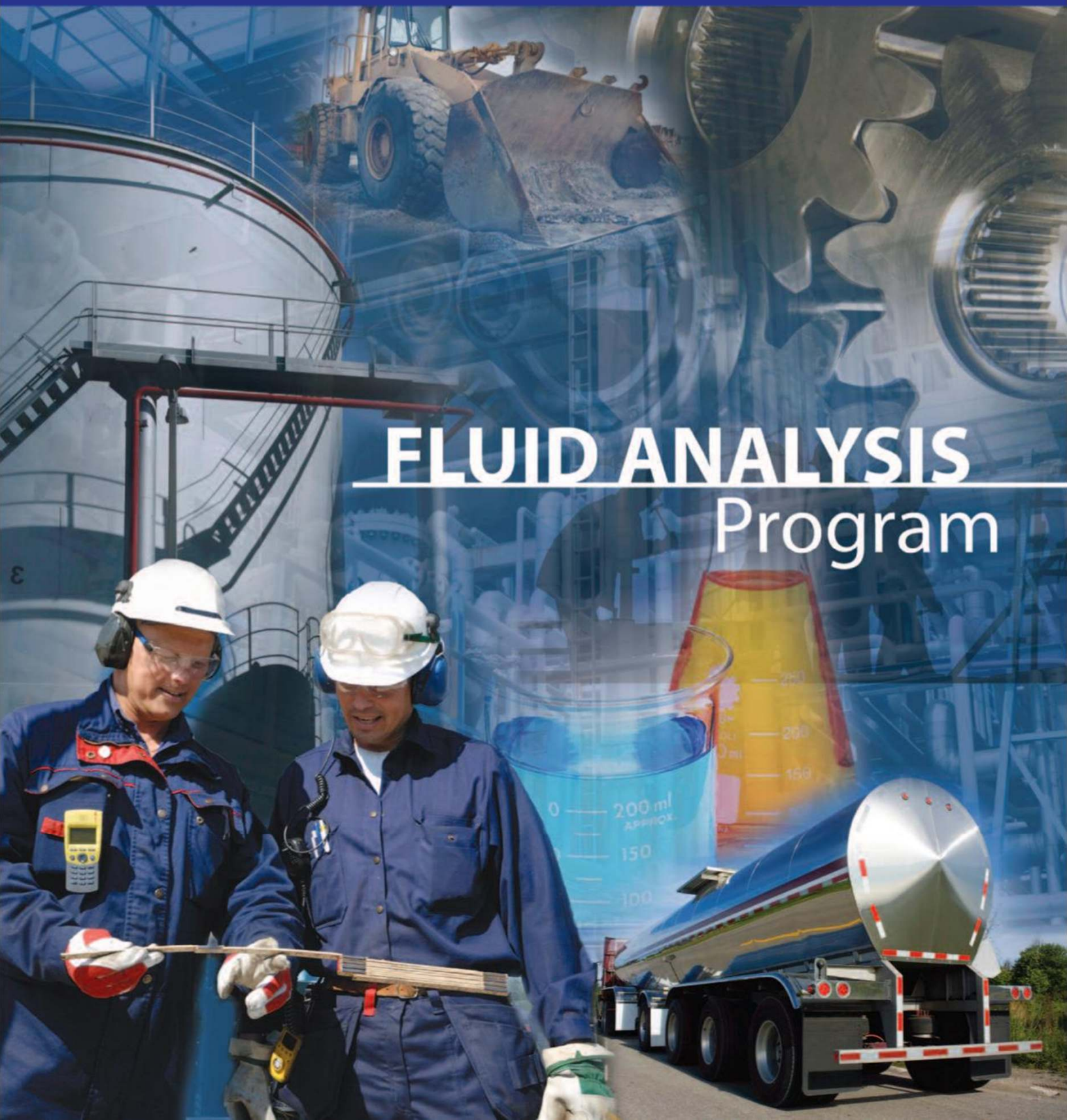
Hartland



FLUID ANALYSIS
Program

What can the Hartland Fluid Analysis Program Do For You?

Hartland Fluid Analysis is a preventive maintenance tool that provides a picture of both the fluid condition and the internal condition of a component or system without disassembly. Imagine being able to see exactly what's happening inside an engine, a gearbox or hydraulic system.

- **Extend oil drain intervals** – Monitoring the condition of the oil optimizes drain intervals so that you get the most out of the fluid you're paying for. Fewer oil changes minimize maintenance costs and maximize uptime.
- **Extend equipment life** – Monitoring system cleanliness and filtration efficiency allows you to keep your equipment longer and significantly reduce replacement costs.
- **Identify minor problems before they become major failures** – State-of-the-art fluid analysis identifies dirt, wear particles, fuel dilution and coolant – contaminants that can cause catastrophic failure or significantly shorten equipment life.
- **Maximize asset reliability** – Testing and analysis ensures that units are up, running and making money.
- **Increase resale value** – Analysis results provide valuable sampling histories that easily justify higher equipment resale values.

Why Hartland?

