

OVERVIEW

Protecting Critical Assets

Electrical systems are among the most valuable assets in your plant and can have the biggest impact on your bottom line. Their acquisition and management costs are high, and failures often lead to catastrophic losses. Electrical systems are being operated at higher voltages and often endure extended maintenance intervals, even while systems are aging, which adversely affects both the life and the reliability of the assets.

Today's maintenance managers are facing the increased challenge of maximizing their aging electrical infrastructure with fewer qualified in-house technical resources. They are also facing stricter regulatory requirements for worker safety, and shrinking maintenance budgets. Advances in technology, including the use of partial discharge testing, are giving managers additional tools to achieve improved reliability and performance of critical electrical assets.

Benefits

- Identify insulation degradation early
- Reduce maintenance costs by extending time between planned outages
- Prioritize urgent maintenance, repair and replacement decisions
- Perform testing online with no interruption of service
- Improve worker safety



Partial discharge testing provides critical data and insights to help manage risk and improve electrical system reliability

Partial discharges (PD) are small electrical sparks that occur within the insulation of medium- and high-voltage electrical assets. Each discrete partial discharge is the result of an electrical breakdown. These discharges erode insulation and eventually result in insulation failure. According to the National Fire Protection Association (NFPA) 70B: Recommended Practice for Electrical Equipment Maintenance, the leading cause of electrical failures is insulation breakdown. Research from IEEE indicates that cables, switchgear, and transformers suffer the greatest losses from insulation failure.

For more than 50 years, companies have performed PD testing on electrical assets as part of ongoing predictive maintenance programs. Data obtained through PD testing and monitoring can provide critical information on the quality of insulation and its impact on overall equipment health. These predictive diagnostics help companies to prioritize capital investments and strategies for maintenance, repair, and operations (MRO) before an unexpected outage occurs.

PD testing and monitoring can help predict future performance and reliability of critical assets, including:

- Transformers
- Bushings and insulators
- Circuit breakers (oil, air, SF6)
- Metal-clad switchgear
- Cables, splices and terminations
- Switches
- Bus
- Current and potential transformers
- Lightning arrestors

Partial Discharge Solutions

Our PD testing and monitoring solutions include both online and offline testing and monitoring of your electrical assets. Depending on your specific operating requirements and application, we can customize a program to best fit your needs. Choose from the following solutions:

- Online PD testing
- Equipment installation and commissioning
- Offline PD testing

Online PD Testing

Online testing is a non-destructive test performed while the equipment is energized and operating at normal voltages. Compared to offline testing that requires interruption of service and production, disconnection and isolation of equipment and cables, and additional time and resources, online PD testing is an inexpensive and cost-effective solution. Our online PD services include a site survey and engineering evaluation, advanced diagnostic testing, and online monitoring solutions.



Site Survey

Our PD site survey is a valuable tool used to detect early signs of insulation deterioration, one of the leading causes of equipment failure. This initial survey is the first step to assess the condition of newly installed or aging electrical equipment and can be performed in as little as a day. Similar to other predictive maintenance techniques, the information gathered from periodic PD surveys can be used to make informed risk management decisions. Performing these surveys ahead of a scheduled maintenance outage can determine where key maintenance is required, helping you prioritize maintenance activities during time-sensitive outages. For newly installed equipment, an initial PD survey can detect and identify damaged components, insufficient clearances, improper installation, poor workmanship, and even design issues before they have a deteriorating effect on the equipment or affect reliable operation.

During the initial site survey, our test engineers will scan your assets utilizing multiple sensors and the latest technology, greatly improving the accuracy of detecting different types of PD signals including:

- Transient earth voltage (TEV) sensors used to detect electromagnetic signals on metallic enclosures such as metal-enclosed/metal-clad switchgear, dry-type transformers, etc.
- Ultra-high frequency (UHF) sensors used to detect airborne electromagnetic PD signals.
- Acoustic emissions (AE) sensors including acoustic and ultrasonic sensors, used to detect sounds emitted from PD sources within switchgear, air, oil-filled and SF6 insulated circuit breakers, transformers, and other associated

electrical equipment, as well as cable terminations and splices.

- High frequency current transformer (HFCT) sensors used to detect PD down the length of the cable.

Pre-screening provides the required data to identify which assets are emitting possible PD signals of concern and require additional engineering evaluation. We then perform an investigative analysis on the identified assets to determine if the signals contain PD characteristics that could be harmful or cause deterioration to the electrical asset. The results of the site survey and engineering evaluation are provided in a written report with detailed findings and recommendations including risk category by asset and recommended follow-up actions such as visual inspection, advanced diagnostic testing, temporary PD monitoring, or offline testing.

