

**BHARAT HEAVY ELECTRICALS LIMITED, BHOPAL**  
**TRANSFORMER ENGINEERING DEPARTMENT**

FORM NO: TRE-2003A

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ANNEXURE TO INDENT-CUM-ENQUIRY - 240614499

DTD:- 24.02.12

DESCRIPTION OF EQUIPMENT : 10000 LPH OIL FILTRATION PLANT FOR  
 125MVAR, 420KV, 3-PH SHUNT REACTOR

WORK ORDER NO. : 61072-A-517-01

CUSTOMER : M/S UPRVUNL PARICHHA TPP

**SPECIFICATION FOR OIL PURIFICATION & FILTRATION PLANT – TWO STAGE**  
**(CAPACITY – 10000 LPH)**

**1. GENERAL:**

This specification covers design, manufacturing, testing, package and dispatch of high vacuum insulating oil treatment (Filtration, deaeration & dehydration) plant.

**1.1 PERFORMANCE REQUIREMENT :**

- 1.1.1 The high vacuum type oil filtration plant of capacity 10000 LPH shall be weather proof mobile & outdoor type and shall be suitable for treatment of new oil and reconditioning of used oil in EHV class power transformer, shunt reactor and other oil filled equipments in order to achieve properties of treated oil within specified limits at the rated capacity.
- 1.1.2 The plant shall be capable of treatment of new oil (as per IEC:296 / IS:335) and reconditioning of used oil (as per IEC:422 / IS:1866 for oil in service) at rated capacity on **"SINGLE PASS BASIS"** as follows -
- Removal of moisture from 100 ppm to 3 ppm.
  - Removal of dissolved gas content from 10% by volume to 0.1% by volume.
  - Improvement of dielectric strength break down voltage from 20 kV to 70 kV (min).
  - Filtration pore diameter : Maximum particle size 0.5 microns or less in the filtered oil.
  - Processing temperature (**direct heating of oil prohibited**) : 60°C (max.)
  - Maximum allowed temperature in oil to prevent oxidation : 60°C (When oil is at atmospheric pressure)
- 1.1.3 Bidder is to furnish alongwith the bid, detailed calculation to establish the sizing and capability of the vacuum pumping system with respect to moisture and gas removal as above.
- 1.1.4 Bidder is to submit alongwith the bid test reports, test methodology to prove the capability of plant offered.
- 1.1.5 The plant shall have 2 independent vacuum pumping system, one for degassing chamber & the other for transformer oil evacuation & creating high vacuum in transformer tank. The blank off vacuum of each pumping system shall be  $10^{-3}$  torr or less. (A detailed justification as to how end parameters shall be met with detailed calculations and test reports in support of the same shall be submitted along with the offer.)
- 1.1.6 The plant shall be provided with control and indication panel with full automation.
- 1.1.7 The plant shall be fitted with hoses for connection of oil lines & vacuum lines to transformers and reactors. Hoses shall have leakage rate of  $10^{-2}$  torr-liter/sec. (max).

REV	DATE	ALT CKD	REV	DATE	ALT CKD	REV 00	NAME	SIGN	DATE
						PREP	D.VARYANI	<i>DV</i>	24-02-12
						CKD	M.KULKARNI	<i>MK</i>	24-02-12

