Maintaining your Compressor in demanding environments

Image by POA (Phot) Sean Clee

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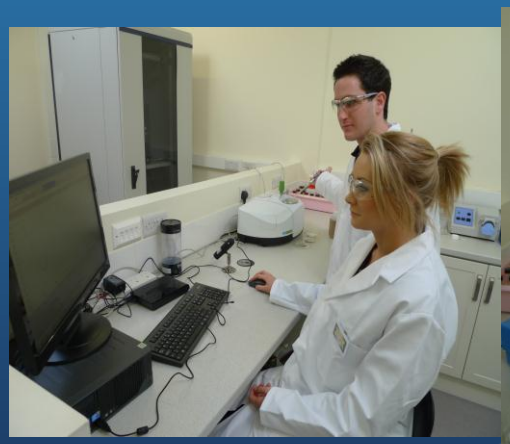
Shaping the future of gas turbine washing

Date

ZOK – Mission Statement

ZOK brings over 30 years experience of delivering long term commercial and environmental benefits to our worldwide customer base via our dedicated global distribution network. An active Research & Development program ensures ZOK's future as a global leader in the production & distribution of environmentally responsible Gas Turbine Compressor Cleaning Solutions, providing our customers with a competitive advantage in their markets.



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What contaminates an engine

- Engines operating in harsh environments are hugely affected by contaminants being ingested. These contaminants can be:
- Particulate-sand-soil & salt
- Hydrocarbons-oil & fuel
- Usually airborne

Why wash an engine at all?

Regular washing with a good quality approved water based cleaning solution will:

- Remove deposited contaminants – restoring aerodynamics & compressor efficiency – helping to ensure:
- Maximum available power output
- Improve fuel efficiency
- Reduce hot section component deterioration

Compressor washing - Keep your compressor happy

- Single most misunderstood process in gas turbine compressor maintenance
- Yet single most cost effective maintenance activity you can carry out

Turbines can lose 10% or more of their operating efficiency if not kept clean

At this stage the penalty is loss of optimum blade profile and extra fuel used to maintain output

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Compressor washing - Keep your compressor happy

- If left alone unnecessary engine removals will occur
- Hot section deterioration will render components as scrap when removed from the engine - not repairable

Why choose a water based wash solution?

- RAF helped develop unique formulation of water based corrosion inhibiting compressor cleaning solution
  - Hostile operating conditions
- Why?
  - To enable flight at a moments notice
- Enabled quick flight turn around and engine protection
- Wash every 25hrs engine run time

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Using water based detergent to wash

- Eco-Friendly
- Aqueous NOT Solvent based cleaners
- Solvent based cleaners eventually harden internal seals
- Solvent based cleaners – difficult to safely/environmentally dispose of
- Unique formulated Surfactant - for increased penetration and removal of fouling
- Wide range of approvals

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Why are these benefits?

- No need to rinse water based cleaning agent from engines
- Good cleaning efficiency- Fewer washes needed
- Low Ash – Fantastic for online washing
- Reduction in metal flake formation
  - Less corrosion of blades
- Surfactant very stable in all conditions
  - No need for agitation

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Obtaining approvals

- To obtain approvals from OEMs the cleaning solutions need to comply with a significant number of stringent tests performed at Internationally recognised Labs
- For Example – SMI (Scientific Material International)
  - Ash <0.01%
  - Some metal elements <0.1ppm for Online washing

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Obtaining approvals

The margin for error is minute hence testing performed in-house to every batch to ensure only the highest quality products leave the factory

ZOK GOLD is approved by Siemens Germany and Rolls-Royce

Approvals

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

MINISTRY OF DEFENCE

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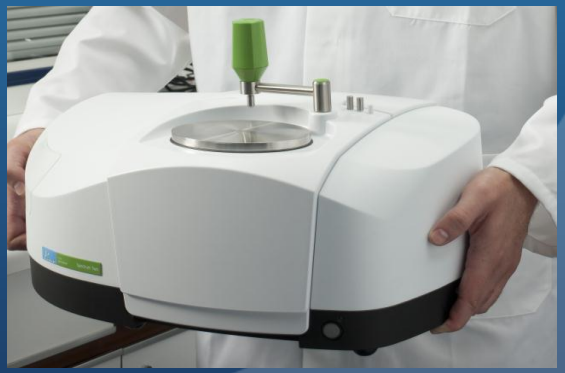
Gas compressor washing working for Power Stations

- Wash procedures performed on an Indonesian Power station
- Wash and rinse samples analysed for information regarding:
  - Types of contaminant
  - Quantities of contaminants
  - Leading to a recommendation for the most effective wash duration and dilution ratio



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The Results

- Off-line washing removes particulate matter and “sticky” coating on blades
- On-line washing removes particulate matter
- Rinse samples still contained traces of contaminants but at significantly reduced levels compared to the wash fluids
- Successful - as we can now quantify what washing achieves

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Organic contaminants within wash samples

Concentration of contaminants within samples taken during an off line wash.

