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Experts in Condition Monitoring

Lessons to be Learnt from the Marine Industry – By Tom Kent

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Introduction

On-site Testing & Analysis Solutions for Fuel, Oil & Water Condition Monitoring

- Oil Sampling and Field Testing
- Laboratory & Field Wear Debris Analysis
- On-line Oil & Wear Debris Analysis
- Water Quality Field Testing
- Laboratory Logistics
- Supplier of Expert Information
- Largest Independent Provider of Marine On-site Oil Analysis Equipment
- Started in 1992

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Comparison of Marine and Wind

Marine	Compared to	Wind
Expensive		Expensive
Complex		Complex
Only make money when moving (even loose money when not working)		Only make money when moving (even loose money when not working)
Often in remote locations		Often in remote locations
Very expensive to fix		Very expensive to fix
Harsh Environments		Harsh Environments
Health and safety issues		Health and safety issues

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Starting Simple

Portable Test Equipment (Suitable for Lubricating Oil and Fuel)

- Water in Oil - The single most important, and biggest selling test
- TBN - Not necessary for wind turbine gearboxes
- TAN - Indication of oil oxidation / condition
- Viscosity - Quick reference test
- Metallic Debris - For both oil and grease
- Quick
- Easy
- Inexpensive

Others

- Hand Held Vibration – Not suitable for wind
- Thermography – Less suitable for wind

NOTE: For wind industry use your technicians to carry out the analysis in the nacel. Make the decision about the oil there and then not have to revisit in a few weeks time – reduce the total work load.

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Investigate Further (Getting it to a Laboratory)

Good sampling practice saves machines

- Know what to sample and when – Incorrect information can lead to the wrong decision
- Good sample practice – Pre flushing, clean equipment, correct labels / Information “Follow Best Practice”. (very important for ISO Code particle tests.)
- Take a representative sample - Test only the working fluid not the fluid lost on “dead spots”
- Always supply accurate system info - Running hours, oil type, part replacements, equipment reference, sample location etc..
- Results trend- For Look for “normal” pattern
- Supplied as part of lubrication package
- Industry standard for oils and fuel
- Delayed - especially in marine / offshore
- Expensive

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On-Line is Future

Condition Monitoring in real time

- New to the market but being quickly embraced – Similar to the wind industry
- Excellent results
- Proven Cost savings
- Used to control equipment – Reduce wear and tear
- Integrates with other ship systems – Wind industry is lagging behind on this.
- Manpower reductions - Staff quality has been slipping for years, and ships often leave engine room unattended for hours.
- Viewed on board and sent to head office
- Industry standard for oils and fuel
- Instant results – speed is essential
- Reduction in false alarms
- Expensive

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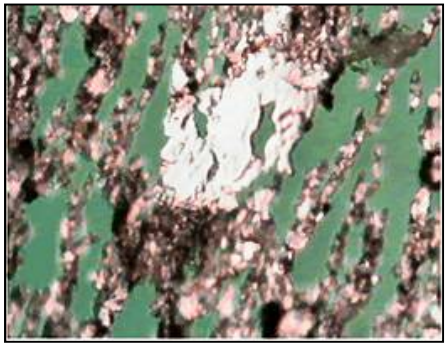
What to Monitor in Marine and Wind Turbine Gearboxes

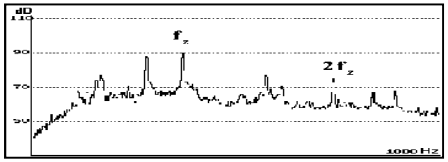
Precursors of failure

- Water in Oil
- Contaminants
- Viscosity changes
- Oxidisation
- Particulates (dust, sand, build debris, contaminated oil charge etc.)
- Excessive temperature
- Pressures



Indications of failure

- Wear metals
- Vibration (up to 500 measurement points on some vessels)
- Excessive temperature (again)
- Noise



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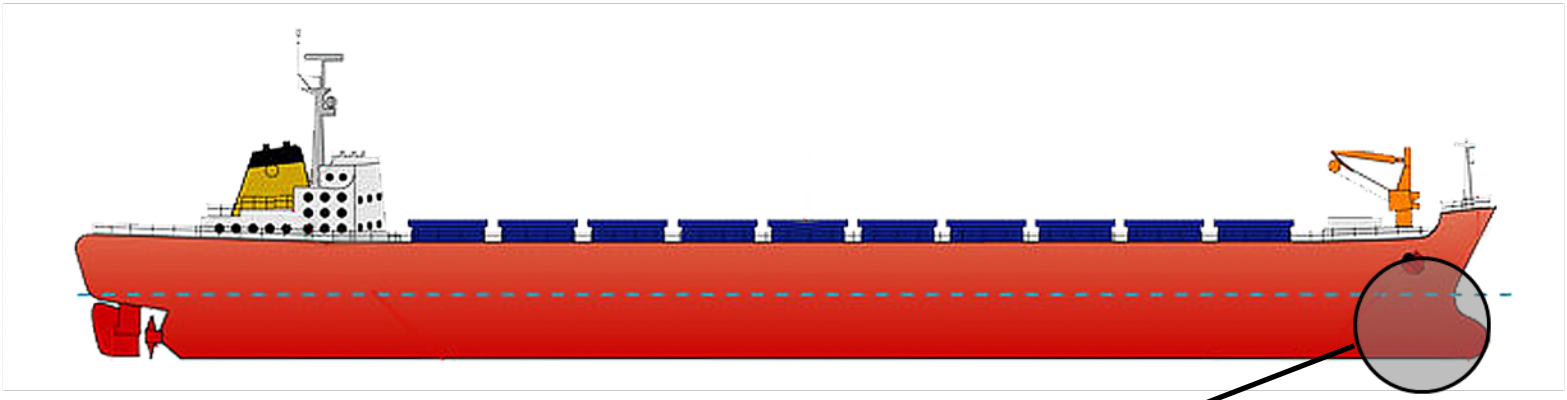
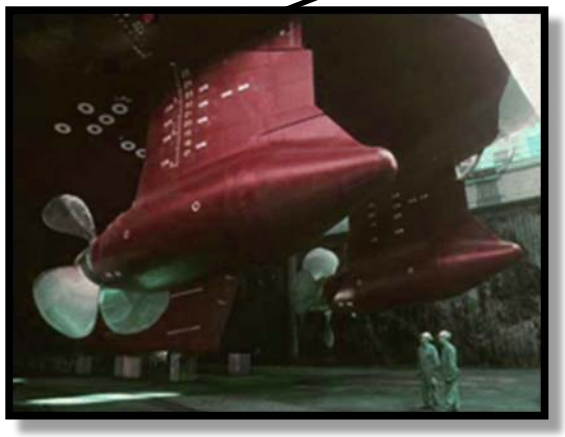
Thrusters and Pods





