Response to RFIs on Farah substation

ANNEXURE - I

The technical Specifications of Shunt reactors as follows

1.2.3.1 Standards

All shunt reactors shall be designed and manufactured in accordance with the latest edition of IEC standards. This includes the following main applicable standards:

- IEC 60076 Power Transformers
- IEC 60137 Insulating bushings for alternating voltages above 1000V
- IEC 60296 Fluids for electrotechnical applications - Unused mineral insulating oils for transformers and switchgear
- IEC 60529 Degrees of protection provided by enclosures
- IEC: 60099-1 and IEC:60099-4 Metal-oxide surge arresters without gaps for AC systems

1.2.3.2 General

Shunt reactors shall be 3 phase, oil immersed consisting of a complete independent unit with outdoor bushings, surge arrestors, cooling equipment, auxiliaries and accessories. All shunt reactors supplied shall be installed outdoors and shall be required to operate under the system characteristics and climatic conditions specified in Section 3.1.5 and 3.2.1. Each shunt reactor shall produce its full rated reactive power at its designated substation after applying any derating factors due to climate and altitude. The shunt reactors shall comply with guidelines established in IEC 60076.

The shunt reactors shall be rated in accordance with Table 2.1.10 of the Technical Data Sheets.

The shunt reactors shall be capable of operating continuously at the specified output and at voltages at 10% higher than the rated voltages without undue heating, vibration, noise and other operating difficulties.

Additional Requirements:

- Shunt Reactor shall be capable of controlling the dynamic over voltage occurring in the system due to load rejection.
- The reactor shall capable of withstanding switching surge overvoltage up to 2.5 p.u. followed by power frequency overvoltage up to 1.35 p.u. The reactor must withstand the stresses due to transient dynamic conditions which may cause additional current flow as a result of changed saturation characteristics.
- Reactor shall be completely shielded with no external stray flux.

An auxiliary electrical supply of 400/230VAC, 3-phase shall be available from the substation. This AC power is dedicated to operation of electric motors (fans, pumps, etc.) and AC control and protective devices required for the proper operation of the shunt reactor.

220VDC shall be available (from the substation) for Alarm and Protection and Control functionalities of the shunt reactor.

1.2.3.3 Cooling System

Shunt reactors shall be capable of operating continuously at full load utilizing ONAN type cooling.
The coolers shall be of the fin type, fully hot-dip galvanized, detachable and equipped with lifting eyes, vent holes with plugs, plugs for filling and draining and with shutoff valves to permit the removal of any cooler without draining the oil from the shunt reactor tank. The coolers shall be removable during operation or transportation of the shunt reactor. All radiator isolating valves shall be fully oil tight and vacuum capable and shall be mounted to the shunt reactor and radiator by bolted flanges.

Only shunt reactors less than 10MVA shall have radiators mounted directly to the tank, all other shunt reactors shall be mounted via a manifold.

1.2.3.4 Temperature Rise

In continuous service, at the specified ratings, the rise in temperature above the ambient air shall not exceed 60°C for the windings and 55°C for the top oil.

For cores and other parts the rise in temperature shall, in no case, reach a value that will damage the core itself, metallic parts or adjacent materials.

1.2.3.5 Short-Circuit Withstanding Capability

The shunt reactor shall be designed and constructed to withstand without damage:

- Three-phase short-circuits and solid line-to-ground short circuits that can appear at the winding terminal.
- Transportation or impact forces of 3g or greater.

1.2.3.6 Vibration and Noise Levels

Special attention shall be given in order to avoid undue vibrations and noise in the shunt reactor.

1.2.3.7 Core

The core shall be made of high grade, un-aging, cold rolled grain oriented steel. Laminations shall have low losses and high permeability. Insulated packets of the core are to be connected so that no potential differences will exist between them. Flux distortion shall be minimized to reduce noise level.

The cores, framework, clamping arrangements, shall be capable of withstanding any shocks to which the equipment may be subjected during transport and operation.

Both the core and frames shall be earthed via a single point earthing design where each connection to either the frame or core is brought out through separate 2KV bushings complete with removable bolted shorting links that connect them to an earth stud on the tank lid. All components shall be rated for the maximum possible circulating current should the core or the frame become inadvertently earthed. The bushings located on the lid shall be protected from inadvertent physical damage by a removable cover or similar.

1.2.3.8 Windings

The turns in coils shall be thoroughly treated in such a way as to develop the full mechanical and electrical strength of the shunt reactor. Oil from radiators shall be directed into the bottom of each winding.

All windings 220KV and above may have graded insulation; and all windings rated less than 220KV shall be fully insulated.

All winding conductors and connections shall be manufactured from burr free profiled high conductivity copper or aluminum. All electrical connections within the windings shall be fully brazed or welded and capable of withstanding all shocks encountered in service, transport,
earthquakes etc. All connections from windings shall be mechanically sound and fully supported.

