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BEARING RELIABILITY CONFERENCE & EXPO

Fluid Analysis for Bearing Reliability

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Question: Why Oil Analysis….?

Answer: To improve the lives of Maintenance & Reliability Engineers…..

An effectively executed fluid analysis program eliminates the guesswork, risk and reactionary nature of your maintenance department. When companies transition from preventive maintenance to predictive maintenance, they realize greater impact, uptime and savings. These are proven results that drive performance and business success.

POLARIS Laboratories, 2015

Why do Bearings fail, or impair reliable operations

- Mechanical Problems
  - Misalignment
  - Incorrect Fits
- Changes in Operation
  - Load
  - Temperature
- Contamination
- Fluid Condition

Condition Monitoring Techniques

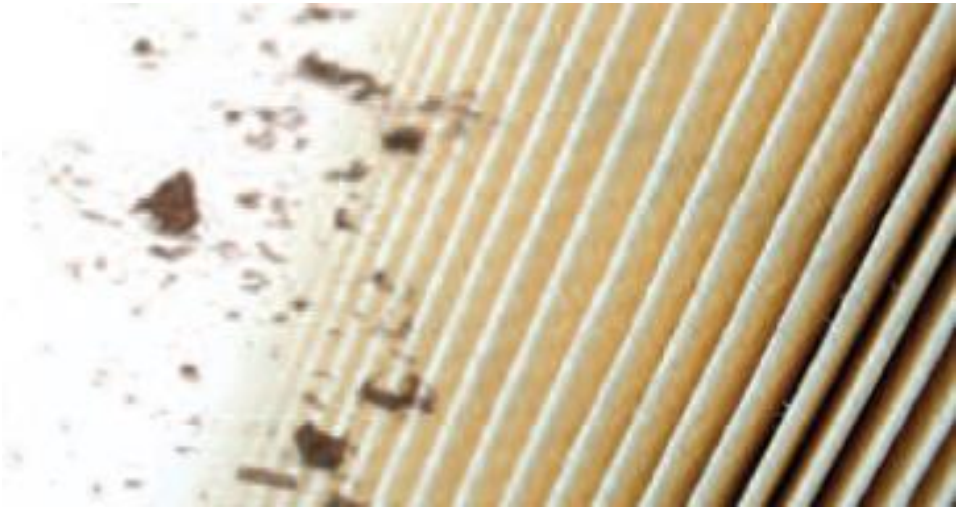
Condition	Oil Analysis	Wear Debris Analysis	Vibration Analysis	Thermography
Contamination	Excellent	Good	Poor	Poor
Wear	Excellent	Excellent	Fair	Poor
Misalignment	Poor	Fair	Excellent	Good
Heat Problems	Fair	Fair	Poor	Excellent
Gear/Bearing Defects	Poor	Poor	Excellent	Poor

Contamination

Over 80% of equipment failures are contamination related breakdowns, oil analysis is one of the easiest ways to monitor contamination

Common Problems:

- Dirt
- Water
- Process Contaminants
- Grease
- Sealant/Build Debris
- Fuel Dilution
- Coolant



PARTICULATE CONTAMINATION

- Particles cause 82% of wear in the 6 main industrial sectors in Canada – National Research Council of Canada
- "Bearings can have an infinite life when particles larger than the lubricant film are removed." – SKF
- Compared to 40-micron filtration…wear was reduced 70% with 15-micron filtration." – General Motors

ACCEPTABLE LEVELS OF WATER

- Research indicates that very small amounts of water reduce bearing life
- For turbine oil systems ASTM D4378 In-Service Monitoring Guideline lists 0.2% (2000 ppm) as maximum (which is too high)
- SKF recommends maximum of .02% (200 ppm) for bearings
- Best practice is to maintain lowest level practical below saturation point

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HOW MUCH WATER IS TOO MUCH?

Life Extension Factor

Current Moisture Level

ppm	2	3	4	5	6	7	8	9	10
50000	12500	6500	4500	3125	2500	2000	1500	1000	782
25000	6250	3250	2250	1563	1250	1000	750	500	391
10000	2500	1300	900	625	500	400	300	200	156
5000	1250	650	450	313	250	200	150	100	78
2500	625	325	225	156	125	100	75	50	39
1000	250	130	90	63	50	40	30	20	16
500	125	65	45	31	25	20	15	10	8
250	63	33	23	16	13	10	8	5	4
100	25	13	9	6	5	4	3	2	2

Estimated life extension for mechanical systems utilizing mineral-based fluids.

Example: By reducing average fluid moisture levels from 2500 ppm to 156 ppm machine life (MTBF) is extended by a factor of 5.

