Advanced Diagnostic Testing Services

Provides detailed and reliable results

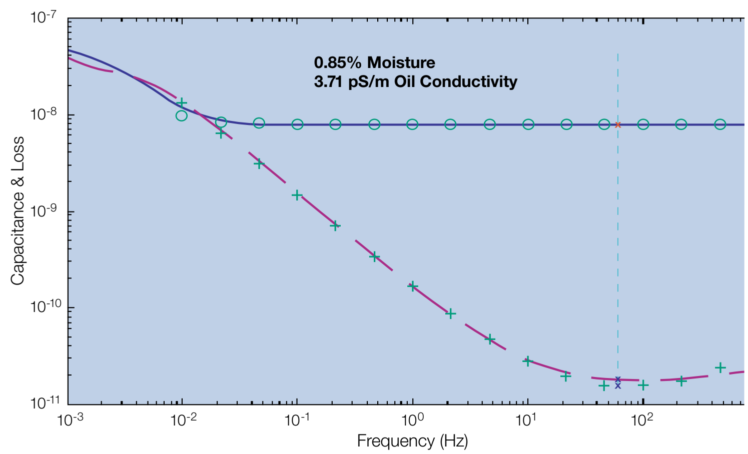
Advanced Diagnostic Testing Services from the world's leading manufacturer of power transformers

ABB leadership begins with our unmatched experience in the power transformer industry. ABB Transformer Remanufacturing and Engineering Services (TRES) experts have detailed design and development knowledge of Westinghouse, General Electric, ABB, Asea, BBC, National Industri, Moloney, and other transformers built over the years. As the successor OEM, ABB has the original design information for these units. In addition to these designs, ABB can draw on broad industry knowledge gained from years of transformer service and repair experience of all manufacturers' transformer designs. What's more, ABB utilizes the most up-to-date design programs and design practices in the industry. This combination of knowledge, diagnostic tools and field experience is what makes ABB the acknowledged leader in the field of Advanced Diagnostic Services.

ABB can diagnose your power transformers and provide you with the information you need to make effective O&M decisions

Dielectric Frequency Response (DFR) — More actionable information than standard power factor tests

The Dielectric Frequency Response test is used to assess the integrity of a transformer's insulation system. The test determines the volume of moisture and presence of contaminants in the solid insulation as well as the conductivity and power factor of the oil. This is an extremely useful tool in an overall condition assessment program as standard power factor tests alone do not yield this information.



Dielectric Frequency Response

The DFR test is a measurement of the dielectric properties (i.e. capacitance, loss, and Power Factor) of the transformer's insulation as a function of frequency. This off line test utilizes the same type of connections as the standard 60 Hz insulation power factor test. However, it covers a frequency range, typically from 1 mHz to 1000 Hz while the standard power factor (Doble) test is done only at 60 Hz. The DFR test yields more information with increased sensitivity to insulation issues by utilizing the dielectric response phenomenon.

