

TRU-TEST™ Fluid Analysis Laboratory Locations

INDIANAPOLIS

7451 Winton Drive
Indianapolis, IN 46268

HOUSTON

10910 W. Sam Houston Pkwy. N., Suite 700
Houston, TX 77064-6314

SALT LAKE CITY

3060 W. California Avenue, Suite B
Salt Lake City, UT 84104

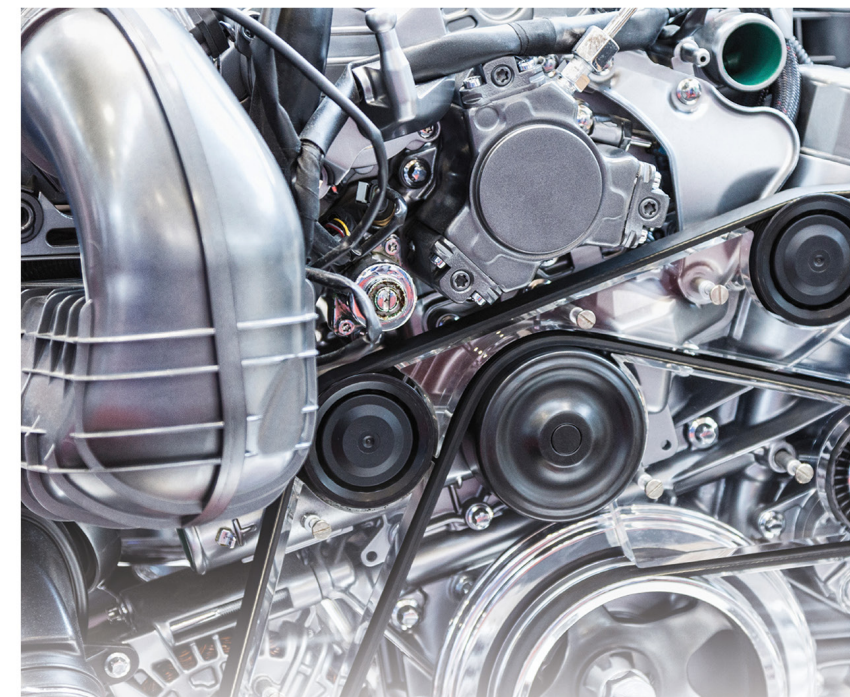
EDMONTON

5140 75th Street
Edmonton, AB T6E 6W2 Canada

Send your samples to the laboratory location nearest you.



PITTSBURGH POWER Contact Information
3600 South Noah Drive, Saxonburg, PA 16056-9745
Customer Service: 724-360-4080
www.pittsburghpower.com





What Can OPS Tru-Test™ Fluid Analysis Do For You?

Fluid Analysis provides you with a snapshot of what is happening inside your equipment. It tells you the condition of the lubricant and identifies component wear and contamination in virtually any application. With OPS' Tru-Test™ Fluid Analysis program, you can identify dirt, wear particles and other contaminants that can cause catastrophic failure or significantly shorten equipment life. When you make Tru-Test™ an integral part of your preventive maintenance program, you will be able to:

- **Identify opportunities for optimizing filtration performance**
- **Safely extend oil drain intervals**
- **Extend equipment life**
- **Minimize downtime by identifying minor problems before they become major failures**
- **Maximize asset reliability**

Benefits of Using Tru-Test™

- High quality testing by an independent ISO 17025 A2LA accredited laboratory
- Results available online immediately upon sample processing completion
- Innovative data management tools that will help you affect change in daily maintenance practices

Why Tru-Test™?

High Quality Testing

With Tru-Test™, you can be confident you're testing with a laboratory that knows your equipment better than anyone and all of OPS' independent 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 service.

Innovative Data Management Capabilities

Tru-Test's online reporting software option, HORIZON®, will show you how to get the most from your testing results and analysis. Results are FREE and available almost immediately after sample processing is complete. You can easily set or change application preferences and filters to organize the critical information you need to stay focused on your goals. HORIZON® Management Reports can show you how to use the data to affect positive change in your daily maintenance practices by:

- Keeping sampling schedule on track
- Identifying bottlenecks in turnaround time
- Influencing future purchasing decisions
- Register samples online

Best in Class Customer Service

To OPS, best in class customer service means our experienced service technicians monitor all reports and contact you when any report reaches a level of severity that requires attention (level 3 or 4). Our technicians know your equipment and help customers troubleshoot problems. They will also make maintenance recommendations to help prevent minor problems from becoming catastrophic failures. Rest assured that at OPS, our technicians are knowledgeable, accessible, and always willing to help.