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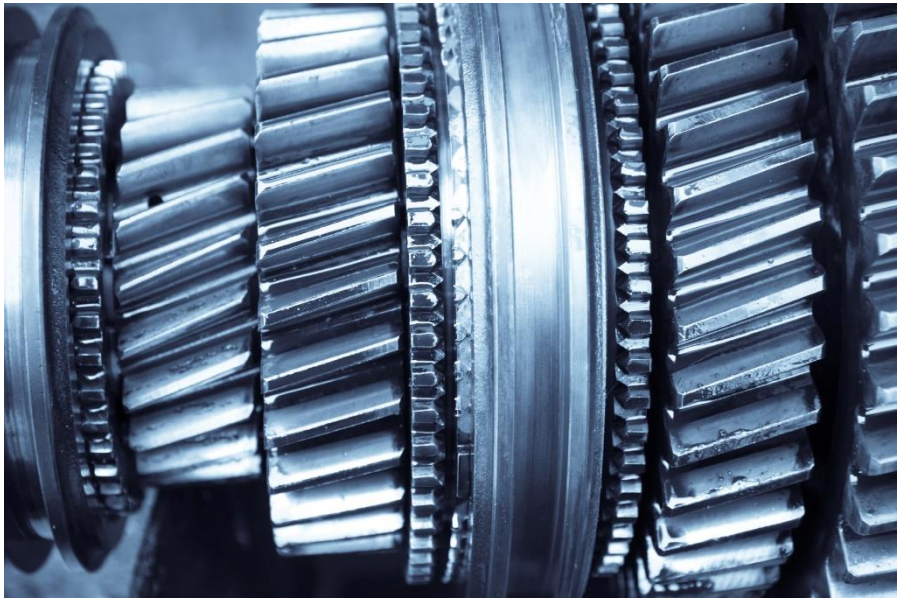
Fluid Condition

Acid Number & Oxidation

Viscosity

Additive Levels

Wear Metal Monitoring



Wear Metals

Iron	Chromium	Nickel	Aluminium	Copper	Lead	Tin	Cadmium	Silver	Titanium	Vanadium
13	0	0	1	2	0	0	0	0	0	0

Fluid Analysis for Bearing Reliability

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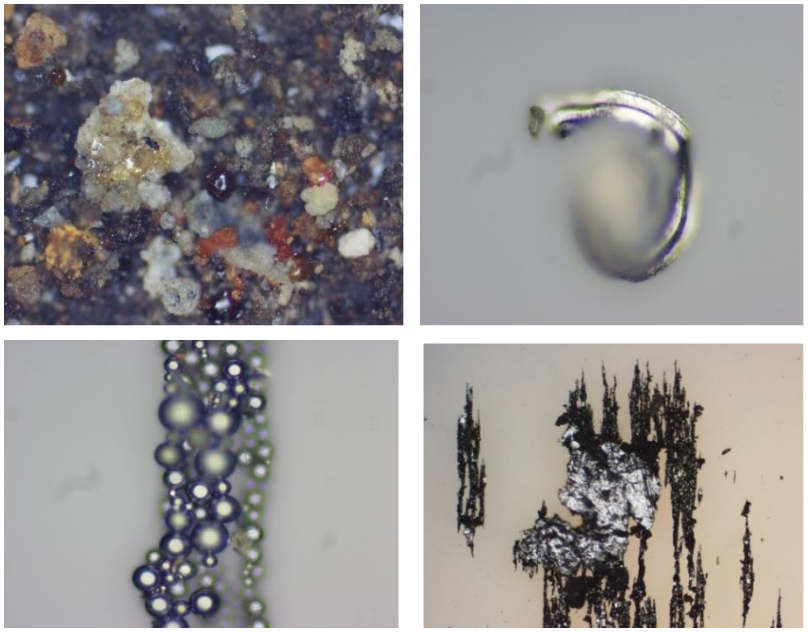
	Wear Metals (ppm)										Contaminant Metals (ppm)			Multi-Source Metals (ppm)						Additive Metals (ppm)				
Sample #	Iron	Chromium	Nickel	Aluminum	Copper	Lead	Tin	Cadmium	Silver	Vanadium	Silicon	Sodium	Potassium	Titanium	Molybdenum	Antimony	Manganese	Lithium	Boron	Magnesium	Calcium	Barium	Phosphorous	Zinc
19	2	0	0	0	1	0	0	0	0	0	2	4	0	0	0	0	0	0	1	43	115	1	351	435
18	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	42	106	0	330	410
17	1	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	34	90	1	304	355
16	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	21	77	0	318	403
15	1	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	27	81	0	314	387

	Sample Information							Contaminants			Fluid Properties					
Sample #	Date Sampled	Date Received	Lube Time	Unit Time unk	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/0.1 mm
19	29-Dec-2013	05-Jan-2014			No		Unk			<.1 - FTIR	35.9		0.75		2	4
18	17-Nov-2013	22-Nov-2013			No		No			<.1 - FTIR	34.7		0.55		5	7
17	17-Oct-2013	22-Oct-2013			No		Unk			<.1 - FTIR	34.9		0.16		5	6
16	15-Aug-2013	25-Aug-2013			No		Unk			<.1 - FTIR	33.9		0.56		3	5
15	19-Jun-2013	08-Jul-2013			No		Unk			<.1 - FTIR	34.5		0.70		3	5

	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
19	22/22/20	36898	31669	18469	9984	**2751**	151	9	2	Laser
18	22/21/18	27074	13091	3453	1462	441	41	3	1	Laser
17	22/21/18	38134	18477	4653	1764	419	36	4	1	Laser
16	22/21/17	33486	11315	1995	804	219	10	1	0	Laser
15	22/21/18	33767	17030	5420	2116	482	35	3	1	Laser

Wear Debris Analysis

- Analytical Ferrography
  - Rubbing Wear
  - Abrasive Wear
  - Cutting Wear
  - Spheres (Pre-Cursor to Fatigue)
  - Spalling Wear (Fatigue)
  - Laminar Bearing Wear
  - Corrosive
    - Red Oxides
    - Black Oxides
  - Non-Metallic Contaminants



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Going Beyond The Sample Report

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Lubricant Analysis Report

North America: +1-877-808-3750

0	1	2	3	4
NORMAL		ABNORMAL		CRITICAL

Overall report severity based on comments.

