

REAL Services

RELIABILITY ENGINEERING ANALYTICAL LABORATORY

The patented **LTC³ Technology** is the first technology developed since the 1960's for testing of electrical transmission & distribution equipment for "Equipment Condition".

Load Tap Changers

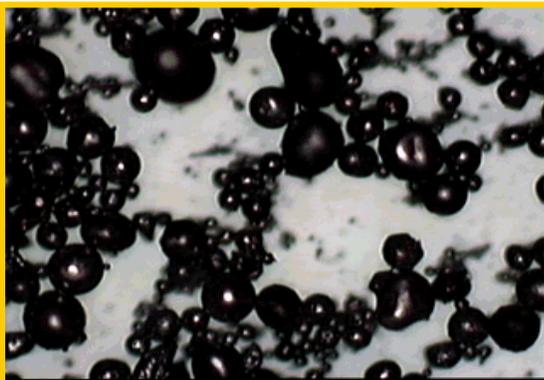
Transformers

Circuit Breakers

Reactors & Switches



Easy & Quick Sampling



Clear & Accurate Analysis

U.S. Patents -

6,691,557 & 6,928,861

The use of liquid-filled power transfer equipment is widespread in the electrical utility industry. These devices, including but not limited to transformers, load tap changers, tap changers, circuit breakers, off-load tap changers, on-load tap changers, switches, and the like, are usually filled with a dielectric insulating liquid. Liquids include natural petroleum hydrocarbons, synthetic hydrocarbons, biodegradable and non-hydrocarbon fluids.



LTC³ Technology provides monetary savings from the start. Providing comparable quantitative and qualitative data for the typical 14 tests everytime a sample is submitted for testing and analysis. **LTC³ Technology** provides relevant information about your capital investment, the T&D Equipment.



Rewarding Results



.... Raising T&D Equipment Condition Testing to a Higher Power.™



Cutting edge technology developed exclusively for the power industry, allows REAL Services' testing to determine the T&D "EQUIPMENT CONDITION" going beyond the "Fluid Condition".

REAL Services
RELIABILITY EVALUATION ANALYTICAL LABORATORY

T&D EQUIPMENT CONDITION

U.S. Patents 6,691,557 / 6,928,861
Protected by U.S. Patent 6,691,557

REAL BIG WATER & POWER
Portage Trail Substation
Cuyahoga Falls, OH

CRITICAL

CRITICAL

Sample ID: PWP-C-03422-5-1-LTC
Equip. Desc.: C-03422-5-1; Load Tap Changer
Lubricant Type: Shell Dalina
Reservoir Cap.: 345.00 Gal(s) 1,305.83 Ltr(s)
Operations: 7,362
Lube Time: Not Provided Hr(s)

Sample Date: 4/25/2004
Received Date: 4/28/2004
Test Date: 4/30/2004
Prev. Sample: 2/14/2004
First Sample: 3/1/2004
No. Samples: 4

Date: 4/25/2004
Date: 4/28/2004
Date: 4/30/2004
mple: 2/14/2004
mple: 3/1/2004
mple: 4

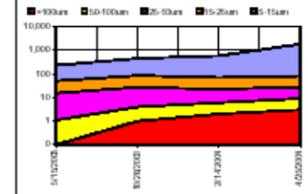
increase of resistive material, spounds, sulfur and coking, ation.

Recommendation(s): Consider efforts to schedule this unit for maintenance action in the near future. Specifically, inspect contacts for electrical discharge, secure loose mounting hardware and reduce water contamination. CHANGE OR FILTER FLUID to reduce water and coking contamination. CHECK contact tension to ensure it is within O.E.M. specifications. RESAMPLE equipment to verify the generation of electrical discharge properties.

