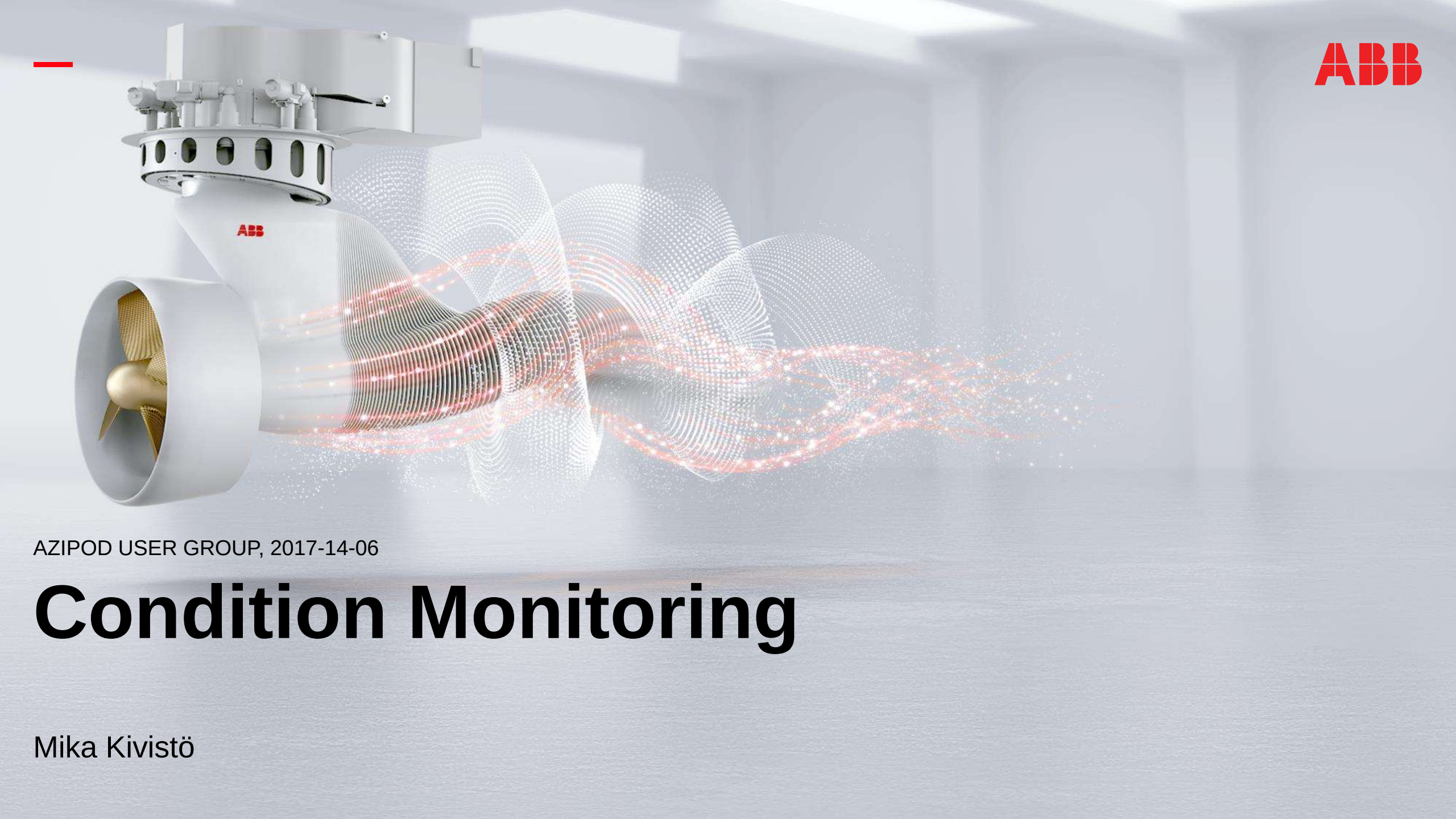


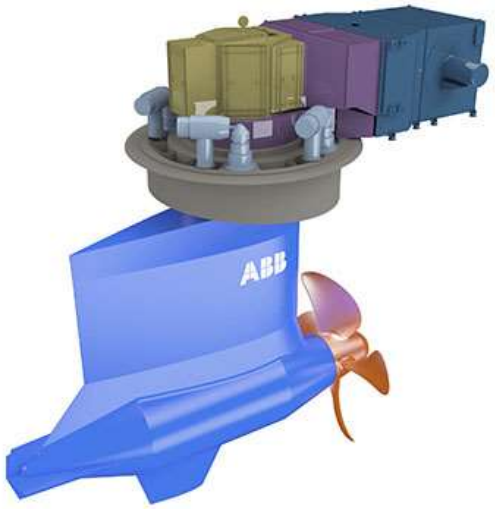
AZIPOD USER GROUP, 2017-14-06

Condition Monitoring

Mika Kivistö

Introduction

Azipod® Condition Monitoring Services



Azipod® Condition Monitoring Services

- Vibrations analysis
- Oil analysis
- Acoustic emissions measurements for slewing bearings
- Site surveys
- Boroscopy inspections for Azipod bearings

ABB specialists and wide partner network

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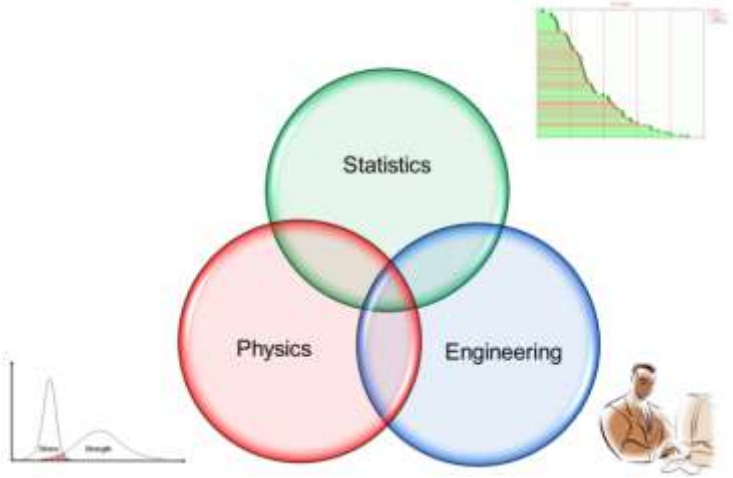
Condition Monitoring
Identification and prediction



Recognize abnormal situations and identify possible causes

Predict remaining operation time

Remaining life time estimation is based on statistical analysis of operation data and fault history

