# भारत हैवी ईलैक्ट्रिकल्स लिमिटेड
# BHARAT HEAVY ELECTRICALS LIMITED
## पारेषण व्यापार अभियांत्रिकी प्रबंधन
## TRANSMISSION BUSINESS ENGINEERING MANAGEMENT

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| ग्राहक/ CUSTOMER | POWERGRID CORPORATION OF INDIA LTD. (PGCIL) |
| परियोजना/ PROJECT | 765/ 400 KV AGRA (NEW) SUBSTATION |
| NOA NO. | CC-CS/ 444-NR-1/ 552546/ 3/ G3/ NOA-I/ 5163 & 5164 DATED 31.12.14 |



### विषय-सूचि/ CONTENTS



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# SECTION 1

# Intent, Design criteria, System design and scope

1.1.1. This specification is intended to specify the requirements for design, engineering, manufacture, assembly, stage testing, inspection, testing before supply, packing, forwarding, delivery at site and complete erection of all equipment and accessories, testing of the system, trial run, commissioning of the system, final painting and carrying out acceptance test at site of Oil Handling System along with its accessories and auxiliary equipment / instruments etc. as mentioned in this section and in various other sections of this specification for 765 kV/ 400 kV Agra UPPTCL (New) Substation at Fatehabad, Agra.

1.1.2. The requirements specified under SECTION 2 and SECTION 3, of the specification shall be considered as part of this section. In case of variance between various sections, the requirements of Section 1 shall prevail.

1.1.3. It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respect to high standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to Purchaser / Owner, who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material, which in his/their judgment is not in full accordance with the specifications.

1.1.4. The bidder shall be deemed to have understood completely all the tender drawings and documents and quoted accordingly. Contract shall be on lump sum basis for the package. Within the scope of the contract, no variation shall be admissible to Contractor so far the inputs remain unchanged.

1.1.5. In case of any deviation, the bidder shall indicate separately the deviations clause-wise with respect to the specification in the `Schedule of Deviation' as described in Section 5. Deviations in any other form including clarifications / assumptions / etc will not be considered and it will be construed that the bid conforms strictly to the specification.

1.1.6. This specification makes it obligatory for the contractor to arrange / obtain necessary approval / clearance from statutory organizations wherever applicable for the plant / machinery / sub-systems under the scope specified

1.1.7. The system shall be designed to suit the extreme of outside conditions as given in “Section 3” of the specification.

1.1.8. The term `Owner' appearing in this specification shall refer to UP Power Transmission Corporation Ltd. (UPPTCL), the term customer shall refer to 'Powergrid', the term `Purchaser' shall refer to Bharat Heavy Electricals Limited (BHEL) and the term `Contractor' shall refer to the successful Bidder.

## 1.1.9. SCOPE

This specification covers design, engineering, manufacturing, assembly, stage testing, inspection, testing before supply, packing, forwarding delivery at site including testing of 6000LPH oil purification and filtration plant along with its accessories and auxiliary equipment/ instruments etc. for the transformers and reactors supplied by various manufacturers of repute to be commissioned at any 765/ 400 kV substation of UPPTCL and subsequently to be used for maintenance of these transformer and reactors after being put into service.

## 2.0.0 STANDARDS

Except as modified by this specification, all equipment and instruments shall comply with the latest relevant national / international standard viz. IS, IEC, VDE, BS, ASIM etc. on the subject and the reference of standard shall be clearly indicated by the contractor in their offer.

## 3.0.0 TECHNICAL REQUIREMENT OF OIL FILTRATION PLANT

The oil filtration and purification plants are required for purification of the new as well as old used oil of various 765/400/220/132 kV substations equipment of various makes and size.

## 4.0.0 PERFORMANCE REQUIREMENT

4.1.0 The oil filtration plant shall be capable of accepting clean new insulating oil received filled in delivery tanks / barrels having a water content of 100 ppm by weight (approx.) saturated with air at 12% by volume (approx.) at a temperature of about 00 C and shall be capable of treating this oil complying to IEC–60296 / IS-335 to the following guaranteed parameters in a single pass at the rated flow.

| | | |
|---|---|---|
| 1. | Reduction of Gas content of | : Less than 0.2% |
| 2. | Reduction of Moisture content of | : Less than 5 ppm. |
| 3. | Filtration "pore diameter" | : Maximum 1 micron |
| 4. | Dielectric strength (Test according to IEC publication 156 with cap electrodes R= 25 mm, electrodes distance 2.5mm. | : more than 60 kV |
| | or<br>Test according to ASIN D 1816 (0.04 inch. gap) | : more than 25 kV |
| 5. | Dissipation factor of oil tan delta at 90°C after filling into the equipment | : 0.2 % i.e, 0.002 |
| 6. | Neutralization value | |
| | i) Before treatment | : 0.5 mg KOH/g (maximum) As per IS: 1866 : 1993 |
| | ii) After treatment | |
| | a) For new oil | : 0.04 mg KOH / gr. as per IS 335 / IEC-60296 |
| | b) For old oil | : The characteristic of oil after again not yet finalized valued to be decided in Consultation with bidder As per IS–335:1983/ IEC-60296. |

4.2.0 The plant shall be suitable for carrying out the following operations :-

(a) Degassing, dehydrating and filtrating of transformer oil under vacuum and to give required guaranteed parameters in a single pass of oil at the rated flow.

(b) Evacuation of Transformers tanks filled with Nitrogen gas for protection during shipping or land transportation simultaneous to the oil treatment under high vacuum.

(c) Filling of treated oil into transformer / Reactor tank under high vacuum with the help of the plant.

(d) Completely evacuating oil from the transformer / reactor tanks requiring drying out of insulation and to carry out drying procedure of insulation by evacuating transformer / reactors tank and by filling hot oil into the tanks effect continuous circulation with through out capacity continuously till the parameters are achieved.

(e) The plants should be adoptable to spray the oil into the transformer being dried out as at cl. 5.2.0(d) above to effect quick drying of insulation.

(f) The plant must also be capable to treat oil of transformers/ reactors which are in service as the old/ used oil has higher acidity and low interfacial tension. The degree of vacuum required is much higher that what required for new oils. As much it is the most important function of the oil filtration plant to treat such oils and to give required guaranteed parameters in a single pass.

4.3.0 The oil purifying machine shall be for outdoor services entirely self contained, completely weather proof and shall be of mobile design complete with pneumatic tyre wheels with spring under the heavy base steel frame and tow bar suitable for rolling the machine on ground / along public roads. This shall also be fitted with over run brakes. This machine shall work with three phase 400 / 440 volts, 50 C/S Ac supply. The purification of the oil required in case of transformer / reactors shall be by circulating the oil through vacuum filtration and purification machine i.e., the machine shall draw the oil from the oil drums connected through a header or oil reservoir and deliver into the transformer tank under high vacuum filtration and purification machine is required to remove the impurities of the oil mainly consists of:

1. Moisture in form of :
   a) Free and finely despersed moisture
   b) Moisture in solution.
2. Sludge formed due to dust fibres from winding insulation.
3. Dissolved gases or air.
4. Carbonaceous products formed due to arcing including micro carbon particles.
5. Adrentitious solids viz. Insoluble or particaly oxidation products.
6. Drum scale and any other foreign solid particles

**4.4.0 Main features of vacuum filtration and purification machine.**

1. Thermostatically controlled oil heaters.

2. Ultra filters or any other suitable filters.
3. Electrically driven oil inlet pump combination which shall be suitable to take oil completely from the transformer tank under full vacuum.
4. Electrically driven discharge pump designed for sucking oil against vacuum from vacuum chambers.
5. One or more vacuum chambers adequately designed to treat oil up to ultra high vacuum equipped with level indicating and flow controlling, devices for maintaining the level of oil foam in vacuum chamber for a predetermined flow rate.
6. The electrically driven vacuum pump combinations of suitable capacities one suitable for creating vacuum in vacuum chambers for oil treatment and other for evacuating transformer / reactor tank upto desired vacuum.
7. Vacuum gauges.
8. Temperature Indicators.
9. Flow indicators.
10. Oil register meter.
11. Moisture content measuring Instrument.
12. Gas content measuring instrument.
13. Filter choke indicator.
14. The whole equipment shall be enclosed in a sheet metal cover without external levers but with hinged doors to facilitate operation of the machine.
15. Vacuum pump water cooling system.
16. Oil inlet and discharge hose pipes.
17. Electric cable for connecting the machine to the mains.
18. Base plate with tow bar.
19. All necessary controls Instrumentation and Alarms etc.

## 4.5.0 OPERATION:

The insulating oil in the Transformer / reactors tank shall be filled under high vacuum. The insulating oil to be filled in the tank shall be treated in the thermostatically controlled indirect type of heater up to 40-60 °C by an auxiliary fluid or any other suitable arrangement thus eliminating over heating or localise heating of oil. This preheated oil shall then be passed through ultra filter working on effective and tested method for removal of solid impurities generally present in the transformer oil and it will also be subjected to vacuum at treatment in vacuum chambers having adequate vacuum at temperature at 60 °C of oil for removing dissolved moisture and gases. The separation of dissolved moisture and gases. The separation of dissolved impurities shall be carried out under vacuum. oil after purification in the vacuum chambers shall be pumped out through a discharge pump with high suction and discharge into transformer / reactor tank.

## 4.6.0 COMPONENT EQUIPMENT

The purification system shall be fully assembled on heavy duty steel base which shall be sufficiently braced to minimise vibration. A drip lip shall be provided on the base to collect spillage and drippage.

## 4.6.1 PRELIMINARY FILTER

One coarse filter shall be provided before the inlet pump to prevent entering particles of any appreciable size into the system. This shall be complete with magnetic particles to prevent them from entering the system.

