Monitor Bearing Health with Confidence

PRESENTER: **SIMON WILSON**, SALES DIRECTOR,
ENERGY & INDUSTRIAL

ABOUT GASTOPS

AT WTUI SINCE 1999!

Innovative solutions for **equipment health management**

35,000+ sensors since 1995

Aviation
Energy
Marine
Industrial

Founded in 1979
Employee owned
205 employees

Ottawa, Ontario – Head Office

Global Partner Network

TECHNOLOGY & CAPABILITY

CRITICAL EQUIPMENT CONDITION INTELLIGENCE

Simulation

Digital Twin

Modeling capabilities which provide key insight into operational parameters de-risking designs and changes

On-Line

MetalSCAN

On-line fluid sensing technology, providing real-time health monitoring of critical rotating equipment

At-Line

ChipCHECK

FilterCHECK

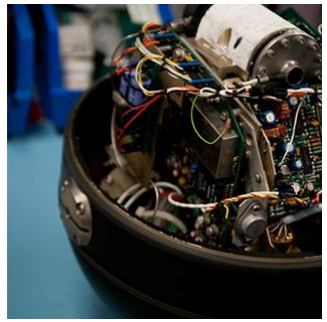
Automated in-field analysis tools which offer insight for time critical decision making

Off-Line

Oil / Filter / Chip Analysis

Traditional & Advanced analysis services offering insight into abnormal lubricant and machinery condition

MRO



Maintenance, Repair and Overhaul of mission critical equipment

DAMAGE INDICATION IS UNRELIABLE

- Bearing and gear damage is a leading causes of unplanned removals
- Undetected event to significant production loss
- Chip detectors are the leading cause of false and missed events
- False positives lead to unplanned shutdowns
- Damage develops progressively in advance of component failure

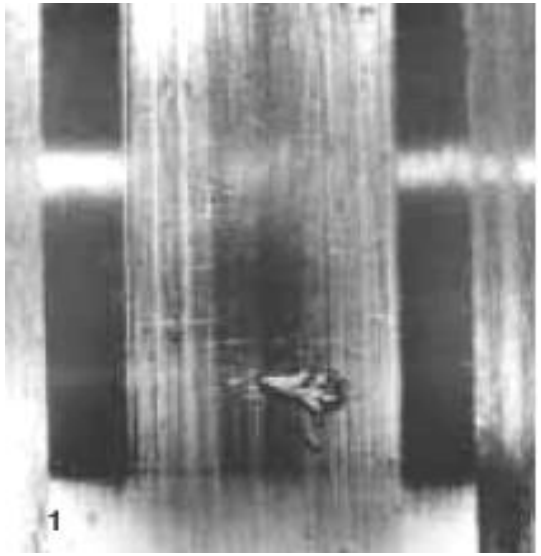
> *"Package lubrication issues were second in Forced Outage (FO) hours,* ***10%-plus by chip detector problems****."*

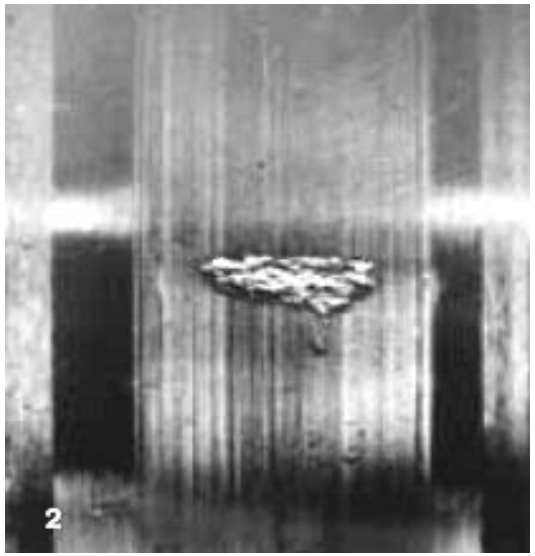
Source: WTUI 2017, LMS100 Users

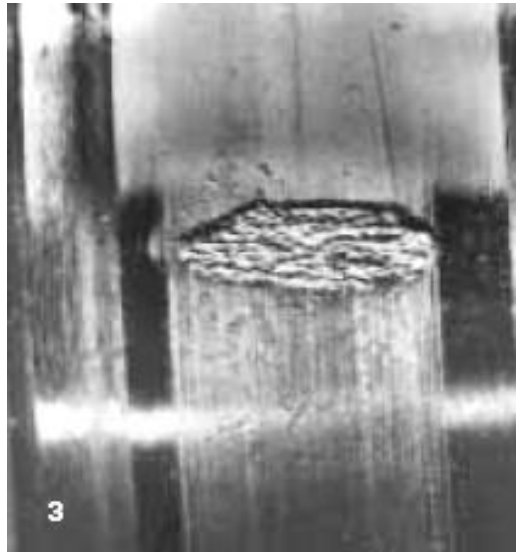
Source: WTUI 2017, LMS100 Users

BEARING SURFACE FATIGUE DAMAGE

- Damage develops progressively in advance of component failure
- Bearing damage is one of the leading causes of unplanned engine removals
- A missed detection on an aeroderivative leads to severe consequences

