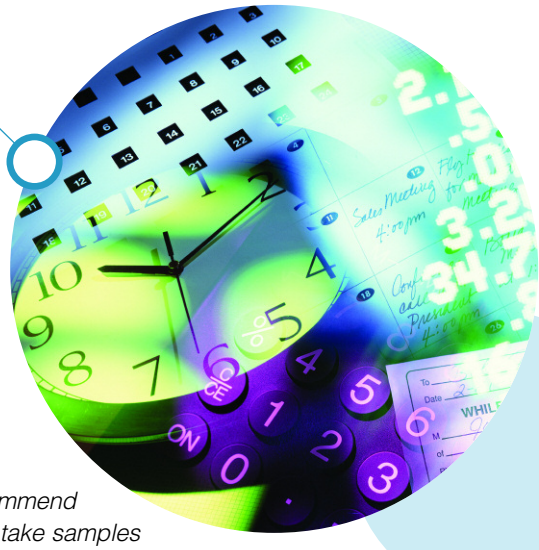
sampling interval

ExxonMobil Marine Lubricants



Establishing an appropriate sampling interval is an important step in building a value-added oil analysis program.

Sampling frequency should be adjusted based on your fleet's unique operating conditions and its maintenance goals. The equipment tables are intended to provide only initial guidance.

Enhanced Signum Oil Analysis can help you maintain consistent sampling intervals.

Your local ExxonMobil Marine Lubricants representative can discuss options with you for optimizing your equipment's oil change periods.

We recommend that you take samples at the normal oil change period recommended by the equipment manufacturer or established calendar/hours.

Marine Propulsion Equipment *

Sample Point	Frequency
High-Speed Diesel Engines	250-500 hours
Medium-Speed Diesel Engines	1000-2000 hours
Slow-Speed Engines System Oil	1000-2000 hours
Gas Turbines	250-500 hours
Steering Gear Hydraulics	500-2000 hours
Reduction Gears	250-500 hours
Cam Shaft Systems	250-500 hours
Thrusters	500-1000 hours
Stern Tubes	1000-2000 hours

Marine Supporting Equipment *

Sample Point	Frequency
Auxiliary Engines	500-1000 hours
Turbochargers	1000-2000 hours
Compressors (Air/Refrigeration)	3 to 6 months
Purifiers	1000-2000 hours
Deck Hydraulics	3 to 6 months
Deck Gear Drives	3 to 6 months

* *Sampling frequency should be governed with OEM guidelines.*

With the enhanced Signum Oil Analysis program you will know whether you are changing the oil more often than is necessary — or not often enough.

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wear metals and contaminants

ExxonMobil
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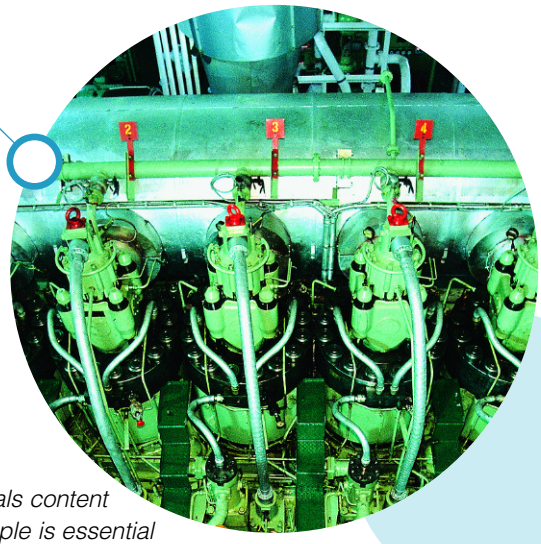

The metals content of a sample is essential information for knowing how your oil is performing.

A basic understanding of wear metals and contaminants can help you better understand and extract value from Signum Oil Analysis.

Signum Oil Analysis provides recommendations and interpretation based on your specific equipment parameters.

The tables at right and below summarize some key sources of wear metals and contaminants from typical marine applications.

For a more detailed evaluation of your particular application, please consult your ExxonMobil Marine Lubricants representative.