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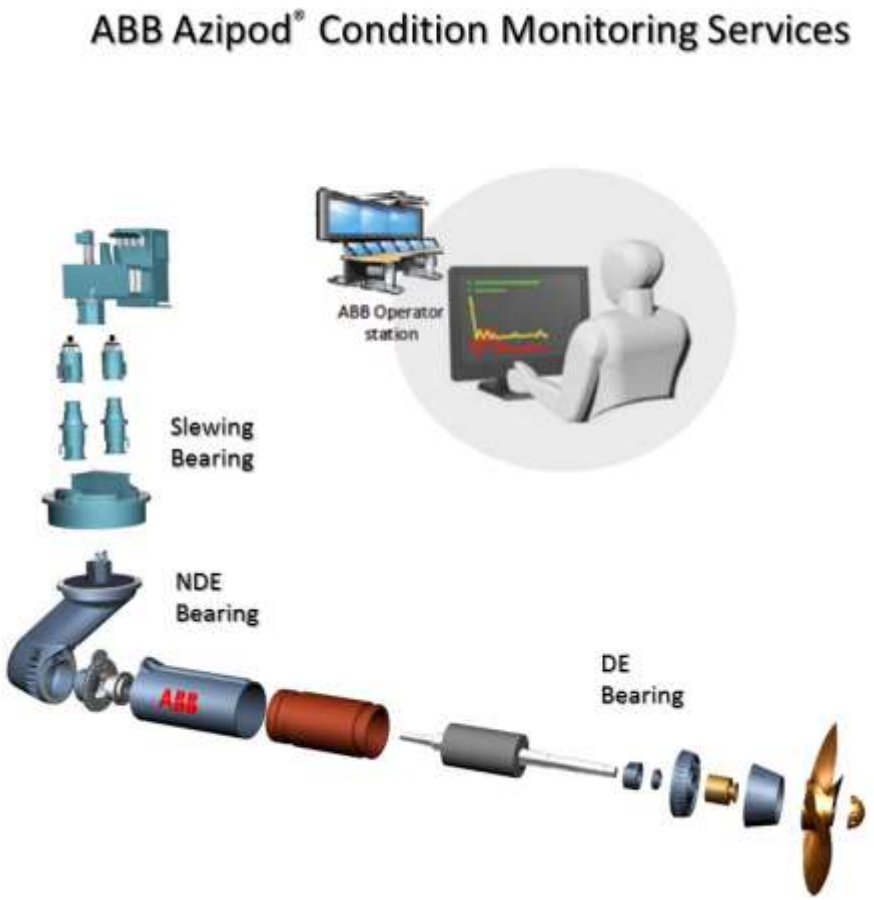
Condition Monitoring
Criticality of components



Focus on the most critical components

- Shaft line bearings
- Slewing bearing

Selecting the best possible method for monitoring

Criticality data is based on 27 years of operation and over 13 million cumulative operation hours.

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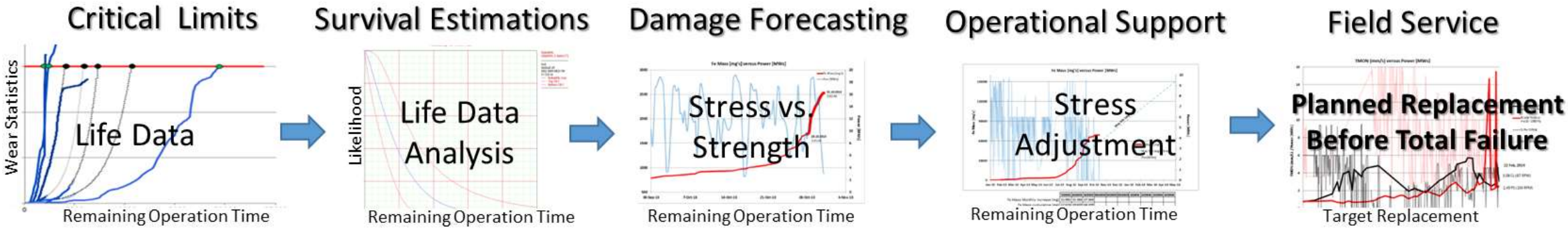
Analysis and operational support

