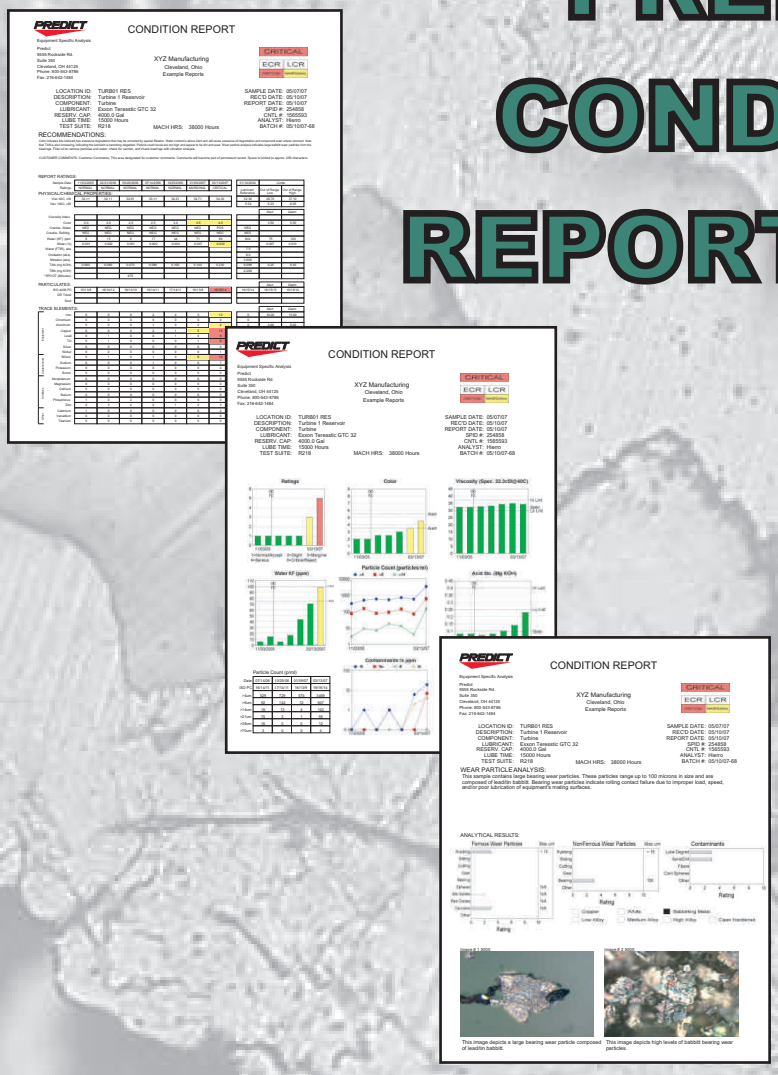
PROACTIVE
LUBRICATION MANAGEMENT

Extending the life and productivity of your equipment.

PREDICT CONDITION REPORT GUIDE



PREDICT

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REPORT COVER

PREDICT

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CONDITION REPORT

A

XYZ Manufacturing
Cleveland, Ohio
Example Reports

B CRITICAL

C ECR	LCR D
CRITICAL	MARGINAL

E

LOCATION ID: TURB01 RES
DESCRIPTION: Turbine 1 Reservoir
COMPONENT: Turbine
LUBRICANT: Exxon Teresstic GTC 32
RESERV. CAP: 4000.0 Gal
LUBE TIME: 15000 Hours
TEST SUITE: R218
MACH HRS: 38000 Hours

F

SAMPLE DATE: 05/07/07
REC'D DATE: 05/10/07
REPORT DATE: 05/10/07
SPID #: 254858
CNTL #: 1565593
ANALYST: Hierro
BATCH #: 05/10/07-68

G

H

RECOMMENDATIONS:

Color indicates this lubricant has excessive degradation that may be corrected by special filtration. Water content is above Alert and will cause excessive oil degradation and component wear unless removed. Note that TAN is also increasing, indicating the lubricant is becoming degraded. Particle count levels are too high and appear to be dirt and wear. Wear particle analysis indicates large babbitt wear particles from the bearings. Filter oil to remove particles and water, check for varnish, and check bearings with vibration analysis.

