DYNAMIC POSITIONING CONFERENCE
October 13-14, 2015

THRUSTERS

Preventative Maintenance Methods for Heavy Duty Azimuth Thrusters

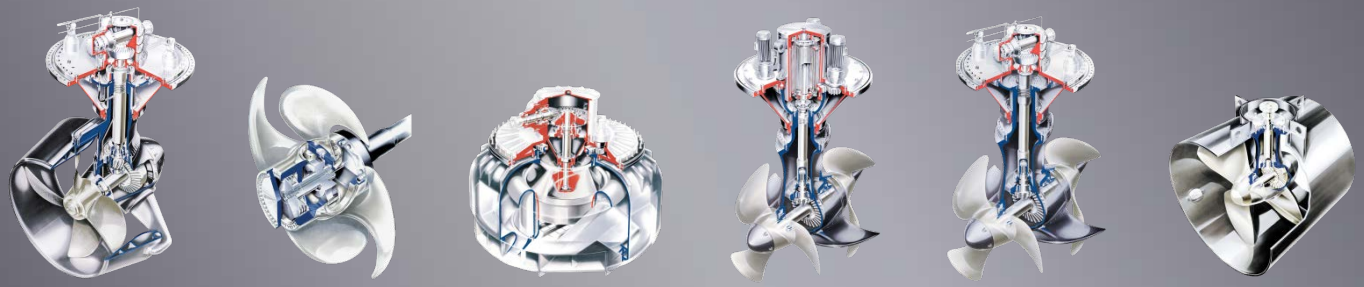
Frank Zeller
Schottel

YOUR PROPULSION EXPERTS

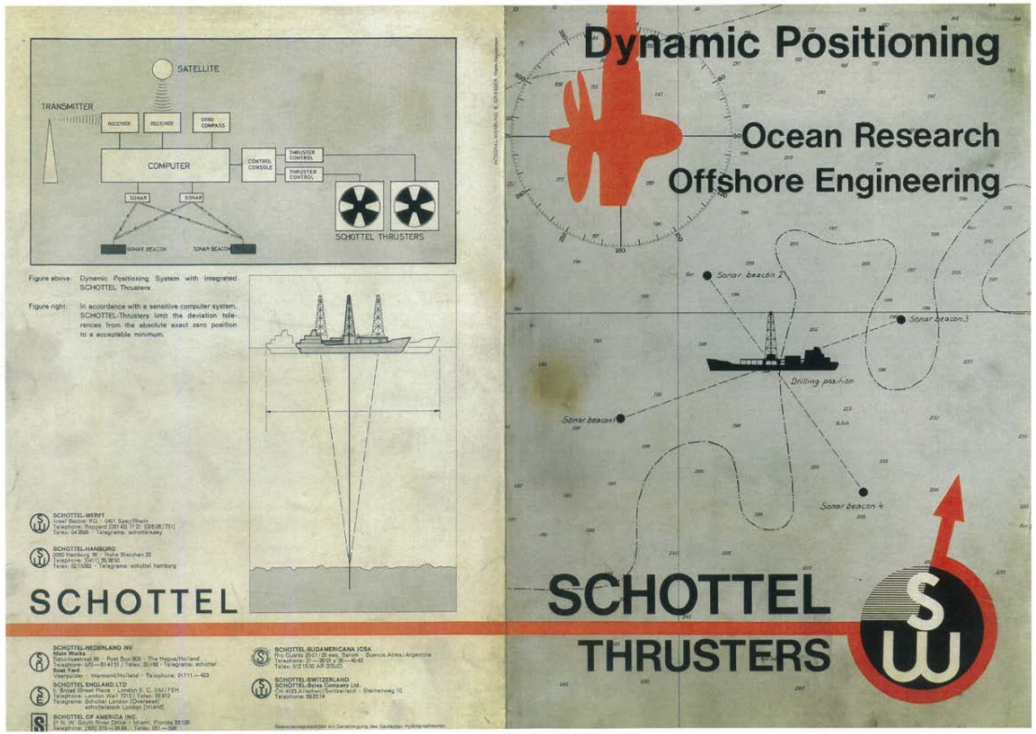
Preventive maintenance methods for heavy duty azimuth thrusters

