Gearbox Repair Experiences

2006 Wind Turbine Reliability Workshop

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What happens if units run too long?

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Tooling for disassembly

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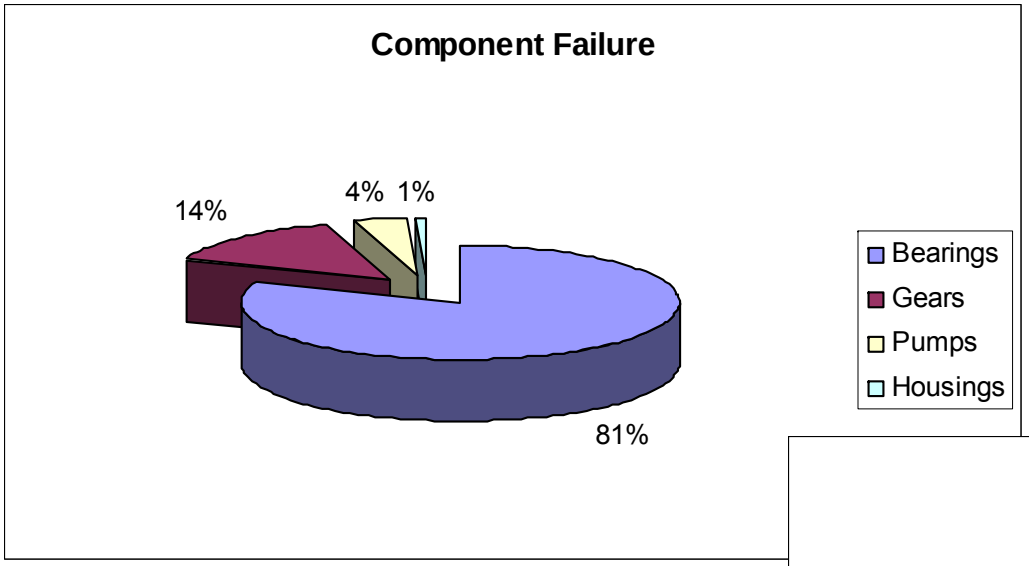
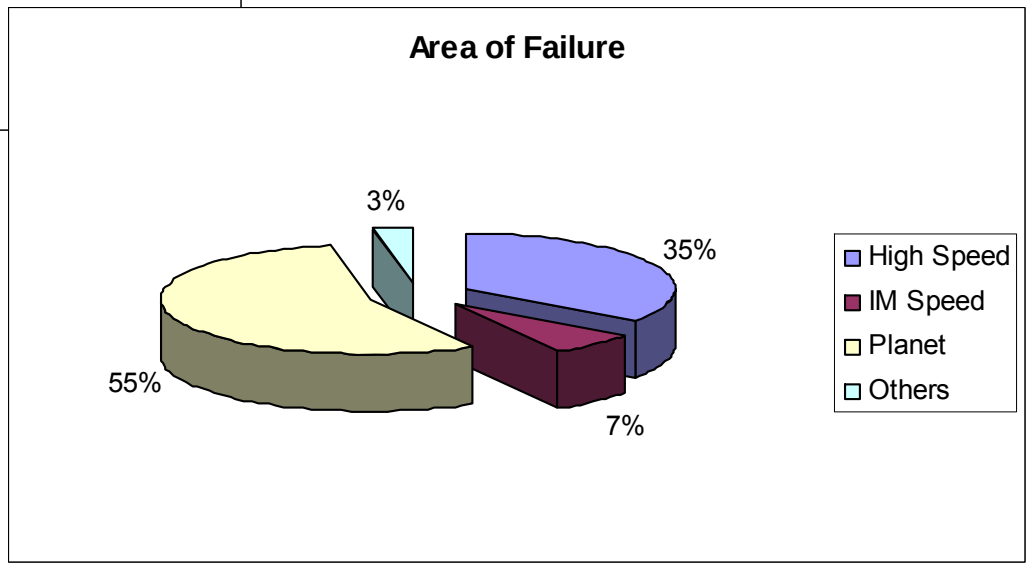
Failure Types in Wind Turbine Gearboxes (500-900 kW)