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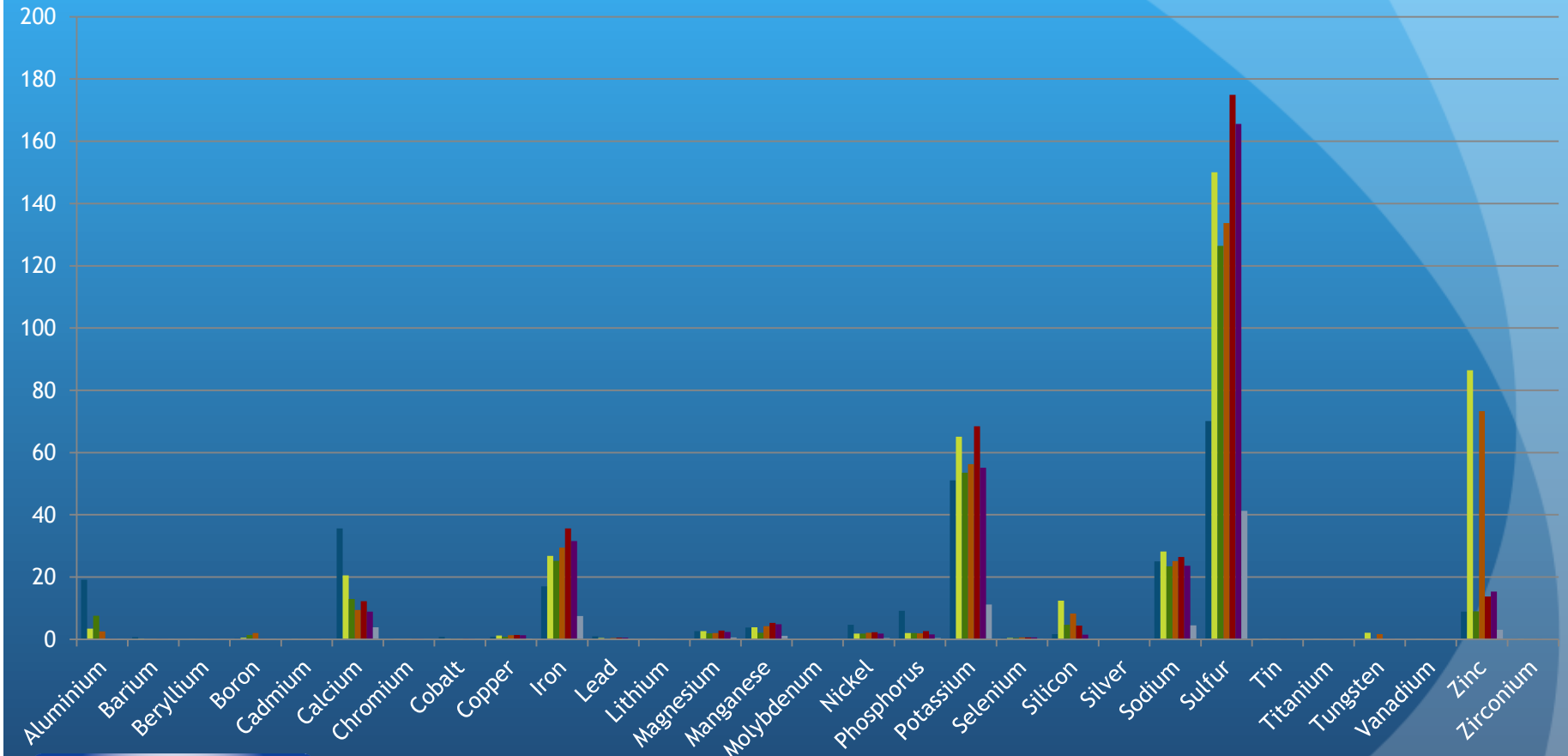
Waste matter identified in wash samples