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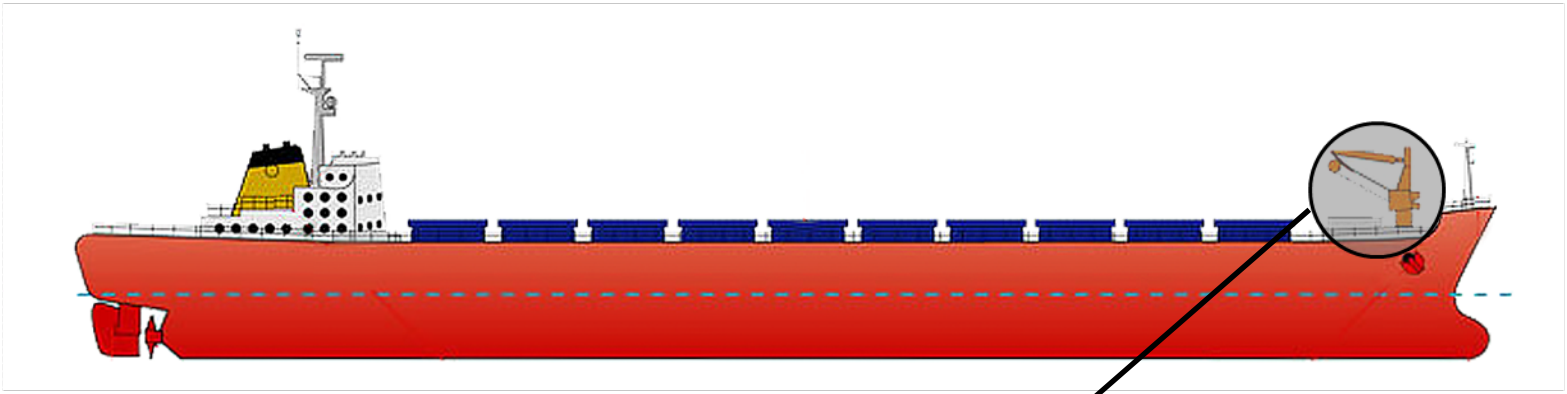
Cranes, Winches and Other Hydraulics



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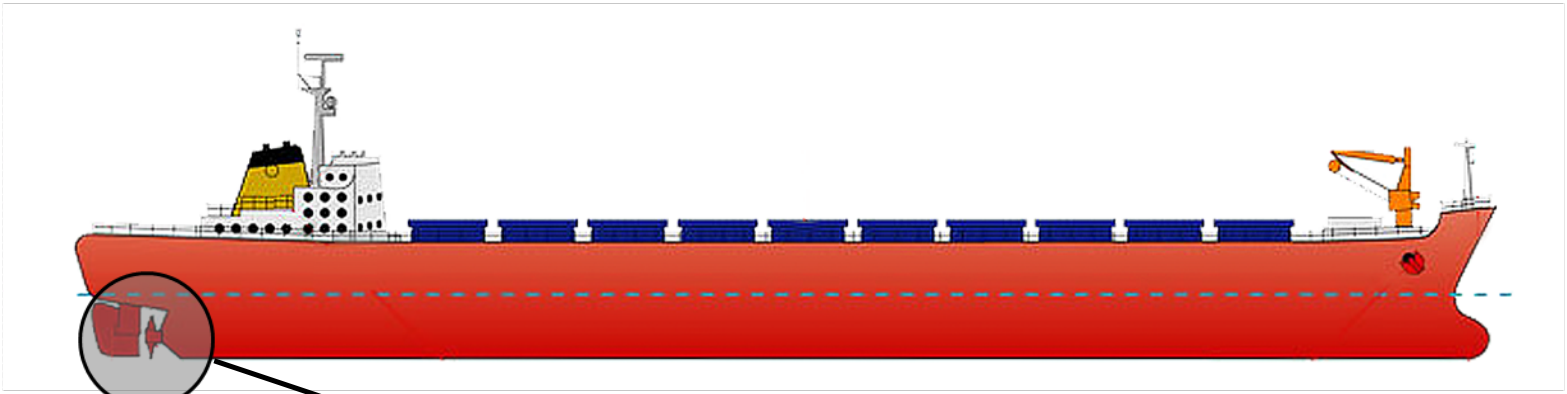
Stern Tube



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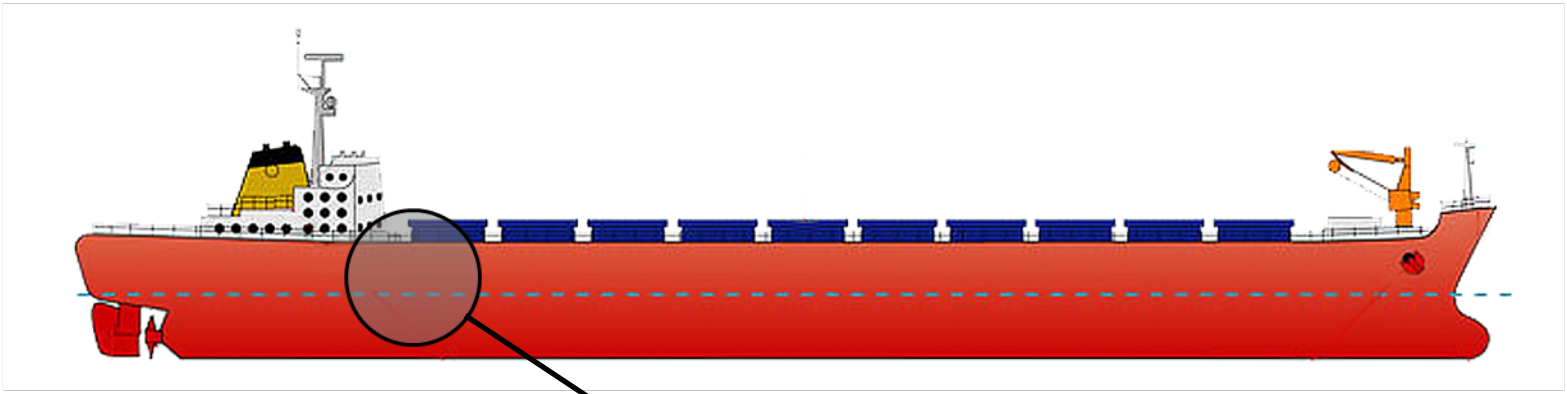
Bunkers (Fuel)