Account Information	Component Information	Sample Information
Account Number:	Component ID: 33113022 E	Tracking Number:
Company Name:	Secondary ID: 2KR00883	Lab Number: I-098153
Contact:	Component Type: DIESEL ENGINE	Lab Location: Indianapolis
Address:	Manufacturer: CATERPILLAR	Data Analyst: JDT
Phone Number:	Model: 980G	Sampled: 17-May-2014
	Application: QUARRY	Received: 20-Jun-2014
	Sump Capacity: 0 gal	Completed: 25-Jun-2014
Filter Information	**Miscellaneous Information**	**Product Information**
Filter Type: FULLFLOW		Product Manufacturer: MOBIL
Micron Rating: 15		Product Name: DELVAC 1300 SUPER
		Viscosity Grade: SAE 15W40

Comments: SUGGEST INSPECTING this unit for excessive bearing wear; Suggest INSPECTING COOLING SYSTEM (head gasket, heads, seals, EGR gaskets, etc.) for leaks. Coolant indicators (Sodium and/or Potassium) are at a SEVERE LEVEL. Bearing metal is at a SEVERE LEVEL; Lube mixing possible due to change in additive levels; 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	Aluminium	Copper	Lead	Tin	Cadmium	Silver	Vanadium	Silicon	Sodium	Potassium	Titanium	Molybdenum	Antimony	Manganese	Lithium	Boron	Magnesium	Calcium	Barium	Phosphorous	Zinc
18	21	0	0	0	1	0	0	0	0	0	4	3	2	0	33	0	0	0	24	469	922	0	575	698
19	12	0	0	0	1	0	0	0	0	0	2	2	0	0	33	0	0	0	23	537	1035	0	652	731
20	33	0	0	2	20	7	1	0	0	0	4	118	9	0	76	0	0	0	15	798	1416	0	944	1126
21	27	0	0	0	12	3	0	0	0	0	4	54	6	0	56	0	0	0	15	777	1427	0	878	1068
22	41	1	1	1	85	71	1	0	0	0	6	651	15	0	171	0	0	0	13	705	1321	0	871	1087

	Sample Information							Contaminants			Fluid Properties					
Sample #	Date Sampled	Date Received	Lube Time h	Unit Time h	Lube Change	Lube Added gal	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/0.1 mm
18	23-Apr-2012	02-May-2012	350	44663	Yes		Unk	>10 - GC	0.7 - FTIR	<.1 - FTIR		5.7		4.23	10	8
19	01-Jun-2012	13-Jun-2012	300	45075	Yes	0	Yes	>10 - GC	0.6 - FTIR	<.1 - FTIR		7.0		7.22	15	7
20	N/A	07-Oct-2013	300	47232	Yes	0	Yes	<1 - Estimate	1.9 - FTIR	<.1 - FTIR		14.9		5.58	15	12
21	25-Mar-2014	22-Apr-2014	350	47715	Yes	0	Yes	<1 - Estimate	2.2 - FTIR	<.1 - FTIR		14.6		6.95	15	11
22	17-May-2014	20-Jun-2014	751	48476	Yes	0	Yes	<1 - Estimate	1.8 - FTIR	<.1 - FTIR		15.2		7.23	14	14

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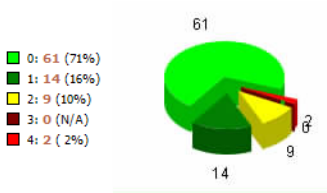
SEVERITY STATUS



SAMPLES SUGGESTING MAINTENANCE

URER:	LAB NO. 645203	SAMPLED: 02/11/2008	LUBE TIME: 40	LUBE CHG: Y
	SEVERITY: 4	RECEIVED: 02/12/2008	UNIT TIME: 9540	LUBE ADD: 55000

COOLANT INDICATORS (SODIUM, POTASSIUM) ARE AT A MODERATE LEVEL; COOLANT LEAKS AT THIS LEVEL WILL TICS; SUGGEST MONITORING COOLANT LEVEL CLOSELY BETWEEN SAMPLES; SUSPECT MOST OF THE COPPER MAY BE AND FILTER CHANGE ACKNOWLEDGED; RESAMPLE IN 30 DAYS;

URER:	LAB NO. 665369	SAMPLED: 03/06/2008	LUBE TIME: 250	LUBE CHG: N
	SEVERITY: 4	RECEIVED: 03/14/2008	UNIT TIME: 7950	LUBE ADD:

LUBRICANT AND FILTER CHANGE IS SUGGESTED IF NOT DONE AT SAMPLING TIME; SUGGEST PERFORMING COOLING ASSIUM) ARE AT A SIGNIFICANT LEVEL; BEARING METAL IS AT A SEVERE LEVEL; HIGH IRON AND/OR CHROME AND/OR ER IS AT A MODERATE LEVEL; FLAGGED ADDITIVE LEVELS ARE DIFFERENT THAN WHAT SHOULD BE PRESENT FOR THE T IMPLY THAT THE LUBRICANT DOES NOT MEET PROPER API, SAE, OR ISO CLASSIFICATIONS.); RESAMPLE IN 30 DAYS;

