

The No-Outage Testing Matrix



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THIS IS THE FOURTH IN A SERIES OF REGULAR ARTICLES that focuses on electrical inspection methods and technologies that are performed while the electrical system remains energized. Although no-outage inspections can be very valuable tools, always remember to comply with proper safety guidelines when conducting the energized “on-line” inspections.

Introduction

We are often asked by our customers, “Which technology is better, infrared or partial discharge testing?” Such an inquiry shows that there is much greater awareness today that new no-outage technologies exist and also illustrates the need for additional basic application information. I usually respond that both technologies are good, but cannot be compared side-by-side. Infrared detects conductor problems where current flowing through higher than normal resistance is the culprit and PD detects insulation problems where voltage is the villain. Both technologies need to be applied to prevent failures. This article is aimed at helping target the best no-outage testing methods for various types of electrical equipment through the use of a simple matrix.

No-Outage Technologies

Although there are many useful electrical on-line predictive maintenance technologies available to assess equipment condition, the following represent the most effective tools for assessing the condition of medium- and high-voltage equipment. A brief application summary is included for each technology.

Visual Inspections are very useful but may be limited due to equipment construction. However, it is recommended to always conduct thorough visual inspections in conjunction with any of the other no-outage technologies. Visual inspections may indicate unusual conditions that other technologies may not directly detect.

Infrared (IR) technology is primarily used to detect conductor problems and can be useful for inspecting any equipment where connections are visible. Insulation problems rarely create a detectable temperature rise, so other technologies should also be employed. IR is probably the best on-line tool for detecting low-voltage problems.

Partial discharge (PD) testing using electromagnetic signal detection is very useful in identifying problems within switchgear, cables, dry-type transformers, and other devices. PD testing is not as effective when inspecting open constructed equipment as airborne acoustic or corona camera surveys.

Airborne Acoustic (AA) or ultrasonic listening can be useful in detecting direct line-of-sight surface insulation problems or when the acoustic signal escapes the equipment enclosure through openings. One advantage of using ultrasonic inspections is that surveys can be conducted quickly.

The **Corona Camera** detects direct line-of-sight surface insulation or conductor problems very effectively by producing an image of the problem that is normally invisible during daylight conditions. This technology is perhaps the best for outdoor substations or high voltage applications and also supplements the other no-outage technologies by providing visual proof of surface problems. Just as every apparatus with connections should be IR scanned, all medium- and high-voltage apparatus with bushings should be scanned for corona.

The following matrix has been created to help identify the best no-outage technologies available for each type of electrical equipment listed in the NETA MTS.

No-Outage Testing Matrix

Equipment	Most Effective On-Line Tests					Equipment	Most Effective On-Line Tests				
Switchgear	Vis	IR	PD	AA	Cor	Regulating Apparatus, Load Tap-Changers	IR				Oil
Transformers, Dry-Type	Vis	IR	PD	AA	Cor	Rotating Machinery, AC Motors		PD			
Transformers, Liquid-Filled			PD			Rotating Machinery, AC Generators		PD			
Cables, Medium- and High-Voltage		IR	PD		Cor	Motor Control, Motor Starters, M-V		PD	AA		
Metal-Enclosed Busways		IR	PD			Motor Control, MCC, M-V		PD	AA		
Switches, Air, M-V, Metal-Enclosed	Vis	IR	PD	AA	Cor	Surge Arresters, Surge Protection Devices	Vis	IR	PD	AA	Cor
Switches, Air, M- and H-V, Open	Vis	IR		AA	Cor	Capacitors and Reactors, Capacitors	Vis	IR	PD		
Switches, Oil, Medium-Voltage			PD			Capacitors & Reactors, Reactors, Dry-Type	Vis	IR	PD	AA	Cor
Switches, Vacuum, Medium-Voltage			PD			Capacitors & Reactors, Reactors, Liq			PD		Oil
Switches, SF ₆ , Medium-Voltage			PD			Outdoor Bus Structures	Vis	IR		AA	Cor
Switches, Cutouts	Vis	IR		AA	Cor	Automatic Circuit Reclosers, Oil/Vacuum			PD		Oil
Circuit Breakers, Air, Medium-Voltage			PD								
Circuit Breakers, Oil, Medium-Voltage			PD								Oil
Circuit Breakers, Oil, High-Voltage			PD		Cor						Oil
Circuit Breakers, Vacuum, M-V			PD								
Circuit Breakers, SF ₆			PD		Cor						Gas
Circuit Switchers			PD		Cor						Gas
Instrument Transformers		IR	PD	AA	Cor						
Regulating Apparatus, Volt Regulators		IR	PD		Cor						Oil

Legend
 Vis = Visual Inspection
 IR = Infrared
 PD = Partial Discharge
 AA = Airborne Acoustic (ultrasound)
 Cor = Corona Camera
 Oil = Oil Sample Analysis
 Gas = Gas Analysis (SF₆)

Oil/gas sampling and analysis is an effective tool to indicate both the condition of the insulation and the condition of the equipment. Unfortunately, solid insulation cannot be sampled in the same manner, so other on-line technologies must be employed to evaluate equipment constructed with solid dielectrics.

Conclusion

So what is the best no-outage technology? The answer is the one that will detect the problem. While none of the technologies discussed in this article can single-handedly detect every type of problem, by employing all of these technologies as part of an annual predictive maintenance program, many problems will be detected and many failures will be prevented. 🌐

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