ONLINE PARTIAL DISCHARGE MONITORING SYSTEM

August 2023

Engineering Department

WEST BENGAL STATE ELECTRICITY TRANSMISSION COMPANY LIMITED
পশ্চিমবঙ্গ রাজ্য বিদ্যুৎ সংবহন কোম্পানি লিমিটেড
(পশ্চিমবঙ্গ সরকারের একটি উদ্যোগ)

Regd. Office: VidyutBhawan, Block – DJ, Sector-II, Bidhannagar, Kolkata – 700091. CIN: U40101WB2007SGC113474; Website: www.wbsetcl.in

TECHNICAL SPECIFICATION FOR ONLINE PARTIAL DISCHARGE MONITORING SYSTEM

1. SCOPE:

The scope shall cover Engineering, supply, installation, testing and commissioning of partial discharge continuous monitoring system, with all necessary auxiliaries and accessories to make a complete system as per technical specification, including site demonstration of successful operation. Any items/accessories necessary to make the system fully functional for the trouble-free online PD monitoring of complete GIS installation shall be considered as included in the scope.

2. STANDARD:

The calibration and frequency response of couplers shall be as per latest update of NGC Technical Guidancenote TGN (T) 121, issue 1, 1997. Data sheet shall be submitted for the UHF couplers meetingthis requirement.
The sensitivity of the offered system shall be in accordance with latest update of CIGRE document for UHF detection TF 15/33.03.05 that will be verified as part of site sensitivity tests.

3. DEVIATION:

Normally the offer should be as per Technical Specification without any deviation. But any deviation felt necessary to improve performance, efficiency and utility of equipment must be mentioned in the Deviation Schedule with reasons duly supported by documentary evidence. Such deviations suggested may or may not be accepted by the Board. Deviations not mentioned in Deviation schedule will not be considered.

4. DESIGN OF ONLINE PDM SYSTEM:

An on-line continuous Partial Discharge Monitoring (PDM) system shall be designed to provide an automatic facility for the simultaneous collection of PD data at all points on the GIS & its associated GIB ducts and Voltage Transformers adopting UHF technique. The data stored shall provide a historical record of the progress of PD sources and shall identify the areas of maximum activity.

The PDM system shall be provided with capacity for readily interfacing with UHF PD couplers of present and future GIS Bays as shown in SLD plus 20% spares (as applicable for PDM system). The PD Monitoring PC Work Station shall be housed in a lockable cabinet with duplicate keys and shall be located in the control room of the GIS substation. Workstation PCs shall be pre-loaded with all necessary Hardware & Software. The PCs shall have each Combo drive & Retrievable disk drive (1 TB), Ethernet port 100Mbps, printer. The workstation PC shall be powered by suitable dedicated UPS and same is included in the present scope.

a) The overall sensitivity of PD detection system shall take into account the spacing between couplers and the associated cabling, filters, amplifiers, etc.

b) The PD sensors shall be identified / coordinated with the corresponding detector unit etc. with proper identification labelling and indicated in the substation PDM SLD.

c) All internal items for detector units/control cabinet etc are to be identified / labelled to facilitate troubleshooting.

d) Supply requirement (AC & DC) to be specified for the complete monitoring system.

e) Power supply to PDM PC shall have protection against surges, overload and short circuit. A dedicated on-line UPS system shall also be provided as a backup during supply interruption, to ensure trouble-free & reliable running of the PDM System for a minimum of 30 minutes duration. Ratings of UPS shall be proposed for the approval. The UPS shall have enough capacity to initiate a 'safe' shut down of the PDM PC and the peripherals after this 30- minute period if normal supply fails to resume. The PDM PCs shall restart automatically on resumption of normal supply. The UPS shall not generate spikes during changeover of supply. UPS shall automatically give indication / alarm when it requires battery replacement. Potential Free Contacts shall be generated to signal these events. These contacts shall be wired out to Annunciation / Monitoring systems and to Substation Automation System. Alternately, inverter of suitable capacity is also acceptable**. Critical Process and Status alarms of the PDM system shall be displayed and shall be extended to Substation Automation System.**

f) PDM System shall be provided with a user security for accessing the system with a log-on and password entry procedure. The user levels shall be defined as a Master User and other users for the modification of system, update, and entry of parameters or manual operation. System shall be able to generate 3D point on wave pattern whenever any PD activity detected by the system. System shall be able to give online 3D point on wave pattern, online PRPD (phase resolved PD) and online short time trend etc. System shall be able to generate the all the logs related to system fault, system access, PD event, and any changes in system setting etc.