Remaining life time



Remaining life time analysis is updated in frequently

Operation and maintenance instructions are based on the latest measurement data

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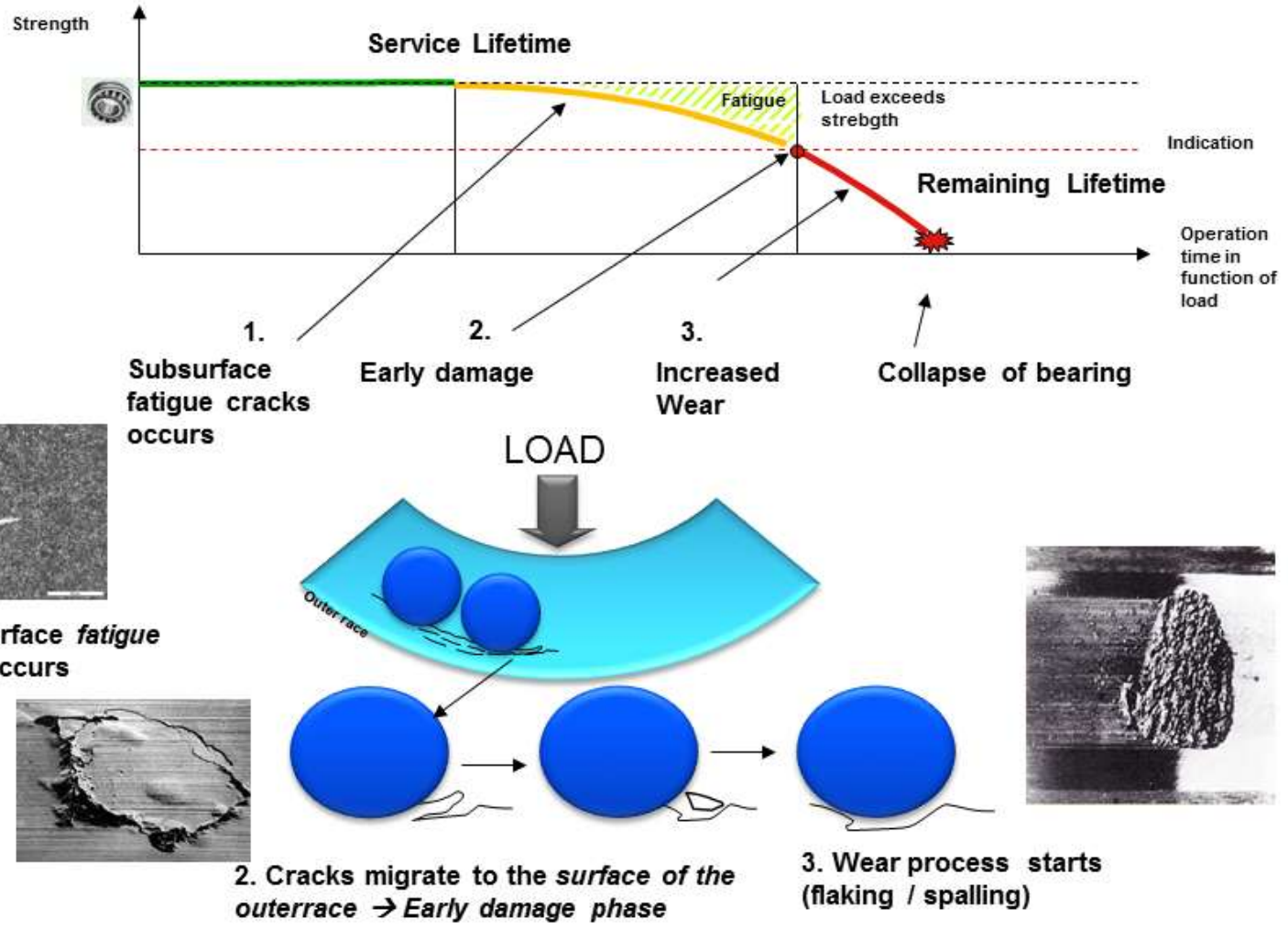
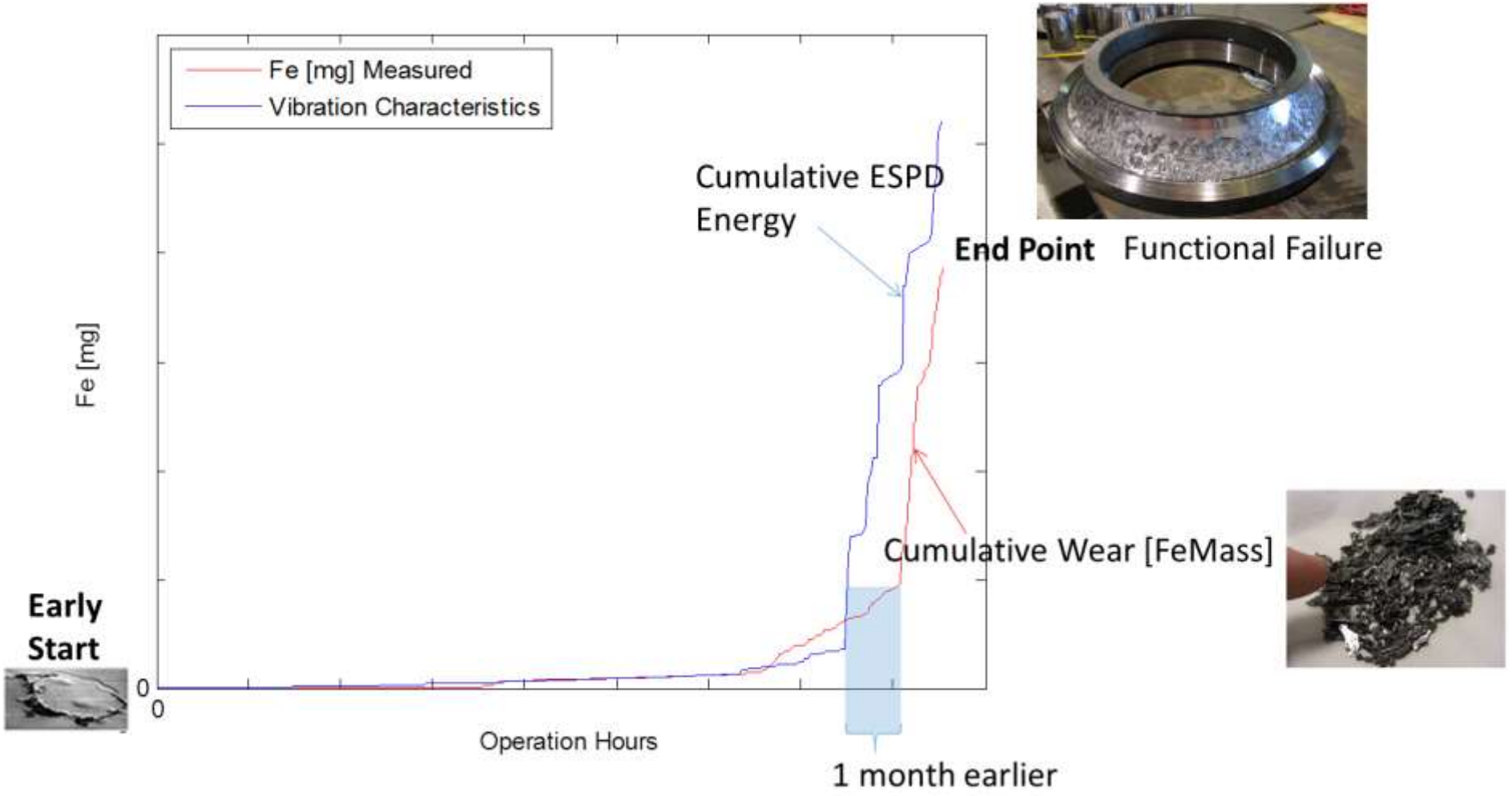
Condition Monitoring
Fault propagation



Remaining operation time

Fault propagation, example case



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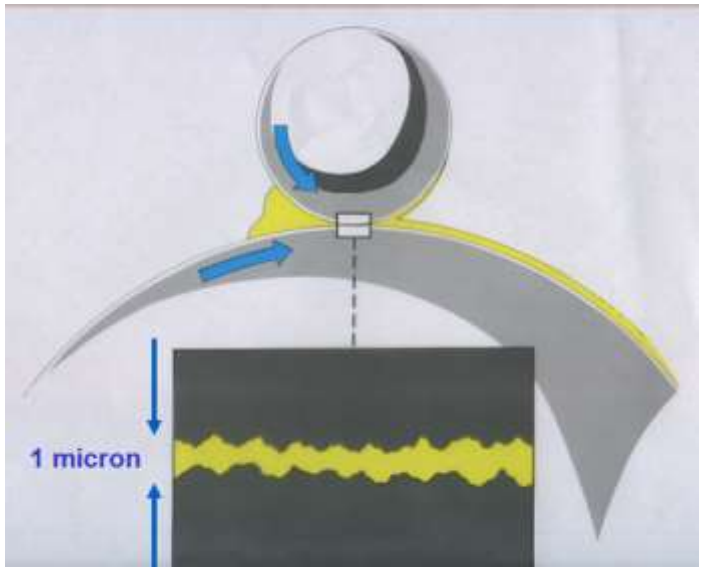
Oil analysis
Lubrication



Function of the lubrication

- Reduces friction between contact surfaces
- Reduces wear by preventing metal-to-metal contacts
- Takes care of the cooling
- Corrosion inhibitor
- Flush debris away from the bearing for filtration

Good lubrication requires

- Proper viscosity level
- Proper lubrication temperature
- Clean lubricant containing no particles
- Enough lubricant between contact area

© ABB Group

Oil analysis

Sampling and analysis

Oil samples (250 ml) are taken by crew and sent to ABB laboratory

Oil samples will be tested in the laboratory according to the certified standards

- Oil Cleanliness class, ISO 4406
- Water-in-oil content
- Viscocity
- Wear particles trend
- Other trends (TAN, PQ-index, Additives, etc.)