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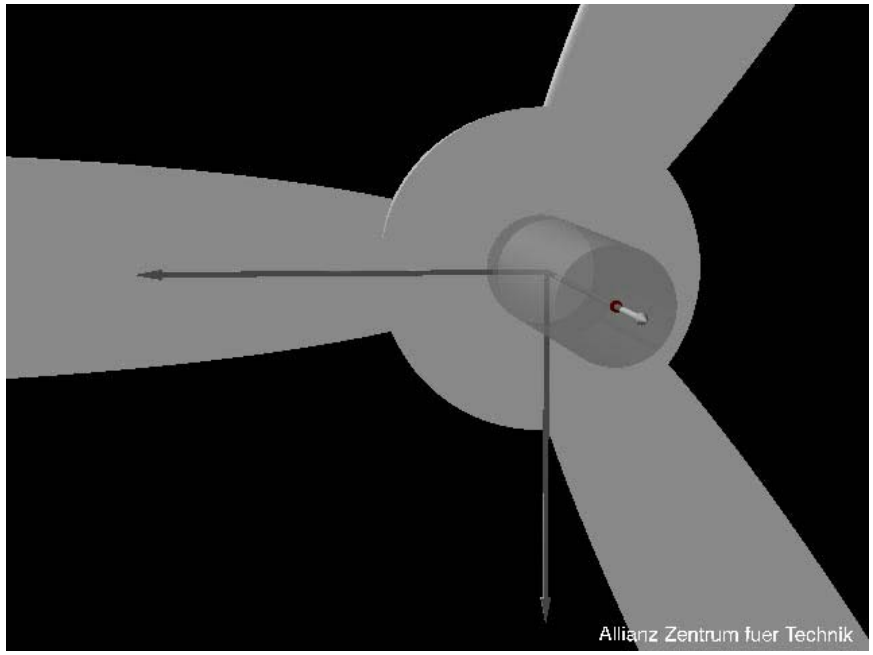
What can be done to prevent it?

- Root Cause Identification and Analysis
- Example: 3 point WTG 1.5 MW
  - Radial movement 0.5 mm
  - By Allianz Zentrum for Technik



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How failures are detected today?

Component observed	Typical Failure	Primary Signal	Detection
Oil Pump	**wear/dammage**	Low oil pressure	direct
High Speed Bearings	**failure**	High Temp - PT 100	direct
IM Bearing	**failure**	Metal in sump	@ service
IM Pinion	**tooth failure**	Vibration	@ service
LS Pinion	**tooth failure**	Vibration	@ service
Planet Wheel	**tooth failure**	Vibration	@ service
Planet Bearing	**failure**	Metal un sump	@ service
Planet Gear	**tooth failure**	Vibration	@ service
Torque Arm	**cracks**	Visual	@ service

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What has changed in 10 years

- Gearbox Design and Calculation programs
  - Grade of sophistication has increased
- Simulations
  - Load definitions have improved
- Accelerated LC tests
  - Requirement for MW units has been introduced
- WTG Software modifications
  - Softer regulated programs (Ramp up – ramp down)
- Condition monitoring
  - Tools for MW being implemented

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Condition Management

Features

- Flexible interface may be modified for customer needs
- Intelligent data reduction, classification and analysis
- Providing on line monitoring and analysis services

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Condition Management

Methods for early warning and condition monitoring

- **Root cause for wear and failure processes**
  - Lubrication film is insufficient
    - Too high temperature
    - Particles or dirty in the oil
    - Lack of additives
  - Wear and further surface fatigue particles are developed
  - Vibration level is increased
  - Failure
- **Key factors in a gear unit lifetime**
  - Good lubricating system with good lubricant
  - Good lubricant chemical condition
  - Loading conditions equates the specified loading spectrum
  - Early warning of the changed working (loads, speed, lubrication) conditions