Frank Zeller

October 2015



DYNAMIC POSITIONING



CONTENT

- General influences
- Wear and tear
- Preventive actions
- Preventive maintenance
- Condition monitoring
- Typical applications
- Example from field
- Summary

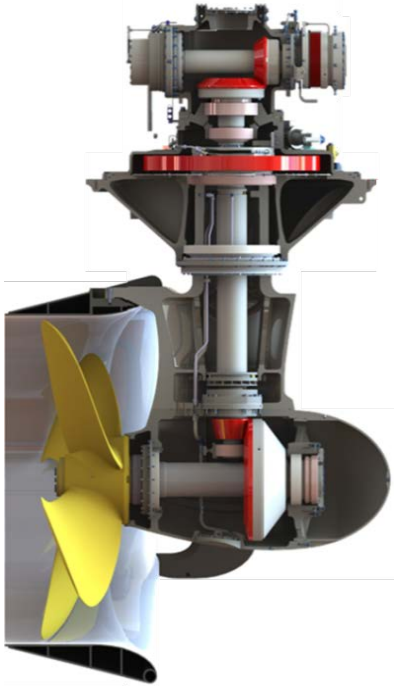
GENERAL INFLUENCES

Harsh Weathers

Calm Weathers

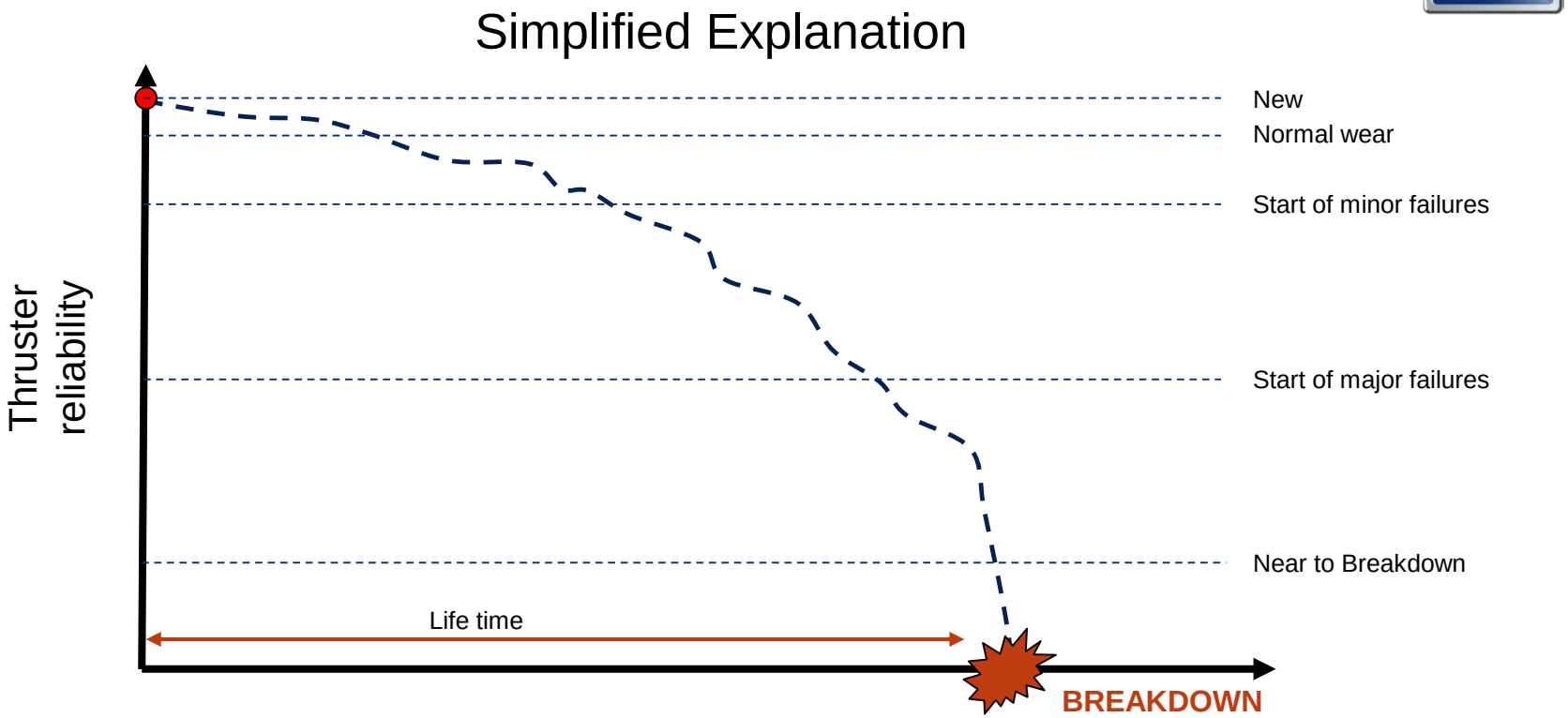
GENERAL INFLUENCES

- corrosion
- hydrodynamic loads
- foreign object damage
- grounding

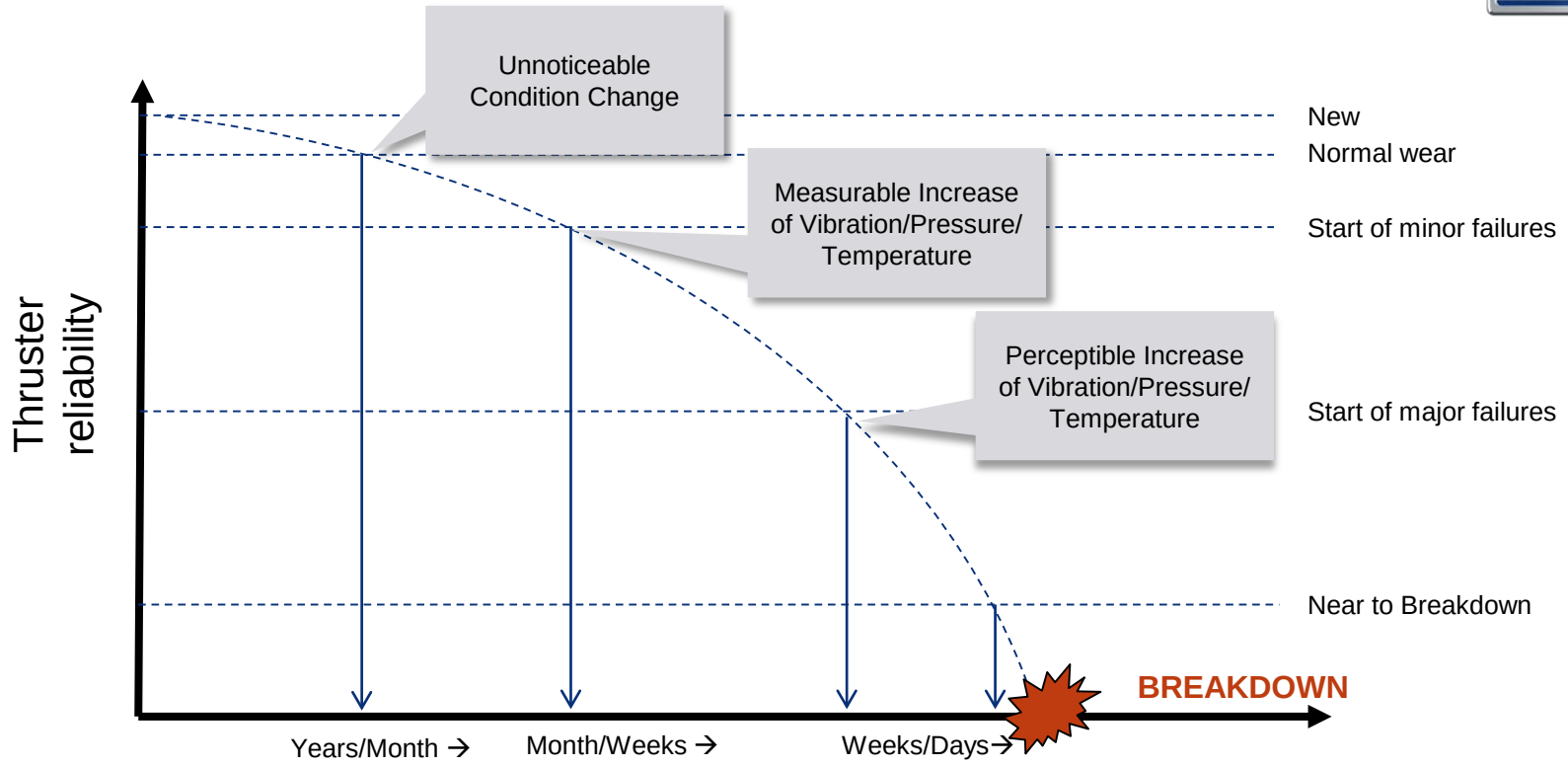


- steering forces
- structural fatigue
- vibration
- operational loads
- engine loads
- thermal cycles