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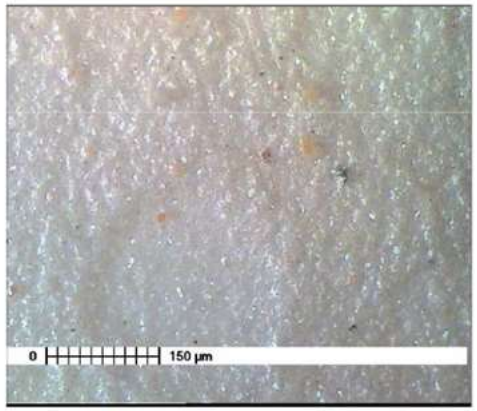
Oil Analysis
Oil cleanliness

Number of particles in 1ml

Particle size	ISO 4406 code range	ISO Code
4µ	1 300 000 - 2 500 000	28
6µ	320 000 - 640 000	26
14µ	80 - 1 300	17



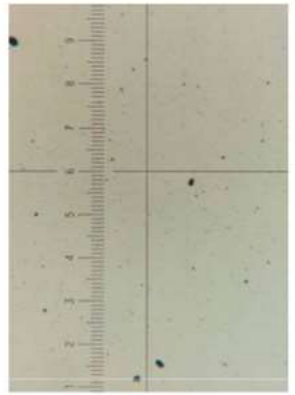
ISO class 28/26/17

More than	Up to and Including	Scale Number
1 300 000	2 500 000	28
640 000	1 300 000	27
320 000	640 000	26
160 000	320 000	25
80 000	160 000	24
40 000	80 000	23
20 000	40 000	22
10 000	20 000	21
5 000	10 000	20
2 500	5 000	19
1 300	2 500	18
640	1 300	17
320	640	16
160	320	15
80	160	14
40	80	13
20	40	12
10	20	11
5	10	10
3	5	9
1	2,5	8
1	1,3	7
0	0,64	6
0	0,32	5
0	0,16	4
0	0,08	3
0	0,04	2
0	0,02	1
0	0,01	0

Reference sample from oil barrel

Particle Size	ISO 4406 code range	ISO Code
4µ	2 500 – 5 000	19
6µ	640 – 1 300	17
14µ	80 - 160	14

ISO 4406 Cleanliness Code 19/17/14



Required ISO Cleanliness Class limit

New oil from barrel needs to be filtered before adding it to the Azipod® NDE Bearing

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Oil Analysis

Spectrographic Analysis

Spectrographic Analysis		
Iron	ppm	2
Aluminium	ppm	<1
Chromium	ppm	<1
Molybdenum	ppm	<1
Copper	ppm	<1
Lead	ppm	<1
Tin	ppm	<1
Nickel	ppm	<1
Silver	ppm	<1
Manganese	ppm	<1
Vanadium	ppm	<1
Silicon	ppm	1
Titanium	ppm	<1
Sodium	ppm	6
Boron	ppm	26
Phosphorus	% wt	0.0417
Zinc	% wt	0.0001
Calcium	% wt	<0.0001
Magnesium	% wt	<0.0001

Spectrographic analysis from the oil sample. Special attention for following components

- Iron
- Silicon
- Sodium

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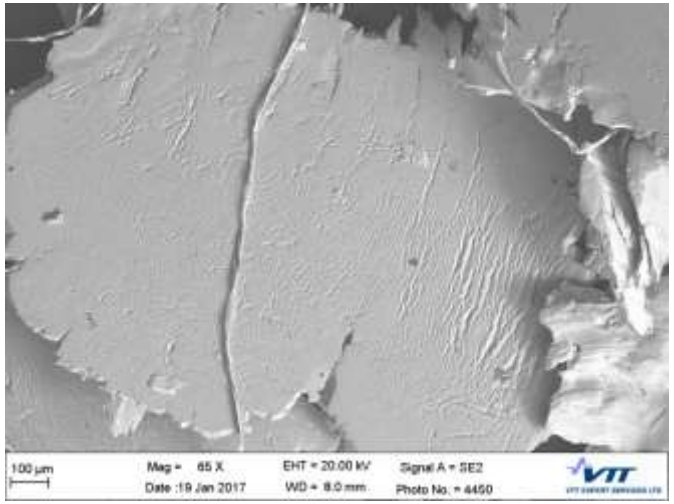
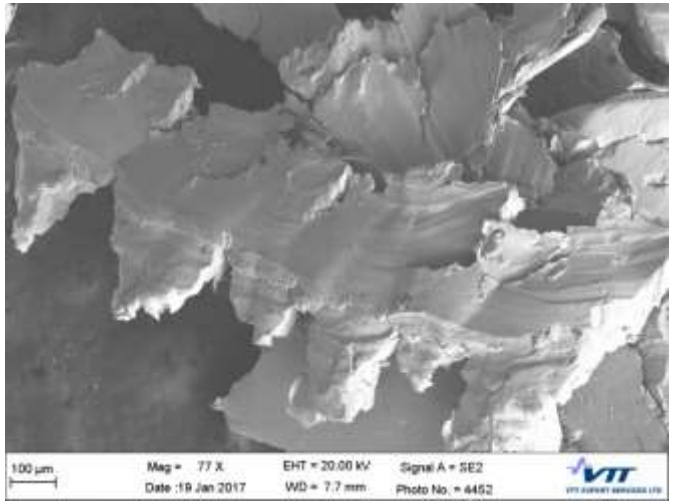
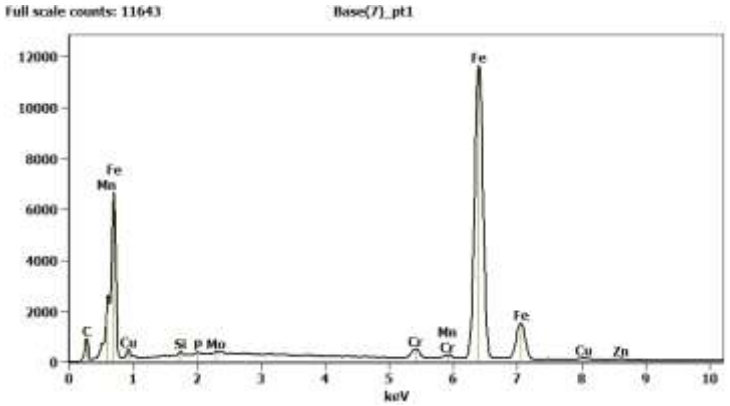
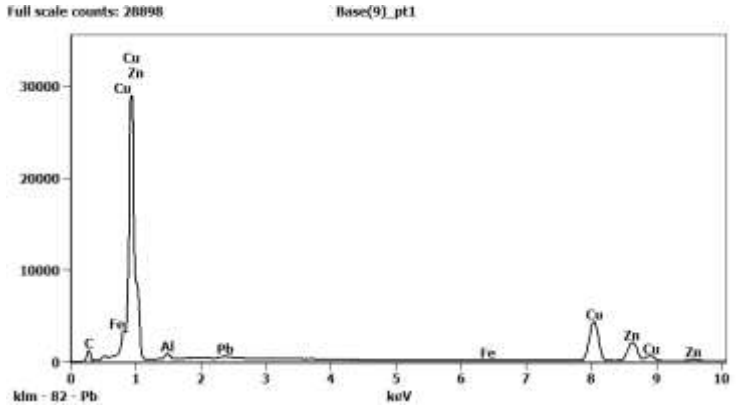
Oil Filter Analysis

