
- iv) Power frequency spark over test for lightning arrester as per relevant IS/IEC.

Reports for the following type tests on coupling device shall be submitted

- 1) Return loss test.
- 2) Composite loss test.
- 3) Distortion and inter modulation test.
- 4) Impulse voltage test
- 5) Tests on Arrestors

Bidder shall furnish, alongwith his bid copies of all type and routine test conducted earlier on similar coupling device in accordance with relevant standards.

**B) H.F. Cable :**

The H.F. cable shall conform to type tests and be subjected to routine tests as per IEC: 96-2/BS: 2316/IS: 5802.

**C) PLCC terminal ;**

Reports for the following type tests for PLCC Terminals shall be submitted

Tests to determine various characteristics of PLCC terminals as per IEC-495.

- a) Voltage variation
- b) Carrier frequency range & band.
- c) Frequency accuracy
- d) Transmit/Receive frequency difference.
- e) Automatic gain control
- f) Harmonic distortion
- g) Selectivity
- h) Output impedance, Return loss & Tapping loss
- i) Return loss, If inputs/ Outputs
- j) Balance to ground
- k) Limiter action
- l) Spurious emission
- m) Carrier frequency levels and levels
- n) Attenuation distortion
- o) Noise generated within terminal
- p) Near and cross talk
- q) Group delay distortion
- r) Conducted noise
- s) Telephone signaling channel
- t) Speech levels
- u) Voltage withstand test
- v) Insulation test

#### **D) Protection Coupler :**

Reports for the following tests shall be submitted for approval for protection coupler and the relays associated with PLCC equipment for network protection signaling equipment and interface unit with protective relay units if any:

- 1) Protection coupler (As per IEC 60834 - 1)
  - a) Power supply variation
  - b) Power supply interruption
    - a) Reflected noise
    - b) Reverse polarity
  - c) Interference by discrete frequency
  - d) Transmission time
  - e) Interference by frequency deviation. (Wherever applicable)
  - f) Alarm functioned
  - g) Security
  - h) Dependability
  - i) Voltage withstand test
  - j) Insulation test.
  - k) Electrical fast transient test (along with carrier terminal)
  - l) HF disturbance test (along with carrier terminal)
  - m) Electrostatic discharge test (along with carrier terminal)
  - n) Radiated electromagnetic field susceptibility test (along with carrier terminal)
  - o) Environment test (as per IS 9000)
- 2) Relays
  - a) Impulse voltage withstand test as per Clause 6.1 of IS:8686 (for a test voltage appropriate to Clause III as per Clause 3.2 of IS:8686)

- b) High Frequency Disturbance test as per Clause 5.2 of IS:8686 (for a test voltage appropriate to Clause III as per Clause 3.2 of IS:8686).

### **E) Heat Soaking of panels**

All the solid-state equipment/system panels shall be subjected to the Heat Soaking as per the following procedure:

All solid-state equipment shall be burn-in for minimum of 120 hours continuously under operation condition. During the last 48 hours of testing, the ambient temperature of the test chamber shall be 50<sup>0</sup>C. Each PLCC panel shall be complete with all associated sub-systems and the same shall be in operation during the above test. During the last 48 hours of the above test, the temperature inside the parcel shall be monitored with all the doors closed. The temperature of the panel interior shall not exceed 65<sup>0</sup>C.

### **1.16 Mandatory Testing & Maintenance Equipment**

Print testing kit for PLCC terminal, E/M interface & subscriber unit, Protection coupler & EPAX - comprising of following items of reputed make in addition to any other special items required for testing and maintenance of this equipment packed in a carrying brief case:

1. Screw driver set with multi up fixing feature
2. Nose pliers
3. Cutting Pliers
4. Ordinary Pliers
5. Adjustable wrench
6. Soldering iron with tip earthed
  - a) 150 watts - 1 No.
  - b) 35 Watts - 1 No
  - c) 10 Watts - 1 No
7. Operated with isolated (step down) transformer having provision for interchangeable taps.  
Desoldering pump
8. Print extender

9. Print puller
10. Large selection of test leads
11. Solder wire
12. Large selection of plugs, jacks & pistol probes compatible with equipment supplied
13. Dummy load
14. Interface card/print for Tx to Rx loop-back
15. Test oscillator/tone generator with indicating meters - either built in or separate.
16. ESD wrist band
17. ESD conducting mat

#### **1.17 LIST OF COMMISSIONING TESTS**

The following tests shall be carried out on complete system/subsystem during commissioning:

1. Composite loss and return loss on coupling device using dummy load.
2. Composite loss (Attenuation) for HF Cable coupling device.
3. End to end attenuation measurement for verification of optimum coupling mode. Test shall be done for all combinations.
4. End to end return loss for optimum coupling mode.
  - a) Open behind line trap.
  - b) Grounded behind line trap.
5. If end-to-end return loss for optimum coupling mode is not satisfactory, same shall be measured for other coupling modes also.
6. Adjustment of Tx/Rx levels on PLCC equipment as per test schedule.
7. AF frequency response (end to end) for the entire 4 kHz Bandwidth for speech and teleoperation channels.

8. Measurement of noise in 2 kHz bandwidth with and without line energised.
9. SNR (test-one) with line energised noting down weather conditions.
10. Transmission time for teleprotection and other data channels.
11. Observation of Tx/Rx levels (test-tone) for each channel at both ends by sequential switching on/off parallel channels using dummy load and also with the transmission line.
12. Observation of end to end and trunk dialing performance.
13. Observation of end-to-end protection signaling (command sent & received) in conjunction with protective relays, noting down transmission/receipt of unwanted commands under switching operations in the switchyard during protective relay testing.

#### Notes

1. All measurements for link attenuation, composite loss and return loss shall be carried out for the entire range of carrier frequencies with specific attention to the frequencies.
  - i) within coupling device bandwidth.
  - ii) within line trap bandwidth and
  - iii) operating frequencies.
2. Following tests shall be carried out independently at each and
  - i. Composite loss & return loss for coupling device.
  - ii Attenuation test for HF cable coupling device.
  - iii Levels and other local adjustments (on dummy load)  
Final adjustment shall be on end to end basis.
  - iv Test for loading by parallel channels with dummy load  
This test can be done alongwith tests for coupling device.
  - v. Protection signaling under local loop test (dummy load)
3. Necessary test instruments required for all the above tests shall be brought by commissioning engineers of the contractor.

**POWER LINE CARRIER COMMUNICATION (PLCC)**

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**ANNEXURE-A**

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It is confirmed that there are no deviations and the offer is in full compliance with the specification. It is also confirmed that there are no deviations in any other form such as comments, variations and/or exceptions. Further it is confirmed that at all drawings / data sheets/QP/ type tests reports shall be submitted to BHEL for organising approval of ultimate customer. Also, furnishing of all relevant information / repetition of type tests (if required for meeting the specification requirement) shall be carried out by us at no extra cost to BHEL & without affecting delivery requirements.

-----

Signature of the authorized representative of Bidder

Name \_\_\_\_\_

Designation\_\_\_\_\_

Place\_\_\_\_\_

Date \_\_\_\_\_

Company seal

GUARANTEED TECHNICAL PARTICULARS

**COUPLING DEVICES (PHASE TO PHASE TYPE)**

1. Name of Manufacturer and Country
2. Type, Model and Catalogue Number
3. Whether suitable for mounting Outdoor in Switchyard & Type of mounting
4. Maximum temperature limit for satisfactory operation of coupling device mounted outdoor
5. Net weight
6. Nominal Primary Side Impedance
7. Nominal secondary Side Impedance
8. Composite loss within Passband
9. Return loss within Passband
10. Available Bandwidth (with 4400/6600/ 8800 pF CVTs)
11. Nominal Peak Envelope Power (with Distortion and Intermodulation Products 80 dB Down)
12. Maximum number of PLC terminals that can be connected in parallel:
  - (a) 20 W (P.E.P.) PLC terminals
  - (b) 40 W (P.E.P.) PLC terminals
  - (c) 100 W (P.E.P.) PLC terminals

13. Power Frequency Impedance between primary terminal and Earth Terminals of Coupling Device.
14. 1 Minute Power Frequency Insulation level between Primary and Secondary Terminals of Coupling Device
15. Impulse (1.2/50 micro-sec.) Withstand Level between Primary and Secondary Terminals of Coupling Device
16. Power Frequency Current Carrying Capacity of Drain Coil (or Primary Winding of Matching Transformer).
  - (a) Continuous current
  - (b) Short time current for 0.2 sec.
  - (c) Inductance of drain coil with tolerances (at 50 Hz)
17. Surge Arrester in Primary Side of Coupling Device:
  - (a) Type model & catalogue number
  - (b) Power frequency sparkover voltage
  - (c) Type of construction
  - (d) Maximum permissible arrester discharge current with 8/20 micro sec. impulse discharge
  - (e) Maximum permissible short time current (2.2 micro sec.)
  - (f) Power frequency discharge current for 0.2 sec.
  - (g) Impulse spark over voltage 1.2/50 micro sec.
  - (h) Rated voltage
  - (i) Whether Site tunable

18. Surge arrester in Secondary Side of Coupling Device
  - (a) Type model & catalogue number
  
  - (b) Power frequency spark over voltage
  
  - (c) Impulse spark over voltage (1.2/50 micro sec.
  