All cylinders and wraps shall be made from pre-compressed transformer board. All cylinder joints shall be fully scarfed with overlaps being made only on duct strips. Only fully molded caps and collars are acceptable; designs utilizing “Petal” collars or caps are not acceptable.

When used, enamel covered wires shall have a minimum radial thickness of 0.05mm and where crossovers or transpositions occur they shall be mechanically and electrically protected.

No electrical out-of-balance turns will be acceptable between phase windings. All duct strips and spacers shall be full contoured and shall be of a solid construction, strips and spacers stacked together are not acceptable. All paper-covered conductors shall use thermally upgraded paper. All continuously transposed conductors shall be fully epoxy bonded to withstand all free buckling and short circuit forces.

1.2.3.9 Tank

The tank shall be constructed of high-grade steel plate, suitable reinforced to withstand handling and pressure during fault condition without any destruction.

The tank shall be provided with manholes, valves and de-aerating cocks as may be required for the prescribed maintenance of the shunt reactor. The tank shall be provided with earthing terminals for a wire of 95mm2 at two opposite sides of the tank.

1.2.3.10 Corrosion Protection

The corrosion protection shall be carried out as specified in Section 1.1.21.

1.2.3.11 Oil

All oil used during the manufacture of the shunt reactor shall be free of all additives. Oil supplied for the filling of the shunt reactor shall be new and shall contain at least 0.3% by weight oxidation inhibitor of type di-tert-butyl-para cresol (DBPC) according to IEC 60296.

The oil shall not contain PCB. If oil samples taken from the shunt reactor on delivery contain 2ppm or more PCB, the Employer shall have the right to refuse the delivery of the shunt reactor.

1.2.3.12 Bushings

Bushings shall be of type stated in IEC 60137.

The star point of the winding shall be separately bought out through the tank lid by means of an outdoor bushing, located so that it cannot be associated with the main phase bushings. All bushings shall have permanent phase markings adjacent to the bushing flange.

1.2.3.13 Accessories

The following accessories shall be provided for the shunt reactor:

- Oil temperature indicator for the top oil equipped with a maximum reading device individually insulated and a minimum of two separately adjustable contacts for alarm and tripping, with all immersed parts able to be removed without the need to interfere with the tank
- Winding temperature indicator shall be equipped with a maximum reading device individually insulated and a minimum of two separately adjustable contacts for alarm and tripping, with all immersed parts able to be removed without the need to interfere with the tank
- An aseismic Buchholtz relay for gas protection with a minimum of two non-mercury separate contacts for signal and tripping. A gas capture and test device shall be connected to the Buchholtz and located adjacent to the control cubicle
- Oil level indicator equipped with a minimum of two separately adjustable contacts for alarm and tripping
Oil drying device, type Silica Gel breather
- Terminal box equipped with disconnect able terminals for signal cables to the auxiliary cubicle

1.2.3.14 Routine Type Tests

General
Full and complete testing of the shunt reactor with accessories shall be carried out according to the relevant IEC Standards. The more important tests are listed below.

The Contractor shall give a complete description of the proposed test methods. The test methods and the performance of the test shall be subject to the approval of the Project Manager. All instruments and equipment necessary for the testing shall be provided by the Contractor.

Test Particulars
Testing shall include but not be limited to the following:

- When a shunt reactor is to be subject to a temperature rise test, dielectric test including an impulse test shall be carried out as soon as practicable after this test, that is whilst the shunt reactor is still hot
- The no-load losses and the current of the shunt reactor shall be measured at 90%, 100% and 110% of rated voltage before commencement of the dielectric test. The no-load losses and current measured after completion of the dielectric test shall be the values used in determining the performance of the shunt reactor
- Impulse test shall be applied on all shunt reactor terminals, including neutrals. Impulse test oscillography records shall be made available
- Noise level measurements shall be carried out according to IEC 60076
- Bushings shall be fully tested according to IEC 60137
- Insulation power factor tests shall be performed with bushings in place

Type Tests
The following type tests shall be carried out. The tests shall be according to IEC 60076, except where otherwise specified.

- Temperature rise test
- Noise level
- Examination of harmonics
- Tests on bushings

Routine Tests
The following routine tests shall be carried out. The tests shall be according to IEC 60076, except where otherwise specified.

- Winding resistance measurements
- Polarity tests
- No-load loss at 90%, 100% and 110% of rated voltage
- Exciting current at 90%, 100% and 110% of rated voltage
- Load loss at rated current
- Separate source withstand tests
- Induced voltage tests
- Impulse voltage withstand tests. Full wave and chopped wave
- Pressure tests on tank and coolers for oil tightness. If a temperature test is made, the pressure test shall be made while the shunt reactor is still hot
- Operational tests of all devices and wiring
- Insulation tests on auxiliary devices and wiring
- Test on bushings
### Routine Tests (Cont…..)

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