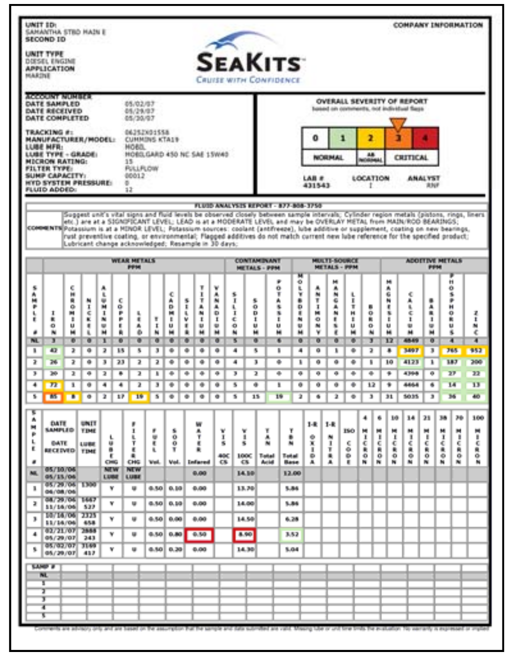
Technical Bulletin

SEAKITS™
CRUISE WITH CONFIDENCE



How to Read an Oil Analysis Report

Reading a fluid analysis report can be an overwhelming and sometimes seemingly impossible task without an understanding of the basic fundamentals for interpreting laboratory results and recommendations. Referring to the report descriptions and explanations below will help you better understand your results and, ultimately, better manage a productive, cost-saving reliability program.

Customer, Equipment and Sample Information

The information submitted with a sample is as important to who is reading the report as it is to the analyst interpreting the test results and making recommendations. **Know your equipment and share this information with your laboratory.** Accurate, thorough and complete lube and equipment information not only allows for in-depth analysis, but can eliminate confusion and the difficulties that can occur when interpreting results.

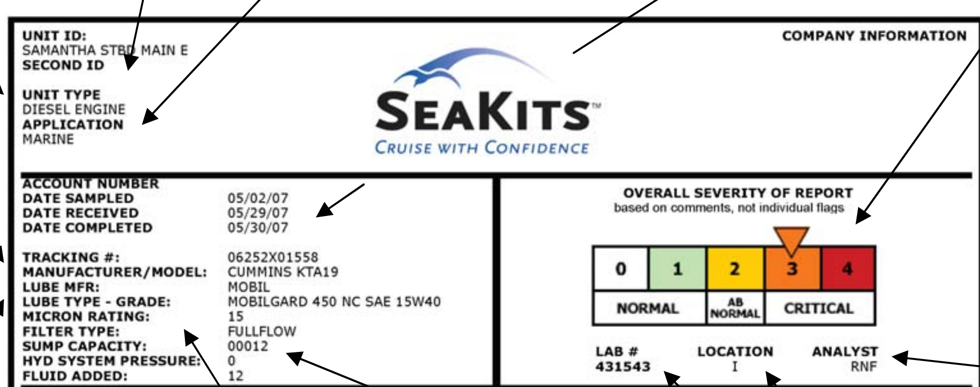
Unit, Lube, Turnaround Time and **Account** information are listed on the left side of the report emphasizing the data most critical to laboratory processing and data interpretation. Details such as what kind of compressor, gearbox, engine, etc. influences flagging parameters and depth of analysis.

Second ID is each **customer's** opportunity to uniquely identify units being tested and their location.

Application identifies in what type of environment the equipment operates and is useful in determining exposure to possible contaminants.

Make note of the difference between the **Date Sampled** and the **Date Received** by the lab. Turnaround issues may point to storing samples too long before shipping or shipping service problems.