Flow sight indicators in the inlet and outlet pipings

### 4.6.2 OIL INLET PUMPS

Electricity driven pumps of suitable capacity shall be provided for suction of oil for treatment to the filtration and purification machine. This should be of positive displacement gear type combinations of pumps suitable to take out oil completely from the transformer tank under full vacuum, in case of drying out or insulation of transformer. The pumps shall be complete with an internal relief value to protect the same from over pressure, single mechanical seal, belt driven and double speed motor. It shall also have a bypass line with flow control valve duly complete with lockable arrangement to adjust the flow rate. One gear pump of similar capacity with isolation valve shall also be provided in parallel to the first pump as an stand by to ensure continuous operation of the machine even in case of failure of the first pump. The pump should be suitable for continuous operation of the machine and it shall be provided with an automatic arrangement through flow switch and a time delay circuit to stop the pump automatically in the event when the oil flow is not present during this delayed time of about 30 seconds thereby ensuring that the equipment will not operate without oil supply. Alternatively interlocking between the heater and the inlet pump may be provided in order to stop the pump when there is no oil flow through the heater and subsequently heater shall not be energised unless the oil is actually flowing. In this case flow will not be necessary before the heater.

### 4.6.3 HEATING SYSTEM

The electric heating system shall either be of indirect type or direct type and it shall be possible to remove or replace the heater elements without disturbing the oil in the heating chamber. The auxiliary oil could also be used to impart heat to the vacuum chamber where actual dehydrating is taking place if necessary.
The heating system shall have a capacity of 150 kW and heating density less than 2 watts / sq. cm. Electrical heater elements shall be suitably designed for partial or full operation through a control arrangement in order to facilitate transformer drying also through heated oil up to temperature 90 $^{0}$C. The complete control scheme shall be fully described. This shall be thermostatically controlled so that the temperature of oil during treatment of transformer oil should not rise higher than 60 $^{0}$C. The heating system shall be provided with proportionating thermostat indication in order to control the electric heating elements to maintain the desired oil temperature. This thermostat should be capable to activate the heater contactors through a series of time delay relays, on deviation from set point, which in turn will energise the required number of heating elements to return the oil temperature to the set point. On seeing this set point the elements should de-energise step by step through a time delay sequence. One more thermostat shall be provided with setting of temperature little higher that the set point of first one as protection to safeguard malfunctioning of former thermostat. These thermostats shall be mounted in a locked box to ascertain the settings of thermostats at required temperature and the readings of both thermostats should be visible from outside box. The electrical switching 'ON' and 'OFF' of the heater shall be by suitable switches provided on main panel of the machine. In case flow switch has been provided before the heater an interlocking arrangement between

heater and flow switch shall be provided so that heater should not be energised unless oil is flowing. Following shall also be provided with the heating system.

a) Two number dial type thermometers to indicate the temperature of oil at inlet and outlet of heater.
b) Safety valve aeration valve and drainage valve.
c) Over heat protection with sound alarm to prevent damage to the oil due to overheating of the heater for any reason. The contractor shall submit heater power calculations justifying heating capacity offered.

## 4.7.0 FILTRATION SYSTEM

a) Filter Press: A filter press shall be provided for clearing of dirty oil as and when required in addition to the filter cartridges or edge type filters.

b) The filter cartridges should be of suitable material and non-hydroscopic. These shall be so arranged in the filter unit that all the solid impurities including micro carbon particles are effectively removed and should be designed for easy and quick replacement. The filter shall be capable of removing 99% of all particles of 1.0 micron in size or larger. Pressure gauges on both sides of the filter shall be provided to indicate the need to change cartridges. A sludge outlet for removing the solid impurities shall be provide to clean the elements without opening the machine. The contractor shall indicate the number of hours for which one set of cartridge type filters will be able to serve as specified in Cl. 4.0.0 to have an idea about the frequency of replacement of cartridges. The rate for these filters shall also be given under cl. 9.0.0 (Spares). The filters shall be provided with aeration and drainage valves.

c) The contractor should also offer edge type filters as an alternative for cartridge filter to be provided in series with filter press be provided for cleaning of edge type filter packs.

d) It has to be mentioned here that contractor should offer cartridge type filters, in their bids with all details.
e) Necessary arrangement shall be made to isolate the Filter Press from the oil line whenever it is so needed. Suitable arrangement with valves shall be provided to bypass the filtration system if and when required.

## 4.8.0 DEGASSING COLUMN

One or more vacuum chambers of suitable capacities with atomising system to remove the last traces of moisture and dissolved gasses from the oil shall be provided in this machine in order to treat the oil under high vacuum at adequate pressures to achieve specified levels of moisture and gases after a single pass. The vacuum chambers shall be designed having liberal falling heights of oil and adequate numbers of suitable sized layers as an oil distribution device so that there shall be no foam formation in the oil even with highest water and air contents in order to allow continuous operation at full capacity under vacuum. In case the degassing column is in multi stages, all the chambers must be distinctly separated by syphon seal arrangements and preferably placed horizontally. The chambers will have complete visibility of oil under process of treatment by providing sight glasses and light to observe the oil level in the chambers.

Proper temperature of oil shall be maintained in the vacuum chamber so that oil shall completely be dehydrated and degassified. To control high oil level and foam level in the vacuum chambers, an optical level monitor is to be provided if considered necessary. This optical level monitor should be inter locked with the inlet gear pump and when oil / foam level increases beyond specified level, the inlet gear pump should stop to prevent flooding. The minimum oil level in the Degassing chambers shall be provided with a view that the maximum free fall height is achieved with in this limited space. The vacuum chambers shall be fabricated of suitable material such as carbon steel and shall be designed for operation at full vacuum. All internal welds must be smooth and interior should be sand blasted to remove rust and scale and shall be painted with best suitable paint viz. White urethan paint etc.

All required accessories viz. vacuum gauge, vacuum break valve, oil drain valve, and, main and auxiliary vacuum connections shall be provided on the column. It shall be ensured that no leakage is from the vacuum break valve and the valves are not vigorously tightened. The main vacuum connection shall permit the use of the processing chamber, to act as a large trap when transformers / reactors is over filled and oil is drawn in to the vacuum line. An adequate control system shall be provided to stop the inlet pump. A sound alarm shall also be provided to give indication of this fact to the operator. The auxiliary vacuum connection shall provide a direct connection to the vacuum pump.

## 4.9.0 DISCHARGE PUMP

The oil after purification, dehydration and degassification in the degassing chamber will be drawn out by a discharge pump which should be a centrifugal pump. The above centrifugal pump should be a glandless canned motor pump without any rotary seal. This discharge pump should have adequate capacity to deliver the required quantity of oil from the degassing chamber under vacuum.

## 4.10.0 VACUUM PUMP COMBINATIONS

The plant shall be provided with two independent sets of vacuum pumps combinations for continuous duty, one pump combination to creates vacuum in the degassing chambers of the plant and the other for purpose of evacuating transformer / reactor tanks for maintaining vacuum in them whiles the oil is being treated by the plant. These sets of pump combinations could also be arranged t work in parallel when required however both the pump combinations should be adequately rated for taking up the duty of other, for meeting any emergency. Each vacuum pump combination shall have sufficient capacity in order to have an ultimate blank off of 10-3 torr on less. The pump combinations shall consist of roots blower backed up by a Rotary oil sealed pump provided with a gas ballast valve. The combination shall ensure required water vapour pumping capability for matching of vacuum pump performance both roots and rotary vacuum pumps shall be of same manufacturer only. The acceptable makes for vacuum pumps are Shinko Seiki (Japan)/ Balzers (Germany)/ Leybold (Germany)/Nash (USA).

Minimum specifications for the Vacuum pumps connected to the Degassing chamber are:

| | |
|---|---|
| Rotary oil sealed pump | - 1 No. |
| Displacement/Exhaust speed | 3700 Ltrs/min. |

| | |
|---|---|
| Ultimate Vacuum with G.B. Closed | 5x $10^{-3}$ Torr |
| Ultimate Vacuum with G.B. Open | 5x $10^{-3}$ Torr |
| Mechnical Booster Pump | - 1 No. |
| Displacement/ Exhaust speed | 1400 M3 /hr. |
| Ultimate Vaccuum | $10^{-1}$ Torr |

Minimum specifications for the Vacuum Pumps for evacuating the Transformer are-

| | |
|---|---|
| Rotary oil sealed pump | -1 No. |
| Displacement/Exhaust speed | 3700Ltrs/min |
| Ultimate Vacuum with G.B. Closed | 5X$10^{-3}$ Torr |
| Ultimate Vacuum with G.B. Open | 5X$10^{-3}$ Torr |
| Mechanical Booster Pump | 1 No. |
| Displacement/ Exhaust Speed | 1400M3 /hr. |
| Ultimate Vacuum | $10^{-4}$ Torr |

Minimum Specifications for the Vacuum Pumps for evacuating the Transformer are

| | |
|---|---|
| Rotary Oil Sealed Pump | 1 No. |
| Displacement/Exhaust Speed | 3700 Ltrs/min |
| Ultimate Vacuum with G.B. Closed | 5X$10^{-3}$ Torr |
| Ultimate Vacuum with G.B. Open | 5X$10^{-3}$ Torr |
| Mechanical Booster Pump | 1 No. |
| Displacement/ Exhaust Speed | 1400M3 /hr. |
| Ultimate Vacuum | $10^{-4}$ Torr |

In case the degassing column is in three stages the vacuum pumping system shall be as below:

| | | |
|---|---|---|
| First Stage | - | Single stage Rotary pump. |
| Second Stage | - | Roots Pump and single stage Rotary Pump. |
| Third Stage | - | Roots pump of higher capacity. |

In order to have flexibility, all Rotary Pumps should be identical and all roots pumps except of third stage will be identical.

For effective cooling these pump combinations shall be adequately cooled through water jacket and radiator with a fan to take care of the tropical climatic conditions with high humidity in which the plant has to work in the field. The pump combinations shall be complete with separations intended for the purposes of condensation of oil vapours and to directly refeed the same in the oil system.

A suitable chiller for this purpose shall be provided in order to have better efficiency. However, this shall be provided in parallel to the conventional condensation system

through water so that in case of breakdown of the chiller. The chiller could be isolated from the system and still machine could operate. Water circulating pumps shall be provided for vapour condensers. Roots pumps of both the combinations shall be provided with built in pressure limitation valves and the Rotary oil sealed pumps with electromagnetic quick reclosing valves and exhaust separators. Both the high vacuum pumps combinations shall be driven through electric motors supplied complete with integral base plates. The combinations shall be complete with vacuum switches to start or stop the roots blowers at desired pressure. Push buttons for starting / stopping the rotary pumps and selector switches to allow operation of the rotary pump without roots blower shall be provided. All necessary protections against over temperature of lubricating oil shall be provided.

