

TOGA[®] Electrical Insulating Fluid Analysis

Improving performance and protecting assets.



Hartford Steam Boiler





It happens all the time - transformers fail unexpectedly, and there are often no external visual clues on what caused a breakdown.

But, testing the transformer insulating fluid can help predict a failure before it happens. The key to testing is gaining an accurate evaluation of the test results. Hartford Steam Boiler's Transformer Oil Testing Program (TOGA®) does just that.

Case study: Preventing loss

TOGA testing discovered arcing in a 10 MVA transformer. TOGA samples showed the transformer operation stable after returning to service but we suspected lightning damage. A damaged conductor was found which was easily repaired at a scheduled outage. It was repaired at a cost of \$50,000 as opposed to the unit's total cost of \$300,000 and it did not require an expensive forced outage.

A lot of companies offer insulating fluid testing, but...

HSB gives you a competitive edge by helping you better manage your electrical equipment assets. TOGA uses proven technology and engineering know-how to protect the integrity of your transformer. TOGA has been keeping transformers on-line and in business since 1985. TOGA's unique, interpretive program improves performance and asset protection through:

- Consistent sample extraction
- Repeatable laboratory analysis
- Accurate results evaluation and trending
- Experienced, actionable intelligence
- Technical guidance for results

Why sample?

Transformer failures can mean more than equipment replacement costs. A breakdown or failure can totally or partially shut a plant down and threaten your competitive edge as your uptime plummets and your revenues are compromised.

For example: Testing the insulating liquid on a 170 MVA generator step-up transformer at a medium-sized coal fired power plant identified abnormal carbon dioxide to carbon monoxide ratios. The test also showed higher than expected temperatures at low-power production loads. This transformer model also had a history of fluid distribution problems resulting in a poorly cooled core. Over time, these higher temperatures would have compromised the insulation, accelerating the rate of aging and reducing the useful life of the transformer.

Instead, a \$20,000 repair was performed during the next scheduled outage. Had this problem not been identified early through

fluid testing, equipment replacement could have cost up to \$1.5 million. Further, if the transformer unexpectedly failed without a ready replacement, it would have shut the unit down for six months with business interruption expense of up to \$10 million.

Transformer failure rates

- 5 to 30 of 1,000 power transformers fail based on IEEE survey
- 5.8 of 1,000 HSB insured transformers fail based on HSB data
- 1.5 of 1,000 TOGA transformers failed from all causes



TOGA, a proven early warning system

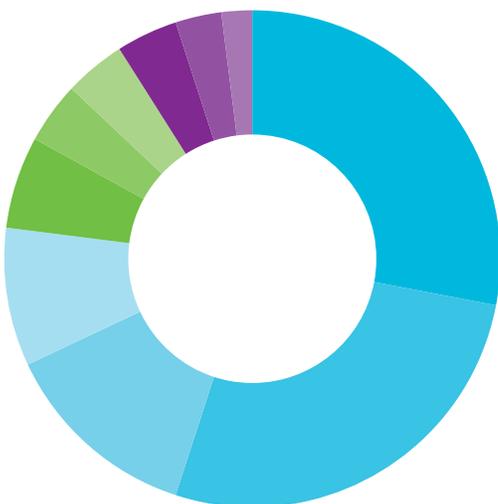
When transformer insulation experiences an electrical or thermal fault, combustible gases become dissolved in the oil. Analyzing the insulating fluid for these gases gives important information of current issues and potential problems. This information can then be used for developing maintenance programs that help prevent costly failures and power interruptions. That's how TOGA acts as an early warning system to help preserve your assets.

Some transformer failures occur without warning while some progress to failure over days, months and years. TOGA gives you tools to help identify failure types and keep your fluid-filled equipment healthy. Analysis of our claims database shows that the TOGA program could have identified about 50% of transformer failures before they occurred.



TOGA detectible

Causes of Transformer Failures		
Name	%	TOGA Benefits
● Electrical Disturbances	28	✓
● Other	27	
● Lightning	13	
● Defective Insulation	9	✓
● Electrical Connection	6	✓
● Overload	4	✓
● Foreign objects	4	✓
● Moisture	4	✓
● Line Disturbance	3	
● Stress/Fatigue	2	



A clearer picture through comprehensive testing

No single test can give a true picture on the condition of your fluid-filled electrical equipment. That's why TOGA uses a number of different testing techniques to accurately identify fluid-filled electrical equipment abnormalities.

