

## DIAGNOSTIC CHANGES

When appropriate, Weidmann Diagnostic Solutions (WDS) utilizes industry-accepted standards when presenting diagnostic interpretations for Dissolved Gas-in Oil (DGA) and Oil Quality tests. These are consensus guidelines which are reviewed and revised at regular intervals. When the guidelines are revised WDS will review those revisions and if necessary revise the diagnostic interpretations that we offer to our clients.

### Dissolved Gas-in Oil

#### Key Gas Interpretation

The key gas diagnostics are based on the gases listed in IEEE C57.104-1991 "Guide for the Interpretation of Gases Generated in Oil-Immersed Transformers" Section 4.5. In Figure 3 the key gases; Ethylene, Carbon Monoxide, Hydrogen, and Acetylene are listed along with relative proportions which indicate general fault conditions. WDS Gas threshold levels are taken from IEEE C57.104-1991 Table 1 with the exception of Acetylene. It is the industry consensus that the levels of Acetylene given in Table 1 are too high. Any indication of Acetylene in a transformer is a matter of concern. WDS has established the following levels for Acetylene:

<u>C57.104-1991 Code</u>	<u>Acetylene Level</u>
Condition 1	$\leq 2$ ppm
Condition 2	$> 2$ ppm $< 5$ ppm
Condition 3	$\geq 5$ ppm $\leq 8$ ppm
Condition 4	$> 8$ ppm

The key gas threshold levels should be used when there is no historical data available to calculate gas generation rates. IEEE C57.104-1991 gives diagnostic recommendations based on the rate of Total Dissolved Combustible Gas (TDCG) generation.

#### Rogers Ratio

Calculation and interpretation of Rogers Ratios is taken from IEEE C57.104-1991. These ratios can be used to indicate the type of fault.

#### Cellulose (paper) Insulation

The ratio of  $\text{CO}_2/\text{CO}$  is used as an indicator of the thermal degradation of cellulose. The ratio for normal cellulose degradation is from 7 to 10. WDS incorporated minimum threshold levels of 500 ppm for CO and 5000 ppm for  $\text{CO}_2$ . One of these threshold values must be met before the ratio of  $\text{CO}_2/\text{CO}$  is evaluated. These threshold levels avoid misinterpretation of this ratio at low gas levels.

#### Condition Codes

The condition codes, which include recommended operating procedures and sampling intervals are based on gas generation rates and are taken from IEEE C57.104-1991 Table 3.

#### Silicone Fluid Diagnostics

The silicone fluid diagnostics are taken from IEEE C57.146-2005.

#### ■ Weidmann Diagnostic Solutions Inc.

One Gordon Mills Way · PO Box 799 · St. Johnsbury, VT · 05819-0799 USA  
Phone 802 748 3936 · Fax 802 748 8630  
Internet: [www.weidmann-diagnostics.com](http://www.weidmann-diagnostics.com)

## Insulating Fluid Diagnostics

Weidmann Diagnostic Solution's oil quality diagnostics are referenced to IEEE C57.106-2006, "Guide for Acceptance and Maintenance of Insulating Oil in Equipment". In the previous 2002 revision of IEEE C57.106, the limits for water content were given in % Saturation at the Top Oil temperature and the values were calculated based on the following recommended maximum moisture contents in the cellulose insulation based on voltage class.

Recommended Moisture Content in Cellulose (ref. Table 4B C57.106-2002)

<u>Voltage Class</u>	<u>Moisture Content</u>
≤ 69kV	3% Maximum
>69 - < 230 kV	2% Maximum
230 kV and greater	1.25% Maximum

In 2006 IEEE C57.106 was revised specifically to reverse this change. The relationship between % Saturation in oil and the moisture content in the solid insulation is ONLY valid if the insulation system is in equilibrium. The argument from the IEEE working group that revised this standard was that because moisture content time constants can be from days to weeks, a transformer is rarely in equilibrium, therefore the conversion from % saturation to moisture in the cellulose should not be used to set limits for acceptable moisture levels in the oil.

The present version is IEEE C57.106-2006. This revision has gone back to the moisture levels in Table 6 "Suggested Limits for Continued Use of Service-Aged Insulating Oil (Grouped by Voltage Class)". Weidmann Diagnostics Solutions has revised our oil quality diagnostics to reference this current revision of the standard. Therefore, we have removed the calculation for % Saturation and we are using the moisture content of the oil (as measured in ppm) for diagnostics.

IEEE C57.106-2006 gives different suggested limits for oil quality tests depending on the status of the oil; New bulk oil, Oil Processed in a transformer prior to energization, and Oil from units in service. Weidmann Diagnostic Solutions has created a data field on our Sample Data Sheets for our clients to indicate what category the oil belongs to which is being tested. Please fill in this data so that we can use the proper diagnostic levels suggested in the standards.

As always, Weidmann Diagnostic Solutions encourages input from our clients regarding the format of our reports. Please feel free to contact your local WDS Laboratory Manager with any comments or suggestions. You may wish to visit the IEEE website, [www.ieee.org](http://www.ieee.org) to order the most current industry standards as well.



Thomas A. Prevost  
VP Technology, Diagnostics & Monitoring