## 4.11.0 ELECTRIC MOTORS

TEFC Electrical motors suitably rated to operate on 400 / 440 volts, 50 cycles per second, three phase AC power supply complete with direct on line starter shall be provided for driving various pumps. The motors shall conform to relevant Indian or International Standards.

## 4.12.0 INSTRUMENTS

The complete plant shall be supplied with all required measuring instruments locally mounted on the various equipments as well as necessary instruments shall also be mounted on the control panel.

A) The following instruments shall be locally mounted.

i) Two nos. temperature measuring thermometers scaled in degree centigrade duly protected from external shocks installed at oil inlet and outlet of heater. Outlet thermometer to be provided with alarm contact. One thermometer to be provided for auxiliary oil heating system, if heating is of indirect type.

ii) Temperature actuated switches for the heaters and for other applications.

iii) Pressure indicators at the inlet and outlet of ultra filter and at the discharge pump.

iv) Two nos. absolute pressure indicators one at the degassing chamber and the other for transformer tank.

v) Two nos. vacuum transmitters for vacuum gauges one for vacuum chamber and other for transformer.

vi) Decicators having reagents like activated alumina or charcoal on all vacuum instrumentation connection to prevent contamination by oil / moisture oil.

vii) Level gauge on degassing chamber.

viii) Oil flow counter with a dual register oil totalising meter in the discharge line for totalling upto 9999999 litres. The upper register shall contain 7 digits and shall be not resettable type. The lower register shall contain 8 digits, with the last one

reading in tenths of a litre and shall be of resettable for each work. This shall be located such that it is visible clearly to the operator viewing the control panel.

ix) Flow switches, flow indicators, thermocouples and all other necessary transmitters according to the requirements of instrumentation, controls and alarms on the control panel.

**B) INSTRUMENTS MOUNTED ON THE CONTROL PANEL**

i) One electronic high vacuum gauge to cover pressure range from one milli-Torr to atmospheric pressure suitable for monitoring pressure at the degassing chamber of the plant and transformer locations through a selector switch. For the recorder, the instrument will provide a pressure responsive output independent of selector switch. The pressure responsive output shall be provided throughout the entire pressure range of the gauge at either sensing stations.

ii) Temperature Indicators of oil with a switch for setting required temperature.

iii) One differential pressure gauge across filter.

iv) Hygrometer to indicate, moisture contents in ppm with precision of the inlet and outlet oil with a selector switch and shall cover the complete range as required.

v) Measurement gauge to measure with precision gas content in % by volume in the inlet and outlet oil with a selector switch and shall cover the complete range as required.

vi) Required no. of recorders on the switch panel for the simultaneous registration and plotting with time of following :

a) Temperature of inlet and outlet oil
b) Vacuum in degassing chamber and transformer tank.
c) Water content in the inlet and outlet oil.
d) Gas constant in inlet and outlet oil.

The recorders shall be suitable for plotting the readings with different colourings.

vii) Volt meter.
viii) Ampere Meter.

**4.13.0 CONTROL PANEL**

a) The plant shall have an industrial type suitably sized control panel of rugged construction mounted on legs welded to base plate. The panel shall be externally braced to minimise vibrations of the electrical components. The inside of the panel shall be finished with white enamel. It houses a sub-panel on which are mounted the air circuit breakers, all motor starters, heater contactors, control relays, fuses, fuse blocks, terminal strips and alarm horns. All wires shall be numbered every two inches and shall be neatly bundled to terminate at numbered terminal blocks. Complete wiring shall be furnished. A complete electric wiring diagram for the plant indicating all devices and instruments and terminal

blocks etc shall be made out on one or more metallic enamelled plates with white back grounds and suitably mounted so as to be readily available for guidance during operation / maintenance of the plant. This diagram plate shall be in addition to the wiring drawings which the contractor shall make available along with their instruction manuals. On the panel doors shall be mounted necessary oil tight push buttons and selector switches, pilot lights, alarm lights, alarm resets and other controllers. The acceptable make for contractor, relays, switchgear etc are Seimens/ ABB/ L&T/ Alstom.

b) **Annunciator Alarm system**

Alarm annunciations for the following shall be provided on the panel. These annunciations shall be through audio alarms as well as through visual by means of light or any other reliable device.

i) Loss of vacuum in degassing column.
ii) Loss of vacuum in transformer.
iii) Total loss of flow (Tripping of oil pump and vacuum pumps)
iv) High oil temperature at the heater outlet.
v) High oil level in degassing column.
vi) Low oil level in degassing column.
vii) Ultra filter chocked.
ix) Any other annunciation considered necessary by the supplier.

The annunciator alarm system shall have the back lighted name plate type operation on A.C voltage, complete with a lamp cabinet. The window designation lettering shall be block letter type and in English language. Lettering shall be as large as the window size permit. Windows shall be of suitable size containing 2 lamps connected in parallel. The interior finish of the lamp compartment shall be white enamel of a quality that will not deteriorate with continuous operation of the lamps. A horn shall be mounted inside the cubicle. The annunciator shall have test, reset and alarm silencing push buttons of the momentary contact type for separate mounting below the display rack. The annunciator alarm system shall be so designed that each alarmed condition will cause the appropriate light to be lit and the alarm horn to sound. The alarm silence button shall silence the horn but the alarm light shall remain ON until the alarmed condition has been corrected. The alarm silencer shall only mutes the horn for the existing alarm condition and not for any other that might occur immediately thereafter, even if the previous alarm condition or conditions have not been corrected.

c) **Graphic Sub-Panel**

The panel shall have graphic sub-panel to exhibit illuminated flow diagram. The flow diagram shall indicate conditions of all electrically operated valves, vacuum pumps oil pumps and heater in the circuit and various pipings viz. Oil vacuum etc, with different colour schemes. The graphic flow diagrams shall be duly protected from fading by suitable filter screen. The front of the panel on which shall be mounted various instruments and remote controls, graphic panel etc. shall face such that the operator can observe and operate while standing outside the base frame of the plant. Inside the plant a small work bench shall be provided. The panel shall be covered by casing of the complete plant however, while operating the face covering of the panel can be lifted up and fixed in a

position to act as a rain sun shade. A folding desk near the control panel shall also be provided.

## 4.14.0 CASING

The complete equipment alongwith controlling units shall be housed in suitable weather proof sheet enclosure, made of anodised aluminium alloy of rugged robust and ever shining type with hinged doors complete with locking arrangement to facilitate easy operation and maintenance of the machine and for giving access to the electric controls, vacuum pressure and oil gauges. A removable inspection cover shall be provided to permit periodic inspection and lubrication of the machine.

## 4.15.0 BASE PLATE

This shall consist of reinforced structural steel suitably designed for mounting the complete machine. Adequate arrangement shall be made in the base plate for drawing oil accidently spilled during operation / maintenance. Suitable pulling hook and slinging arrangement (lugs) for lifting the complete machine through crane for purposes of loading/ un-loading in vehicle for transportation, shall be provided in the base frame.

**4.16.0** The vacuum piping of suitable size and length between the chambers and the vacuum pumping system and also for connection of vacuum pumping system to the transformers/ reactors tank shall be provided. It shall be made of steel and be flanged and welded. This shall be suitable to withstand the max. vacuum as could be created by vacuum pumping system without collapsing. Flexible connector and shut off valves at suitable places in this piping shall also be provided. The vacuum connection shall be absolutely vacuum leak proof.

## 4.17.0 OIL PIPING

Oil piping and fittings of suitable size shall be of suitable material preferably steel. All oil valves shall consist of standard size ball valves with stainless steel balls and tafelon seats and seals or piston type valves. The valves shall be capable of being disassembled for maintenance without disassembling any piping. All the piping shall be suitably lagged with heat insulation.

**(A)** The oil inlet piping of adequate size shall be complete with the following :

i) Oil sampling valve on the discharge side of the inlet pump.
ii) Pressure, gauge on the inlet pump bypass line and two temp. gauges one before and one after the heater.
iii) Pressure switch between the inlet pump and heater
iv) Temperature Indicator / controller between heater and filter, vacuum rated shut-off valves before and after the filter, all required manual shut off valves etc.
v) Solenoid operated or non return valves at inlet of oil
vi) Suitable quick coupling connection for attaching flexible hose and locking of the same.

### (B) OIL DISCHARGE PIPING

The discharge piping of adequate size shall be complete with the following

i) Check valve at discharge to avoid accidental back filling when the unit is not running and to prevent damage to the totalising meter.

ii) Pressure gauges, sampling valves, automatic control valve to match discharge pump output with inlet flow rate.

iii) The completely valved by-pass line between inlet and discharge lines be suitably designed to allow full recirculation of oil back through the vacuum chambers. The valve shall be of lockable type.

iv) Suitable quick coupling connection for attaching flexible hose and locking of the same.

v) Magnetic filter after the gear pump.

**c) Inlet Recirculation By-Pass**

A recirculation piping and control system shall be installed in the inlet piping, designed to function as follows:

i) On normal shut down of the inlet pump and heater (by the operator or by the high level switch in the process chamber) motorized valve shall close shutting off oil flow to the chamber, but the inlet pump shall continue to run (on time delay control) building up pressure which shall open a pressure control valve causing recirculation of oil through the heater (to cool the heater elements) and back to the inlet of the pump. At the end of the time delay period, the inlet pump shall continue to run unless the oil temperature is below the over temperature thermostat setting.

ii) On over temperature alarm condition the heaters shall shut off and the motorised valve shall close, forcing the oil to recirculate in the manner described above untill the oil temperature drops below the present thermostat setting at which point the inlet pump shall stop.