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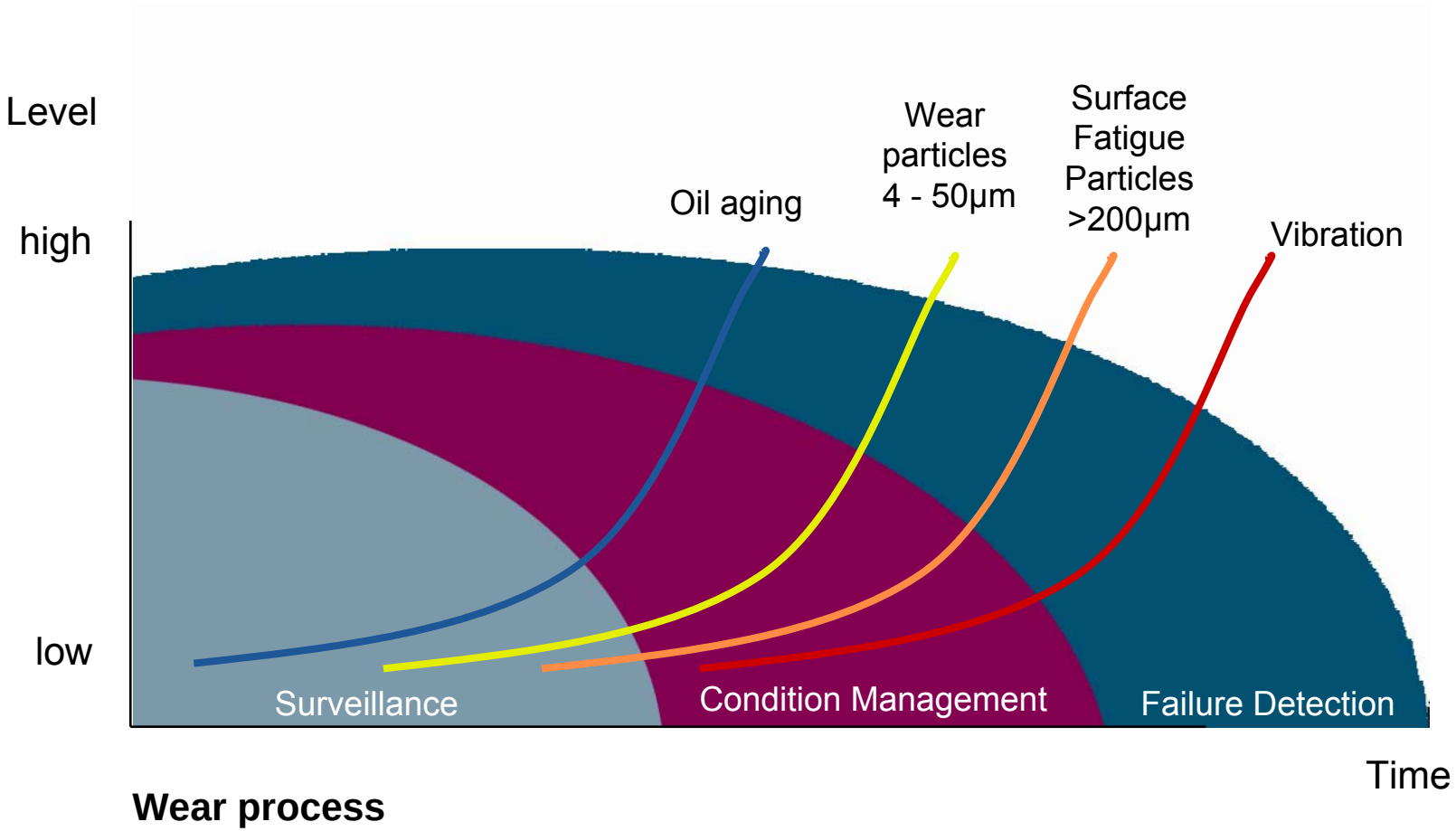
Condition Management

Method of early warning



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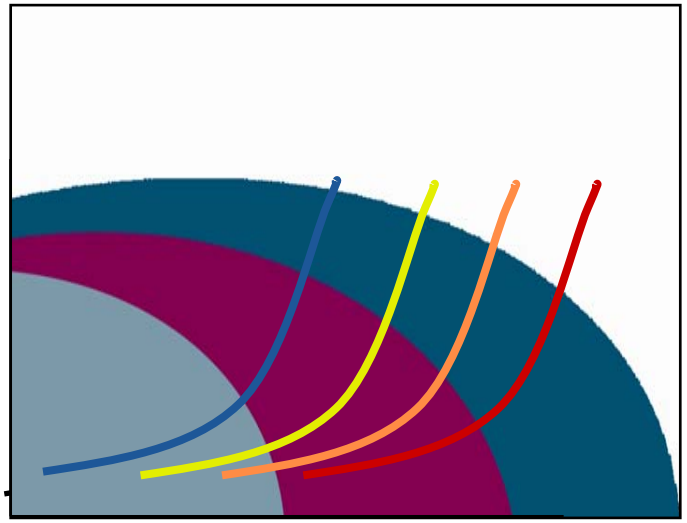
Condition Management

Features



- Trend of oil properties; good operating conditions guarantee longer lifetime for bearings and gears
- Trend of wear particles; early signal of any wear
- Torque measurements; knowledge of real load conditions, power spectra and detection of harmful operating conditions
- Local measurement of bearing and oil temperatures; early signal of cooling system malfunction or lubrication problems
- Measuring vibration of components; failure detection, early signal of misalignment

