

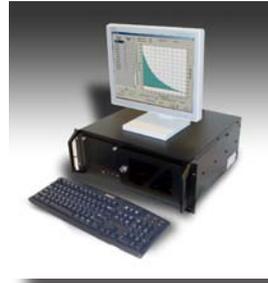
## Services & Products for Power Transformers

MISTRAS Group Inc., has been a leader in the evaluation of Power Transformers for over 20 years. Over the years we have developed state of the art instrumentation and successful test procedures to help maintenance engineers make decisions based on the *actual* condition of equipment.

### *Field Testing of Power Transformers*

We have been continuously improving our field testing services by working together with the Electric Power Research Institute (EPRI) and several US and International utilities. A research project was started for the development of a new Acoustic Emission (AE) technique for the detection and location of gassing sources in Power Transformers and Load Tap Changers. The purpose of the study was to advance state of the art applications for AE technology.

Our approach is to use several Non-destructive Testing (NDT) techniques (acoustic emission, moisture, dissolved gas analysis, high frequency current transducer, oil-quality tests, infrared, vibration and visual inspection). These techniques are applied while the transformer is in service without affecting its operating conditions, *see figure below*.

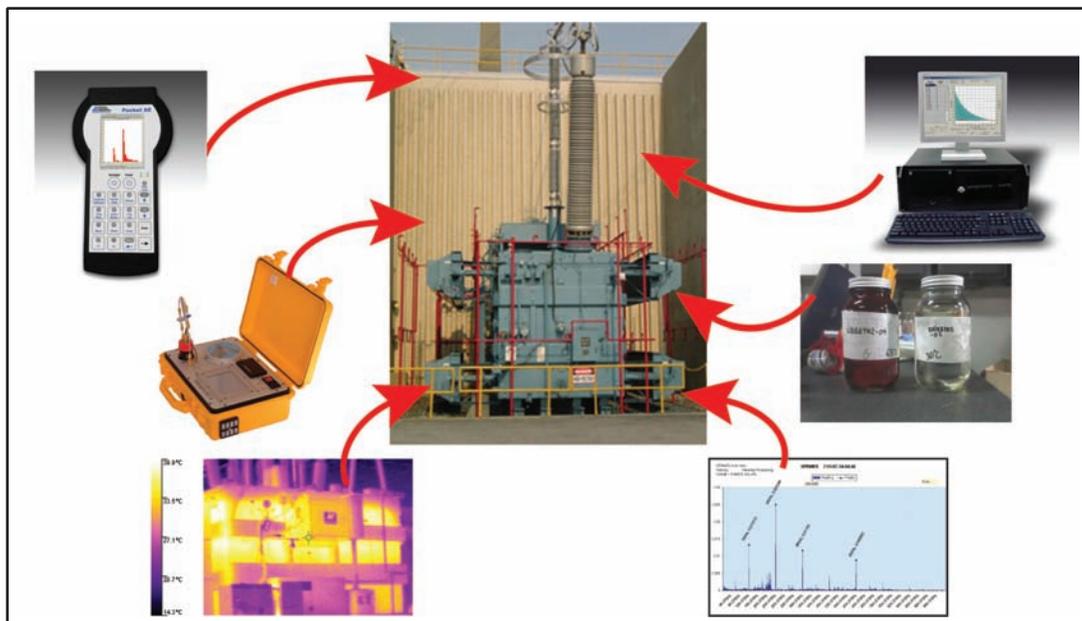


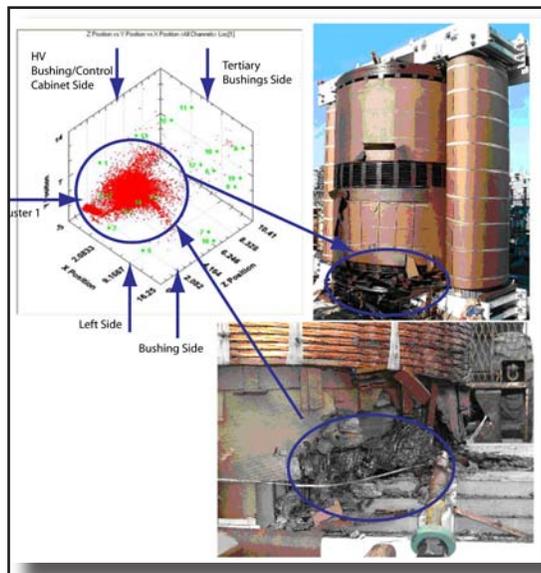
This inspection technique uses a multi-disciplined approach to detect, locate and assess faults. Some faults that can be detected are partial discharge (in service as well as during induced voltage factory testing), overheating on conductors, defects on load tap changer components,

preventive autotransformer compartment, core overheating, arcing, loose connections, etc.

A database and grading system has been developed and continuously updated with several hundred tests. In many cases, internal inspection correlations have been performed (shown in the Core Degradation pictured on the next page). The database and grading system contains data from both Main Tank evaluations as well as Load Tap Changers. The assessment is provided using AE and DGA values with two location algorithms used during testing. They are:

1. All-acoustic (up to 24 acoustic sensors)
2. Electro-acoustic (High frequency current transducer and up to 23 acoustic sensors)





Core Degradation

accelerated aging. In order to reduce these risks, a loading analysis based on IEEE C57.91 STD can be made.

This analysis estimates the hot spot temperature in the winding and the aging rate during the overload. The result of the study is the calculated aging rate of the transformer. The analysis information includes load profiles and operating temperatures for the period of time under analysis.