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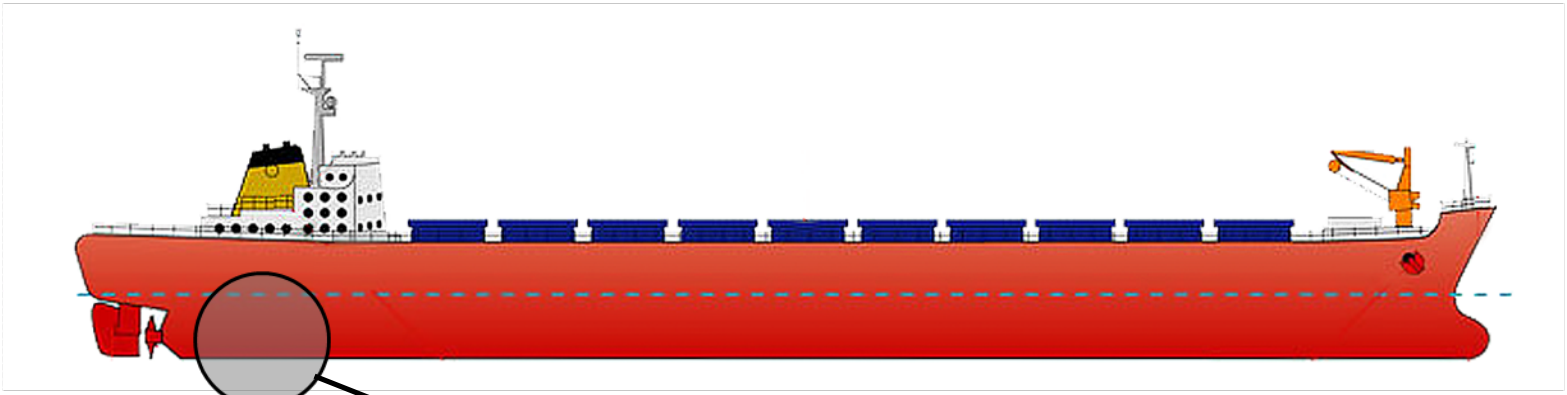
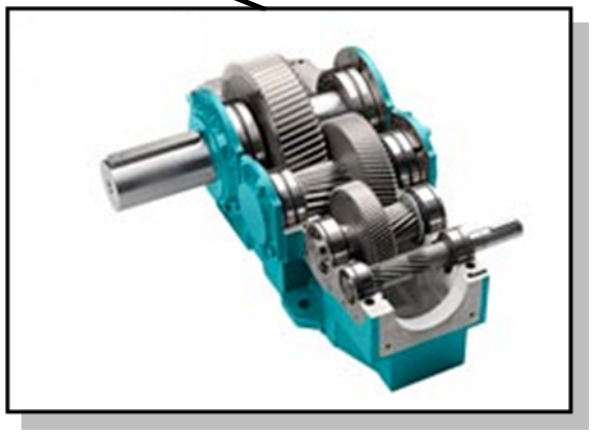
Gearboxes





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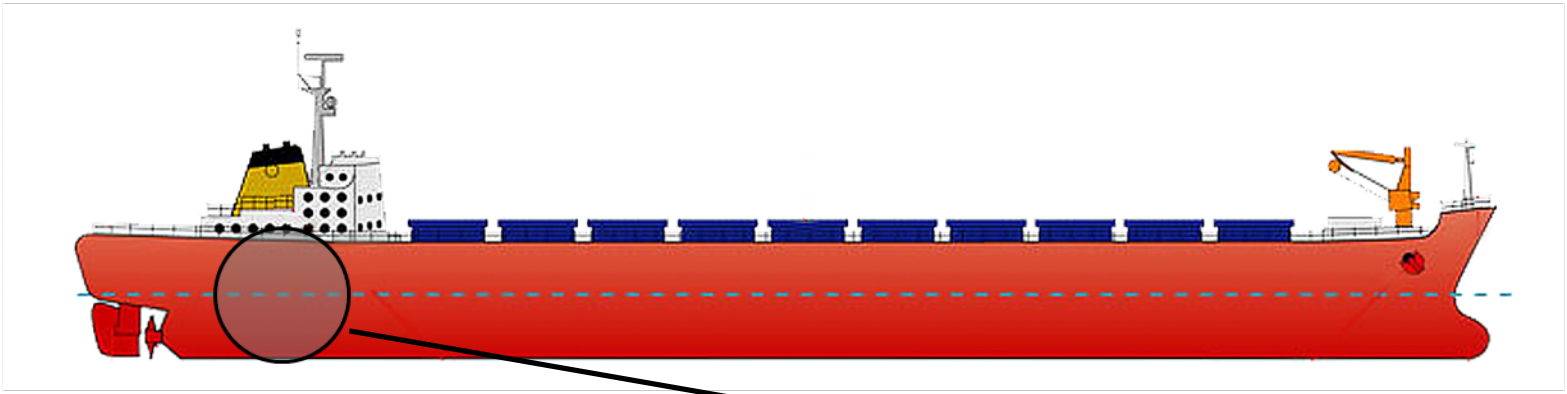
Turbocharger (Vibration)



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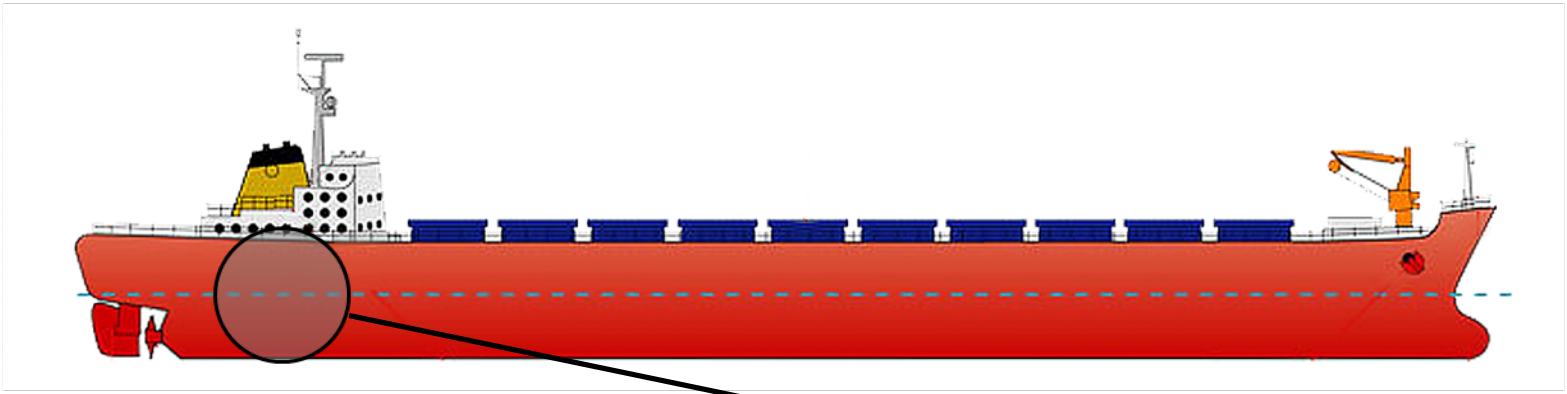
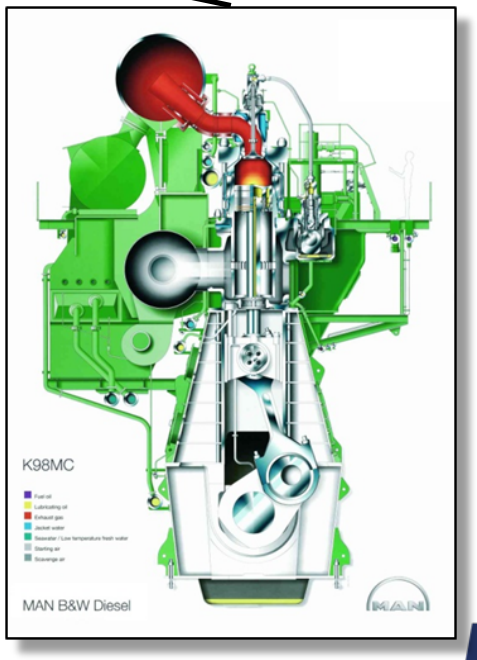
Main Engine