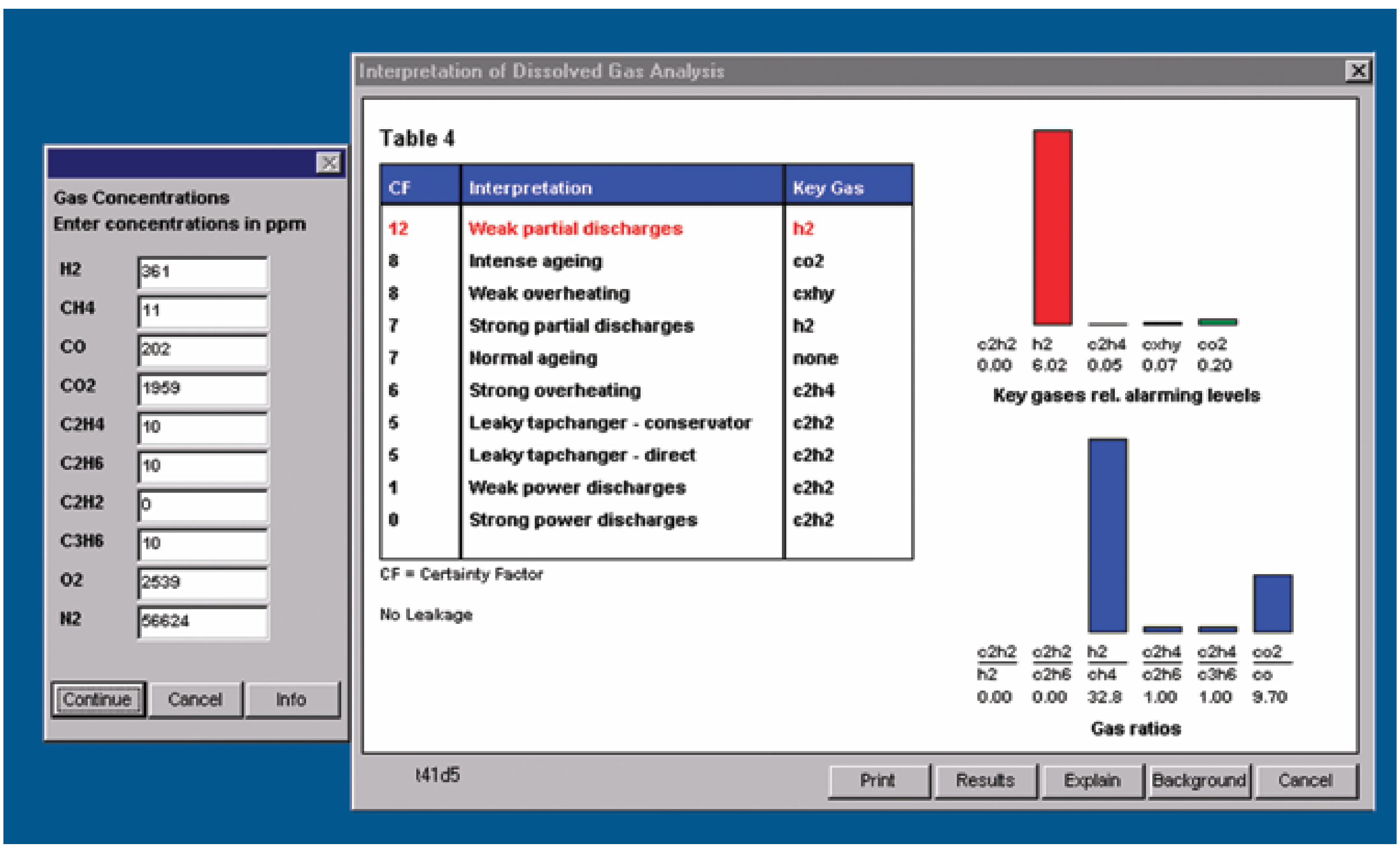
A further application is the Dielectric Frequency Response Signature method, (DFRS), where the signature of the measured response is then compared with a modeled response of a transformer with a "normal" insulation structure and a library of signatures of known defects. The method is dem onstrated by utilization in cases where high or abnormal power factor results were measured in the field.

The DFR test has gained popularity in recent years as a diagnostic tool for transformer insulation system tesing. One important primary use of the test has been for determining the moisture content in the cellulose insulation structure of power transformers. The analysis of moisture in transformers is performed using the results of the DFR measurement and an analysis tool that models the actual insulation geometry and the insulating material (oil, paper, pressboard, etc.) of the transformer. ABB has used these tools for years for analysis of transformers both in the factory and in the field. The experience gained has shown the potential of the DFR test for identifying not only moisture problems, but also other defects in the transformer insulation structure.

ABB's Advanced Dissolved Gas Analysis (DGA) Software — Deeper analysis that comes from years of ABB experience

ABB has developed an internal software package that utilizes DGA raw data, ratios, trends, and key indicators. When coupled with our resident design expertise and transformer construction knowledge, ABB is able to offer a more detailed analytical interpretation than what is standard practice in the industry. This combination gives us the ability to pinpoint specific sources and causes of gas generation, which in turn allows customers to take corrective actions more quickly and accurately.

