

### SAMPLE INFORMATION

Customer Name:	Great Lakes Generation	Sample Number:	19-1-6
Lubricant Type:	DTE 832	Date Received:	07/20/2015
Equipment ID:		Contact Name:	Jack Boilerman
Sample Date:	07/14/2015	Report Date:	07/27/2015
Hours:	Unknown	Analyst:	MMM
Machine Name:	Unit 2 Gas Turbine	Filtration(type):	

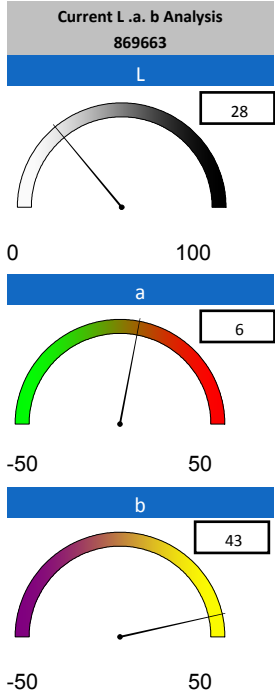


## TURBINE

### RESULTS SUMMARY

The MPC color value, UltraCentrifuge value and Particle Count data indicate the presence of an elevated level of degradation byproducts associated with varnishing. RULER analysis shows the level of phenolic antioxidants to be less than 20% of new oil value. As antioxidants become depleted the potential for varnish formation increases. Excessive varnish can lead to filter plugging, stiction and the malfunction of close tolerance moving parts. Use of filtration which targets the removal of varnish is recommended.

MEMBRANE PATCH COLORIMETRY



**Description of Test:** The process of making a patch isolates and agglomerates insoluble by-products associated with varnish. The color of the membrane patch provides a guideline as to the extent of varnish potential. Generally a value over 35 is considered abnormal.

Date:	07/27/15	8/11/2014	5/28/2013	11/19/2012							
Lab #:	869663	869638	869612	869442							
<b>MPC VALUE: 51</b>		<b>MPC VALUE: 44</b>		<b>MPC VALUE: 32</b>							
L	a	b	L	a	b	L	a	b	L	a	b
28	6	43	25	5	36	13	3	29	11	2	18

**Membrane Patch Colorimetry Results:**  
The MPC color value of 51 is above the critical limit of 50, indicating a high level of insoluble degradation products associated with varnish. The increasing b value suggests the presence of degraded antioxidants.

PARTICLE COUNT

**Description of Test:** Particulate contamination is tested using two methods, optical and pore blockage. Optical particle count passes the oil through a beam of light. Anything in the oil which interrupts the beam is counted as a particle. This method will count soft (varnish) particles. Pore blockage particle count passes the oil through a calibrated mesh screen which captures only hard particulates. A significant difference in the two results may be due to the presence of water, soft contaminants or insolubles.

Date:	07/27/2015	08/11/2014	05/28/2013	11/19/2012
Lab #:	869663	869638	869612	869442
Particle Count (pore blockage)	15/14/12	15/14/12	15/14/11	15/13/9
Particle Count (optical)	21/20/18	17/15/13	16/15/12	16/14/10

**Particle Count Results:**  
Pore blockage results are low, indicating an acceptable level of hard particulates. Optical particle count results are above the acceptable limit. The difference in the two results suggests the presence of soft contaminants.

ULTRA CENTRIFUGE

**Description of Test:** A small amount of oil in a test tube is run for 30 minutes at 17,000 RPM in an ultra centrifuge. By subjecting the sample to significant G-forces, we are able to extract insoluble contaminants that are much too small to be detected by normal particle counting. The amount of the agglomerated material is compared to a rating scale to derive the UC Value (1-8). When the UC Value exceeds 4, a marginal condition is noted. A UC value exceeding 6 is considered to be a critical result.