DWI/TCB/TRE/010

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- 1.1.8 The high vacuum type oil purification plant shall be complete with oil pumps for drawing oil from transformer and reactors. Oil heater of adequate rating, suitable filter or centrifuge as required to ensure oil quality, degasifier complete with vacuum pumps, oil extraction pump etc. of adequate capacity such that outcome from the purification plant is of guaranteed purity.
- 1.1.9 The plant shall also be suitable for cleaning and degassing of the oil stored in the storage tanks.
- 1.1.10 All equipments required as above shall be mounted on a tow able road worthy trailer unit with 4 nos. pneumatic tyres. The equipment shall be suitable for outdoor use.
- 1.2 DESIGN & CONSTRUCTION**
- The features and construction details of 10000 LPH capacity mobile outdoor type oil filtration & purification plant shall be in accordance with the requirements stated hereunder:
- 1.2.1 OIL PUMP (INLET SIDE)**
- 1.2.1.1 One no. electrically driven oil pump of single stage positive displacement gear type shall be provided. Suitable mechanical seals shall be provided to ensure vacuum tightness. A built in pressure relief valve to recirculate the oil to suction side in case of accidental pressure rise shall be provided. Suction lift of the pump shall be atleast 5 meters of transformer oil at atmospheric pressure & temperature. A separate by pass valve should be provided across the gear pump so that the flow rate through the filter can be adjusted as required.
- 1.2.1.2 The pumps shall be provided with an interlock with delay such that if there is no oil flow for 30 sec. through the heater, the pump shall trip automatically & also if the pump is not operating the heater will not be energized.
- 1.2.3 MAGNETIC STRAINER**
- 1.2.3.1 The plant shall be provided with a suitable magnetic strainer with wire mesh to filter all particles of sizes above 0.5 mm & all magnetic particles. The strainer shall be installed at the suction of the oil pump described above.
- 1.2.4 HEATER**
- 1.2.4.1 An oil heater for heating up inlet oil shall be provided at the discharge side of the oil pump.
- 1.2.4.2 The oil heater vessel shall be of mild steel welded construction & insulated with glass/mineral wool.
- 1.2.4.3 The vessel shall be constructed for high vacuum & pressure application.
- 1.2.4.4 Electric heater shall be provided inside the heater vassal to heat up oil from lowest ambient temperature to temperature required for filtration/degasification operation in single pass. The heater shall also be rated for heating the inlet oil from lowest ambient temperature to 60° C in single pass during filling up of transformer. Two separate temperature settings with thermostatic controllers shall be provided for this purpose.
- 1.2.4.5 The heating shall be indirect type and specific heat load shall not exceed 2.0 watt/cm<sup>2</sup> in order to avoid local overheating.
- 1.2.4.6 The total heating capacity shall be divided into three independent thermostatically controlled heating stages evenly balancing the three phases of power supply. The control switches and knob shall be housed on a control panel.
- 1.2.4.7 An additional preset temper proof safety thermostat set at the highest temperature shall be provided on the heater to put off the heater and give audio and visual alarm to take care of

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accidental overheating.

1.2.4.8 The heater body shall be so designed as to allow replacement of heating elements without draining of oil. Suitable pressure relief valve, vent and drain valves & two (2) dial type temperature gauges at inlet & outlet of heater shall be provided.

**1.2.5 FILTER**

1.2.5.1 Cartridge filter as may be required to ensure maximum particle size to less than 1.0 micron in the filtered oil shall be provided.

1.2.5.2 The filter body shall be fabricated of mild steel & designed for leak tightness at full vacuum & high pressure. The oil will flow from dirty oil chamber to clean oil chamber through filter elements.

1.2.5.3 Cartridge type elements used shall be suitable for transformer oil in service and filtration. The media shall be non hygroscopic and of high dirt holding capacity.

1.2.5.4 The filter elements shall be easily removable for replacement when required. Compound gauge to indicate pressure across the filter vent and drain with valves and other necessary accessories shall be mounted on the filter for each operation.

**1.2.6 FILTER PRESS**

1.2.6.1 For treating dirty oil, filter press of adequate rating also to be supplied for supplementing the capacity of filter elements. These units shall be designed for quick and easy replacement of media. A sludge outlet for receiving the solid impurities and cleaning the filter plate without opening the unit shall be provided. The unit shall be provided with vent & drain valves, pressure gauges at inlet and outlet and other necessary accessories.

**1.2.7 EXTERNAL SOLENOID OPERATED VALVES**

1.2.7.1 Two valves should be provided at the inlet and outlet of the plant. The moment inlet & outlet pumps are switched on, these valves will be open, thus making way for oil to pass. In case of power failure, oil from the transformer will not enter the plant and vacuum system.