I

CUSTOMER COMMENTS: Customer Comments: This area designated for customer comments. Comments will become part of permanent record. Space is limited to approx. 256 characters.

J

REPORT RATINGS:

K

L

									Limits	
Sample Date	11/03/2005	02/21/2006	06/20/2006	07/14/2006	10/25/2006	01/09/2007	03/13/2007	01/12/2004		
Ratings	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	MARGINAL	CRITICAL	Lubricant Reference	Out of Range Low	Out of Range High
PHYSICAL/CHEMICAL PROPERTIES:										
Visc 40C, cSt	32.11	32.11	32.61	33.11	34.21	34.71	34.30	32.30	29.70	37.10
Visc 100C, cSt								5.54	5.23	6.05
									Alert	Alarm
Viscosity Index										
Color	2.0	2.0	2.5	2.5	3.0	3.5	4.5		3.50	5.50
Crackle, Water	NEG	NEG	NEG	NEG	NEG	NEG	POS	NEG		
Crackle, Refridg.	NEG	NEG	NEG	NEG	NEG	NEG	NEG	NEG		
Water (KF), ppm	6	15	6	17	44	71	99	N/A	75	100
Water (%)	0.001	0.002	0.001	0.002	0.004	0.007	0.010		0.007	0.010
Water (FTIR), abs								7.5		
Oxidation (abs)								6.0		
Nitration (abs)								3.600		
TAN (mg KOH)	0.080	0.080	0.070	0.080	0.100	0.140	0.230	0.098	0.25	0.40
TBN (mg KOH)								0.269		
* RPVOT (Minutes)			975							
PARTICULATES:									Alert	Alarm
ISO 4406 PC	15/13/9	16/14/12	16/13/10	16/14/11	17/14/11	16/13/9	19/16/14	16/15/14	18/15/13	19/16/14
DR Trend										
Soot										
TRACE ELEMENTS:									Alert	Alarm
Iron	0	0	0	2	4	3	12	0	10.00	15.00
Chromium	0	0	0	0	0	0	0	0		
Aluminum	0	0	0	1	0	2	4	0	3.00	5.00
Copper	0	0	0	2	1	5	15	0	5.00	10.00
Lead	0	1	0	0	1	0	9	0	3.00	8.00
Tin	0	1	0	0	0	1	8	0	3.00	8.00
Silver	0	0	0	0	0	0	0	0		
Nickel	0	0	0	0	0	0	1	0		
Silicon	0	1	0	1	0	6	19	2	5.00	10.00
Sodium	0	0	0	1	0	0	7	0		
Potassium	0	0	0	0	0	0	0	0		
Boron	0	0	0	0	0	0	0	0		
Molybdenum	0	0	0	0	0	0	0	0		
Magnesium	0	0	0	0	0	0	0	0		
Calcium	0	0	0	0	0	0	0	8		
Barium	0	0	0	0	0	0	0	0		
Phosphorus	1	0	2	0	0	0	0	0		
Zinc	2	3	2	2	1	2	3	0		
Cadmium	1	0	0	0	0	0	2	4		
Vanadium	0	0	0	0	0	0	0	0		
Titanium	0	0	0	0	0	0	0	0		

Equipment: Iron, Chromium, Aluminum, Copper, Lead, Tin, Silver, Nickel
Contaminants: Silicon, Sodium, Potassium, Boron
Additives: Molybdenum, Magnesium, Calcium, Barium, Phosphorus, Zinc
Other: Cadmium, Vanadium, Titanium

M

(*) - Test performed by a PREDICT contracted ISO 17025 Accredited Laboratory

A Customer name, city, state, facility/area.

B Overall condition rating.

C Single Equipment Condition Rating.

D Single Lubricant Condition Rating.

E Equipment and lubricant information.

F Sample Tracking information -

- Sample Date: Date sample was taken
- Received Date: Date sample was received.
- Report Date: Date report was generated.