Typical Contaminant Sources

Contaminant	Potential Sources
Silicon	Abrasive Dirt, Sealant, Defoamant, Fuel Catalyst
Boron	Cooling Water Treatment
Sodium	Salt Water, Anti-freeze
Potassium	Cooling Water Treatment
Acid	Oil Degradation (TAN)
Oxidation	Thermal Degradation of Oil
Water	Coolant, Condensation
Glycol	Anti-freeze
Fuel Dilution	Fuel System, Blow-by
Soot	Incomplete Combustion, Blow-by
Magnesium	Sea Water Contamination
Zinc (EMD only)	Antiwear Additive, Galvanized Metal Materials
Insolubles	Products of Combustion or Foreign Contamination
Vanadium	Heavy Fuel Contamination
Asphaltenes	Heavy Fuel Oil

Typical Wear Metal Sources

Metal	Potential Sources
Iron	Cylinders, Gears, Rings, Crankshafts, Camshaft, Liners, Bearings, and Liner Plating
Chromium	Rings, Bearings
Lead	Bearing Overlays
Copper	Hydraulic Pumps, Bearing Cages, Bushings, Bronze Components
Tin	Bearing Plating, Compressor Pistons, Bushings
Aluminum	Pistons, Bearing and Pump Housings, Blower and Compressor Impellers
Nickel	Valves, Fuel Catalyst (when Silicon is high)
Silver (EMD Engines only)	Bearing and Bushing Plating

Testing for the presence of metals helps determine component wear levels and if harmful contamination is entering the oil.

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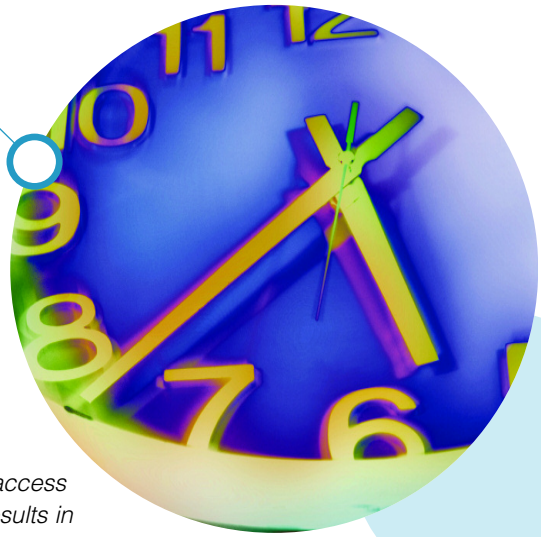
onboard testing

ExxonMobil
Marine Lubricants



Having access to key results in "real-time" can provide the information shipboard engineers need to identify and correct problems before they become serious and costly.

Signum Oil Analysis offers shipboard engineers immediate access to key analysis results via onboard testing.

We understand that there may be times you will not want to wait for a comprehensive oil analysis report.

- The enhanced Signum Oil Analysis program's "Onboard Test Kit" allows shipboard engineers to test samples for alkalinity retention (TBN), water contamination and changes in viscosity. It includes a digital test cell for easier reading.
- Our oil analysis program also provides an "Onboard Quick Test Kit" for fast, accurate water and viscosity testing.

Your local ExxonMobil Marine Lubricants representative will review Signum Oil Analysis Onboard Testing with you in detail.

To order Signum Oil Analysis sample bottle kits and onboard test kits, contact your customer service representative.

Signum Oil Analysis is a highly effective way to ensure peace of mind.

With the Signum Oil Analysis Onboard Test Kit, shipboard engineers have the results of key tests in a matter of seconds.

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Enhanced Signum Oil Analysis tests an oil sample's physical properties, chemical composition and metals to provide the data you need to help manage an effective oil analysis program.