Tru-Test™ Fluid Analysis Test Packages

Tru-Test™ Fluid Analysis kits provide advanced diagnostic and preventive maintenance testing designed to evaluate fluid condition, component wear and contamination in engines, hydraulic systems, transmissions, differentials, gear boxes, final drives, turbines and compressors.

To order Tru-Test Fluid Analysis kits, sampling equipment or supplies, contact your local OPS Sales Representative or distributor.

OIL ANALYSIS TEST PACKAGE INFORMATION

A-104-D

Test	Method	Engine	Non-Engine
24 Metals by ICP	ASTM D5185	●	●
Fuel Dilution-GC	ASTM D7593	●	
Fuel Dilution (est.)	Viscosity		
Soot %	ASTM E2412	●	
Water (est.)	Crackle	●	●
Viscosity @ 40°C or 100° C	ASTM D445	●	●
Oxidation/Nitration	ASTM E2412	●	
Base Number	ASTM D4739	●	
Acid Number	ASTM D664		●

ICP=Inductive Coupled Plasma

GC=Gas Chromotography

A-104-H COOLANT ANALYSIS

TEST	METHOD	TEST	METHOD
15 Metals by ICP	ASTM D6130	Nitrites	POLARIS
Visuals	POLARIS	SCA Number	POLARIS
Hardness	POLARIS	pH	ASTM D1287
Freeze Point	ASTM D3321	Speciffc Conductance	Meter Measurement
Boil Point	POLARIS	Total Dissolved Solids	Meter Measurement
Antifreeze %	POLARIS	HPLC (Corrosion Inhibitor Protection)	POLARIS

Taking Samples

Why Sample

Regular sampling with TruTest will provide the necessary information you need to continually maximize asset reliability. Monitoring results over an extended period of time will ensure the component is functioning properly and not wearing excessively etc. You will also confirm oil quality allowing you to extend oil drains to maximize oil life, reducing costs and providing proper protection for the component.

How to Sample

Sample should be taken while equipment is operating so that wear metals and contaminants don't have an opportunity to settle. Take a flowing sample by removing dust cap from sampling valve (right) installed on OPS product. Hold sample bottle under valve and depress to fill the bottle 3/4 full. If component is not equipped with sampling valve use a siphon to draw fluid or collect from drain etc.



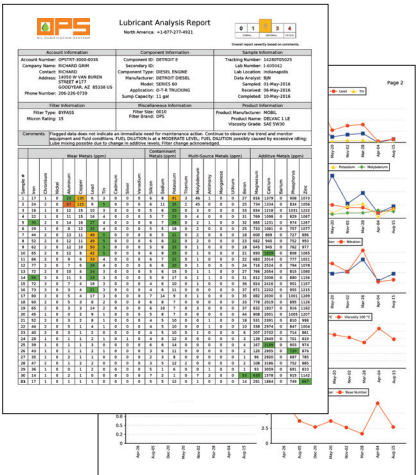
Determining Sampling Intervals

In many cases, the OEM will suggest an appropriate sampling interval. The type of equipment and the environment it operates in as well as the value of the equipment to your business needs to be considered. Environmental factors such as hot, dirty operating conditions, short trips with heavy loads and excessive idle times, are examples of factors that can extend of shorten sample intervals.

SUGGESTED SAMPLING INTERVALS & METHODS

	Component Interval*	Service Requirement	Sample Method
Engine–Transportation	20,000 miles or OE recommended interval	Sample oil and change OPS filter	OPS sampling valve
Engine–Vocational Application	250 hours or OE recommended interval	Sample oil and change OPS filter	OPS sampling valve
Engine–Transit Bus	3,000 miles or OE recommended intervals	Sample oil and change OPS filter	OPS sampling valve
Hydraulic Systems	250–500 hours chagne OPS filter	Sample oil and change OPS filter	OPS sampling valve
Gearboxes or other Industrial fluids	250–500 hours	Sample oil	Draw/Siphon

* If you are interested in extended sampling and service intervals, please contact your OPS representative



How to Read the Tru-Test™ Fluid Analysis Report

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 Fluid Analysis program that can be followed consistently each time the unit is sampled. **Accurate, thorough and complete fluid and equipment information allows for more in-depth analysis and can eliminate confusion when interpreting results.**

Component ID is each **customer's** opportunity to uniquely identify components being tested and their location Using unique identifier on every sample allows lab to combine reports providing historical data for trend analysis.

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

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

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.

The laboratory at which testing was completed. Lab locations are **Indianapolis, Houston, Salt Lake City** and **Edmonton**. 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.

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**.

