

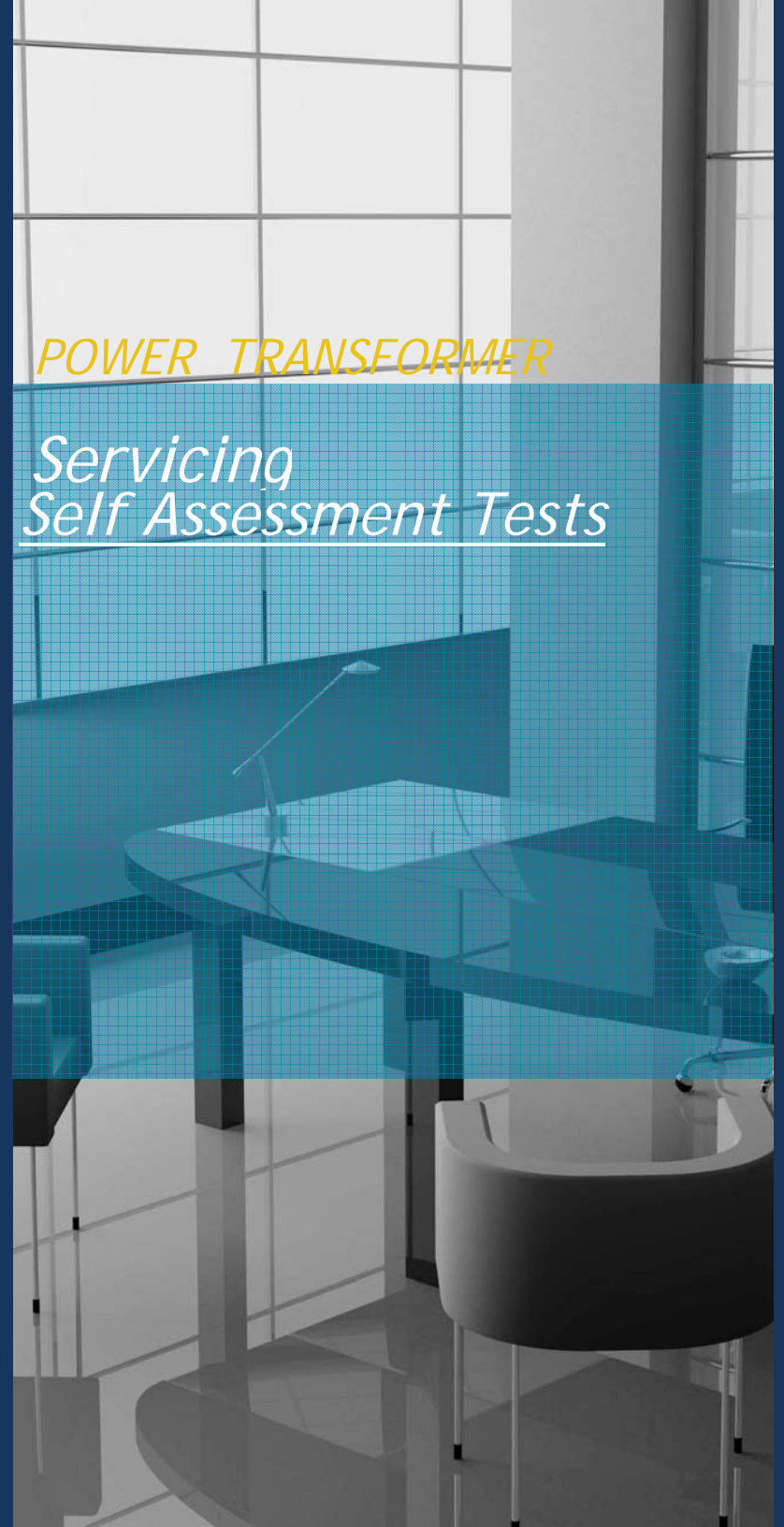
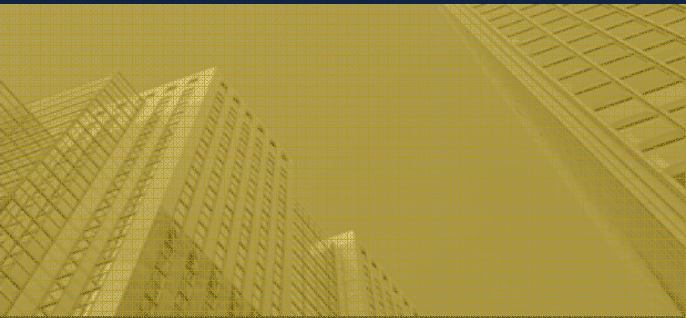