Severity is represented on a sliding scale and is color-coded so that critical units are more apparent at first glance. Overall severity is based on report Comments—not individually flagged results.
0—Normal
1—At lease one or more items have violated initial flagging points yet are still considered minor.
2—A trend is developing.
3—Simple maintenance and/or diagnostics are recommended.
4—Failure is eminent if maintenance not performed. Occasionally, a test result can violate the S4 excursion level. But, if there is no supporting data or a clear indicator of what is actually happening within the unit, maintenance action may not be recommended.



Manufacturer and Model can also identify metallurgies involved as well as the OEM's standard maintenance guidelines and possible wear patterns to expect.

Lube Manufacturer, Type and Grade identifies a lube's properties and its viscosity and is critical in determining if the right lube is being used.

Fluid Added is how much oil has been added since the last sample was taken.

Filter Types and their **Micron Ratings** are important in analyzing particle count—the higher the micron rating, the higher the particle count results.

Sump Capacity identifies the total volume of oil (in gallons) in which wear metals are suspended and is critical to trending wear metal concentrations.

The laboratory at which testing was completed is denoted by an I for **Indianapolis** and an H for **Houston**. The following **Lab #** is assigned to the sample upon entry for processing and should be the reference number used when notifying the lab with questions or concerns.

Data Analyst Initials

Recommendations

A data analyst's job is to explain and, if necessary, recommend actions for rectifying significant changes in a unit's condition. Reviewing comments before looking at the actual test results will provide a roadmap to the report's most important information. Any actions that need to be taken are listed first in order of severity. Justifications for recommending those actions immediately follow.

FLUID ANALYSIS REPORT - 877-458-3314	
COMMENTS	Suggest unit's vital signs and fluid levels be observed closely between sample intervals; Cylinder region metals (pistons, rings, liners etc.) are at a SIGNIFICANT LEVEL; LEAD is at a MODERATE LEVEL and may be OVERLAY METAL from MAIN/ROD BEARINGS; Potassium is at a MINOR LEVEL; Potassium sources: coolant (antifreeze), lube additive or supplement, coating on new bearings, rust preventive coating, or environmental; Flagged additives do not match current new lube reference for the specified product; Lubricant change acknowledged; Resample in 30 days;

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"**Highlighted**" numbers denote test results the analyst has **flagged** because they exceed pre-set warning parameters and warrant closer examination or require action. Individual results are flagged by **severity color** to better explain the overall severity assigned to the sample.

	WEAR METALS PPM											CONTAMINANT METALS - PPM			MULTI-SOURCE METALS - PPM					ADDITIVE METALS PPM				
SAMPLE #	IRON	CHROMIUM	NICKEL	ALUMINUM	COPPER	LEAD	TIN	CADMIUM	SILVER	TITANIUM	VANADIUM	SILICON	SODIUM	POTASSIUM	MOLYBDENUM	ANTIMONY	MANGANESE	LITHIUM	BORON	MAGNESIUM	CALCIUM	BARIUM	PHOSPHORUS	ZINC
NL	3	0	0	1	0	0	0	0	0	0	0	5	0	6	0	0	0	0	3	12	4849	0	4	4
1	42	2	0	2	15	5	3	0	0	0	0	4	5	1	4	0	1	0	2	8	3497	3	765	952
2	26	2	0	3	23	2	2	0	0	0	0	4	3	0	1	0	0	0	1	10	4123	1	187	200
3	20	2	0	2	8	2	1	0	0	0	0	3	2	0	0	0	0	0	0	9	4398	0	27	22
4	72	1	0	4	4	2	3	0	0	0	0	5	0	1	0	0	0	0	12	9	4464	6	14	13
5	85	8	0	2	17	19	5	0	0	0	0	5	15	19	2	6	2	0	3	31	5035	3	36	40

Elemental Analysis

Elemental Analysis, or Spectroscopy, identifies the type and amount of wear particles, contamination and additives. Determining metal content can alert you to the type and severity of wear occurring in the unit. Measurements are expressed in parts per million (ppm). Consult the Seakits Wear Metals Guide for a quick reference to possible wear metal sources.