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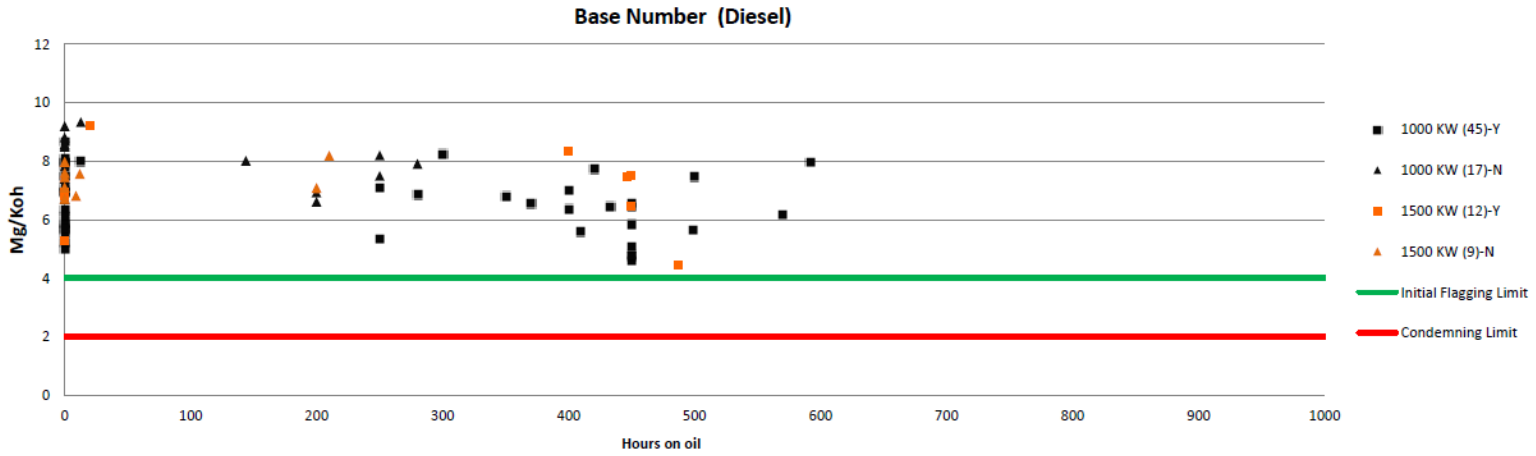
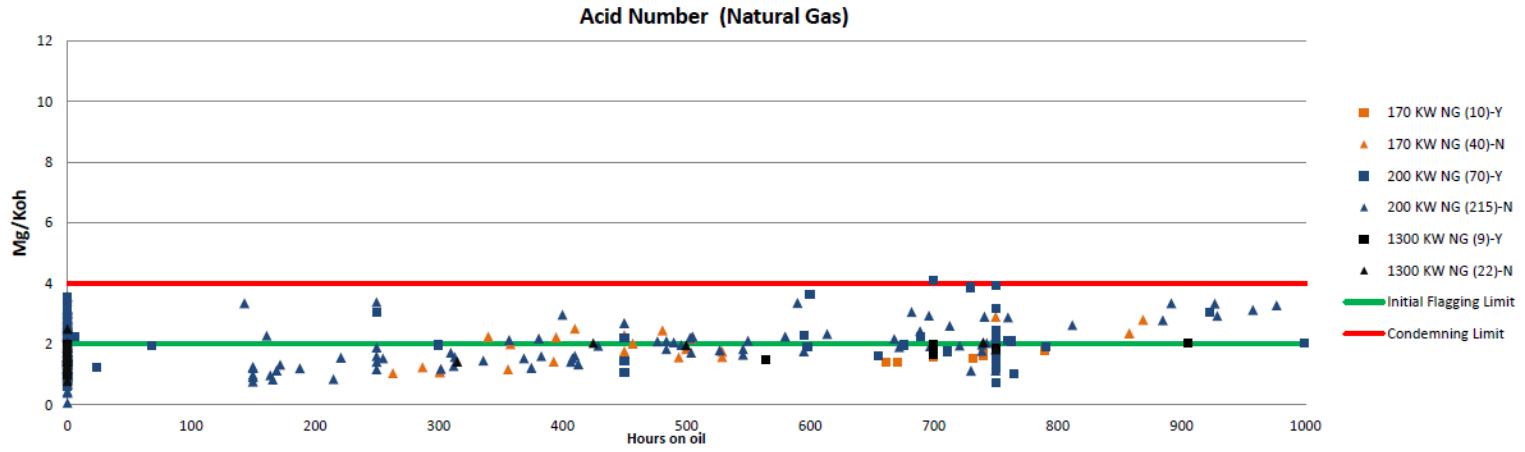
Charts Identify trends





Getting Started – Program implementation

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Know your equipment and share your knowledge

- Full Details for Equipment
- Manufacturer
- Model
- Lubricant Type & Grade
- Filtration
- Sump Volume
- Running Hours
- Working Environment
- Specific Issues with a machine

All this affects Data Interpretation

Component Information	
Component ID:	GATE-PA GEARBOX
Secondary ID:	GOLDEN GATE
Component Type:	MARINE TRANSMISSION
Manufacturer:	ZF
Model:	7550
Application:	MARINE
Sump Capacity:	15 gal