High Quality Testing

With **Hartland**, you can be confident you're testing with the people that know your equipment better than anyone. And, Hartland laboratories are ISO 17025 A2LA accredited. This is the highest level of quality attainable by a testing laboratory backed by the most stringent accrediting body in the industry. You can be confident that the results you receive are accurate, repeatable and traceable to a standard and that your fluid analysis program is supported by a documented quality system you can depend on to deliver superior testing and customer services.

Innovative IT Solutions

Hartland's online reporting option will show you how to get the most from your information. Results are available through HORIZON® online almost immediately after sample processing is complete.

Taking Samples

Hartland Fluid Analysis will show you how regular sampling and TREND ANALYSIS – monitoring test data over an extended period of time – will provide the information you need to continually maximize asset reliability and, ultimately, increase company profits.

Fluid analysis is most effective when samples are representative of the typical environmental conditions under which they operate. Dirt, system debris, water and light fuels tend to separate from the lubricants and coolants when system temperatures cool. Take samples while the systems are operating under normal conditions or immediately after shutdown while they are still at operating temperature.

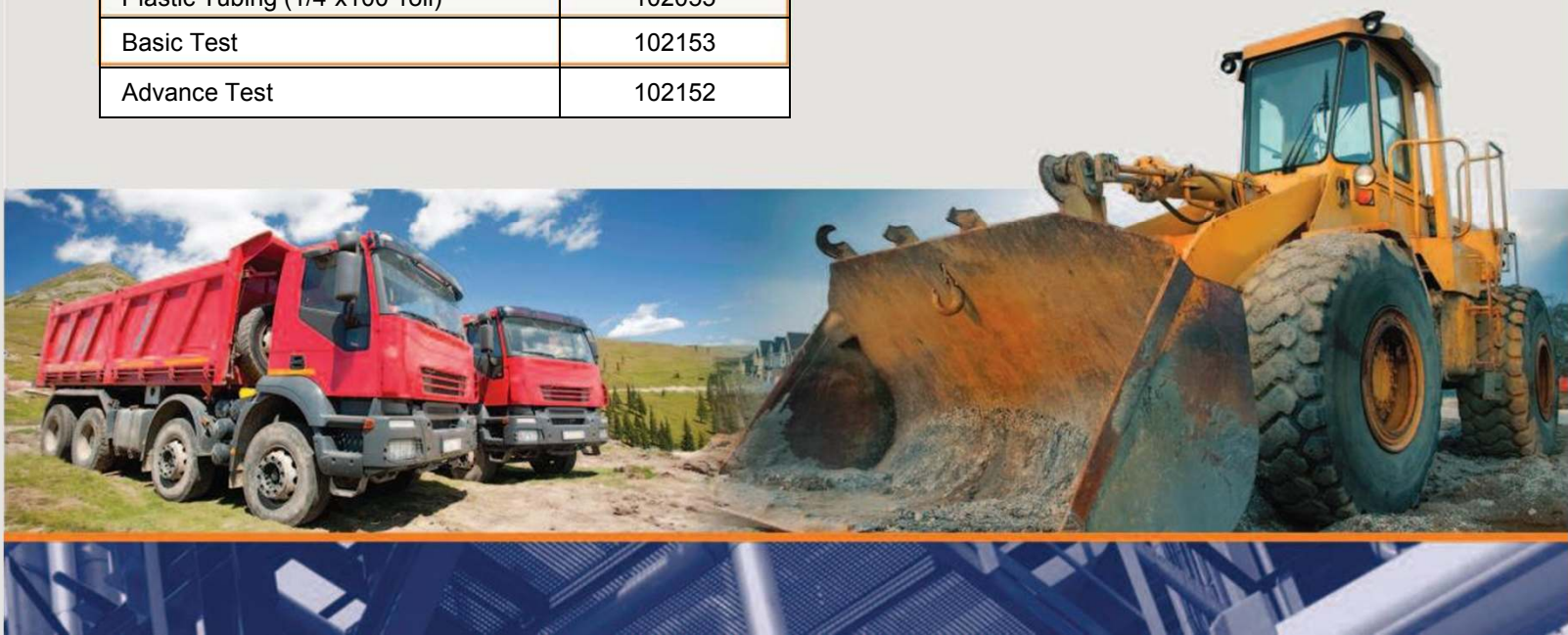
Samples should also be taken at regularly scheduled intervals and from the same sampling point each time. Although an equipment manufacturer's recommendations provide a good starting point for developing preventative maintenance practices, sampling intervals can easily vary. How critical a piece of equipment is to production is a major consideration for determining sampling frequency, as are environmental factors such as hot, dirty operating conditions, short trips with heavy loads and excessive idle times.

Suggested Sampling Intervals & Methods

	Component Interval	Suggested Method & Location
Engines	250 hours or at recommended change interval	By vacuum pump through dipstick retaining tube or sampling valve installed in filter return
Hydraulics/ Transmissions	250-500 hours	By vacuum pump through oil fill port of system reservoir at mid-level
Differentials Gearboxes	750 hours	By vacuum pump through oil level or plug or dipstick retaining tube

Sampling Equipment and Supplies

Description	Navision #
Vacuum Pump with Case	102048
Plastic Tubing (1/4"x100' roll)	102055
Basic Test	102153
Advance Test	102152



Fluid Analysis Test Packages

Fluid analysis test kits can be ordered through **Hartland Lubricants**. Kits provide advanced diagnostic, preventive maintenance testing designed to evaluate lubricant condition, component wear and contamination in engines, hydraulic systems and transmissions.