G Machine Condition Analyst Report Identification Codes

- SPID # - Sample point ID# associated with this sample point.
- Control # - Control number associated with this sample point.
- Analyst - Machine Condition Analyst's name.
- Batch # - Specific number assigned to a group of samples. Comprised of the date samples were received and numerical order of entry for that day.

H Recommendations - Action advised by the Predict Machine Condition Analyst based on their analysis of the current sample, historical data, and trend from similar equipment.

I Customer Comments - Area designated for comments entered by the customer. Comments are transmitted and stored in the Predict database, allowing Analysts to view this information.

J Report Ratings - Date of sample and sample rating determined by the Analyst. Condition ratings can be three levels or five levels.

NORMAL (1) Indicates no maintenance action is needed.

SLIGHT (2) Indicates a potential problem may be developing. No maintenance action needed.

MARGINAL (3) Indicates an abnormal trend is identified that may become serious. Watch closely, no maintenance action is needed at this time.

SERIOUS (4) Indicates a serious problem is developing that requires a maintenance action to reduce or eliminate the problem.

CRITICAL (5) Indicates a severe wear or lubricant condition that requires immediate action to eliminate.

A THREE LEVEL system utilizes ratings NORMAL, MARGINAL, and CRITICAL listed above. A FIVE LEVEL rating system uses ratings 1 through 5 described above.

K Lubricant Reference Table - This column shows the test values for the new lubricant. The sample date, physical properties, and trace elements are displayed. Information on reference samples is obtained from the EDS (Equipment Data Sheet) completed by the customer.

L Limits - Low-end or high-end range limits are predetermined by the customer, or other sources based on indvidual component, lubricant, or environment. Limits that are close to or out of the specified range are shaded a color based on the significance of the change.

- ALERT: First limit values determined by the customer. When a test result triggers the alert limit, the color will be shaded YELLOW for that test result. Test results are indicative of a possible abnormal condition.
- ALARM: Second set of limit values determined by the customer. Test result data detects a significant change to the equipments normal operating parameters. Results that exceed the alarm level status are shaded RED in the column.

M Data - Test result values of the current and six previous samples. Results include Physical and Chemical Properties, Particulates, and Trace Elements.

Refer to the last page of this document for a glossary of terms and definitions to help interpret the information contained in the reports.

DYNAMIC GRAPHING OF REPORT DATA

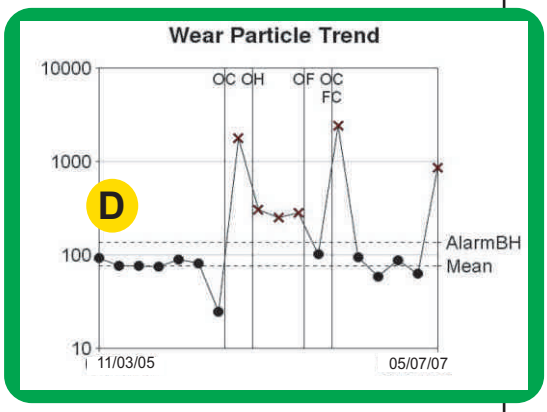
A Customer name, location, facility/area, lubricant and component details, sample tracking information. Same as sections A - G on page 2 of this Condition Report Guide.

B Test results data. Test results will display in graph format on page two of the Predict Condition Report. The graphing system of the Predict Condition Report is dynamic, meaning graphs will display only if there is data to report.

C Graph Symbols:

OH - Component Overhaul
FC - Oil Filter Changed
PG - Purged Grease
OF - Oil Filtered using an external filter device
OC - Oil Changed

D X - Indicates an abnormal sample test value that is outside parameters determined to be normal for this particular piece of equipment. The point is not included in the statistical calculation. This information only pertains to the DR test results graph.