ABB's ownership of the design database of Westinghouse, GE, ASEA, BBC, Moloney, National Industri, and other industry-standard transformers, combined with our modern transformer design capabilities, puts ABB in the unique position of being able to offer this proprietary software and perform this detailed analysis.



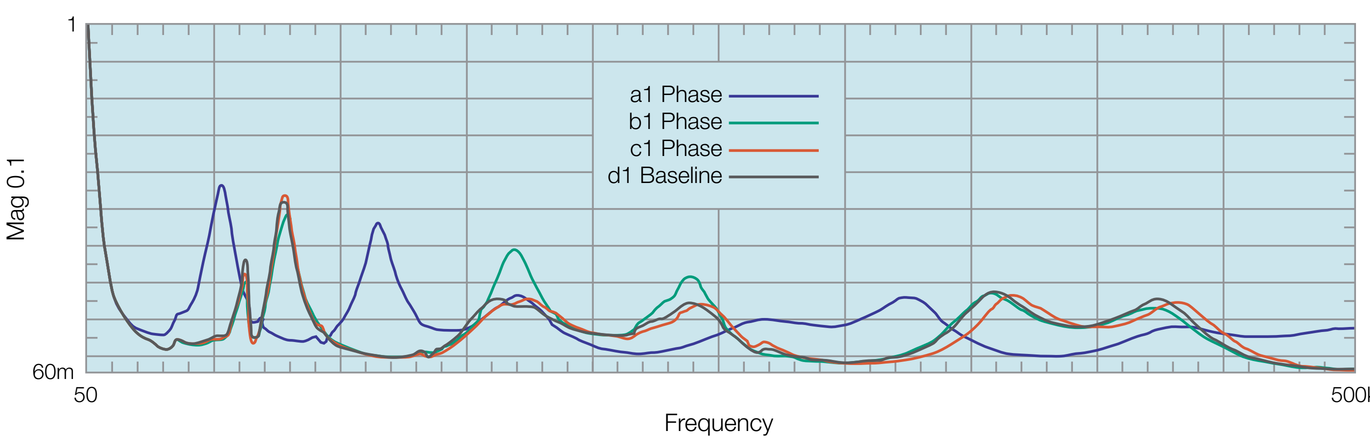
Frequency Response Analysis (FRA) — An important tool for identifying potential winding geometry changes

Frequency Response Analysis is a low-voltage, off line measurement of the impedance of the transformer winding as a function of frequency. The test is performed by applying a variable frequency ac voltage to each individual winding of the transformer and measuring the current that flows out of the winding. The plot of the current divided by voltage vs. frequency is known as the Swept Frequency Response Analysis (SFRA) of the winding.

Winding defects shown in coil displacement

ABB recommends the FRA test be performed in the factory at the time of original transformer testing to provide a baseline reading of the windings in an as-new condition. For installed transformers, a test in the field can be used to provide the baseline value. FRA should be performed periodically during the service life of the transformer or after a specific incident producing significant through fault currents in the transformer. Comparison of such an FRA test to the original baseline value is very useful in diagnosing the condition of the windings.

ABB's expert interpretation of FRA test results is an excellent method to check for movement or displacement of windings or winding circuits and is much more definitive than low-voltage impedance tests routinely performed on transformers. The value of the FRA test is to identify potential winding geometry changes that may affect the ability of the transformer to withstand through faults, helping avoid catastrophic transformer failures.



SFRA result of transformer with winding defects in a phase

Demonstrating the value of DFR: Case Study #1

Better information for client resulted in avoidance of unnecessary maintenance

Our client provided ABB with a list of seven transformers. In each case, moisture in oil test results indicated the need for oil processing and drying. Working with the client, ABB performed DFR testing and determined that only two units actually required drying instead of seven. ABB's recommendation to dry two transformers, while carefully monitoring the other five, afforded a significant amount of O&M savings. This also avoided over-drying and loosening the windings of several units.