Hartland Oil Analysis Test Package				
Oil	**Basic Oil Analysis**		**Advanced Oil Analysis**	
Application	Engines	Non-Engines	Non-Engines	Non-Engines
Elemental Analysis by ICP	•	•	•	•
Water % by Crackle	•	•	•	•
Viscosity @ 40°C or 100°C	•	•	•	•
Fuel Dilution	•		•	
Soot %	•		•	
Total Acid Number				•
Total Base Number			•	
Oxidation/Nitration	•	•	•	•
ISO Particle Count				•
Particle Quantifier			•	

* Engines and Unfiltered Gear Boxes will receive a Particle Quantifier instead of a Laser Optical Particle Count.

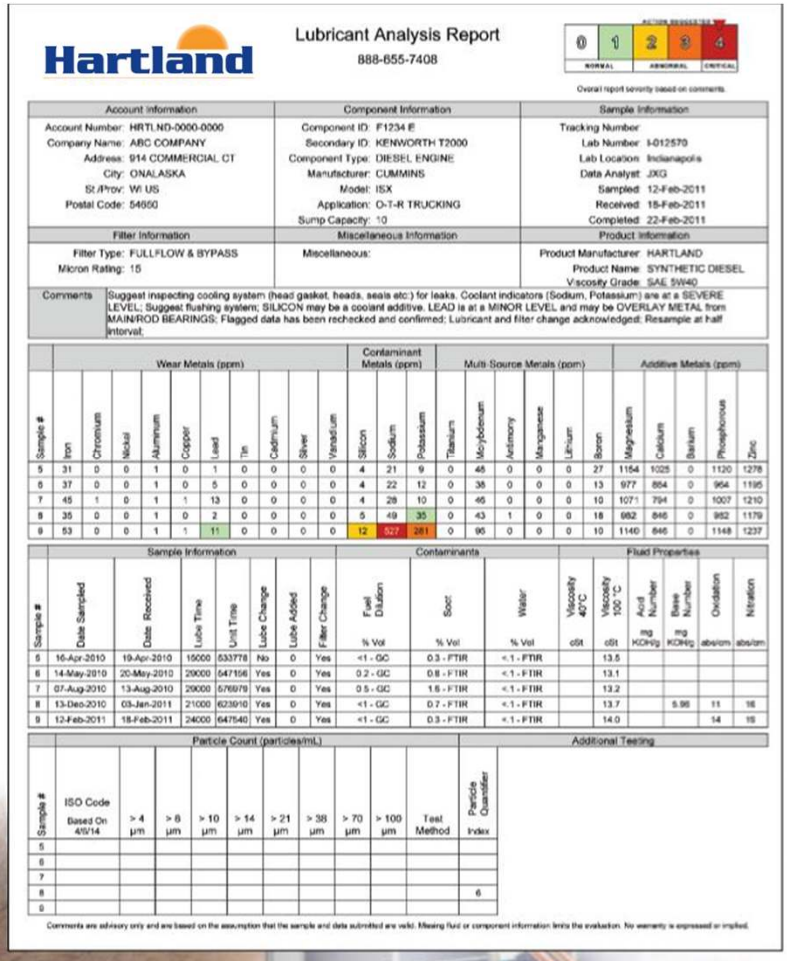
Hartland Coolant Analysis Test Package		
Coolant	**Basic Coolant Analysis**	**Advanced Coolant Analysis**
Application	**Engines**	**Non-Engines**
Elemental Analysis by ICP	•	•
pH	•	•
Glycol % (Ethylene or Propylene)	•	•
Freeze Point	•	•
Boil Point	•	•
Nitrates	•	•
SCA Number	•	•
Carboxylic Acid	•	•
Specific Conductance	•	•
Total Hardness	•	•
Visuals (foam, color, oil, fuel, magnetic & non-magnetic precipitate & odor)	•	•

Diesel Fuel Analysis – Test Packages

	Contamination	Smoking	Filter Plugging	Cleanliness	Wear Prevention	Fuel Quality		Biodiesel Blends
Tests						Summer	Winter	
ICP mod. ASTM D5185	•					•	•	
Kinematic Viscosity mod ASTM D445						•	•	
Flash Point ASTM D93	•					•	•	
Water by Karl Fischer mod ASTM D1744				•	•			•
Particle_Count mod. ISO 11500, ISO 4406			•	•	•			
Water & Sediment ASTM D2709	•	•				•	•	
Pour Point ASTM D97			•				•	•
Cloud Point ASTM D2500			•				•	•
Cold Filter Plug Point ASTM D6371			•					•
Thermal Stability mod. ASTM D6468	•		•			•	•	
Bacteria, Fungi & Mold mfr. method	•		•			•	•	•
Cetane Index ASTM D976		•				•	•	
API Gravity ASTM D287		•				•	•	
Distillation ASTM D86		•				•	•	
Sulfur ASTM D7220		•				•	•	
Lubricity ASTM D6079					•			
Acid Number mod. ASTM D664								•
Biodiesel Content ASTM D737								•
Oxidation Stability EN 142112								•

To order kits: email orderdesk@hartlandlubes.com

How to Read the Hartland Fluid Analysis Report



Hartland

Lubricant Analysis Report

888-655-7408

0	1	2	3	4
NORMAL		ABNORMAL		CRITICAL

Overall report severity based on comments.