SEM and EDS spectrum









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Vibration measurements

Severity of vibration

Measurements taken from bearing housings

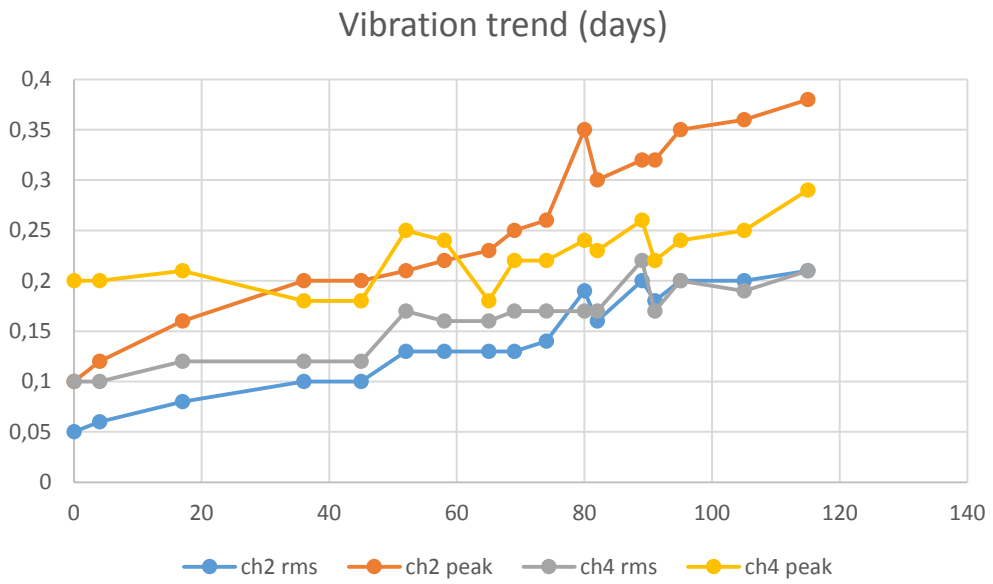
- Sensors are mounted permanently
- Online-system or portable data collector

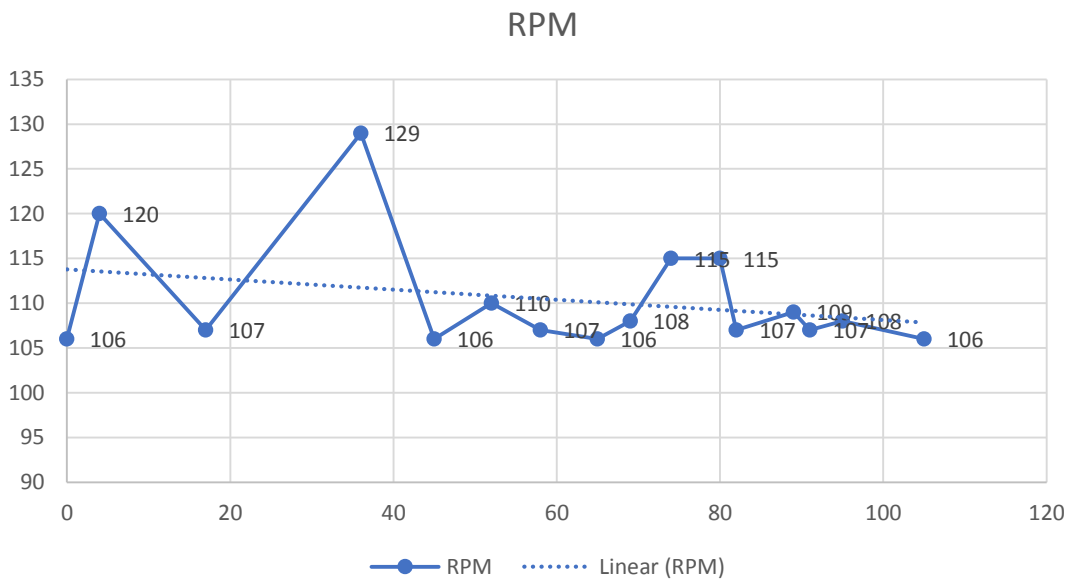
Standards gives limits only for vibration velocity (mm/s)

- Stable operation and load conditions
- Bearing analysis from acceleration signal
- Trend of values is important in monitoring system

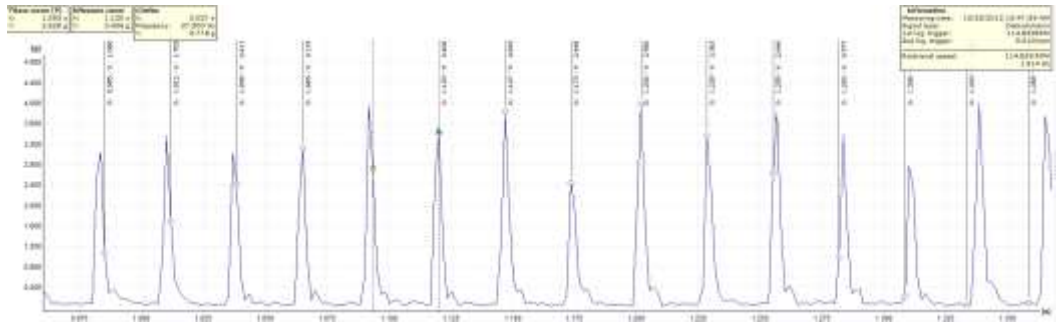
Vibration measurements

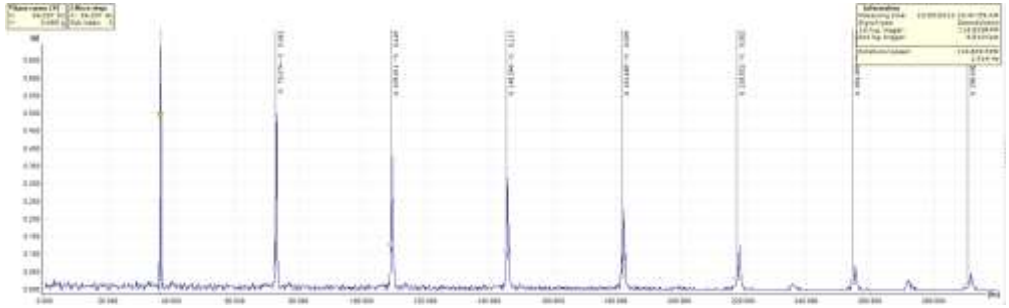
Vibration trend





Vibration measurements
Fault identification





Analysis in time- and frequency domain

Components and dimensions are know so it’s possible to calculate excitation forces