POWER TRANSFORMER

*Servicing
Self Assessment Tests*

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Let us help you read the pulse of a Transformer

PEL has launched an advanced transformer diagnostic services that uses state-of-the-art electronic equipment, operated by highly skilled and experienced test engineers, to provide utility and industrial customers with a fast, non-invasive, internal health check for power transformers. The services, designed to help keep transformers from any manufacturer operating at maximum load and energy efficiency, without compromising reliability or safety, can be applied at any stage of the asset's life, from installation and commissioning, or as part of a condition based asset maintenance program, right through to diagnosing and locating a potential problem before it becomes a serious fault.

SERVICES

Addressing the needs of Electrical Power
Generation & Distribution Companies

Electrical systems throughout the world are experiencing problems with aging insulation. When an insulation system fails, the results are usually catastrophic. Failure causes substantial financial losses due to lost production and damage to expensive equipment. These losses can amount to thousands of dollars per hour. With the ability to predict when a possible insulation failure will occur, clients will be able to reduce their lost profit opportunities. Industry now and in the future cannot tolerate unplanned outages.

Performing offline and invasive tests also add to the replacement cost. Hence, there is an increasing need to move from traditional schedule-based maintenance programs to condition-based maintenance. A large number of techniques are available for transformer health monitoring. However, a focused approach is required for diagnostics. Considering the long service life of a power transformer and prevalent use of human judgment (expert), there is a need to structure a knowledge base around expert knowledge while continuing to create new diagnostic capabilities which can be plugged in.

WHAT WE DO

Insulation Resistance

Winding Resistance

Transformer Turn Ratio

Sweep Frequency Response Analysis

Frequency Domain Spectroscopy

Capacitance & Dissipation factor

Bushing Power Factor

Excitation Current

Leakage Reactance

The service Department at PEL brings together the ability, skills and associated product knowledge to provide a comprehensive range of services. These services provide the best possible solutions for you and allow you to have the *peace of mind* in the knowledge that your electrical power and distribution assets are being effectively working

Insulation Resistance

The insulation resistance test is also known as a Meggar test. Its objective is to measure the leakage current resistance between any two points separated by insulation. The test, therefore determines how effective the insulation is in resisting the flow of electrical current. The voltage is typically around 500–5000 V dc; hence, this test is useful for checking the quality of the insulation over time as the product is used.