## 4.18.0 OIL AND VACUUM HOSES

A) **OIL HOSE**

For inlet service, the hose shall be 20 meters long for each and 40 mm nominal diameter and for discharge also it shall be 40 mm nominal diameter and 20 meters long. The hoses shall be made of reinforced nitrile rubber, and should be suitable for transformers oil service upto a maximum temperature of 1000 °C, full vacuum and pressure as per requirement. The service end of the hoses shall be supplied with quick connect fittings and attached caps compatible with standard hose quick connect fittings for attachment to transformer and to the delivery tank. During oil handling static electricity may be charged in certain type of oil hoses. Therefore, all oil hoses shall be built up around an earthed core or have built in earth conductor to avoid static electricity to be charged to a high potential.

B) **VACUUM HOSE**

The hose of reinforced nitrile rubber 100mm nominal diameter, 20 meters long in sections complete with aluminium flange and nitrile rubber gaskets shall be supplied for connecting vacuum pumping system of plant to the transformer/ reactor tank. It shall be complete with end fittings for connections as well as

suitable to withstand maximum vacuum without collapsing and kinding. Suitable provision shall be made to detect the oil flow. If it ever occurs through the hose pipe.

## 4.19.0 ELECTRICAL SYSTEM

a) One length of 50 meters of 1100 volts grade 3½ core weather proof flexible cable with plug and socket of suitable current rating as per IS shall be supplied for connection of the unit to the mains. Suitable arrangement viz. Cable drum or any other alternative shall also be provided with the machine in order to wound easily the cable length when not is use.

b) All components shall be suitable for 400 V/ 440 V, 3 phase 50 Hz electric supply. Proper earthing of the system shall be provided for equipment and personal safety, and atleast two grounded terminals shall be provided at proper places, so that it could be connected through earth leads to the earth mat of the substation.

c) Adequate number of tube lights bulbs / wherever necessary shall be provided inside the plant to provide proper illumination in order to have full visibility of all components, instruments etc. installed in the plant. A tube light at the suitable position on the control panel shall also be provided to given visibility on all measuring instruments and recorders when working with the plant in dark.

## 4.20.0 MOUNTING

The machine is required duly mounted on a four wheeled under carriage with wheels of suitable size, to facilitate towing of the plant in the desired direction to transformer/ reactor sites without difficulty to process the oil for commissioning of these equipments. Necessary jacks shall be provided to lift the plant and to take its load off the wheels while in use at site if uneven. To ascertain proper levelling two spirit levels at two perpendicular sides shall be provided. The wheels shall be complete with pneumatic tyres and spring. Wheels shall also be fitted with over run brakes. The units shall be complete with metallic body to guard the machine against abnormal conditions in outdoor use.

## 4.21.0 IONIC REACTION COLUMN

Provision at suitable places in the patch of oil being processed shall be made for connecting on Ionic reaction column to be used for the removal of acidity and products of oxidation and ageing in used transformer oil . The ionic reaction column shall be supplied with the plant and it shall be possible to bypass this column when not required to be used.

The ionic reaction column shall be of suitable size, and activated alumina shall be used as adsorbent, for removal of the acidity from oil. The column should have sufficient amount of activated alumina in order to control the acidity of transformer oil to the desired recommended value. Necessary tools and apparatus required to regenerate the activated alumina shall also be supplied in order to provide facility of regeneration of activated alumina. Contractor shall furnish the complete details of the system and process.

## 5.0.0 TECHNICAL DATA SHEET:

**NOTE:** The technical data in respect oil filtration and purification plant are given below for guidance of bidders. The offers shall meet these technical requirements in full and guarantee the various parameters as laid down below:

| Sl. No. | DESCRIPTION | DATA |
|---|---|---|
| 1. | 6000 litres/hr. capacity ultra High Vacuum oil purification and filtration plant | 1 No. |
| 2. | Capacity | 6000 litres per hour. |
| 3. | Purpose | To treat the new transformer / reactor oil complying to IS: 335-1983/ IEC 60296 received and filled in delivery tanks / barrels having water content of 100ppm by weight (approx.) and saturated with air at 12% by volume (approx.) on single pass basis to<br><br>i) Reduction of gas content to 0.2%<br>ii) Reduction of moisture content to 5ppm<br>iii) Filtration pore diameter maximum one micron<br>iv) Dielectric strength<br><br>As per IEC- 156 (60 kV)<br>As per ASIM D 1816 (25 kV)<br>v) Neutralisation value<br><br>a) Before treatment- 0.5 mg KOH /g (Max) as per IS: 1866 : 1983<br>b) After treatment – (for new oil) 0.04 mg-KOH/gr as per IS: 335/ IEC 60296 |
| a. | To completely evacuate oil from Transformer under high vacuum Conditions and drying out of insulation by hot oil circulation. | -do- (for old and used oil)- Value to be given by the bidder. |
| b. | Plant must be capable of meeting the above specified parameters to treat old oil / used oil and for maintenance of transformer/ reactors. | The bidder must furnish necessary calculation for obtaining the above required parameters for new/used oil with the type of equipment offered by them. |

| | | |
|---|---|---|
| | | The transformer evacuation system:<br>The capacity of the vacuum pumps should be similar to the main plant vacuum pumps so that inter-changeability can be attended. |
| c. | Type | Weather proof and mobile type, for outdoor use and suitable to work satisfactorily under climatic conditions with ambient temperature of 50$^0$C and relative humidity of 100% maximum. |
| d. | Operating Voltage | 400/440 V 50 c/sec, (3ø + N) AC supply |
| e. | i) Processing Temperature<br>ii) Degassing Vacuum requirement | 40-60 $^0$C<br>To be given by the bidder. |
| f. | Maximum Temperature Transformer Drying out. | 100 $^0$C |
| g. | Capacity of Heating system | 150 kW and heating density less than 2 watts /cm2 |
| h. | i) Efficiency of filteratio system<br>ii) Time required for treatment of oil | 99% of all particles of 1.0 microm in size or larger<br>14 hours continuous operation for treating 82000 litre capacity transformer/ reactor oil. |
| i. | Ultimate clean off of both the vacuum pumping system. | 10-3 Torr or less. |
| j. | Cooling of vacuum pumping system | Water cooling through water jacket and radiator with fan to be designed for contineuous operating under the tropical climate conditions of the site of use. |
| k. | Condenstation system for Separators in vacuum pumping System | By providing a suitable chiller however, conventional system through water circulation shall also be provide in parallel to the chiller to maintain condensation in case of its break down. |
| l. | Ionic Reaction colums | Adequately sized with activated alumina as adsorbent for removal of acidity from approx. 82000 lit. of Transformer oil to the desired specified / recommended value. At least 200 kg of activated alumina to be provided in 2 or more containers of suitable size for case of handling and regeneration of the alumina. Necessary tools or devices for |

| | | |
|---|---|---|
| | | regeneration should also be included with in the scope of supply. |
| m. | Mounting | Mounted on a four wheeled under carriage with wheels complete with pnenumatice tyres, suspension and springs fitted with overrun brakes. Facility for towing of the plant in the desired direction in the field and to pull it on the public roads by some pulling unit. It shall be designed for maximum running speed of 30-40 km with an average speed or running about 20 kms. The machine shall be provided with outrigger type screw jacks (4 Nos) foror taking off load from wheels while parked and while working. |
| n. | Enclosure | The machine shall be fully enclosed, all weatherproof type with louvers and exhaust fan for ventilation shall have adequate lighting inside. An operator desk and folding stool to be provided in front of indoor panel. Hinged type doors (Complete with locking arrangement) on all sides to provide complete access to equipment when necessary. Material of enclosure to be anodized aluminium alloy to provide fully rust resistant finish. |
| o. | Control Panel | a) Indoor mounted having following measuring recording instruments.<br>i) One electronic high vacuum gauge to cover pressure from one milliatorr to atmospheric pressure.<br>ii) Temperature Indicators.<br>iii) The differential pressure gauge across filter.<br>iv) Hygrometer.<br>v) Gas content measuring instrument.<br>vi) Required no. of recorders for registration with time of temperature, vacuum, water content and gas content of two points.<br>vii) Ampere meter.<br>viii) Volt meter.<br>b) Alarm facia on panel<br>i) Loss of vacuum in degassing chamber.<br>ii) Loss of vacuum in transformer. |

| | | | |
|---|---|---|---|
| | | | iii) Total loss of oil flow.<br>iv) High oil temperature.<br>v) High oil level in degassing column.<br>vi) Low oil level in degassing column.<br>vii) Ultra filter choked.<br>viii) Illuminated flow diagram as specified. |
| p. | Piping, valves and coupling | | Piping to be fully insulated and all valves to be numbered and hose couplings to be quick locking type. |
| q. | Hoses | | a) Oil Hoses:<br>i) For inlet service 20 meters long and 40 mm nominal diameter.<br>ii) For discharge service, 20 meters long 40 mm nominal diameter. Thee shall be of reinforced nitrile rubber and shall be complete with quick connect fittings and attached caps for attachment to transformer tank.<br>b) Vaccum Hose:<br>i) It shall be of reinforced nitrile rubber with 100 mm diameter and 20 mm long in sections complete with aluminium flange and nitrile rubber gaskets. |
| r. | Electric supply cable and connection and protection | a)<br>b) | 3 ½ (4 core) flexible rubber sheathed completely insulated and screened cable suitable to be rolled on small drum. Suitable to terminate in the industrial type socket.<br>Connection at the machine to be through industrial type metal clad male/ female plug in type socket having locking facility and completely all weatherproof. The male/female sockets should be flush mounted in the machine and provided with chain mounted metal cover. |
| s. | Spare | | For two years trouble free operation. |

## 6.0.0 ERECTION, TESTING AND COMMISSIONING

After receipt of the plant at the site of use, the necessary erection and commissioning of the plant in order to make the same fully operative, shall be carried out by the Engineer of the manufacturer. Since, the above plant may be used for the treatment of transformer oil as per recommendations of the foreign suppliers of power transformer / Reactors and comply to IS: 335 therefore, it will be ensured by the contractor that the values of various parameters of the treated oil at the site of substation are accurate and reliable for better regulation of the power system. All the measuring instruments provided on the plant and which are essentially required to monitor, and to record the quality of treated oil through the plant shall be fully and accurately celebrated with the respect to the instruments which have been procured separately, thereby ensuring to obtain more reliable values of different parameters.

