

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.

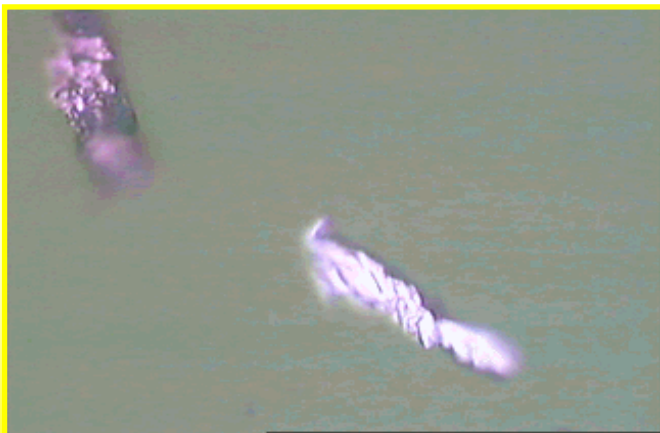
Equipment Condition

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?™

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?™



REWARDING RESULTS

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

NORMAL
MARGINAL
CRITICAL

3 - TIERED RATING SYSTEM

REAL Services
RELIABILITY ENGINEERING & ANALYTICAL LABORATORY

EQUIPMENT PARTICLE ANALYSIS

700 Portage Trail, Cuyahoga Falls, OH 44221-3957
800.483.R.E.A.L., 330.630.3700
Fax: 330.630.3733
www.REALServices.com

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)

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 (Fe₃O₄). 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.

CRITICAL

Date: 6/30/2012
Date: 7/9/2012
Date: 7/10/2012
Date: 5/12/2012
Date: 4/9/2001
Date: 87

Please confirm that the increased wear in this equipment was performed on

of the 125µm white non-ferrous metal particles seen in image was taken AFTER

been Transmitted

REAL Services

PdM Analyst: NBR

QUANTITATIVE TESTING:
NAS-1638 Particle Count / 100 mL

ISO-4406 Contamination Code / 1.0 mL

ASTM-D-445 Viscosity @ 40°C

QUALITATIVE TESTING:
Ferrous Metal Wear:

Classification	1	5	10	µm	Max
Rubbing				≤ 15	
Severe Sliding				45	
Cutting/Plowing					
Rolling Cont (Bearing)				125	
Spheres					
Gear					
Black Oxides (Fe ₃ O ₄)				N/A	
Red Oxides (Fe ₂ O ₃)					
Corrosive (FeO)					
Other					

Non-Ferrous Metal Wear:

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

Contaminants:

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

Particle Data

Particle Size	N/P	40°C cSt	25.54
2-5 µm	N/P	Water-IR	464
5-15 µm	5,678	D-974 TAN	2.12
15-25 µm	725	D-1500 Color	2.0
25-50 µm	321		
50-100 µm	132		
>100 µm	11		

Lube Data

EPC:	6,867	D-92 Flash	375°F
PLP:	17.3%	R-BOT min.	1,560
ISO Scale:	N/P 21 18	Cu D-130	1B

ASTM-D-5185 Spectrochemical-23

WEAR ELEMENTS (ppm)	REF.
Iron ⁵⁶ (Fe) _{25.9}	1 2 2 1 87
Chrome ⁵² (Cr) _{51.9}	0 0 0 0 0
Aluminum ¹³ (Al) _{28.9}	0 0 0 0 67
Copper ⁶³ (Cu) _{65.5}	0 0 0 0 34
Lead ²⁰⁷ (Pb) _{207.2}	0 1 2 0 11
Tin ^{118.7} (Sn) _{118.7}	0 1 1 0 8
Silver ^{107.87} (Ag) _{107.87}	0 0 0 0 0
Nickel ^{58.7} (Ni) _{58.7}	0 0 1 0 0
Indium ^{114.8} (In) _{114.8}	0 0 0 0 0
Antimony ^{121.7} (Sb) _{121.7}	0 0 0 0 0