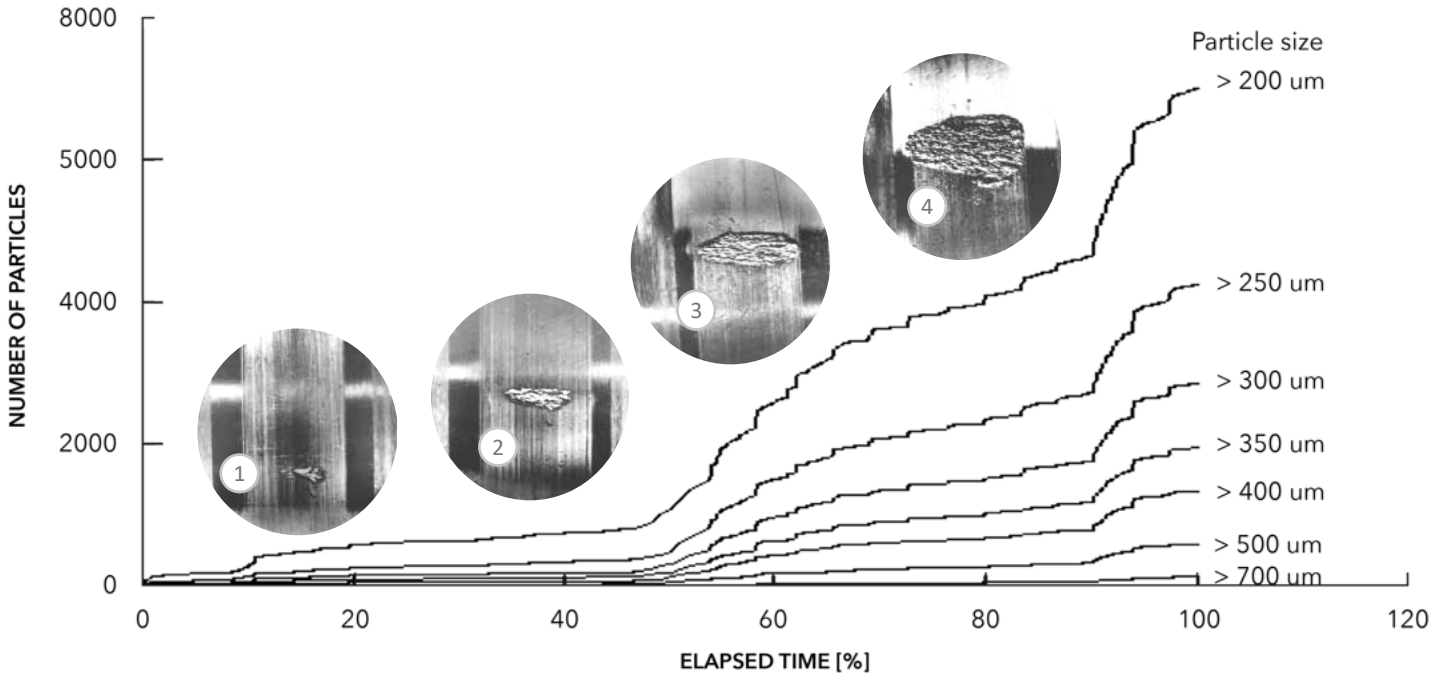


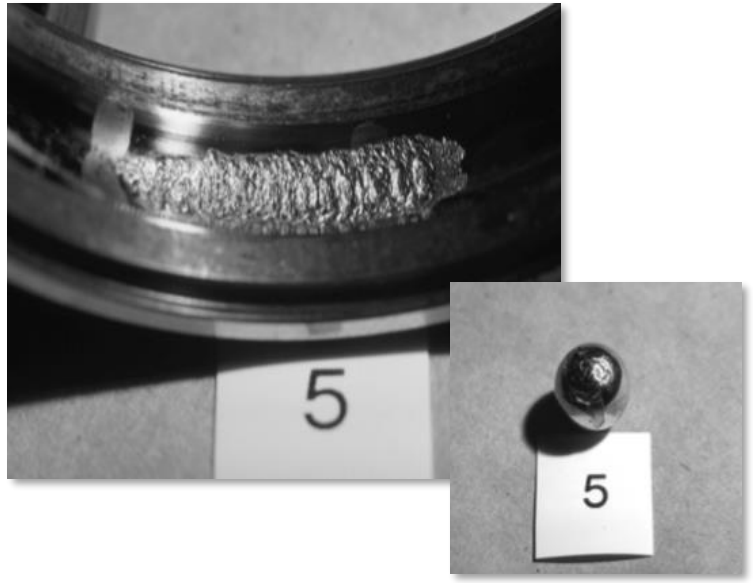


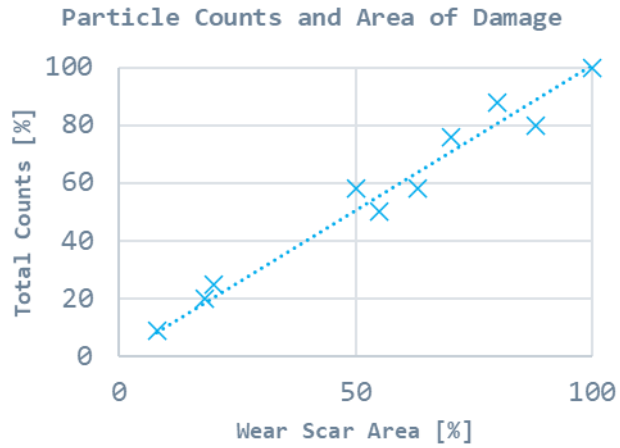


Reference : SKF Product Information 401

DAMAGE DEBRIS – RATE & SIZE







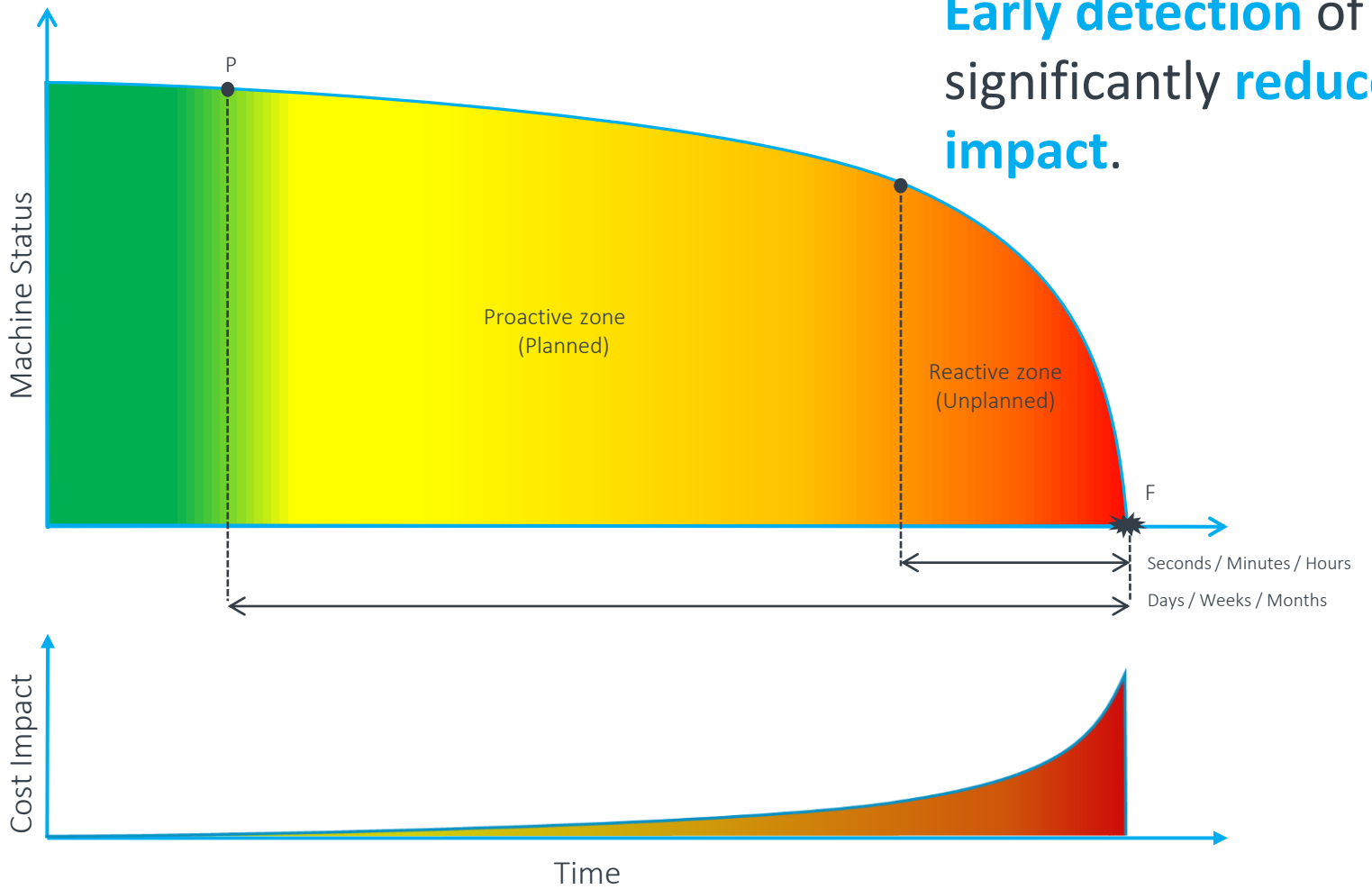
Quantitative measures for prognostics:

- Rate of debris generation is dependant on load & speed
- Quantity of debris is dependent on bearing size
- Particle counts directly relate to area of damage
- Particle size distribution is independent of bearing size

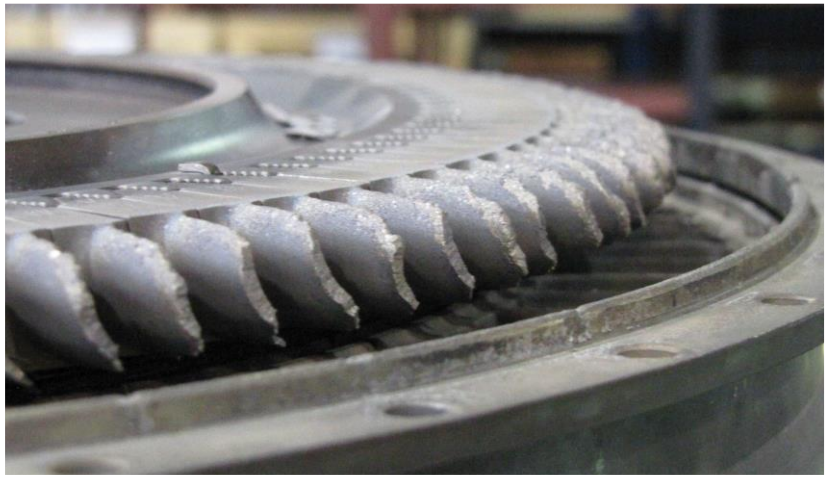
Reference : “In-Line Oil Debris Monitor (ODM) for the Advanced Tactical Fighter”, SAE 961308, Muir D et al