Account Information	Component Information	Sample Information
Account Number: HRTLND-0000-0000	Component ID: F1234 E	Tracking Number:
Company Name: ABC COMPANY	Secondary ID: KENWORTH T2000	Lab Number: I-012570
Address: 914 COMMERCIAL CT	Component Type: DIESEL ENGINE	Lab Location: Indianapolis
City: ONALASKA	Manufacturer: CUMMINS	Data Analyst: JXG
St./Prov: WI US	Model: ISX	Sampled: 12-Feb-2011
Postal Code: 54650	Application: O-T-R TRUCKING	Received: 18-Feb-2011
	Sump Capacity: 10	Completed: 22-Feb-2011
Filter Information	**Miscellaneous Information**	**Product Information**
Filter Type: FULLFLOW & BYPASS	Miscellaneous:	Product Manufacturer: HARTLAND
Micron Rating: 15		Product Name: SYNTHETIC DIESEL
		Viscosity Grade: SAE 5W40

Comments: Suggest inspecting cooling system (head gasket, heads, seals etc.) for leaks. Coolant indicators (Sodium, Potassium) are at a SEVERE LEVEL; Suggest flushing system; SILICON may be a coolant additive. LEAD is at a MINOR LEVEL and may be OVERLAY METAL from MAIN/ROD BEARINGS; Flagged data has been rechecked and confirmed; Lubricant and filter change acknowledged; Resample at half interval;

	Wear Metals (ppm)										Contaminant Metals (ppm)			Multi-Source Metals (ppm)						Additive Metals (ppm)				
Sample #	Iron	Chromium	Nickel	Aluminum	Copper	Lead	Tin	Cadmium	Silver	Vanadium	Silicon	Sodium	Potassium	Titanium	Molybdenum	Antimony	Manganese	Lithium	Boron	Magnesium	Calcium	Barium	Phosphorous	Zinc
5	31	0	0	1	0	1	0	0	0	0	4	21	9	0	46	0	0	0	27	1154	1025	0	1120	1278
6	37	0	0	1	0	5	0	0	0	0	4	22	12	0	38	0	0	0	13	977	864	0	964	1195
7	45	1	0	1	1	13	0	0	0	0	4	28	10	0	46	0	0	0	10	1071	794	0	1007	1210
8	35	0	0	1	0	2	0	0	0	0	5	49	35	0	43	1	0	0	18	982	846	0	982	1179
9	53	0	0	1	1	11	0	0	0	0	12	527	281	0	95	0	0	0	10	1140	846	0	1148	1237

	Sample Information							Contaminants			Fluid Properties					
Sample #	Date Sampled	Date Received	Lube Time	Unit Time	Lube Change	Lube Added	Filter Change	Fuel Dilution % Vol	Soot % Vol	Water % Vol	Viscosity 40°C cSt	Viscosity 100°C cSt	Acid Number mg KOH/g	Base Number mg KOH/g	Oxidation abs/cm	Nitration abs/cm
5	16-Apr-2010	19-Apr-2010	15000	533778	No	0	Yes	<1 - GC	0.3 - FTIR	<.1 - FTIR		13.5				
6	14-May-2010	20-May-2010	29000	547156	Yes	0	Yes	0.2 - GC	0.8 - FTIR	<.1 - FTIR		13.1				
7	07-Aug-2010	13-Aug-2010	29000	576978	Yes	0	Yes	0.5 - GC	1.5 - FTIR	<.1 - FTIR		13.2				
8	13-Dec-2010	03-Jan-2011	21000	623910	Yes	0	Yes	<1 - GC	0.7 - FTIR	<.1 - FTIR		13.7		5.96	11	16
9	12-Feb-2011	18-Feb-2011	24000	647540	Yes	0	Yes	<1 - GC	0.3 - FTIR	<.1 - FTIR		14.0			14	19

	Particle Count (particles/mL)										Additional Testing
Sample #	ISO Code Based On 4/6/14	> 4 µm	> 6 µm	> 10 µm	> 14 µm	> 21 µm	> 38 µm	> 70 µm	> 100 µm	Test Method	Particle Quantifier Index
5											
6											
7											
8											6
9											

Comments are advisory only and are based on the assumption that the sample and data submitted are valid. Missing fluid or component information limits the evaluation. No warranty is expressed or implied.

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 oil analysis 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.

Properly document your equipment and share this knowledge with your laboratory. Implement a sampling process for every piece of equipment in your oil analysis program that can be followed consistently each time the unit is sampled. 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.