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On-line Monitoring of Slow Speed Diesels

Main Propulsion of

- Bulk Carriers
- Container ships
- Large Cargo

Man B&W , Sulzer/Wartsila

Two Lubrication Systems

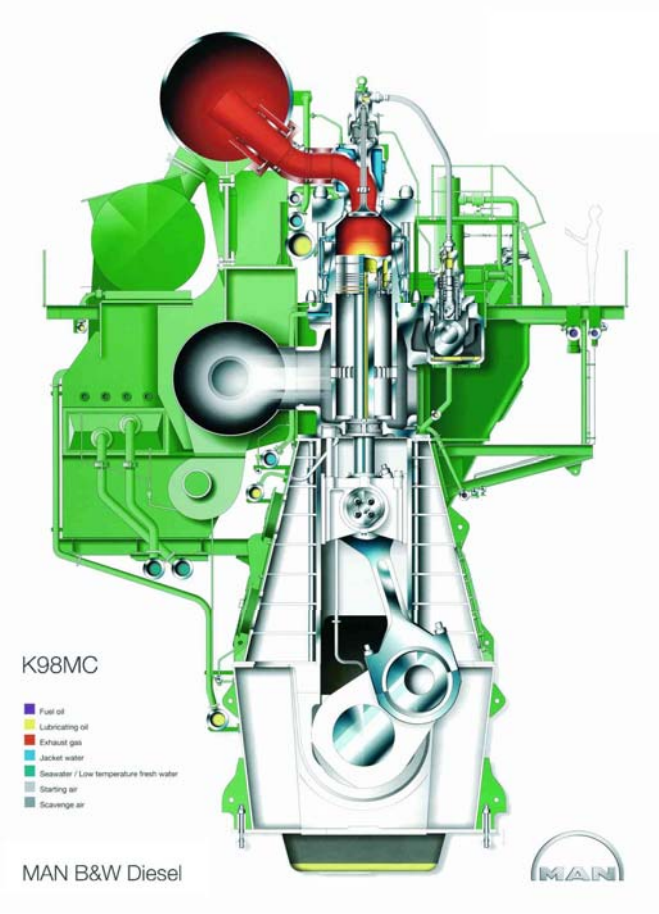
- Main Crankcase
- Cylinder Lube

Two highest cost of the vessel are

- Fuel
- Cylinder Lubricant

They are Huge!!!!

- Up to 980mm Bore X up to 14 Cylinders
- 3+ meter stroke



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MV “Emma Maersk” Sulzer 14RT- flex 96 C

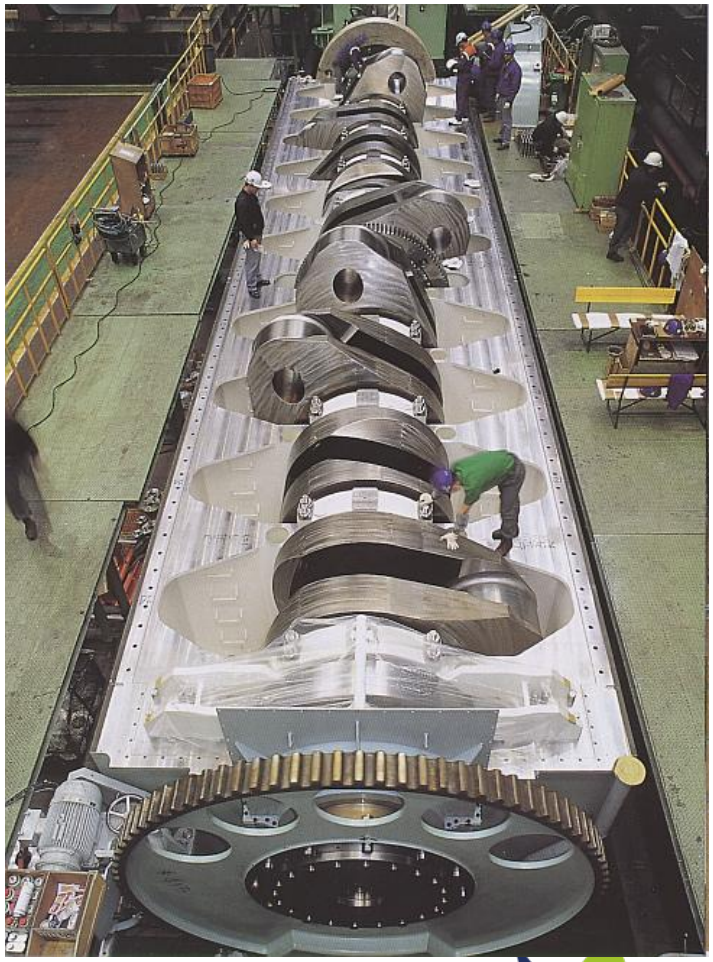
– Capacity 13,000 TEU / 6500 FEU
– Fuel consumption 354 t HFO / day
– About 170,000 US$ / day
– That’s about 29 t HFO /100 km
– Cylinder oil consumption 1.8 t / day
– About 4500 US$ / day = 1,125,000 US$ / year

To carry the same cargo on the road it needs 6500 big lorries

– Consumption 325 t Diesel /100 km
– That’s about 7,800 t Diesel / day!