Product Information	
Product Manufacturer:	CHEVRON
Product Name:	DELO 400
Viscosity Grade:	SAE 15W40

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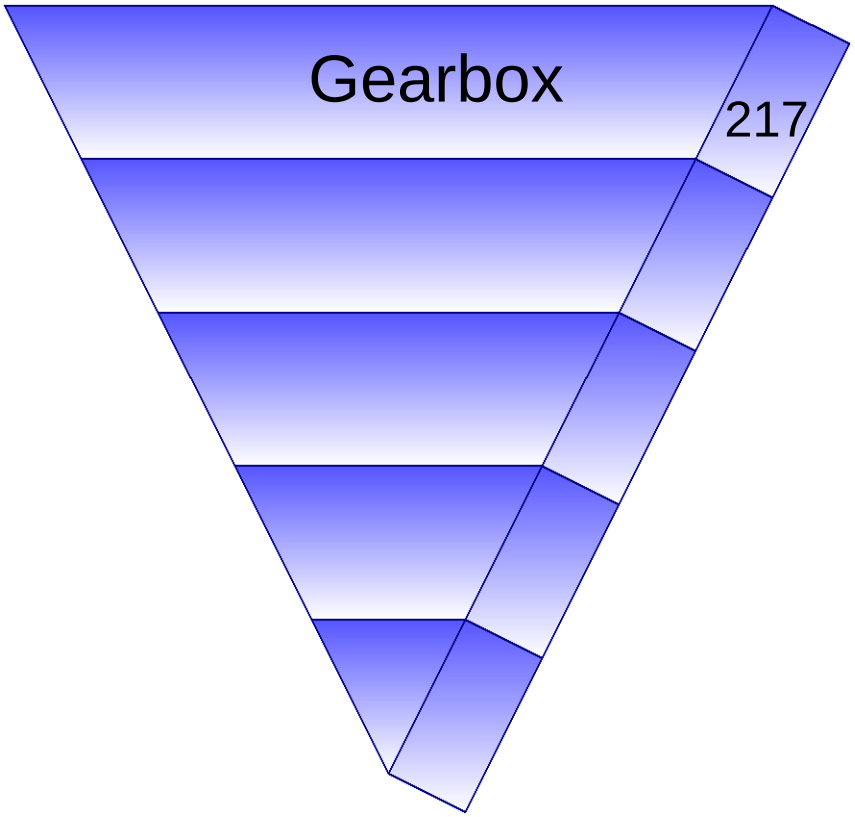
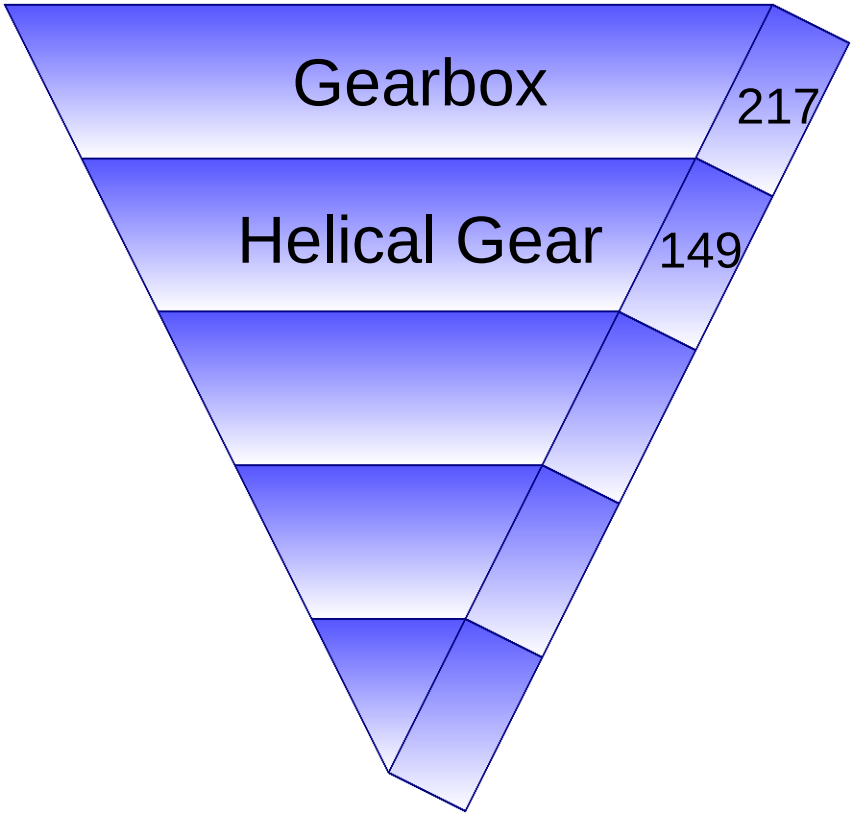