## 7.0.0 TESTS

In addition to clause no. 2.5.0 of general condition following tests as stipulated in relevent standard shall also be carried out by the supplier.

## 7.3.0 FACTORY TESTS

Each item of equipment shall be shop assembled and tested to ensure that all parts function properly and that no interference occurs in its moving parts. Chamber, manifolds, hoses, valves and piping shall be hydrostatically tested at a minimum of 9 kg./cm2 or as per procedure recommended in the relevant Indian or International Standards and leaks shall be repaired and tested for soundness of repaired areas. A performance test shall be made on completely reassembled plant and a complete test report shall be submitted to Purchaser. The test report shall cover the following:

i) General information about the plant, rating of all plants and equipments with brief description.
ii) General construction and inspection test.
iii) Operation and performance test to include continuous operation at $50^0$C ambient for 40 hours and tests as per relevant standards. Functioning / performance level switches and oil distribution system in degassing chamber.
iv) Setting valves of safety elements viz. setting of flowing switches, regulating thermostat, vacuum interlocking, time delay relays, vacuum switch etc.
v) Electrical data with respect to all motors, oil heater, and plants measured in all the three phases of supply.
vi) Characteristics of treatment of oil in single pass for new oil as well as for used oil.
vii) Vacuum leakage test, including leakage test, on return valves.
viii) Dielectric strength test.
ix) Hydro test / Pneumatic test with compressed air.
x) Insulating resistance Test.
xi) Noise level.
xii) Calibration result of all instruments on the panel and locally mounted instruments with respective precise measuring instruments fully certified for satisfactory calibration.
xiii) For any other test as per the recommendation of relevant IEC, ASTM, ISO, ANSI, or any other relevant international standards.

## 8.0.0 TOOLS AND TACKLES

One complete set of requisite new tools and tackles shall be supplied with each unit free of cost. The tool box containing all necessary tools shall be supplied with the plant. The manufacturer shall also give all recommended tackles with the tool box.

## 9.0.0 MANDATORY SPARES

The Contractor shall supply the following mandatory spares

i) Filter cartridges for processing used oil 100 Nos.

ii) Edge Type filters 100 Nos.

## 9.1.0 SPARES

The recommended spares for the filteration and purification machine for five years trouble free operation shall be supplied. Contractor shall ensure to give in particular all recommended spares for the vacuum plant, instrumentation vacuum gauges, recorders etc. as per their principals past experience on similar plant for the required period. If the contractor considers that availability of certain component spares may create problems in future, such spares shall be listed clearly alongwith its price in their offer. The contractor shall indicate the requirement of filter cartridges for operating the filter machine to process used oil for a gross operation period of 1000 running hours on full load. They should also recommend the quantity of filter cartridges recommended to be stored as spares to meet out about two years requirements. The contractor who also make an alternative offer for providing edge type filters, shall also give their recommendations, regarding the quantity of edge type filters, to meet out about two years requirements. The contractor shall quote the rates of all the items of spares in the prescribed schedule.

Besides this instruments (Float switch, dial thermometers etc) as may be required for system design and smooth/ efficient functioning of plant in line with description as given in clause 4.12.0, but not specifically mentioned herein, shall also be supplied by the bidder at no extra cost to the Purchaser. Such items shall be clearly brought out in the offer.

a. One (1) lot of all chemicals and consumables required for commissioning of oil filled equipment i.e. Transformers at the station.

b. The contractor shall also supply the first fill of lubricants for the equipment under the scope.

10.0 Scope of Services

10.1 The scope of services includes commissioning of the system, conducting performance test to the satisfaction of the owner/purchaser and handing over of the fully operational system to the Owner/ purchaser.

10.2 It is the responsibility of the supplier to train at least two (2) site engineers of Purchaser/Owner in efficient handling of the plant. Handing over of the plant shall be deemed complete only upon certification from Purchaser/Owner to this effect.

10.3 The bidder shall ensure that sufficient quantities of commissioning spares are made available for timely completion of commissioning of the system. The bidder shall furnish a list of commissioning spares that shall be brought by him. The unused commissioning spares shall be returnable to the bidder.

10.4 After commissioning of the transformers and reactors the filtration plant shall be completely refurbished by the contractor for future use by the employer and handed over to the purchaser/ owner. The scope of refurbishing shall include:

1 Functional checking of the plant.

2 Supply and refitting at site of any damaged part of plant, which may require replacement such as gaskets, 'O' rings, Cartridge filter element, Filter press, Oil hoses, Vacuum hoses.

3 Touch up painting of the plant.

4 Submission of a detailed list of sub-suppler(s)'s/dealer(s)'s addresses for various spare parts purchase. The addresses mentioned therein should be preferably be of the same place (region) or of nearby places for the convenience of the Owner.

10.5 During commissioning and at the time of refurbishing the plant the contractor shall bring his own tools and tackles (on returnable basis) which may be required for maintenance, overhaul, and replacement of various equipment/components to be supplied under this contract.

**11.1 Approval of documents**

**11.2 Quality Plan**

Quality plans have to be submitted to purchaser. These shall be approved by Purchaser/owner.

**11.3 Field Quality Plan**

Contractor shall submit the field quality plan for approval of Purchaser / Owner. Various checks required beginning receipt & storing of material to commissioning of system shall be mentioned in field quality plan.

**11.4 Drawings and Data Sheets**

11.4.1 Drawings / Technical Datasheets have to be submitted to purchaser. These shall be approved by purchaser/owner.

11.4.2 Bidder to furnish detailed calculations to establish the size, and capabilities of vacuum pumping system with respect to moisture and gas removal as desired in design criterion.

11.4.3 Schematic diagram of the oil filtration plant showing all the components.

11.4.4 Outline drawings indicating the principal dimensions and weight of the plant.

11.4.5 Technical data sheets for all major components with characteristic curves of the pumps showing total dynamic head pump input power, efficiency and NPSH against capacity.

11.4.6 Diagram showing the type of lubrication system, cooling system etc.

11.4.7 Complete descriptive and illustrated literature on the plant being supplied.

11.4.8 Design calculations.

11.4.9 Complete illustrative description with salient features and operating / troubleshooting instructions.

**11.5 Inspection**

Inspection shall be carried out by purchaser/customer based on approved QAP, Drawings, GTP & relevant standards.

**11.6 Exclusion** – Unloading & storage of OFP at site is excluded from contractor's scope of works

**11.7 VARIOUS HEADS TO BE QUOTED FOR:**

| Sl. No. | Item | Qty | Rate | Total |
|---|---|---|---|---|
| 1. | Oil Filtration plant inline with Technical specification no. TB-376-565-033 Rev.0 | 1 No. | | |

# SECTION 2

## Equipment Specification

General Technical particulars (GTP) regarding equipment specification stipulated in section-1 of this technical specification shall be adhered to strictly.

# SECTION-3

# PROJECT DETAILS & GENERAL SPECIFICATION

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## SITE INFORMATION

| | Particular | Details |
|---|---|---|
| a) | Owner | UP POWER TRANSMISSION CORPORATION Ltd |
| b) | Customer | POWERGRID |
| c) | Project Title | 765kV/400kV Agra UPPTCL (New)Substation |
| d) | Location | Fatehabad (Agra ) UP |
| e) | Transport Facilities | ROAD/TRAIN |
| | **SITE CONDITIONS** | |
| a) | Max. ambient air temp. | 50°C |
| b) | Min. ambient air temp. | 0°C |
| c) | Max. design ambient temp. | 50°C |
| d) | Design reference temp. | 50°C |
| e) | Average Humidity | Max. 100% |
| f) | Special corrosion conditions | No |
| g) | Solar Radiation | 1.2kW/sqmtr |
| h) | Atmospheric UV radiation | High |
| i) | Altitude above sea level | Less than 1000meter |
| j) | Pollution Severity | High Pollution level (25mm/kV) |
| k) | Seismic Zone | As per the seismic zone defined in the relevant BIS but not less than 0.3g horrizontal |
| | WIND DATA | |
| | Wind velocity | As per IS |
| | Average No. of thunderstorm days per annum | As per IS |

## 1.0 GENERAL

This Chapter covers Technical Requirements and requirements of auxiliary items.

a) 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 unless included in the list of exclusions.

b) Material and components not specifically stated in this specification but which are necessary for satisfactory operation of the equipment and accessories specified in this specification shall be deemed to be included unless specifically excluded and shall be supplied at no extra cost.

c) Whenever a material or article is specified or described 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.

d) In case any Deviation Schedule, Bid Proposal Sheet, Schedule of Data Requirements (DRS), test reports or any other document/information are not furnished along-with the bid, the bid is liable to be rejected. Unless brought out clearly, the Bid will be deemed to conform to the specification scrupulously. All deviations from the specification shall be clearly brought out in the respective deviation schedule.

Auxiliary supplies as described below would be available at site.

| Normal Voltage (Volts) | Variation in voltage | Frequency (Hz) | Phase | Neutral connection |
|---|---|---|---|---|
| 415 | + 10 % | 50 + 5 % | 3 Ph- 4wire | Solidly earthed |
| 240 | + 10 % | 50 + 5 % | 1 Ph-2wire | Solidly earthed |
| 220 | + 10 % | DC | | Isolated(2 wire system) |
| 48 | | DC | | Isolated(2 wire system) (+ Earthed) |

f) The Bidder shall clearly indicate in the bid the specific standards in accordance with which the works will be carried out.

g) The equipment must be new, of highest grade, the best quality of their kind, to best engineering practice and latest state of art, and in accordance with purpose for which they are intended and ensure satisfactory performance throughout the service life.

h) All similar parts of the equipment shall be made to gauge and shall be interchangeable with and shall be made of same materials and workmanship as the corresponding parts of the equipment. Where feasible, common components, units shall be employed in different pieces of equipment in order to optimize the spare part stock-up and utilization.

i) The requirement regarding external RIV as specified for equipment shall include the terminal fittings and the equipment shall have been tested preferably with fittings, if any.