Date	07/14/06	10/25/06	01/09/07	05/07/07
ISO PC	16/14/11	17/14/11	16/13/9	19/16/14
>4um	529	729	575	3469
>6um	92	142	72	607
>14um	18	13	4	143
>21um	75	3	1	59
>38um	16	0	0	12
>70um	3	0	0	4

DEFINITIONS

Wear Particle Concentration (WPC) - WPC indicates the relative amount of all magnetic particles present in the sample 0.1 to 300+ microns in size. Magnitude of the WPC is important, but the trend of the values is the indicator of machine wear condition. This is a trending mechanism and not a particle count. WPC=DL+DS

Density Large (DL) - The trend data read from the "large" channel representing the trend of magnetic particles >5 microns in maximum dimension. Value is not a particle count.

Density Small (DS) - The trend data read from the "small" channel representing the trend of magnetic particles <3 microns. Value is not a particle count.

Mean - The average of WPC values determined to be normal wear for each specific unit. Abnormal wear data are excluded (*outliers).

Standard Deviation (STD DEV) - Standard deviation of WPC values determined to be part of the normal population.

Alarm BH - The Alarm BH (High) value is based on the trend of samples rated NORMAL for the sample point. Alarm BH is calculated by multiplying a factor (default is 2.0) times the standard deviation and adding to the population mean of “normal” wear readings. WPC values above this threshold are considered normal.

CONDITION REPORT
KEY - LUBRICANT

PHYSICAL PROPERTIES

FT-IR (Fourier Transform Infrared /abs cm-1) - When samples are analyzed by FT-IR the results are in the form of spectra. These results are quantified by using Fourier transform which process certain wave numbers giving measurement to the area displaced by these 'peaks'. They are reported in absorption units per centimeter (cm-1) orabs/cm-1.

Water (IND/KF) - The "KF" indicates that the Karl Fisher test. The presence of abnormal levels of water within any lubricant system decreases the lubricant's ability to effectively lubricate the metal surfaces and causes red oxides (rust) and corrosion. Water contamination is a common cause of equipment failure.

Oxidation - Oxidation indicates the amount of carboxylic acids that are present in the lubricant sample. These acids increase corrosive wear and create sludge, varnish, and lacquer deposits.

Nitration - Nitration by-products are formed by the combustion of fuel and air during normal operation or as a result of abnormal "blowby" past compression rings on an engine. The by-products are highly acidic, create deposits, and accelerate the oxidation process.

Sulfates - Indicates the amount of metal sulfates that are present within the lubricant above the amount normally found in an unused lubricant sample. Metal sulfates are typically additives used in the design of oxidation inhibitors and detergents. Excessive levels of sulfates can lead to combustion chamber deposits and top ring wear (internal combustion engines).

Fuel - Any presence of solvents, i.e. fuel dilution, in a lubricant seriously reduces the lubricant's effectiveness. The resulting decrease in viscosity can lead to decreased lubricant film strength, adding to the risk of abnormal wear.

Refrigerant - POS (positive) indicates that an entrained gas, Freon, or ammonia was detected by the "crackle" test. These gases reduce the lubricant's ability to function causing an increase in friction and wear. Comments will appear when the viscosity is dangerously low.

Insolubles - Measurement of the excess amount of carbon and solid-like particles within the lubricant. Normal operating range is determined by trend.

AN (Acid Number) / BN (Base Number) -
Titration test measuring the acid or base level of the lubricant. AN is a bulk chemical measurement that is nonspecific. The numbers are affected by certain additives, oxidation products, and combustion by-products. BN measures the base reserve of the oil. This test is performed according to ASTM D-664 (AN) and D-4739 (BN) and is measured in mg KOH/ gram total.

TRACE ELEMENTS

The results are obtained by a Rotating Disk Electrode (RDE) spectrometer and reported in terms of parts per million (ppm) for the lubricant and wear particles ranging in size up to approximately 5-8 microns. Below is a brief description of the elements and their importance to the equipment and lubricant.
ASTM D6595 is used as a guideline.

Iron - Ferrous wear particles. Indicates steel or iron wear originating from rings, shafts, gears, bearings, valve trains, cylinder walls and pistons in some engines.

Chromium - Chrome (white nonferrous metal) primary sources are chrome plated parts such as rings, liners, etc.

Aluminum - White nonferrous metal and soap complex for greases. Indicates the wear of pistons, valves, seals, plain bearings and certain types of bushings.

