

# REAL Services

**RELIABILITY ENGINEERING ANALYTICAL LABORATORY**

**REAL Services** is the most comprehensive PdM Laboratory with practical experience relating Equipment Particle Analysis (Ferrography) and Used Lubricant Analysis for capital equipment reliability assessment to provide a return on investment of your PM Program.

**Equipment Condition**

**Fluid Condition**

**Reliability Centered Maintenance**



**QUICK & EASY SAMPLING**



**CLEAR & ACCURATE ANALYSIS**

**Fluid Condition:**

**REAL Services** sample testing includes quality control and cleanliness of Lubricants & Fluids for petroleum products, synthetic hydrocarbons, biodegradable fluids, non-hydrocarbon fluids, water glycols, emulsions and greases.

**What is your equipment really producing?<sup>TM</sup>**

**Equipment Condition:**

Your concern is for that capital investment, the equipment. How your equipment is operating and more importantly how it will continue to operate. **REAL Services'** testing & analysis allows you to focus on the root cause; provides tangible monetary savings from the start.

**What does your PM Program mean?<sup>TM</sup>**



**REWARDING RESULTS**

Cutting edge technology developed for the Department of Defense, allows REAL Services' testing to determine the "EQUIPMENT CONDITION" going beyond mere Oil Analysis or "Fluid Condition". All at an affordable price.

**NORMAL**  
**MARGINAL**  
**CRITICAL**

## 3 - TIERED RATING SYSTEM

700 Portage Trail, Cuyahoga Falls, OH 44221-3057  
800.483.R.E.A.L., 330.630.3700  
Gregory Power Partners, Sherwin Alumina, Gregory, TX

**MARGINAL**

**SAMPLE SUMMARY REPORTS:**  
For quick reference of sample Rating & Recommendation.

**CONDITION REPORTS:**  
For quick reference of sample Rating & Recommendation.

**REFERENCE SAMPLE:**  
Data from a virgin reference sample is shown on report for comparison.

**RECOMMENDATION(s):**  
Clear, concise action items and maintenance recommendations.

**REPORT FORMAT:**  
- Color and pictorial report format.  
- All data is graphed & trended.

**QUALITATIVE:**  
- Particle Size, Shape & Composition  
- Severe Sliding Wear  
- Cutting/Plowing & Alignment Wear  
- Rolling Contact & Bearing Wear  
- Gear & Fatigue Wear  
- Metallurgical Information  
- Metal Oxides & Tempering  
- over 23 other Parameters

**QUANTITATIVE STANDARDS:**  
- NAS-1638 Particle Count  
- ISO-11500 Particle Count (optional)  
- AS4059 Partical Count (optional)  
- ISO-4406 2 or 3 Digit Code  
- NAS & SAE Codes (optional)  
- ISO-4407 Manual Particle Count  
- ASTM-D-445 Viscosity  
- ASTM-D-7418 FT-IR Analysis  
- ASTM-D-5185 Spectrochemical-23  
- Equipment Particle Concentration

Sample ID: GPP-297228  
Equip. Desc.: GTG 1A; Gas Turbine  
Lubricant Type: Chevron GST-32  
Reservoir Cap.: 6,200.00 Gal(s) 23,467.00 Ltr(s)  
Machine Time: 72,874.0 Hr(s)  
Lube Time: 1,587.6 Hr(s)

Sample Date: 6/30/2013  
Received Date: 7/9/2013  
Test Date: 7/10/2013  
Prev. Sample: 5/12/2013  
First Sample: 4/9/2001  
No. Samples: 137

**Recommendation(s):**  
CHANGE OIL to correct LOW viscosity and reduce high Iron, Nitration and Solvent levels. Oxidation levels have continue to increase from 0.61 to 2.87 to 4.89 Abs/cm, Nitration levels increased from 0.00 to 6.10 Abs/cm. Sulfates increased from 0.88 to 1.07 Abs/cm and Solvent levels 0.00 to 1.31 to 11.11 Abs/cm. Moisture contamination has increased slightly from 433 to 464 ppm.

