REACTANCE
Power Engineering

Failure Investiogation of a 50 MVA, 220/20 kV Power Transformer

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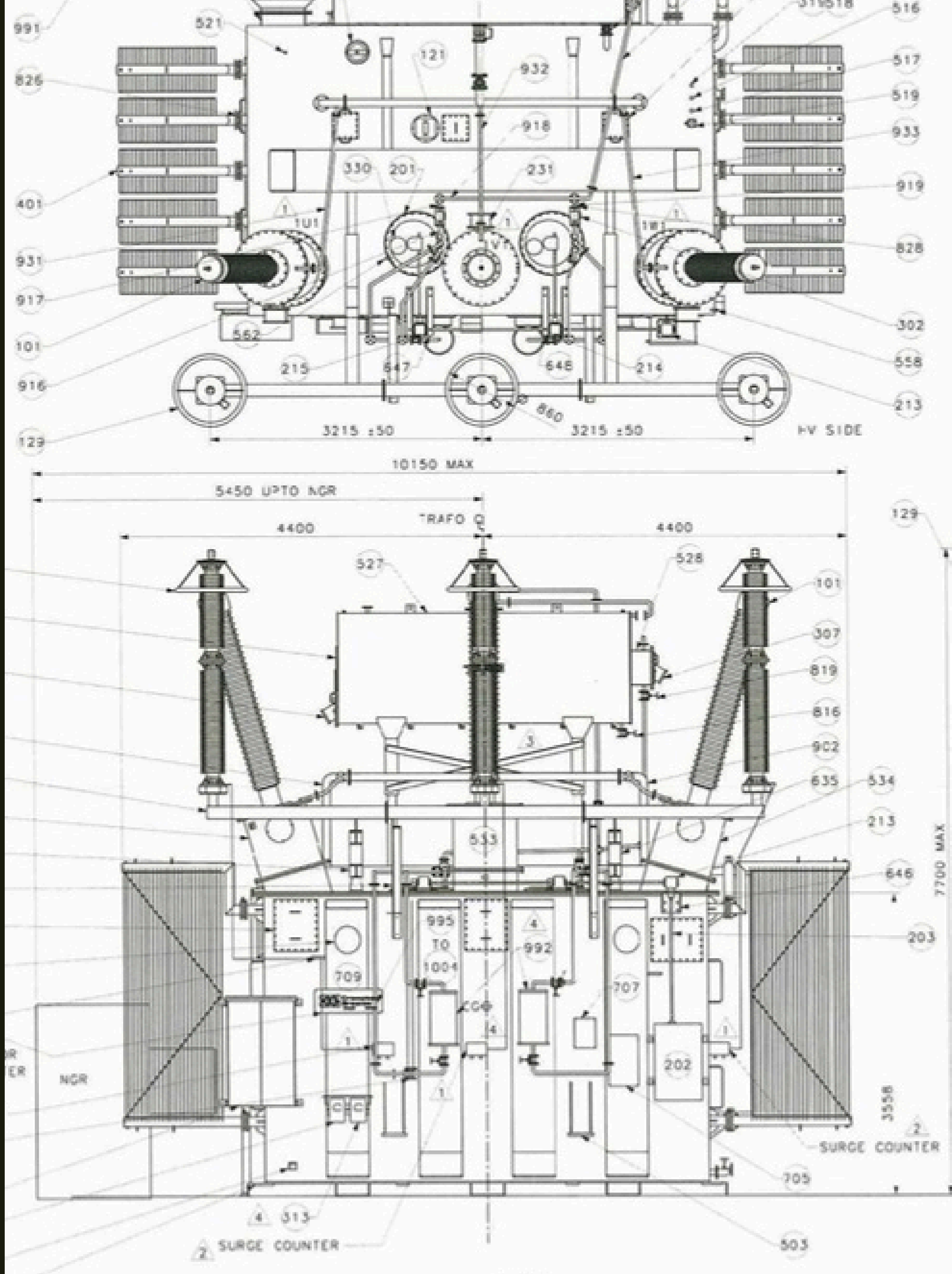
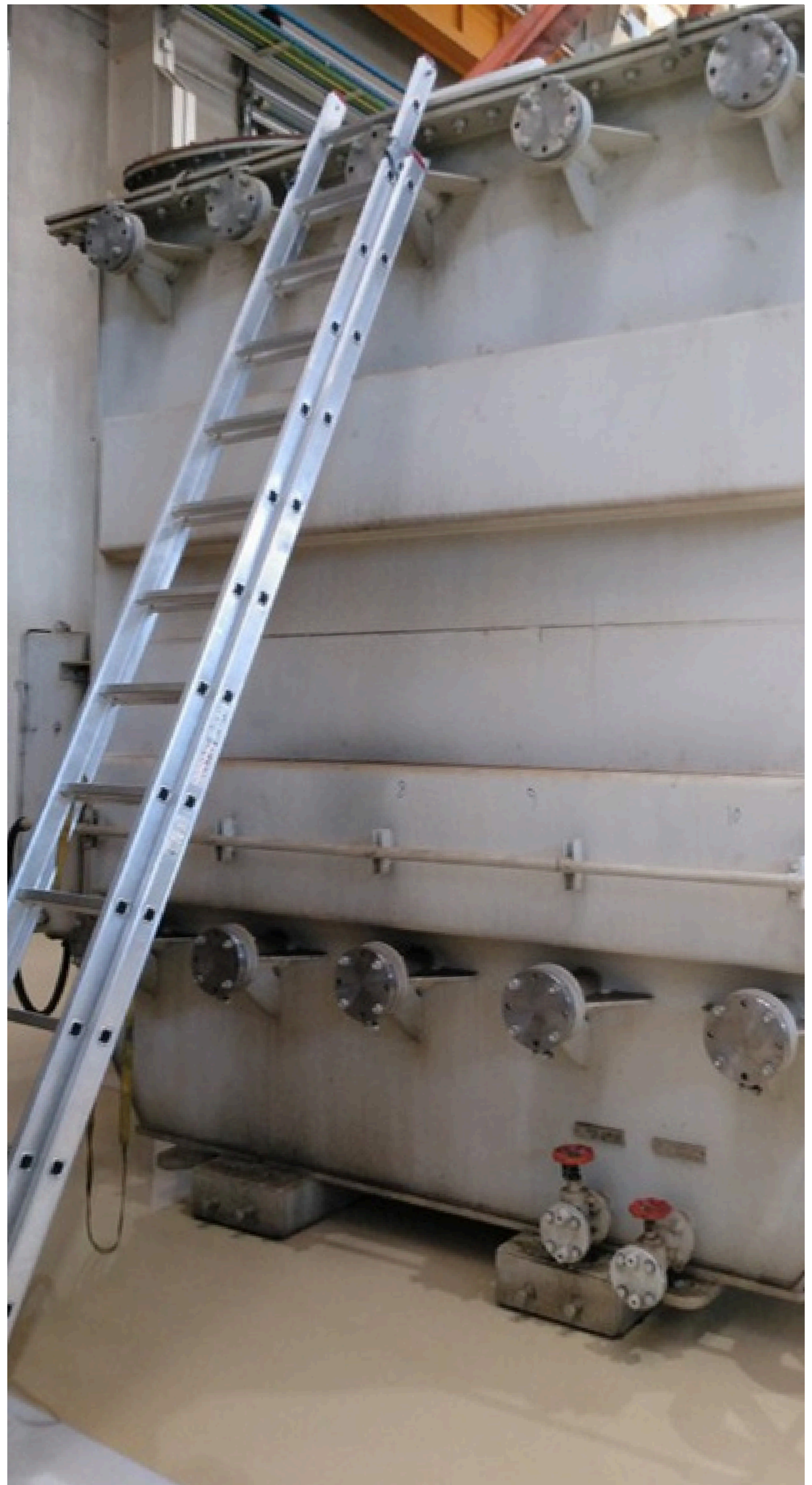