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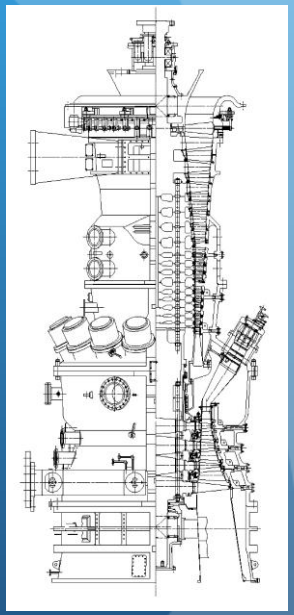
GT Wash Case Study

- Washing performed on three Siemens engines at a UK Power Station
- Before Washing started:
  - Unplanned shut downs every 4-6 weeks
  - Unacceptable range of engine temperatures
- Unplanned shut downs due to loss of engine performance
- Not washing with a detergent so engine not being cleaned well enough



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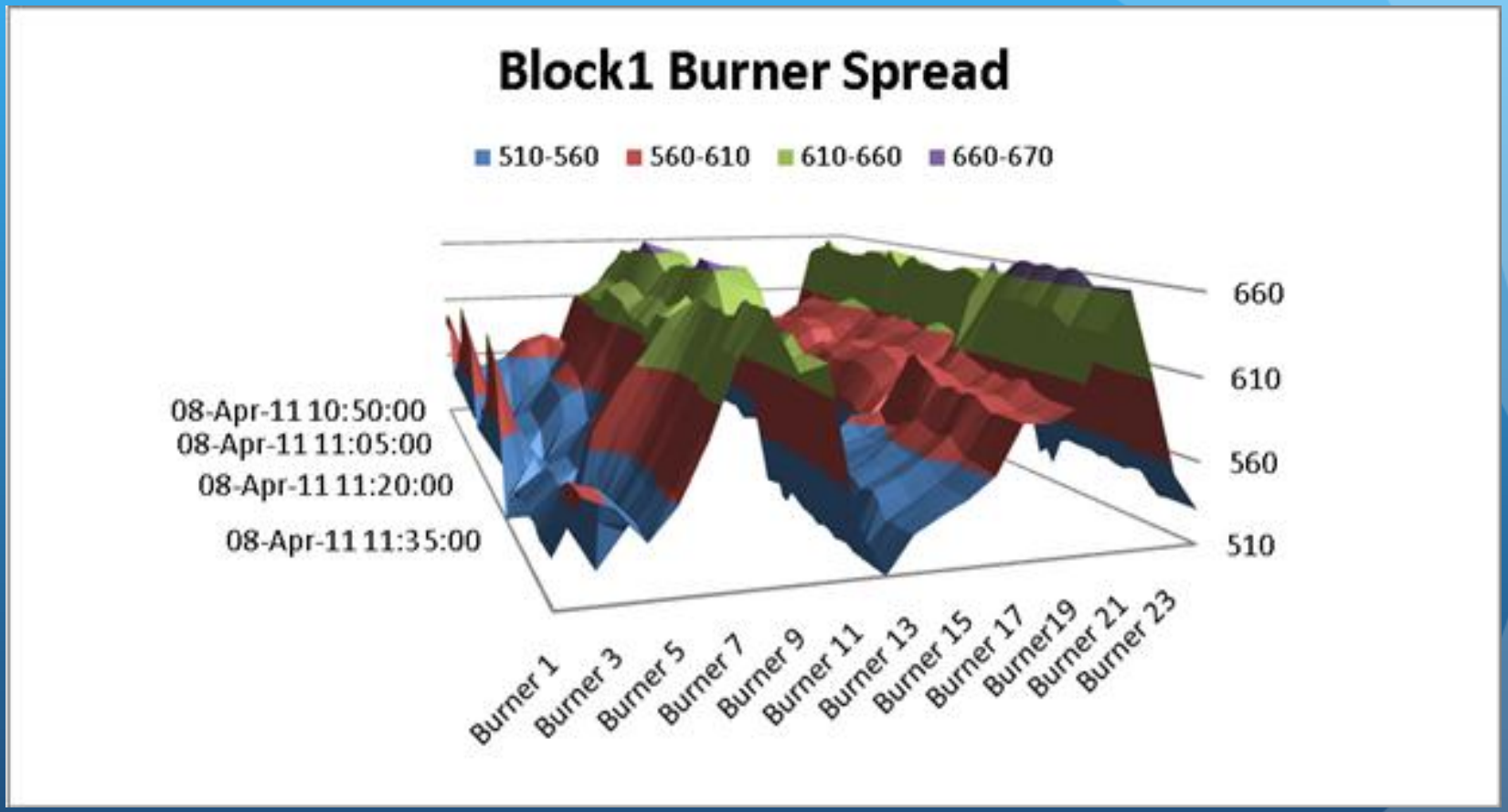
Exhaust Temperatures Before Washing