### PHYSICAL PROPERTIES

Sample Date(s)	02/10/13	03/31/13	04/24/13	05/12/13	06/30/13	REF
Viscosity D-445	30.73	30.40	29.01	27.57	25.54	31.00
Water-IR	Neg	456	515	433	464	≤500
D-974 TAN mgKOH	0.01	0.08	0.14	1.50	2.12	≤2.00
D-1500 Color	2.0	0.0	1.0	1.5	2.0	≤2.0
D-92 Flash °F	415°F	410°F	405°F	390°F	375°F	≥400
D-2272 R-BOT min.	N/P	2,468	N/P	N/P	1,560	≥500
D-130 Cu Corrosion	N/P	1A	N/P	N/P	1B	1B

### ASTM-D-7418 FT-IR ANALYSIS

Oxidation Abs/cm	0.70	1.54	0.61	2.87	4.89	≤1.00
Nitration Abs/cm	0.21	1.56	0.31	0.00	6.10	≤0.40
Sulfates Abs/cm	0.61	1.03	0.17	0.88	1.07	≤0.10
Solvents Abs/cm	0.75	0.52	0.00	1.31	11.11	≤0.10

### ASTM-D-5185 ELEMENTAL ANALYSIS

WEAR ELEMENTS (ppm)	02/10/13	03/31/13	04/24/13	05/12/13	06/30/13	REF
Iron <sup>56</sup> (Fe) <sub>95.8</sub>	1	2	2	1	87	0
Chromium <sup>52</sup> (Cr) <sub>51.9</sub>	0	0	0	0	0	0
Aluminum <sup>27</sup> (Al) <sub>26.9</sub>	0	0	0	0	57	0
Copper <sup>63</sup> (Cu) <sub>63.5</sub>	0	0	0	0	34	0
Lead <sup>207</sup> (Pb) <sub>207.2</sub>	0	1	2	0	11	0
Tin <sup>118.7</sup> (Sn) <sub>118.7</sub>	0	1	1	0	8	0
Silver <sup>107.8</sup> (Ag) <sub>107.8</sub>	0	0	0	0	0	0
Nickel <sup>58.7</sup> (Ni) <sub>58.7</sub>	0	0	1	0	0	0
Indium <sup>114.8</sup> (In) <sub>114.8</sub>	0	0	0	0	0	0
Antimony <sup>121.7</sup> (Sb) <sub>121.7</sub>	0	0	0	0	0	0

### ADDITIVE PACKAGE ELEMENTS (ppm)

Molybdenum <sup>95.9</sup> (Mo) <sub>95.9</sub>	0	1	1	0	0	0
Magnesium <sup>24.3</sup> (Mg) <sub>24.3</sub>	0	0	0	0	12	0
Calcium <sup>40.0</sup> (Ca) <sub>40.0</sub>	0	0	0	1	6	147
Barium <sup>137.3</sup> (Ba) <sub>137.3</sub>	0	0	0	0	0	115
Phosphorous <sup>30.9</sup> (P) <sub>30.9</sub>	0	0	268	159	485	597
Zinc <sup>65.3</sup> (Zn) <sub>65.3</sub>	98	0	1	1	0	651

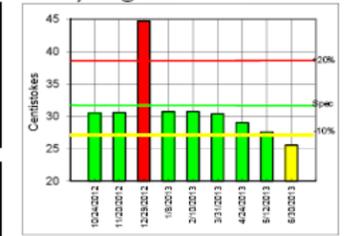
### CONTAMINANT ELEMENTS (ppm)

Sodium <sup>22.9</sup> (Na) <sub>22.9</sub>	0	0	0	0	0	0
Silicon <sup>28.0</sup> (Si) <sub>28.0</sub>	0	1	0	0	0	0
Potassium <sup>39.0</sup> (K) <sub>39.0</sub>	0	0	0	0	0	0
Boron <sup>10.8</sup> (B) <sub>10.8</sub>	0	0	0	0	0	0

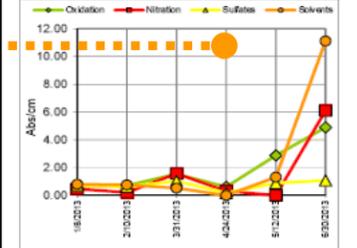
### TRACE METAL ELEMENTS (ppm)