CONDITION MONITORING THEORY: INCREASE PRE-WARNING

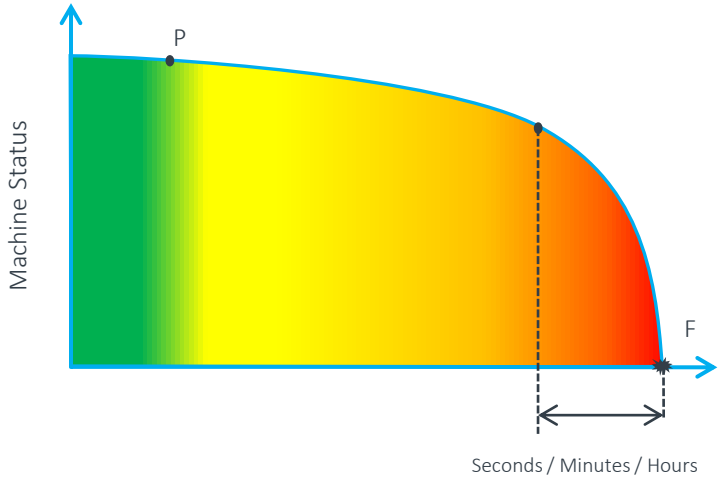
Early detection of an event significantly **reduces the cost impact**.



REACTIVE MONITORING TECHNOLOGIES



- Indication seconds or minutes before event
- Limited advanced warning for maintenance planning
- Severe and expensive secondary damage
- Limited or no root cause analysis



Reactive Zone (Unplanned)

REACTIVE WON'T HELP

Little or no pre-warning

OIL ANALYSIS

- Infrequent sampling period
- Lengthy feedback loop
- Inconclusive results
- Labour intensive
- Missed indications are common

CHIP DETECTORS

- ~15% capture efficiency
- Magnetic particle capture only
- Qualitative interpretation only
- False alarms are common
- Missed indications are common

TEMPERATURE MONITORING

- Shutdown device
- Missed indications are common

VIBRATION MONITORING

- Shutdown device
- Expert interpretation required

ADVANCED ODM: PROACTIVE PROTECTION METHOD

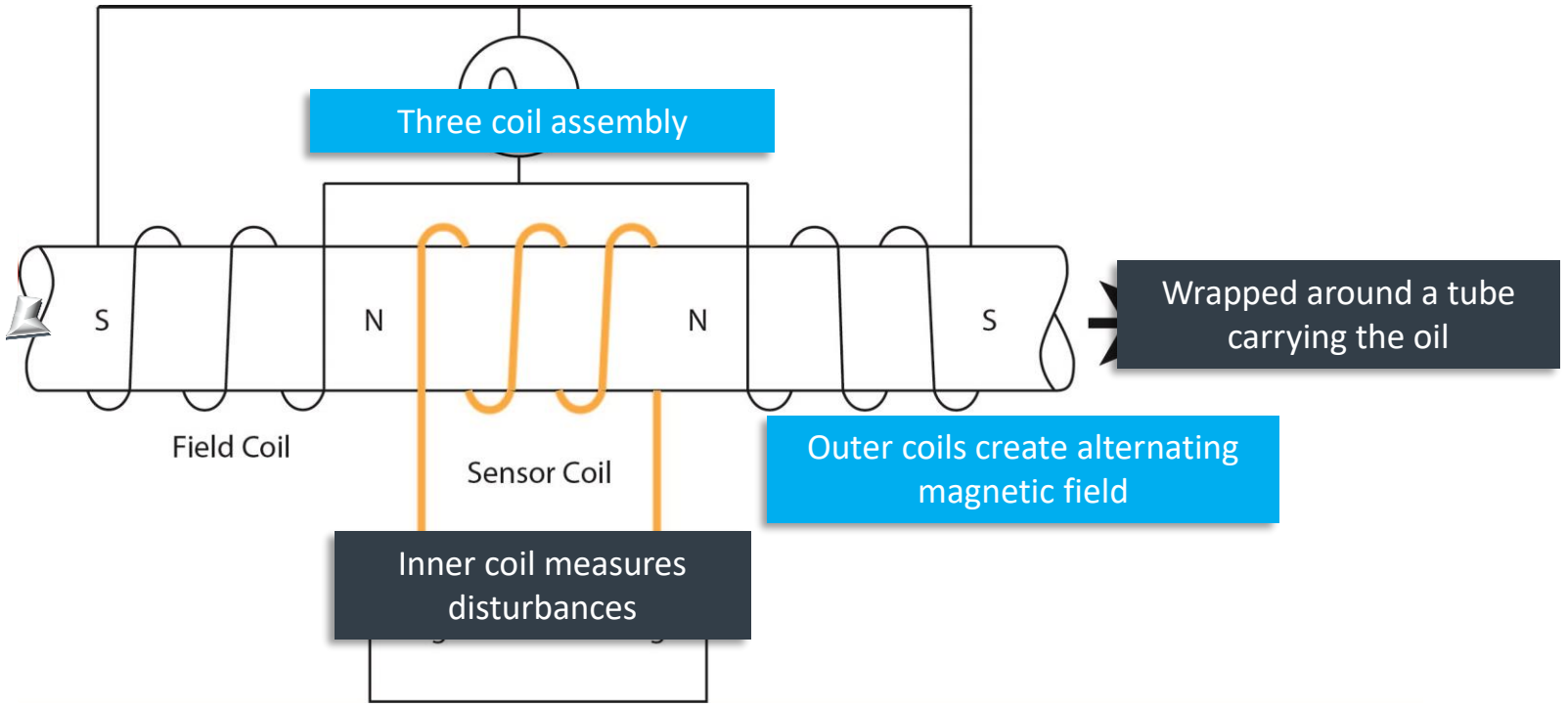
Rich, reliable data for earliest detection and predictive maintenance action

- 100% debris detection
- Flow through design
- Proven alarm limits
- Particle size information
- Particle type information
- Remaining useful life Prediction
- Easy & intuitive
- Maintenance-free

