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GE LM2500 bearing damage case study

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Online Lube Oil Debris Monitoring (OLODM)
as an
Effective and Reliable Early Detection System
for
Bearing Damage in Aero-Derivative Gas Turbines



Agenda

1. Introduction to VBR Turbine Partners
2. Ball & roller bearings in aero-derivative gas turbines
3. Possible consequences of bearing damage in gas turbines
4. Benefits of a reliable early detection of bearing damage
5. Requirements for effective early detection of bearing damage
6. Online lube oil debris monitoring for aero-derivative gas turbines
7. GE LM2500 bearing damage case study
8. Wrap-up
9. Questions?



1. Introduction to VBR Turbine Partners - 1

VBR Turbine Partners are independent ISO 9001 / 2008 certified maintenance experts for GE LM gas turbines and their auxiliaries, control systems & packages.

We support the owners and operators of GE LM gas turbines to reduce their operating costs, maintenance costs & exhaust emissions and to increase their levels of availability, reliability, performance & maintainability.

VBR Turbine Partners were founded in 2000 by three former Thomassen & GE engineers.

We have maintenance service locations in the Netherlands, the United Kingdom and the United Arab Emirates and qualified maintenance service agents in Spain, Russia, Nigeria, Australia and New Zealand.

VBR provides GE LM maintenance solutions and maintenance services to customers in Europe, Russia, the Middle East & North Africa and provides GE LM spare parts to customers all over the world (excluding USA).

Our certifications:

ISO 9001 / 2008

SCC Petrochemical

Achilles & FPAL

Offshore



1. Introduction to VBR Turbine Partners - 2

Our core expertise:

Cost effective inspection, maintenance, repair, overhaul, emission reduction, life extension and power plant relocation of GE LM1600, LM2500, LM5000 & LM6000 aero-derivative gas turbines and their auxiliary systems, control systems & packages.

Our maintenance solutions:

- * 24/7 Maintenance agreements
- * Maintenance management support
- * RAPID remote maintenance support
- * Cheng Cycle & CLN emission reduction
- * Inspection, repair and replacement
- * Engine overhaul & hot section exchange
- * DLE mapping
- * Control system upgrades & retrofits
- * Strategic spare parts planning
- * Power plant relocation



1. Introduction to VBR Turbine Partners - 3

Our maintenance services:

- * Controls & instrumentation field service
- * Mechanical field service
- * Meggitt OEM & ATEX certified valve overhaul
- * Condition monitoring
- * Consultancy
- * Education & training
- * Spare parts

Authorized distribution:

- * Meggitt / Whittaker Controls valves
- * Cheng Cycle & CLN NOx reduction by CPS
- * MetalSCAN by GasTOPS
- * Esterline / Weston Aerospace sensors
- * JADwash green performance cleaner

MEGGITT
smart engineering for
extreme environments

CHENG | power
systems

MetalSCAN
On-Line Oil Debris Monitor

Esterline
Advanced Sensors

JAD  **wash**



1. Introduction to VBR Turbine Partners - 4

The VBR systematic maintenance improvement philosophy for GE LM gas turbines:
From re-active corrective maintenance to pro-active preventive maintenance.

1. Investigate and determine current maintenance situation:

- a. Investigate current maintenance situation engine, auxiliaries, control system, package
- b. Determine existing maintenance issues and maintenance gaps

2. Develop corrective maintenance plan(s) and deploy corrective actions:

- a. Develop corrective maintenance plan(s) – project approach
- b. Deploy corrective actions during scheduled engine stop(s)

3. Shift to pro-active preventive maintenance management:

- a. Install diagnostic tools and data logging applications to improve maintainability
- b. 24/7 online monitoring & maintenance support to deliver RAPID remote maintenance

The essential human element in the VBR systematic maintenance improvement philosophy:
Educate & train engine operators and maintenance engineers at the customer site.