Copper - Brass (copper/zinc) and bronze (copper/tin) in bearings. Anti-corrosive additive. Indicates wear from oil slinger rings, screw compressors, bearing retainers, plain and thrust bearings, rocker arm bushings, wrist pin bushings, thrust washers, transmission discs and clutch plates.

Lead - Nonferrous or babbitt metal (with tin). An overlay metal in most bearings.

Tin - White nonferrous or babbitt metal (with lead). Wear from bearings when babbitt overlays are used. Also an indicator of piston wear in some engines.

Silver - White nonferrous metal. Wear of bearings which contain silver alloy. In some instances, a secondary indicator of oil cooler problems, especially when coolant is detected.

Nickel - Alloy metal. Secondary indicator of wear from certain types of bearings, shafts, valves, and valve guides.

Sodium - Detergent, coolant additive, EP agent, or process contamination.

Silicon - Anti-foaming agent or a measure of dust and dirt contamination, usually indicating improper intake filtration. Excessive dirt and abrasives can greatly accelerate component wear.

Potassium - Detergent, coolant additive, EP agent, or process contamination.

Boron - Detergent, dispersants, or EP additive. Molybdenum - Alloy metal or lubricant additive to decrease the friction between wearing surfaces. May also indicate piston ring wear.

Magnesium - White nonferrous metal. Can be found in some oils as a dispersant, detergent additive, alloying metal.

Calcium - Detergents, dispersant, acid neutralizers.

Barium - Corrosion inhibitors, detergents, rust inhibitors.

Phosphorus - Anti-wear additive (zinc dithiophosphate) or fire-resistant additive (phosphate esters).

Zinc - Anti-wear additive (zinc dithiophosphate), copper alloying metal.

Cadmium - Alloy metal, plating found in nuts and bolts.

Vanadium - White nonferrous metal. Heavy fuel contaminant.

Titanium - White nonferrous metal. Alloy used in making high quality steel gears and bearings.

ANALYTICAL FERROGRAPHY

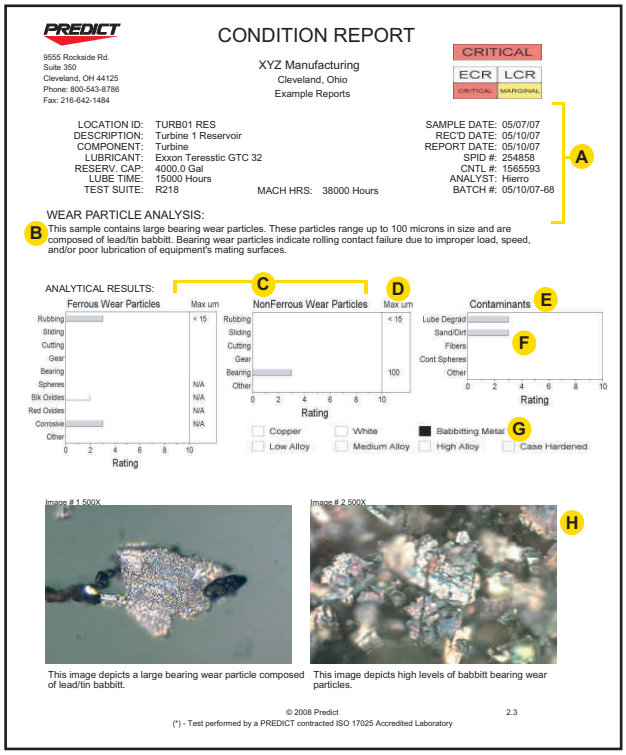
A Customer name, location, facility/area, lubricant and component details, sample tracking information. Same as sections A - G on page 2 of this Condition Report Guide.

B Wear Particle Analysis - The Predict Analysts' observations and recommendations regarding the Ferrographic Analysis. Analytical Ferrography is capable of analyzing particles up to 300 microns, extending analysis beyond traditional lube testing methods.

C Analytical results can be Ferrous Wear Particles (containing Iron) or Non-Ferrous Wear Particles (non-iron in composition).