CASE STUDY 01

Failure Investiogation of a
50 MVA, 220/20 kV Power Transformer



OVERVIEW

Asset: 50 MVA 200/20 kV Power Transformer
Year of Manufacture: 2007
Service Life: 12 Years

OBJECTIVE

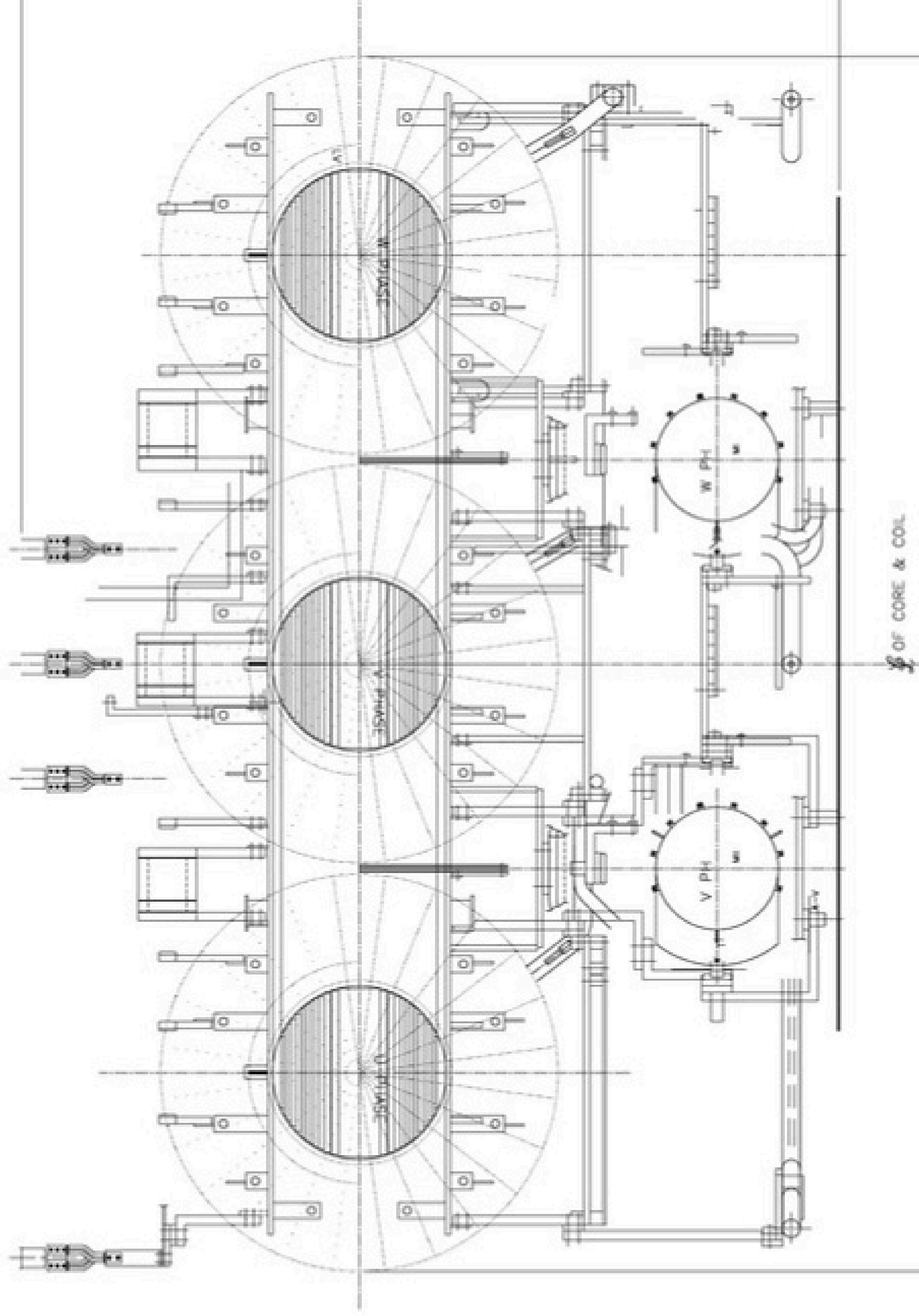
Analyze the root cause of the 50 MVA transformer failure following differential protection tripping. Evaluate internal/external damage, assess winding integrity via electrical tests, and define a site-based rehabilitation strategy.

THE CHALLENGE

The unit tripped on differential protection, followed by a second event involving OLTC surge, pressure relief, and Buchholz alarms.

Initial investigation revealed severe damage: a bulged main tank, cracked 245kV bushing flanges, and selector switches torn from their compartments.

The challenge lies in conflicting root cause theories. While the OEM suggests electromagnetic forces from a short circuit caused the failure, site evidence — including arcing patterns and the absence of fault current in certain HV phases — points toward a mechanical failure of the OLTC connection plate as the primary initiator.