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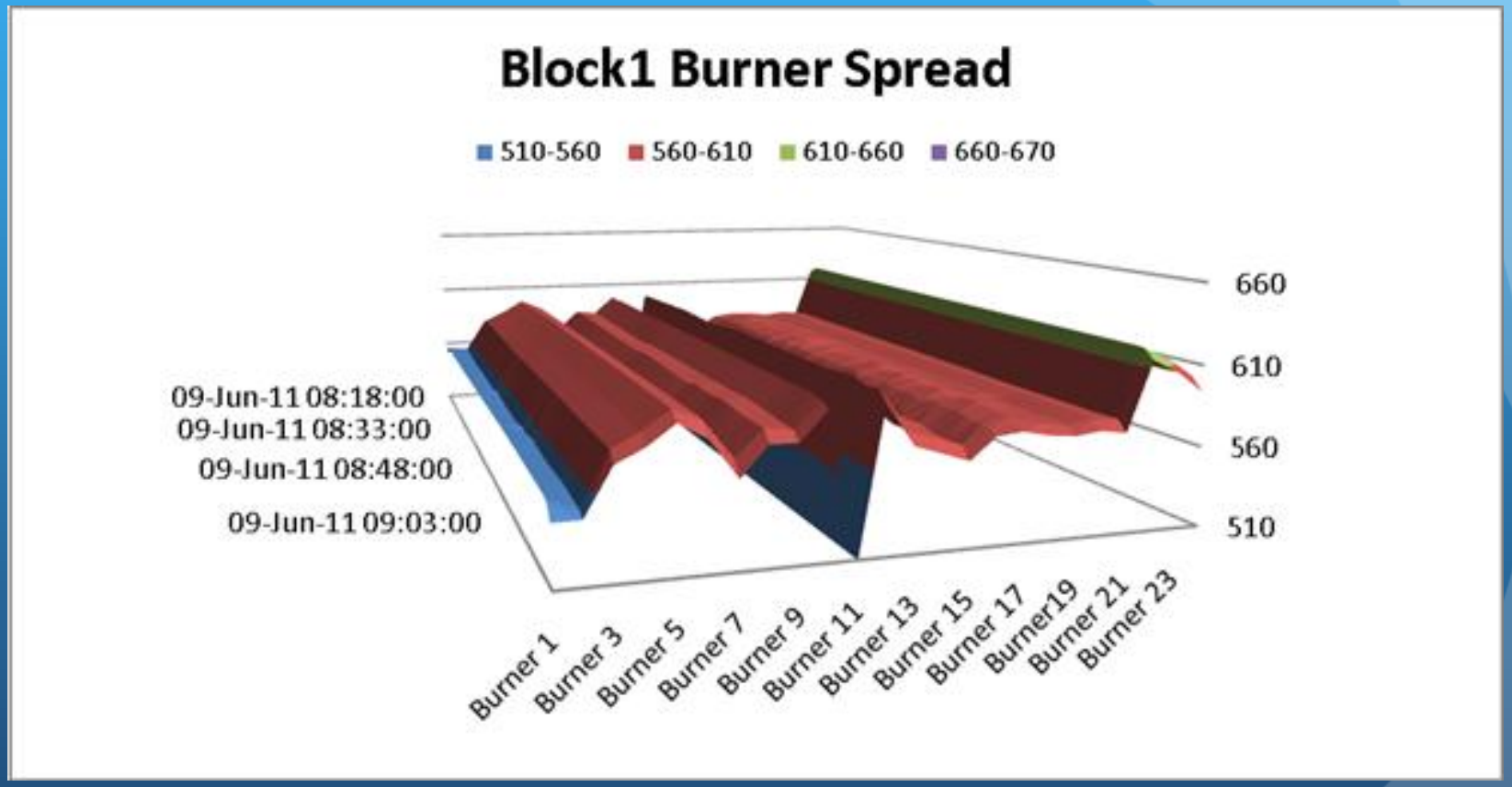

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ZOK GOLD Trial

- Originally washing with demineralised water
  - Now running a range of dilutions to find optimum cleaning point
- Both wash and rinse samples sent back to ZOK for analysis

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GOLD Standard Results

- Initially one turbine was to be left to compare the cleaning results- Results so good all engines cleaned!
- Engine temperatures much more consistent
- Early stages of the study suggests that we are experiencing improved engine efficiency and availability
- Major inspection later this year will show just how clean ZOK GOLD makes an engine!