## 2.0 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED

a) The equipment furnished under this specification shall perform all its functions and operate satisfactorily without showing undue strain, restrike etc.

b) The equipment shall be able to withstand forces due to wind load, short circuit, system over voltages, fluctuations, frequency variations etc., all forces considered together.

## 3.0 SUPPORT STRUCTURES (If in the scope of Bidder)

a) The support structures should be hot dip galvanised with minimum 610 gram/m2 net of zinc.

b) The design calculations taking into account the environmental conditions of the substations shall be furnished for sizing of the structures.

## 4.0 STANDARDS

a) The equipment to be furnished under this specification shall conform to latest issue with all amendments of standard specified under respective Chapters of this Specification.The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to compliment each other. The bidder shall also note that list of standards presented in this specification is not complete. Whenever necessary the list of standards shall be considered in conjunction with specific IS/IEC.When the specific requirements stipulated in the specifications exceed or differ than those required by the applicable standards, the stipulation of the specification shall take precedence.

b) Other internationally accepted standards which ensure equivalent or better performance than that specified in the standards referred shall also be accepted.

c) In case governing standards for the equipment is different from IS or IEC, the salient points of difference shall be clearly brought out in additional information schedule alongwith English language version of standard or relevant extract of the same. The equipment conforming to standards other than IS/IEC shall be subject to POWERGRID's approval.

## 5.0 ENGINEERING DATA AND DRAWINGS

5.1 The list of drawings/documents which are to be submitted to the Purchaser shall be discussed and finalised by the Purchaser at the time of award. The supplier shall necessarily submit all the drawings/ documents unless anything is waived.

5.2 The Contractor shall submit 4 (four) sets of drawings/ design documents /data / detailed bill of quantity and 1 (one) set of test reports for the approval of the Purchaser. The contractor shall also submit the softcopy of the above documents in addition to hardcopy.

## 5.3 Drawings

5.3.1 All drawings submitted by the Contractor 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, dimensions, internal & the external connections, fixing arrangement required and any other information specifically requested in the specifications.

5.3.2 Drawings 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. POWERGRID has standardized a large number of drawings/documents of various make including type test reports which can be used for all projects having similar requirements and in such cases no project specific approval (except for list of applicable drawings alongwith type test reports) is required. However, distribution copies of standard drawings/documents shall be submitted as per provision of the contract. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in SI units.

5.3.3 The review of these data by the Purchaser 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. This review by the Purchaser may not indicate a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. This review and/or approval by the Purchaser 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.

5.4 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.

5.5 All engineering data submitted by the Contractor after final process including review and approval by the Purchaser 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 Purchaser in Writing.

5.7 Approval Procedure

The scheduled dates for the submission of the drawings 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 and for providing final documentation.

i) Approval/comments/ As per agreed by

| | | |
|---|---|---|
| | Purchaser on initial | schedule submission |
| ii) | Resubmission (whenever required) | Within 3 (three) weeks from date of comments |
| iii) | Approval or comments | Within 3 (three) weeks of receipt of resubmission. |
| iv) | Furnishing of distribution copies (5 hard copies per substation and one scanned copy (pdf format) for Corporate Centre) | 2 weeks from the date of approval |
| v) | Furnishing of distribution copies of test reports | |
| (a) | Type test reports (one scanned softcopy in pdf format per substationplus one for corporate centre & one hardcopy per substation) | 2 weeks from the date of final approval |
| (b) | Routine Test Reports (one copy for each substation) | -do- |
| vi) | Furnishing of instruction/ (2 copies per substation and one softcopy (pdf format) for corporate centre & per substation) | As per agreed schedule operation manuals |
| (vii) | As built drawings (two sets of hardcopy per substation & one softcopy (pdf format) for corporate centre& per substation) | On completion of entire works |

NOTE:

(1) The supplier may please note that all resubmissions must incorporate all comments given in the earlier submission by BHEL/POWERGRID or adequate justification for not incorporating the same must be submitted failing which the submission of documents is likely to be returned.

(2) All drawings should be submitted in softcopy form, however substation design drawings like SLD, GA, all layouts etc. shall also be submitted in AutoCAD Version. SLD, GA & layout drawings shall be submitted for the entire substation in case of substation extension also.

(3) The instruction Manuals shall contain full details of drawings of all equipment being supplied under this contract, their exploded diagrams with complete instructions for storage, handling, erection, commissioning, testing, operation, trouble shooting, servicing and overhauling procedures.

(4) If after the commissioning and initial operation of the substation, the instruction manuals require any modifications/ additions/changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the supplier to BHEL/POWERGRID.

(5) The manufacturer shall furnish to the Purchaser catalogues of spare parts.

(6) All As-built drawings/documents shall be certified by site indicating the

changes before final submission.

## 6.0 MATERIAL WORKMANSHIP

### 6.1 General Requirement

6.1.1 Where the specification does not contain references to workmanship, equipment, materials and components of the covered equipment, it is essential that the same must be new, of highest grade of the best quality of their kind, conforming to best engineering practice and suitable for the purpose for which they are intended.

6.1.2 Incase where the equipment, materials or components are indicated in the specification as “similar” to any special standard, the Purchaser shall decide upon the question of similarity. When required by the specification or when required by the Purchaser the Contractor shall submit, for approval, all the information concerning the materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the supplier.

6.1.3 The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety, subject to mutual agreements. All joints and fastenings shall be devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfill their required function. In general, screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the BHEL/POWERGRID.

6.1.4 Whenever possible, all similar part of the Works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall also be interchangeable and shall be made of the same materials and workmanship as the corresponding parts of the Equipment supplied under the Specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.

6.1.5 All materials and equipment shall be installed in strict accordance with the manufacturer’s recommendation(s). Only first-class work in accordance with the best modern practices will be accepted. Installation shall be considered as being the erection of equipment at its permanent location. This, unless otherwise specified, shall include unpacking, cleaning and lifting into position, grouting, levelling, aligning, coupling of or bolting down to previously installed equipment bases/foundations, performing the alignment check and final adjustment prior to initial operation, testing and commissioning in accordance with the manufacturer’s tolerances, instructions and the Specification. All factory assembled rotating machinery shall be checked for alignment and adjustments made as necessary to re-establish the manufacturer’s limits suitable guards shall be provided for the protection of

personnel on all exposed rotating and / or moving machine parts and shall be designed for easy installation and removal for maintenance purposes. The spare equipment(s) shall be installed at designated locations and tested for healthiness.

6.1.6 The supplier shall apply oil and grease of the proper specification to suit the machinery, as is necessary for the installation of the equipment. Lubricants used for installation purposes shall be drained out and the system flushed through where necessary for applying the lubricant required for operation. The supplier shall apply all operational lubricants to the equipment installed by him.

6.1.7 All oil, grease and other consumables used in the Works/ Equipment shall be purchased in India unless the Contractor has any special requirement for the specific application of a type of oil or grease not available in India. In such is the case he shall declare in the proposal, where such oil or grease is available. He shall help POWERGRID in establishing equivalent Indian make and Indian Contractor. The same shall be applicable to other consumables too.

6.1.8 Corona and radio interference voltage test and seismic withstand test (for 132kV and above voltage level) procedures for equipments shall be in line with the procedure given at Annexure-A and B respectively.

**6.2 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 equipments located in non-air conditioned areas shall also be of same type.

**6.2.1 Space Heaters**

6.2.1.1 The heaters shall be suitable for continuous operation at 240V as supply voltage. On-off switch and fuse shall be provided.

6.2.1.2 One or more adequately rated thermostatically connected heaters shall be supplied to prevent condensation in any compartment. The heaters shall be installed in the compartment and electrical connections shall be made sufficiently away from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.

6.2.1.3 Suitable anti condensation heaters with the provision of thermostat shall be provided.

**6.2.2 FUNGI STATIC VARNISH**

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

**6.2.3 Ventilation opening**

Wherever ventilation is provided, the compartments shall have ventilation

openings with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds and suitable provision shall be made so as to avoid any communication of air / dust with any part in the enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc.

**6.2.4 Degree of Protection**

The enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc. to be installed shall provide degree of protection as detailed here under:

a) Installed out door: IP- 55
b) Installed indoor in air conditioned area: IP-31
c) Installed in covered area: IP-52
d) Installed indoor 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

The degree of protection shall be in accordance with IS: 13947 (Part-I) / IEC-60947(Part-I) / IS 12063 / IEC-60529. Type test report for degree of protection test, shall be submitted for approval.

**6.3 RATING PLATES, NAME PLATES AND LABELS**

Each main and auxiliary item of substation is to have permanently attached to it in a conspicuous position a rating plate of non-corrosive material upon which is to 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 of substation in question has been designed to operate, and such diagram plates as may be required by the Purchaser. The rating plate of each equipment shall be according to IEC requirement.

All such nameplates, instruction plates, rating plates of transformers, reactors, CB, CT, CVT, SA, Isolators, C & R panels and PLCC equipments shall be bilingual with Hindi inscription first followed by English. Alternatively two separate plates one with Hindi and the other with English inscriptions may be provided.

**6.4 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 supplier unless specifically excluded under the exclusions in these specifications and documents.

**7.0 DESIGN IMPROVEMENTS / COORDINATION**

7.1 The bidder shall note that the equipment offered by him in the bid only shall be accepted for supply. However, the Purchaser or the Contractor may propose changes in the specification of the equipment or quality thereof

and if the Purchaser & contractor agree upon any such changes, the specification shall be modified accordingly.

7.2 If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any change in the price and/or schedule of completion before the Contractor proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.

7.3 The supplier shall be responsible for the selection and design of appropriate equipments to provide the best co-ordinated performance of the entire system. The basic design requirements are detailed out in this Specification. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.

7.4 The supplier has to coordinate designs and terminations with the agencies (if any) who are Consultants/Contractor for the Purchaser. The names of agencies shall be intimated to the successful bidders.