ADDITIVE PACKAGE ELEMENTS (ppm)

Molybdenum ^{95.9} (Mo) _{95.9}	0 1 1 0 0
Magnesium ^{24.3} (Mg) _{24.3}	0 0 0 0 12
Calcium ^{40.0} (Ca) _{40.0}	0 0 0 1 6
Barium ^{137.3} (Ba) _{137.3}	0 0 0 0 0
Phosphorous ^{30.9} (P) _{30.9}	0 0 268 159 485
Zinc ^{65.3} (Zn) _{65.3}	98 0 1 1 0

CONTAMINANT ELEMENTS (ppm)

Sodium ^{22.9} (Na) _{22.9}	0 0 0 0 0
Silicon ^{28.0} (Si) _{28.0}	0 1 0 0 0
Potassium ^{39.0} (K) _{39.0}	0 0 0 0 0
Boron ^{10.8} (B) _{10.8}	0 0 0 0 0

TRACE METAL ELEMENTS (ppm)

Vanadium ^{50.9} (V) _{50.9}	0 0 0 0 1
Titanium ^{47.9} (Ti) _{47.9}	0 0 0 0 0
Cadmium ^{112.4} (Cd) _{112.4}	0 0 0 0 0

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 (Fe₃O₄). 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.

CRITICAL

Date: 6/30/2012
Date: 7/9/2012
Date: 7/10/2012
Date: 5/12/2012
Date: 4/9/2001
Date: 87

Please confirm that the increased wear in this equipment was performed on

of the 125µm white non-ferrous metal particles seen in image was taken AFTER

been Transmitted

REAL Services

PdM Analyst: NBR

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)
- ISO-4406 2 or 3 Digit Code
- ISO-11171 3 Digit Code (optional)
- ASTM-D-445 Viscosity
- ASTM-D-7418 FT-IR Analysis
- ASTM-D-5185 Spectrochemical-23
- Equipment Particle Concentration
- various other testing available.

REAL Services
RELIABILITY ENGINEERING & ANALYTICAL LABORATORY

USED LUBRICANT ANALYSIS

700 Portage Trail, Cuyahoga Falls, OH 44221-3957
800.483.R.E.A.L., 330.630.3700
Fax: 330.630.3733
www.REALServices.com

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)

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.

MARGINAL

Sample Date: 6/30/2012
Received Date: 7/9/2012
Test Date: 7/10/2012
Prev. Sample: 5/12/2012
First Sample: 4/9/2001
No. Samples: 87

PHYSICAL PROPERTIES

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

WEAR ELEMENTS (ppm)	REF.
Iron ⁵⁶ (Fe) _{25.9}	1 2 2 1 87
Chrome ⁵² (Cr) _{51.9}	0 0 0 0 0
Aluminum ¹³ (Al) _{28.9}	0 0 0 0 67
Copper ⁶³ (Cu) _{65.5}	0 0 0 0 34
Lead ²⁰⁷ (Pb) _{207.2}	0 1 2 0 11
Tin ^{118.7} (Sn) _{118.7}	0 1 1 0 8
Silver ^{107.87} (Ag) _{107.87}	0 0 0 0 0
Nickel ^{58.7} (Ni) _{58.7}	0 0 1 0 0
Indium ^{114.8} (In) _{114.8}	0 0 0 0 0
Antimony ^{121.7} (Sb) _{121.7}	0 0 0 0 0

ADDITIVE PACKAGE ELEMENTS (ppm)

Molybdenum ^{95.9} (Mo) _{95.9}	0 1 1 0 0
Magnesium ^{24.3} (Mg) _{24.3}	0 0 0 0 12
Calcium ^{40.0} (Ca) _{40.0}	0 0 0 1 6
Barium ^{137.3} (Ba) _{137.3}	0 0 0 0 0
Phosphorous ^{30.9} (P) _{30.9}	0 0 268 159 485
Zinc ^{65.3} (Zn) _{65.3}	98 0 1 1 0