WEAR AND TEAR

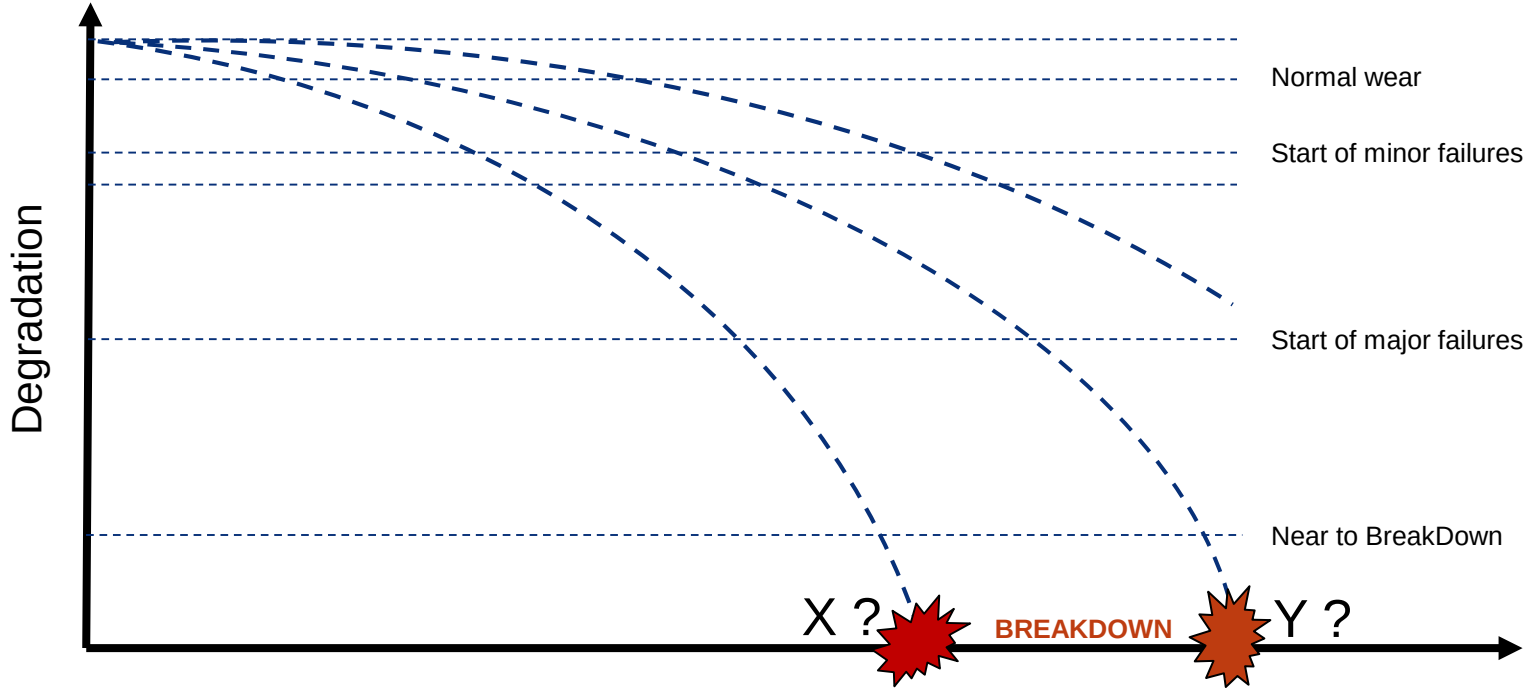


WEAR AND TEAR



WEAR AND TEAR

