camlin energy

Early Detection That Informed a Multi-Asset Strategy for a Canadian Utility

CASE STUDY

CAMLINENERGY.COM

CHALLENGE

Detecting Hidden Bushing Defects

A Canadian utility had implemented a **targeted bushing replacement program** to comply with federal PCB regulations and meet end-of-use dates by 2025.

While older bushings were proactively replaced, newly installed bushings remained susceptible to hidden manufacturing defects, with key challenges including intermittent partial discharge (PD) activity, Power Factor (PF) changes that may indicate insulation issues but are difficult to attribute to bushing versus tank, the potential for early-stage defects to be missed by standard six-yearly electrical tests, and the need to maintain network reliability while detecting latent faults early.

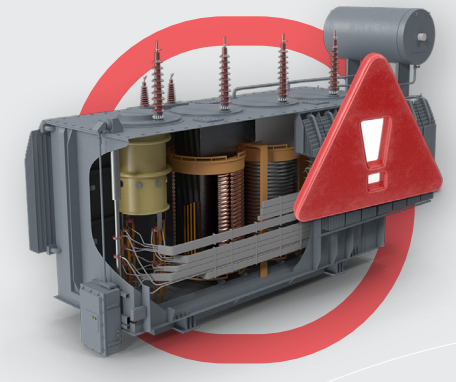
The utility needed a monitoring solution capable of **early detection, localisation, and actionable insight** to prevent in-service failure.

EVENT

TOTUS Detects Developing Bushing Faults

TOTUS online bushing monitoring was installed on new 130kV HV bushings. Two years after installation, the system began triggering alarms on two units that showed a gradual rise in Power Factor, correlating with repetitive partial discharge activity.

Analysis of the PhaseResolved Partial Discharge (PRPD) patterns confirmed that the source of activity was internal to the bushings, most likely caused by metallic contamination suspended in the oil. As temperatures increased, the PD became more repetitive and more pronounced, revealing a manufacturing-related defect that routine offline testing alone would not have detected.



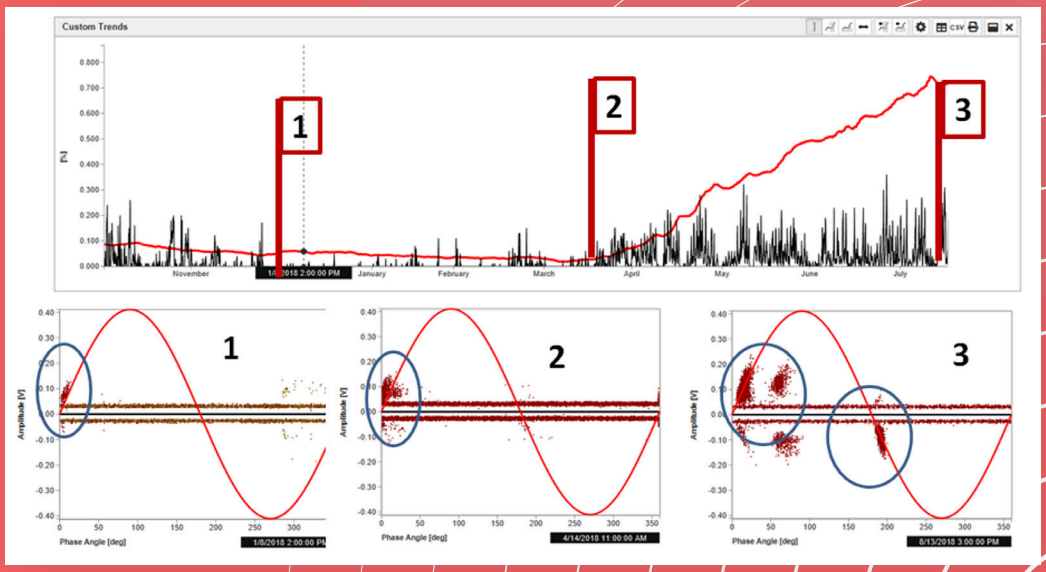
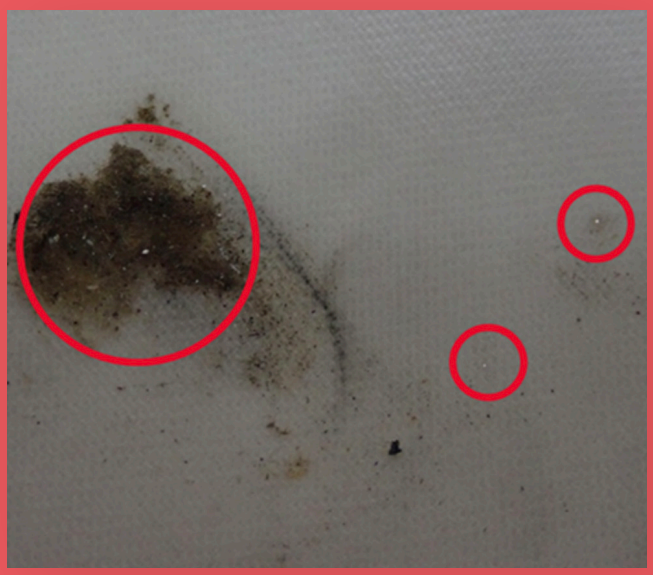