7.5 The supplier will be called upon to attend design co-ordination meetings with the Engineer, other Contractor's and the Consultants of the Purchaser (if any) during the period of Contract. The Contractor shall attend such meetings at his own cost at POWERGRID Corporate Centre, Gurgaon (Haryana) or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

**8.0 QUALITY ASSURANCE PROGRAMME**

8.1 To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the supplier'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 supplier shall adopt suitable quality assurance programme to control such activities at all points necessary. The detailed programme shall be submitted by the contractor after the award for reference. A quality assurance programme of the supplier shall generally cover the following:

(a) His organisation structure for the management and implementation of the proposed quality assurance programme:

(b) Documentation control system;

(c) Qualification data for 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 Purcahser.

(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.

POWERGRID/BHEL or his duly authorised representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the supplier/his vendor's quality management and control activities.

**8.2 Quality Assurance Documents**

The supplier would be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of POWERGRID/BHEL inspection of equipment/material

**9.0 TYPE TESTING, INSPECTION, TESTING & INSPECTION CERTIFICATE**

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

9.2 The reports for all type tests as per technical specification shall be furnished by the supplier alongwith equipment / material drawings. However, type test reports of similar equipments/ material already accepted in POWERGRID shall be applicable for all project with similar requirement. 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 POWERGRID or representative authorized by POWERGRID or Utility or representative of accredited test lab or reputed consultant.

The test reports submitted shall be of the tests conducted within last 10 (ten) years prior to the date of bid opening i.e. 26.08.11. In case the test reports are of the test conducted earlier than 10 (ten) years prior to the date of bid opening, the contractor shall repeat these test(s) at no extra cost to BHEL.

Further, 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 type tests not carried out, same shall be carried out without any additional cost implication to the Purchaser.

The supplier shall intimate the BHEL/POWERGRID the detailed program about the tests atleast two (2) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies.

Further, in case type tests are required to be conducted/repeated and the deputation of Inspector/Purchaser's representative is required, then all the expenses shall be borne by the supplier.

9.3 The Purchaser intends to repeat the type tests on Power Transformer and Shunt Reactor except Dynamic short circuit tests on transformers, for which test charges shall be payable as per provision of contract. The price of conducting 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 test charges would be considered in bid evaluation. In case 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. BHEL/POWERGRID reserves the right to witness any or all the type tests. The BHEL/POWERGRID also reserves the right to waive the repeating of type tests partly or fully and in case of waival, test charges for the same shall not be payable.

The Purchaser shall bear all expenses for deputation of purchaser's representative(s) for witnessing the type tests under this clause except in the case of re-deputation if any, necessitated due to no fault of the purchaser.

For outdoor receptacles, trefoil clamps, diesel engine, alternator, motors, cable glands, lighting fixtures, ACSR/AAC conductor, IPS aluminum tube and junction boxes, type test reports are not required to be submitted for the makes indicated at Annexure-E /POWERGRID approved list of subvendors. For the new makes(other than those indicated at Annexure-E / POWERGRID approved list of subvendors), type test reports as per relevant standard shall be submitted for POWERGRID's approval.

9.4 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/sub-vendors 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.

9.5 The supplier shall give the Purchaser /Inspector fifteen (15) days written notice for on-shore and six (6) weeks notice for off-shore material being ready for joint testing including contractor and POWERGRID. Such tests shall be to the Contractor's account except for the expenses of the Inspector. The Purchaser/inspector, unless witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed alone with the test which

shall be deemed to have been made in the Inspector's presence and he shall forthwith forward to the Inspector duly certified copies of tests in triplicate.

9.6 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.

9.7 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 CIP by the Purchaser.

9.8 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.

9.9 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.

9.10 The Purchaser will have the right of having at his own expenses any other test(s)of reasonable nature carried 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.

9.11 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 equipments for these tests shall be provided by the Purchaser.

## 10.0 TESTS

### 10.1 Pre-commissioning Tests

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 are given in respective chapters and shall be included in the Contractor's quality assurance programme.

**10.2 Commissioning Tests**

10.2.1 The available instrumentation and control equipment will to be used during such tests and the Purchaser will calibrate, all such measuring equipment and devices as far as practicable.

10.2.2 Any special equipment, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.

10.2.3 The specific tests requirement on equipment have been brought out in the respective chapters of the technical specification.

10.3 The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning the equipment and the switchyard. However necessary fee shall be reimbursed by POWERGRID on production of requisite documents.

**11.0 PACKAGING & PROTECTION**

11.1 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 Purchaser, the Contractor 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 Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Purchaser takes no responsibility of the availability of the wagons.

11.2 All coated surfaces shall be protected against abrasion, impact, discoloration 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.

**12.0 FINISHING OF METAL SURFACES**

12.1 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.

## 12.2 HOT DIP GALVANISING

12.2.1 The minimum weight of the zinc coating shall be 610 gm/sq.m and minimum average thickness of coating shall be 86 microns for all items having thickness 6mm and above. 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 be 610 gm/sq. m minimum.

12.2.2 The galvanized 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.

12.2.3 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 galvanization.

12.2.4 The galvanized steel shall be subjected to six one minute dips in copper sulphate solution as per IS-2633.

12.2.5 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. The following galvanizing tests should essentially be performed as per relevant Indian Standards.

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

12.2.6 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.

## 12.3 PAINTING

12.3.1 All sheet steel work 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 at least 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.

12.3.2 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.

12.3.3 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.

12.3.4 The exterior and interior colour of the paint in case of new substations shall preferably be RAL 7032 for all equipment, marshalling boxes, junction boxes, control cabinets, panels etc. unless specifically mentioned under respective sections of the equipments. Glossy white colour inside the equipments /boards/panels/junction boxes is also acceptable. The exterior colour for panels shall bematching with the existing panels in case of extension of a substation. Each coatof 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 equipments.

12.3.5 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 alongwith the Bids for Purchaser's review & approval.

12.3.7 For aluminium casted surfaces, the surface shall be with smooth finish. Further, in case of aluminium enclosures the surface shall be coated with powder (coating thickness of 60 microns) after surface preparation for painting.

## 13.0 HANDLING, STORING AND INSTALLATION

13.1 In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Purchaser or his representative, the Contractor shall erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented. Commercial use of switchyard equipment means completion of all site tests specified and energisation at rated voltage.

13.2 Contractor may engage manufacturer's Engineers to supervise the unloading, transportation to site, storing, testing and commissioning of the various equipment being procured by them separately. Contractor shall transport, erect, test and commission the equipment as per instructions of the manufacturer's supervisory Engineer(s) and shall extend full cooperation to them.

13.3 Material opened for joint inspection shall be repacked properly as per manufacturer's recommendations.During storage of material regular periodic monitoring of important parameters like oil level / leakage, SF6 / Nitrogen pressure etc. shall be ensured by the contractor.

13.4 In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the Purchaser. Contractor shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawings/ instructions

correctly.

13.5 Where assemblies are supplied in more than one section, Contractor shall make all necessary mechanical and electrical connections between sections including the connection between buses.Contractor shall also do necessary adjustments/alignments necessary for properoperation of circuit breakers,isolators and their operating mechanisms. All components shall be protected against damage during transportation, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.

13.6 Supplier shall be responsible for examining all the shipment and notify the Purchaser immediately of any damage, shortage, discrepancy etc. for the purpose of Purchaser's information only. The Contractor shall submit to the Purchaser every week a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

13.7 The supllier shall be fully responsible for the equipment/material until the same is handed over to the Purchaser in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over by Purchaser, as well as protection of the same against theft, element of nature, corrosion, damages etc.

13.8 The words 'erection' and 'installation' used in the specification are synonymous.

13.9 Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.

13.12 **Equipment Bases**

A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base unless otherwise agreed to by the Purchaser. Each base plate shall support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have threaded drain connections.

**14.0 TOOLS AND TACKLES**

The Contractor shall supply with the equipment one complete set of all special tools and tackles for the erection, assembly, dis-assembly and maintenance of the equipment. However, these tools and tackles shall be separately, packed and brought on to Site.

**15.0 AUXILIARY SUPPLY**

15.1 The sub-station auxiliary supply is normally met through a system indicated under section "Electrical & Mechanical Auxiliaries" 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 the parameters as indicated in the following.

| Normal Voltage | Variation in Voltage | Frequency in HZ | Phase/Wire | Neutral connection |
|---|---|---|---|---|
| 415V | ± 10% | 50 ± 5% | 3/4 Wire | Solidly Earthed. |
| 240V | ± 10% | 50 ± 5% | 1/2 Wire | Solidly Earthed. |
| 220V | 190V to 240V | DC | - | Isolated 2 wire System |
| 48V | _ | DC | _ | 2 wire system (+) earthed |

Combined variation of voltage and frequency shall be limited to ± 10%.

**16.0 SUPPORT STRUCTURE (If in the scope of supplier)**

16.1 The equipment support structures shall be suitable for equipment connections at the first level i.e 14.0 meter, 8.0 meter and 5.9 meter from plinth level for 765 kV,420 kV and 245 kV substations respectively. All equipment support structures shall be supplied alongwith brackets, angles, stools etc. for attaching the operating mechanism, control cabinets & marshalling box (wherever applicable) etc.

16.2 Support structure shall meet the following mandatory requirements:

16.2.1 The minimum vertical distance from the bottom of the lowest porcelain part of the bushing, porcelain enclosures or supporting insulators to the bottom of the equipment base, where it rests on the foundation pad shall be 2.55 metres.

**17.0 Deleted**

**18.0 CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES & MARSHALLING BOXES FOR OUTDOOR EQUIPMENT**

18.1 All types of boxes, cabinets etc. shall generally conform to & be tested in accordance with IS-5039/IS-8623, IEC-60439, as applicable, and the clauses given below:

18.2 Control cabinets, junction boxes, Marshalling boxes & terminal boxes shall be made of sheet steel or aluminum enclosure and shall be dust, water and vermin proof. Sheet steel used shall be atleast 2.0 mm thick cold rolled or 2.5 mm hot rolled or alternately 1.6 mm thick stainless steel can also be used. 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 aluminum enclosed box the thickness of aluminum shall be such that it provides adequate rigidity and long life as comparable with sheet steel of specified thickness.

18.3 A canopy and sealing arrangements for operating rods shall be provided inmarshalling boxes / Control cabinets to prevent ingress of rain water.

18.4 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.