- Rotating frequency
- Bearing faults
- Blade pass-frequency

Vibration Measurements
Measurement System

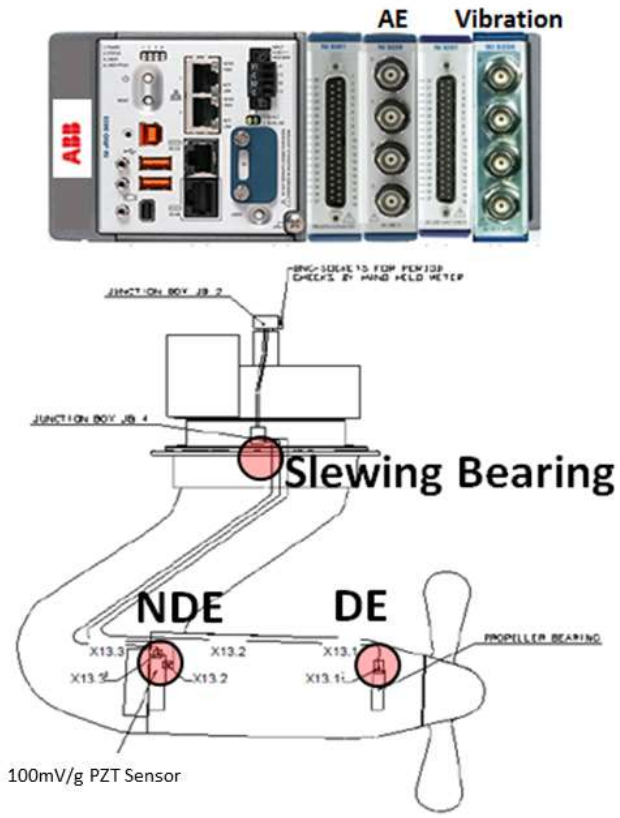


ABB Azipod® On-Line Measurement System

- Shaft line bearings, vibration measurements
- Slewing bearing, acoustic emission

Advanced data analysis and trending

- Embedded device, smart data
- Data transfer with slow connections

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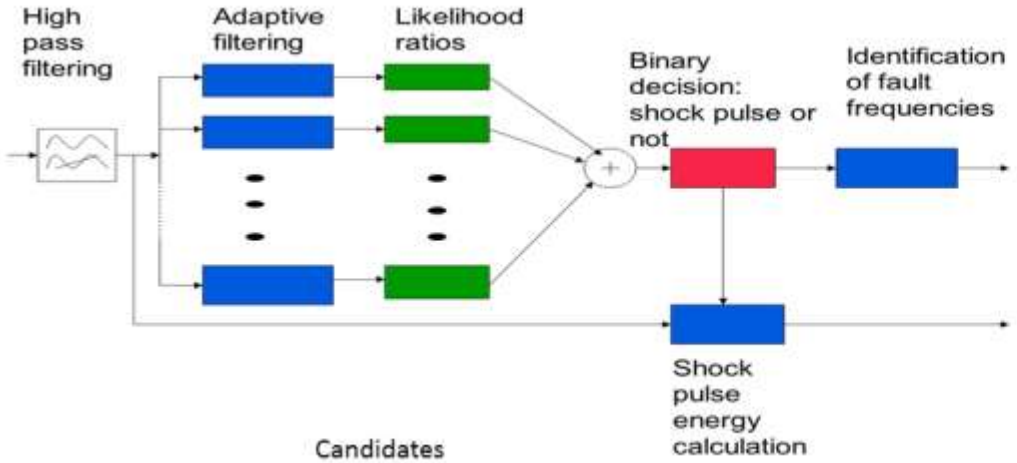
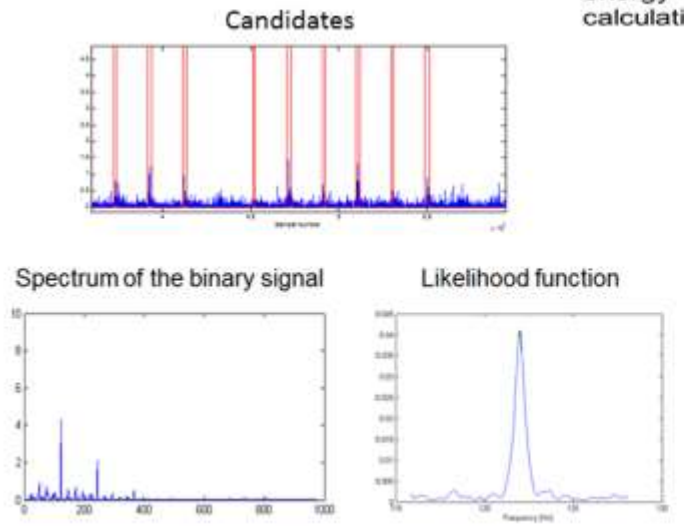
Vibration Measurements
Measurement parameters

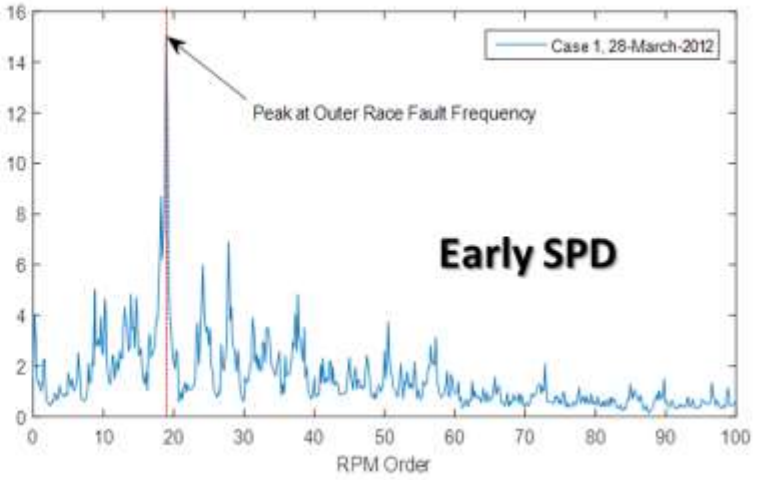


Early SPD Outputs:

- Bearing fault or not
- Fault type
- Shock pulse energy per one rotation
- Maximum shock pulse energy