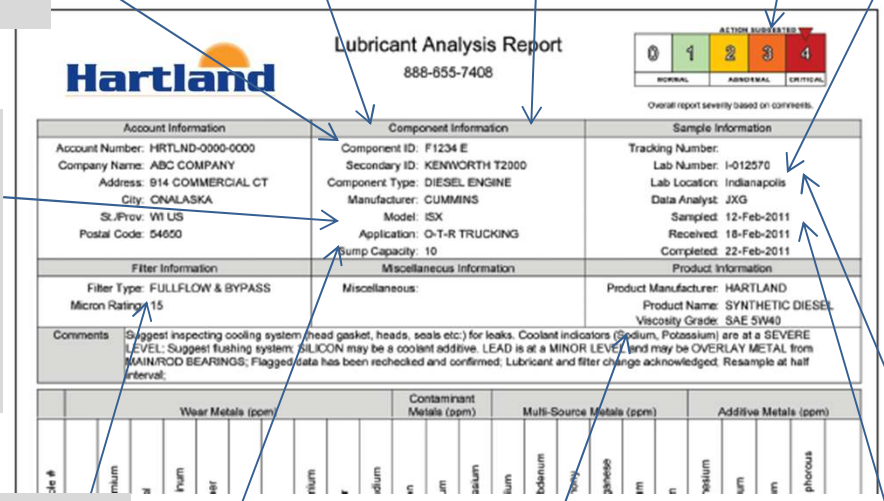
How to Read the Hartland Fluid Analysis Report

Component Type should give as much detail as possible. What kind of compressor, gearbox, engine, etc., influences flagging parameters and depth of analysis. Different metallurgies require different lubrication and have great impact on how results are interpreted.

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

Severity Status Levels:
0- Normal.
1. At least 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 is not performed.

Component ID is each customer's opportunity to uniquely identify components being tested and their location.



Lubricant Analysis Report
888-655-7408

Hartland

Account Information	Component Information	Sample Information
Account Number: HRTLND-0000-0000	Component ID: F1234 E	Tracking Number:
Company Name: ABC COMPANY	Secondary ID: KENWORTH T2000	Lab Number: I-012570
Address: 914 COMMERCIAL CT	Component Type: DIESEL ENGINE	Lab Location: Indianapolis
City: ONALASKA	Manufacturer: CUMMINS	Data Analyst: JXG
St./Prov: WI US	Model: ISX	Sampled: 12-Feb-2011
Postal Code: 54650	Application: O-T-R TRUCKING	Received: 18-Feb-2011
	Sump Capacity: 10	Completed: 22-Feb-2011
Filter Information	**Miscellaneous Information**	**Product Information**
Filter Type: FULLFLOW & BYPASS	Miscellaneous:	Product Manufacturer: HARTLAND
Micron Rating: 15		Product Name: SYNTHETIC DIESEL
		Viscosity Grade: SAE 5W40

Comments: Suggest inspecting cooling system, head gasket, heads, seals etc:) for leaks. Coolant indicators (Sodium, Potassium) are at a SEVERE LEVEL; Suggest flushing system; SILICON may be a coolant additive. LEAD is at a MINOR LEVEL and may be OVERLAY METAL from MAIN/ROD BEARINGS; Flagged data has been rechecked and confirmed; Lubricant and filter change acknowledged. Resample at half interval;

Wear Metals (ppm)												Contaminant Metals (ppm)			Multi-Source Metals (ppm)						Additive Metals (ppm)				
Lab #																									

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

The laboratory at which testing was completed is denoted by an I for Indianapolis, S for Salt Lake City, H for Houston, A for Atlanta. The following Lab # is assigned to the sample upon entry for processing and should be the reference number used when contacting the lab with questions, concerns or feedback.

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

Data Analysts Initials

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. Also noted is testing Date Completed.

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

Product Information identifies a lube's properties and its viscosity and is critical in determining if the right lube is being used.

Recommendations

A data analyst's job is to explain and, if necessary, recommend actions for rectifying significant changes in the lubricant or the unit's condition. Reviewing comments before looking at the actual test results will provide a road map 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.

Comments	Suggest inspecting cooling system (head gasket, heads, seals etc:) for leaks. Coolant indicators (Sodium, Potassium) are at a SEVERE LEVEL; Suggest flushing system; SILICON may be a coolant additive. LEAD is at a MINOR LEVEL and may be OVERLAY METAL from MAIN/ROD BEARINGS; Flagged data has been rechecked and confirmed; Lubricant and filter change acknowledged; Resample at half interval;

	Wear Metals (ppm)										Contaminant Metals (ppm)			Multi-Source Metals (ppm)						Additive Metals (ppm)				
Sample #	Iron	Chromium	Nickel	Aluminum	Copper	Lead	Tin	Cadmium	Silver	Vanadium	Silicon	Sodium	Potassium	Titanium	Molybdenum	Antimony	Manganese	Lithium	Boron	Magnesium	Calcium	Barium	Phosphorous	Zinc
5	31	0	0	1	0	1	0	0	0	0	4	21	9	0	48	0	0	0	27	1154	1025	0	1120	1278
6	37	0	0	1	0	5	0	0	0	0	4	22	12	0	38	0	0	0	13	977	884	0	964	1195
7	45	1	0	1	1	13	0	0	0	0	4	28	10	0	46	0	0	0	10	1071	794	0	1007	1210
8	35	0	0	1	0	2	0	0	0	0	5	49	35	0	43	1	0	0	18	982	846	0	982	1179
9	53	0	0	1	1	11	0	0	0	0	12	527	281	0	96	0	0	0	10	1140	846	0	1148	1237