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Testing of ZOK GOLD in the field (ongoing)

- ZOK GOLD under test at a Power Station in the UK has experienced the following results:
- Reduced NOx levels from 57.3mg/Nm^3 to 41.4 mg/Nm^3
- Increase of compressor efficiency
- Heat rate has decreased since washing with a detergent

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Why manufacture ZOK GOLD?

- ZOK GOLD was formulated to comply with the Oslo and Paris Commission
- To comply with the stringent requirements of OSPAR
- OSPAR regulates for the prevention of pollution in the North East Atlantic

OSPAR COMMISSION

Protecting and conserving the North-East Atlantic and its resources

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OSPAR Classification

Min Value	Max Value	Category
>=0	<1	Gold
>=1	<30	Silver
>=30	<100	White
>=100	<300	Blue
>=300	<1000	Orange
>=1000		Purple

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Accreditations and testing

- Tested against Rolls-Royce and G.E. specification.
- Products conform to both sets of specifications.
- ZOK GOLD is accredited by Rolls-Royce for use in their engines.
- Currently seeking accreditation from Siemens & G.E.

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SIEMENS

Rolls-Royce

imagination at work

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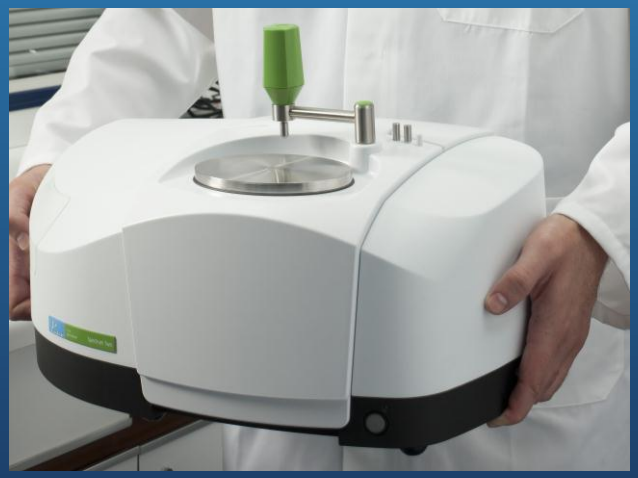
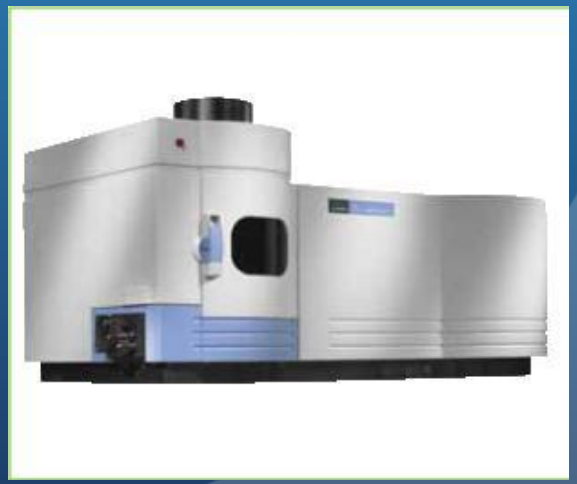
In-house Testing

- Batch testing
- ICP and IR analysis of final product
- QC techniques to ensure that the fluids dispatched will always meet OEM criteria





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ZOK GOLD

- ZOK GOLD - is the next generation cleaner
  - Biodegradable
  - Eco-Friendly
  - Low marine toxicity
- ZOK GOLD uses a renewable source of surfactant
  - New surfactant = an improved cleaner

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New Surfactant

- The development of ZOK GOLD hinged on the formulation of a new generation of surfactant

Producing:

- Improved biodegradability
- Eco-friendly 27 & mx solutions
- New surfactant tested and found to be a better cleaner than previous solutions

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Future Developments

- Development of surfactant technology including:
  - Improved cleaning
  - Environmental Profile

- Alternative sources of renewable surfactants

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Conclusion

- Don’t let your GT become a financial ‘black hole’
- Remember the Things you can do to keep your GT happy
- Compressor washing keeps you on top of your game
- Water based cleaners are non-toxic
- GOLD field trials demonstrate excellent cleaning record
- ZOK has the facility to analyse your wash samples – benefit to you
- Custom washing schedules provides maximum return on investment

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Any Questions?