BPFO 19,114



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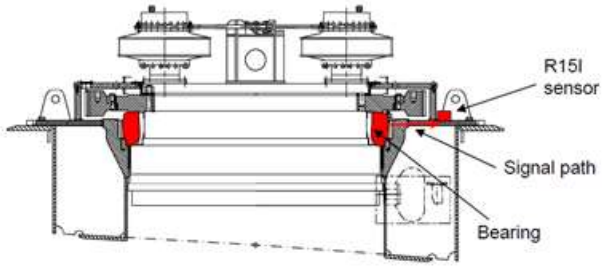
Acoustic Emission Measurements

Slewing Bearing



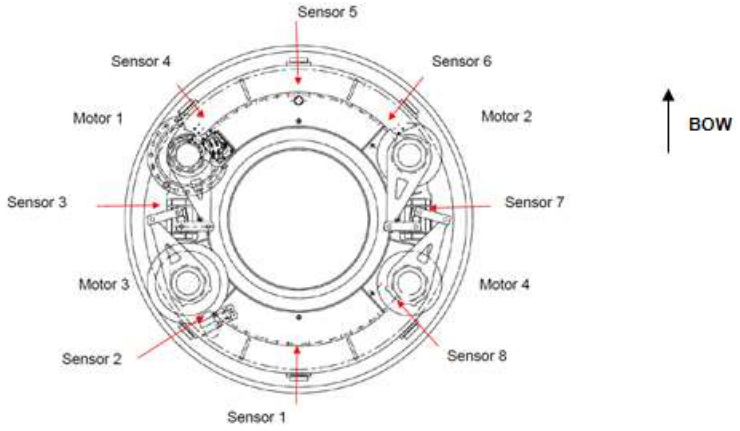
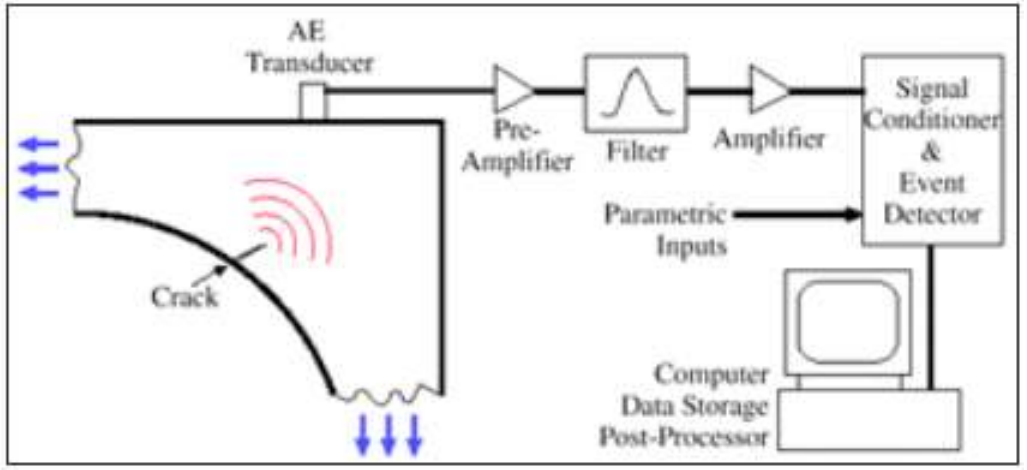
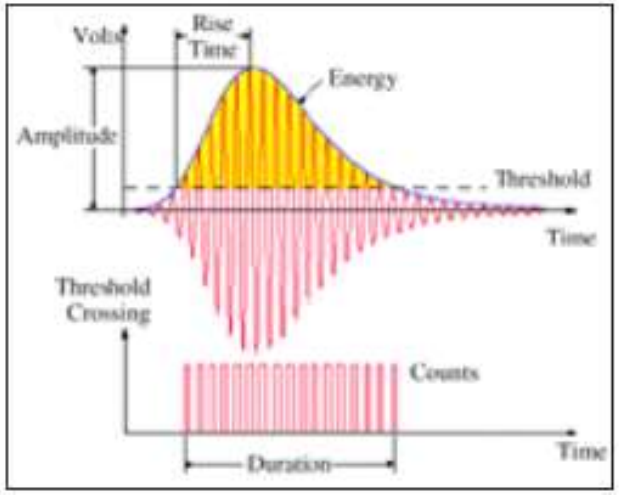


Figure 1 *Sensor positions on Starboard Azipod structure.*





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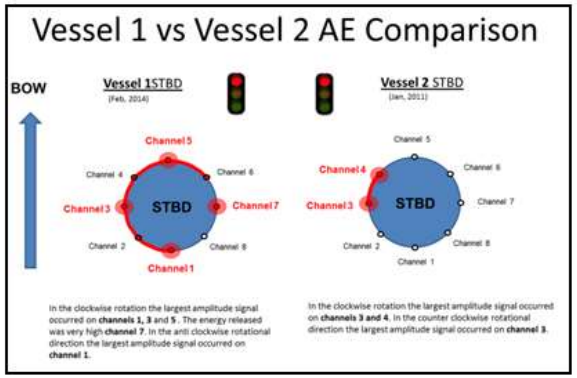
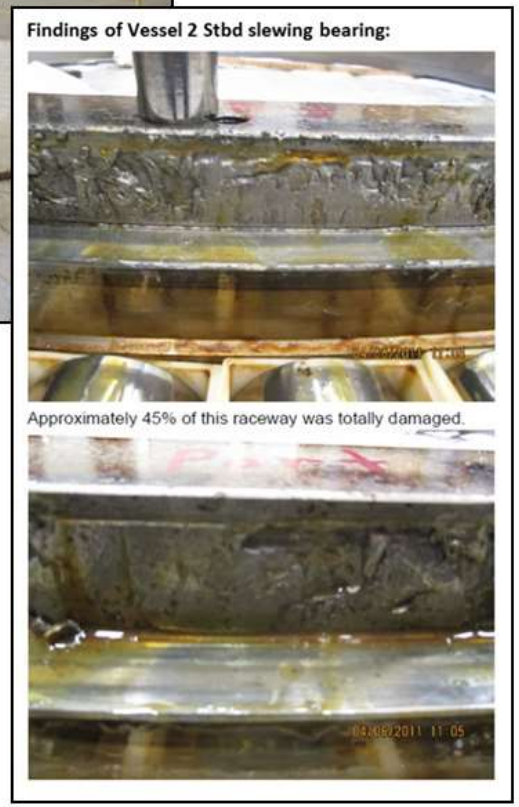
Acoustic Emission Measurements

Slewing bearing, example case





Alarm levels were exceeded in 2/8 sensors.
Attention and alarm levels based on more than 100 measurements on several vessels.

Bearing was replaced in dry docking.