g) Pre-amplifier and frequency down convertor installed as part of the coupler is not acceptable. UHF amplification or conditioning is only allowed at electronic node unit.

h) The capacity of each detector unit to be specified to accommodate as many numbers of PD sensors signal.

i) The applicable standards to meet IEC & IEEE requirements for electromagnetic compatibility shall be specified. The offered system should have been tested for the same for working in a 400kV & above substation environment. **The necessary documentation has to be submitted in this regard.**

5. CALIBRATION:

The UHF Couplers have to be first calibrated as per CIGRE procedure TF 15/330305 as part of factory acceptance tests to guarantee detection sensitivity of 5pC or better.
The GIS of same design shall be used as test specimen during the coupler calibration. The pulse injection level determined through above factory calibration tests shall only be used as reference for site sensitivity checks during commissioning of PDM system. **The data sheet/ frequency response characteristics shall be submitted for reference.**

6. EVERY DAY USE & MAINTENANCE:

The system shall be designed suitable for an unmanned s/s and operate automatically. The system shall generate alarms if suspected partial discharge activity is noticed or the system itself is in failure, thereby eliminating the necessity of periodic system access by the user and one such alarm shall **be connected to Substation automation system (SAS).** The alarms shall be configured coupler wise.

7. COMPUTERS AND PERIPHERALS:

The PC operating system shall be the latest version of MS Windows Prof. It should be suitable for continuous process application and should have been tested for the same. The hardware configuration of PC should be the latest available in the market of industrial type. For storing the historical PD database, sufficient storage facility in the form of hard disc and retrievable hard disk drive of 1TB as specified shall be available in the substation. The PC monitor shall be 21" LED type.

8. FILTERING FACILITY:

The filtering facility has to be provided in order to distinguish real PD from internal/external noise such as switching operations, self-test signal, radio, communication signal etc. The PDM system itself shall be able to discriminate the noise from real PD. The exposed gas barriers of the GIS shall be shielded effectively against noise interference & tested. The gas barrier shields/belts shall be suitable for outdoor use also & able to withstand high ambient temperature. Site measurements have to be performed after installation of the PDM system in order to identify the various sources of external noise to incorporate the same in the filtering facility. This filtering will preferably be through software by band pass, which can be manually activated (as an option) to filter out noise signals in the trend plot display. If hardware filtering is employed then adequate measures have to be taken to avoid masking of other signals, which may lie in the same frequency range. **The method adopted for the above shall be specified taking into account the sensitivity requirement of PDM system as per CIGRE document.** The noise filters shall be selectable individually coupler-wise.

9. SELF-TEST (DIAGNOSTIC) FACILITY:

Built-in self-checking facility shall be incorporated in the control system which will continuously verify the correct operation of the whole monitoring system with the simulated PD signal viz. checking of the sensitivity of individual detector units, response of PD sensors in addition to the checking of the system functioning. The periodicity of such self-check operation shall be specified. In case of system failure this shall trigger an alarm for communication to SAS. External check facility: Propose the arrangement/device available for externally checking the healthiness of PD sensors by pulse injection in addition to built-in monitoring facility.

10. DETECTOR UNITS:

The sensitivity of each detector unit shall be furnished. The Sensitivity level of individual detector units shall be selectable depending on the site background noise level. The detector unit must support continuous and simultaneous (not multiplexed) data acquisition from UHF sensors to ensure no PD pulses are missed. It shall be based on wide band detection of UHF frequencies (minimum 500Mhz of wideband). The detector unit sensitivity shall be up to -80dBm so that it does not miss small PD signals into GIS.