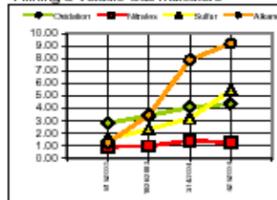
Discussion of Test Results: The equipment particle concentration (EPC) has increased for this equipment from 581 to 1,826, this EPC level remains well within acceptable limits for this type of equipment. Analytical results show a high concentration of Ferrous metal particles. These metal particles are from the Load Tap Changer (LTC) mounting hardware. The movement of this hardware has resulted in the electrical discharge to surrounding components. Indication of the electrical discharge is from the generation of Spheres. The electrical discharge is supported by the increasing concentration of Coking and Filming compounds. Analysis also show particles in the 50 micrometer (um) range along with 120um cutting wear indicating wear on the switch shaft. The Filming compounds can be quantified in terms of Coking at 78 ppm, Oxidation at 4.37 Abs/cm, Nitration at 1.26 Abs/cm, Sulfur at 5.43 Abs/cm. Volatile and explosive compounds in the form of Alkanes have continue to increase from 3.45 to 7.89 to 9.20 Abs/cm. This elevated levels is of great concern and can lead to ignition by the internal electrical discharge.

QUANTITATIVE TESTING:

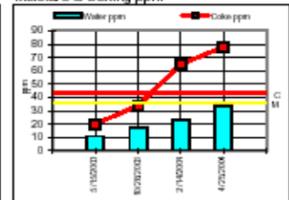
NAS-1638 Particle Count



Filming & Volatile Gas Indicators



Moisture & Coking ppm



QUALITATIVE TESTING:

Ferrous Metal Erosion:

Classification	1	5	10	µm	Max
Resonance / Fatigue	0	0	0	15	< 15
Severe Sliding	0	0	0	60	60
Cutting/Flowing	0	0	0	120	120
Rolling	0	0	0	> 5	> 5
Spheres	0	0	0	> 5	> 5
Impaction	0	0	0	> 5	> 5
Black Oxides (Fe ₃ O ₄)	0	0	0	N/A	N/A
Red Oxides (Fe ₂ O ₃)	0	0	0	N/A	N/A
Corrosive (Fe ₂ O ₃)	0	0	0	N/A	N/A
Other	0	0	0	N/A	N/A

Non-Ferrous Metal Erosion:

Classification	1	5	10	µm	Max
Resonance / Fatigue	0	0	0	15	< 15
Severe Sliding	0	0	0	60	60
Cutting/Flowing	0	0	0	120	120
Rolling	0	0	0	> 5	> 5
Spheres	0	0	0	> 5	> 5
Impaction	0	0	0	> 5	> 5
Oxides	0	0	0	> 5	> 5
Other	0	0	0	> 5	> 5

Non-Metals:

Classification	1	5	10	µm	Max
Filming	0	0	0	N/A	N/A
Sand & Dirt	0	0	0	N/A	N/A
Fibers	0	0	0	N/A	N/A
Plastic/Ceramic	0	0	0	N/A	N/A
Carbon & Organics	0	0	0	N/A	N/A
Other	0	0	0	N/A	N/A

Particle Data	Lube Data
5-15 µm: 1,745	40°C est: 10.0
15-25 µm: 53	Water ppm: 34
25-50 µm: 19	Coke ppm: 78
50-100 µm: 6	Oxidation: 4.37
>100 µm: 3	Nitration: 1.26
EPC: 1,826	Sulfur: 5.43
ISO Scale: 18/13	Alkanes: 9.20

centration of Ferrous metal. Note this indication to show the

n Transmitted



PdM Analyst: NBR

02126

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PdM Analyst: NBR

NORMAL
MARGINAL
CRITICAL

3 - TIERED RATING SYSTEM

REAL Services' revolutionary technology is so powerful one sample can identify specifically equipment, fluid or maintenance related problems.

SAMPLE SUMMARY REPORTS:

For quick reference of sample Rating & Recommendation.

RECOMMENDATION(s):

Clear concise action items and maintenance recommendations.