**1.2.8 DEGASSING CHAMBER**

1.2.8.1 The degassing chamber shall be of welded construction and shall be suitable for operation under full vacuum. The fill of rasching rings & trays for distribution shall be designed for efficient distribution of oil over large areas. Incoming transformer oil should be spread over these rings in the form of film and over a longer surface area, thus achieving better degassing and dehumidification.

1.2.8.2 The degassing chamber shall be either single stage or multi stage type suitable for ensuring the desired oil properties. Arrangement for condensing back lighter fraction (Aromatics) of the insulating oil into the system shall be provided.

1.2.8.3 The degassing channels shall have adequate height to allow long enough free fall for complete degassing. Design shall be such as to minimize foam formation.

1.2.8.4 The degassing chambers shall be provided with suitable level monitor for oil or foam level in the chamber and shall trip the inlet gear pump when the level rises above the designed maximum level in the order to prevent foam/ oil to enter the vacuum pumping system. The oil inlet pump starts again automatically once the oil level in the degassing chamber falls below the preset oil level.

1.2.8.5 Necessary illuminated sight glass shall be provided through which oil flow through the degasser can be viewed clearly.

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1.2.8.6 The degasser shall be provided with vacuum gauges, vacuum breaking valves, main and auxiliary vacuum connections and other necessary accessories.

**1.2.9 VACUUM PUMPING SYSTEM**

1.2.9.1 The pump shall be provided with a suitable vacuum pumping system for creating adequate high vacuum in the degassing chambers. The vacuum pumping system shall consist of suitable combination of roots blowers and rotary vane vacuum pumps with inter-stage condensing units.

1.2.9.2 The roots blowers shall be reputed make. Suitable built in the laby-rinth packing system, slinger rings, oil return chambers shall be provided between bearings and working chambers to prevent penetration of lubricating oil to the working chamber. The pump motor shall be dynamically balanced. The pump shall be suitable for starting evacuation from atmospheric pressure and shall be applied with necessary overflow valve.

1.2.9.3 The rotary vane vacuum pumps shall be installed after the roots blower. An automatic by-pass valves across the root blowers shall permit operation of rotary vane pump alone to operate when so required. Rotary vane pumps are provided with gas ballast valve to prevent contamination of vacuum pump oil with moisture. The vacuum pump shall also be provided with suitable non-return valve device such that in the event of power failure the vacuum in the degassing chamber shall be maintained and the vacuum pump oil is not sucked back into the degassing chamber. A high vacuum safety valve (piston type) to prevent back streaming of oil and air intrusion shall be provided. The pump motors shall have return stop device.

Necessary water cooled condensing unit to condense the lighter fraction (aromatics) and return the same to the transformer oil shall be provided to reduce the loss of aromatics.

**1.2.10 VACUUM PUMPING SYSTEM FOR TRANSFORMER EVACUATION**

1.2.10.1 An independent vacuum pumping system shall be provided for evacuating the transformer for oil filling. The vacuum level required for transformer evacuation for oil transfer is about 0.76 torr (1 m bar) for transformer oil heated to 70-80°C. The capacity shall be adequate for evacuation of transformer with oil volume of approx. 65,000 litres within 4 hour. The vacuum system for degasser & transformer evacuation shall be inter connected in such a way that it shall be possible to use either or both the systems for any of the purpose. "A re-inforced hose of 10 mtr. length should be provided. The hoses must be for vacuum leakage rate of  $10^{-2}$  torr litre/sec."

**1.2.11 OIL EXTRACTION PUMP**

1.2.11.1 Suitable pumping system shall be provided for extracting oil from degasser under vacuum and supplying the transformer/ reactor etc. at discharge pressure of  $1.5 \text{ kg/cm}^2$  at the outlet hose nozzle of the plant, the pump shall be either glandless centrifugal type with canned motors suitable for extracting oil from high vacuum degassing chamber. The oil extraction pump shall be located at a suitable level below the degassing chamber so as to ensure adequate suction head for the pump. The pump shall be supplied with double check valve assembly and solenoid operated non return valve. In order to stop reverse flow of oil in case of power failure, the pumping system shall preferably be self priming type, alternatively priming device with safety interlock to protect pump against dry running shall be provided. Sampling valve shall be provided at the discharge of extraction pump for testing of oil properties. A recirculation line with valves shall be provided to re-circulate a part of the purified oil to the inlet point if necessary under operation.