11. TREND PLOT:

The trend plot facility shall be available with the update period of hourly/daily/weekly/monthly/yearly. It shall be possible to view the historical trends for the complete archived data accumulated over several years.
PDM system shall have dynamic range up to 70dBm for at least 10 frequencies between 300MHz to 1500MHz (with a step of 100MHz between two consecutive selected frequencies) to enable customer differentiate high amplitude of PD with low amplitude. The trending shall support showing amplitude with varying ranges of PD signals from 15dBm to -75dBm.

12. PD MONITORING MODES:

There shall be two different modes of system operation viz. a dedicated Continuous PD Monitoring mode for the normal day to day operation of the system & a dedicated HV commissioning test mode which is exclusively for PD monitoring during HV commissioning test. The HV commissioning mode shall also operate as an independent feature. The System shall be capable of synchronizing, capturing and displaying PD data for a power test frequency in the range 40Hz to 220Hz. In the HV Commissioning mode the real time display shall be possible for a minimum of two complete bays with associated bus bars and at with one second update period. The HV test software shall automatically record the HV voltage information along with PD so as to check PD inception & extinction voltages precisely. The complete HV & PD data recorded during HV test shall be possible to be reviewed in replay mode after the HV test.

13. ALARM FACILITY:

The PDM system shall generate alarm when action is required; viz.
a) PD alarm (abnormal PD activity indicating a risk of failure) &
b) PD system fail alarm
- to be connected to SAS.

PDM system shall have flexibility to decide on the severity of PD alarm by putting limitation of number of PD signals acquired by system in every 5 minutes and setting amplitude threshold values of PD signals for acquisition and alarming criteria. Customer shall have flexibility to record from 01 to 09 significant PD signals in 5-minute period.

The PDM system shall provide flexibility to create PD alarm from various options e.g. Number of significant PD activities over time-period, Maximum PD Amplitude, Maximum Discharge Rate and combination of all three (combining by logical operations)

14. REAL TIME DISPLAY:

The PDM system should have the facility of Real Time display, which will give an instant indication of PD activity coupler wise, with one-second update period. The PDM system shall be able to capture the PD data triggered by associated switching operations of CBs & isolators; but have flexibility of not counting this PD data for Alarming.

15. SCHEMATICS:

The PDM system should have GIS schemes bay-wise incorporating PD sensor identification and location along with spacer location. The sectional view of typical bay arrangement of GIS showing active parts shall also be included as part of the PDM software.

16. PRINT OPTION/FACILITY:

PDM system should have the option/facility of printing all trend plots/reports/POW patterns/displays, etc. Laser Colour printer shall be provided for this purpose at substation.

17. DATA ARCHIVES:

This is to provide access to historical data and file storage with date and time stamp. Sufficient storage facility shall be available to review historical data updated for the lifetime of switchgear. The substation & headquarters PCs shall have a backup device in the form of a retrievable disk drive of 1TB capacity for this purpose.

18. PD FAULT IDENTIFICATION & LOCATION/PATTERN RECOGNITION/PREDICTIVE MAINTENANCE:

Diagnostic Software: In order to interpret various types of PD defects, intelligent diagnostics software shall be built- in as part of the PDM software capability. The PD analysis software shall be based on Artificial Neural Networks (ANNS), Genetic Algorithms (GAs), Fuzzy logic algorithms etc that are conditioned over more than millions of PD records from multiple GIS from different vendors globally. This is mainly to reduce the dependence on PD specialist. The system shall provide clear indication of PD fault type e.g. Free Particles, Floating Electrode, Void etc. with confidence interval. The PDM system shall also be equipped with separate Multiple Hybrid Expert System for Multiphase analysis in 3:1 GIS/GIL. The bidder shall also make available typical point-on-wave patterns as library pictures to train the user.

Software Updates: It shall be possible to upgrade / update the system software throughout the lifetime of the system with the ongoing development / refinement in PD technology.