Our laboratories are recognized leaders in analysis of insulating fluid and TOGA provides you with the most effective battery of tests for your specific equipment. TOGA also recommends the proper sample frequency needed to monitor your equipment. Using the latest technology, TOGA has the technical capability, experience and the knowledge to enhance your electrical equipment reliability and performance. Our program provides in-depth information about electrical equipment to help users better plan maintenance schedules, avoid unnecessary downtime and better manage capital equipment assets.

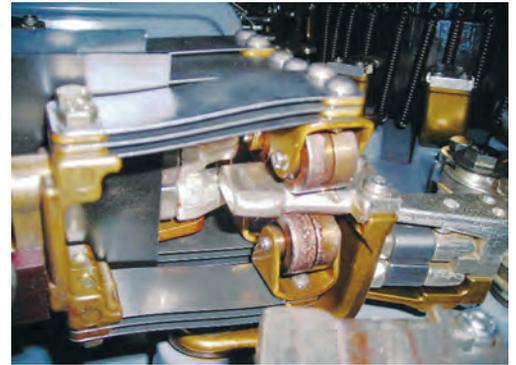
Routine TOGA tests

Dissolved Gas-in-Oil Analysis (DGA) gives an early indication of abnormal behavior of equipment by analyzing the types and quantities of combustible gases dissolved in the fluid. TOGA typically analyzes for hydrogen, oxygen, nitrogen, carbon monoxide, carbon dioxide, methane, ethylene, ethane and acetylene. Certain quantities and combinations of these gases indicate insulation overheating/overloading, liquid overheating, partial discharge (corona), or abnormal arcing or heating inside transformers, load tap changers and oil circuit breakers. For example, the presence of acetylene is typically associated with arcing activity. We use DGA for most insulating fluids like mineral oil, ester based and silicon fluids. Data from a dissolved gas analysis can provide:

- Advance warning of developing faults
- Evidence of improper application of the unit
- Status checks on new and repaired equipment
- Information for use in scheduling repairs

Case study: Overload

An auxiliary transformer which supplies power to plant motors developed a high resistance connection in the de-energized tap changer. A forced outage during the peak generating season is expensive, so TOGA was used to monitor the fault progression. The dissolved gas analysis monitored the active fault until a step change indicated a deterioration in the unit's condition. A plant outage was scheduled, repair parts were ordered, and a successful planned outage repair was completed. A transformer failure would have caused a power plant trip resulting in a multi-day forced outage to repair and reconfigure the electrical system.



Screen testing evaluates the physical, electrical and chemical properties of the insulating fluids like mineral oil, esters and silicon fluids. These tests gage how suitable the insulation liquid is for the intended application.

TOGA's screen tests include:

- Dissipation factor@ 40°C
- Interfacial tension
- Acidity
- Color
- Dielectric strength
- Dissolved moisture
- Specific gravity

Additional fluid tests

Polychlorinated biphenyls (PCBs), furan, and particle count tests, and spectroscopy are used to confirm equipment status or assist with troubleshooting a problem. The corrosive sulfur test stresses the fluid under laboratory conditions. Then an observation is made on copper and paper-wrapped copper strips for the presence of corrosive sulfur.

Metals-in-oil testing analyzes the presence of metals to provide vital information about fault locations and excessive wear in mechanical components. TOGA uses spectroscopy to report metals and contaminants. Furan analysis estimates the degradation of solid insulation. This test can also be used to assess the relative expended life of the transformer insulation.



More than testing, you gain an understanding

Knowing the condition of your equipment not only helps avoid losses, it also helps you work smarter. TOGA's interpretive engineering reports give your maintenance staff the knowledge they need to establish priorities, plan work assignment schedules, arrange outside service, and order parts and materials. Our service includes an interactive web site to help you track:

- Online sample orders
- Online report review for current testing results
- Online view of historical data and trending
- Secure Internet site for your engineers and local maintenance personnel

TOGA can help identify the root causes for transformer failures. Many transformer breakdowns are the result of insulation deterioration. Overheating and internal electrical faults such as arcing or partial discharge (corona) cause transformer insulation to break down over time. Insulating liquid contaminated with moisture and aging byproducts can accelerate the deterioration of the insulation system. We help identify this problem and more to keep your equipment healthy and on-line.

Other services

TOGA® Lube Oil, Hydraulic and Heat Transfer Fluid Analyses

HSB Infrared Thermography Services

Secure superior performance. Gain a competitive advantage. Add technical support to your staff without increasing headcount. Call us toll-free (800) 386-2675 (USA only) or (484) 582-1866.

Visit our website at www.hsbtoga.com for more information.

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NOT IF, BUT HOW