	Sample Information							Contaminants			Fluid Properties					
Sample #	Date Sampled	Date Received	Lube Time	Unit Time	Lube Change	Lube Added	Filter Change	Fuel Dilution	Soot	Water	Viscosity 40°C	Viscosity 100 °C	Acid Number	Base Number	Oxidation	Nitration
								% Vol	% Vol	% Vol	cSt	cSt	mg KOH/g	mg KOH/g	abs/cm	abs/cm
5	16-Apr-2010	19-Apr-2010	15000	533778	No	0	Yes	<1 - GC	0.3 - FTIR	FTIR		13.5				

Laboratory may request additional unit and lube information if incomplete on sample label

Elemental Analysis

Elemental Analysis, or Spectroscopy, identifies the type and amount of wear particles, contamination and oil 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).

Combinations of these Wear Metals can identify components within the machine that are wearing. Knowing what metal 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 (ZDDP).

	Wear Metals (ppm)										Contaminant Metals (ppm)			Multi-Source Metals (ppm)						Additive Metals (ppm)				
Sample #	Iron	Chromium	Nickel	Aluminum	Copper	Lead	Tin	Cadmium	Silver	Vanadium	Silicon	Sodium	Potassium	Titanium	Molybdenum	Antimony	Manganese	Lithium	Boron	Magnesium	Calcium	Barium	Phosphorous	Zinc
5	31	0	0	1	0	1	0	0	0	0	4	21	9	0	48	0	0	0	27	1154	1025	0	1120	1278
6	37	0	0	1	0	5	0	0	0	0	4	22	12	0	38	0	0	0	13	977	884	0	964	1195
7	45	1	0	1	1	13	0	0	0	0	4	28	10	0	46	0	0	0	10	1071	794	0	1007	1210
8	35	0	0	1	0	2	0	0	0	0	5	49	35	0	43	1	0	0	18	982	846	0	982	1179
9	53	0	0	1	1	11	0	0	0	0	12	527	281	0	96	0	0	0	10	1140	846	0	1148	1237

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 are listed by Date Received in the lab- oldest first. They are also assigned a Lab Number for easy internal tracking. Important to also note is whether or not the Lube has been Changed since the last sample was taken.

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

7	45	1	0	1	1	13	0		0	0	4	28	10	0	46	0	0	0	10	1071	794	0	1007	1210
8	35	0	0	1	0	2	0	0	0	0	5	49	35	0	43	1	0	0	18	982	846	0	982	1179
9	53	0	0	1	1	11	0	0	0	0	12	527	281	0	96	0	0	0	10	1140	846	0	1148	1237

	Sample Information							Contaminants			Fluid Properties					
Sample #	Date Sampled	Date Received	Lube Time	Unit Time	Lube Change	Lube Added	Filter Change	Fuel Dilution % Vol	Soot % Vol	Water % Vol	Viscosity 40°C cSt	Viscosity 100 °C cSt	Acid Number mg KOH/g	Base Number mg KOH/g	Oxidation abs/cm	Nitration abs/cm
5	16-Apr-2010	19-Apr-2010	15000	533778	No	0	Yes	<1 - GC	0.3 - FTIR	<.1 - FTIR		13.5				
6	14-May-2010	20-May-2010	29000	547156	Yes	0	Yes	0.2 - GC	0.8 - FTIR	<.1 - FTIR		13.1				
7	07-Aug-2010	13-Aug-2010	29000	576979	Yes	0	Yes	0.5 - GC	1.6 - FTIR	<.1 - FTIR		13.2				
8	13-Dec-2010	03-Jan-2011	21000	623910	Yes	0	Yes	<1 - GC	0.7 - FTIR	<.1 - FTIR		13.7		5.96	11	16
9	12-Feb-2011	18-Feb-2011	24000	647540	Yes	0	Yes	<1 - GC	0.3 - FTIR	<.1 - FTIR		14.0			14	19

	Particle Count (particles/mL)										Additional Testing	
Sample #	ISO Code Based On 4/6/14	> 4 µm	> 6 µm	> 10 µm	> 14 µm	> 21 µm	> 38 µm	> 70 µm	> 100 µm	Test Method	Particle Quantifier Index	
5												

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.