Winding Resistance

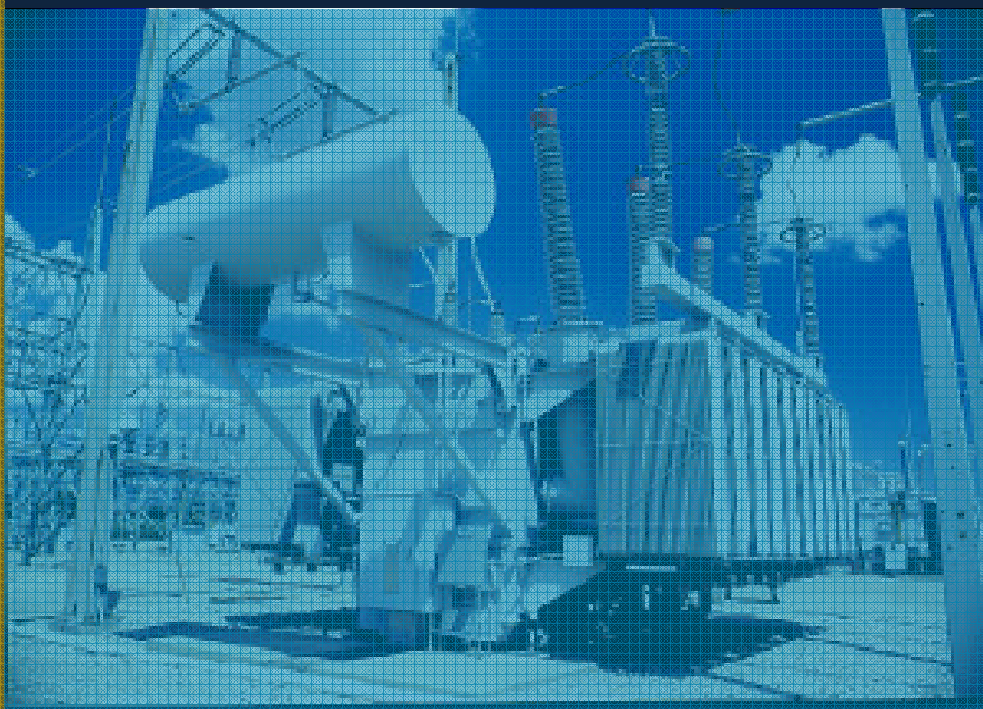
The winding resistance measurement equipment is used to inject a DC current of up to 5kV through the transformer windings and it then measures the voltage drop across that winding to enable the resistance to be calculated. This test helps to check that the transformer connections are correct and that there are no shorted turns, defective joints, or bad contacts.

Transformer Turn Ratio

This test energizes the selected winding at a specified voltage and measures the induced voltage on other winding. The Transformer Turn ratio (TTR) helps determine if the windings are short circuited.

Leakage Reactance

This test helps in detecting winding movement or core and coil displacement in a Transformer.



Core Excitation Current

This test measures the required current to excite the Transformer core. High values of excitation current are generally indicative of short turn or core damage in the transformer.

Capacitance & Dissipation factor

Capacitance and Dissipation factor measurements on capacitive bushings are of utmost importance to detect defects in the potential steering electrodes - long before they lead to a breakdown of the insulation. Measurements between tank and winding or inter winding results are performed to detect mechanical movements of windings inside the transformer without optical inspection.

Sweep frequency Response Analysis

The Sweep Frequency Response Analysis (SFRA) test, diagnoses the condition of the transformer windings and magnetic core. It is performed by injecting a variable frequency AC voltage to each winding and plotting the responding current as a curve. Typically, these 'finger print' reference curves are captured either when the transformer is new or when it is known to be in good condition. They can be used as a baseline reference during maintenance tests or when there is a reason to suspect a problem. In the hands of PEL's team of transformer test experts the SFRA test is an excellent way of checking for movement or displacement of windings and can even locate the exact position of a fault.

Frequency Domain Spectroscopy

Frequency Domain Spectroscopy (FDS) is used to assess the integrity of a transformer's insulation system by measuring its dielectric properties as a function of frequency over the range from 1 mHz to 1000 Hz. This test provides information about the volume of moisture and presence of contaminants in the solid insulation, as well as the conductivity and power factor of the oil.