1. Introduction to VBR Turbine Partners - 5

A selection of our customers:

AGSM Verona
Air Liquide
AKZO-Nobel
Bairnsdale Power Station
BASF
Bornholms Trafikken
BP-Exploration
BP Europe SE
Centrica Energy Upstream
Cofely Italia
Cofely France
Conoco Phillips
Dalkia
Dong - Energy
Dong - Horsens
DC Generation A/S
Dresser-Rand
DSM

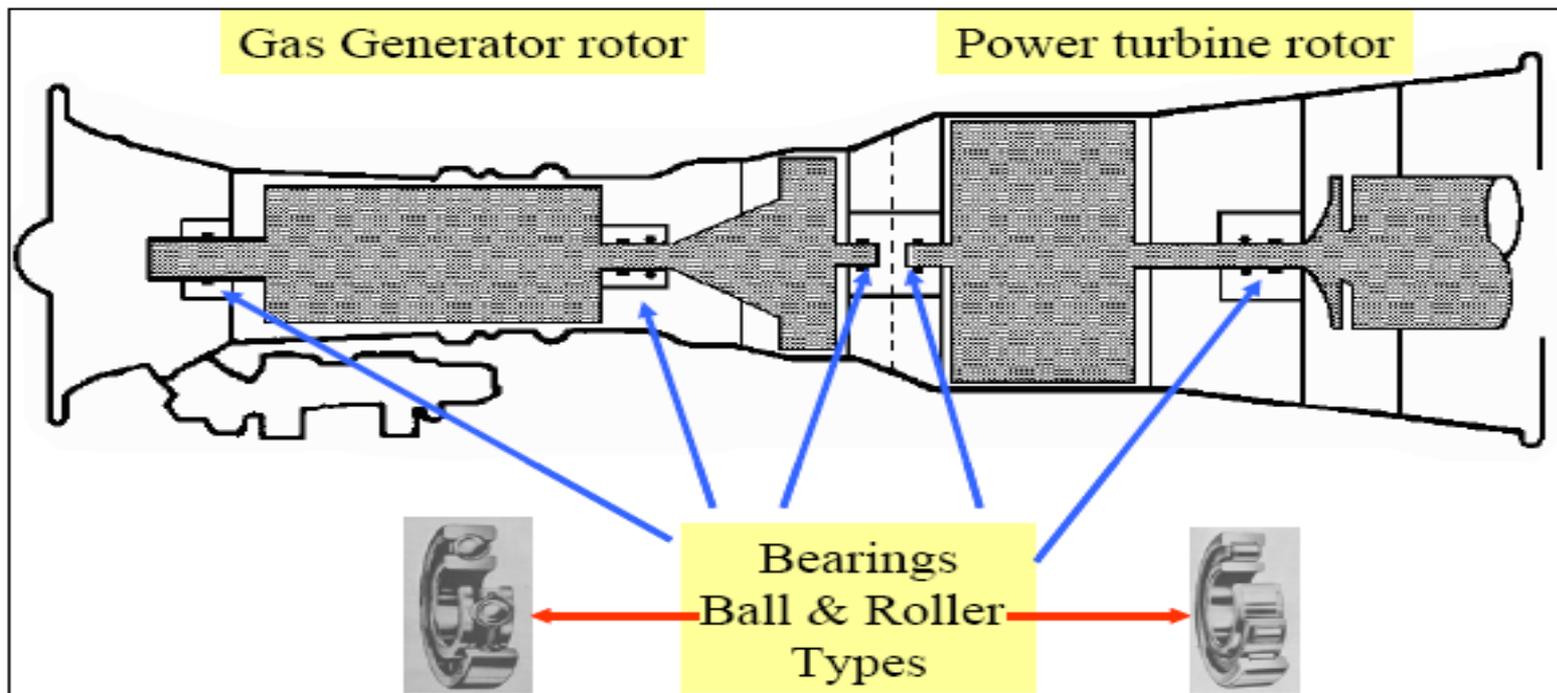
Dupont
Ecocarburantes
EDF Luminus
Edison
Electrabel
Elettrogorizia
Energie Saarlux
E.ON - Benelux
E.ON - Ruhrgas
E.ON – UK
EVH GmbH
GKN Aerospace
IREN
KVV-Silkeborg
LUKOIL
Maersk Oil & Gas
Marathon Oil
NAM

National Grid
Nexen Petroleum UK
Novawatt
NUON / Vattenvall
Open Grid Europe
Quadra Power
Rio Tinto
RWE / Essent
Shell
SNAM Retegas
SoGiCo
SPE
Stadtwerke Brandenburg
Stadtwerke Schwerin
Statoil
Tortosa Energia
Trans Alta Energy
Venture Production (CH4)
... and more ...