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

Equipment Installation and Commissioning

Permanent installation of high frequency current transformer (HFCT) sensors will enable online access and diagnostic testing while ensuring safety and compliance with the National Fire Protection Association's Standard for Electrical Safety in the Workplace (NFPA 70E). Our installation and commissioning team can install temporary or permanent PD sensors and monitoring systems during a planned outage. Once installed, no further outage or disruptions are required for online testing.



Diagnostic Testing

Typically only 5-10 percent of medium- and high-voltage assets will have significant levels of PD activity. However, when PD activity is identified, additional diagnostics may be required to locate and characterize the PD. Utilizing our portable multi-channel diagnostic test system our field engineers apply multiple detection modes and data spectrums to analyze and determine the exact location and PD type including corona, floating electrodes, particles, voids, and surface discharges. Upon completion of the advanced diagnostic testing, a written report is provided categorizing the signal, type, and severity of the defect, along with short- and long-term recommendations for remediation.

Portable Online Monitoring

Occasionally, it may be necessary to conduct online monitoring over a short period of time. A portable PD monitor can be used to perform online monitoring for a few weeks up to a few months. Utilizing our monitoring unit, multiple sensors, amplifiers, and cables, we will trend your assets to provide a more accurate assessment and recommendation. Typically, this solution is less expensive than installing a permanently-mounted PD monitoring system.

Permanent Online Monitoring

For your most critical assets that have demonstrated high levels of PD, including those that are nearing the end of their life, continuous online PD monitoring may be the answer. Measure and analyze data on your electrical assets and provide remote access via LAN or modem to deliver continuous and accurate data on the condition and capability of the equipment. Continuous monitoring will also provide timely alerts and identify impending failures before an unplanned outage occurs.

Infrared/Thermographic

In addition to insulation failures, another leading cause of electrical equipment failure is overheating caused by poor connections, overloaded circuits, failing components, or imbalanced loads. Thermographic surveys can be used in conjunction with PD surveys to identify thermal issues. Combining these two surveys can result in an effective and efficient maintenance strategy for identifying equipment at risk of in-service failure and reducing unnecessary maintenance outages.

Offline PD Testing

Offline partial discharge testing, primarily used for cable testing, offers a significant advantage over other technologies because of its ability to measure the cable system's response to a specific stress level and predict its future performance without causing a fault. Offline testing is also known for its ability to pinpoint the exact defect location on field-aged cables, enabling the maintenance manager to accurately plan for maintenance and repair.



Offline testing is also commonly used in acceptance testing on newly-installed cables. When de-energization is preferred, we can conduct offline testing as part of your predictive maintenance program including:

- Advanced diagnostic testing for in-service assets where the site survey identified levels of PD and needs further investigation
- Routine maintenance tests can also be performed during planned outages
- Acceptance testing for assets before they are put into service

Tan Delta Testing

Tan delta (Dissipation Factor) is one of the most effective offline nondestructive diagnostic tools used to determine the condition of extruded cable insulation. By comparing periodic readings of the capacitance and tan delta of your insulating material with the benchmark readings, you can measure the deterioration of the insulation, predict the life expectancy, and plan maintenance and repairs before an unexpected outage

occurs. A significant advantage of tan delta testing is the ability to detect water trees, which are a major source of insulation failures in aged, extruded cables. The testing frequency depends on the rate of change of the insulation quality, history of past failures, and operating conditions. Harsh environments including extreme temperature, heavy loading, vibration/seismic activity, and water and chemical exposure, may require more frequent testing. Our test engineers can help you evaluate your requirements and establish a program that best meets your needs.

Very Low Frequency Testing (VLF)

VLF AC withstand testing was developed in the early 1980s as a substitute for DC Hipot testing. DC hipot testing is no longer a recommended test method for field-aged extruded cables because of its destructive nature and inability to determine insulation quality. A VLF withstand test is a non-diagnostic pass/fail test and is one of the best ways to evaluate an electrical asset to determine its overall insulation integrity.

Summary

PD testing plays a critical role in determining the health of your electrical assets and ensuring maximum uptime. It also provides maintenance 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, we can help you develop and implement the right combination of technology, online or offline, to meet your maintenance requirements. Vertiv's Electrical Reliability Services team offers unparalleled expertise in PD testing, providing fast, accurate results to help you improve power system reliability and worker safety.

Plug Into Our Expertise

To learn more about this service and other Vertiv solutions, please contact your local sales representative office for Vertiv's Electrical Reliability Services or visit VertivCo.com. In the United States, call 1-877-468-6384.