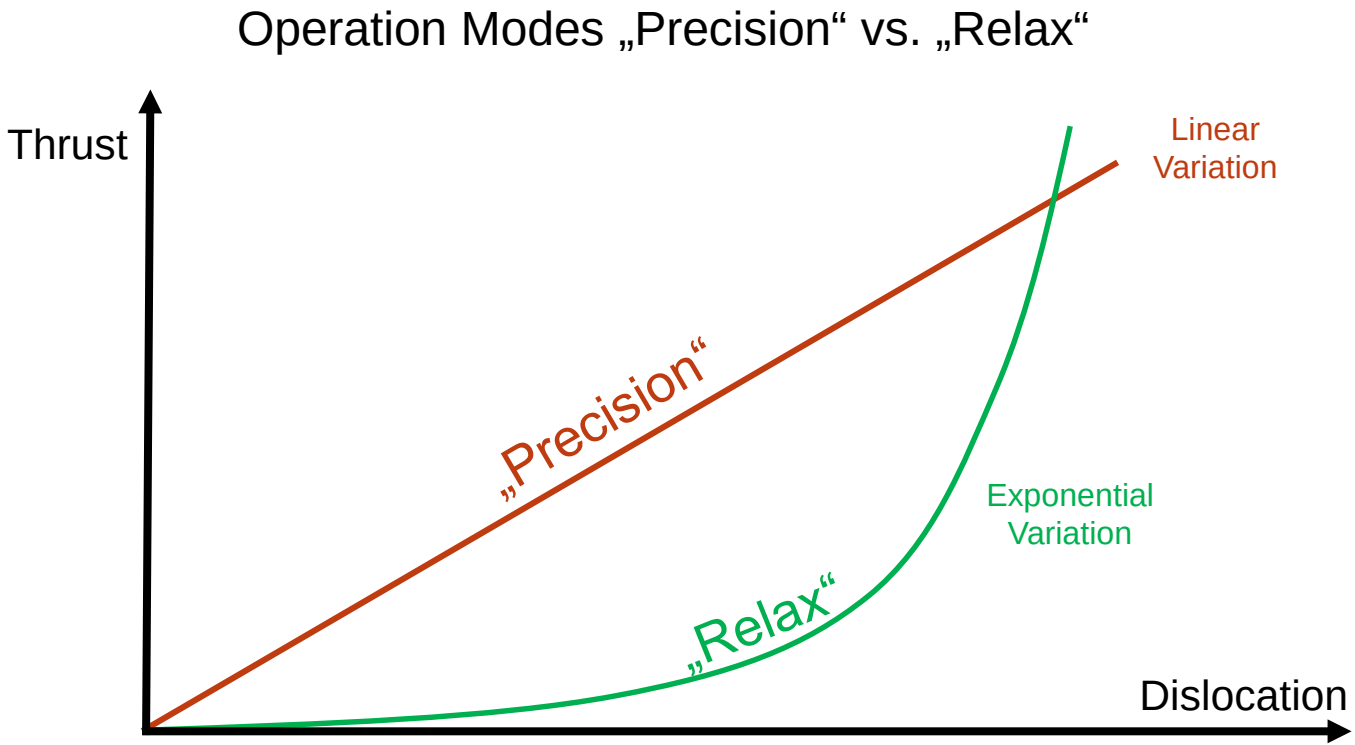
Influence of operation conditions and maintenance