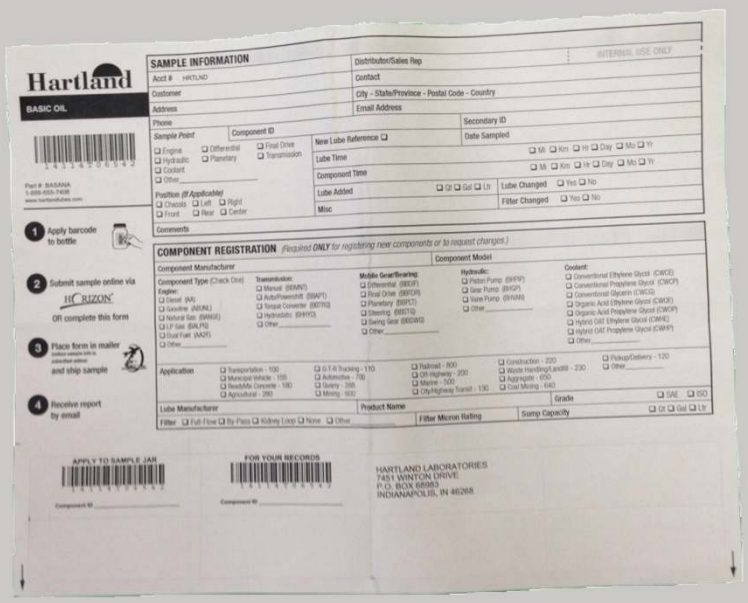
The Particle Count is a cumulative range between 4 and 100 microns. This test is valuable in determining large particle wear in filtered systems.

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

(Engine oil samples only)

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 ASTM D1744 determines the amount of water present. These results appear in the Special Testing section of your report.

Step 1


Hartland
BASIC OIL
SAMPLE INFORMATION
COMPONENT REGISTRATION
APPLY TO SAMPLE JAR
FOR YOUR RECORDS
HARTLAND LABORATORIES
7451 WINTON DRIVE
P.O. BOX 68983
INDIANAPOLIS, IN 46268

Component Registration Forms

A **Component Registration Form** is included with every sample kit. Fill it out **only** when sampling a new component for the first time **or** to notify the laboratory of a change in component and/or fluid information already registered with the laboratory. **Complete, up-to-date information ensures that you receive the proper testing and an accurate analysis of the results.**

- Fill out the **Component Registration Form** completely and accurately.
  - Use this form **only** for first-time samples or changes in unit **or** fluid information previously submitted.
- Include it in the black mailer with the sample jar.

Step 2

Sample Labels

Complete a **sample jar label** for **every** sample submitted to the laboratory. **Be sure to fill out all label information completely and accurately to ensure proper testing and accurate, in-depth analysis.** Once complete, attach the label to the sample bottle. Fill in the unit's ID on the removable tracking number sticker located to the right of the sample label and retain for your records.

- Fill out the **sample jar label** completely and accurately.
  - Include **all** unit and fluid informationrequested including unit ID, type of component and position, time on both the fluid and the unit and whether or not fluid has been added or changed.
- Attach label to sample jar.
- Complete sample tracking sticker and retain for your records.

NOTE: When you provide the most accurate and complete unit and fluid information, your laboratory can deliver the most accurate and complete results and recommendations.

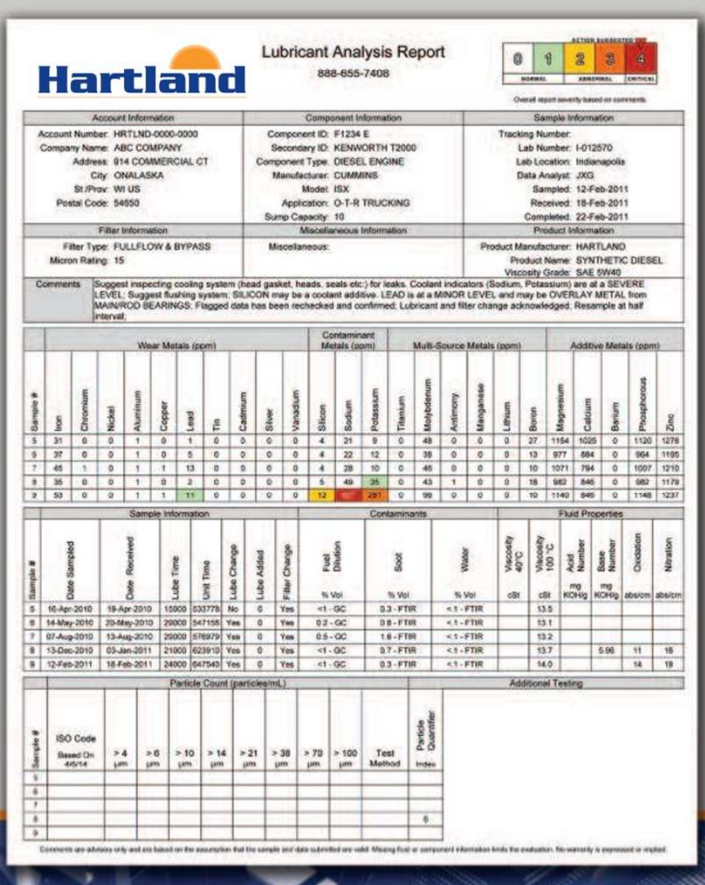
Step 3

Sampling and Shipping

Take samples representative of normal operating conditions. Pull samples at regularly scheduled intervals and from the same sampling points each time. Place the labeled sample jar and component registration form, if applicable, in the mailer provided. Complete the return address label for the laboratory location nearest you and attach it to the black mailer. Apply the appropriate postage and ship. **It is highly recommended that a track-able delivery service be used for shipping samples to the laboratory.**

- Take representative samples.
- Complete and attach the return address label to the black mailer.
- Include sample jar **and** component registration form, if applicable, in water proof mailing bag.
- Ship by track-able delivery service such as FedEx or UPS.