A jumbo jet travels 500 m using the same amount of energy per ton of cargo

11,000 full 20-foot containers. That is equal to a train 71 km long



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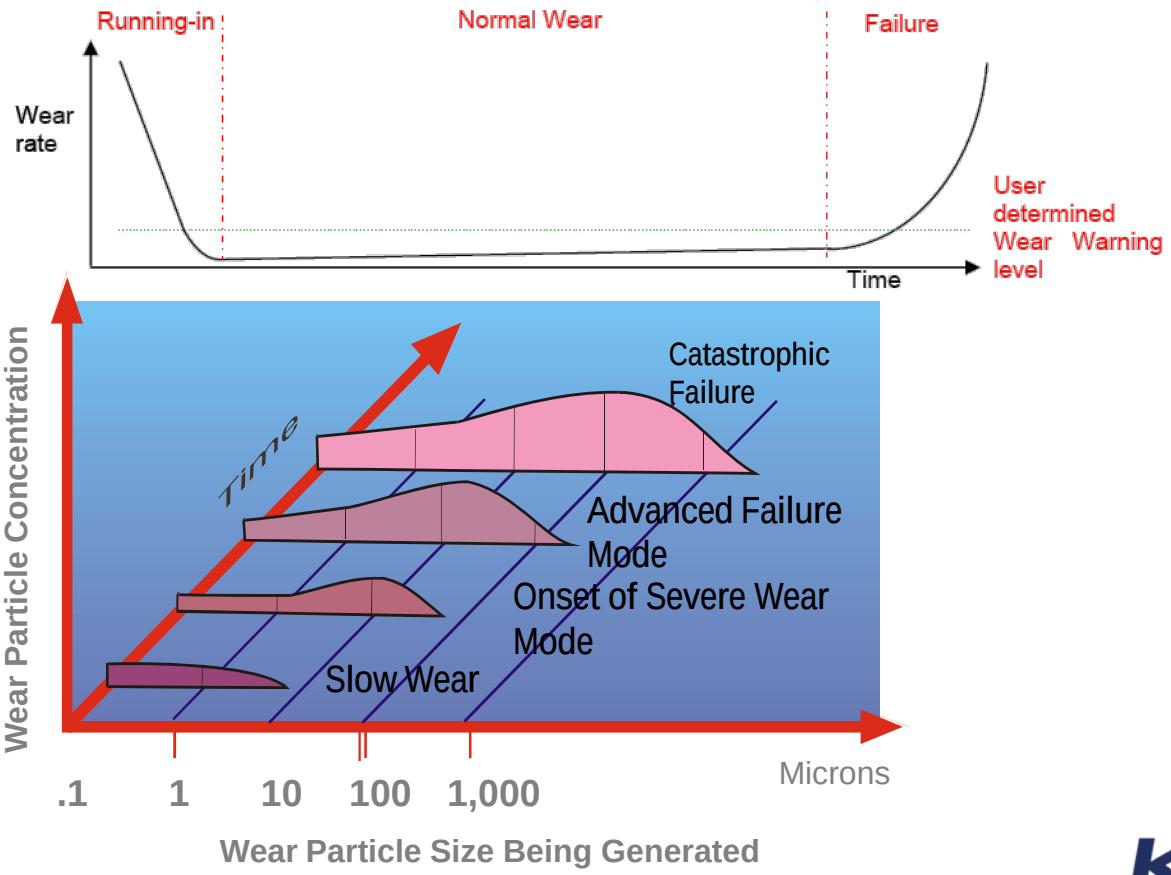
Wear Debris

Why Monitor Total Ferrous Wear Debris?

"Debris formed from surface interaction is a valuable source of information on wear mechanism and mode…



N. Myshkin, L. Markova and A. Grigoriev, Metal-Polymer Research Institute, "Condition Monitoring and Predictive Analysis of Tribosystems by Wear Debris". Practicing Oil Analysis Magazine. March 2005

…wear can be divided into three stages: running-in, stationary and severe…

…running in, is relatively short…

…stationary wear, should occur over a prolonged period of time at a minimal (mild) wear rate…

…Severe wear results from continuous surface interaction or lubricant degradation. This third stage can and should be prevented by maintenance...

…real-time monitoring … …such devices make it possible to evaluate machine condition and predict their wear"