This analysis can be used:

- To calculate the aging of the transformer over a specific period of time
- To operate the transformer safely during a planned overload
- To verify correct operation of cooling system

This test can be applied for 24 hours evaluating critical units for obtaining trending information on an annual



basis and "on-line nursing" for long term monitoring of transformers.

### Loading Analysis

Loading transformers beyond their nameplate rating is a common practice. These overloads produce high temperatures in the transformer. Operating the transformer under this condition involves several risks, such as bubble formation, permanent deformations in metallic structure, oil leaks due to thermal expansion, CO and CO<sub>2</sub> formation from cellulose degradation and



Pocket AE - Power System

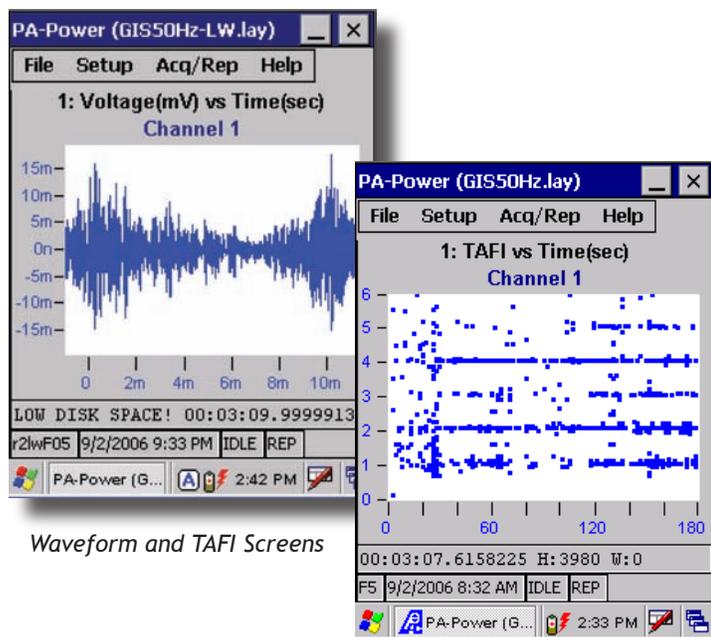
### Products

Our advanced instrumentation is designed, developed and manufactured in our Princeton Junction, NJ headquarters. Leading edge technology is used for the production of these products for the inspection of power transformers.

#### Pocket AE™ Power

The Pocket AE™ Power System is a portable acoustic emission system (one or two channels) that can be used as a screening tool to perform time-based inspections in power transformers as well as other high voltage equipment such as Gas Insulated Substations, Instrument Transformers, Circuit Breakers, Cable Splices, etc.

Specialized software (PDDMate™) has been developed and integrated to aid the Test Engineer in identifying if the source detected by acoustic emission is synchronized with the voltage determining if the fault detected is electrical in nature, see Waveforms and TAFI Screens on next page. This unit is a battery operated portable, handheld unit.



Waveform and TAFI Screens

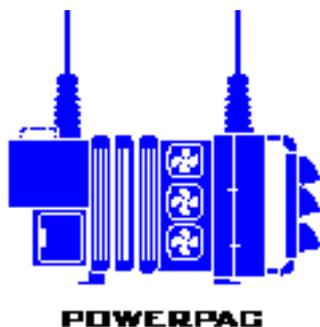
### Multi-Channel AE System

High Speed Acoustic Emission instruments with capability to handle up to 24 piezoelectric sensors and several 4-20 mA inputs for (for temperature, currents, voltages, etc.) are used in the field and/or test floor to evaluate power transformers.

This system is portable and designed to be used in high voltage environments. Data acquisition software includes our specialized three dimensional location software for the detection and location of faults within the transformer.

### Technology Package PowerPAC™

PowerPac™ is an Acoustic Emission technology package for testing power transformers. Developed under an EPRI sponsored tailored collaboration, this package is designed to provide on-line monitoring of power transformers to detect, locate and assess electrical and thermal faults. It contains state of the art hardware and software (data acquisition, post-test filtering analysis and PowerPAC™ database and grading system) designed for AE testing on power transformers.



Classroom and hands-on training is included to facilitate immediate use of the technology. Up to date EPRI reports, case studies and publications are included with this package as well as remote and on-site consulting time.

### On-line Monitoring

AE On-line Monitoring provides plant personnel the ability to detect anomalies or faults at an early stage, and plan action.



Sensor Highway II -Power

### Sensor Highway II™ - Power

The Sensor Highway II has been developed for unattended use in "Asset Integrity Monitoring" management and condition monitoring applications. The system is capable of operating in extreme weather as well as factory conditions.

The key feature of the Sensor Highway II™ System is its highly flexible sensor fusion interface for input and processing of many different sensors. The system transmits data from AE sensors, accelerometers, and various sensors with current and voltage outputs.

The Sensor Highway II™ has several communication interfaces available for data communication and remote control. The principal interface is its Ethernet 10/100 (and optionally, wireless Ethernet). Other available interfaces include Telephone and Cell Phone modem. A personalized, password protected webpage is created where the customer can access the data at anytime.



On-site



Control Room



### Wireless Technology

Physical Acoustics offers wireless and hard-wired plant and structural integrity monitoring using acoustic emission measuring techniques.

We have designed and developed the first acoustic emission wireless sensors. These sensors can be arranged to form a wireless mesh network and be used to monitor power transformers, instrument transformers, gas insulated substations, breakers etc.

### Training

Transformer Condition Assessment training courses are available at our corporate office in Princeton Junction, or can be held at a location of your selection.

To find out more about power equipment applications, contact us at 609-716-4000 or email:

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or visit:

[www.mistrasgroup.com/substations](http://www.mistrasgroup.com/substations)

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