19. Details of interlock provided with cover enclosed -
  
20. Overall dimensions
  
21. No of H.F. terminals provided for carrier equipment. connection

### **HIGH FREQUENCY CABLE**

1. Name of Manufacturer and Country
2. Type, Model and Catalogue No.
3. Applicable standards
4. Characteristic Impedance
5. Rated Capacitance
6. Service Voltage
7. Attenuation per km. of cable at various Carrier Frequencies in the Range of 50 to 500 KHz. (Typically at 50,100,200,300, 400,500 KHz)
8. Withstand Test Voltage (RMS) between conductor and Sheath
9. Details and particulars of Insulation
10. Loop Resistance per Km (Typical at 20°C)
11. Details of Armouring
12. Number and Diameter of Stranded Conductor
13. Overall Diameter of Cable
14. Net weight per Km.
15. Minimum bending radius
16. Earthing detail of H. F. Cable
17. Packing length per drum
18. Construction drawing, type test & performance reports enclosed or not

**POWER LINE CARRIER TERMINAL FOR SPEECH & DATA TRANSMISSION**

1. Name of Manufacturer and Country
2. Type, Model and Catalogue No.
3. Type of Modulation
4. Mode of transmission
5. Carrier Frequency Range
6. Nominal Carrier Frequency Band in either direction of transmission
7. Return loss within the Nominal Carrier Frequency Band
8. Effectively Transmitted V.F Band
9. Return Loss within the Effectively Transmitted Voice Frequency Band.
10. H. F. Oscillator Details
11. I. F. Oscillator Details
12. Frequency Difference between the V.F. Input and V.F. Output of a pair of terminals connected back to back for permissible Ambient Temperature and supply voltage variations.
13. Maximum H. F. Amplifier output with Single/Multiple tone keying (Peak Envelope Power).

14. Nominal carrier frequency Power (Peak Envelop Power) at output terminals.
15. H. F. Impedance at output of carrier terminals.
16. Stability of the carrier frequency.
17. Improvement in S/N due to compander
18. Whether carrier is suppressed or reduced during transmission of signal
19. Whether frequency locking between Tx/Rx provided.
20. Automatic gain control range and regulation
21. Level of spurious emission at
  - (a) Edge of nominal Carrier Frequency band
  - (b) 4.0 KHz away from nominal carrier frequency band.
  - (c) 8.0 KHz away from nominal carrier frequency band.
22. Relative level at V. F. 4 wire terminating points :
  - (a) Send leg
  - (b) Receive leg
23. Permissible limits for level variation with frequency relative to 800 Hz in a speech channel (without companders) transmitted over a pair of terminals connected back to back

24. Level of telephone signalling channel :
  - a. Input level
  - b. Output level
25. Near and far end cross talk due to telephone signalling channel in a pair of PLC Terminals (without companders) connected back to back.
26. Pulse distortion of telephone signalling channel when operated at a signalling speed of 10 pps and with a mark to space ratio of 40/60 in PLC terminals connected back to back.
27. Psophometric Noise contribution of a pair of PLC terminals connected back to back
28. Group delay distortion in the frequency band relevant to the transmission of protection signals.
29. Performance Under Noise condition :
  - a. Noise generated within terminal
  - b. Additional noise introduced when terminals are connected back to back at repeater station
  - c. Noise Bandwidth.
30. Power supply requirements :
  - (a) Voltage
  - (b) Permissible voltage variation
  - (c) Maximum current
  - (d) Quiescent Current
31. Installation details
32. Insulation level

33. Meters provided on Test Panel, their range and purpose.
34. Is the equipment suitable to work in Dust laden atmosphere?
35. Whether interior lamps with door switch is provided in cabinets
36. Over all dimensions (Cabinet)
  - (a) Length mm
  - (b) Width mm
  - (c) Height mm
37. Weight
38. Earthing detail of PLC Cabinet
39. Whether Tx/Rx loop-back facility is available for testing locally
40. **Whether site tunable**

**POWER LINE CARRIER TERMINAL FOR NETWORK PROTECTION**

1. Name of Manufacturer and country
2. Type, Model and Catalogue No.
3. Type of Modulation
4. Mode of transmission
5. Carrier Frequency Range
6. Nominal Carrier Frequency Band in either direction of transmission
7. Return loss within the Nominal Carrier Frequency Band
8. Effectively Transmitted V.F Band
9. Return Loss within the Effectively Transmitted Voice Frequency Band.
10. H. F. Oscillator Details
11. I. F. Oscillator Details
12. Frequency Difference between the V.F. Input and V.F. Output of a pair of terminals connected back to back for permissible Ambient Temperature and supply voltage variations.

13. Maximum H. F. Amplifier output with Single/Multiple tone keying (Peak Envelope Power).
14. Nominal carrier frequency Power (Peak Envelop Power) at output terminals.
15. H. F. Impedance at output of carrier terminals.
16. Stability of the carrier frequency.
17. Improvement in S/N due to compander
18. Whether carrier is suppressed or reduced during transmission of signal
19. Whether frequency locking between Tx/Rx provided
20. Level of spurious emission at
  - (a) Edge of nominal Carrier Frequency band
  - (b) 4.0 KHz away from nominal carrier frequency band
  - (c) 8.0 KHz away from nominal carrier frequency band.
21. Whether frequency locking between Tx/Rx provided
22. Relative level at V. F. 4 wire terminating points :
  - (a) Send leg
  - (b) Receive leg

23. Permissible limits for level variation with frequency relative to 800 Hz in a speech channel (without companders) transmitted over a pair of terminals connected back to back
24. Variation in overall loss of speech circuit with a pair to PLC terminals connected back (without Companders & limiters) when voice frequency input level changes from 10 to 0 dBm
25. Psophometric Noise contribution of a pair of PLC terminals connected back to back
26. Noise frequency Band width
27. Group delay distortion in the frequency band relevant to the transmission of protection signals.
28. Signal Delay with Two PLC Terminals connected back to back
29. Power supply requirements :
  - (a) Voltage
  - (b) Permissible voltage variation
  - (c) Maximum current
30. Installation details
31. Meters provided on Test Panel, their range and purpose.
32. Is the equipment suitable to work in Dust laden atmosphere without air conditioning?

33. Whether interior lamps with door switch is provided in cabinets
34. Over all dimensions
  - (a) Length           mm
  - (b) Width           mm
  - (c) Height           mm
35. Weight
36. Insulation level
37. Cabinet earthing details
38. Whether indication is available in sending end panel for receipt/execution of trip signal/command at remote end.
39. Whether Tx/Rx loop-back facility is available for testing locally
40. Whether site tunable

**VF TRANSMISSION TERMINAL FOR NETWORK PROTECTION SIGNALS  
(PROTECTION COUPLER)**

1. Name of Manufacturer and Country
2. Type, Model and Catalogue Number
3. Whether equipment works on frequency shift principle of coded signal principle
4. Whether Equipment is suitable for Independently Protecting Two Circuits
5. Frequencies used in the equipment for transmission of signal for coded Signal transmission
  - (a) Guard frequency
  - (b) Working frequency (Trip System - I)
  - (c) Working frequency (Trip System - II)
  - (d) Working frequency (Trip System I&II)
6. Criteria used for command Transmission
7. Whether equipment is protected against Tripping by Spurious Signals.
8. Transmission time corresponding to telegraph speed for transmission on PLCC channel of coded signal
  - (a) 600 Bds.
  - (b) 400 Bds.
  - (c) 200 Bds.