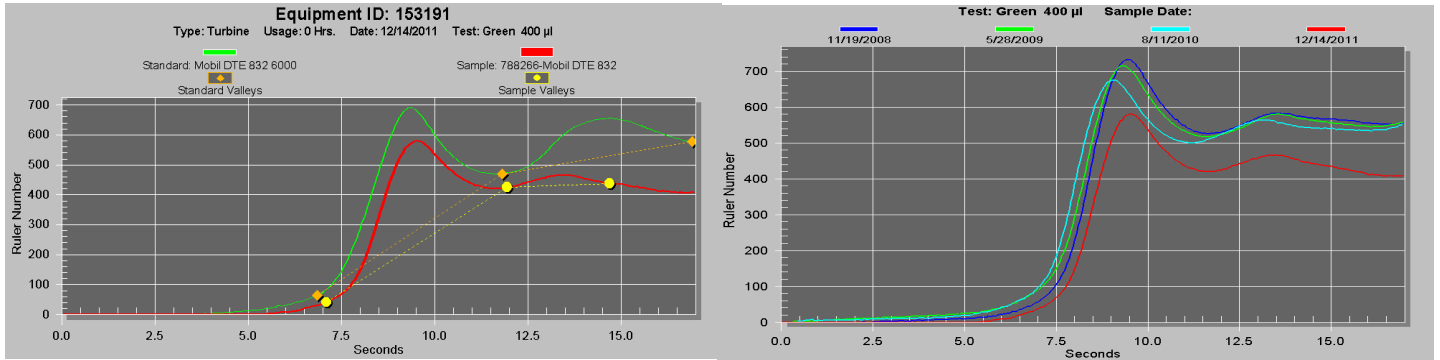
Date:	07/27/2015	08/11/2014	05/28/2013	11/19/2012
Lab #:	869663	869638	869612	869442
<b>UC VALUE: 6</b>		<b>UC VALUE: 4</b>		<b>UC VALUE: 3</b>
<b>UC VALUE: 1</b>				

**UC Results:**  
The UC value of 6 is above the acceptable limit and correlates with the elevated MPC value and particle count data.

**RULER**

**Description of Test:** The RULER accurately measures the remaining active antioxidants in the lubricant. Antioxidants are the most important additive components in many lubricants including turbine, hydraulic, compressor and aerospace fluids. The RULER number represents the concentration of the antioxidants monitored relative to a new oil.

Date:	07/27/2015	08/11/2014	05/28/2013	11/19/2012
Lab #:	869663	869638	869612	869442
AMINE	79	86	92	99
PHENOLIC	15	22	29	31
ZDDP	N/A	N/A	N/A	N/A



**Ruler Results:**

RULER data shows the level of amine antioxidants to be 79% of new oil level. The level of phenolic antioxidants is 15% of new oil level. These results suggest this lubricant is at risk for varnish formation.

**ACID NUMBER (mg KOH/g)**

**Description of Test:** Acid Number (AN) is an indicator of oil health. As the oil oxidizes, acidic byproducts are generated within the oil. As the oil's ability to resist oxidation drops, more of these byproducts are generated causing the AN to increase. A sharp increase in acid number can indicate that the oil is approaching the end of its useful life. Turbine oil generally has an AN of around 0.03 new, and in service should not exceed 0.2.

Date:	07/27/2015	08/11/2014	05/28/2013	11/19/2012
Lab #:	869663	869638	869612	869442
Acid Number	0.08	0.07	0.06	0.06

**Acid Number Results:**

The acid number result of 0.08 is well below the alarm limit and is considered normal.

**KARL FISCHER WATER %**

**Description of Test:** Karl Fischer titration is a direct measurement of water in a lubricating oil. Water is considered to be the most destructive of contaminants causing accelerated oil degradation and corrosion to system components. Also, excessive water in large static reservoirs can lead to microbial growth. The presence of water can severely alter the load carrying capacity of a lubricant. Industrial specifications set the warning limit for turbines at 0.1% or 1000 ppm.

Date:	07/27/2015	08/11/2014	05/28/2013	11/19/2012
Lab #:	869663	869638	869612	869442
Water %	0.002	0.002	0.002	0.001

**Karl Fischer Results:**

The level of water detected 0.002% or 20ppm is within acceptable limits and is considered normal.

IR SPECTROSCOPY (indexing numbers) (\*)

**Description of Test:** FTIR covers the monitoring of base stock degradation, oxidation and additive depletion in machine lubricants, hydraulic fluids, and other fluid types. This test is based on trending of different parameters in various oils and fluids.

Oil Type: DTE 832

Date: 07/27/2015 08/11/2014 05/28/2013 11/19/2012

Lab #:	New Oil	869663	869638	869612	869442
Thermal Event Acid	0	1	1	0	0
Acid Oxidation	5	7	5	4	4
Ester	0	1	1	1	1
Aromatic Additive	66	64	65	65	66
Base Oil Aromatic	225	217	220	219	220
Amine Antioxidants	82	80	80	81	82
Phenolic Antioxidants	120	95	96	98	99

**IR Results:**

FTIR results for this sample indicate no significant lubricant degradation and a strong correlation to both reference and trend data.