Combinations of these **Wear Metals** can identify components within the machine that are wearing. Knowing what metals a unit is made of can greatly influence an analyst's recommendations and determine the value of elemental analysis.

Knowledge of the environmental conditions under which a unit operates can explain varying levels of **Contaminant Metals**. Excessive levels of dust and dirt can be abrasive and accelerate wear.

Additive and **Multi-Source Metals** may turn up in test results for a variety of reasons. Molybdenum, antimony and boron are additives in some oils. Magnesium, calcium and barium are often used in detergent/dispersant additives. Phosphorous is used as an extreme pressure additive in gear oils. Phosphorous, along with zinc, are used in anti-wear additives (ZDP).

	WEAR METALS PPM											CONTAMINANT METALS - PPM			MULTI-SOURCE METALS - PPM					ADDITIVE METALS PPM				
SAMPLE #	IRON	CHROMIUM	NICKEL	ALUMINUM	COPPER	LE	T	CADMI	SILV	TITANI	VANADI	SILIC	SODIUM	POTASSIUM	MOLYBDENUM	ANTIMONY	MANGANESE	LITHIUM	BORON	MAGNESIUM	CALCIUM	BARIUM	PHOSPHORUS	ZINC
NL	3	0	0	1	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	6	0	0	0	0	3	12	4849	0	4	4
1	42	2	0	2	15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5	1	4	0	1	0	2	8	3497	3	765	952
2	26	2	0	3	23	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3	0	1	0	0	0	1	10	4123	1	187	200
3	20	2	0	2	8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2	0	0	0	0	0	0	9	4398	0	27	22
4	72	1	0	4	4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	1	0	0	0	0	12	9	4464	6	14	13
5	85	8	0	2	17	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	15	19	2	6	2	0	3	31	5035	3	36	40

Iron (Fe)

Definition

Iron is a wear metal detected with Elemental Analysis by ICP (inductively-coupled plasma), which detects up to 24 metals, measuring less than 5μ in size, that can be present in used oil due to wear, contamination or additives. Wear Metals include iron, chromium, nickel, aluminum, copper, lead, tin, cadmium, silver, titanium and vanadium. Contaminant Metals include silicon, sodium, and potassium. Multi-Source Metals include molybdenum, antimony, manganese, and lithium. Additive Metals include boron, magnesium, calcium, barium, phosphorous and zinc. Elemental Analysis is instrumental in determining the type and severity of wear occurring within a unit.

Standard Test Method Used

ASTM D5185

Reporting Measurement

ppm

Amount of Sample Needed

2 mL

Test Limitation

Possible Sources

Reciprocating Compressors
Shafts, Pistons, Crosshead, Packing Glands, Gears, Housing Casting, Valves

Rotary Compressors
Gears, Shafts, Bearings, Casting

Turbines / Centrifugal Compressors
Shafts, Gears, Bearings, Valves

Hydraulics
Rods, Cylinder, Gears, Shafts, Pistons

Reciprocating Engines
Cylinder Liners, Rings, Gears, Crankshaft, Camshaft, Rods, Valve Train, Oil Pump Gear,

When reviewing your report online, you can click on the metal to see its **definition**, the **ASTM test method** used, how the **results are reported**, the **amount of sample** needed to perform the test, **possible sources** as to where the metal is coming from, and an **illustration of the test** equipment.

Test Data

Test results are listed according to age of the sample—oldest to most recent, top to bottom—so that trends are apparent. Significant changes are flagged and printed in the gray areas of the report.

Samples appear in an oldest to newest numbered sequence so that results are easily associated with them throughout the report.

Viscosity measures a lubricant's resistance to flow at temperature and is considered its most important physical property. Depending on lube grade, it is tested at 40 and/or 100 degrees Centigrade and reported in centistokes.