Bushing Power Factor

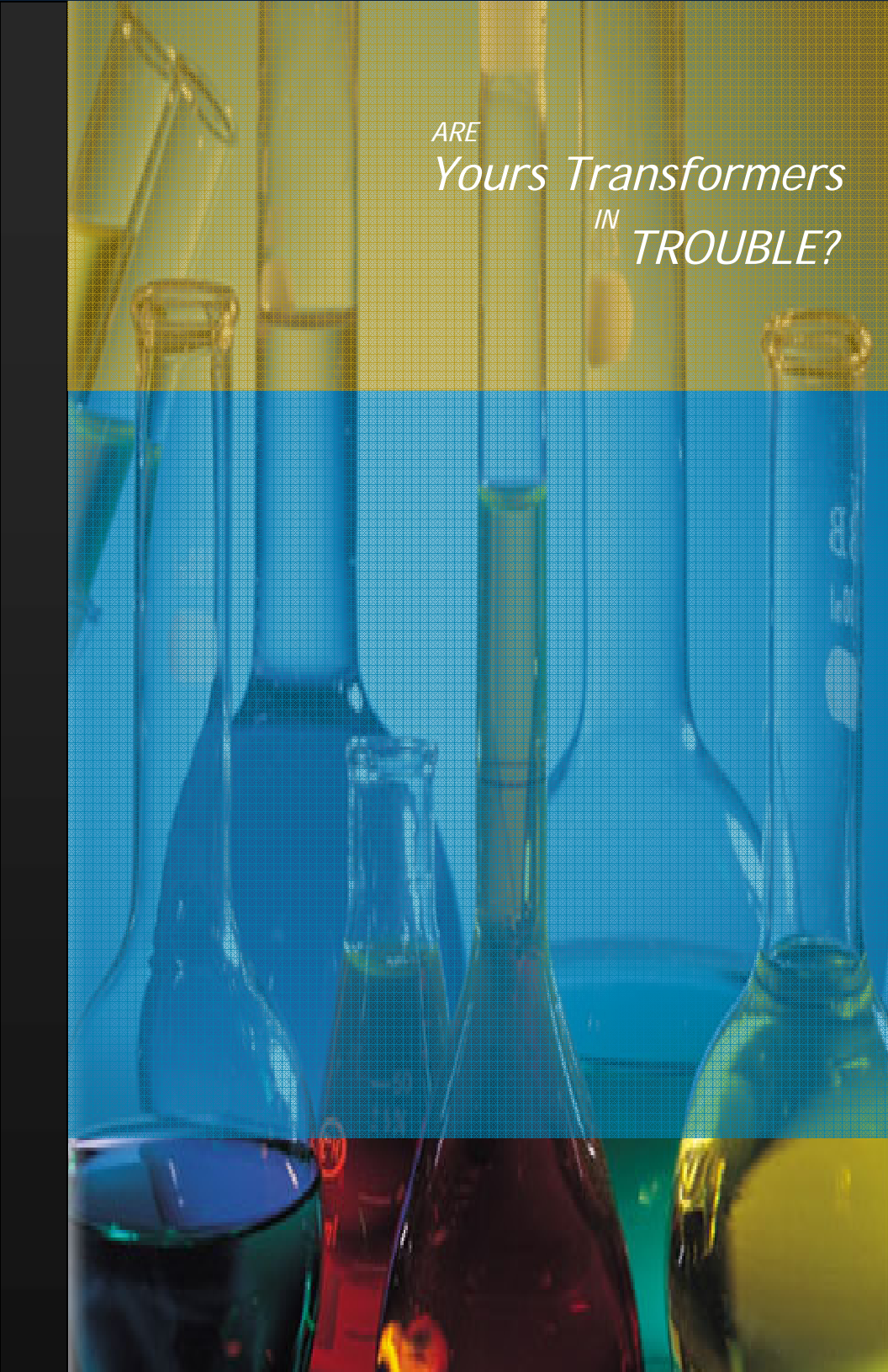
This test measures power loss through the insulating medium of the bushing.

Winding Power Factor

This test measures power loss through the insulating system caused by the insulation deterioration, contamination and mechanical deformation. Abnormally high or low voltages of power factor, dielectric loss, capacitance or leakage current indicate a failure of insulation system.

Core Ground

This test identifies the inadvertent core grounds which causes unwanted circulating current to flow, often leading to overheating situations.



ARE
Yours Transformers
IN
TROUBLE?