Iron

PPM

Flagging

Point

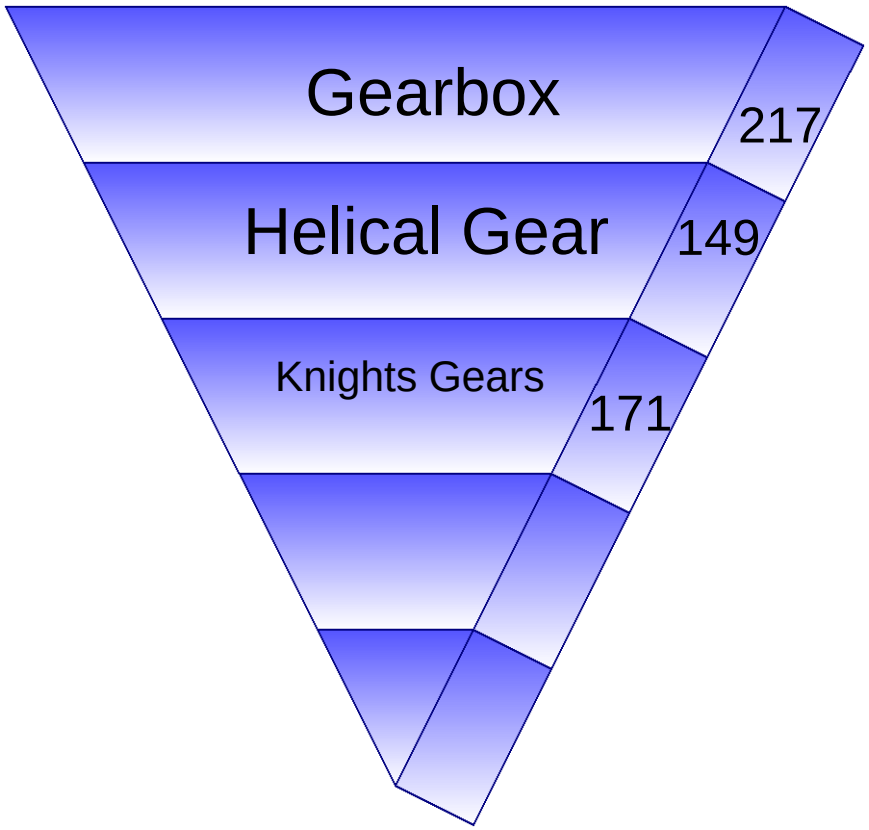


Iron

PPM

Flagging

Point

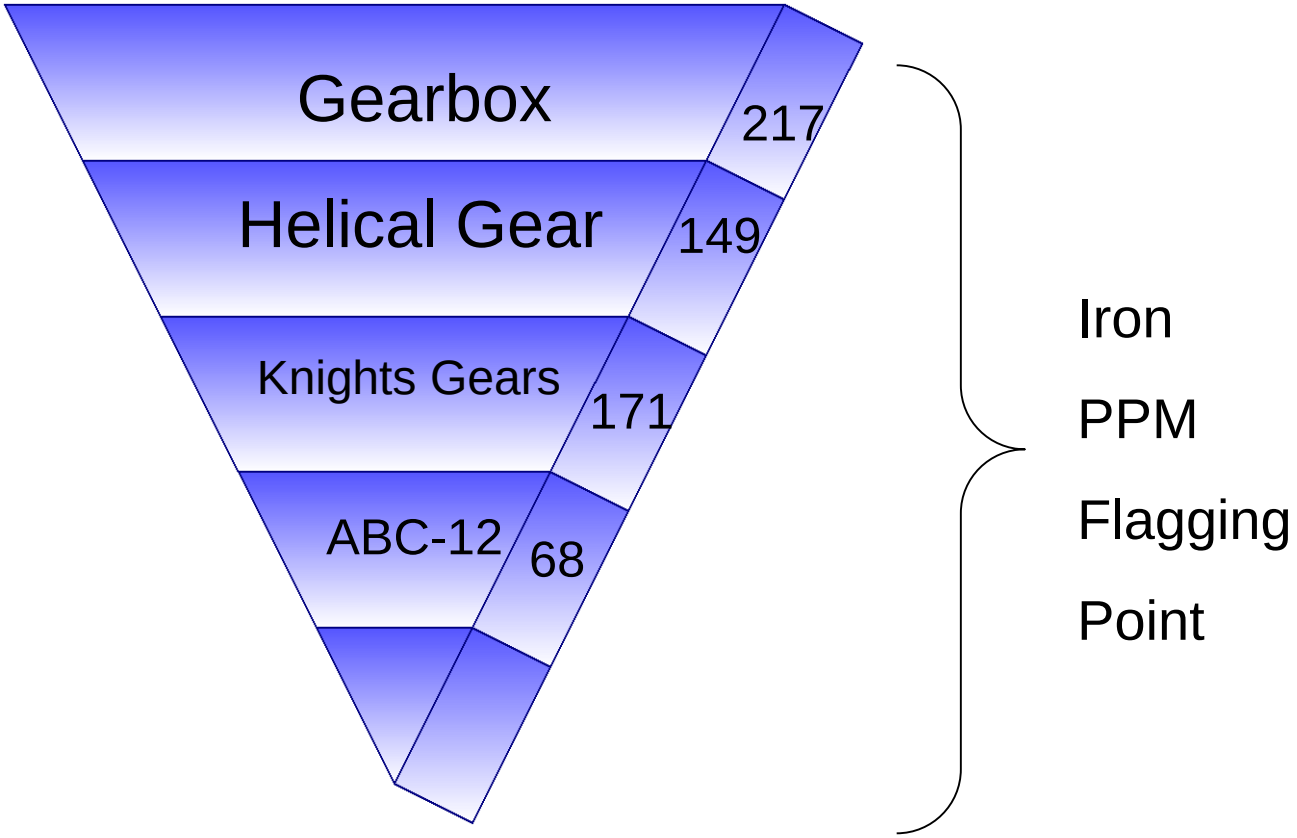


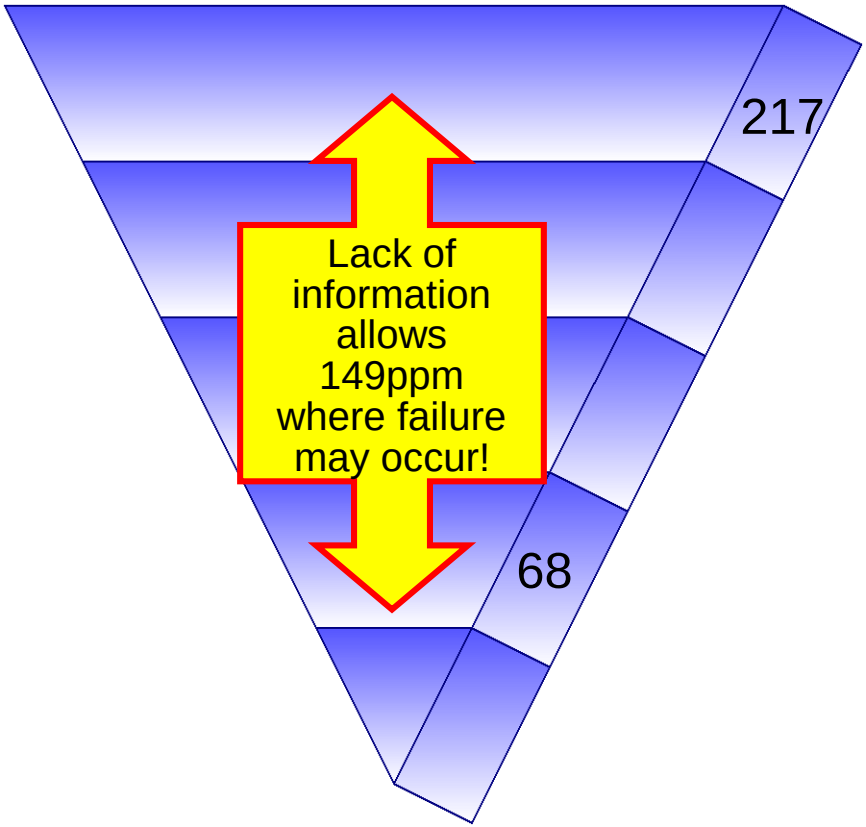
Iron

PPM

Flagging

Point


Gearbox
217
Helical Gear
149