DIAGNOSTIC FINDINGS & SITE OBSERVATIONS

The process began with a analysis of legacy technical specifications, review of original dimensional drawing, rating plate and test report.

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- Internal inspection revealed extreme carbonization and blackish oil.
- Pole A’s selector switch was found broken and hanging, with significant arcing marks on the V-phase tap winding leads.
- Multiple support structures for tap leads and tie-in resistors were fractured. Externally, the impact of high internal pressure was evident through bulged tank walls and cracked bushing mounting flanges.
- DGA results confirmed high-energy arcing, showing massive spikes in Hydrogen (265 ppm), Ethylene (1321 ppm), and Acetylene (1203 ppm).
- Despite the physical destruction of the OLTC and accessories, electrical ratio, magnetization, and winding resistance tests remained within tolerance, suggesting the core and main windings themselves were not permanently damaged during the event.

FAULT ANALYSIS & ROOT CAUSE CONTROVERSY

A critical discrepancy exists between the OEM and the Reactance Power Engineering analysis.

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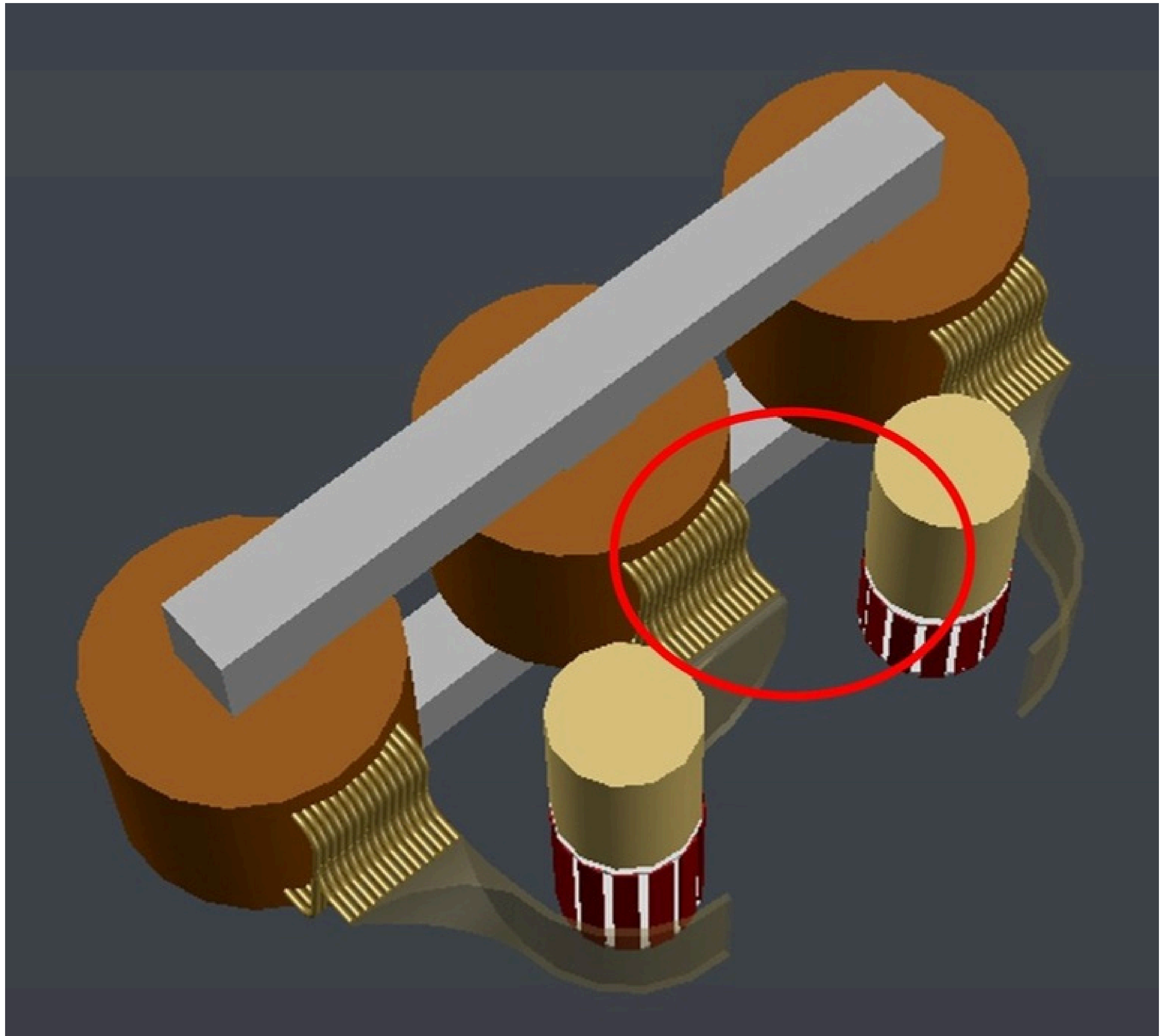