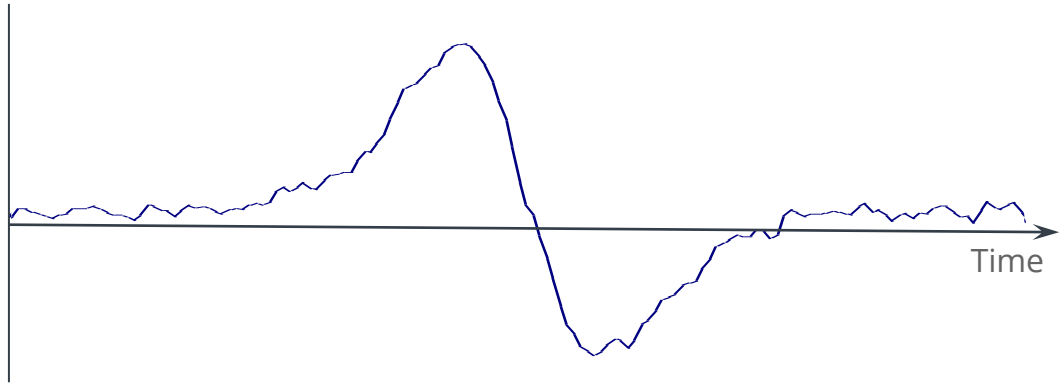
MetalSCAN
ONLY BY GASTOPS

Detect the initiation and **monitor** the progression of damage

Metal**SCAN** **SENSOR**



System Processor Output

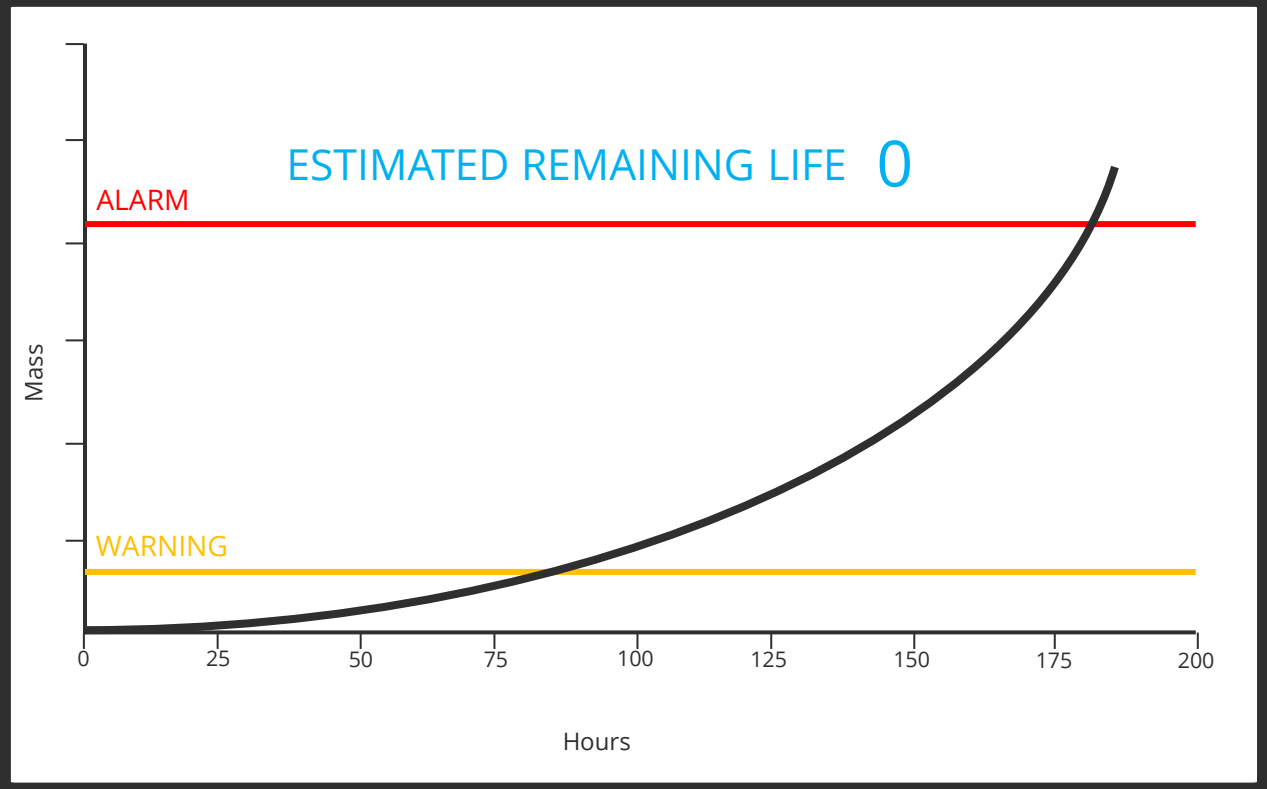


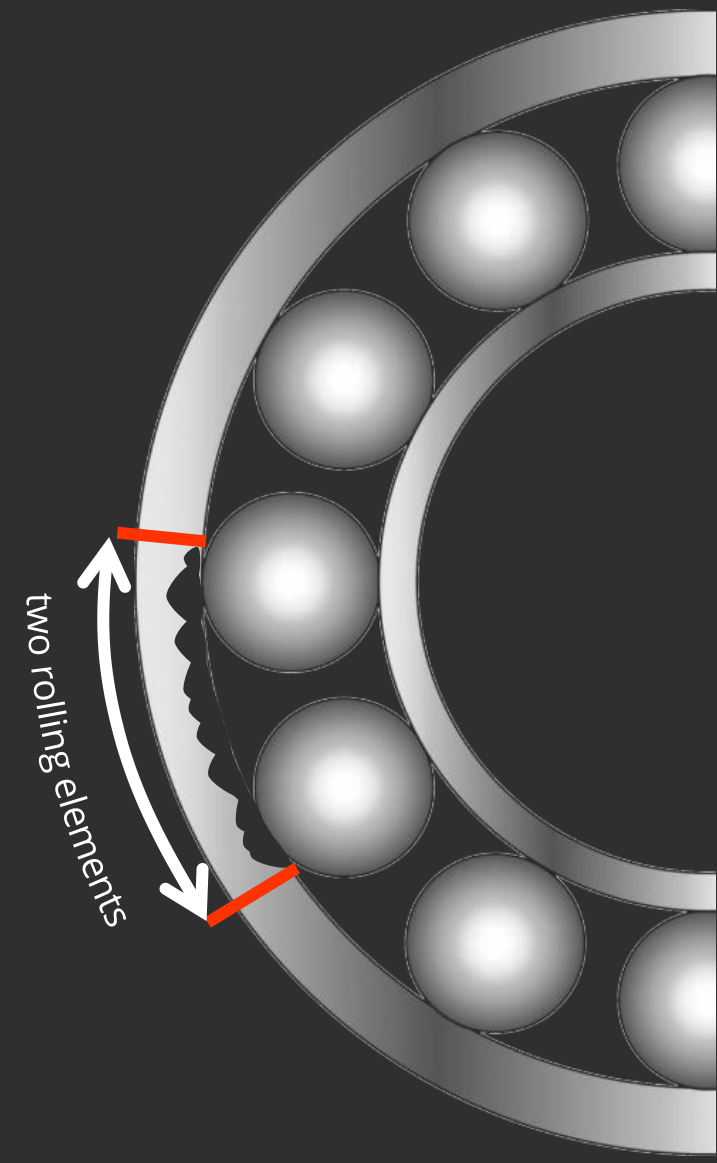
Magnetic metallic particle disturbs magnetic field

Non-magnetic metallic particle produces opposite signal

MetalSCAN OUTPUT

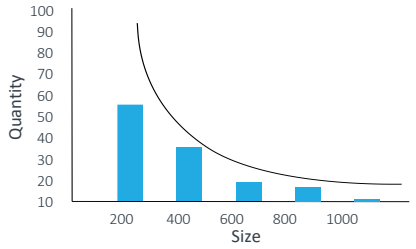
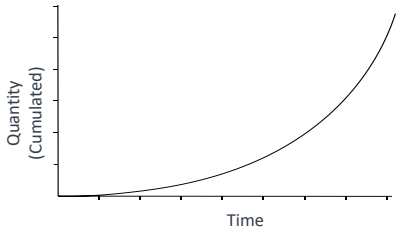
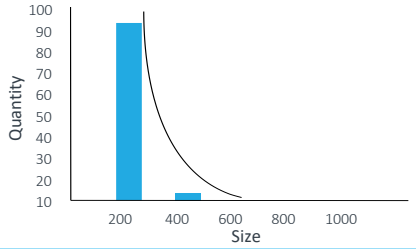
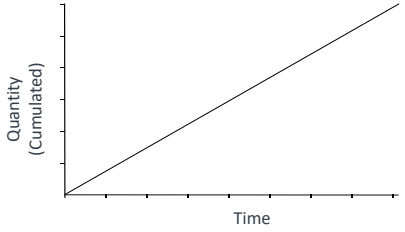
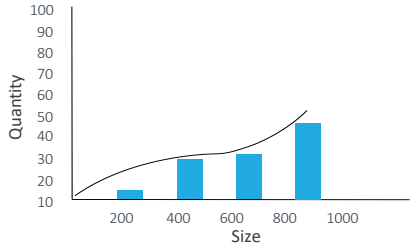
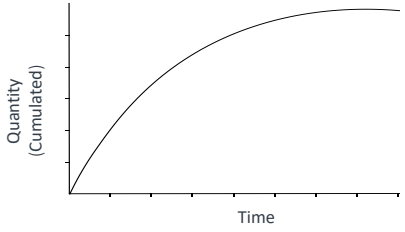
Is it safe to operate? If so, for how long?





ADVANCED OIL DEBRIS MONITORING DAMAGE ANALYSIS

Is it safe to operate? If so, for how long?

