

MAINTENANCE BROCHURE
Transformer Condition Assessment



H&MV Engineering is a leader in HV electrical contracting and consulting services

About Us

H&MV Engineering is a leader in HV electrical contracting and consulting services. High & Medium Voltage Engineering Ltd was established in 1997 and is now among the leading specialist companies in High and Medium Voltage Transmission and Distribution Systems in Ireland.

Why analyse the health of Power Transformers?

Testing to assess the health of power transformers and diagnose problems is of utmost importance to ensure the long term and safe operation of these very expensive power assets.

Performing a range of standard electrical tests repeatedly over an advised time period has proven a very effective way to gain a detailed insight into the condition of your operating transformers and extend their lifespan.

The picture below shows very clearly that it is important to avoid fatal transformer breakdowns. The risk of transformer breakdown strongly depends on its condition. Hence it is important to get to know about the life expectancy of a transformer to ensure safe operation.

Possible impacts of lack of maintenance

- Baseline data not recorded
- Problems during warranty period not detected
- OLTC contact wear
- Oil oxidation begins
- Fan and pump bearing wear
- Visible effects of weathering and UV
- Oil decay products effect paper insulation
- Missed opportunity to intercept accelerated ageing
- Oxidation and hydrolysis enters accelerated ageing state
- OLTC and bushing failure rates increase
- Dielectric withstand diminishes
- Expensive failure

Condition and time based maintenance

Due to new constraints on the energy market, assets are required to remain in service during peak season power demands. To ensure a safe and reliable operation condition based maintenance of the power asset is the way to ensure continuity of supply.

H&MV Engineering are dedicated to collaborating with a customer to create a condi-

tion and time based maintenance schedule that best suits the customers power asset, to ensure longevity in operation.

Power Transformer diagnostic measurements

H&MV Engineering offers a wide range of measurements to determine the health of a customer's power asset, using the most up to date testing methods with world leading test technology.

Overview of Transformer measurements that we offer:

1. Turns ratio and Exciting current
2. Winding resistance (Dynamic and Static)
3. Short circuit impedance
4. Tan Delta (Winding and Bushings)
5. Moisture Determination in liquid and solid insulation
6. Frequency response analysis

1. Turns Ratio and Exciting Current

Detectable features:

- Shorted winding sections
- Core Faults

The transformer ratio test verifies the ratio of the primary winding in relation



The risk of transformer breakdown strongly depends on its condition.



to the number of turns in the secondary winding. Test voltage is applied between P-N or P-P on the HV side of the transformer and resulting voltage measured on LV side. For a given applied primary voltage, the test kit measures both the current flowing in the primary winding and the resulting voltage at the transformer secondary winding.

Results will be tabled as ratio per tap and its deviation from the nominal ratio in percentage and the excitation current. The turns-ratio test detects shorted turns, which indicate insulation failure. Shorted turns may result from short circuits with high currents or insulation failures.

2. Winding Resistance Test

Detectable features:

Static Resistance measurement

- *Bad internal contacts (diverter switch and tap selector switch contacts, connection clamps)*
- *Short circuits between conductors of a winding*
- *Damaged conductor*

Dynamic Resistance measurement

- *Bad, bouncing contacts in the OLTC*
- *Checks if the OLTC is operating without interruption*

Winding resistances are tested in the field to check for loose connections, broken strands and high contact resistance in tap changers. Measurements are carried out on each phase, starting with the lowest tap through to the highest and continue backwards down to the lowest tap again. Taps may show quite different results depending on the direction of the tap movement and defects can behave differently. An interruption caused by a defective tap changer results in comparatively high measured values for ripple and slope.

3. Short Circuit Impedance

Detectable features:

- *Shorted winding sections*

Leakage reactance measurement is a measure of the short circuit impedance of a transformer, a vital tool for diagnosing winding deformation. Mechanical forces resulting from system condition such as overcurrent or transportation can cause displacement of the winding. Once a winding becomes distorted, its ability to withstand stress is severely limited and transformer failure is inevitable.