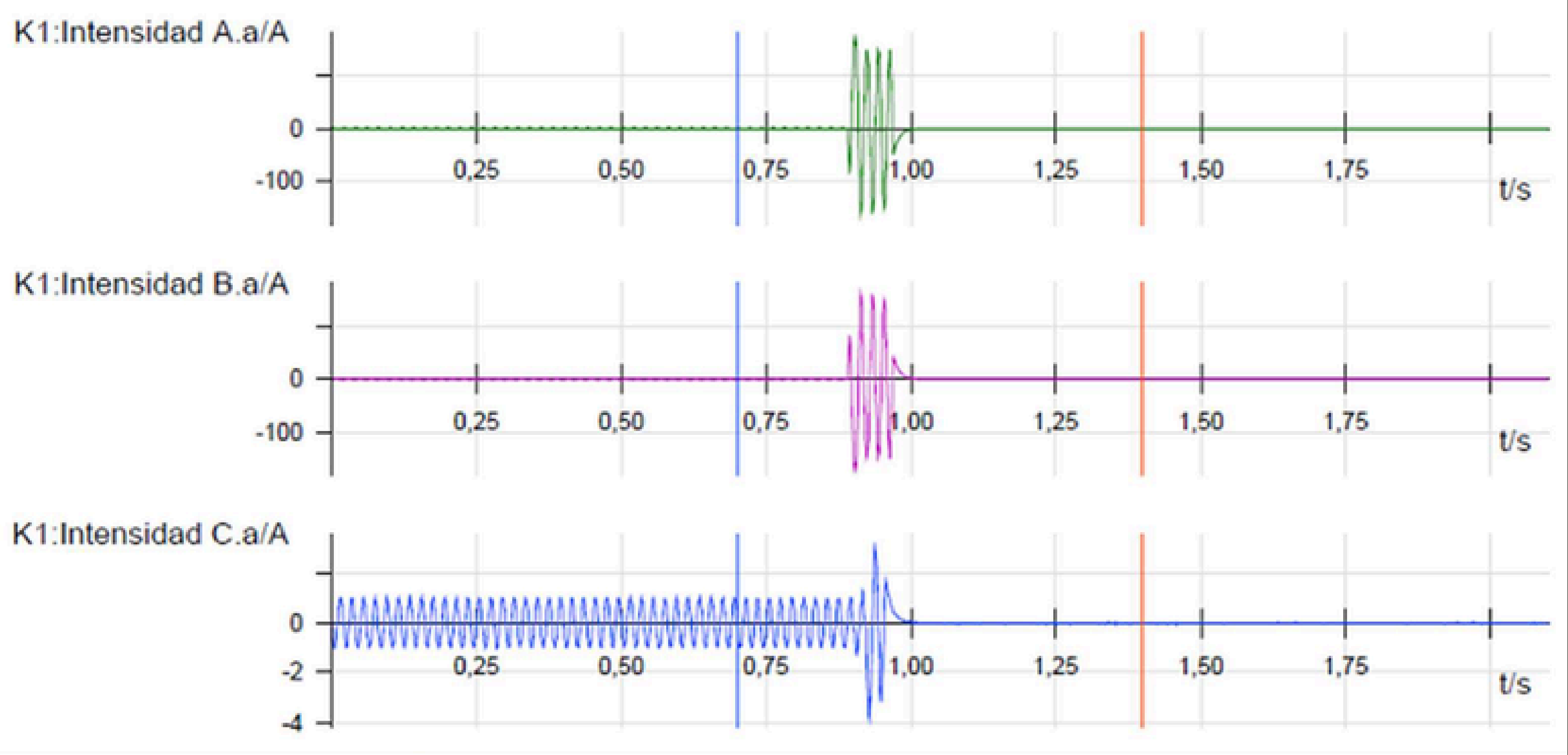


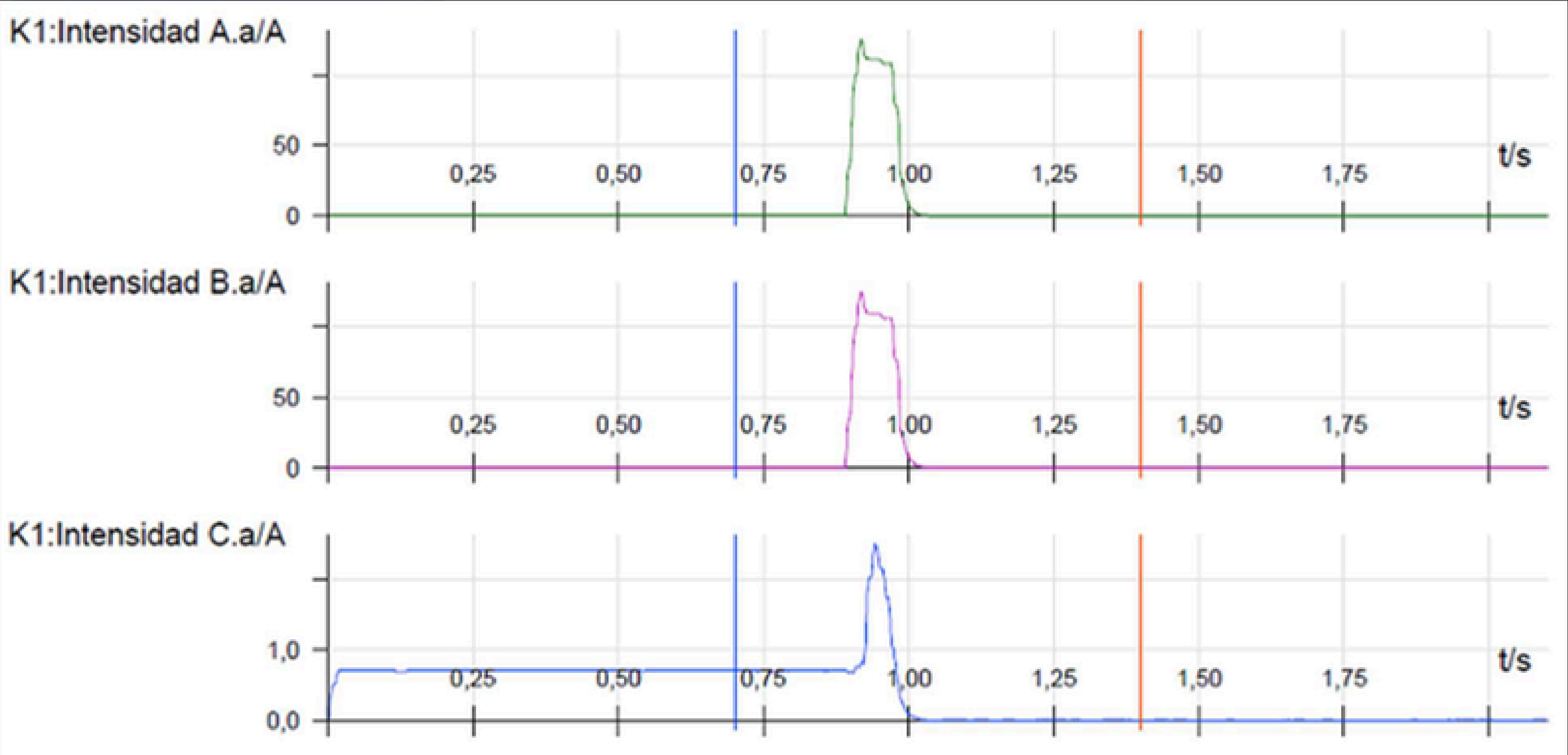
- OEM posits that a short circuit current generated high electromagnetic forces, leading to selector failure.