Vanadium <sup>50.9</sup> (V) <sub>50.9</sub>	0	0	0	0	1	0
Titanium <sup>47.9</sup> (Ti) <sub>47.9</sub>	0	0	0	0	0	0
Cadmium <sup>112.4</sup> (Cd) <sub>112.4</sub>	0	0	0	0	0	0

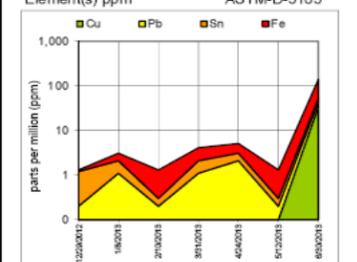
### Viscosity cSt @ 40°C ASTM-D-445



### FT-IR Abs/cm ASTM-D-7418



### Element(s) ppm ASTM-D-5185



Sample ID: GPP-297228  
Equip. Desc.: GTG 1A; Gas Turbine  
Lubricant Type: Chevron GST-32  
Reservoir Cap.: 6,200.00 Gal(s) 23,467.00 Ltr(s)  
Machine Time: 72,874.0 Hr(s)  
Lube Time: 1,587.6 Hr(s)

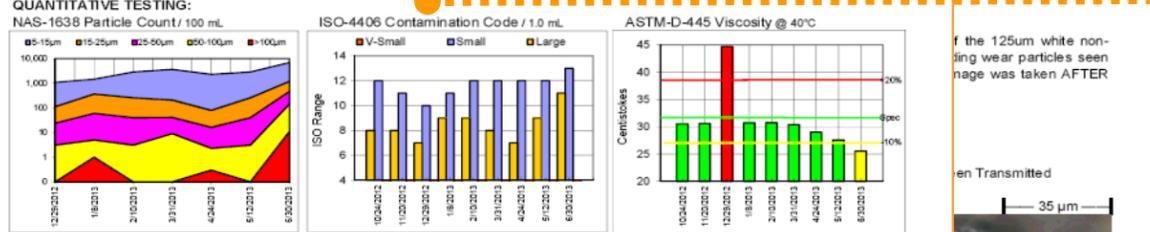
Sample Date: 6/30/2013  
Received Date: 7/9/2013  
Test Date: 7/10/2013  
Prev. Sample: 5/12/2013  
First Sample: 4/9/2001  
No. Samples: 137

**CRITICAL**

Recommendation(s):  
RESAMPLE this equipment at your earliest possible convenience to verify the generation of Babbiting wear and case hardened steel. Consider scheduling this equipment for maintenance action in the near future. Specifically, possible wiped journal bearing. CHECK OPERATING LOADS & TEMPERATURES to ensure that they are within O.E.M. specifications.

Discussion of Test Results:  
Although the equipment particle concentration (EPC) has decreased for this equipment from 2,845 to 1,581, analytical results show the re-appearance of 45 micrometer (µm) High Carbon (~12%) steel Severe Sliding wear and 125µm case tempered Hardened steel Rolling Contact (Bearing) wear particles. Tempering is the rainbow coloration resulting from elevated temperatures at the critical contact pint. Temperatures at this critical contact point are in the 330°C (626°F) range. Analysis also shows the appearance of 125µm white non-ferrous metal Severe Sliding wear and Black Metal Oxides (Fe<sub>2</sub>O<sub>3</sub>). The white non-ferrous metal particles are most likely Aluminum, however, Chrome, Nickel and Stainless Steel are also other possibilities. These particles are of great concern. These particles are of sufficient size to cause a metal to metal interference with close tolerance components.