The short-circuit impedance test, is a reliable indicator of transformer winding deformation. The leakage reactance within a transformer is sensitive to the geometrical changes in the leakage flux path. The leakage flux path is predominantly made up of space between the winding, space between the winding and the tank wall. The short-circuit impedance of a transformer is calculated by measuring the corresponding current of a voltage applied to the primary winding with the secondary winding short-circuit. With the secondary shorted, the current drawn by the primary is essentially the result of the leakage flux

4. Tan Delta

Detectable features:

- *Change in geometry due to mechanical damage or high currents*
- *Breakdowns between grading layers of condenser bushings*
- *Water in solid insulation/ Ageing*
- *Contamination of insulation liquids*
- *Discharge due to bad contacts in bushing test tap*

Tan-Delta measurements are made for all insulation gaps HV to LV, HV to

ground, and LV to ground. The dissipation factor is an indicator of the oil-paper insulation quality of the single gaps. Degradation of oil, water content and contamination with carbon and other particles can increase the DF. Capacitance measurement indicates winding deformation and structural problems such as displaced wedging and winding support.

5. Moisture Determination in Liquid and Solid Insulation (DIRANA)

Detectable features:

- *Measures the water content in solid insulation*
- *Determines the oil conductivity and geometry data*

The DIRANA can determine the condition of high-voltage insulation systems. On basis of the dielectric frequency response (DFR) the DIRANA can, for example, determine the moisture content in oil-paper insulations.

A dielectric response measurement is performed first. This measurement determines the dielectric properties of the insulation in a wide frequency range.

The moisture analysis is performed by comparing the results of the dielectric response measurement with a database, containing dielectric results of cellulose at different temperatures and moisture contents.

6. Frequency Response Analysis (FRA)

Detectable features:

- *Powerful and sensitive method for evaluating mechanical integrity of core, windings and clamping structures within power transformers*
- *Geometrical changes in this network cause deviations of frequency response*



Frequency Response Analysis (FRA) is a powerful and sensitive method used to evaluate the mechanical integrity of core, windings and clamping structures within power transformers by measuring their electrical transfer functions over a wide frequency range. The sweep frequency response analysis is a comparative method, i.e. an evaluation of the transformer condition is done by comparing an actual set of SFRA results to reference results.

Three methods are commonly used to assess the measured traces:

- *Time-based: (Current SFRA results will be compared to previous results of the same unit)*
- *Type-based: (SFRA of one transformer will be compared to a type equal one)*
- *Phase comparison: (SFRA results of one phase will be compared to the results of the other phases of the same transformer)*

H&MV Engineering test equipment

H&MV's highly trained test Engineers are using market leading test equipment fitted in our mobile transformer diagnostic unit.

Our test equipment includes:

- Omicron CPC 100
- Omicron TD1 Tan delta Booster
- Omicron SB1
- Omicron FRAnalyzer
- Omicron FDS – PDC dielectric response analyzer

More about H&MV Engineering

H&MV are fully dedicated to creating a time based maintenance schedule to suit a customer's planned outage so that all testing can be fully carried out in a way that never compromises health and safety.

We are committed to delivering a quality service to ensure the long life of the

customer's asset and provide a detailed report on completion of measurements.

Our staff are highly trained with Omnicron electronics GmbH, Klaus Austria and Megger Ltd, Dover UK. Our staff have a vast level of experience over the last 10 years in the field of taking diagnostic measurements on power transformers throughout Ireland and the UK. We are performing diagnostic testing on transformers from 275kV to 400kV, in many different sectors such as generation, oil and gas, industrial, mining and data centers.

Our test equipment is among the most innovative and world leading on the market which is fitted in our mobile transformer diagnostic unit.

We aim to help make the generation, transmission and distribution of electricity safe and reliable on all projects we are involved in.

