



DESIGNING INNOVATIVE VACUUM
GAUGES AND CONTROLLERS FOR
OVER 30 YEARS

APPLICATION NOTE TRANSFORMER OIL PURIFICATION WITH: BULLSEYE PRECISION GAUGE

ABSTRACT: Transformer oil purification is often composed of filtering and applying a vacuum to the transformer oil, typically in some kind of rig that maximizes surface area. The vacuum enables the water and other gas contaminants to be purged from the oil, improving its effectiveness as a dielectric and minimizing the risk of transformer deterioration caused by impurities.

When enough water enters a transformer over time (4% moisture by dry weight [m/dw]), it is in danger of flashover (arcs/sparks) if the temperature rises to 90°C. Each time the moisture is doubled in a transformer, the life of the insulation is cut by one-half. For vacuum rated transformers, a Bullseye Precision Gauge® can be used for the basic transformer dry-out service.



INTRODUCTION: It is generally accepted that water in oil contamination (even at microscopic levels) is the cause of more electrical breakdowns than any other impurity. Water is a polar liquid, which has a high electric permittivity* or dielectric constant, therefore it is attracted to areas of strong electric fields. For this reason, the internal moisture in transformer oil tanks is not distributed uniformly, but potentially concentrating in the most dangerous parts of the system.

* <http://www.britannica.com/EBchecked/topic/452314/permittivity>

How does water get introduced into the oil?

- Leaking gaskets,
- Poor handling techniques
- From the product of natural insulating paper and oil degradation
 - As the paper degrades, it produces Carbon Dioxide and Water
 - As the insulating oil ages, water, acids, sludge and other polar compounds are formed

So the presence of water in the oil tanks is inevitable during the normal service life of a transformer. Water, especially in the presence of oxygen, is a contaminant that reduces the oil's dielectric (insulation) properties and can lead to a dangerous situation.

There are 5000-7000 pounds of paper insulation in a typical large power transformer operating at a substation. At 2.5% m/dw and above, paper insulation is degrading at a much faster than normal rate. As paper is degraded, the transformer becomes even wetter and decays even faster. When a transformer gets above 4% m/dw, it is in danger of flashover (arcs/sparks); especially if the temperature rises to 90°C or above. Once a transformer reaches 2.5% moisture by dry weight (m/dw) or 30% oil saturation, it should have a dry-out if it is rated for vacuum.

DANGERS OF TRANSFORMER OIL WATER CONTAMINATION

It has been proven that insulating paper with 2% moisture content ages three times faster than one with 1% moisture and thirty times faster with 3% moisture.

It is thus easy to see the importance of maintaining low moisture levels within a transformer to ensure a long and trouble free service life.

For vacuum rated transformers, a Digivac Bullseye Precision Gauge can be used for dry-out service. This is done by applying vacuum to a transformer after the dielectric oil has been removed. A rule of thumb is that when the transformer gets below 100 microns, the water has been sufficiently removed. This process may take days.

UNDERSTANDING THE PRODUCT DESIGN: The Bullseye Precision Gauge is designed to meet the demands of field use. It has a 70-hour battery life, rugged, rubber boot, a magnet for hands-free use, and an integrated stand. It operates on the principle of indirect pressure measurement, where it senses the cooling of the surrounding gases. The less gas (the lower the pressure), the hotter the thermocouple gets and vice versa. This temperature is correlated to a pressure for air, nitrogen, and other similar gases.

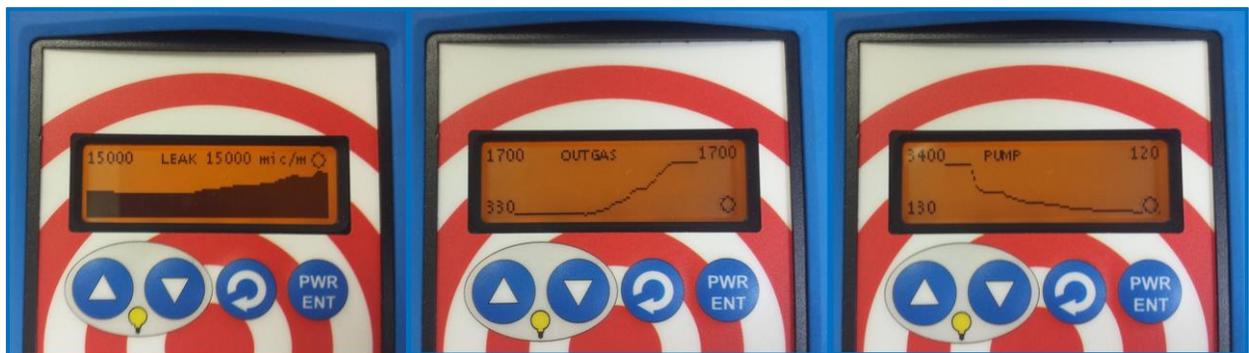
FLEXIBILITY OF APPLICATION: Besides the basic vacuum reading, the Bullseye Precision Gauge gives pump down statistics and a graph to let you know the rate of the pump down, which is especially useful to diagnose a potential leak or problem with the trend.

Drop Test: A transformer service might involve a drop test where you would pump the transformer down from Atmospheric pressure to about 1 Torr, and observe the leak rate.

A 150 micron leak rate may be OK, but a 1 torr leak in 20 minutes may not be. The graphical trending feature of our field gauge enables a technician to see the vacuum rise or fall over time, and easily interprets those trends with vacuum analytics.



BULLSEYE PRECISION GAUGE | VACUUM ANALYTICS GRAPHICS



Remote Monitoring: The Bullseye Precision Gauge is available with an optional Bluetooth feature, which enables a technician to see what the reading is and log data, regardless of where the sensor and display are placed. The option includes an app that can be downloaded to your phone so that you can track the pump down process over time. This is especially useful since this process can take days to complete.

For permanent installations, a DigiVac Model 215V is ideal for measuring vacuum in an oil purification rig. This product includes fail-safe controls that automatically default to atmospheric pressure if power or gauge failure occurs – a must have for interlock or load lock applications.

PRODUCT PERFORMANCE: The Bullseye Precision Gauge is designed to be rugged, accurate, and repeatable for years of consistent and reliable service.

This field gauge:

- Can operate in extreme weather conditions (-14°F to 120°F)
- Incorporates thermocouple passive sensor technology, which has proven reliability in field operations
- Has the ability to be calibrated in the field, and the sensor can be cleaned or replaced. Check out our video on [how to clean a dirty sensor](#)

Each Bullseye Precision Gauge is manufactured in the USA, and is calibrated under real vacuum using a NIST standard.



Because transformers don't just require service when the weather is nice | You need a field gauge that can perform under extreme circumstances

SUMMARY

The [Bullseye Precision Gauge](#) is ideal for the transformer oil purification application, due to its unique vacuum analytics and optional Bluetooth connectivity for remote monitoring, logging, and trending of data.

DigiVac Thermocouple Gauges are designed to meet the demands of field use, where: ruggedness, repeatability, and accuracy are required to get the job done.

Visit our website to discover other product [applications for the Power Industry](#) manufactured by DigiVac.

We would love to hear how you are utilizing one of our products. How can we serve your needs?