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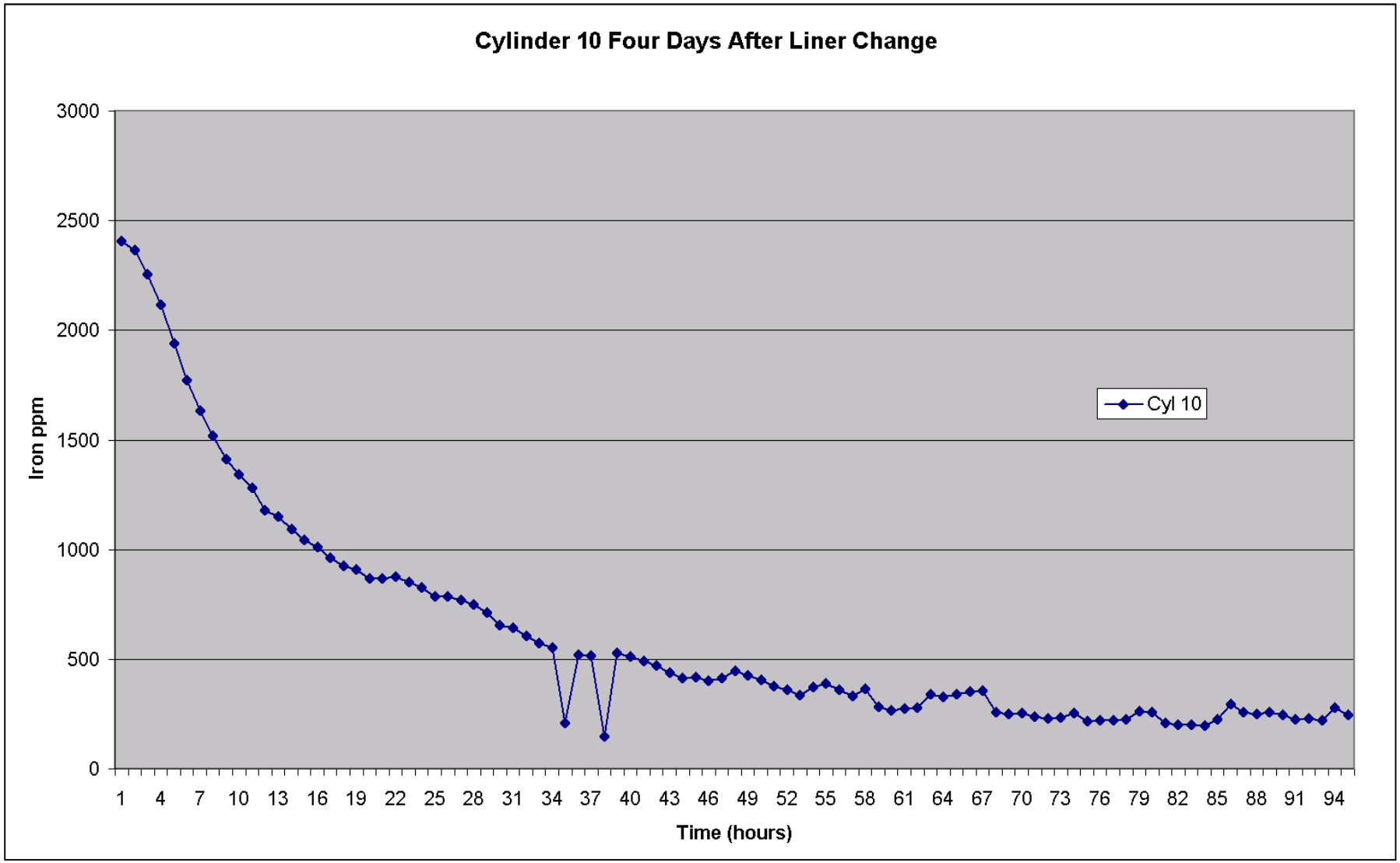
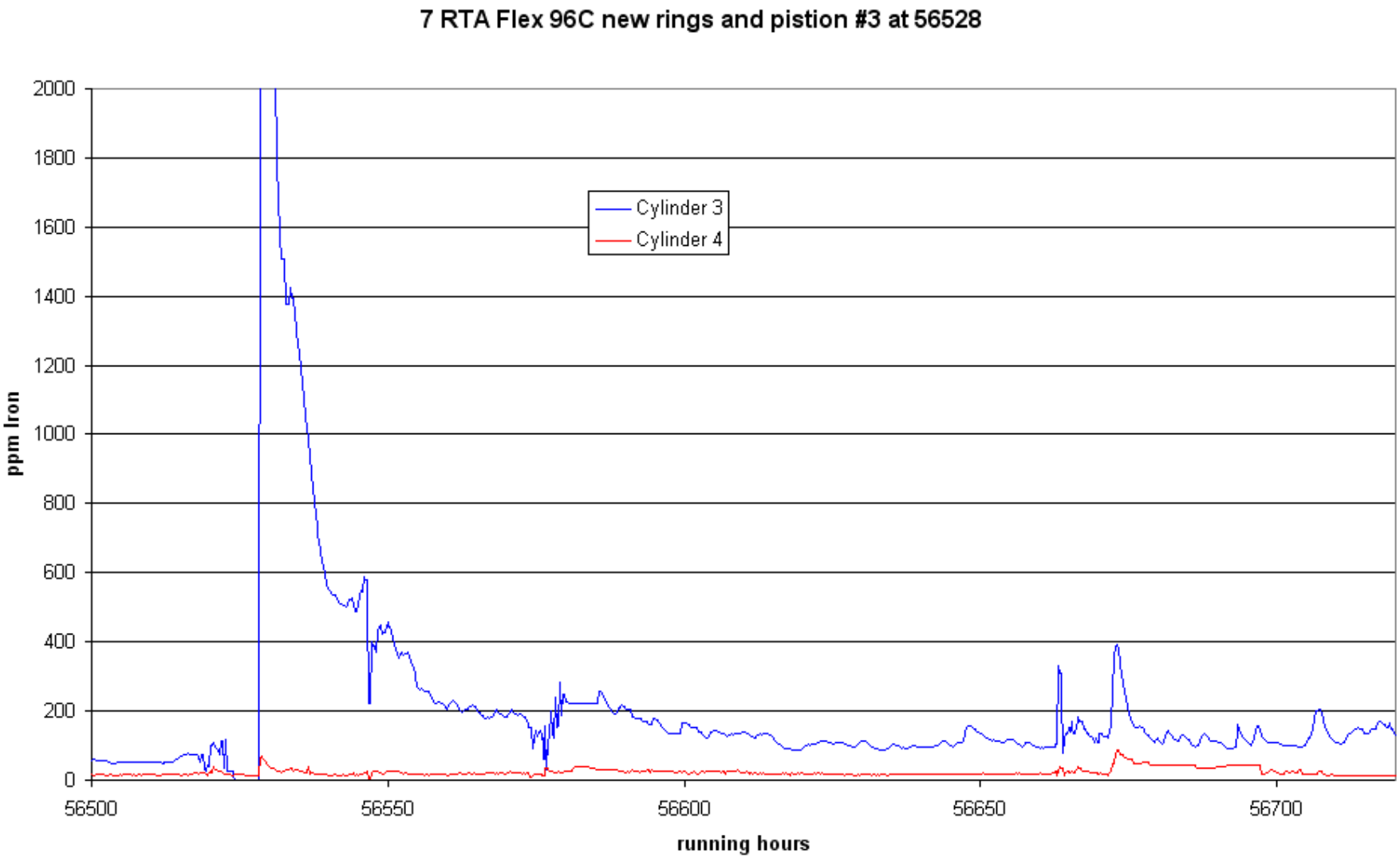
2 Stroke Engine Monitoring using LinerSCAN