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**1.2.12 HOSES FOR TRANSFORMER OIL, VACUUM, AIR & WATER**

- 1.2.12.1 Separate reinforced rubber hoses shall be provided for each operation of oil suction, oil discharge, compressed air supply and cooling water supply and return. The **2 nos. hoses shall be at least 15 meters** long each and shall be complete with hose quick connect couplers for connection to installations under operation.
- 1.2.12.2 Hose pipe for oil service shall be suitable for transformer oil application up to temperature of 100°C, full vacuum and pressure up to 2.5 kg/cm<sup>2</sup>. All oil hoses shall be built up around an earthed core or have built in earthed conductor to avoid static electricity accumulation. Inlet and outlet nozzles of purification plant and corresponding hoses shall be of 50/ 40 NB size respectively in order to avoid error in connecting.
- 1.2.12.3 Vacuum hoses shall be of braided nitrile rubber suitable for full vacuum without collapsing or kinking.
- 1.2.13** (A) Oil sampling valve  
(B) Material of construction and painting  
Suitable valve shall be provided for taking sample during filtration.
- 1.2.13.1 Oil heater, filter vassal, degasser shall be of mild steel construction. The internal & external surface including oil heater, filter vassals, degasifier and structural steel work to be painted shall be shot or sand blasted to remove all rust and scale of foreign adhering matter or grease. All steel surfaces in contact with insulating oil shall be painted with two coats of heat resistant oil insoluble, insulating varnish.
- 1.2.13.2 All internal painted steel surfaces shall be given a primary coat of zinc chromate, second coat of oil and weather resistant varnish of a colour distinct from primary and final two coats of glossy oil and weather resistant paint.
- 1.2.13.3 All paints shall be carefully selected to withstand heat and extremes of weather. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.
- 1.2.13.4 All bolts and nuts exposed to weather shall be hot dip galvanized / cadmium plated and passivated/ zinc plated and passivated.
- 1.2.13.5 Material of construction for vacuum pump, air compressor, air drying plant, air receiver shall be steel of suitable grade.

**1.3 INSTRUMENTATION AND CONTROL**

- 1.3.1 Following minimum instruments shall be provided on the purification plant -
- 1.3.1.1 Compound gauge at oil pump discharge.
- 1.3.1.2 Compound gauge at filter inlet.
- 1.3.1.3 Compound gauge at filter outlet.
- 1.3.1.4 Pressure gauge at discharge pump outlet.
- 1.3.1.5 Pressure gauge at compressor outlet.
- 1.3.1.6 Pressure gauge at air receiver.
- 1.3.1.7 Pressure gauge at degasifier.
- 1.3.1.8 Vacuum gauge at transformer evacuation line.
- 1.3.1.9 Vacuum gauge in between roots vacuum pump and rotary vane vacuum pump.
- 1.3.1.10 Mclead vacuum gauge at degasser & transformer evacuating line.

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- 1.3.1.11 Sight glass at degasifier.
- 1.3.1.12 Dial type temperature indicator at heater inlet.
- 1.3.1.13 Dial type temperature indicator at heater outlet.
- 1.3.1.14 Voltmeter.
- 1.3.1.15 Oil flow meter (positive displacement type).
- 1.3.1.16 Ammeter.

**1.3.2 CONTROL PANEL**

A centralised electrical panel with auxiliary step down transformer, connectors, backup protection fuses, indicating lamps etc. to be provided with following minimum **audio and visual annunciation**.

- (a) High temperature at heater outlet
- (b) High differential pressure across filters
- (c) Oil pump trip
- (d) Vacuum pump trip
- (e) Loss of vacuum in degassing chamber
- (f) Loss of vacuum in transformer evacuation line
- (g) No oil flow through heater
- (h) High oil level in degasser

All controls and annunciation equipment should be suitable for 240 V AC.

