TechTalk

On-line Medium Voltage Switchgear

Compiled by John Sherriff | May 2020 | Rev 1

The scope

To create a real competitive advantage, an organisation has to achieve optimum performance from its asset base, with simultaneous cost and risk reduction. Martec understands this uncompromising need and has developed a functionally rich portfolio of solutions for the organisation wanting to take up this challenge.

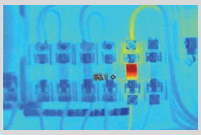
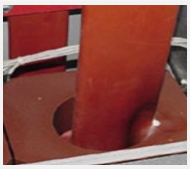
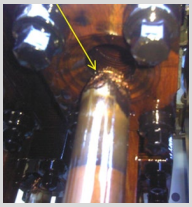
This TechTalk serves as an inspection and routine testing guide for switchgear, switchboard assemblies, and their associated components. It supports a predictive maintenance strategy. The objective is to identify the system components for inspection and testing purposes to complement good maintenance practices, enhancing reliability. This will minimise unplanned outages ensuring more efficient equipment supports production and possible life extension of the asset's components.

Substations and switchgear in an electrical system perform the functions of voltage transformation, system protection, power factor correction metering, and circuit switching. Electrical power apparatus, such as transformers, regulators, air switches, circuit breakers, capacitors, and lightning arresters comprise the components necessary to perform these functions.

References

1) IEC 62271: High-Voltage Switchgear and Controlgear.
2) IEC 60694: Common High-Voltage Switchgear and Controlgear Standard.
3) IEC 60270 – High-voltage test techniques - Partial discharge measurements.
4) SANS 10198: The selection, handling and installation of electric power cables of rating not exceeding 33 kV Part 13: On-site testing, commissioning, maintenance, diagnostics and fault location.
5) https://testguy.net/content/258-Switchgear-and-Switchboard-Inspection-and-Testing-Guide#general

Breakdown process caused by partial discharges within switchgear

Section	Component	Defect type		Progression	End result
Low voltage	Control-gear contacts/wiring		High resistance connectors	Overheating	Eroded / burnt insulation
Bus bar	Connections		Contamination	Surface tracking	Erosion Electrical tree
	Insulators		Cracked/broken	Partial discharge	
	Cable to VT's		Loose connection	Overheating	
Voltage Transformers	Not aligned		Incorrect air gap	Partial discharge	Failure Fusing, welding or full arch flash
	Connections		Bad contact	Overheating	
Current Transformers	Not aligned		Incorrect air gap	Partial discharge	
	Connections		Bad contact	Overheating	
	Earth wire		Incorrect air gap	Partial discharge	
Switchgear	Contacts		Bad contact	Overheating	
	SF6		Contamination, decomposition, SF6 loss	Sustained arcing	Explosion, toxic by-products
	Oil		Contamination / decomposition		Explosion, fire

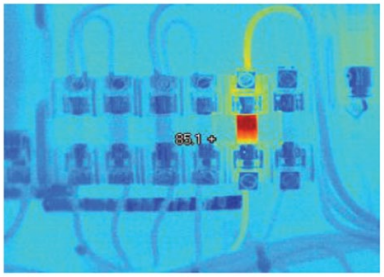
Visual and Mechanical / Electrical assessments and inspections

Inspect the physical, electrical, and mechanical condition of switchgear or switchboard, including its base bolts, alignment, earthing and required clearances.

Conduct on-line Partial Discharge Frequency System Analyser (PDFSA) assessments combine with ultrasound and infra-red to locate and quantify the risk of premature defect activities.

Wiring and bolted connections

Bolted electrical connections should be inspected for high resistance, either by use of a low-resistance ohmmeter (DLRO), calibrated torque-wrench, or infrared scan. Loose bolted electrical connections can lead to higher energy consumption and eventual equipment failure if not properly addressed.



Electrical discharges might also form around bolt heads or other sharp projections that are not properly insulated or shielded. When using a low-resistance ohmmeter, investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

Bolt-torque levels should be in accordance with manufacturer's published data. The use of ultrasound and on-line partial discharge technology can be employed to locate connection defects whilst the switchgear is energised.

Electrical discharge

If electrical discharges occur in switchgear assemblies, it is usually localised in thin air gaps that exist between a high-voltage bus bar and its adjacent insulation or between two adjacent insulating members.

Electrical discharges might also form around bolt heads or other sharp projections that are not properly insulated or shielded.

Moisture

Moisture carried in air (Humidity) modifies the dielectric properties of air, which in modern switchgear is a significant part of the insulation system. The reduced breakdown strength of the air increases the probability of partial discharge.

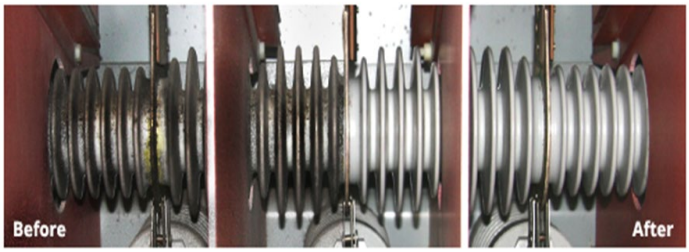
Note: Although most switchgear panels are fitted with heaters ranging from 80 to 120 matt, while some manufactures specify panel heaters as optional. (This is the area of concern, do the panels have heaters, do the heaters operate as per specification or is the heaters in operation)

Heaters reduce the risk of condensation forming within the switchgear panels and therefore it is one of the important factors to regularly test and maintain to the correct standards.

On outdoor assemblies, roof or wall seams should be checked for evidence of leakage, and any leaking seams should be sealed. Prolonged leakage can be identified by rust or water marks on surfaces adjacent to and below leaky seams. The assembly base should be checked for openings that could permit water to drain into the interior, and any such openings should be caulked or grouted. Larger openings should be sealed to prevent rodent intrusion.

Insulations and barrier checks

Tracking is an electrical discharge phenomenon caused by electrical stress on insulation. This stress can occur phase-to-phase or phase-to-ground. Although tracking can occur internally in certain insulating materials, these materials as a rule are not used in medium- or high-voltage switchgear insulation. Tracking, when it occurs in switchgear assemblies, normally is found on insulation surfaces. Accumulated dirt, oil or grease might require liquid solvents or other alternative methods to be removed.



Electrical insulators should be inspected for evidence of physical damage or contaminated surfaces. Damage caused by electrical distress is normally evident on the surface of insulating members in the form of corona erosion or markings or tracking paths.