REPORT FORMAT:

Color and pictorial report format. All data is graphed & trended

QUALITATIVE:

- Paper & Plastic Insulation
- Corrosion
- Coking
- Filming
- Harmonic Resonance Fatigue
- Electrical Arcing or Discharge
- over 23 other Parameters

QUANTITATIVE:

- Filming
- Coking
- Oxidation
- Burning of Insulating Fluid
- Combustible Compounds
- Water
- over 10 other Parameters

REAL Services
RELIABILITY EVALUATION ANALYTICAL LABORATORY

T&D EQUIPMENT SAVE REPORT

U.S. Patents 6,691,557 / 6,928,861

700 Portage Trail Cuyahoga Falls, OH 44221, 3057

REAL BIG WATER & POWER
Portage Trail Substation
Cuyahoga Falls, OH

SAVE

Sample ID: PWP-C-03422-5-1-LTC
Equip. Desc.: C-03422-5-1; Load Tap Changer
Lubricant Type: Shell Dalina
Reservoir Cap.: 345.00 Gal(s) 1,305.83 Ltr(s)
Operations: 65,339
Lube Time: Not Provided Hr(s)

Sample Date: 4/25/2001
Received Date: 5/2/2001
Test Date: 5/4/2001
Prev. Sample: 4/25/2001
First Sample: 4/25/2001
No. Samples: 1

McGraw Edison Load Tap Changer, C-03422-5-1; is one of two-(2) main LTC of the municipality. Dissolved Gas Analysis (DGA) test results indicates NORMAL operation and to sample next year.



LTC³ condition CRITICAL. Recommendation: Schedule this unit for maintenance action. Specifically, inspect and correct electrical discharge and arcing of contact, secure mounting hardware and reduce water contamination to eliminate electrical discharge inside LTC.



Although the equipment particle concentration (EPC) of 269 is well within acceptable limits for this type of equipment, analytical results show a high concentration of Ferrous metal erosion debris. These metal particles are from the LTC mounting hardware. The movement of this hardware has resulted in the electrical discharge to surrounding components and contacts. This image displays the Textites or Spheres (i.e. the Sparks) from electrical discharge.

Note: This was a FIRST time this equipment has been tested.

Upon opening of McGraw Edison Load Tap Changer, C-03422-5-1, contact mounting hardware found to have play and movable by hand. Equipment show signs of electrical discharge and arcing of contacts and internal components.



Secondary Damage: Property Damage and Service Interruption was minimized. Service Interruption & Downtime was minimized. Maintenance scheduled and performed during holiday weekend slow period.

LTC³ optimized equipment performance and savings for the utility, customers and investors.

CUSTOMER ESTIMATED SAVINGS:

Original Component Savings:	1,004,500
Secondary Damage Savings:	24,970
Business Interruption:	37,830
Property Damage:	N/A
Rush Shipping Cost Savings:	15,000
Overtime Repair Savings:	7,196

Total SAVINGS: \$ 1,089,496

REAL Return on Investment: 7,263:1

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PdM Analyst: NBR

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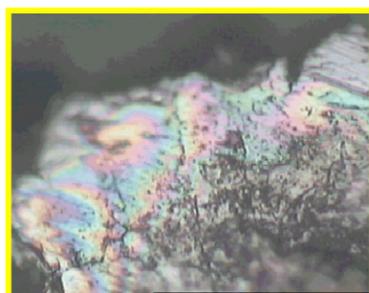
Clear and accurate LTC³ test results allow for the scheduling of maintenance and downtime providing tangible and documented cost savings for the utility, customers and investors.



Test results electronically transmitted directly to your e-mail account.



Outside Contaminants



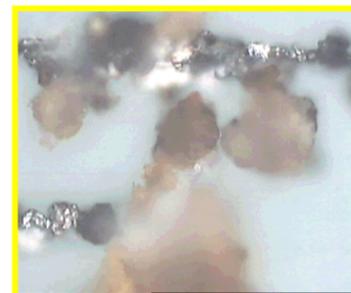
High Heat



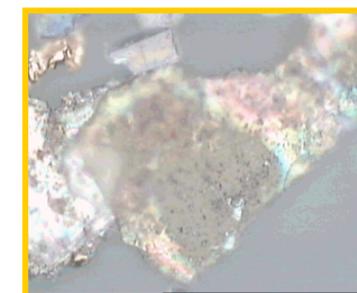
Corrosion



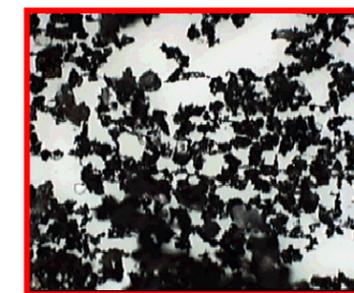
Paper Fiber



Rust



Filming



Coking

Test Comparison Table

REAL Services'

LTC³ Technology easy sampling and one simple test identifies various T&D Equipment problems listed in the test comparison table to the right.