Fault investigation: In case of any indication of suspected PD activity by the online system, further investigation has to be carried out by the contractor for the PD defect identification and location during the warranty / defect liability period.

Special Tools / equipment, Spare Parts, software packages Special Tools: Special tools for cutting and crimping of coaxial cable with 'N Connectors' shall be supplied.

Spare parts: The bidder has to supply critical spares with replacement procedure for the trouble-free operation of the system during its expected lifetime as part of the contract. A detailed list shall be included and submitted for approval during the detailed engineering stage.

Software Packages: The complete software package shall be supplied as part of a back-up facility in the form of DVD/CDs viz. Windows operating system with end user license, PDM Software including HV Test, Drivers for modems etc., software for remote access, printer etc. **The list shall be submitted for reference.** Pulse generator for UHF sensor sensitivity test shall also be supplied as a standard accessory.

19. CONTRACT DRAWINGS/DOCUMENTS AND OPERATION & MAINTENANCE MANUAL:

In the event of placement of order, the following drawings/Documents and manuals shall be submitted in three (3) copies during engineering stage for approval.

a) Details of interfacing of PDM system with UHF PD couplers of present and future GIS Bays as shown in SLD plus 20% spares (as applicable for PDM system).
b) The technical proposal for PDM system along with detailed design documentation.
c) To guarantee that sufficient coverage is available for complete GIS installation to monitor PD activity all design details shall be submitted.
d) UHF attenuation data of GIS shall be submitted for the switching devices, spacers, bends etc.
e) The signal attenuation level of co-axial cable per meter length and justification for the length of cable connection between the couplers and detector units.
f) The Sub-station GIS layout as a separate drawing indicating position of spacers, spread over of PD sensors with distance, sensor identification, the detector unit identification etc.
g) Internal arrangement/wiring diagram for detector units/control cabinet etc.
h) Method of electrical isolation/protection provided between PD sensor and detector circuitry in case of flashover/high potential stress inside GIS.
i) The selected mode of propagation of PD signal (electromagnetic wave) inside GIS for the design of sensors.
j) The protection available for electronics against transient over voltages caused by switching operations.
k) Guaranteed technical particulars & data sheet for various components used in the system.

After approval, the approved drawings (both in hard copies and soft format) and a complete O&M manual covering all aspects of trouble shooting of PDM system shall be provided & also in CD's. For diagram references colour pictures shall be provided. A step-by-step procedure for spare parts replacement shall also be included.

20. FACTORY /SITE TEST FORMATS:

The factory & site tests format to be submitted for approval. The format shall cover all possible tests to confirm healthiness of the system and to record the test values.

21. FUTURE EXPANDABILITY:

The PDM system shall have capability to expand into complete GIS condition monitoring systems. It shall support integration with SF6 leakage monitoring system and Breaker Condition Monitoring system in future. It shall support industry standard protocols, IEC61850, Modbus, DNP3.0 for data integration with the monitoring systems.

22. COMPANY PROFILE:

A. Experience in UHF technology

The supplier should be having vast experience in UHF based technology of PD monitoring. The technological experts in the company should have more than 10 years of experience in PD monitoring technologies. It should also have experience in selling UHF based PD monitoring products to several electric utilities around the Globe.

B. Experience in selling Online PD monitoring system

The supplier should be having vast experience in selling UHF based Online PD monitoring products to electric utilities. The manufacturer must have supplied at least 10 (ten) Online UHF PD monitoring system to different power utilities & industrial end users among which at least 5 (five) should be in India in last 10 (ten) years for the GIS ratings 132kV & above..

List of References: The bidder shall provide a reference list of PD monitoring system, which is supplied by them and in successful operation worldwide in power utilities.

23. SUPPORT AND SERVICEABILITY

The PD Monitoring equipment supplier must have their own local office in India with certified on– roll service engineers equipped with proper tools & tackles to response to any sort of service issues locally. They must have local on-roll experts to provide the technical support time to time. Supplier should be able to provide additional services (on demand on chargeable basis) that includes but not limited to:

- Calibration for sensors
- Expert analysis and reporting on partial discharge events
- HV testing services