SPECIFICATION FOR CONTINUOUS ON LINE PARTIAL DISCHARGE MONITORING SYSTEM

This specification has TWO Sections.

SECTION – 1 : Contains the technical specification of "CONTINUOUS ON LINE P. D. MONITORING SYSTEM" and requirement of technical documentation along with quotation.

SECTION – 2 : Contains project details with project specific requirements of quantity of P. D. Couplers per set .

SECTION – 1

1.0 INTRODUCTION

Partial discharges (corona or small sparks) are symptoms of thermally, electrically or mechanically induced deterioration of stator winding insulation of hydrogenerators due to prolonged operation at high temperatures, mechanical & electrical stresses, pollution and high voltage surges during operation.

This specification covers **"continuous on-line partial discharge monitoring system"** specifically designed to measure partial discharges in the stator slot between high voltage stator winding bars & the slot wall and within the insulation of bars of hydrogenerator, as & when required. Partial discharge monitoring equipment shall be suitable for acquisition of data i.e. quantity, magnitude, polarity & phase angle of the partial discharges and for their analysis & display.
The analyzer must be panel mounted type modular micro processor based state of the art with digital display monitor /controller /work station, with latest software to interpret the PD results.

The equipment shall be of self diagnostic and resistant to false indications and shall be able to effectively separate the real PD activity from noise.. It shall record the data in digital form. The analyzer should automatically suspend measurement when the machine is not in service.

2.0 SPECIFICATION

Partial discharge monitoring equipment required for hydrogenerators (Details of which are furnished in Section – 2) shall be complete with partial discharge couplers, partial discharge analyzer and other associated accessories complete with insulation & installation kit as per specification given below:

2.1 PARTIAL DISCHARGE COUPLERS

Partial discharge couplers shall be of capacitance type of proven design and shall meet the following requirements:

- Epoxy mica type with 80 pf ± 3 pf capacity.
- Dissipation factor should be less than 0.05%
- Minimum 16 kV Voltage rating
- Capable of operating up to class 'F' temperature limits.
- AC withstand voltage not less than 33 kV AC (RMS) at 50 Hz for one minute.
- Couplers shall have resistance to electrical tracking.
- Couplers shall contain a reference sensor to provide a phase reference to the PD Analyzer.
- HV lead between coupler and generator bus ring shall be as short as possible and shall be of low inductance and adequate ground must be supplied with each coupler to ensure low inductance and 3 AWG or higher gauge wire shall be used.
- Coupler shall allow for proper interpretation of PD activity within the generator and the corresponding recommendations.
- Couplers shall be immune to noise.
- Voltage reference sensor shall be wired up to termination box.

2.2 MOUNTING AND INSULATION KIT

Complete with all hardware, coaxial cables for HT & LT connections and other components necessary to establish & insulate the high voltage connections with the stator winding, as well as the signal connections from couplers to termination box. Each signal cable shall be terminated in a shield grounding assembly at the coupler end & termination box end to reduce partial discharge losses and also to prevent pick-up of external discharges/disturbances, so as to improve over all response of partial discharge analyzer.

2.3 PDA TERMINATION BOX

Weather proof termination box as per NEMA Standard, Class-4, provided with protection circuitry to prevent build up of hazardous voltage levels on any part of the box at any time and suitable for termination of LT connection from PD couplers along with necessary hardware for cable termination and mounting of termination box on concrete wall.

2.4 PARTIAL DISCHARGE ANALYZER

Flush Panel Mounted Partial Discharge Analyzer shall be PC compatible with built in tester and shall have provision for connecting to all the PD couplers of one generator or more for measurement of PD activity along with necessary cables for connections from Analyzer to termination box . P. D. Analyser shall be suitable for Continuous On Line measurement of Partial Discharges and with technical specification as detailed below :