Knights Gears
171
ABC-12
68
Iron
PPM
Flagging
Point



Iron

PPM

Flagging

Point

Build the Business Case

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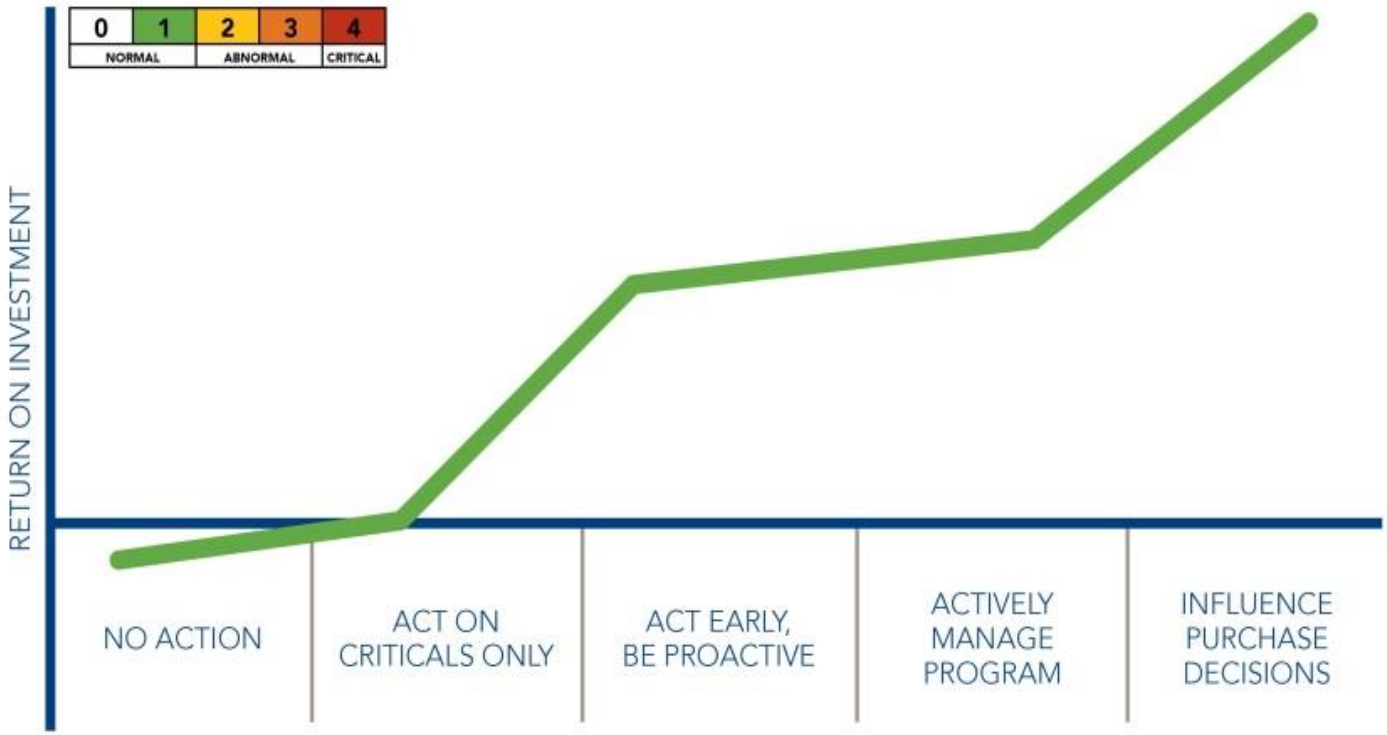
How much can Oil Analysis save your company