Test	Purpose	Importance of Test	Application
Analytical Ferrography	To detect and analyze metallic particles measuring between 10 µm and 100 µm that have been caused by destructive wear processes or fatigue.	Ferrography can: • Pin-point the type and source of problem • Yield quantitative and descriptive information about particles	Engine and Non-Engine
Compatibility	To ensure that marine lubricants from ExxonMobil are compatible with competitive products during vessel switchovers.	• Ensures that when converting lubricants no problems due to product incompatibility occur.	Engine and Non-Engine
Cylinder Oil Scrapedown Analysis	To detect changes in the condition of cylinders in low-speed (crosshead) marine diesel engines.	• Helps to safely optimize cylinder oil feed rates, can reduce wear-related maintenance and operating costs.	Engine
Flash Point	To determine the presence of potential fuel and other combustible contaminants in the oil.	A low flash point or fuel dilution can mean: • Potential crankcase explosion due to contamination from volatile material • Lube oil contamination by fuel • Increase in engine deposits caused by fuel component contamination in the lube oil	Engine
Grease Analysis	To detect significant changes in contaminant levels.	• Helps prevent catastrophic failures of slewing bearings on deck cranes and other critical applications which can result in loss of life and machinery.	Non-Engine
Insolubles	To determine the quantity of insoluble material in the lube oil.	• The significance of a lubricant's insolubles content and required corrective action are usually assessed in relation to the changes in other parameters, such as foreign contaminants or wear.	Non-Engine
Metals	To determine the presence and levels of metallic particles in the oil.	• The presence of wear metals helps determine if equipment components are wearing or if harmful contamination is entering the oil.	Engine and Non-Engine
Oxidation	To determine whether the lubricant has oxidized and caused it to deteriorate.	Oxidation can mean: • Increased wear and corrosion • Shorter equipment life • Increased viscosity • Excessive deposits and plugging	Engine and Non-Engine
Particle Count	To monitor the cleanliness of critical hydraulic and circulating oil systems.	• Cleanliness is a critical factor in the running of hydraulic and circulating oil systems. • Debris can interfere in the fine tolerances of the system's pumps and valves or cause premature bearing wear.	Non-Engine
Particle Quantifier (PQ)	To determine ferrous metal fatigue failures and metal-to-metal contact not usually detectable with current spectrographic analysis.	PQ can detect at an early stage: • Anti-friction bearing wear • Plain bearing wear • Early indications of piston scuffing • Gear wear	Engine and Non-Engine
Detecting Asphaltenes Contamination (DAC)	To determine the level of asphaltenes contamination that comes from raw or partially burned fuel entering the engine lube oil.	Detecting excessive asphaltenes in engine oil can help to: • Prevent harmful piston undercrown deposits that can lead to piston crown burning • Stop excessive sludge from forming in the engine crankcase	Engine
Soot	To determine the soot content in an oil by percentage weight.	Soot contamination can mean: • Decreased engine performance • Reduced fuel economy • Excessive deposits and sludge • Shorter oil life • High blow-by	Engine
Total Base Number (TBN)	To determine the amount of acid-neutralizing additive present in the oil.	• Determines oil degradation • Suggests increasing wear • Predicts corrosion • Alerts to changing fuel characteristics	Engine
Viscosity	To determine the oil's resistance to flow at 40°C for non-engine applications and 100°C for engine applications. • If viscosity is low, gas chromatography is used to determine fuel dilution.	• An increase in viscosity may be due to high soot or insolubles content, water contamination, or admixture with higher viscosity fuel or lubricant. • A decrease in viscosity may be due to water contamination, or admixture with lower viscosity fuel or lubricant. • Both high or low viscosity can result in premature equipment wear.	Engine and Non-Engine
Water	To determine the water content of the oil.	• Water contamination can cause severe wear due to corrosion, poor film thickness, or hydrogen embrittlement.	Engine and Non-Engine

ENGINE	Engine	Engine w/ DAC	Scrapedown
Viscosity @ 100°C	X	L	L
Water, Disp. (Infrared)	X	L	L
Total Base Number	X	L	L
Flash Point (SETA)	FS	L	
Oxidation	X	L	L
Soot	X	L	L
Fuel Dilution by Gas Chromatography	C, FS		
Analytical Ferrography	C, L	C, L	C, L
Particle Quantifier	X	L	L
Detecting Asphaltene Contamination		L	
Strong Acid Number			TBNS, L
Compatibility	C, L	C, L	
Metals	X	L	L
Aluminum	X	L	L
Boron	X	L	L
Chromium	X	L	L
Copper	X	L	L
Iron	X	L	L
Lead	X	L	L
Magnesium	X	L	L
Nickel	X	L	L
Silicon	X	L	L
Sodium	X	L	L
Tin	X	L	L
Vanadium	X	L	L
Zinc	X	L	L
Barium	X	L	L
Potassium	X	L	L
Molybdenum	X	L	L
Calcium	X	L	L
Phosphorous	X	L	L
Silver	X	L	L