- No. of PD input – As specified at Section - 2
- Dynamic range of ± 20 mV to ± 4000 mV
- Minimum windows width of 20 mV
- 24 phase windows or more
- 3.6^0 resolution or better
- Data acquisition should be selectable between 20 sec. & 100 sec. for each pair of couplers.
- Band width should be within 0.1 MHz to 350 MHz range
- Noise separation through "Digital Comparison of Pulse Arrival Time with resolution of 6 ns" to distinguish as PD pulses, Noise pulses and other non - PD pulses.
- Amplifier for extra partial discharge measurements.
- 4000 mV or more attenuator with high PD activities.
- Communication protocol suitable for connection to computer.
- Each channel individually programmable.
- One Noise Channel.
- Low level noise levels shall also be programmable for each channel.
- Three Analog input for current, temperature & humidity.
- 2 nos. Electrical Alarm Contacts for high/low PD.
- Frequency of collecting / monitored test data shall be programmable and shall be capable of being collected at preset fixed time or fixed time base.
- System status contact.
- 4 to 20mA signal for data transmission to central Control Room.
- Should be able to store data for five years or more with four recordings per day.
- Shall be capable of providing predictive on Line Alarm and protection form PD induced insulation deterioration resulting from voids, cracks and/or surface tracking corona activity.

2.5 PARTIAL DISCHARGE ANALYSIS SOFTWARES

Latest version of Microsoft window based PD SOFTWARE for diagnosis & analysis of P.D. data and PREDICTIVE MAINTENANCE SOFTWARE shall be supplied with P. D. Monitor for complete data acquisition, controlling & analyzing of partial discharge activities. The software supplied shall be suitable for WINDOW XP PRO operating system of the computer work station available at the power house.

All Software packages shall be provided with software support for minimum period of **TWO years** after commissioning of the equipment.

Customer's SCADA system is placed in central control room located about 300 mts away from the machines. It shall be possible to communicate with SCADA over serial RS 232 PORT with MOD BUS RTU slave protocol. All networking hardware and data cables between SCADA and P.D. analyzer of units shall be in supplier's scope. Scheme shall be so designed that all four P.D. analyzer shall be connected to SCADA. Also 4-20 mA signals, alarm & trip signals shall be made available to SCADA.

2.5.1 GRAPHICAL DISPLAY

The software should be able to display the details as specified below:

- Two-axis plot indicating number of PD pulses per second Vs Magnitude of PD pulses with Polarity.
- Should be able to superimpose two –axis graphs for comparison
- Three-axis plot indicating Number of PD pulses for second, Magnitude of PD pulses with Polarity Vs Phase angle of PD pulses.
- Should be able to superimpose two three –axis graphs(mentioned above) for comparison.
- Pulse magnitude, pulse repetition rate, PD intensity, phase resolved data in graphed form.

2.5.2 TABULAR DISPLAY

The software should be able to display in a tabular form various pulses measured during the tests, the pulses should be clearly categorized as follows:

- PD Pulses
- Noise Pulses
- Other Non –PD Pulses

2.6 PORTABLE COMPUTER & COLOUR PRINTER

Latest version of Portable Computer (Lap Top) and Colour Printer of reputed make shall be compatible for use with Partial Discharge Analyser for data acquisition, storage, analysis & display of partial discharge activities.

2.7 POWER SUPPLY

Partial Discharge Analyzer covered in this specification shall be suitable for 240 ± 20% Volt, 50 ± 5% Hz., Single Phase AC supply and provided with necessary protection for input voltage surges.

2.8 WORKING ENVIRONMENT

Partial Discharge Analyzer covered in this specification shall be capable of operating trouble free at an ambient temperature range of 0° to 50° C (Max.), 98.8% relative humidity, noise level of 90 dB and vibration level of approx. 100 microns (at 100 Hz.) Temperature in the vicinity of PD couplers will be approx. 100° C (max. absolute).

3.0 SCOPE OF SUPPLY

The supplier shall design, manufacture, inspect, test, supply and install (at site) a proven partial discharge analysis (PDA) system for continuous on-line monitoring of the condition of stator winding insulation without an interruption in the operation of the machine. The PDA system supplied & installed shall not in any way compromise the integrity and safety of the machine. The system shall be complete in all respect covering the following major items. Any other item which is not specifically stated, but essentially required for installation & trouble free operation of the system shall also deemed to have been included in the supplier's scope without any additional cost to purchaser.