9. Whether in the presence of spurious signals as well as Protection Signals simultaneously, the equipment will initiate a Trip Command.
10. Mode of Transmission of guard signal
11. Whether equipment is suitable for Direct Circuit Breaker tripping.
12. Maximum number of Noises Impulses pps in Presence of which the equipment will satisfactorily perform its duty.
13. Signal Delay with Two Terminals connected back to back
14. Whether the Command Signal is acknowledged at receiving end and in the event of non-receipt of the correct signal, the command is repeated or not by the transmitter?
15. Whether it is possible to alter the priority of commands of various codes at site.
16. What are the performance based results under severe line noise conditions for
  - (a) False trip probability
  - (b) Fail to trip probability
17. Transmitter Input Requirements (Contact Ratings)
  - (a) Voltage
  - (b) Current
  - (c) Power
  - (d) No. of Contacts

18. Receiver Output (Contact Rating)
  - (a) Voltage
  - (b) Current
  - (c) Power
  - (d) No. of Contracts
19. Additional facilities provided in Receiver output
20. Supervisory and Alarm Contact Facilities
  - (a) Current
  - (b) Voltage
  - (c) No. of contacts
21. Installation
22. Power Supply
  - (a) Voltage
  - (b) Current
  - (c) Power
23. Type and number of counters for recording the number of Trip Commands sent and number of Trip Commands received
24. Whether loop test is possible
25. Insulation Level
26. Whether the equipment is suitable for transmitting and receiving more than two independent commands (please give full details)

| <b>BHEL</b>                     |                         | MANUFACTURER'S NAME & ADDRESS |       | <b>MANUFACTURING QUALITY PLAN</b>   |                  |   |                     | PROJECT:  |        |   |   |         |    |
|---------------------------------|-------------------------|-------------------------------|-------|---|------------------|---|---------------------|---|--------|---|---|---------|----|
|                                 |                         |                               |       | ITEM:   |                  | QP No. _____<br>Rev No. _____<br>Date _____ |                     | PACKAGE:<br>CONTRACT NO.:<br>CONTRACTOR: BHEL/ TBD/ NEW DELHI |        |   |   |         |    |
| SUBSYSTEM:                      |                         |                               |       | PAGE _____ OF _____   |                  |   |                     |   |        |   |   |         |    |
| SL. No.                         | COMPONENT AND OPERATION | CHARACTERISTIC                | CLASS | TYPE OF CHECK   | QUANTUM OF CHECK | REFERENCE DOCUMENT                          | ACCEPTANCE OF NORMS | FORMAT OF RECORD  | AGENCY |   |   | REMARKS |    |
| 1                               | 2                       | 3                             | 4     | 5   | 6                | 7   | 8                   | 9   | D*     | P   | W | V       | 11 |
|                                 |                         |                               |       |   |                  |   |                     |   |        |   |   |         |    |
|                                 |                         |                               |       | <b>LEGEND:</b><br>* RECORDS IDENTIFIED WITH 'TICK' SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION. |                  |   |                     |   |        |   |   |         |    |
| MANUFACTURER/<br>SUB-CONTRACTOR |                         | CONTRACTOR                    |       | Indicate 'P' 'PERFORM, 'W' WITNESS and 'V' VERIFICATION   |                  |   |                     | REVIEWED BY   |        | Name & Sign of Approving Authority & Seal |   |         |    |
| SIGNATURES                      |                         |                               |       |   |                  |   |                     |   |        |   |   |         |    |

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## CHECK LIST FOR INFORMATION TO BE FURNISHED WITH OFFER

BIDDER SHALL PUT A TICK '✓' IF THE INFORMATION IS ENCLOSED WITH THE OFFER,  
PUT A CROSS 'X' IF THE INFORMATION IS NOT ENCLOSED OR WRITE 'NOT  
APPLICABLE' IF THE QUERY/ SCHEDULE IS NOT RELEVANT AND RETURN THIS  
CHECKLIST AS PART OF THE OFFER DULY SIGNED

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The offer may not be considered if the following information and this Checklist are not enclosed with the Offer.

**BIDDER:**

**OFFER REFERENCE:**

1. Technical offer with detailed schedules of equipment/ material and spares \_\_\_\_\_
2. Guaranteed Technical Particulars as per Section - 4 \_\_\_\_\_
3. Schedule of Deviations listing deviations, if any, clause-wise with respect to technical specification \_\_\_\_\_
4. List of past supplies complete with Purchase Order & Project name, quantity, order reference, etc., where identical equipment have been supplied. \_\_\_\_\_
5. Manufacturer's Quality Plans for approval \_\_\_\_\_
6. Field Quality Plan for approval \_\_\_\_\_
7. General Arrangement drawings with dimensions and weights and foundation/ fixing details \_\_\_\_\_
8. Drawing/ data submission Schedule \_\_\_\_\_
9. a) Type test reports. The type test reports shall be accompanied with a list listing all the relevant clauses of the applicable standard and the corresponding type test report. The manufacturer shall also furnish a certificate certifying that the test reports have been carried out on equipment identical in all respects to the one offered. In case the reports are for a different equipment and the applicability of the report is permitted as per applicable standards, the justification shall be enclosed to the list of type test reports. \_\_\_\_\_  
b) Type Test Charges
10. Bar Chart showing time schedule showing time required for design, manufacture, test and inspection, transport, erection, site testing and commissioning \_\_\_\_\_
11. Makes of all important components, like motors, operating switches, fuses, etc. \_\_\_\_\_
12. Any additional information called for in any part of the technical specification. \_\_\_\_\_

**Date:**

**Signature of the authorized representative of Bidder**

**Company Seal**

### SECTION - 3 GENERAL TECHNICAL REQUIREMENTS

#### 3.0 GENERAL

This section stipulates the General Technical Requirements under the Contract and will form an integral part of the Technical Specification.

- a) The provisions under this section are intended to supplement general requirements for the materials, equipment and services covered under other sections and; is not exclusive. However in case of conflict between the requirements specified in this section and requirements specified under other sections, the requirements specified under respective sections shall hold good.

#### 3.1 SITE INFORMATION

|                 |                               |   |
|-----------------|-------------------------------|---|
|                 | Particulars                   |   |
| a)              | Customer/ Purchaser/<br>Owner | BSEB/BHEL/BSEB                                      |
| b)              | Engineer/ Consultant          | STEAG Energy Services (India) Pvt Ltd, Noida, India |
| c)              | Project Title                 | 220/ 132 kV Switchyard at Barauni TPS               |
| d)              | Location                      | Barauni / Bihar                                     |
| e)              | Postal Address                | Shall be furnished to successful bidder             |
| SITE CONDITIONS |                               |   |
| a)              | Max. ambient air temp.        | 42.4° C   |
| b)              | Min. ambient air temp.        | 8.4° C  |
| c)              | Max. design ambient<br>temp.  | 50° C   |
| d)              | Min. design ambient<br>temp.  | 5° C  |
| e)              | Max. RH                       | 100 %   |
| f)              | Min. RH                       | ---   |
| g)              | Height above MSL              | Less than 1000 m                                    |
| h)              | Pollution Severity            | Shall be furnished to successful bidder             |
| i)              | Seismic Zone                  | Zone – IV as per IS 1893                            |
| WIND DATA       |                               |   |
| b)              | Site Wind Pressure            | 50 m / sec  |
| c)              | Average Annual Rainfall       | 1119.1mm (Max. rain fall in 24 hrs is 352.8 mm)     |

### **3.2 INSTRUCTION TO BIDDERS**

The bidders shall submit the technical requirements, data and information as per the technical data sheets, provided in Section-4.

The bidders shall furnish catalogues, engineering data, technical information, design documents, drawings etc fully in conformity with the technical specification.

It is recognised that the Contractor may have standardised on the use of certain components, materials, processes or procedures different than those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered provided such proposals meet the specified designs, standard and performance requirements and are acceptable to the Purchaser. Unless brought out clearly, the Bidder shall be deemed to conform to this specification scrupulously. All deviations from the specification shall be clearly brought out in the respective schedule of deviations. Any discrepancy between the specification and the catalogues or the bid, if not clearly brought out in the schedule, will not be considered as valid deviation.