Transformer distress signal can only be decoded by testing the transformer oil, the heart of the Electrical Transformer Power design. When working properly & within specifications, transformer oil:

- *Increase transformer efficiency & useful life time.*
- *Serves as a dielectric fluid & heat transform medium.*
- *Saves on replacement costs, cuts downtime, & improves customer service*

PEL can help you examine the pulse of your transformers with our transformer **Assessment Package**. It will tell you if your transformer oil is within specification & diagnose internal faults inside the paper, windings, & core. The package consists of:

- **Fluid Quality Tests** *incompliance with IEC.*
- **Dissolve Gas Analysis.**

A routine transformer check up requires six tests to tell the quality of the Oil. The recommended tests along with the brief introduction are outlined below:

Di-electric Strength (Breakdown Voltage)

Breakdown voltage of transformer oil indicates its ability to resist electrical stress in electrical equipment.

Neutralization (Acidity Number)

This test measures the neutralization number. When oil oxidizes in air/transformer, acid & sludge are produced, along with water. A severe increase in neutralization number can be detrimental to the insulation system.

Viscosity

Viscosity influences temperature of the equipment. The low the viscosity, the easier the oil circulates leading to improved heat transfer.

Flash Point

The safe operation of electrical equipment requires an adequately high flash point that is measured.

Interfacial Tension (IFT):

It is the measurement of molecular attractive force between their unlike molecules at the interface of oil & water.

Dielectric dissipation factor (DDF):

DDF is a measure for dielectric losses caused by the oil. Increased DDF can indicate contamination of the oil by moisture particles or soluble polar contaminants or poor refining quality. DDF shall be measure at 90°C. However by the agreement between two parties, DDF may be measured at temperatures other than 90°C. In such cases the temperature of measurement should be stated in the report.

Sulfur content:

Different organo-sulfur compounds are present in transformer oil, dependent on the crude oil origin & the degree & type of refining. Refining treats sulfur & aromatic hydrocarbons. As some sulfur compounds have an affinity to metals, they may act as copper passivators or they may promote corrosion.

Water Content (Moisture Content):

A Low water content in mineral insulating oil is necessary to achieve adequate electrical strength & low dissipation losses.

Color & Appearance

A visual inspection of insulating oil (oil sample in transmitted light under a thickness of approx. 10cm & at ambient temperature) indicates the presence of visible contaminants, free water or suspended matter

Corrosive Sulpher

Some sulfur compounds, e.g. mercaptans, are very corrosive to metal surfaces, i.e. steel, copper and shall not be present in new oil.

Dissolved Gas Analysis:

Dissolved gas-in-oil analysis (DGA) is the most commonly requested oil diagnostic test performed on transformer oil. It is an effective diagnostic method when used in a routine yearly check-up. All transformers contain insulating materials that break down due to excessive thermal or electrical stress, forming gaseous by-products.

These by-products are indicative of the type of activity present within the transformer, such as an incipient-fault condition. The DGA can also shed light on the materials involved & the severity of the condition. DGA is a powerful tool for detecting incipient-faults & for investigations after failures have

Typical gases generated from mineral oil/cellulose (paper & pressboard) insulated transformers include hydrogen, methane, ethane, ethylene, acetylene, carbon monoxide, & carbon dioxide. The composition of gases generated provides information about the type of incipient-fault condition present. For example, four general categories of fault conditions have been described & characterized by Key Gases.

Categories of Key Gases & General fault Conditions

KEY GASES	GENERAL FAULT CONDITION
Methane, ethane, ethylene & small amounts of acetylene.	Thermal condition involving the oil
Hydrogen, methane & small amounts of acetylene.	Partial Discharges
Hydrogen, acetylene & ethylene.	Sustained arcing
Carbon Monoxide & Carbon dioxide.	Thermal condition involving the paper.

Other Tests**Pour Point****PCB****Degree of Polymerization****Density****Furfural Content****Oxidation Stability**

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