D MAX µm - Indicates the largest particle in microns measured in each particle category. By definition, normal rubbing wear particles are less than 15 microns in size.

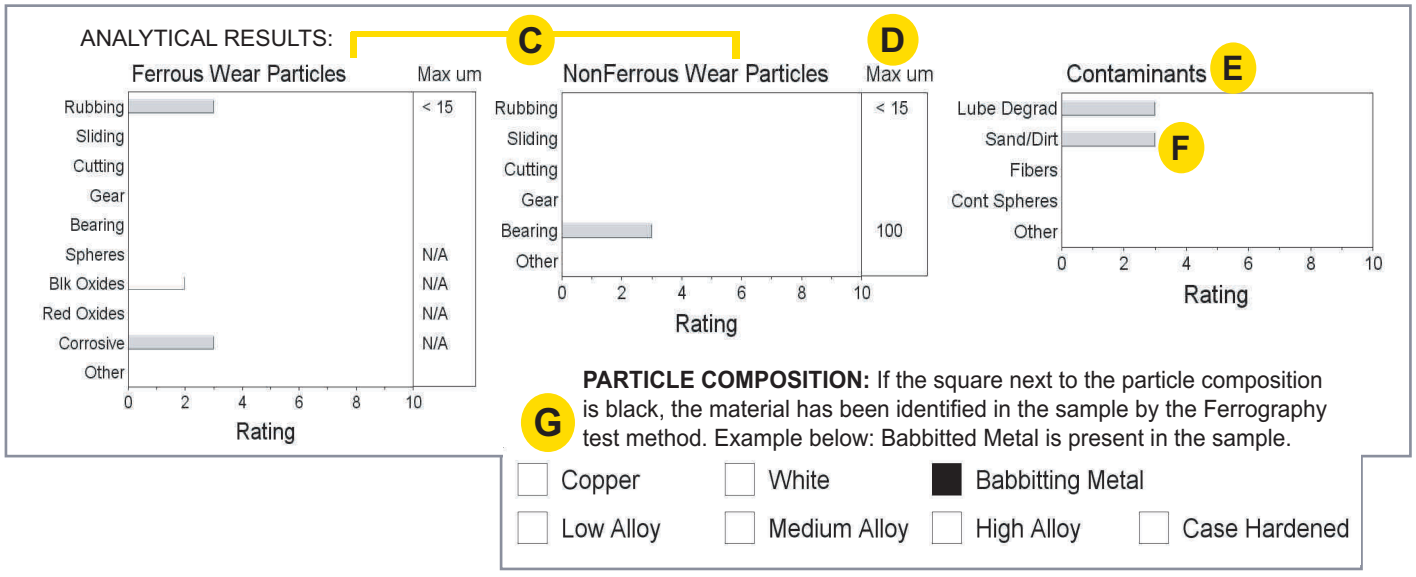
E Analytical results can also be various Contaminants. A detailed list of contaminants can be found on page 6 of the Condition Report Guide.



ANALYTICAL FERROGRAPHY -

The Ultimate in Equipment Analysis

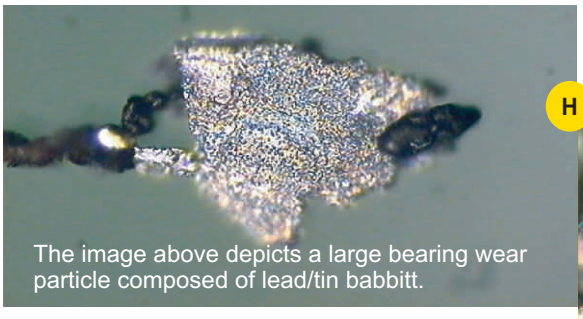
F Gradient Bar Color - Bar graph displays white to black based on concentration. Greater concentrations will show a darker color value on the gradient. Babbitt metal will display black on the graph.



G **PARTICLE COMPOSITION:** If the square next to the particle composition is black, the material has been identified in the sample by the Ferrography test method. Example below: Babbitted Metal is present in the sample.