Wherever a material or article is specified or defined by the name of a particular brand, Manufacturer or Vendor, the specific name mentioned shall be understood as establishing type, function and quality and not as limiting competition.

Equipment furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/ or needed for erection, completion and safe operation of the equipment as required by applicable codes, though they may not have been specifically detailed in the Technical Specifications unless included in the list of exclusions. Materials and components not specifically stated in the specification but which are necessary for commissioning and satisfactory operation of the switchyard unless specifically excluded shall be deemed to be included in the scope of the specification and shall be supplied without any extra cost. All similar standard components/parts of similar standard equipment under supply shall be inter-changeable with one another.

The Contractor shall supply type tested (including special tests as per tech. specification) equipment and materials. The test reports shall be furnished by the Contractor, along with equipment/ material drawings. In the event of any discrepancy in the test reports, (i.e., if any test report is not acceptable due to any design/ manufacturing changes or due to non-compliance with the Technical Specification and/ or applicable standard), the tests shall be carried out without any additional cost implication to the PURCHASER. The PURCHASER reserves the right to get any or all type/tests conducted/repeated.

### **3.3 STANDARDS**

The works covered by the specification shall be designed, engineered, manufactured, built, tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of India.

The equipment to be furnished under this specification shall conform to latest issue (with all amendments) of specified standards.

In addition to meeting the specific requirement called for in Sections 1 and 2 of the Technical Specification, the equipment shall also conform to the general requirement of the applicable standards, which shall form an integral part of the specification.

The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to complement each other.

When the specific requirements stipulated in the specifications exceed or differ from those required by the applicable standards, the stipulation of the specification shall take precedence.

Other internationally accepted standards, which ensure equivalent or better performance than that specified in the standards referred, shall also be accepted. The bidder shall submit copies of such standards.

In case governing standard for the equipment is different from IS or IEC,, the salient points of difference shall be clearly brought out in the offer along with English language version of standard or relevant extract of the same. The equipment conforming to standards other than IS/IEC shall be subject to Purchaser's / owner's approval.

The bidder shall clearly indicate in his bid the specific standards in accordance with which the works will be carried out.

### **3.4 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED**

All equipment shall also perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation All equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, ice & snow, (wherever applicable) short circuit etc for the equipment. The equipment shall also comply to the following:

- a) All outdoor EHV equipment except marshalling kiosks shall be suitable for hot line washing.
- b) To facilitate erection of equipment, all items to be assembled at site shall be "match marked".
- c) Piping, if any, between equipment control cabinet and operating mechanism to marshalling box of the equipment shall bear proper identification to facilitate the connection at site.

### **3.5 ENGINEERING DATA**

#### **3.5.1 Drawings**

All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, material description,

Bill of Materials, weight of each component, break-up for packing and shipment, the external connections, fixing arrangement required. the dimensions required for installation and interconnections with other equipment and materials, clearances and spaces required for installation and interconnections between various portions of equipment and any other information specifically requested in the specifications.

Each drawing submitted by the Contractor shall be clearly marked with the name of the Purchaser, the unit designation, the specifications title, the specification number and the name of the Project. If standard catalogue pages are submitted, the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

Further work by the Contractor shall be in strict accordance with these drawings and no deviation shall be permitted without the written approval of the Purchaser, if so required.

The review of these data by the Owner will cover only general conformance of the data to the specifications and documents, interfaces with the equipment provided under the specifications, external connections and of the dimensions which might affect substation layout. Owner may not indicate a thorough review of all dimensions, quantities and details of the equipment, material, any devices or items indicated or the accuracy of the information submitted. This review and /or approval by the Owner shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and documents.

All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at the Contractor's risk. The Contractor may make any changes in the design which are necessary to make the equipment conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Purchaser. Approval of Contractor's drawing or work by the Purchaser shall not relieve the contractor of any of his responsibilities and liabilities under the Contract

All engineering data submitted by the Contractor after final process including review and approval by the Owner shall form part of the Contract Document and the entire works performed under these specifications shall be performed in strict conformity, unless otherwise expressly requested by the Owner in Writing.

### 3.5.2 Approval Procedure

The scheduled dates for the submission of these as well as for, any data/ information to be furnished by the Purchaser would be discussed and finalised at the time of award. The following schedule shall be followed generally for approval.

|    | Stage   | No. of copies | Submission Schedule /Remarks |
|----|---|---------------|------------------------------|
| i) | Initial Submission Drawings, Data sheets, Type test Reports and O & M | 5             | As per agreed schedule       |

|       |  |            |  |
|-------|--|------------|--|
|       | Instructions (in case of standard products)  |            |  |
| ii)   | Resubmission, if required  | 5          | Within 3 (three) weeks from date of comments including both ways postal time   |
| iii)  | Approval or comments   |            | Within 3(three) weeks of receipt of resubmission.  |
| iv)   | Furnishing of distribution copies of drawings in bound volume  | See remark | 2 Weeks from the date of final approval<br>Five (5) copies for each substation plus two (2) copies for corporate centre. |
| v)    | Furnishing of distribution copies of type test reports in bound volumes  | See remark | 2 Weeks from the date of final approval<br>One (1) copies for each substation plus two (2) copies for corporate centre.  |
| vi)   | Furnishing of distribution copies of Routine test reports  | See remark | 2 Weeks from the date of final approval<br>One (2) copies for each substation  |
| vii)  | Furnishing of instruction/ operation manuals   | See remark | As per agreed schedule<br>Four (4) copies for each substation plus three (3) copies for corporate centre.                |
| viii) | Video Cassette (VHS-PAL) highlighting installation and maintenance techniques/ requirements of circuit breaker & Isolators | See remark | As per agreed schedule<br>One (1) copy for each substation plus two (2) copies for corporate centre.                     |
| ix)   | RTFs of as-built drawings  | See remark | As per agreed schedule<br>Two (2) copies for each substation plus two (2) copies for corporate centre.                   |
| x)    | As-built drawings  | See remark | After completion of works<br>Two (2) copies for each substation plus two (2) copies for corporate centre.                |
| xi)   | CD-ROM/ Optical Disc of all 'As - built drawings/ design documents   | See remark | on completion of works<br>one (1) set for each substation plus two (2) set for corporate centre.                         |

NOTES:

- a) The contractor may note that all re-submissions must incorporate all comments given in the prior submission by the Purchaser. Adequate justification for not incorporating the same must be submitted, failing which the submitted documents may be returned.
- b) The drawings, which are required to be frequently referred during execution, should be submitted on cloth lined paper. The list of such drawings shall be finalised with the Contractor at the time of Award.

- c) All major drawings shall be submitted in Auto Card Version 12 or better.
- d) The instruction Manuals shall contain full detailed drawings of all equipment being supplied under this contract, their exploded views with complete instructions for storage, handling, erection, commissioning, testing, operation, trouble shooting, servicing and overhauling procedures.
- e) If after the commissioning and initial operation of the installation, the instruction manuals require any modifications/ additions/ changes, the same shall be incorporated and the Contractor shall submit the updated final instruction manuals to the Purchaser.
- f) The Contractor shall furnish to the Purchaser, spare parts catalogues also

### **3.6 COLOUR SCHEME**

All steel structures, plates, etc. shall be painted with non-corrosive paint on a suitable primer. It may be noted that normally all Purchaser's electrical equipment in Purchaser's switchyard are painted with shade 697 of IS 5. All the indoor cubicles shall be of same colour scheme. For other miscellaneous items, the Purchaser will approve colour scheme.

### **3.7 PROVISIONS FOR EXPOSURE TO HOT AND HUMID CLIMATE**

Outdoor equipment supplied under the specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity' heavy rainfall and environment favourable to the growth of fungi and mildew. The indoor equipment located in non-air-conditioned areas shall also be of same type.

One or more adequately rated thermostatically controlled heaters, suitable for continuous operation at 240-V supply, shall be provided to maintain temperature so as to prevent condensation in any compartment. On-off switch and fuse shall also be provided. The surface temperature of the heater assembly shall be restricted to a value which will not shorten the life of the heater sheaths or the wire insulation or other components in the compartment. The heaters shall be installed in the compartment and electrical connections shall be made sufficiently away from the heaters to minimize deterioration of supply wire insulation. The heaters shall be designed to prevent any contact between the heater wire and air. The design and construction of the heater shall be to approval.