Product Manufacturer, Name and **Grade** identify 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.



Lubricant Analysis Report

North America: +1-877-277-4921

0	1	2	3	4
NORMAL		ABNORMAL		CRITICAL

Overall report severity based on comments.

Account Information		Component Information		Sample Information	
Account Number: OPSTRT-3000-0036 Company Name: RICHARD GRIM Contact: RICHARD Address: 14050 W VAN BUREN STREET #177 GOODYEAR, AZ 85338 US Phone Number: 206-226-0739		Component ID: I12345 E Secondary ID: Component Type: DIESEL ENGINE Manufacturer: DETROIT DIESEL Model: SERIES 60 Application: O-T-R TRUCKING Sump Capacity: 11 gal		Tracking Number: 14280T05025 Lab Number: I-405042 Lab Location: Indianapolis Data Analyst: BJN Sampled: 01-May-2016 Received: 06-May-2016 Completed: 10-May-2016	
Filter Information		Miscellaneous Information		Product Information	
Filter Type: BYPASS Micron Rating: 15		Filter Size: 0010 Filter Brand: OPS		Product Manufacturer: MOBIL Product Name: DELVAC 1 LE Viscosity Grade: SAE 5W30	
Comments	Flagged data does not indicate an immediate need for maintenance action. Continue to observe the trend and monitor equipment and fluid conditions. FUEL DILUTION is at a MODERATE LEVEL; FUEL DILUTION possibly caused by excessive idling; Lube mixing possible due to change in additive levels; Filter change acknowledged.				

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 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. Sodium and Potassium could be environmental or signs of coolant contamination.

Multi-Source Metals may be formulated in some oils or contaminants from wear or intrusion, etc.

Additive Metals sample results are compared to oil specifications to ensure proper levels.

Sample #	Wear Metals (ppm)										Contaminant Metals (ppm)		Multi-Source Metals (ppm)						Additive Metals (ppm)					
	Iron	Chromium	Nickel	Aluminum	Copper	Lead	Tin	Cadmium	Silver	Vanadium	Silicon	Sodium	Potassium	Titanium	Molybdenum	Antimony	Manganese	Lithium	Boron	Magnesium	Calcium	Barium	Phosphorus	Zinc
1	17	1	0	20	135	6	3	0	0	0	6	8	41	3	46	1	0	0	27	816	1379	0	908	1073
2	24	2	0	67	115	9	5	0	0	0	6	11	35	2	45	0	0	0	25	734	1334	0	834	1056
3	16	1	0	12	15	10	3	0	0	0	5	6	20	0	3	0	0	0	33	834	1218	0	1031	1222
4	22	1	0	11	15	16	4	0	0	0	5	7	23	0	4	0	0	0	31	769	1098	0	829	1087
5	30	2	0	14	16	27	4	0	0	0	6	7	26	0	2	1	0	0	32	865	1231	0	974	1267
6	29	1	0	8	12	25	4	0	0	0	5	5	18	0	2	0	0	0	25	733	1081	0	757	1077
7	44	2	0	13	11	48	5	0	0	0	6	5	21	0	2	0	0	0	18	600	889	0	727	896
8	52	2	0	12	11	49	5	0	0	0	6	6	22	0	2	0	0	0	23	662	940	0	752	950

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.

Fuel and **Soot** are reported in % of volume. High fuel dilution decreases unit load capacity as a result of reduced oil viscosity. Excessive soot is a sign of reduced combustion efficiency (only on engine oil samples).

Water in oil decreases lubricity, prevents additives from working and furthers oxidation, acid formation and sludge build up.. 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.

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.

Base Number provides an indication of the engine oil's ability to neutralize degradation acids – sulfuric acid and nitric acid – that form during the combustion process through the combination of water with sulfur from fuel and nitrogen from the air.

Oxidation occurs during the natural breakdown of the oil. As it degrades acids are formed. **Nitration** is a sign of combustion blow-by which eventually forms nitric acid. Oxidation and nitration will increase as base number decreases.