PREVENTIVE ACTIONS

Different Operation Modes (e.g. PSV HAVILA AURORA)

PREVENTIVE ACTIONS



PREVENTIVE ACTIONS

Depending on the selected operation modes the wear and tear will be influenced:

(High Precision Mode (HP)/Ecomomical Mode (E))

RPM:

HP	larger range & more cycles	−
E	smaller range & less cycles	+

Torque:

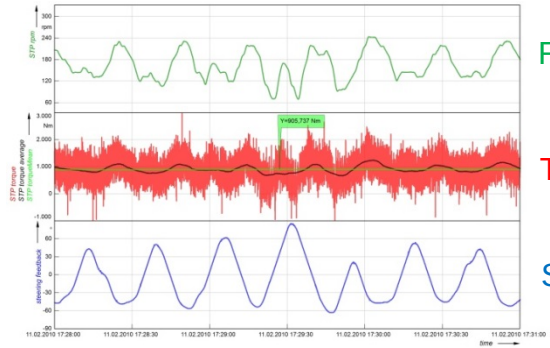
HP	larger range & higher torque	−
E	smaller range & lower toque	+

Steering:

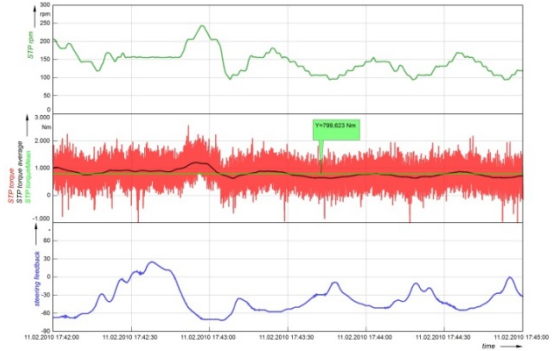
HP	larger range & more cycles	−
E	smaller range & less cycles	+

HP-Mode

E-Mode

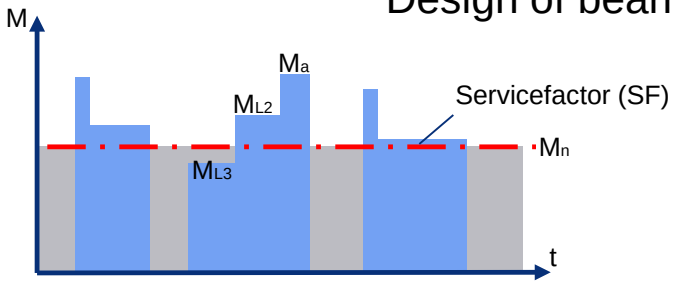


(same period, same sea state)



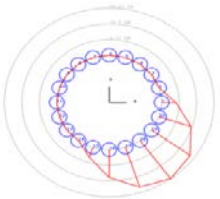
PREVENTIVE ACTIONS

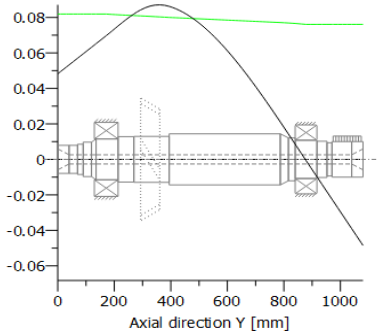
Design of bearing arrangements



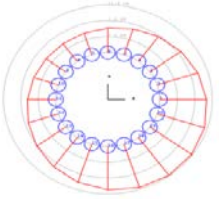
The bearing service life is determined on the basis of the individual application load conditions, defined by the service factor or an individual load spectra.