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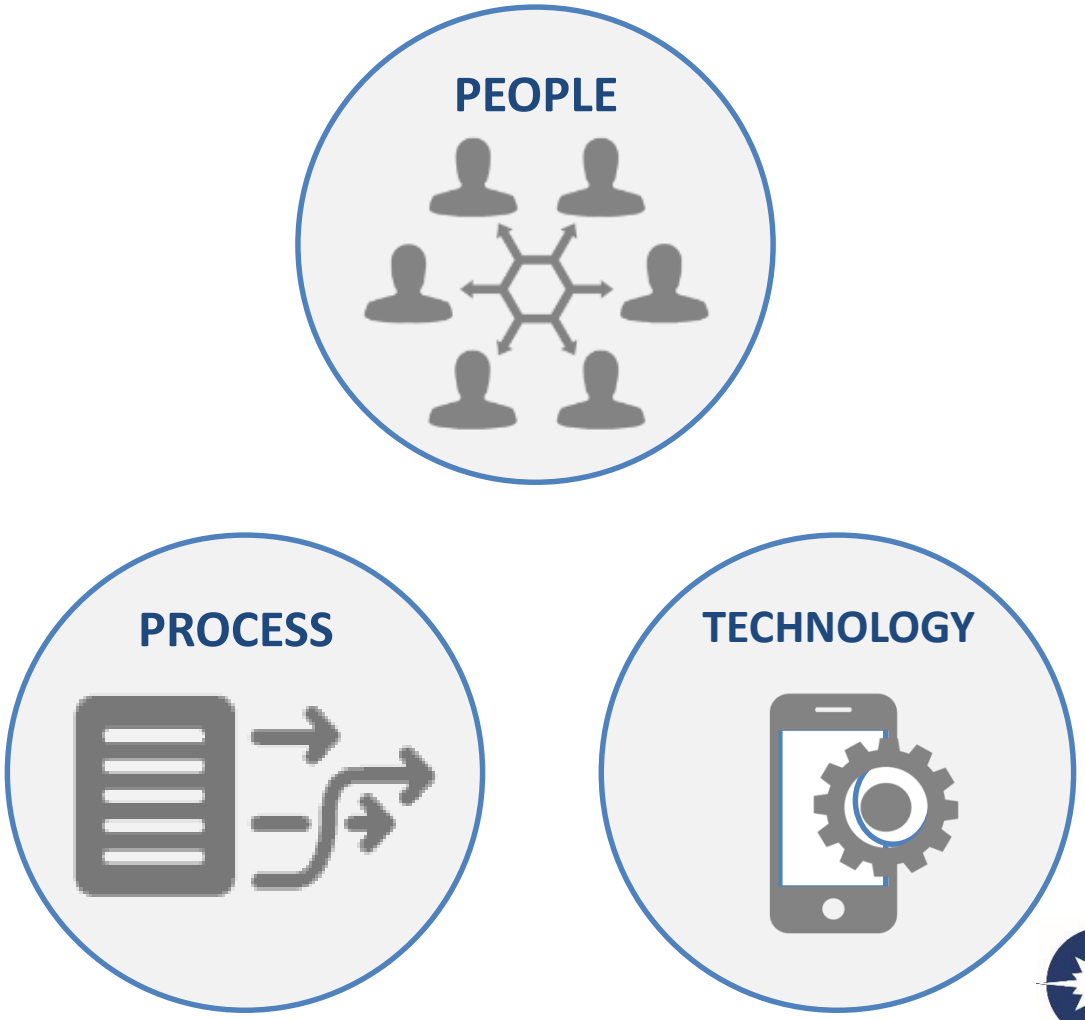
What do I need..?



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Prepare Your Team [People]

- Leadership Support
- Organizational Goals
- Monitor Key Performance Indicators
- Personal Accountability
- Training

Prepare Your Process

- Standardized Procedures
- Proper Tools
- Task Integration
- Work Orders
- Track Savings

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Prepare The Technology

- System Integration
- Mobile Devices
- Management Reports

Return On Investment

Conclusions

- Regular Oil Analysis WILL improve your Bearing Reliability
- Ensure your program is set up accurately
- Determine what you want to achieve from Oil Analysis
- Develop a plan to execute the project
- Fully understand the services available to you
- Meet regularly internally and with laboratory provider
- Use the Data from YOUR samples to assist in reliability and maintenance decisions

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Thank you……

Any Questions or Discussion

Gwyn Simmonds, European Territory Sales Manager


+44 7766 073860


gsimmonds@polarislabs.com


www.polarislabs.com


www.linkedin.com/in/gwynsimmonds

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