Besides the space heaters, special moisture and fungus resistant varnish may be applied to parts, which may be subjected to or predisposed to the formation of fungi due to presence or deposit of nutrient substances. The varnish shall not be applied to any surface or part where the treatment will interfere with the operation or the performance of the equipment.

The compartments may be provided with ventilation openings, if required. These openings shall be covered with fine wire mesh of brass to prevent ingress of insects and minimise the entry of dirt and dust. Openings in outdoor equipment shall be provided with shutter type blinds.

The degree of protection shall be in accordance with IS 13947 (Part-1) / IEC-947 (Part-1). Type test report for degree of protection test, on each type of the box shall be submitted for approval.

The minimum requirements for panels are as follows :

- a) Installed out door: IP- 55
- b) Installed indoors in air-conditioned area: IP-31
- c) Installed in covered area: IP-52
- d) Installed indoors in non air-conditioned area where possibility of entry of water is limited: IP-41.
- e) For LT Switchgear (AC & DC distribution Boards): IP-52.

### **3.8 RATING PLATES, NAME PLATES AND LABELS**

Each main and auxiliary item of substation shall have, permanently attached to it in a conspicuous position, a rating plate of non-corrosive material. Upon this plate, shall be engraved manufacturer's name, year of manufacture, equipment name, type or serial number together with details of the loading conditions under which the item in question has been designed to operate, and such diagram plates as may be required by the Purchaser. The rating plate shall be according to IEC recommendations.

All such nameplates, instruction plates, rating plates shall be bilingual with Hindi inscription first followed by English. Alternatively two separate plates, one with Hindi and the other with English inscription, may be provided.

### **3.9 QUALITY ASSURANCE PROGRAMME**

To ensure that the equipment and services under the scope of this Contract, whether manufactured or performed within the Contractor's Works or at his Sub-contractor's premises or at the Purchaser's site or at any other place of Work, are in accordance with the specifications, the Contractor shall adopt a suitable quality assurance programme to control such activities at all points, as necessary. Such programme shall be outlined by the Contractor and shall be finally accepted by the Purchaser after discussions before the award of Contract. A quality assurance programme of the contractor shall generally cover the following:

- (a) Contractor's organisation structure for the management and implementation of the proposed quality assurance programme :
- (b) Documentation control system;
- (c) Qualification data of bidder's key personnel;
- (d) The procedure for purchases of materials, parts components and selection of sub-Contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
- (e) System for shop manufacturing and site erection controls including process controls and fabrication and assembly control;
- (f) Control of non-conforming items and system for corrective actions;
- (g) Inspection and test procedure both for manufacture and field activities;
- (h) Control of calibration and testing of measuring instruments and field activities;
- (i) System for indication and appraisal of inspection status;
- (j) System for quality audits;
- (k) System for authorising release of manufactured product to the Purchaser
- (l) System for maintenance of records;
- (m) System for handling storage and delivery; and

- (n) A quality plan detailing out the specific quality control measures and Procedures adopted for controlling the quality characteristics relevant to each item of equipment furnished and/or services rendered.

The Purchaser or his duly authorised representative reserves the right to carry out quality audit and quality surveillance of the system and Procedure of the Contractor/his vendors quality management and control activities.

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Purchaser and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The list of pre-commissioning tests to be performed shall be included in the Contractor's quality assurance programme.

### **3.10 Quality Assurance Documents**

The Contractor shall be required to submit the following Quality Assurance Documents within three weeks after despatch of the equipment.

All Non - Destructive Examination Procedures, stress relief and weld repair. Procedure actually used during fabrication and reports including radiography interpretation reports.

Welder and welding operator qualification certificates Welder's identification list, listing welder's qualification procedure and welding identification symbols.

Raw material test reports on components as specified by the specification and/or agreed to in the quality plan.

Stress relief time temperature charts/oil impregnation time temperature charts

Factory test results for testing required as per applicable codes/mutually agreed quality plan/standards referred in the technical specification.

The quality plan with verification of various customer inspection points (CIP) as mutually agreed and methods used to verify the inspection and testing points in the quality plan were performed satisfactorily.

### **3.11 INSPECTION, TESTING & INSPECTION CERTIFICATE**

The Purchaser, his duly authorised representative and/or outside inspection agency acting on behalf of the Purchaser shall have at all reasonable times free access to the Contractor's premises or Works and shall have the power, at all reasonable times to inspect and examine the materials and workmanship of the Works during its manufacture or erection if part of the Works is being manufactured or assembled at other premises or works, the Contractor shall obtain for the Engineer and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. inspection may be made at any stage of manufacture, despatch or at site at the option of the Purchaser and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.

The reports for all type tests and additional type tests as per technical specification and shall be furnished by the Contractor along with equipment/material drawings. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited based on ISO/IEC Guide 25/17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by the representative(s) of BSPGCL or Utility. The test-reports submitted shall be of the tests conducted within last 5 (five) years prior to the date of LOA i.e. 24.09.2013. In case the test reports are of the test conducted earlier than 5 (five) years prior to the date of LOA, the contractor shall repeat these test(s) at no extra cost to the purchaser.

In the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design/manufacturing changes (including substitution of components) or due to non-compliance with the requirement stipulated in the technical specification or any/all additional type tests not carried out without any additional cost implication to the Purchaser.

The purchaser intends to repeat the type tests and additional type tests on transformers, reactors, cables and battery chargers for which test charges shall be payable as per provision of contract. The price of conducting type tests and additional type tests shall be included in Bid price and break up of these shall be given in the relevant schedule of Bid Proposal sheets. These type tests charges would be considered in bid evaluation. In case the bidder does not indicate charges for any of the type tests or does not mention the name of any test in the price schedules, it will be presumed that the particular test has been offered free of charge. Further, in case any bidder indicates that he shall not carry out a particular test, his offer shall be considered incomplete and shall be liable to be rejected.

All equipment being supplied shall conform to type tests and shall be subject to routine tests in accordance with requirements stipulated under respective sections. Purchaser reserves the right to witness any or all the type tests. The Contractor shall intimate the Purchaser the detailed programme about the tests at least three (3) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies. Purchaser reserves the option for getting any or all the type tests repeated on the equipment. The Contractor shall also submit type test procedure for approval of the Purchaser.

The Contractor shall give the Purchaser/inspector thirty (30) days written notice of any material being ready for testing. Such tests shall be to the Contractor's account except for the expenses of the inspector. Unless witnessing of the tests is virtually waived, the Purchaser/ inspector will attend such tests within thirty (30) days of the date of which the equipment is notified as being ready for test/ inspection, failing which the Contractor may proceed with the test which shall be deemed to have been made in the Inspector's presence and the Contractor shall forthwith forward duly certified copies of test reports in triplicate to the Inspector.

The Purchaser or Inspector shall, within fifteen (15) days from the date of inspection as defined herein, give notice in writing to the Contractor, of any objection to any

drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and shall either make the modifications that may be necessary to meet the said objections or shall confirm in writing to the Purchaser/ inspector giving reasons therein, that no modifications are necessary to comply with the Contract.

When the factory tests have been completed at the Contractor's or Sub-Contractor's works, the Purchaser/ inspector shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the Purchaser/inspector, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Engineer/ Inspector. Failure of the Purchaser/inspector to issue such a certificate shall not prevent the Contractor from proceeding with the Works. The completion of these tests or the issue of the certificate shall not bind the Purchaser to accept the equipment should it, on further tests/ after erection, be found not to comply with the Contract. The equipment shall be dispatched to site only after approval of test reports and issuance of MICC by the Purchaser.

In all cases where the Contract provides for tests whether at the premises or at the works of the Contractor or of any Sub-Contractor, the Contractor except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Purchaser /Inspector or his authorised representative to carry out effectively such tests of the equipment in accordance with the Contract and shall give facilities to the Purchaser Inspector or to his authorised representative to accomplish testing.

The inspection by Purchaser and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the Contract.

The Purchaser will have the right of having at his own expenses any other test(s) of reasonable nature carded out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests, to satisfy that the material comply with the specification.