Step 4


Hartland

Lubricant Analysis Report

888-655-7408

Account Information	Component Information	Sample Information
Account Number: HRTLND-0000-0000	Component ID: F1234 E	Tracking Number:
Company Name: ABC COMPANY	Secondary ID: KENWORTH T2000	Lab Number: I-012570
Address: 914 COMMERCIAL CT	Component Type: DIESEL ENGINE	Lab Location: Indianapolis
City: ONALASKA	Manufacturer: CUMMINS	Data Analyst: JXG
St./Prov: WI US	Model: ISX	Sampled: 12-Feb-2011
Postal Code: 54650	Application: O-T-R TRUCKING	Received: 18-Feb-2011
	Sump Capacity: 10	Completed: 22-Feb-2011
Filter Information	**Miscellaneous Information**	**Product Information**
Filter Type: FULLFLOW & BYPASS	Miscellaneous:	Product Manufacturer: HARTLAND
Micron Rating: 15		Product Name: SYNTHETIC DIESEL
		Viscosity Grade: SAE 5W40

Comments: Suggest inspecting cooling system (head gasket, heads, seals etc.) for leaks. Coolant indicators (Sodium, Potassium) are at a SEVERE LEVEL; Suggest flushing system; SILICON may be a coolant additive. LEAD is at a MINOR LEVEL and may be OVERLAY METAL from MAIN/ROD BEARINGS; Flagged data has been rechecked and confirmed; Lubricant and filter change acknowledged; Resample at half interval;

	Wear Metals (ppm)										Contaminant Metals (ppm)			Multi-Source Metals (ppm)					Additive Metals (ppm)				
Sample #	Iron	Chromium	Nickel	Aluminum	Copper	Lead	Tin	Cadmium	Silver	Vanadium	Silicon	Sodium	Potassium	Titanium	Molybdenum	Antimony	Manganese	Lithium	Boron	Magnesium	Calcium	Barium	Phosphorus	Zinc
5	31	0	0	1	0	1	0	0	0	0	4	21	9	0	48	0	0	0	27	1154	1025	0	1120	1276
6	37	0	0	1	0	5	0	0	0	0	4	22	12	0	38	0	0	0	13	977	864	0	964	1195
7	45	1	0	1	13	0	0	0	0	0	4	28	10	0	46	0	0	0	10	1071	794	0	1007	1210
8	35	0	0	1	0	2	0	0	0	0	5	49	35	0	43	1	0	0	18	982	846	0	982	1179
9	53	0	0	1	1	11	0	0	0	0	12	62	281	0	99	0	0	0	10	1140	845	0	1148	1237

	Sample Information							Contaminants			Fluid Properties					
Sample #	Date Sampled	Date Received	Lube Time	Unit Time	Lube Change	Lube Added	Filter Change	Fuel Dilution % Vol	Soot % Vol	Water % Vol	Viscosity 40°C cSt	Viscosity 100 °C cSt	Acid Number mg KOH/g	Base Number mg KOH/g	Oxidation abs/cm	Nitration abs/cm
5	16-Apr-2010	19-Apr-2010	15000	533778	No	0	Yes	<1 - GC	0.3 - FTIR	<1 - FTIR		13.5				
6	14-May-2010	20-May-2010	29000	547156	Yes	0	Yes	0.2 - GC	0.6 - FTIR	<1 - FTIR		13.1				
7	07-Aug-2010	13-Aug-2010	29000	576979	Yes	0	Yes	0.5 - GC	1.6 - FTIR	<1 - FTIR		13.2				
8	13-Dec-2010	03-Jan-2011	21000	623910	Yes	0	Yes	<1 - GC	0.7 - FTIR	<1 - FTIR		13.7		5.96	11	16
9	12-Feb-2011	18-Feb-2011	24000	647540	Yes	0	Yes	<1 - GC	0.3 - FTIR	<1 - FTIR		14.0			14	19

	Particle Count (particles/mL)										Additional Testing
Sample #	ISO Code Based On 4/6/14	> 4 µm	> 6 µm	> 10 µm	> 14 µm	> 21 µm	> 38 µm	> 70 µm	> 100 µm	Test Method	Particle Quantifier Index
5											
6											
7											
8											6
9											

Comments are advisory only and are based on the assumption that the sample and data submitted are valid. Missing fluid or component information limits the evaluation. No warranty is expressed or implied.

Test Reports and Data Management

Hartland's free online reporting option – **HORIZON® 4.0** – is fast, bringing you test results almost immediately after processing is complete. **HORIZON® 4.0** Management Reports allow you to affect positive changes in your daily maintenance practices by keeping sampling on track, identifying bottlenecks in turnaround time that are costing you money and summarizing unit problems that could influence future purchasing decisions. And control over an extensive host of personal application settings and preferences gives you the power to **put the information you need most in front of you first.**

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- Affect positive change in your daily maintenance practices.
- Keep sampling schedules on track.
- Identify bottlenecks in sample turnaround time.
- Influence future purchasing decisions.
- Place the information you need most in front of you first.
- Track sample progress through laboratory.

Send your samples to the laboratory location nearest you.

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