SIZE PROFILE	TREND	COMPOSITION	DIAGNOSIS
		Ferrous metal only	Bearing Damage
		Ferrous metal only	Seal Damage
		Ferrous & Non-Ferrous metal	Build Debris

Differentiate between **build** and **damage** debris

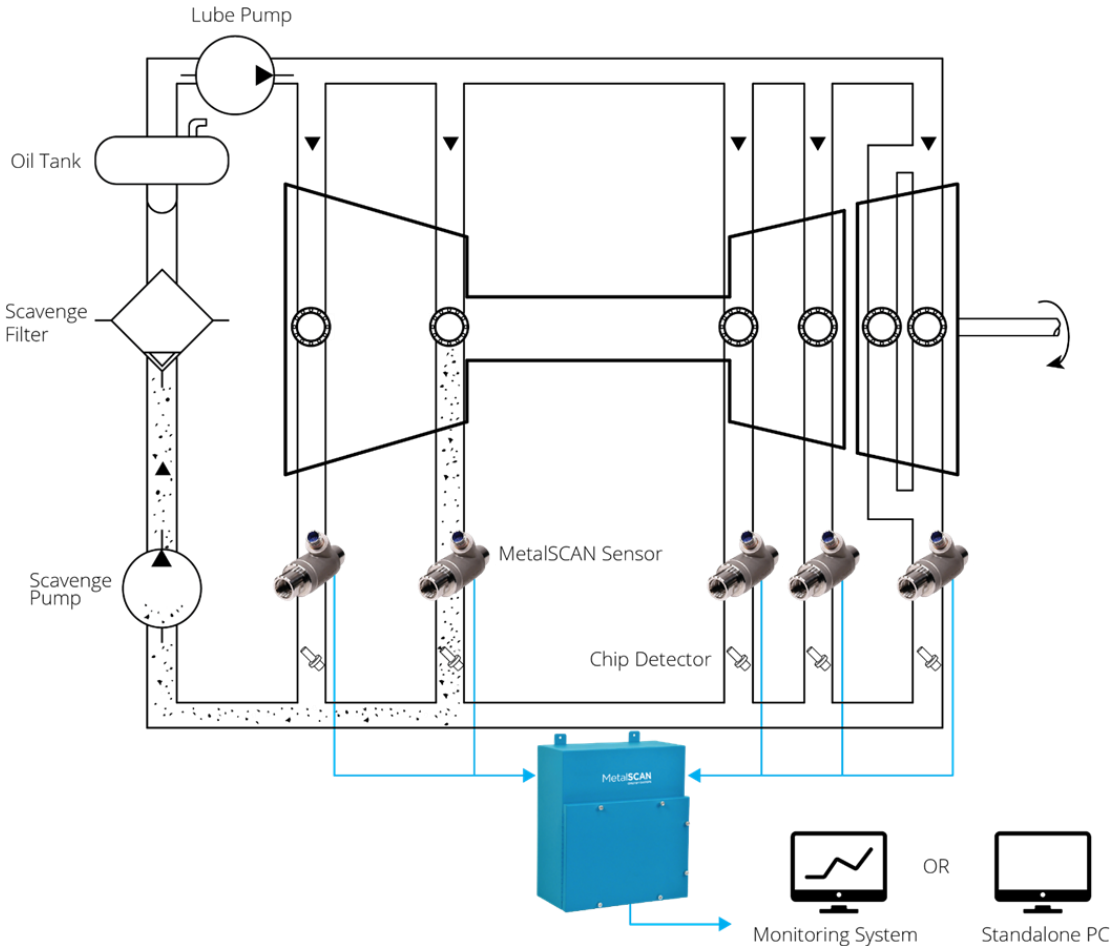
ADVANCED OIL DEBRIS MONITORING ADVANTAGES - GAS TURBINES

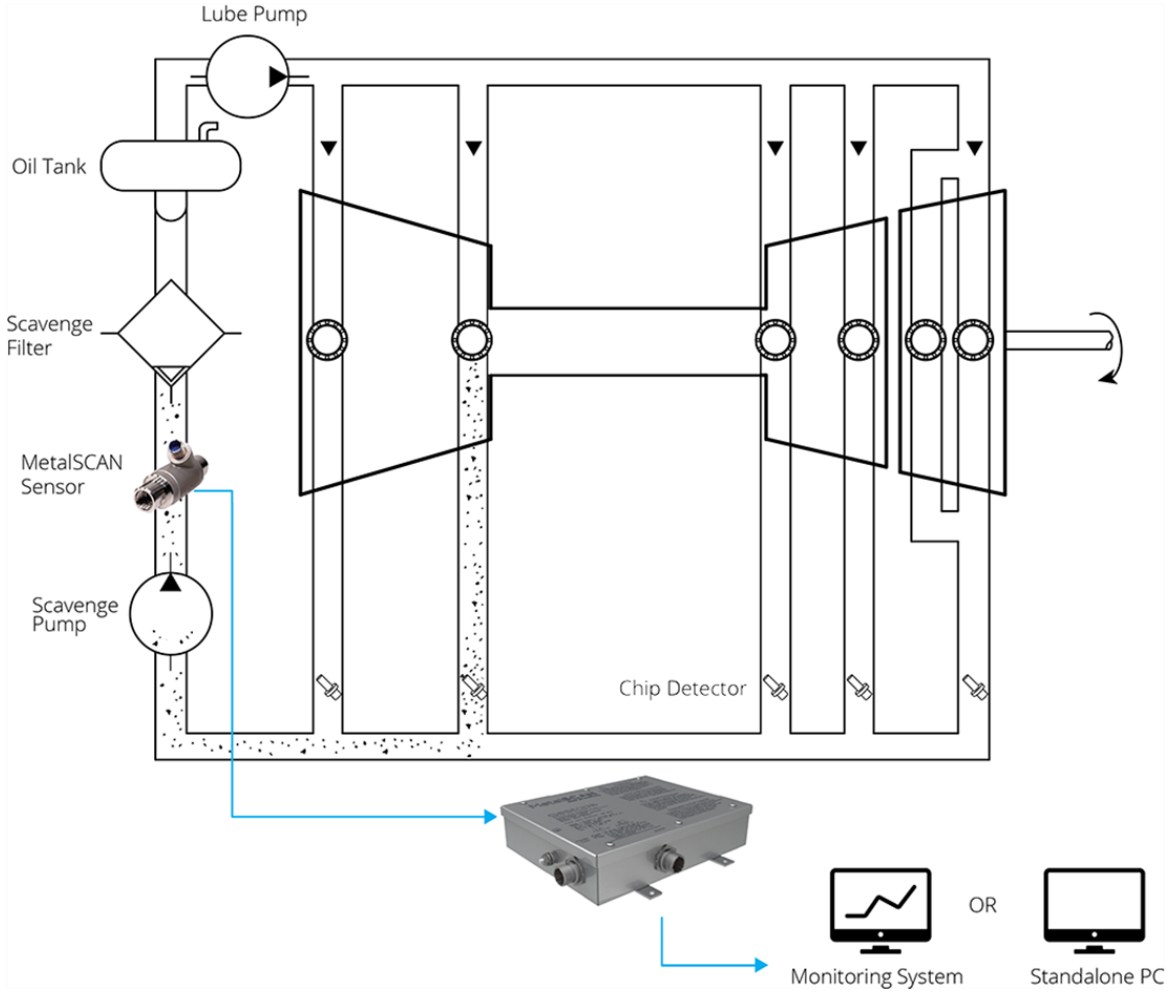
Comparison	ECD	MetalSCAN ONLY BY GASTOPS	MetalSCAN Advantages
On-line Indication	✓	✓	Continuous real time detection vs. discrete on/off indication
Particle Detection Probability	~15%	100%*	All metallic damage debris passing through the sensor is detected
Ferrous Detection	✓	✓	Detection of all Fe bearing & gear material*
Non-Ferrous Detection		✓	Detection of NFe bearing cage damage, pump damage, build debris*
Particle Counting		✓	Counts all particles above threshold
Particle Sizing & Mass		✓	Particle type/size info for discrimination of bearing damage, failure modes & build debris
Saturation		✓	Flow through technology supports unlimited particle quantity
Condition Indicator		✓	Graphical display for remaining life indication (prognostics & diagnostics)
No False Indications/Alarms		✓	Intelligent signal processing and condition indicators
No Routine Maintenance		✓	No cleaning, no calibration, includes built-in-test
No Forced Outage		✓	No shutdown required to troubleshoot
No Missed Detections		✓	Reliable with electro-mechanical features optimised for the application