Oxidation measures the breakdown of a lubricant due to age and operating conditions. Oxidation prevents additives from working and therefore promotes increased acid content, as well as increased viscosity. Nitration is an indication of excessive "blow-by" from cylinder walls and/or compression rings and indicates the presence of nitric acid, which speeds up oxidation. Too much disparity between oxidation and nitration can indicate air to fuel ratio problems. As Oxidation/ Nitration increases, TAN will also increase and TBN will begin to decrease.

The ISO Code is an index number that represents a range of particles within a specific micron range, i.e. 4, 6, 14. Each class designates a range of measured particles per one ml of sample. The particle count is a cumulative range between 4 and 6 microns. This test is valuable in determining large particle wear in filtered systems.

Providing your lab with a New Lube sample allows the analyst to verify product integrity and establishes a guideline for analyzing subsequent used oil samples. It will appear first on all reports for the unit.

SAMPLE #	DATE SAMPLED / DATE RECEIVED	UNIT TIME / LUBE TIME	LUBE CHG	FILTER CHG	FUEL Vol.	SOOT Vol.	WATER Infared	VIS 40C CS	VIS 100C CS	TAN Total Acid	TBN Total Base	I-R OXIDA	I-R NITRA	ISO CODE	4 MICRON	6 MICRON	10 MICRON	14 MICRON	21 MICRON	38 MICRON	70 MICRON	100 MICRON
NL	05/10/06 05/15/06		NEW LUBE	NEW LUBE			0.00		14.10		12.00											
1	05/29/06 06/08/06	1300	Y	U	0.50	0.10	0.00		13.70		5.86											
2	08/29/06 11/16/06	1667 527	Y	U	0.50	0.10	0.00		14.00		5.86											
3	10/16/06 11/16/06	2325 658	Y	U	0.50	0.00	0.00		14.50		6.28											
4	02/21/07 05/29/07	2888 243	Y	U	0.50	0.80	0.50		8.90		3.52											
5	05/02/07 05/29/07	3169 417	Y	U	0.50	0.20	0.00		14.30		5.04											

TESTING SERVICES

Acid Number

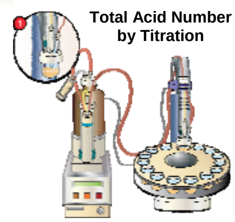
DEFINITION
Acid Number is the amount of acid present. Numbers higher than that of new lubricant is an indication of oxidation or contamination of some kind.

STANDARD TEST METHOD USED
ASTM D664

REPORTING MEASUREMENT
mg KOH/g

AMOUNT OF SAMPLE NEEDED
4g

TEST LIMITATION



Total Acid Number by Titration

Fuel and Soot results are all reported in % of volume. High fuel dilution decreases unit load capacity. Excessive soot is a sign of reduced combustion efficiency.

Water in oil decreases lubricity, prevents additives from working and furthers oxidation. Its presence can be determined by crackle or FTIR and is reported in % of volume. Water by Karl Fischer determines the amount of water present. These results appear in the Special Testing section of your report.

Total Acid Number is the amount of acid present in the lubricant. Numbers higher than that of new lube indicate oxidation or some type of contamination. Total Base Number measures the lube's alkalinity, or ability to neutralize acid. When TAN and TBN approach the same number, the lube should be changed or "sweetened," meaning more lube could be added.

When reviewing your report online, you can click on the test name to see its definition, the ASTM test method used, how the results are reported, the amount of sample needed to perform the test and an illustration of the test equipment.

Special Testing

Special testing is often done when additional, or more specific, information is needed. For example, an Analytical Ferrograph might be requested when a ferrous metal larger than 5 microns has been detected by Direct Read Ferrography. The AF can determine actual size of the particle, its composition—iron, copper, etc.—and the type of wear it's creating—rubbing, sliding, cutting, etc. Additional special testing could include, Water by Karl Fischer and RPVOT (Rotating Pressure Vessel Oxidation Test).