

Partial Discharge Testing for Switchgear

- *Performed online without disrupting process operations, offline for commissioning new gear*
- *Non-destructive, non-invasive predictive maintenance tool*
- *Optimizes capital expenditures and improves system reliability*
- *Helps eliminate unplanned outages and lost profit as a result of system downtime*



Condition Assessment of Switchgear

Partial discharges are small electrical sparks that occur within the insulation or on the surface of the insulation of medium and high voltage electrical assets. Each discrete partial discharge is the result of an electrical breakdown of a small portion of the insulation surface or an air pocket within the insulation. Partial Discharge can occur on the surface of insulators or within voids, gaps and similar defects in medium voltage switchgear. If allowed to continue,

partial discharge will erode the insulation, resulting in tracking or a tree-shaped pattern of deterioration (electrical tree) and eventually result in complete breakdown and failure of the switchgear. Such failures cause unplanned power outages, loss of plant production, equipment damage, and/or personnel injury. Data obtained through Partial Discharge testing and monitoring can provide critical information regarding the quality of insulation and its impact on

system health. By detecting and trending partial discharge, it is possible to observe its development over time in order to assist asset managers with strategic decisions regarding the repair or replacement of the asset—prioritizing capital and MRO investments before an unexpected outage occurs.

Integrated Partial Discharge Solutions for Switchgear

Emerson's Integrated Partial Discharge Testing and Monitoring Solutions include both online and offline testing, and periodic and continuous monitoring of your switchgear. Depending on your specific operating requirements and application, Emerson can customize a program that best fits your needs. Choose from the following:

- *Online Partial Discharge Testing*
 - *Handheld Survey*
 - *Periodic Partial Discharge Testing*
 - *Continuous Online Monitoring*
- *Ultrasonics*
- *Offline Partial Discharge Testing*
- *Tan Delta*
- *Very Low Frequency Testing (VLF)*

Online Partial Discharge Testing

Emerson's Online Partial Discharge Testing is performed online without disrupting plant or facility operations. This non-destructive, non-invasive predictive maintenance tool assesses the condition of switchgear, feeder cables, and bus duct to provide critical information regarding the levels of partial discharge and its potential impact on the health of the electrical asset. The cost to perform online testing is relatively

inexpensive compared with offline testing that requires interruption of service and production. For critical facilities that operate 24x7, online testing is considered the single best option for detecting insulation condition.

Emerson can also provide the following online testing and monitoring solutions for switchgear:

- Permanently mounted sensors for "hard to access areas" or areas that pose a safety concern.
- Short-term continuous monitoring for those areas that require monitoring under load for an extended period of time.
- Permanent continuous monitoring systems for the most critical assets in your system—including those that are nearing the end of their useful life, or have demonstrated high levels of partial discharge through other testing methods.

Ultrasonics

All electrical equipment produces a broad range of sound. The basic electrical problems that produce distinct ultrasound waves that can be detected by Ultrasonic Testing include partial discharge, corona and tracking. Ultrasonic measurement is most powerful on a comparative basis and will significantly increase the reliability of correct detection of partial discharge when used with other Emerson online partial discharge testing technologies.

Offline Partial Discharge Testing

Offline Partial Discharge Testing is often used to commission new gear prior to energization as a final quality control check and to obtain baseline measurements prior to being placed in service. When systems are already in service and de-energization is preferred, Emerson can conduct offline testing as part of your predictive maintenance program.

Measuring Method

Partial Discharge testing can be conducted on medium voltage switchgear with a voltage range of 3.3kV to 36kV and is suitable for both solid insulated switchgear (SIS) and air-insulated switchgear (AIS). Emerson conducts periodic partial discharge testing using a PD Surveyor and a Portable PD test unit with non-invasive sensors. The PD Surveyor is the first multi-purpose handheld device able to conduct the initial pre-screen to identify the critical equipment for testing. Typically only 5 to 10% of medium and high voltage assets will have significant levels of PD activity. This pre-screening will provide the required data to develop an overall test plan that ensures focus on the right assets, minimizing unnecessary spending. The pre-screen also provides a safety check prior to opening panels or performing work.