2. Ball & roller bearings in aero-derivative gas turbines

Gas turbine main bearings serve the critical function of supporting and controlling the position of the shaft and the associated rotor.



Typical aero-derivative gas turbine main bearings



3. Possible consequences of bearing damage in gas turbines

Possible consequences of bearing damage in gas turbines are:

- Degraded shaft position control which can cause blades to contact the casing
- Risk of expensive secondary damage when this blade contact happens
- Unplanned engine stop
- Extra time required for problem analysis, repair decision and repair delivery
- Contaminated lube oil system which will require days of flushing
- Unplanned loss of production
- Unplanned loss of revenue



4. Benefits of a reliable early detection of bearing damage

Bearing damage happens to all aero-derivative gas turbines. Since bearing damage cannot be predicted in an effective way (yet) the next best thing is to detect the damage at the very moment that it starts on a very small scale ...

Reliable early detection of bearing damage enables a gas turbine operator to:

- Make well-informed decisions about a necessary bearing replacement
- Keep the engine running while organizing a scheduled bearing repair stop
- Get the necessary spare parts and maintenance engineers on site
- Bring the engine to a scheduled bearing replacement stop
- Complete the repair and restart the engine as quickly as possible
- Optimize the production and revenue generation capacity of the engine
- Prevent expensive secondary damage to the engine



5. Requirements for effective early detection of bearing damage

The requirements for effective early detection of bearing damage are:

- Identification of the actual start of the damage (earliest detection possible)
- Continuous assessment of the degree and the progression of the damage
- Reliability of the damage detection (no false alarms, no missed alarms)



6. Online lube oil debris monitoring for aero-derivative gas turbines

Online lube oil debris monitoring for aero-derivative gas turbines provides a 24/7 assessment of the health status of all main bearings in a gas turbine.

When a bearing problem should occur it signals the very start of the damage and it provides trending information about the development of the damage in the very early stages.