*All particles above the sensor detection threshold which is determined by the application

SENSOR SOLUTIONS

MetalSCAN CONFIGURATION OPTIONS (Multi vs. Single)





MetalSCAN SELECTION GUIDE (Multi vs. Single)

Guideline		Multi	Single	Benefit Summary
Data	Individual sump debris detection	★★★	☆☆☆	Allows for individual sump isolation
	Earliest indication	★★★	★★☆	Damage particles reach sensor immediately
	Trending & limits	★★★	★☆☆	individual sump or combined alarm limits
	Remote monitoring	★★★	★★☆	Less local involvement
Actions	Active load adjustment	★★★	★★☆	Load reduction to augment RUL trend projection
	Troubleshooting	★★★	★☆☆	Early detection enhances advanced troubleshooting
	Proactive planning	★★★	★★☆	Early detection and trending supports planning
	Peaker operation	★☆☆	★★★	Opportunity for a more affordable and easy retrofit
ROI	Savings delivered	★★★	★★☆	User feedback: $100k to $1M+ per detection event
	Repair benefits	★★★	★★☆	Damage has been isolated early and did not spread
	Cost	$$	$	Installation < 1 day (single) vs 2 days (multi)

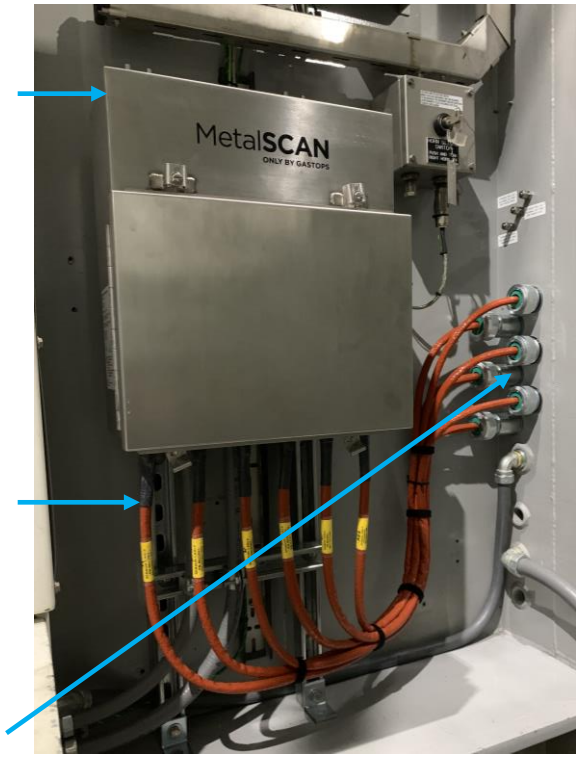
☆☆☆ N/A ★☆☆ Base solution ★★☆ Good solution ★★★ Optimal solution

MULTI SENSOR INSTALLATION

MetalSCAN Multi Sensor Electronics Enclosure

MetalSCAN Sensor Cables

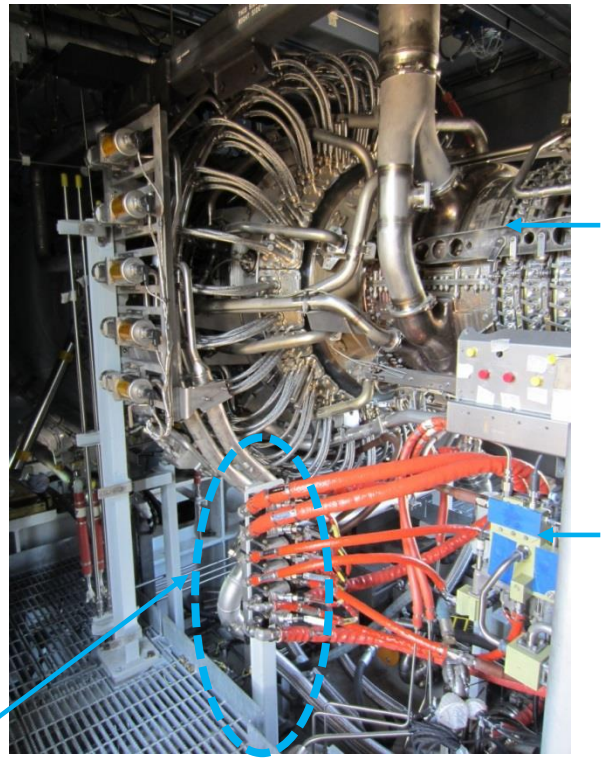
Multiple Package Bulkhead Pass Through Options Available



Outside Engine Package

MetalSCAN Electronics Enclosure installs on outside of package. Sensor cables (length options available) connect to the MetalSCAN Sensors inside the package through package bulkhead glands or existing "Roxtec" style cable entry block.

MetalSCAN Sensor



LM6000 (Similar MetalSCAN install for LM2500/5000/S100)

Scavenge Pump

Inside Engine Package

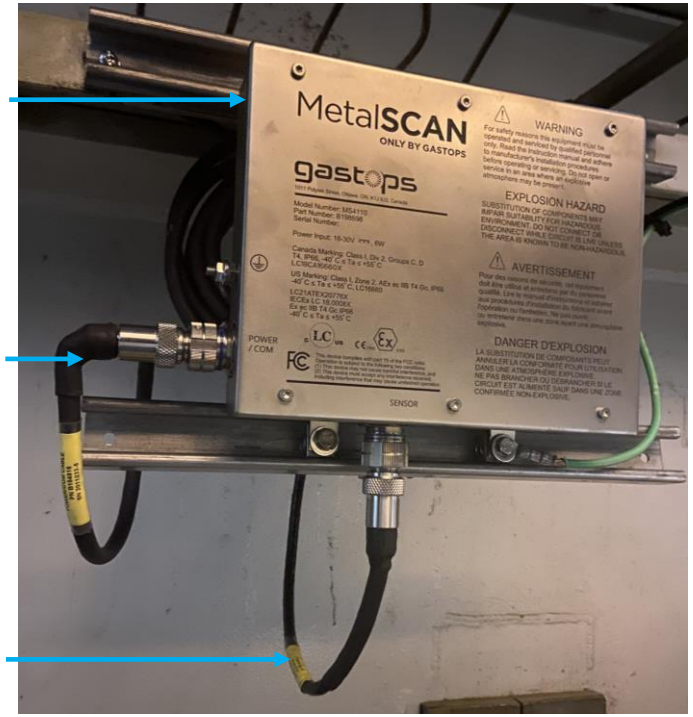
MetalSCAN Sensors install on a stand with hosing going from Sump → MetalSCAN Sensor, and then from MetalSCAN Sensor → Scavenge Pump.