The Purchaser reserves the right for getting any field tests not specified in respective sections of the technical specification conducted on the completely assembled equipment at site. The testing equipment for these tests shall be provided by the Purchaser

### **3.12 FINISHING OF METAL SURFACES**

All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hot-dip galvanized after fabrication. High tensile steel nuts & bolts and spring washers shall be electro-galvanized to service condition 4. All steel conductors including those used for earthing/ grounding (above ground level) shall also be galvanized according to IS: 2629.

### 3.12.1 HOT DIP GALVANISING

The minimum weight of the zinc coating shall be 610 g/ m<sup>2</sup> and minimum thickness of coating shall be 85 microns for all items thicker than 6mm. For items lower than 6mm thickness requirement of coating thickness shall be as per relevant ASTM. For surface which shall be embedded in concrete, the zinc coating shall not be less than 610 g/ m<sup>2</sup>.

The galvanised surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surface, flaking or peeling off, etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

After galvanizing no drilling or welding shall be performed on the galvanized parts of the equipment excepting that nuts may be threaded after galvanizing. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanisation. The galvanized steel shall be subjected to six one-minute dips in copper sulphate solution as per IS-2633.

Sharp edges with radii less than 2.5 mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions.

Following galvanizing tests shall essentially be performed as per relevant Indian Standards.

- Coating thickness
- Uniformity of zinc
- Adhesion test
- Mass of zinc coating

Galvanised material must be transported properly to ensure that galvanised surfaces are not damaged during transit. Application of zinc rich paint at site shall not be allowed.

### 3.12.2 PAINTING

All sheet steelwork shall be degreased, pickled, phosphated in accordance with the IS-6005 "Code of practice for phosphating iron and sheet". All surfaces, which will not be easily accessible after shop assembly, shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with atleast two coats of primer. Oil, grease, dirt and swaf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, stoving-type zinc chromate primer. The first coat may be 'flash dried' while the second coat shall be stoved.

After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting.

The exterior colour of the paint shall be as per shade no. 697 of IS -5 and inside shall be glossy white. Each coat of primer and finishing paint shall be of slightly different shade to enable inspection of the painting. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipment.

In case the Bidder proposes to follow his own standard surface finish and protection procedures or any other established painting procedures, like electrostatic painting etc., the procedure shall be submitted along with the Bids for Purchaser's review & approval.

### 3.13 AUXILIARY SUPPLY

The sub-station auxiliary supply is normally met through a system indicated under section-5 having the following parameters. The auxiliary power for station supply, including the equipment drive, cooling system of any equipment, air-conditioning, lighting etc shall be designed for the specified Parameters as under. The DC supply for the instrumentation and PLCC system shall also conform to the parameters as indicated in the following.

| Normal Voltage | Variation in Voltage | Frequency HZ | in Phases | Neutral connection |
|----------------|----------------------|--------------|-----------|--------------------|
| 415V           | +/- 1 0%             | 50 +/- 5%    | 3/4-Wire  | Solidly            |
| 240 V          | +/- 1 0%             | 50 +/- 5%    | 1 /2-wire | Earthed.           |
| 220V           | 240-190 V            | DC           | 2-wire    | Isolated           |
| 50 V           | 53- 41.5 V           | DC           | 2-wire    | +ve -earthed       |

Combined variation of voltage and frequency shall be limited to +/- 10%.

### 3.15 CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS

3.15.1 All power clamps and connectors shall conform to IS:5561 & NEMA CC1 and shall be made of materials listed below-

|    |  |   |
|----|--|---|
| a) | For connecting ACSR conductors   | Aluminium alloy casting, conforming to designation A6 of IS:617 and shall be tested for all test as per IS:617  |
| b) | For connecting bimetallic equipment terminals made of copper/ brass with ACSR conductors | Connectors made from Al alloy casting, conforming to designation A6 of IS 617 with 2-mm thick bimetallic liner and shall be tested as per IS 617. Copper alloy liner shall be cast integral with Al body. |
| c) | For connecting G.I. Shield wire  | Galvanised mild steel   |

|    |   |   |
|----|---|---|
| d) | i) Bolts, nuts & Plain washers          | Electro-galvanised for sizes below M12, for others hot dip galvanized                 |
|    | ii) Spring washers for items 'a' to 'c' | Electro-galvanised mild steel suitable for at least service conditions as per IS 1573 |

Each equipment shall be supplied with the necessary terminals and connectors, as required by the ultimate design for the particular installation. The conductor terminations of equipment shall be either expansion, sliding or rigid type suitable for 4" IPS (O.D. : 114.2 mm, ID: 97.18 mm) aluminium tube or suitable for Quad/Twin Moose ACSR Conductor (450 mm sub-conductor spacing and 250 mm Sub-Conductor spacing for 400 kV & 220 kV respectively). The requirement regarding external corona and RIV as specified for any equipment shall include its terminal fittings and the equipment shall be factory tested with the connectors in position. If corona rings are required to meet these requirements they shall be considered as part of that equipment and included in the scope of work.

Where copper to aluminium connections are required, bimetallic clamps shall be used, which shall be properly designed to ensure that any deterioration of -the connection is kept to a minimum and restricted to parts which are not current carrying or subjected to stress. The design details of the joints shall be furnished to the Purchaser by the Contractor.

Low voltage connectors, grounding connectors and accessories for grounding all equipment as specified in each particular case, are also included in the scope of Work.

No current carrying part of any clamp shall be less than 10 mm thick. All ferrous parts shall be hot dip galvanized. Copper alloy liner of minimum 2 mm thickness shall be cast integral with aluminium body for Bimetallic clamps.

All casting shall be free blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.

Flexible connectors, braids or laminated straps made for the terminal clamps for bus posts shall be suitable for both expansion or through (fixed/ sliding) type connection of 4" IPS Al tube as required. In both the cases the clamp height (top of the mounting pad to centre line of the tube) should be same.

Clamp shall be designed to carry the same current as the conductor and the temperature rise shall be equal or less than that of the conductor at the specified ambient temperature. The rated current for which the clamp/connector is designed with respect to the specified reference ambient temperature, shall also be indelibly marked on each component of the clamp/connector, except on the hardware.

All current carrying parts shall be designed and manufactured to have minimum contact resistance.

Clamps and connectors shall be designed to be corona controlled. Corona extinction voltage for 400kV class clamps shall not be less than 320KV (rms) and R.I.V. level shall not be more than 1000 micro volts at the test voltage specified in respective sections.

### 3.15.2 Tests

Clamps and connectors should be type tested as per IS:5561 and shall also be subjected to routine tests as per IS:5561. Type tests/special tests shall be carried out on three samples.

The following is the list of type tests:

- i) Temperature rise test (max. temp. rise allowed is 35°C over 50°C ambient)
- ii) Short time current test
- ii) Corona (dry) and RIV (dry) test (for 220 kV and higher voltage level)
- iv) Resistance test and tensile test

### 3.16 CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES & MARSHALLING BOXES FOR OUTDOOR EQUIPMENT

All types of boxes, cabinets, etc. shall generally conform to & be tested in accordance with IS-5039/ IS 8623, IEC: 439, as applicable, and the clauses given below:

Control cabinets, junction boxes, Marshalling boxes and terminal boxes shall be made of sheet steel or aluminium enclosure and shall be dust, water and vermin proof. Sheet steel used shall be at least 2.0-mm thick cold rolled or 2.5 mm hot rolled. The box shall be properly braced to prevent wobbling. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation. In case of aluminium enclosed box the thickness of aluminium shall be such that it provides adequate rigidity and long life as comparable with sheet steel of specified thickness.

Cabinet/boxes shall be free-standing, floor-mounting type, wall mounting type or pedestal mounting type as per requirements. Cabinet/boxes shall be provided with double hinged doors with padlocking arrangements. The distance between two hinges shall be adequate to ensure uniform sealing pressure against atmosphere. The quality of the gasket shall be such that it does not get damaged/cracked during the operation of the equipment.

All doors, removable covers and plates shall be gasketed all around with suitably profiled EPDM gaskets. The gasket shall be tested in accordance with approved quality plan. The quality of gasket shall be such that it does not get damaged/cracked during the ten years of operation of the equipment or its major overhaul whichever is earlier. All gasketed surfaces shall be smooth straight and reinforced if necessary to minimise distortion and to make a tight seal. Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh made of brass.