☐ Copper ☐ White ■ Babbitting Metal

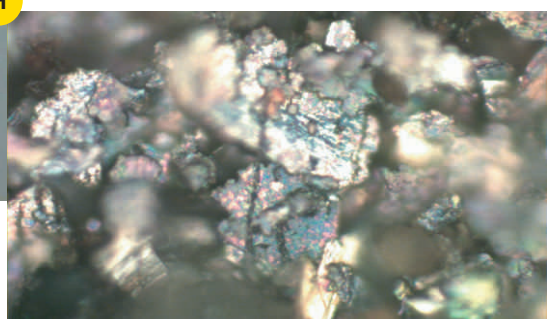
☐ Low Alloy ☐ Medium Alloy ☐ High Alloy ☐ Case Hardened



The image above depicts a large bearing wear particle composed of lead/tin babbitt.

Large particles are the result of abnormal wear condition. If they remain in the lubricant, they will cause the most damage.

H Images are taken at 500x, allowing for identification of wear particle details such as babbitt, sand and dirt. The image below is a 100 micron particle of bearing wear particles.



CONDITION REPORT KEY - PARTICLES

WEAR PARTICLES - Ferrous and Nonferrous

Normal Rubbing - Wear particles that are continuously generated in all equipment. Sizes range from 1 to 15 microns and are typically smaller than five microns.

Severe Sliding - Wear particles that are generally produced from the sliding contact surfaces undergoing high stress. Particles are >15 microns in size and are produced when gears/bearings/cylinders are operated with incorrect lubrication or under severe load and/or speed conditions.

Cutting - Wear particles generated as a result of one surface penetrating another. Sizes can range from 5 to >400 microns. There are two sources of these particles: misalignment of components and/or abrasive contamination. Sometimes observed when equipment is undergoing a break-in operating period.

Gear- Wear particles generated from the gear tooth pitch line (laminar) and/or tip and root (sliding). Sizes range from 15 to >500 microns. This type of wear is generally the result of improper load to speed applied to gear teeth and incorrect lubrication.

Bearing - Wear particles generated as a result of fatigue in the rolling elements and races of antifriction bearings and the planer surfaces of friction type journal bearings. Journal bearings include babbitted and unbabbitted bearings. Sizes range from 15 to >500 microns. Common causes of generation include contamination, excessive load, and incorrect lubrication.

Spheres - The onset of rolling contact fatigue is indicated by the presence of spherical wear particles. Sizes are generally <5 microns. Spheres normally precede rolling element fatigue spalling or brinelling.

FERROUS OXIDES

Black Oxides - Associated with insufficient lubrication between metal surfaces. Particles are formed under high temperatures. This is a result of low oil pressure, low oil level, restrictions in oil feed lines (bent, twisted, etc.).
Size range varies.

Red Oxides - Commonly termed rust. Associated with water contamination and historical debris (improper sampling). Water could have been present in the lube system at some time for red oxides to form even though the current sample does not contain water. Particle size varies. Water contamination is a common cause of equipment failure.

Corrosive Wear - Corrosive or chemical wear results from chemical action on metal surfaces combined with rubbing action of those surfaces. The lubricant becomes acidic. Circulating metal particles in the lubricant, as well as the outer wear surfaces, become dissolved to sub-micron proportions. Size ranges are <0.1 micron.

CONTAMINANTS

Lubricant Degradation - High concentration of friction polymers which indicates extreme pressure and/or temperature and over stressing of the lubricant. No particular size range. In some specialty lubricants, lube degradation indicates additive depletion. Molybdenum disulfide, borates, copper, etc. usually have metal particles within them.

Sand/Dirt - External contamination in the lubricant. Sources can be from rebuilt units, improperly cleaned new machinery, perforated air filters, poorly installed or poorly functioning breathers. Particle size is generally >5 microns.

Contaminant Fibers - Indicate filter element breakdown internal or external oil filtration unit. Other sources include process or outside contamination (cleaning rags).

Contaminant Spheres - Welding, grinding, sandblasting, and combustion processes produce spheres which can contaminate lube systems. Sizes range from 5 > 15 microns.

ISO 9001:2000 Certified
ISO 17025:2005 Accredited

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