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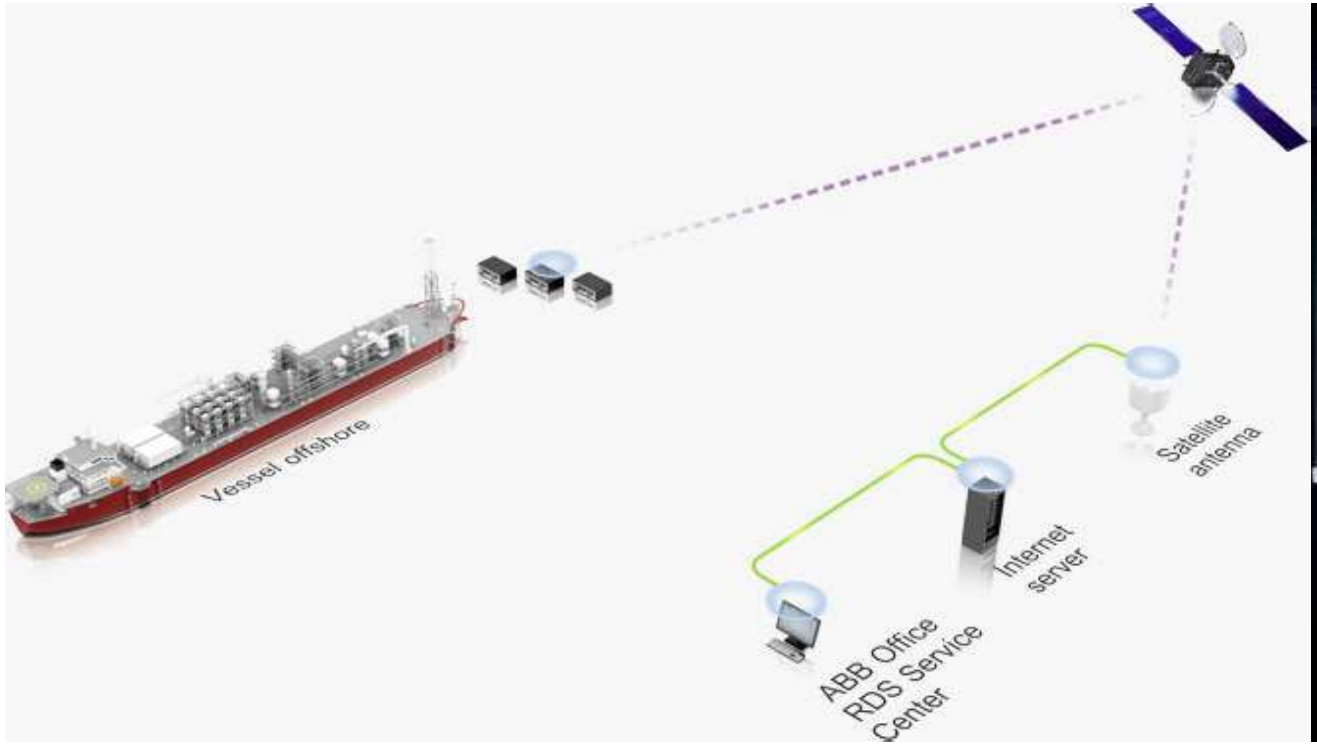
Remote Diagnostics Services
Monitoring and Diagnostics platform RDS

A dedicated monitoring and diagnostic platform for collection, storage and analysis of data from on-board components.

RDS Diagnostic solutions are available to determine equipment status and identify the problem source

Remote Diagnostics Services
Data Analysis

ABB Azipod® Remote Diagnostic Services
Collaboration Operations Center



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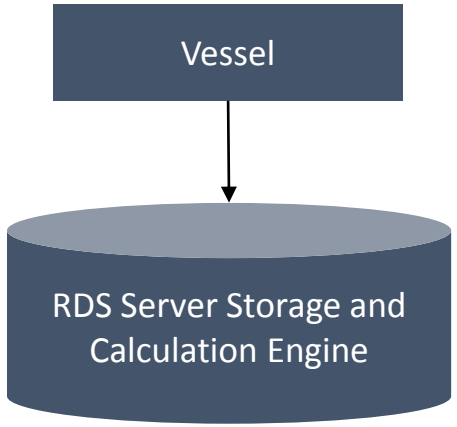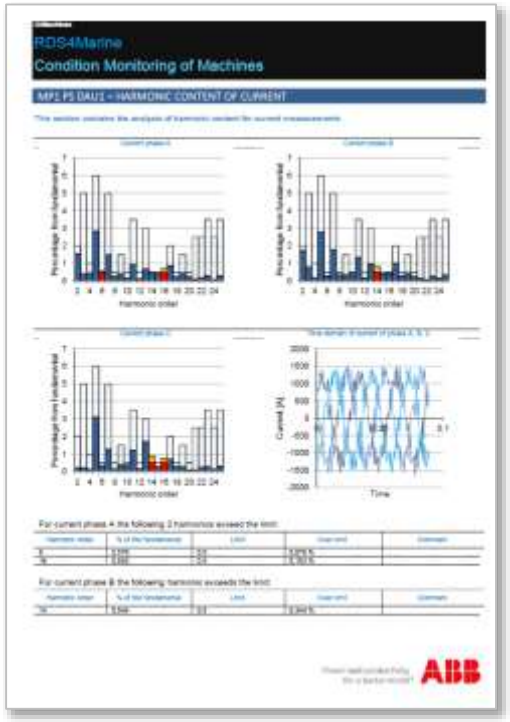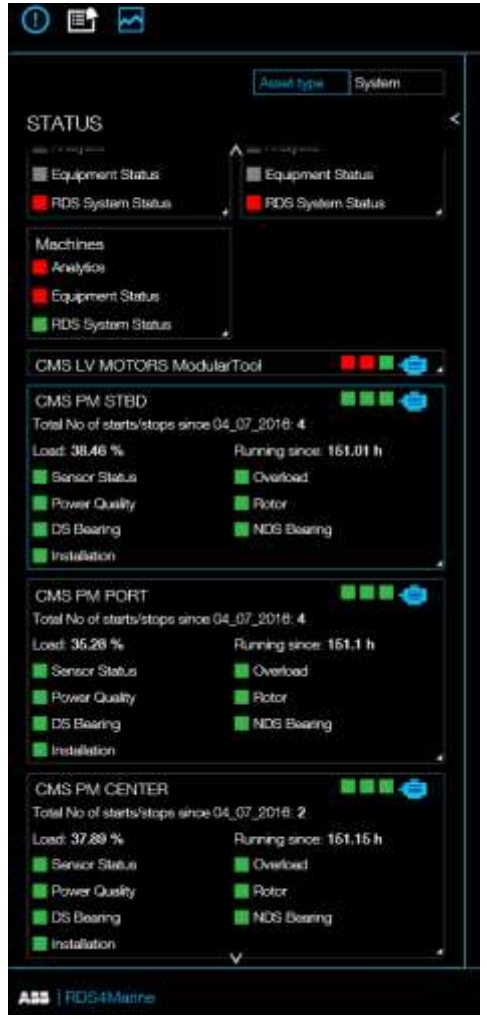
Remote Diagnostics Services
Data Management and Reporting Tools