- Explosive Compounds;
- Moisture;
- Coking;
- Filming;
- Insulation Breakdown;
- Electrical Discharge, Arcing, Sparking, Corona
- and much more.

LTC³ Technology testing, diagnosis and analysis works independent of insulating fluids for all T&D Equipment.

- Transformers;
- Load Tap Changers;
- Circuit Breakers;
- Voltage Regulators;
- Reactors and more.

LTC³ revolutionary technology works with all types of insulating oils.

- Petroleum Based Oils
- Synthetic Oils
- Biodegradable Oils
- Non-Hydrocarbons

	D-96	D-1524	D-1500	D-1533	D-974	D-1275	D-3612	D-1816	D-971	D-3635	D-2140	D-5837	D-1197	D-924	LTC ³ Technology
	Sediment	Visual Exam	Color / Appearance	Moisture	Total Acid Number	Corrosive Sulfur	Dissolved Gas Analysis	Dielectric Breakdown	Interfacial Tension	Elemental Analysis	Carbon-Type Composition	Furanic Compounds	Resistivity	Power Factor Draw	
Harmonic Resonance Fatigue	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y
Loose Mounting Hardware	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y
Excessive Contact Load / Tension	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y
Shaft Alignment Problems	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y
Direct Faling / Arcing / Corona	-	-	-	-	-	-	Y?	-	-	-	-	-	Y?	Y?	Y
Corrosion of Tank (FeO)	-	-	-	Y?	Y?	Y	-	-	-	-	-	-	-	-	Y
Outside Contamination	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y
Excessive Heating (Fe ₂ O ₃)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y
Tempering	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y
Burning of Fluid	-	-	Y	-	-	-	-	-	-	-	-	-	-	-	Y
Organic Compounds	-	-	-	-	-	-	Y	-	-	-	-	Y?	-	-	Y
Comustable Compounds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y
Water / Moisture Contamination	-	-	-	Y	-	-	-	-	-	-	-	-	-	-	Y
Rust (Fe ₂ O ₃)	-	-	-	Y?	-	-	-	-	-	-	-	-	-	-	Y
Paper Fiber Insulation	-	-	-	-	-	-	Y?	-	-	-	-	Y	-	-	Y
Plastic Insulation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y
Coking / Carbon Residue	-	-	-	-	-	-	-	Y?	Y?	-	Y	-	Y?	Y?	Y
Filming	-	-	-	-	-	-	-	Y	Y	-	-	-	Y?	-	Y
Sand & Dirt	Y	Y	-	-	-	-	-	-	-	-	-	-	-	-	Y
Metallurgy	-	-	-	-	-	-	-	-	-	Y?	-	-	-	-	Y
Qualitative Data	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y
Composition	-	-	-	-	-	-	-	-	-	Y	-	-	-	-	Y
Equipment Problems	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y
Fluid Problems	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y
Maintenance Problems	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y
Earliest Possible Warning	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y
Schedual Maintenance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y
Schedual Downtime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y
Meaningful & Direct Results	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y
Easy to Understand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y
Data Graphed & Trended	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y

Faults and resulting degradation of insulating fluids occur during the operation of liquid-filled electric power transfer equipment in the utility industry. These failures may be detected by using a complex series of tests collectively ranging in price from \$600-\$1,200/sample. While dissolved gas analysis is helpful, other tests such as sediment, visual exam, moisture, corrosive sulfur, interfacial tension, total acid number, color, carbon-type composition, dielectric breakdown, power factor, resistivity, elemental analysis and furanic compounds can only hope to identify problems.

LTC³ Technology: 1-test provides comparable data for all of the tests above at a fraction of the cost.

800.483.R₇E₃A₂L₅

www.REALServices.com

GOD Bless America



Your local representative for **REAL Services:**

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REAL Services' has a policy of being environmentally conscientious. All wastes, including used fluids, are disposed of using companies that are certified by the U.S. Environmental Protection Agency as complying with the strictest state and/or Federal guidelines for recycling of these materials.