SINGLE SENSOR INSTALLATION

MetalSCAN Single Sensor Electronics Enclosure

MetalSCAN Power and Communications Cable (to Monitoring System)

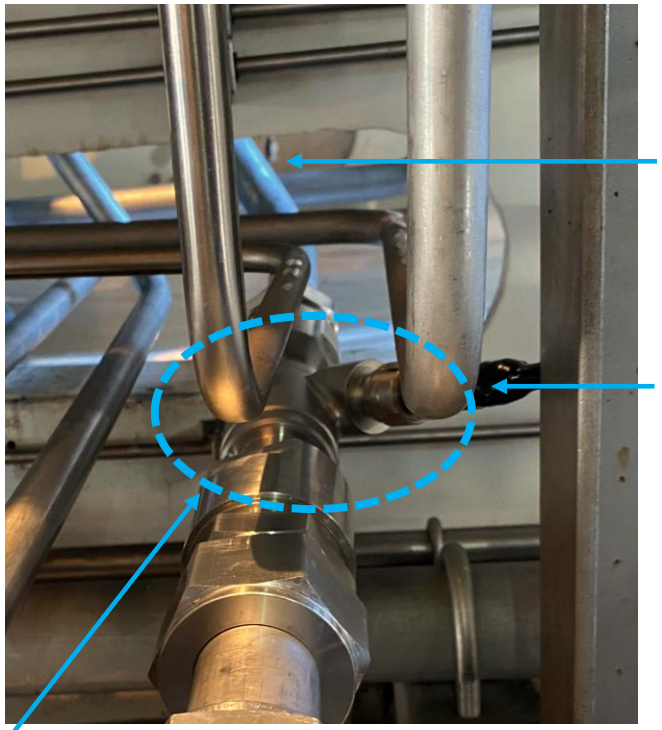
MetalSCAN Sensor Cable



Outside Engine Package

MetalSCAN Electronics Enclosure installs on outside of package. Sensor cable (length options available) connects to the MetalSCAN Sensor through package bulkhead gland or existing "Roxtec" style cable entry block.

MetalSCAN Sensor



Scavenge Pump Discharge Line

MetalSCAN Sensor Cable

Lubrication System Installation

MetalSCAN Sensor installs in lubrication system plumbing downstream of common scavenge pump outlet. Mechanical integration approach is specific to lubrication system-package.

ADVANCED O&M TROUBLESHOOTING

ADVANCED O&M TROUBLESHOOTING – THE COMPLETE SOLUTION

Early warning enables enhanced troubleshooting*

MetalSCAN
ONLY BY GASTOPS

REAL TIME INDICATION OF DAMAGE

ONLINE

FilterCHECK
ONLY BY GASTOPS

EXTRACTION OF FILTER DEBRIS

ChipCHECK
ONLY BY GASTOPS

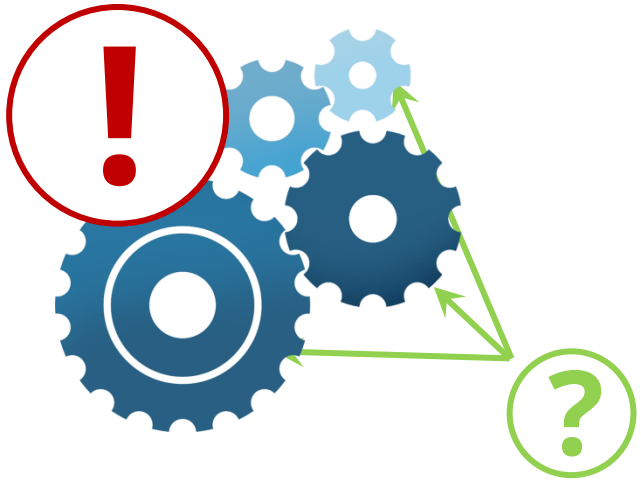
ALLOY IDENTIFICATION OF DEBRIS

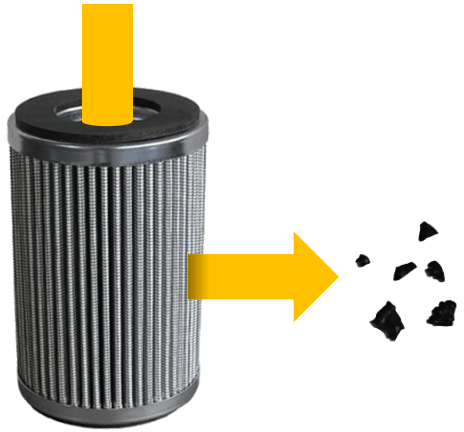
AT-LINE / OFF-LINE

* GEK117488 – GE Field Guide for Lubrication System Debris

ADVANCED O&M TROUBLESHOOTING – THE COMPLETE SOLUTION

Early warning enables enhanced troubleshooting*





MetalSCAN ONLY BY GASTOPS

REAL TIME INDICATION OF DAMAGE

ONLINE

FilterCHECK ONLY BY GASTOPS

EXTRACTION OF FILTER DEBRIS

ChipCHECK ONLY BY GASTOPS

ALLOY IDENTIFICATION OF DEBRIS

AT-LINE / OFF-LINE

* GEK117488 – GE Field Guide for Lubrication System Debris

ADVANCED O&M TROUBLESHOOTING – THE COMPLETE SOLUTION

Early warning enables enhanced troubleshooting*

MetalSCAN
ONLY BY GASTOPS

REAL TIME INDICATION OF DAMAGE

ONLINE

FilterCHECK
ONLY BY GASTOPS

EXTRACTION OF FILTER DEBRIS

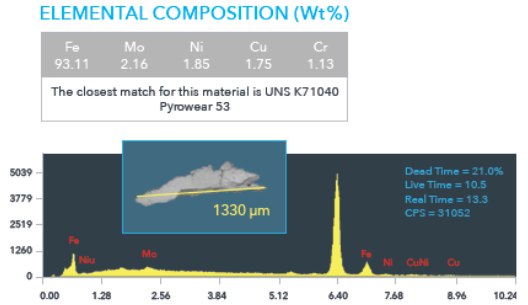
ChipCHECK
ONLY BY GASTOPS

ALLOY IDENTIFICATION OF DEBRIS

AT-LINE / OFF-LINE

* GEK117488 – GE Field Guide for Lubrication System Debris

ADVANCED O&M TROUBLESHOOTING
Laboratory Services



Fluid Analysis Package

Includes the following:

- RDE AES (ASTM D6595)
- Viscosity (ASTM D445)
- Acid Number (ASTM D974)
- Water Content (ASTM D6304)
- FTIR (ASTM D2412)
- Particle Count (NAS 1638)
- Color (ASTM D1500)

Filter Analysis Package

Includes the following:

- Filter Debris Analysis (ASTM D7919)
- Chip Debris Analysis (ASTM D8182)

Chip & Material Analysis

- Chip Debris Analysis (ASTM D8182)
- SEM – EDXRF Quantitative Elemental Classification