Running / Bedding in on a Slow Speed Diesel Engine

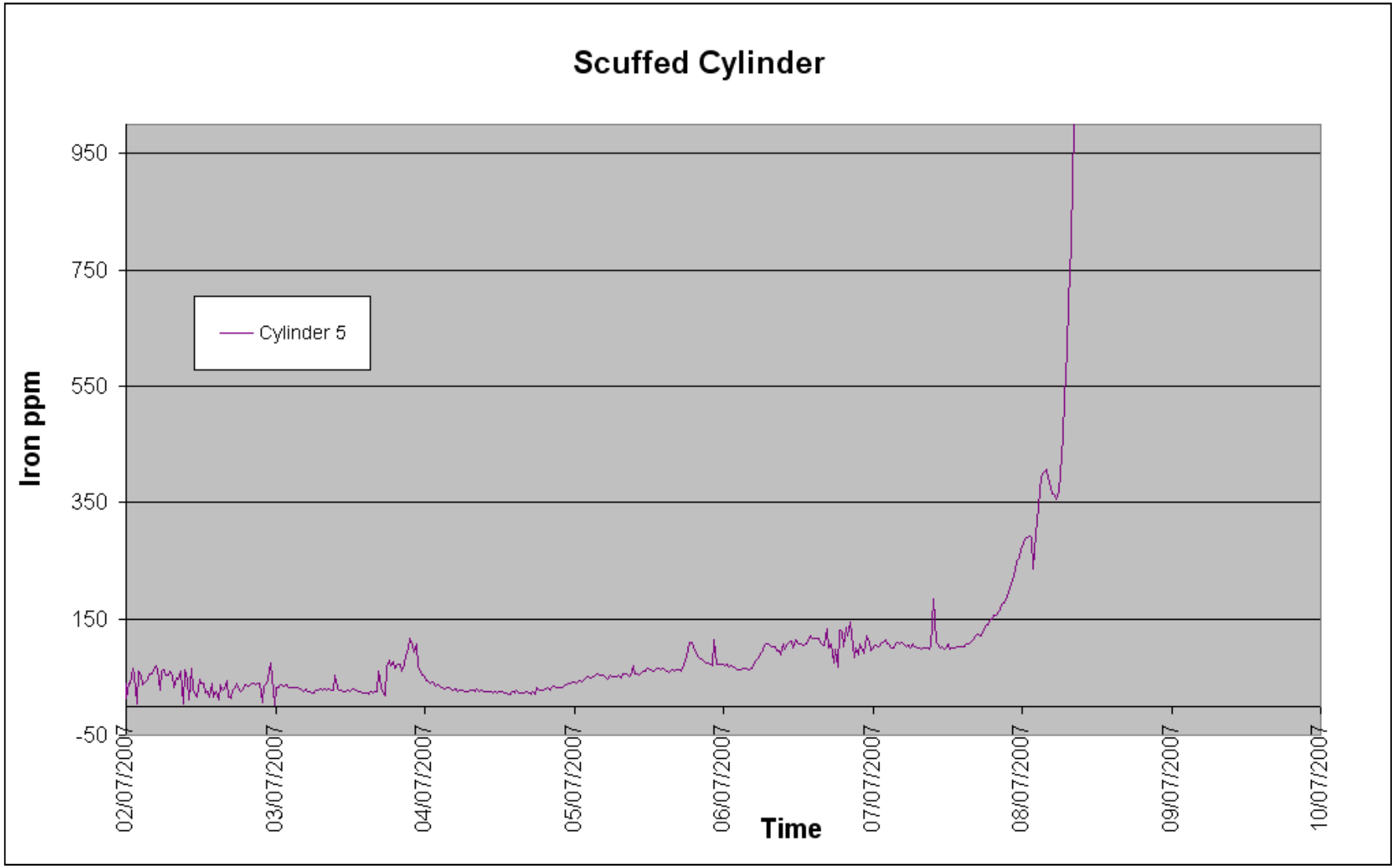


2 Stroke Engine Monitoring using LinerSCAN



2 Stroke Engine Monitoring using LinerSCAN

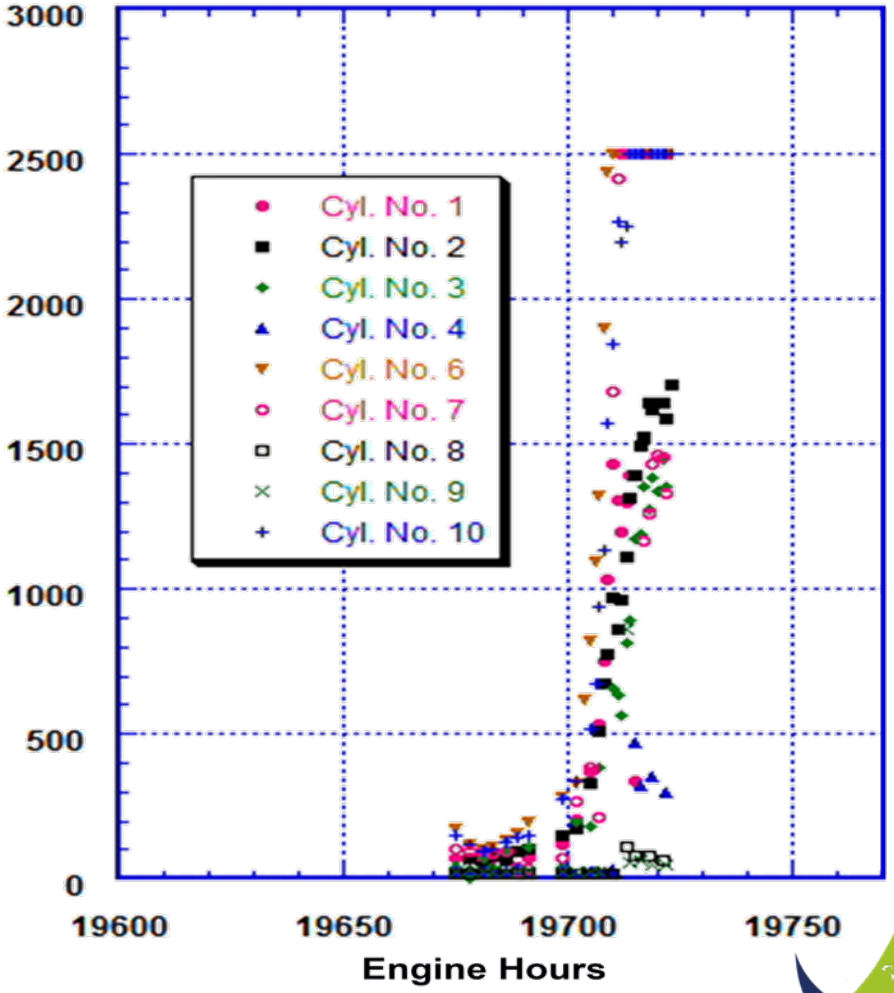
Self Propagating Wear on a Cylinder Liner



2 Stroke Engine Monitoring using LinerSCAN

Fuel Quality

- Engine switched to new fuel, DNV: within specification
  - Al + Si = 21 mg/kg (80 allowed)
- Normal iron levels from Sensor before fuel change (19693)
- Iron levels increased after fuel change significantly.
- High readings were ignored and sensors switched off for 200 hrs
- Engine was then opened:
  - All liner showed severe wear
  - Cylinder 4 was most damaged (bedding in)



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2 Stroke Engine Monitoring using LinerSCAN

What happened?

- Hard ceramic catalyst fines were being forced into the metal surface and caused scuffing.
- Cylinder 4 was most damaged, most likely because the piston rings were still bedding in