KEY	
X	Normal test
C	Condition test
FS	Fuel Specific test; Distillate Fuel engines receive Gas Chromatography (i.e., Mobilgard 12 series, Mobilgard ADL series, Delvac series), Residual Fuel engines receive Flash Point (i.e., Mobilgard M series)
TBNS	Total Base Number (TBN) Specific test for scrapedown samples only. If sample's TBN is below 10, run Strong Acid Number (SAN) test.
PS	Product Specific test; Synthetic oils receive Total Acid Number (TAN) test and Mineral oils receive Oxidation by IR test
L	Lab Specific test run only at Pernis laboratory

NOTE: The following test slates are only run at Pernis laboratory:
1) Engine w/ DAC
2) Scrapedown
3) Hydraulic w/ SAN/TAN/pH
4) Grease

NON-ENGINE	Air Compressor	Gas/ Refrigeration Compressor	Gas Turbine	Circulating	Circulating – Heat Transfer	Circulating – Stem Tube	Hydraulic	Hydraulic w/ SAN/TAN/pH	Gear Drive	Steam Turbine	Fresh Oil Tank	Grease
Viscosity @ 40°C	X		X	X	X	X	X	L	X	X	PS	
Viscosity @ 40°C Degassed		X										
Viscosity @ 100°C											PS	
Water, Hot Plate	X	X	X	X		X	X	L	X	X	X	
Total Base Number											PS	
Flash Point (Open Cup)					X							
Flash Point (Closed Cup)					L							
Oxidation	PS	PS	PS	PS	X	X	PS	PS	PS	X		
Insolubles					L	L						
Analytical Ferrography	C, L	C, L	C, L	C, L		C, L	C, L	C, L	C, L	C, L		
Particle Quantifier	X	X	X	X		X	X	L	X	X		L
Particle Count (4µm, 6µm,14µm)	X	X	X	X			X	L	X	X		
Karl Fischer, Water	C	C	C	C	X	C	C	C	C	C	C	L
Strong Acid Number								L				
Total Acid Number	PS	PS	X	PS	L		PS	L	PS	X		
pH								L				
Micro Carbon Residue					L							
Compatibility	C, L	C, L	C, L	C, L	C, L	C, L	C, L	C, L	C, L	C, L	C, L	
Metals	X	X	X	X	X	X	X	L	X	X	X	L
Aluminum	X	X	X	X	X	X	X	L	X	X	X	L
Boron	X	X	X	X	X	X	X	L	X	X	X	L
Chromium	X	X	X	X	X	X	X	L	X	X	X	L
Copper	X	X	X	X	X	X	X	L	X	X	X	L
Iron	X	X	X	X	X	X	X	L	X	X	X	L
Lead	X	X	X	X	X	X	X	L	X	X	X	L
Magnesium	X	X	X	X	X	X	X	L	X	X	X	L
Nickel	X	X	X	X	X	X	X	L	X	X	X	L
Silicon	X	X	X	X	X	X	X	L	X	X	X	L
Sodium	X	X	X	X	X	X	X	L	X	X	X	L
Tin	X	X	X	X	X	X	X	L	X	X	X	L
Vanadium	X	X	X	X	X	X	X	L	X	X	X	L
Zinc	X	X	X	X	X	X	X	L	X	X	X	L
Barium	X	X	X	X	X	X	X	L	X	X	X	L
Potassium	X	X	X	X	X	X	X	L	X	X	X	L
Molybdenum	X	X	X	X	X	X	X	L	X	X	X	L
Calcium	X	X	X	X	X	X	X	L	X	X	X	L
Phosphorous	X	X	X	X	X	X	X	L	X	X	X	L
Silver	X	X	X	X	X	X	X	L	X	X	X	L

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