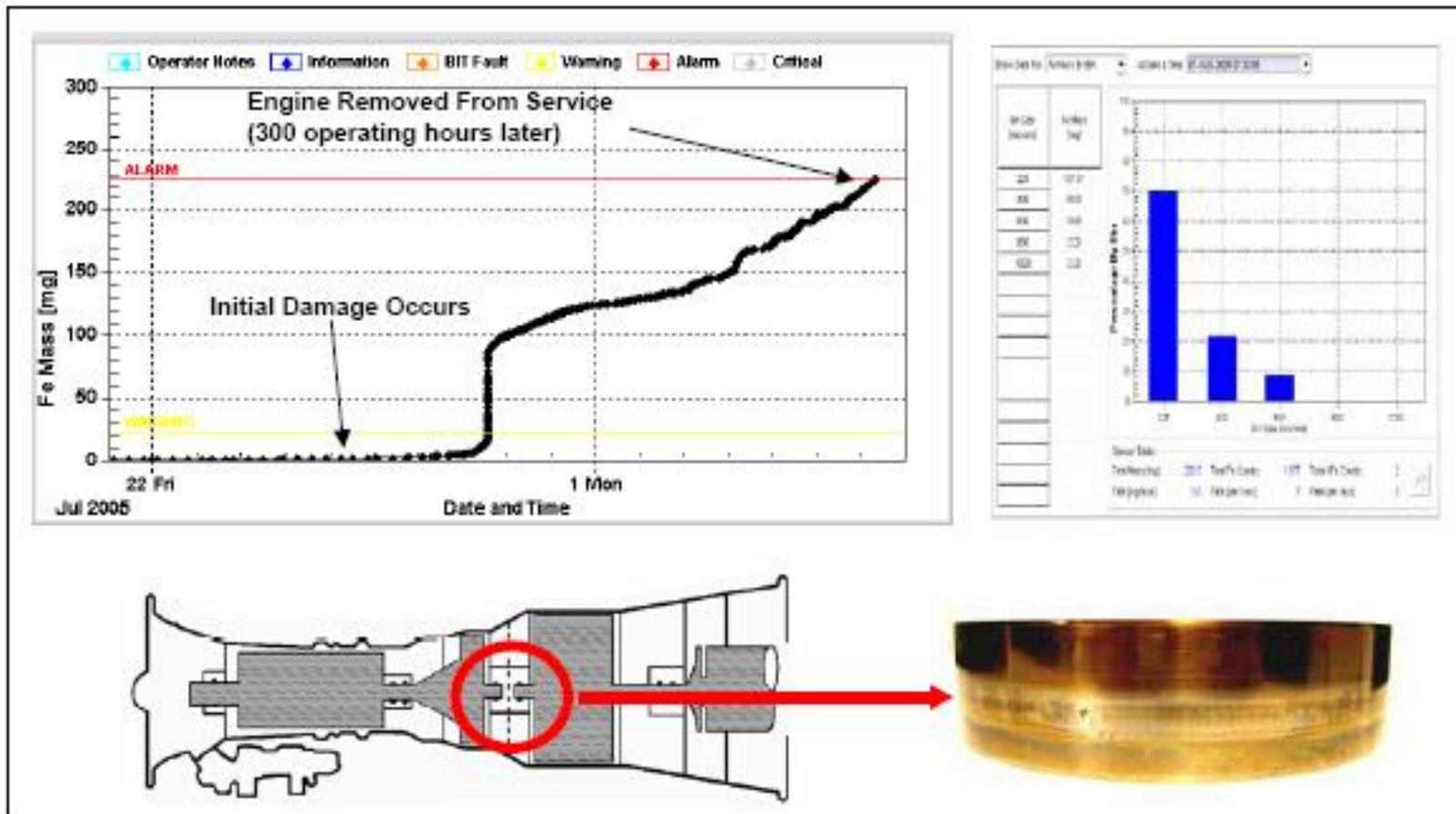
This information allows operators to undertake preventive and corrective actions while the engine is still running and to bring the engine to a scheduled stop before secondary damage has occurred.

Online lube oil debris monitoring enables operators to act pro-actively and to plan necessary maintenance actions beforehand by ordering spare parts and by scheduling the bearing replacement at a convenient moment to:

- minimize engine downtime
- minimize loss of production
- minimize loss of revenue.



7. GE LM2500 bearing damage case study (1)



LM2500 C-sump, bearing 5 & 6



7. GE LM2500 bearing damage case study (2)

Timeline of the bearing damage event in the GE LM2500 gas turbine:

- Engine ran for a significant period of time with virtually no debris being detected
- Once the initial damage occurred the OLODM immediately provided an indication
- The OLODM kept tracking the degree and the progression of the bearing damage
- After a rapid rise of debris the engine power was reduced to 80% to slow down the progression of the damage in order to reach a scheduled maintenance period
- Spare parts and maintenance engineers were on site when the OLODM system passed the second alarm and the engine was brought to a scheduled stop
- Damaged bearings 5 & 6 in the C-sump between the gas generator turbine and the power turbine were replaced in the shortest possible turnaround time
- Secondary damage was avoided and the loss of production and loss of revenue was minimized
- At the moment of engine shutdown the vibration monitoring and oil scavenge temperature monitoring did not provide any indication of bearing damage



8. Wrap-up

In short: online lube oil debris monitoring for aero-derivative gas turbines ...

Fulfills the requirements for a reliable early detection of bearing damage:

- Identification of the actual start of the damage (earliest detection possible)
- Continuous assessment of the degree and the progression of the damage
- Reliability of the damage detection (no false alarms, no missed alarms)

Delivers the benefits of a reliable early detection of bearing damage:

- Improves the troubleshooting and problem solving capacities of the operator
- Minimizes the risk of an unscheduled stop in case of bearing damage
- Minimizes engine down time in case of bearing damage.
- Minimizes loss of production and loss of revenue in case of bearing damage
- Minimizes the risk of expensive secondary damage in case of bearing damage



9. Questions?

Questions?



10. Thank you for your attention!

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www.vbr-turbinepartners.com