CONTAMINANT ELEMENTS (ppm)

Sodium ^{22.9} (Na) _{22.9}	0 0 0 0 0
Silicon ^{28.0} (Si) _{28.0}	0 1 0 0 0
Potassium ^{39.0} (K) _{39.0}	0 0 0 0 0
Boron ^{10.8} (B) _{10.8}	0 0 0 0 0

TRACE METAL ELEMENTS (ppm)

Vanadium ^{50.9} (V) _{50.9}	0 0 0 0 1
Titanium ^{47.9} (Ti) _{47.9}	0 0 0 0 0
Cadmium ^{112.4} (Cd) _{112.4}	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

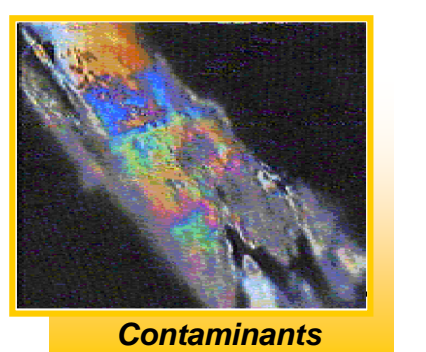
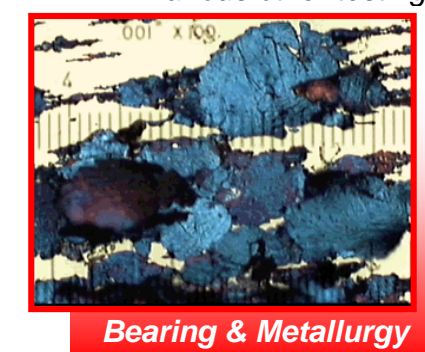
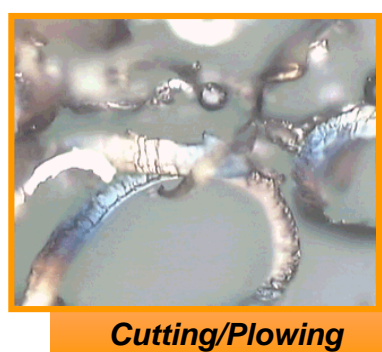
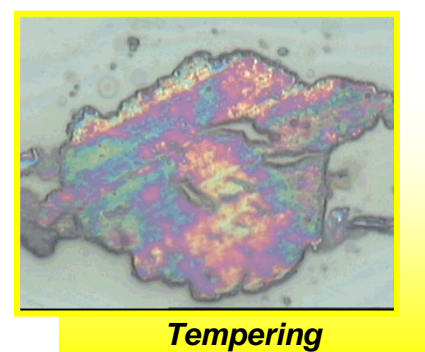
Recommendation(s):
CHANGE OIL to correct LOW viscosity and reduce high Iron, Nitration and Solvent levels. Oxidation levels have continue to increase from 0.61 to 2.87 to 4.89 Abs/cm, Nitration levels increased from 0.00 to 6.10 Abs/cm. Sulfates increased from 0.88 to 1.07 Abs/cm and Solvent levels 0.00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

MARGINAL

Sample Date: 6/30/2012
Received Date: 7/9/2012
Test Date: 7/10/2012
Prev. Sample: 5/12/2012
First Sample: 4/9/2001
No. Samples: 87

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



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

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

330.630.3700
Fax: 330.630.3733
www.REALServices.com

GREGORY POWER PARTNERS
Sherwin Alumina
Gregory, TX

SAVE

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

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)

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

02119 Making you PM Program mean ... "Profit Making"™ Experienced Since 1985 © 2004 REAL Services® Page 1.1 PdM Analyst: NBR

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.R₇E₃A₂L₅

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.

© 2012 REAL Services All rights reserved.

1202 REAL-4-Gate G