3.1 FOR EACH GENERATOR

3.1.1 ONE SET - Partial Discharge Coupler package (Quantity as specified at Section - 2) as specified in clause 2.1, 2.2, & 2.3 above with appropriate length of HT & LT cables per coupler, termination box, connectors for termination of cables and insulating materials for insulation of HT joints, etc. along with complete test result for each PD coupler issued by an accredited laboratory as per ASTM D-1868.

3.1.2 ONE SET – Flush Panel Mounted Partial Discharge Analyzer as specified in Clause 2.4 above.

3.2 COMMON FOR ALL GENERATOR (Total One Set)

3.2.1 ONE SET – Latest version of Microsoft window based PD SOFTWARE for diagnosis & analysis of P.D. data and PREDICTIVE MAINTENANCE SOFTWARE as specified in Clause 2.5 above.

3.2.2 ONE SET – Portable Computer (Lap Top) with Colour Printer as specified in clause 2.6 above and loaded with P.D. Software specified at clause 2.5

3.3 INSTALLATION & COMMISSIONING OF PD EQUIPMENT

- Lumsum Supervision for Installation & Commissioning, calibration & testing of complete lot of PD equipment covered under scope of supply for each generator.
- Preparation and submission of test report on PD equipment for each generator.

- Preparation of **"as-built"** drawings indicating total installation of PDA system with location of PD couplers, method of fastening PD couplers, and their electrical connections for one machine.
- Training at site for customer's engineers on the fundamentals of the PDA system (installed) and the use of PDA instrumentation package & soft wares with suitable recommendations of PDA test procedures, data/result interpretation PDA test file management, etc. for implementation by end user for first set only.

4.0 TESTING

The equipment shall be extensively tested for functional operation, calibration of couplers and reliability.

5.0 INSPECTION

The equipment shall be inspected & tested at supplier's works in the presence of BHEL & Customer's Engineer prior to dispatch. Supplier shall notify the readiness of equipment for inspection & dispatch **at least 45 days in advance** for deputation of inspection team to supplier's works. All charges regarding travel, lodging & boarding for BHEL or Customer shall be borne by respective agency.

6.0 PACKING AND FORWARDING

The complete equipment shall be suitably packed for sea worthy packing and safe transport. Packing of the equipment shall also be suitable for dead storage of equipment for five years.

7.0 DOCUMENTATION:

7.1 With offer.(Two copies each)

(a) Descriptive details/leaflet of each item.
(b) GA drawing of equipment and Interconnection / wiring diagram of system.
(c) Mounting details like weight, panel cutout etc.
(d) Packing specification.
(e) Quality assurance plan and final test report format.

7.2 After ordering but before supply : <u>The copies of documents specified below shall only be forwarded directly to HGE (BHEL, BHOPAL).</u>

(a) **15** - Copies of O&M manual including panel cutout / mounting arrangement / wiring & other necessary drawings.
(b) **15** - Copies of packing list.
(c) **15** - Copies of test certificates.
(d) **15** - Copies of guarantee certificates.
(e) **15** - Copies of reproducible of above documents.
(f) **5** - Copies of documents in electronic form i.e. CD

8.0 Guarantee -- As per Annexure-CL enclosed.

9.0 Liquidated damage

A penalty shall be applicable for late delivery of equipment. Condition and rate of penalty shall be as specified on the enquiry.

SECTION – 2

SPECIFICATION FOR CONTINUOUS ON LINE PARTIAL DISCHARGE MONITORING SYSTEM

1.0 GENERATOR TECHNICAL DATA:

1.1 Project :

1.2 Rating :

1.3 No. of parallel path per phase :

1.4 Insulation Class :

1.5 Power Frequency Test Voltage : 29 kV AC (RMS) for 60 Seconds

1.6 No. of slots :

1.7 Conductors per slot : 2

1.8 Type of winding :

1.9 No. of terminals : ___ nos. per phase, Total __ nos. line terminals and ____ nos. neutral terminals brought outside stator frame

1.10 Insulation Class : 'F'

1.11 Bus Bars/Current rings : Copper flats of size -__x___x __nos. in parallel for each parallel path

1.12 Generator Capacitance per phase: _____micro farad per phase

1.13 No. of P. D. Couplers per phase per parallel path : One no. (Total _____ nos per Set)