18.5 All doors, removable covers and plates shall be gasketed all around with suitably profiled EPDM/Neoprene gaskets. The gasket shall be tested in accordance with approved quality plan, IS:11149 and IS:3400. Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh made of brass.

18.6 All boxes/cabinets shall be designed for the entry of cables from bottom by meanof 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 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. 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.

18.7 A 240V, single phase, 50 Hz, 15 amp 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.

18.8 For illumination, a fluorescent tube or CFL of approximately 9 to 15 watts shall be provided. The switching of the fittings shall be controlled by the door switch. .

For junction boxes of smaller sizes such as lighting junction box, manual operated earth switch mechanism box etc., plug socket, heater and illumination is not required to be provided.

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

18.10 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.

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

18.12 a) The following routine tests alongwith the routine tests as per IS:5039 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 conform to IP-55 as per IS:13947 including application of, 2.5 KV rms for 1 (one) minute, insulation resistance and functional test after IP-55 test.

19.0 Deleted.

**20.0 TERMINAL BLOCKS AND WIRING**

20.1 Control and instrument leads from the switchboards or from other equipment will be

brought to terminal boxes or control cabinets in conduits. All interphase and external connections to equipment or to control cubicles will be made through terminal blocks.

20.2 Terminal blocks shall be 650V grade and have continuous rating to carry the maximum expected current on the terminals and non breakable type. These 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 of Elmex or Phoenix or Wago
or equivalent make.

20.3 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.

20.4 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.

20.5 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.

20.6 The terminal blocks shall be of extensible design.

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

20.8 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.

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

| | | |
|---|---|---|
| a) | All circuits except CT/PT circuits | Minimum of two of 2.5 sq mm copper flexible. |
| b) | All CT/PT circuits | Minimum of 4 nos. of 2.5 sq copper flexible. |

20.10 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.

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

20.12 There shall be a minimum clearance of 250 mm between the First/bottom row of terminal block and the associated cable gland plate for outdoor ground mounted marshalling box and the clearance between two rows of terminal blocks shall be a minimum of 150 mm.

20.13 The supplier shall furnish all wire, conduits and terminals for the necessary

interphase electrical connections (where applicable) as well as between phases and common terminal boxes or control cabinets. For equipments 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 overvoltages either transferred through the equipment or due to transients induced from the EHV circuits.

20.14 All input and output terminals of each control cubicle shall be tested for surgewithstand 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.

## 21.0 LAMPS & SOCKETS

### 21.1 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.

### 21.2 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.

### 21.3 Switches and Fuses:

21.3.1 Each 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 miniature circuit breaker / switchfuse 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.

21.3.2 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.

## 22.0 Deleted

## 23.0 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 be subjected to routine tests as per applicable standards. The motors shall be of approved make.

### 23.1 Enclosures

a) 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.

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

c) 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.

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

**23.2 Operational Features**

a) 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.

b) Motor shall be capable at giving rated output without reduction in the expected life span when operated continuously in the system having the particulars as given in Clause 15.0 of this Section.

**23.3 Starting Requirements:**

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

b) Motors shall be capable of withstanding the electrodynamic stresses and heating imposed if it is started at a voltage of 110% of the rated value.

c) 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.

d) 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 atleast 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.

e) 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 accelerating time whichever is greater. In case it is not possible to meet 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.

**23.4 Running Requirements:**

a) 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.

b) 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.

c) 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.

**23.5 TESTING AND COMMISSIONING**

An indicative list of tests is given below. Contractor shall perform any additional test based on specialities of the items as per the field Q.P./Instructions of the equipment Contractor or Purchaser without any extra cost to the Purchaser. The Contractor shall arrange all instruments required for conducting these tests alongwith calibration certificates and shall furnish the list of instruments to the Purchaser for approval.

(a) Insulation resistance.

(b) Phase sequence and proper direction of rotation.

(c) Any motor operating incorrectly shall be checked to determine the cause and the conditions corrected

# SECTION 4

## List of Data Sheets / Drawings

### 1.0 LIST OF TECHNICAL DATASHEETS/ DRAWINGS

In this section Technical Datasheets (TDS) of various equipment/items and system drawings that are required to be generated is furnished herewith. List of datasheets/drawings and numbers to be accorded is also given below.

The list furnished here is tentative and additional documents may be required during detailed engineering.

| List of Drawings/ Data Sheets/ Documents | | |
|---|---|---|
| **S No.** | **Item Description** | **BHEL's Doc. No.** |
| 01. | P & I Diagram for 6000LPH Transformer Oil Filtration & Evacuation plant | TB-DG-376-565-01 |
| 02. | G A Drawing for 6000LPH Transformer Oil Filtration & Evacuation plant | TB-DG-376-565-02 |
| 03 | GTP for 6000LPH Transformer Oil Filtration and Evacuation plant | TB-DS-376-565-03 |
| 04. | GTP for Motors of 6000LPH Transformer Oil Filtration and Evacuation plant | TB-DS-376-565-04 |
| 05. | Heater Calculation for 6000LPH Transformer Oil Filtration and Evacuation plant | TB-CL-376-565-05 |
| 06. | Power supply diagram for 6000LPH Transformer Oil Filtration and Evacuation plant | TB-DG-376-565-06 |
| 07. | BOM for 6000LPH Transformer Oil Filtration and Evacuation plant | TB-BM-376-565-07 |
| 08. | BOM for Instruments of 6000LPH Transformer Oil Filtration and Evacuation plant | TB-BM-376-565-08 |
| 09. | BOM for Electrical panel of 6000LPH Transformer Oil Filtration and Evacuation plant | TB-BM-376-565-09 |
| 10. | Other drg. document (if any) | TB-DG-376-565-10 |

# SECTION- 5

# SCHEDULES AND ENCLOSURES

## SCHEDULES TO BE FILLED UP BY THE BIDDER

Schedule 1 **Schedule of makes of Equipments**

Schedule 2 **Schedules of Deviations**

Schedule 3 **Schedule of past experience and qualifying requirements**

Schedule 4 **Schedule of performance certificates**

Schedule 5 **Schedule of type test and special tests**

Schedule 6 **Details of contact persons (technical & commercial)**

## SCHEDULE-1

## MAKES OF IMPORTANT ITEMS / COMPONENTS OF EQUIPMENTS AND THEIR DETAILS

| ITEM NAME | NAME OF MANUFACTURER | PLACE OF MANUFACTURE OF ITEM | PLACE OF TESTING AND INSPECTION | COMPLIANCE WITH ISO 9001 (YES/NO) |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

Place

Signature of the authorized representative of Bidder

Name ----------

Date

Designation----------

Company seal----------

## SCHEDULE-2

## SCHEDULE OF TECHNICAL DEVIATION

The following are the deviations / variations / exceptions from the specification:

| Section | Clause No. / Page No. | Statement of deviation/ Variations/Exceptions |
|---|---|---|

1) In case, this schedule is not submitted, it will be presumed that the equipment /material to be supplied under this contract are deemed to be in compliance with the specification.

2) If there is NIL deviation, even then the format to be filled as **NIL DEVIATION**

3) Continuation sheets of like size and format may be used as per the Bidder's Requirement and shall be annexed to this schedule.

Place

Date

Signature of the authorized representative of Bidder

Name ----------

Designation----------

Company seal----------

## SCHEDULE – 3

## SCHEDULE OF PAST EXPERIENCE AND QUALIFYING REQUIREMENT

Following is the list of earlier orders executed by us for supply of equipment / material of similar nature over the last past five years:

| S.No. | Item | Brief rating | Qty | customer | Date Of order | Date of supply | Order value |
|---|---|---|---|---|---|---|---|

Place

Date

Signature of the authorized representative of Bidder

Name----------

Designation----------

Company seal ----------

Note: Continuation sheets of like size and format may be used as per the Bidder's Requirement and shall be annexed to this schedule.

## SCHEDULE – 4

# SCHEDULE OF PERFORMANCE CERTIFICATE

Bidder shall furnish the performance certificate of the similar equipment having the following details:

| S.No. | Item | Brief rating | Qty | Customer | Date Of supply |
|---|---|---|---|---|---|
| | | | | | |

Place

Date

Signature of the authorized representative of Bidder

Name----------

Designation----------

Company seal ----------

Note: Continuation sheets of like size and format may be used as per the Bidder's Requirement and shall be annexed to this schedule.

**SCHEDULE-5**

# SCHEDULE OF TYPE TESTS AND SPECIAL TESTS

The following type tests and special tests as called for in the Specification shall be conducted (all type tests / special tests as mentioned in the relevant clauses of the Specification shall be listed here):

| Sl no. | Clause no/ page no of Specification | Details of test | Lab in which to be conducted | Whether test to be conducted free or on chargeable basis. Mention 'FREE' or 'CHARGEABLE' | If charges per test have been quoted for in the price bid. YES / NO |
|---|---|---|---|---|---|
| | | A. Type Tests | | | |
| | | 1. | | | |
| | | 2. | | | |
| | | B. Routine Tests | | | **DO NOT** |
| | | 1. | | | **MENTION** |
| | | 2. | | | **ANY PRICE** |
| | | C. Site Tests | | | **IN THIS** |
| | | 1. | | | **COLUMN** |
| | | 2. | | | |
| | | D. Special Tests (specified) | | | |
| | | 1. | | | |
| | | 2. | | | |
| | | E. Other tests at works / site recommended by the Bidder | | | |
| | | 1. | | | |
| | | 2. | | | |

**NOTE:**

1) Details have to be furnished on cables as well as accessories, each separately.

**2) NO PRICE SHALL BE FURNISHED IN THIS FORMAT.**

Place

Date

Signature of the authorized representative of Bidder

Name----------

Designation----------

Company seal----------

## SCHEDULE-6

## DETAILS OF CONTACT PERSON BOTH TECHNICAL AND COMMERCIAL

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Name

Address for correspondence

Phone No.

Fax No.

Email

Place

Date

Signature of the authorized representative of Bidder

Name----------

Designation----------

Company seal ----------

Note: Continuation sheets of like size and format may be used as per the Bidder's Requirement and shall be annexed to this schedule.