Quantitative Testing:  
NAS-1638 Particle Count/100 mL  
ISO-4406 Contamination Code / 1.0 mL  
ASTM-D-445 Viscosity @ 40°C



Classification	1	5	10	µm	Max
Rubbing	1	5	10	15	≤15
Severe Sliding	1	5	10	45	45
Cutting/Plowing	1	5	10	125	125
Rolling Cont (Bearing)	1	5	10	125	125
Spheres	1	5	10	N/A	N/A
Gear	1	5	10	N/A	N/A
Black Oxides (Fe <sub>2</sub> O <sub>3</sub> )	1	5	10	N/A	N/A
Red Oxides (Fe <sub>2</sub> O <sub>3</sub> )	1	5	10	N/A	N/A
Corrosive (Fe <sub>2</sub> O <sub>3</sub> )	1	5	10	N/A	N/A
Other	1	5	10	N/A	N/A

Classification	1	5	10	µm	Max
Rubbing	1	5	10	15	≤15
Severe Sliding	1	5	10	45	45
Cutting/Plowing	1	5	10	125	125
Rolling Cont (Bearing)	1	5	10	125	125
Spheres	1	5	10	N/A	N/A
Gear	1	5	10	N/A	N/A
Oxides	1	5	10	N/A	N/A
Other	1	5	10	N/A	N/A

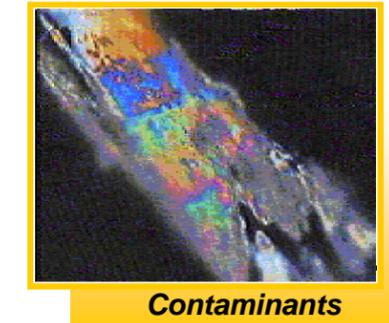
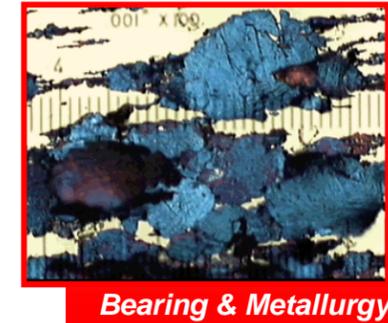
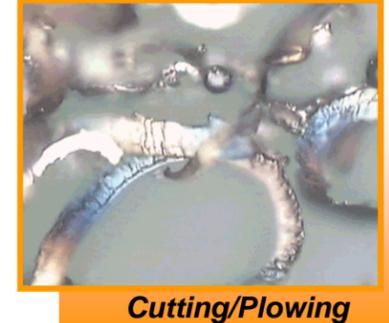
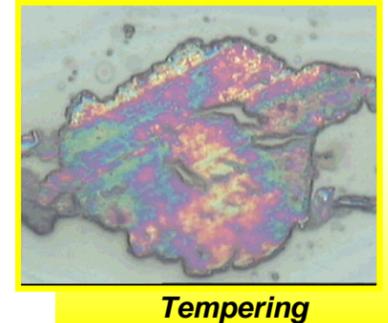
Classification	1	5	10	µm	Max
Filming	1	5	10	N/A	N/A
Sand & Dirt	1	5	10	N/A	N/A
Fibers	1	5	10	N/A	N/A
Spheres	1	5	10	N/A	N/A
Plastic/Ceramic	1	5	10	N/A	N/A
Carbon & Organics	1	5	10	N/A	N/A

Particle Data	Lube Data		
2-5 µm	N/P	40°C cSt	25.54
5-15 µm	5,678	Water-IR	464
15-25 µm	725	D-974 TAN	2.12
25-50 µm	321	D-1500 Color	2.0
50-100 µm	132	D-92 Flash	375°F
>100 µm	11	R-BOT min.	1,560
EPC:	6,867	Cu D-130	1B
PLP	17.3%		
ISO Scale:	N/P		

Reliability Centered Maintenance (RCM) designed to test, analyze and diagnose the "Equipment Condition" allowing for the planning & scheduling of maintenance activates.

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

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



**REAL Services'** easy sampling identifies various equipment problems:

- Alignment Problems;
- Bearing Problems;
- Contamination Problems;
- Filter Problems
- Fluid Related Problems;
- Gear Alignment Problems;
- Over Loading Problems;
- Maintenance Related Problems;

**REAL Services'** testing, diagnosis and analysis works independent of fluids for all equipment:

- Compressors;
- Engines;
- Fans;
- Gear Cases;
- Generators;
- Hydraulic Systems;
- Motors;
- Pumps;
- Transmissions;
- Turbines;
- and much more.