- 1.3.3 Suitable interlock as described against each equipment shall be provided for safe and trouble free operation.
- 1.3.4 All instrument control hardware and alarms shall be mounted on a suitable control panel. A mimic diagram with indication lamps showing on-off status of various equipments shall be provided on the control panel.
- 1.3.5 The plant shall be fully equipped with adequate instrumentation having provision of manual operation, if required. All necessary control and indicating panel shall be provided.
- 1.3.6 The plant shall be complete with all necessary hoses, cables etc. of adequate length for necessary connections to transformer/ reactor and also to utility connections to be provided near such installations for this purpose.
- 1.3.7 It shall be possible to use the oil transfer pump for the purpose of loading oil to transformer or reactors from tankers and vice-versa by bypassing to purification plant, if required.

**1.4 ELECTRICAL SYSTEM**

- 1.4.1 The plant shall receive 440/400 V, 3-phase, 50 Hz, 4 wire power supply through flexible cable in the distribution panel located on the plant. The incomer of the distribution panel shall be switch fuse unit.
- 1.4.2 One length of 50 meters of core 1100 grade flexible cable with crimped lugs at one end shall be provided for connection of the unit to mains. The length of the cable will be covered in the suitable drum.
- 1.4.3 Provision for earthing the plant at the operating locations with earthing terminals for safety shall be provided.

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1.4.4 The plant shall be suitably illuminated and ventilated for comfort of operator.

**2.0 INFORMATION TO BE FURNISHED ALONGWITH THE OFFER -**

The tenderer shall submit the following data alongwith the offer -

- (a) 3 sets of descriptive leaflet, catalogue and technical literature of the model.
- (b) Technical data of the plant indicating quantity, description, rating, capacity of each major component of the plant. Flow diagram showing all major components of the plant, outline dimensional drawing with tyred undercarriage and overall weights etc.
- (c) Total power requirement for the plant in kW.
- (d) Heating density (Watt/cm<sup>2</sup>) of oil heater and total cooling water required for the plant.

**3.0 TRAINING:-**

The supplier shall provide, if required training to our customer (UPRVUNL) at site on intimation by BHEL for commissioning operation and maintenance of the plant for a maximum of 3 mandays per plant per site, and shall obtain certificate from our customer regarding impart of training. For this supplier should quote the charges separately, if any in the offer.

**4.0 INSPECTION, TESTING AND DISPATCH:**

4.1 After receipt of letter of indent/purchase order from BHEL, the supplier shall furnish a detailed quality assurance plan (QAP) for approval. It will be sole responsibility of the supplier to get the approval of QAP before execution of the order. QAP shall include tests/checks for all major components and fittings used in the plant, All stage and process checks and final inspection and testing. Atleast the following requirements will be included in QAP.

- a) Tests/test certificate on inlet gear pump, vacuum pump, outlet pump motors, gauges, instruments and fittings.
- b) Tests/test certificate for raw materials like structural steel and pipe etc.
- c) Vacuum and pressure test on all vessels such as filters, degassing chamber and heating vessel etc.
- d) Vacuum leakage test of complete plant.
- e) Capacity (flow rate) test of the plant.
- f) All electrical and interlock test including insulation test of switch panel.
- g) Performance test of the plant as per paragraph 1.1 above.

4.2 The supplier shall furnish all test certification as per the approved QAP. The oil purification and filtration plant shall be inspected and tested at manufacturer's works in presence of M/s UPRVUNL representative. An advance notice of atleast 15 days should be given to arrange for inspection. Plants shall be dispatched only after clear cut clearance from BHEL. Four sets of inspection and test reports, operation and maintenance manual shall be sent alongwith dispatch document. One set shall be kept inside the equipment.

4.3 The supplier shall furnish a list of all fittings and components in the dispatch details giving description and quantity of each item (quantity of each item shall be mentioned) all items shall be properly packed to avoid damage in transit.

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