Figure 1:

Hourly PD evolution in bushings X3 on LV 130kV side, correlated with Tandelta Increase over the time, before switching the transformer off.

Figure 2:

Findings of metallic particles in the bushing during bushing dissection.



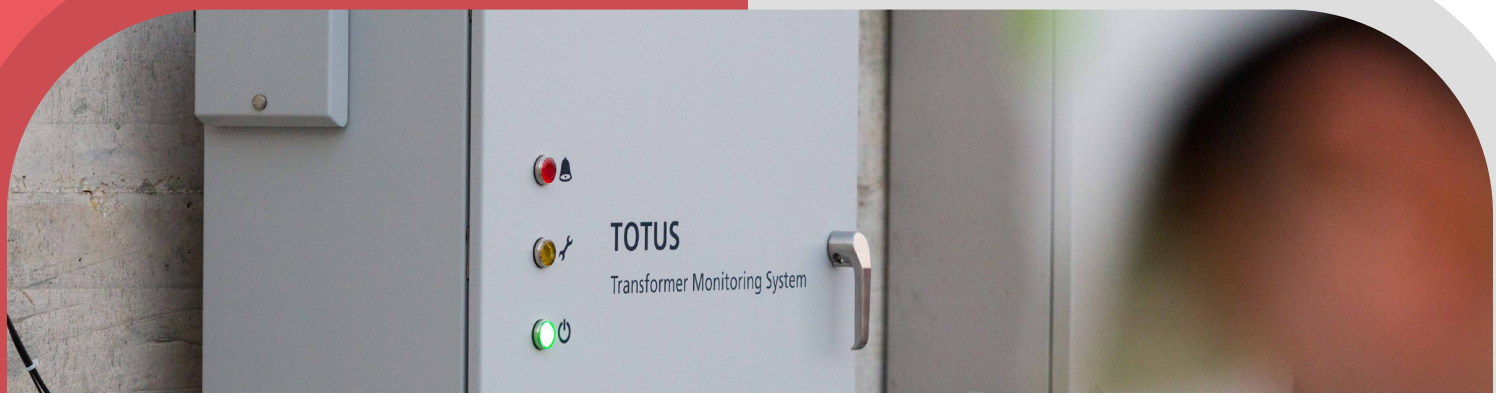
ACTION

Targeted Intervention and Proactive Replacement

Based on the insights provided by TOTUS and clarity from data correlation the utility initiated a controlled outage and performed targeted offline testing. Dissolved Gas Analysis (DGA) and oil quality testing revealed high hydrogen levels exceeding 9,000ppm, along with poor oil condition, indicating active degradation. A subsequent dissection of the bushings uncovered metallic particles trapped inside the insulation structure, which were mobilising at elevated temperatures and generating both partial discharge activity and elevated Power Factor readings.

Guided by online monitoring data and expert analysis, the utility focused its inspection on the affected components and ultimately replaced not only the two bushings initially identified as defective, but also three additional bushings from the same manufacturing batch that were flagged through extended DGA testing.

By acting early and targeting the specific assets at risk, the utility prevented the defects from escalating into a catastrophic failure, avoiding both unplanned outages and potential collateral damage.



camlin energy

OUTCOME

Operational and Commercial Benefits

Technical outcome:

- Early detection of latent bushing defects
- Accurate localisation of risk within bushings rather than the main tank
- Controlled replacement avoided emergency outages

Commercial & Operational Impact:

- Avoided potential catastrophic failure of transformers
- Maintained **network reliability** and compliance with PCB regulations
- Minimised unplanned outage costs, emergency repair logistics, and operational disruption
- Targeted replacement reduced wasted effort and unnecessary interventions
- Strengthened confidence in asset management and investment planning

Key Takeaways:

TOTUS's ability to **separate bushing vs. tank PD** and reject noise is critical for precise diagnostics.

Continuous monitoring converts early warnings into **actionable insights**, enabling proactive decision-making.

Using TOTUS, the utility replaced **five bushings safely**, preventing potential failure, fire, or collateral damage.