Xfrmr#	Temp (°C)	Type	Construction	Oil Cond (pS/m)	Moisture by Oil Sat (%wt)	Moisture by DR (%wt)
1	23	GSU	Core	0.381	2.5	0.9
2	28	GSU	Core	0.492	1.8	0.9
3	23	GSU	Core	0.412	1.4	0.9
4	23	GSU	Core	1.34	2.8	0.7
5	13	3-wdg	Shell	1.5	*	1.2
6	27	Auto	Core	3	3.5	2
7	27	Auto	Shell	0.3	3.3	1

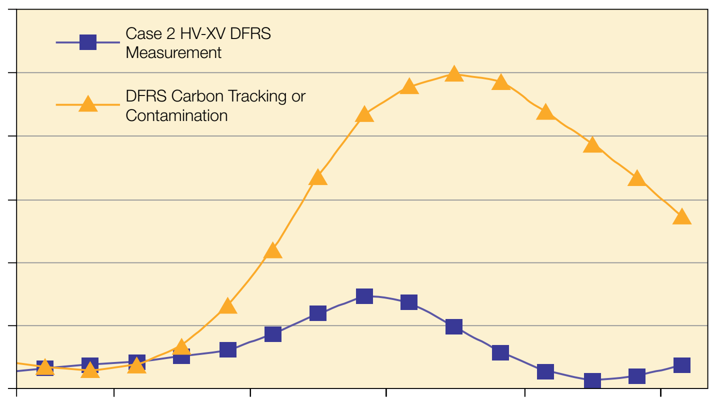
Surface moisture in paper, estimated from moisture in oil, compared with volume moisture in insulation measured by DFR

Demonstrating the value of DFR: Case Study #2

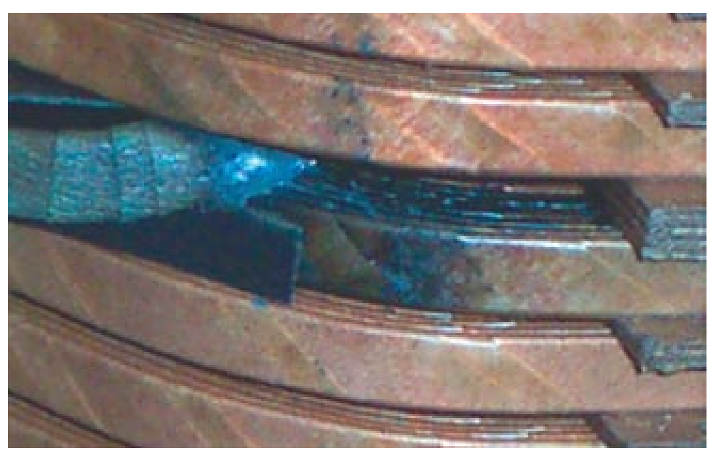
Carbon tracking of the insulation system identifies problem that could have produced catastrophic failure

This transformer was investigated due to combustible gas results in the field. The DFR test was done as part of a condition assessment of the transformer to determine the cause of the gassing. The power factor results were all within the normal industry practice (less than 0.5%). The DFR result showed a noticeable deviation from normal responses. ABB'S Dielectric Frequency Response Signature method (DFRS) was used to investigate the cause of the abnormality. Comparisons were made to library DFRS cases and carbon tracking or contamination was identified as the cause of the deviation. The chart shows a comparison of the transformer DFRS result to a case of known contamination. The fact that there was much less deviation than the library case indicated that the extent of the defect was very limited.

Based on ABB Dissolved Gas Analysis and the suspected carbon tracking identified by the DFRS method, the transformer was disassembled for close inspection of the insulation structure. An area of burning in the winding was found in the High-Low space of one phase of the transformer. The photograph shows the small area where carbon was produced, which was probably caused by a partial discharge. Ultimately, a catastrophic failure was avoided.



DFRS functions for transformer and carbon tracking/contamination



Carbon deposition on the winding causing the DFRS wave shape