**REAL Services'** testing and technology works with all types of fluids & lubricants:

- Petroleum Based Oils;
- Synthetic Oils;
- Biodegradable Oils;
- Greases
- Non-Hydrocarbons;
- Water Glycol Fluids;
- Fire Retardant Fluids;
- and Emulsions.



# REWARDING RESULTS

**REAL Services**  
RELIABILITY ENGINEERING ANALYTICAL LABORATORY

**EQUIPMENT SAVE REPORT**

700 Portage Trail  
Cuyahoga Falls, OH  
44221.3057

800.483.R<sub>7</sub>E<sub>3</sub>A<sub>2</sub>L<sub>5</sub>      330.630.3700  
Fax: 330.630.3733  
www.REALServices.com

**GREGORY POWER PARTNERS**  
Sherwin Alumina  
Gregory, TX

**SAVE**

Sample ID: GPP-297229  
Equip. Desc.: GTG 1B; Gas Turbine  
Lubricant Type: Mobil DTE-832  
Reservoir Cap.: 6,200.00 Gal(s)    23,467.00 Ltr(s)  
Machine Time: 11,319.0  
Lube Time: 1,206.0 Hr(s)

Sample Date: 11/11/2001  
Received Date: 11/26/2001  
Test Date: 12/5/2001  
Prev. Sample: 4/25/2001  
First Sample: 4/9/2001  
No. Samples: 7

Gas Turbine Generator 1B (297229); is one of three-(3) main turbines for GPP and first rated **CRITICAL** 9/25/2001.

**Recommendation:** Consider scheduling this equipment for maintenance action in the near future. Specifically abnormal Aluminum bearing wear. Compare past performance data with current information.

Although the equipment particle concentration (EPC) has decreased for this equipment from 1,093 to 717 and is within acceptable limits for this type of equipment, analytical results show the presence of 70 micrometer (um) White Non-Ferrous Severe Sliding wear and Cutting wear particles. Testing is also show the presence of 70um Rolling Contact (Bearing) wear particles. The Rolling contact (Bearing) wear show the continued signs of tempering or rainbow coloration from elevated temperatures at the critical contact point. The Aluminum is the Babbiting from the Journal Bearing.

Upon opening of Gas Turbine Generator 1B (297229); the journal bearing was found with significant striations with Varnish & Lacquer accumulation as result of over heating of the oil. The sleeve is composed of white non-ferrous metal that has been wiped.

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

Optimized equipment performance and savings for the utility, customers and investors.

**CUSTOMER ESTIMATED SAVINGS:**

Original Component Savings:	35,000,000	
Secondary Damage Savings:	0	To Date of Save (12/31/2001):
Business Interruption:	200,000	<b>REAL Return on Investment 13,834 : 1</b>
Property Damage:	0	
Downtime Cost:	200,000	
Overtime Repair Savings:	0	On Entire Program to Date (4/14/2004):
<b>Total SAVINGS: \$ 35,400,000</b>		<b>REAL Return on Investment: 1,834 : 1</b>

02119      Making you PM Program mean ... "Profit Making"™      Experience Since 1985      PdM Analyst    NBR

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

**REAL Services'** experience extends into a wide range of industries:

- |                        |                    |                            |
|------------------------|--------------------|----------------------------|
| - Petroleum Refining   | - Mineral Mining   | - Automotive Stamping      |
| - Chemical Processing  | - Food Processing  | - Pharmaceuticals          |
| - Adhesives & Sealants | - Die Casting      | - Orthopedic & Prosthetics |
| - Injection Molding    | - EDM Machining    | - Natural Gas Transmission |
| - Surgical Appliances  | - Optical Products | - Steel Foundries          |
| - Textile Machinery    | - CNC Machining    | - Motors & Generators      |
| - and many others ...  |                    |                            |

**800.483.R<sub>7</sub>E<sub>3</sub>A<sub>2</sub>L<sub>5</sub>**

**www.REALServices.com**

GOD Bless America



Your local representative for **REAL Services**:

**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.

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