Sample #	Sample Information							Contaminants			Fluid Properties					
	Date Sampled	Date Received	Lube Time mi	Unit Time mi	Lube Change	Lube Added gal	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/0.1 mm
1	29-Oct-2012	06-Nov-2012	35454	35454	No	3	Yes	1.5 - GC	0.1 - E2412	<.1 - FTIR		13.1		6.61	12	7
2	17-Nov-2012	21-Nov-2012	51754	78568	No	3	Yes	1.6 - GC	0.2 - E2412	<.1 - FTIR		13.2		3.61	15	9
3	01-Feb-2013	04-Feb-2013	32662	133871	Yes		Yes	1.8 - GC	0.2 - E2412	<.1 - FTIR		13.0		6.29	13	9
4	23-Feb-2013	03-Apr-2013	51145	152354	No	3	Yes	2.4 - GC	0.1 - E2412	<.1 - FTIR		12.6		5.48	12	8
5	N/A	14-Mar-2013	0	0	Unk	0	Unk	2.8 - GC	0.3 - E2412	<.1 - FTIR		13.1		5.20	13	9
6	01-Apr-2013	02-Apr-2013	74200	175417	No	0	No	2.7 - GC	0.3 - E2412	<.1 - FTIR		12.9		4.75	13	9
7	23-Apr-2013	25-Apr-2013	92664	193872	No	2	Yes	<1 - Estimate	0.4 - E2412	<.1 - FTIR		15.0		3.47	13	8
8	04-May-2013	08-May-2013	102000	203283	No	2	No	0.2 - GC	0.5 - E2412	<.1 - FTIR		14.7		4.70	14	9
9	30-May-2013	30-May-2013	12000	221602	No	2	Yes	3.1 - GC	0.6 - E2412	<.1 - FTIR		14.9		3.21	16	10
10	30-Jun-2013	03-Jul-2013	148436	249644	No	2	Yes	2.9 - GC	0.9 - E2412	<.1 - FTIR		14.2		4.99	18	12
11	02-Aug-2013	07-Aug-2013	176484	277692	No	2	Yes	2.7 - GC	1.0 - E2412	<.1 - FTIR		14.7		6.03	18	12
12	28-Sep-2013	02-Oct-2013	208000	308883	No	2	Yes	3.0 - GC	1.2 - E2412	<.1 - FTIR		13.0		4.37	20	15
13	11-Nov-2013	14-Nov-2013	244331	345334	No	2	Yes	3.2 - GC	1.4 - E2412	<.1 - FTIR		14.1		5.02	20	14
14	30-Dec-2013	03-Jan-2014	30000	378919	No	2	Yes	3.2 - GC	1.0 - E2412	<.1 - FTIR		13.9		4.19	19	13
15	14-Feb-2014	18-Feb-2014	316000	416099	No	2	Yes	2.6 - GC	1.0 - E2412	<.1 - FTIR		14.1		4.82	20	14
16	01-Apr-2014	03-Apr-2014	33000	448942	No	2	Yes	3.0 - GC	0.9 - E2412	<.1 - FTIR		13.4		5.07	21	14
17	03-May-2014	07-May-2014	376800	476800	No	2	Yes	3.2 - GC	1.0 - E2412	<.1 - FTIR		13.6		3.56	19	13
18	25-Jul-2014	30-Jul-2014	403689	503689	No	2	Yes	2.8 - GC	1.0 - E2412	<.1 - FTIR		15.0		5.22	18	13
19	29-Sep-2014	09-Oct-2014	430000	530000	No	2	Yes	3.4 - GC	1.1 - E2412	<.1 - FTIR		13.7		3.68	20	14
20	17-Nov-2014	20-Nov-2014	455347	555347	No	2	Yes	2.5 - GC	0.6 - E2412	<.1 - FTIR		13.5		4.98	17	11
21	28-Dec-2014	05-Jan-2015	473868	573868	No	2	Yes	3.4 - GC	0.6 - E2412	<.1 - FTIR		12.9		4.90	21	13
22	23-Feb-2015	26-Feb-2015	500000	601878	No	4	Yes	3.1 - GC	0.4 - E2412	<.1 - FTIR		12.2		5.61	22	13
23	10-Apr-2015	16-Apr-2015	533349	633349	No	0	Yes	4.0 - GC	0.4 - E2412	<.1 - FTIR		11.8		4.93	22	12
24	03-May-2015	05-May-2015	548000	648000	No	0	No	2.5 - GC	<.1	<.1 - FTIR		11.8		5.95	23	13
25	06-Jun-2015	12-Jun-2015	565160	665160	No	3	Yes	4.4 - GC	0.4 - E2412	<.1 - FTIR		12.3		5.02	21	12
26	15-Jul-2015	20-Jul-2015	594803	694803	No	4	Yes	3.6 - GC	0.1 - E2412	<.1 - FTIR		12.0		5.56	21	12
27	23-Aug-2015	27-Aug-2015	627586	727586	No	4	Yes	2.6 - GC	0.1 - E2412	<.1 - FTIR		11.7		5.58	21	12
28	N/A	06-Sep-2015	616888	716888	No	2	Yes	1.8 - GC	0.2 - E2412	<.1 - FTIR		13.6		5.18	22	13