Once the assets are prioritized, Emerson's test engineers conduct the periodic PD measurements using non-invasive, PD sensors including Transient Earth Voltage (TEV) sensors and High Frequency Current Transformer

Electrical Reliability Services

(HFCT) sensors. The TEV sensor is an external coupling capacitor that is magnetically attached to the outside of the switchgear panel and acts as a capacitive coupler to detect partial discharge pulses flowing out of the switchgear and onto the grounded metal surface. Alongside the TEV sensor, a calibrated, split-core High Frequency Current Transformer (HFCT) sensor is connected on the ground strap of the cable at the bottom of the switchgear and is capable of picking up both local discharge from the switchgear and partial discharge pulses coming from the cable. The utilization of both sensors together significantly increases the reliability of correct detection of partial discharge levels.

Problem Identification

Using our Integrated Partial Discharge Testing and Monitoring Solutions, our test engineers can identify:

- *Surface Tracking*
- *Corona*
- *Partial discharges within insulators and insulating components*
- *Defective insulation in cable terminations*
- *Surface contamination or moisture*
- *Defective potential transformers and current transformers*
- *Defects in circuit breaker insulation structure*

Innovative Technology

When testing for partial discharge, the biggest challenge is identifying the source of the signals and separating harmful partial discharge pulses from all



the other sources of electrical noise that are present during testing. Partial discharge found in voids and cavities in insulation systems produce very fast pulses with typical widths of a few tenths or hundredths of a picosecond at the source of the discharge. Switchgear PD pulses, for example, are characterized by very fast rise times and a pulse width of a few tenths of a nanosecond. Cable PD pulses, on the other hand, are unique to the switchgear PD pulses in both shape and frequency content. Emerson's innovative technology is the most advanced on the market today and includes a built-in RF noise reduction function that separates these

pulses into PD type (cable PD and switchgear PD) while automatically sorting out electrical "noise" pulses using a single frequency spectral subtraction process. Once the noise pulses have been separated, Emerson's test engineers identify the presence of partial discharges in the switchgear based on magnitude and number of PD pulses per power cycle. By applying Time of Flight (TOF) analysis and by placing the TEV sensors at different points on the switchgear panel, Emerson's test engineers are also able to identify the location of the PD within the switchgear.

PD Tolerance Levels for Switchgear

Air Insulation Switchgear (AIS)		
db Level	MV Level	Condition and Action
<10db	< 1mV	Discharge within acceptable limits
10db - 15 db	1 mV - 6 mV	Some concern, monitoring recommended
15db - 30 db	6 mV - 32 mV	Some concern, regular monitoring recommended
>30db	> 32 mV	Major concern, located PD and should repair or replace

Report of Findings

Upon completion of the data collection and analysis, we will provide a written engineering report containing detailed information about the test results, the condition of your switchgear, recommendations for prioritizing replacement, additional testing, or corrective actions, and a proposed follow-up testing schedule. Each cubicle tested will be rated green, yellow, orange, or red and a recommended action will be provided. The measured

PD magnitude will also be documented for trending purposes.

Maximize Uptime

Partial discharge testing plays a critical role in determining the health of your electrical assets and ensuring maximum uptime. Partial discharge testing provides asset managers with the critical information to target maintenance resources to the areas that require the most attention.

Depending on your specific operating requirements and application, Emerson can help you develop and implement the right combination of technology, online or offline, to meet your maintenance requirements. Improve operational efficiency and worker safety by working with the experts at Emerson.

Emerson—Your Partner in Reliability

From installation to operation, only Emerson has the knowledge and experience to seamlessly integrate all the essential services to ensure maximum uptime. Look to us as your partner. We'll be with you every step of the way with the right combination of technology, people, and services. Contact Emerson to realize the true potential of your assets.

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