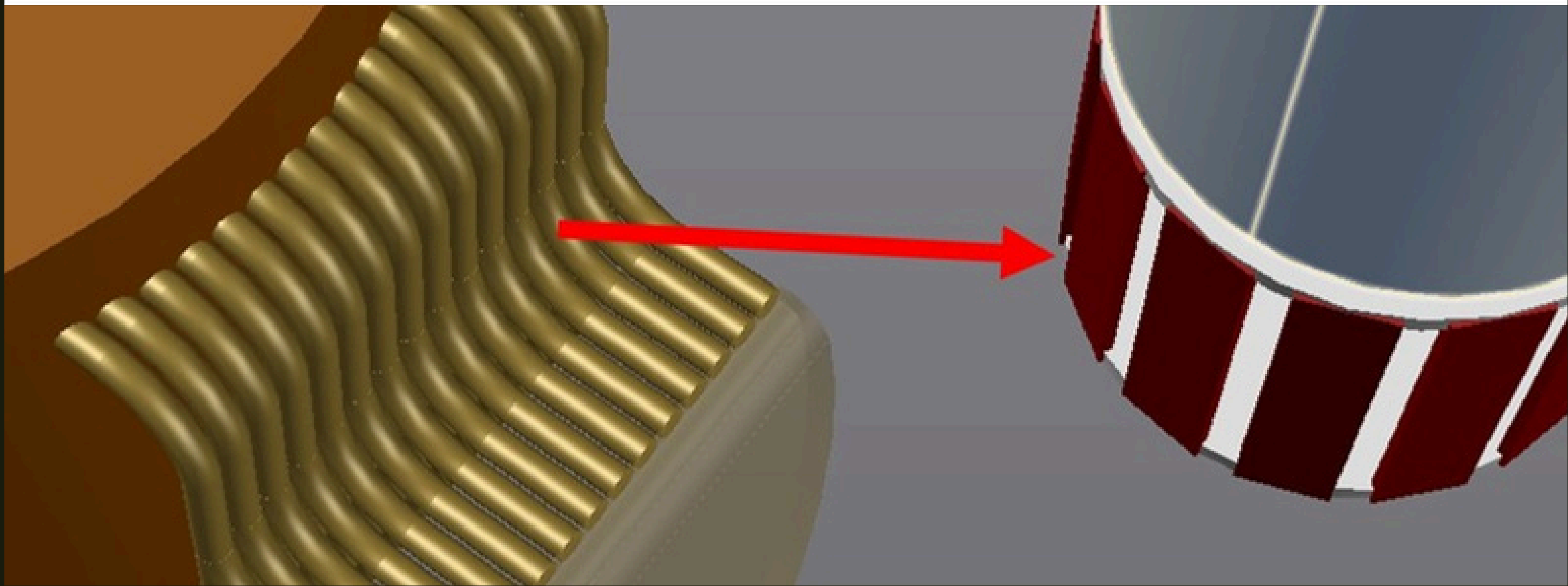
- However, HV current waveforms show zero fault current in the W-leg winding, contradicting OEM's theory of a "short circuit via the whole tap winding."

- Analysis of the arcing marks suggests a different failure mode: the mechanical breaking of a connection plate inside the OLTC oil compartment. This failure likely left components electrically floating, creating potential differences higher than acceptable limits and triggering a flashover.

- The resulting arcing generated the rapid gas and pressure that caused the tank bulging, bushing flange cracks, and subsequent protection relay operations.







REHABILITATION STRATEGY

Rehabilitating the transformer is considered feasible but requires a rigorous process.

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ACTIVE PART INTENSIVE CLEANING & NEW OLTC MOUNTING

- The strategy involves removing the core coil assembly (CCA) for intensive cleaning and replacement of all carbonized insulation and damaged wraps.
- All HV bushings, CTs, and protection relays (Buchholz, PRDs, etc.) must be replaced.
- A crucial step involves repetitive hot oil flushing and NAS filtration to eliminate metallic particles and carbon soot from the core and tank. The unit will then undergo a multi-cycle heating and vacuum process (65-70°C) to restore insulation resistance and polarization index.
- Finally, a new OLTC assembly (Poles A & B) will be installed, followed by final vacuum oil filling and a comprehensive battery of pre-commissioning tests to ensure service readiness.

THE RESULT

Post-failure electrical tests indicate no abnormality in the windings.
Full rehabilitation of the transformer is possible and recommended.

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