Imbeded debris on piston rings

Scuffed liner surface

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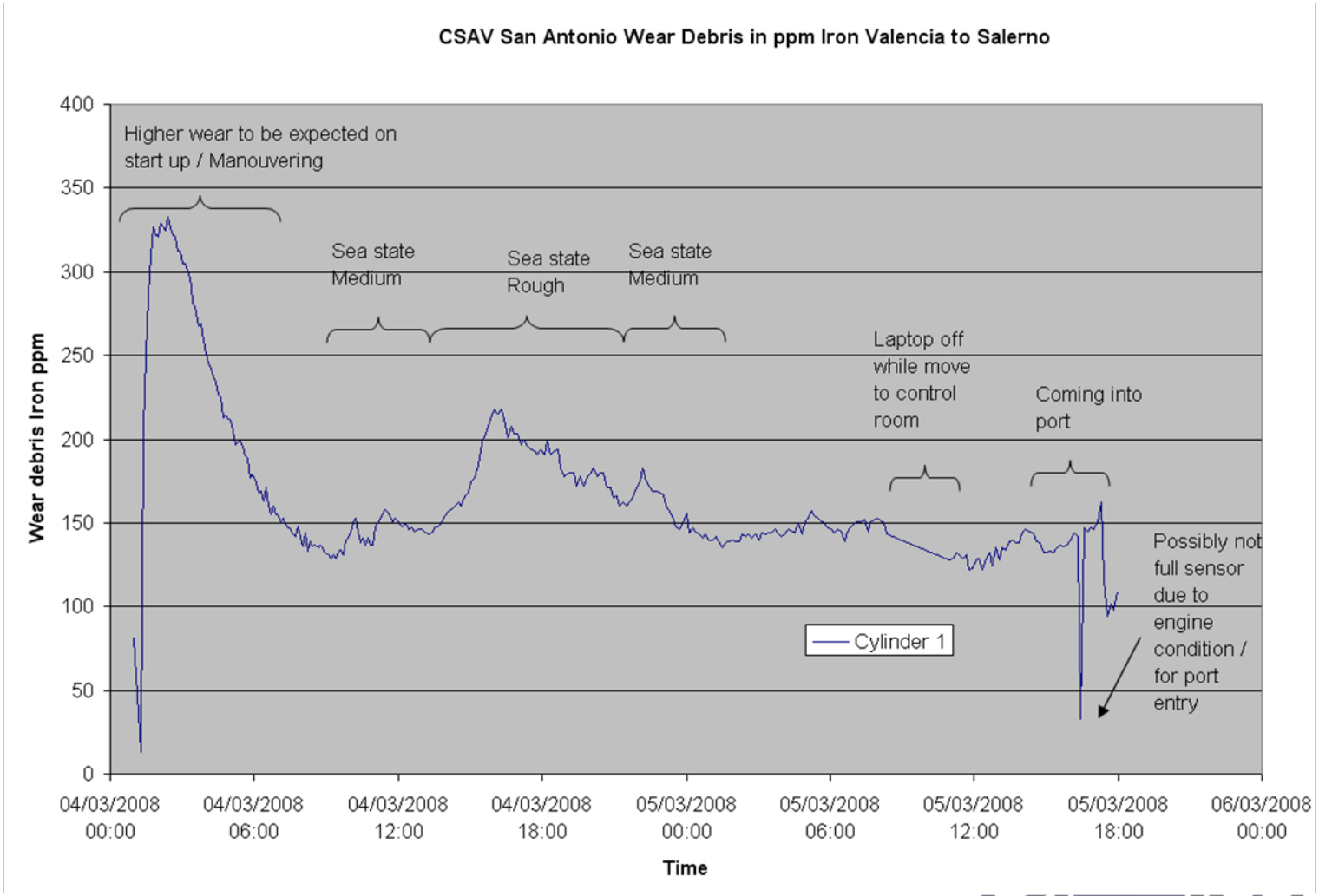
Operation and Environmental Conditions



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Can this be Transferred to the Wind Industry?

Live monitoring of

- Ferrous Particles(40 micron+)
- Non-Ferrous metallic particles 120 micron+)
- Total Ferrous ppm
- Moisture
- Oil condition
- Pressure
- Wind speed
- Turbine RPM
- Oil Flow
- Temperature
- Option for web / GPRS output

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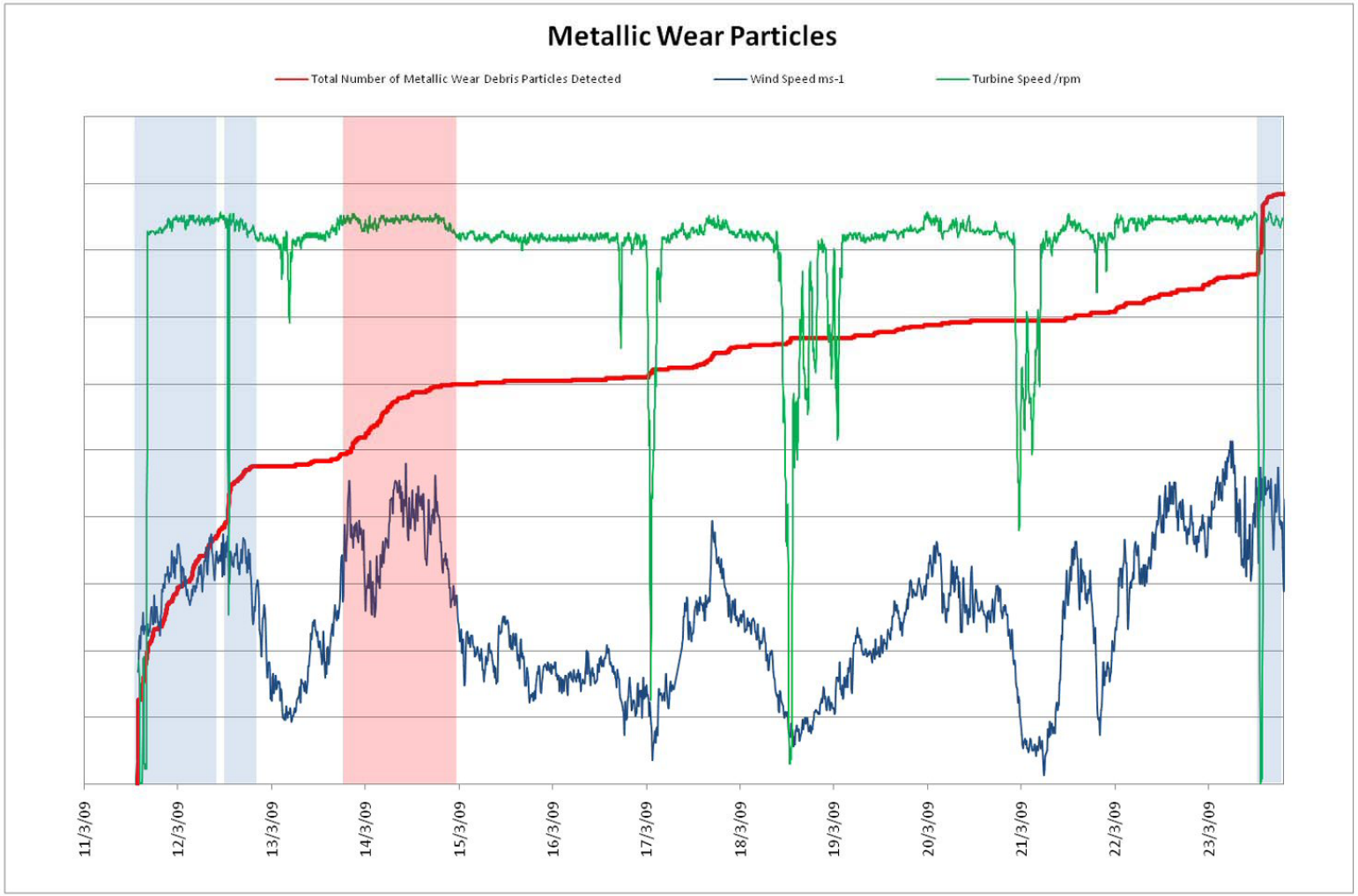
Operation and Environmental Conditions



This information can only be found when monitoring smaller particles (40micron +)

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Things to Learn from Marine Condition Monitoring

- On-line oil analysis is POWERFULL
- Infrequent analysis can be miss-leading
- On-site is easy quick, practical and cheap
- Can spot problems before “ANY” wear occurs. Wear debris analysis is only a small part of what is possible.
- See what affect new oils and greases have
- Vibration and oil analysis are complementary
- Find out when your machines operating / environmental conditions cause wear and adjust its parameters to reduce this affect. – increase oil and gearbox life

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