All boxes/cabinets shall be designed for the entry of cables from bottom by means of weather proof and dust-proof connections. Boxes and cabinets shall be designed with generous clearances to avoid interference between the wiring entering from below and any terminal blocks or accessories mounted within the box or cabinet. Suitable cable gland plate projecting at least 150 mm above the base of the marshalling kiosk/box shall be provided for this purpose along with the proper blanking plates. Necessary number of cable glands shall be supplied and fitted on this gland plate. The gland shall

project at least 25mm above gland plate to prevent entry of moisture in cable crutch. Gland plate shall have provision for some future glands to be provided later, if required. The Nickel- plated glands shall be dust-proof, screw on & double compression type and made of brass. The gland shall have provision for securing armour of the cable separately and shall be provided with earthing tag. The glands shall conform to BS: 6121.

A 240-V, single phase, 50 Hz, 15-A AC plug and socket shall be provided in the cabinet with ON-OFF switch for connection of hand lamps. Plug and socket shall be of industrial grade. For illumination, 20-W fluorescent tube or a 15-W CFL shall be provided. The switching of the fittings shall be controlled by a door switch.

All control switches shall be of rotary switch type and Toggle/piano switches shall not be accepted.

Positive earthing of the cabinet shall be ensured by providing two separate earthing pads. The earth wire shall be terminated on to the earthing pad and secured by the use of self- etching washer. Earthing of hinged door shall be done by using a separate earth wire.

The bay marshalling kiosks shall be provided with danger plate and a diagram showing the numbering/connection/ferruling by pasting the same on the inside of the door.

### **Tests**

- a) In addition to routine tests as per IS 5039, following routine tests shall also be conducted:
  - i) Check for wiring
  - ii) Visual and dimension check
- b) The enclosure of bay marshalling kiosk, junction box, terminal box shall be type tested for IP-55 as per IS: 13947. After IP-55 test, 2.5 kV rms for 1 (one) minute, insulation resistance and functional tests shall be carried out.

A canopy and sealing arrangements for operating rods shall be provided in Marshalling Boxes control cubicles to prevent ingress of rain water.

### **3.17 AUXILIARY SWITCHES**

The auxiliary switches shall conform to following type tests:

- (a) Electrical endurance test - A minimum of 2000 operations for 2 A DC with a time constant greater than or equal to 20 millisecond with a subsequent examination of mV drop/visual defects/temperature rise test.
- (b) Mechanical endurance test. A minimum of 1,00,000 operations with a subsequent checking of contact pressure test/ visual examination.
- (c) Heat run test on contacts.  
Insulation Resistance Test / HV test (2.5 kV for one minute)

### 3. 18 TERMINAL BLOCKS AND WIRING

Control and instrument leads from the switchboards or from other equipment will be brought to terminal boxes or control cabinets in conduits. All inter-phase and external connections to equipment or to control cubicles will be made through terminal blocks.

Terminal blocks shall be 1100-V grade and have continuous rating to carry the maximum expected current on the terminals. Those shall be of moulded piece, complete with insulated barriers stud type terminals, washers, nuts and lock nuts. Screw clamp, overall insulated, insertion type, rail mounted terminals can be used in place of stud type terminals. But preferably the terminal blocks shall be non-disconnecting stud type equivalent to Elmex type CATM4, Phoenix, cage-clamp-type of Wago or equivalent.

Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. The current transformer secondary leads shall also be provided with short-circuiting and earthing facilities.

The terminal shall be such that maximum contact area is achieved when a cable is terminated. The terminal shall have a locking characteristic to prevent cable from escaping from the terminal clamp unless it is done intentionally.

The conducting part in contact with cable shall preferably be tinned or silver-plated. However, nickel-plated copper or zinc-plated steel shall also be acceptable.

The terminal blocks shall be of extensible design.

The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.

The terminal blocks shall be fully enclosed with removable covers of transparent, non-deteriorating type plastic material. Insulating barriers shall be provided between the terminal blocks. These barriers shall not hinder the operator from carrying out the wiring without removing the barriers.

The arrangements shall be in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live.

At least 20 % spare terminals shall be provided on each panel/cubicle/box and these spare terminals shall be uniformly distributed on all terminal rows.

Unless otherwise specified, terminal blocks shall be suitable for connecting the following conductors on each side.

|    |                                 |  |
|----|---------------------------------|--|
| a) | All circuits except CT circuits | Min. of two of 2.5 mm <sup>2</sup> of copper flexible. |
| b) | All CT circuits                 | Min. of 4 nos. of 2.5 mm <sup>2</sup> copper flexible  |

There shall be a minimum clearance of 250 mm between the First/bottom row of terminal block and the associated cable gland plate. Also the clearance between two rows of terminal blocks shall be a minimum of 150 mm.

The Contractor shall furnish all wire, conduits and terminals for the necessary inter-phase electrical connections (where applicable) as well as between phases and common terminal boxes or control cabinets. For equipment rated for 400 kV and above the wiring required in these items shall be run in metallic ducts or shielded cables in order to avoid surge over voltages either transferred through the equipment or due to transients induced from the EHV circuits.

All input and output terminals of each control cubicle shall be tested for surge withstand capability in accordance with the relevant IEC Publications, in both longitudinal and transverse modes. The Contractor shall also provide all necessary filtering, surge protection, interface relays and any other measures necessary to achieve an impulse withstand level at the cable interfaces of the equipment

### **3.19 LAMPS AND SOCKETS**

#### **3.19.1 Lamps:**

All incandescent lamps shall use a socket base as per IS-1258, except in the case of signal lamps.

#### **3.19.2 Sockets**

All sockets (convenience outlets) shall be suitable to accept both 5 Amp & 15 Amp pin round Standard Indian plugs. They shall be switched sockets with shutters.

#### **3.19.3 Hand Lamp:**

A 240 Volts, single Phase, 50 Hz AC plug point shall be provided in the interior of each cubicle with ON-OFF Switch for connection of hand lamps.

#### **3.19.4 Switches and Fuses:**

Each control panel shall be provided with necessary arrangements for receiving, distributing, isolating and fusing of DC and AC supplies for various control, signalling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with switch-fuse units. Selection of the main and sub-circuit fuse ratings shall be such as to ensure selective clearance of sub-circuit faults. Potential circuits for relaying and metering shall be protected by HRC fuses.

All fuses shall be of HRC cartridge type conforming to IS 9228 mounted on plug-in type fuse bases. Miniature circuit breakers with thermal Protection and alarm contacts will also be accepted. All accessible live connection to fuse bases shall be adequately shrouded. Fuses shall have operation indicators for indicating blown fuse condition. Fuse carrier base shall have imprints of the fuse rating and voltage.

### **3.20 FIRST FILL OF CONSUMABLES, OIL AND LUBRICANTS**

All the first fill of consumables such as oils, lubricants, filling compounds, touch up paints, soldering/brazing material for all copper piping of circuit breakers and essential chemicals etc. which will be required to put the equipment covered under the scope of the specifications, into

successful Operation, shall be furnished by the Contractor unless specifically excluded under the exclusions in these specifications and documents.

### **3.21 PACKAGING & PROTECTION**

All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. On request of the Owner / Purchaser, the supplier shall also submit packing details/associated drawing for any equipment/material under his scope of supply, to facilitate the Purchaser to repack any equipment/material at a later date, in case the need arises. While packing all the materials, the limitation from the point of view of availability of Railway wagon sizes in India should be taken into account. The supplier shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharf age and other such charges claimed by the transporters, railways etc. shall be to the account of the supplier.

All coated surfaces shall be protected against abrasion, impact, discolouration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and piping's and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.

### **3.22 Bushings, Hollow Column Insulators, Support Insulators:**

Bushings shall be manufactured and tested in accordance with IS: 2099 & IEC: 137 while hollow column insulators shall be manufactured and tested in accordance with IEC 233/IS 5621. The support insulators shall be manufactured and tested as per IS 2544/IEC 168 and IEC 273. The insulators shall also conform to IEC 815 as applicable.

The bidder may also offer composite silicon insulator, conforming to IEC-1109.

Support insulators, bushings and hollow column insulators shall be manufactured from high quality porcelain. Porcelain used shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified tough and impervious to moisture.

Glazing of the porcelain shall be uniform brown in colour, free from blisters, burrs and similar other defects.