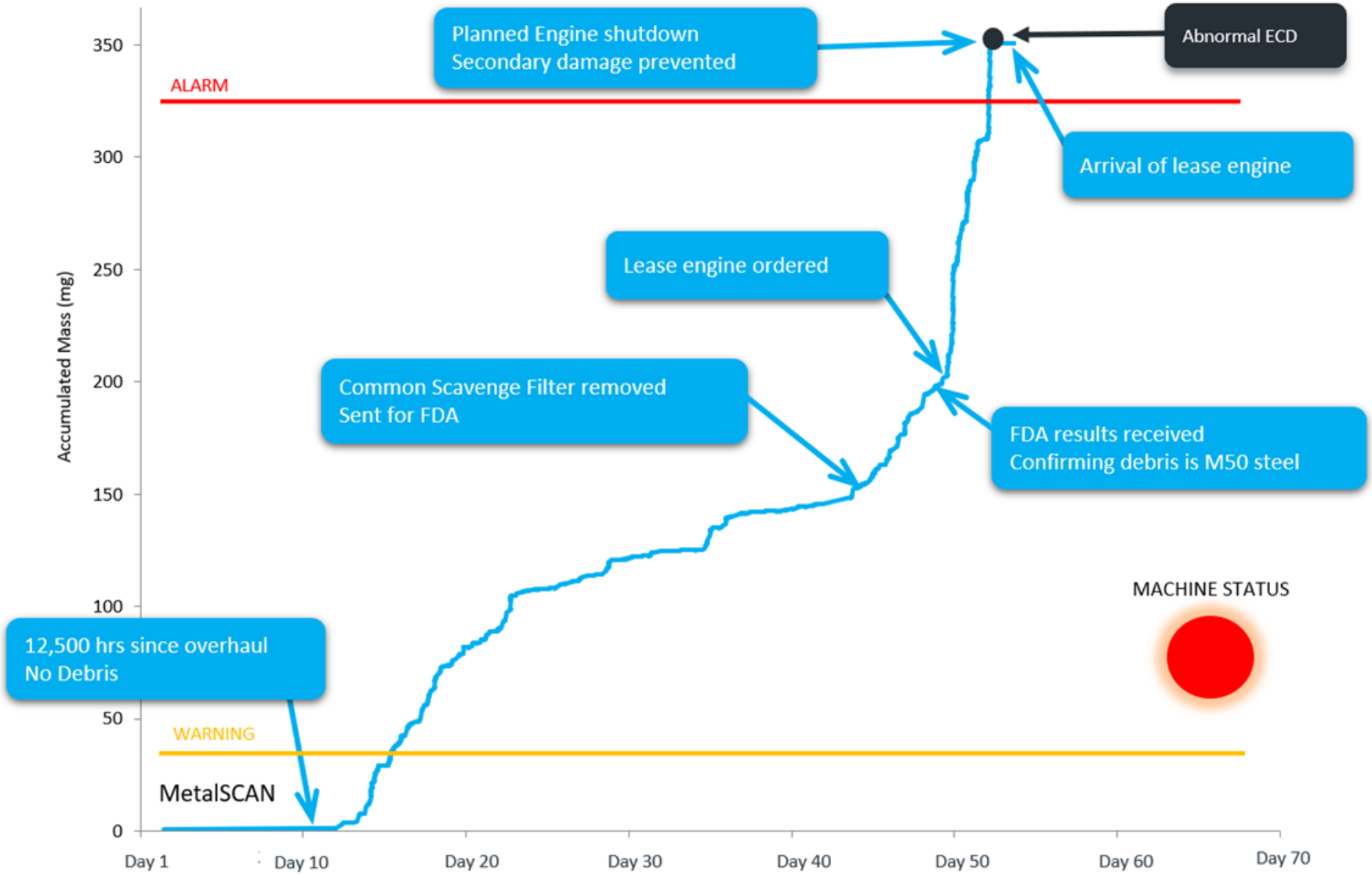
- All LM-engines test results evaluated in **accordance with GE Document GEK 105054** On-Site Operation and Maintenance Manual
- Gastops Oil Analysis Services **recommended in GEK 105054** On-Site Operation and Maintenance Manual and **GEK 117488** Field Guide for Lubrication System Debris


gastops
ADVANCED OIL DEBRIS MONITORING
– THE COMPLETE SOLUTION
CASE HISTORY
MetalSCAN
ONLY BY GASTOPS

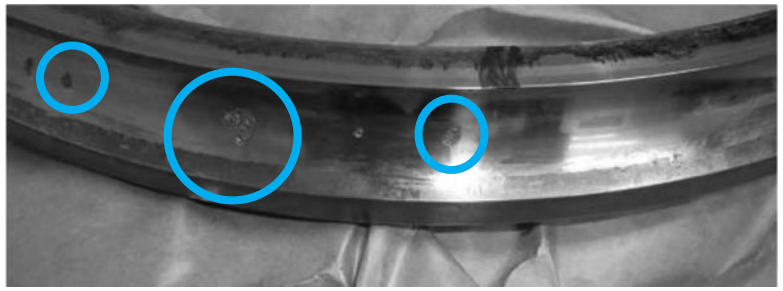
Case History - LM6000 Baseload

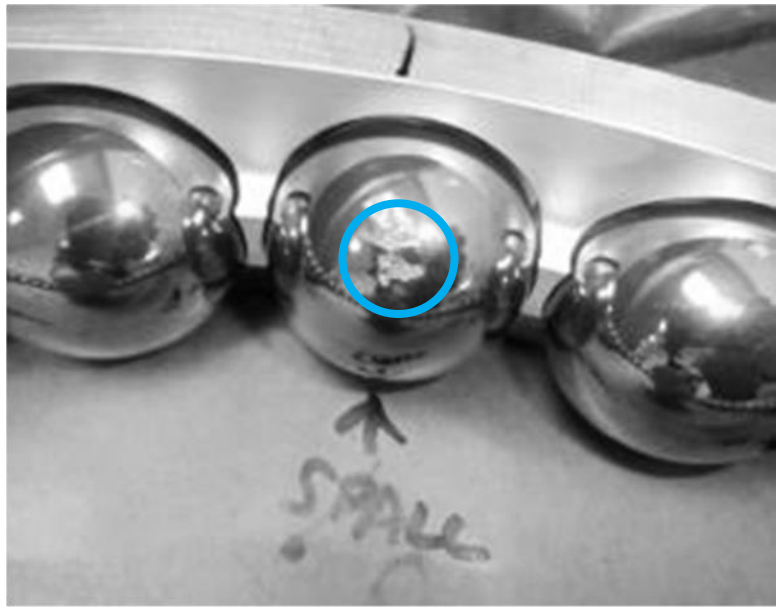
ADVANCED OIL DEBRIS MONITORING WITH MetalSCAN

ONLY BY GASTOPS



ADVANCED OIL DEBRIS MONITORING WITH MetalSCAN





- Alerted when vibration, temperature and ECD's are silent
- Limited damage to problem bearing
- Avoided secondary damage and unplanned shutdown
- Supported maintenance planning for replacement unit
- Reduced production loss and repair costs of unplanned event
- 4 days of unplanned downtime saved!
- Case histories: https://www.gastops.com/products-services/metalscan/

THE MetalSCAN DIFFERENCE

More than just products

Applications

Aeroderivative Gas Turbines

Extruder Gearboxes

Wind Turbine Gearboxes

Marine Propulsion

Test Cells

The Complete Solution

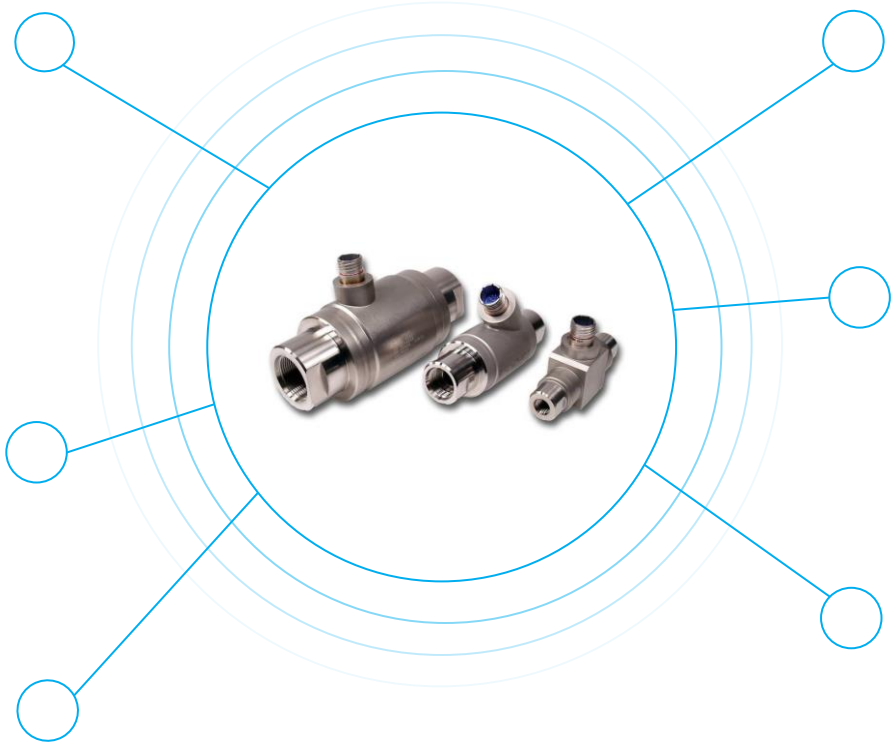
Component damage isolation

Identify Failure Modes

Surface fatigue damage

Build debris

Seal damage



Damage Indication is Unreliable

Bearing and gear damage leads to unplanned events

ECDs are the leading cause of false or missed events

Damage develops progressively over time

Proactive Protection

Real-time damage severity indication

Schedule maintenance activities

Root cause analysis determination

Increase overall availability

Condition Indicators

Warning and Alarm limits

Remaining useful life information

Extend overhaul intervals

Thank you!

Simon Wilson

Sales Director, Energy & Industrial

swilson@gastops.com