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Condition Management

Benefits

- Continuous 24h monitoring
- Cost savings; higher availability and lower maintenance costs
- Early signal of failure
- Planned maintenance instead of unexpected failure and costs
- Longer lifetime by knowledge of real loads, avoiding harmful operations
- Condition analysis and support

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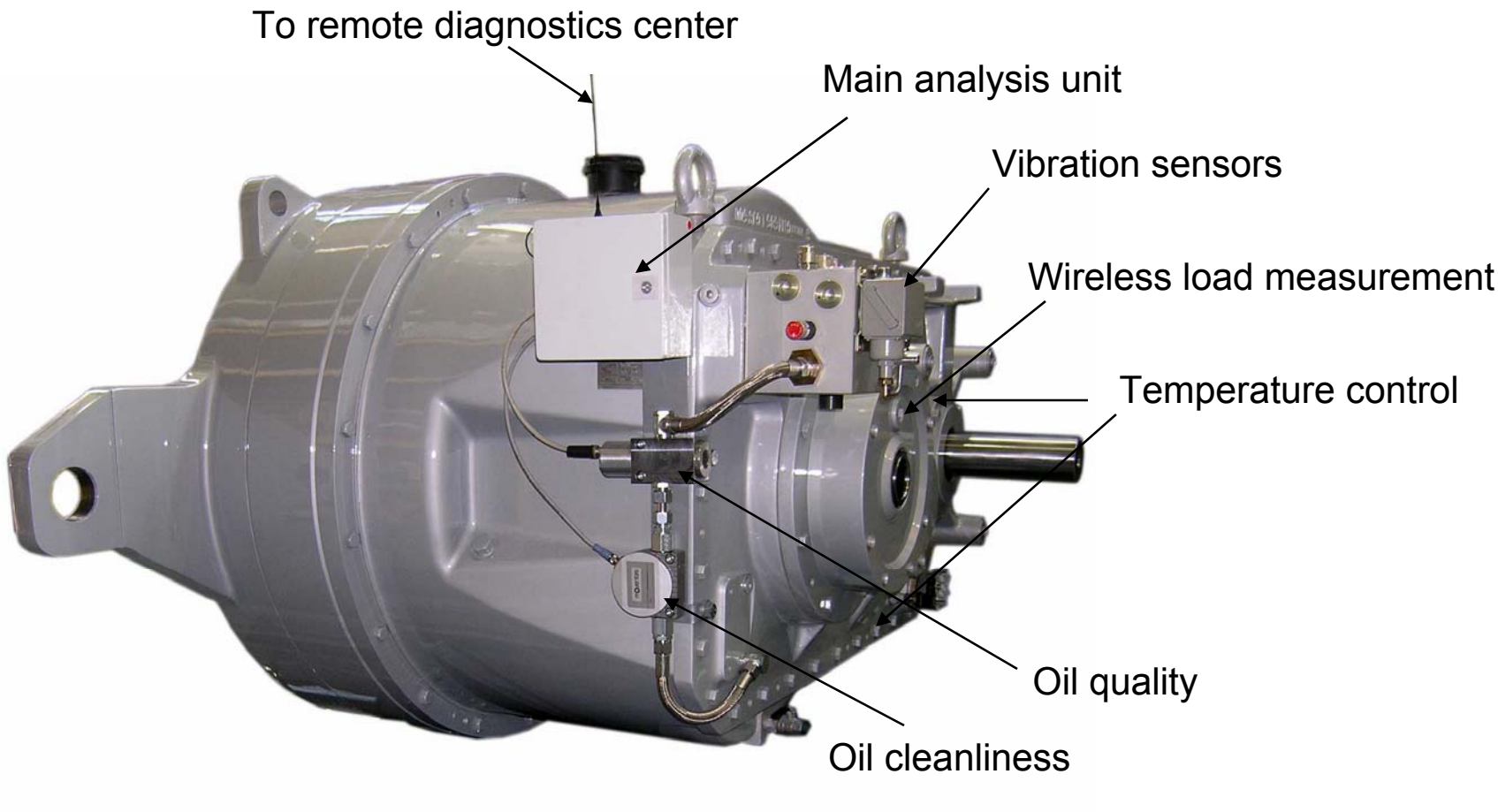
Condition Management

Condition Management and self diagnostics system



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