Supports insulators/bushings/hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.

When operating at normal rated voltage there shall be no electric discharge between the conductors and bushing which would cause corrosion or injury to conductors, insulators or supports by the formation of substances produced by chemical action. No radio interference shall be caused by the insulators/bushings when operating at the normal rated voltage.

Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps and the shape and the

strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.

All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued up porcelain parts by grinding and metal parts by machining. Insulator/bushing design shall be such as to ensure a uniform compressive pressure on the joints.

### **3.23 MOTORS**

Motors shall be "Squirrel Cage" three phase induction motors of sufficient size capable of satisfactory operation for the application and duty as required for the driven equipment and shall conform to type tests and shall be subjected to routine tests as per applicable standards. The motors shall be of approved make.

Motors to be installed outdoor without enclosure shall have hose proof enclosure equivalent to IP 55 as per IS: 4691. For motors to be installed indoor i.e. inside a box, the motor enclosure, shall be dust proof equivalent to IP 44 as per IS: 4691.

Two independent earthing points shall be provided on opposite sides of the motor for bolted connection of earthing conductor.

Motors shall have drain plugs so located that they will drain water resulting from condensation or other causes from all pockets in the motor casing

Motors weighing more than 25Kg. shall be provided with eyebolts, lugs or other means to facilitate lifting.

Continuous motor rating (name plate rating) shall be at least ten (10) percent above the maximum load demand of the driven equipment at design duty point and the motor shall not be over loaded at any operating point of driven equipment that will rise in service.

Motors shall be capable at giving rated output without reduction in the expected life span when operated continuously in the system having the particular as given in Clause 15.0 of this section.

All induction motors shall be suitable for full voltage direct-on-line starting and accelerating to the rated speed along with the driven equipment without exceeding the acceptable winding temperature even when the supply voltage drops down to 80% of the rated voltage.

Motors shall be capable of withstanding the electro-dynamic stresses and heating imposed if it is started at a voltage of 110% of the rated value.

The locked rotor current shall not exceed six (6) times the rated full load current for all motors, subject to tolerance as given in IS: 325.

Motors when started with the driven equipment imposing full starting torque under the supply voltage conditions specified under Clause 15.0 shall be capable of withstanding

at least two successive starts from cold condition at room temperature and one start from hot condition without injurious heating of winding. The motors shall also be suitable for three equally spread starts per hour under the above referred supply condition.

The locked rotor withstand time under hot condition at 110% of rated voltage shall be more than starting time with the driven equipment of minimum permissible voltage by at least two seconds or 15% of the above requirement, the Bidder shall offer centrifugal type speed switch mounted on the motor shaft which shall remain closed for speed lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% of the rated speed in either direction of rotation.

The maximum permissible temperature rise over the ambient temperature of 50 degree C shall be within the limits specified in IS: 325 (for 3 phase induction motors) after adjustment due to increased ambient temperature specified.

The double amplitude of motor vibration shall be within the limits specified in IS: 4729. Vibration shall also be within the limits specified by the relevant standard for the driven equipment when measured at the motor bearings.

All the induction motors shall be capable of running at 80% of rated voltage for a period of 5 minutes with rated load commencing from hot condition.

#### TESTING AND COMMISSIONING

An indicative list of tests is given below. Supplier shall perform any additional test based on specialities of the items as per the field O.P./Instructions of the driven equipment supplier or Owner / purchaser without any extra cost to the owner / Purchaser. The supplier shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the Owner / Purchaser for approval.

Insulation resistance.

Phase sequence and proper direction of rotation.

Any motor operating incorrectly shall be checked to determine the cause and the conditions corrected.

## ANNEXURE - A

### CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST

#### General:

Unless otherwise stipulated, all equipment together with its associated connectors, where applicable, shall be tested for external corona both by observing the voltage level for the extinction of visible corona under failing power frequency voltage and by measurement of radio interference voltage (RIV).

#### Test Levels:

The test voltage levels for measurement of external RIV and for corona extinction voltage are listed under the relevant clauses of the specification.

#### 3.0 Test Methods for RIV:

3.1 RIV tests shall be made according to measuring circuit as per CISPR Publication 16-1(1993) Part -1. The measuring circuit shall preferably be tuned to frequency within 10% of 0.5 MHz but other frequencies in the range of 0.5 MHz to 2 MHz may be used, the measuring frequency being recorded. The results shall be in micro-volts.

3.2 Alternatively, RIV tests shall be in accordance with NEMA standard Publication No. 107-1964, except otherwise noted herein.

3.3 Temporary additional external corona shielding may be provided in measurement of RIV. Only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted within 3.5 meters of terminals.

3.4 Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100%, 115% and 130% of the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 400 kV and 220 kV is listed in Section -1/ Section -2 of the specification together with maximum permissible RIV level in micro-volts.

3.5 The measuring instruments shall be as per CISPR recommendation or equivalent device so long as it has been used by other testing authorities.

3.6 The RIV measurement may be made with a noise meter. A calibration procedure of the frequency to which noise meter shall be tuned shall establish the ratio of voltage at the high voltage terminal to voltage read by noises meter.

#### 4.0 Test Methods Visible Corona

The purpose of this test is to determine the corona extinction voltage of apparatus, connectors etc. The test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a

search technique shall be used near the onset and extinction voltages, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 130% of RIV test voltage and maintained for five minutes. The voltage will then be decreased slowly until visible corona disappears. The procedure shall be repeated at least 4 times with corona inception and extinction voltage recorded each time. The corona extinction voltage for purpose of determining compliance with the specification shall be the lowest of the four values at which visible corona (negative or positive polarity) disappears. Photographs with laboratory in complete darkness shall be taken under test conditions, at all voltage steps i.e. 85%, 100%, 115% and 130%. Additional photographs shall be taken at corona inception and extinction voltages. At least two views shall be photographed in each case using panchromatic film with an ASA daylight rating of 400 with an exposure of two minutes at a lens aperture of f/5.6 or equivalent. The photographic process shall be such that prints are available for inspection and comparison with conditions as determined from direct observation. Photographs shall be taken from above and below the level of connector so as to show corona on bushing, insulators and all parts of energised connectors. The photographs shall be framed such that test object essentially, fills the frame with no cut-off.

The test shall be recorded on each photograph. Additional photographs shall be taken from each camera position with lights on to show the relative position of test object to facilitate precise corona location from the photographic evidence.

In addition to photographs of the test object, at least four photographs shall be taken of the complete test assembly showing relative positions of all the test equipment and test objects. These four photographs shall be taken from four points equally spaced around the test arrangement to show its features from all sides. Drawings of the laboratory and test set up locations shall be provided to indicate camera positions and angles. The precise location of camera shall be approved by Purchaser's inspector, after determining the best camera locations by that energisation of test object at a voltage which results in corona.

The test to determine the visible corona extinction voltage need not be carried out simultaneously with test to determine RIV levels.

However, both tests shall be carried out with the same test set up and as little time duration between tests as possible. No modification on treatment of the sample between tests will be allowed. Simultaneous RIV and visible corona extinction voltage testing may be permitted at the discretion of Purchaser's inspector if, in his opinion, it will not prejudice other test.

### **Test Records:**

In addition to the information previously mentioned and the requirements specified as per CISPR or NEMA 107-1964 the following data shall be included in test report:

- a) Background noise before and after test.
- b) Detailed procedure of application of test voltage.
- c) Measurements of RIV levels expressed in micro-volts at each level.
- d) Results and observations with regard to location and type of interference sources detected at each step.

- e) Test voltage shall be recorded when measured RIV passes through 100 micro-volts in each direction.
- f) Onset and extinction of visual corona for each of the four tests required shall be recorded.

## **ANNEXURE - B**

### **SEISMIC WITHSTAND TEST PROCEDURE**

The seismic withstanding test if required to be conducted on the complete equipment shall be carried out along with supporting structure.

The supplier shall arrange to transport the structure from his premises/POWERGRID sites for the purpose of seismic withstand test only.

The seismic level specified shall be applied at the base of the structure. The accelerometers shall be provided at the Terminal Pad of the equipment and any other point as agreed by the Purchaser / owner. The seismic test shall be carried out in all possible combinations of the equipment. The seismic test procedure shall be furnished for approval of the Purchaser / owner.