Load distribution





Load distribution

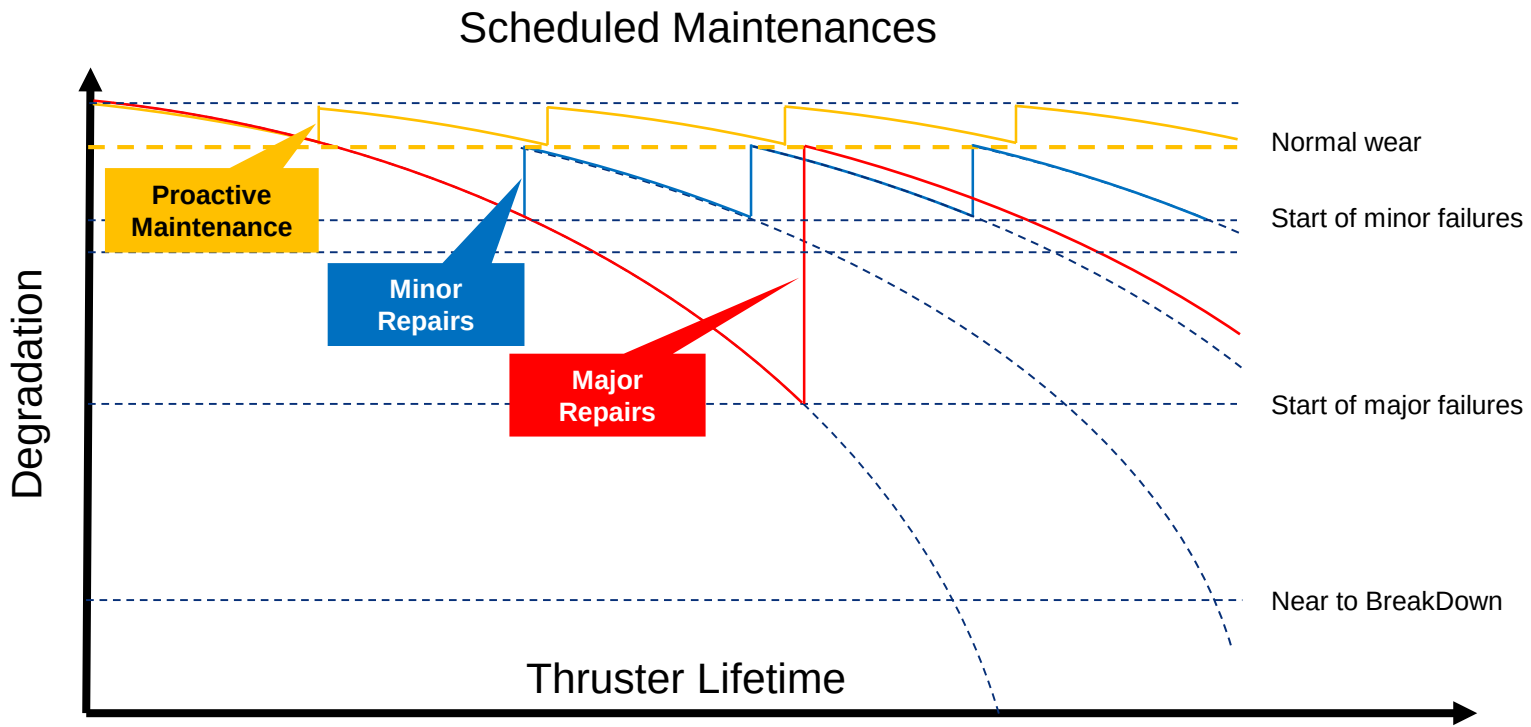


- Considers the inner geometry of the bearing
- Bearing clearance
- Change of clearance through thermal effects
- Change of clearance due to fits
- Displacement and tilting of the bearing due to deformation of shafting/housing
- Lubrication system
- Lubricants and impurity

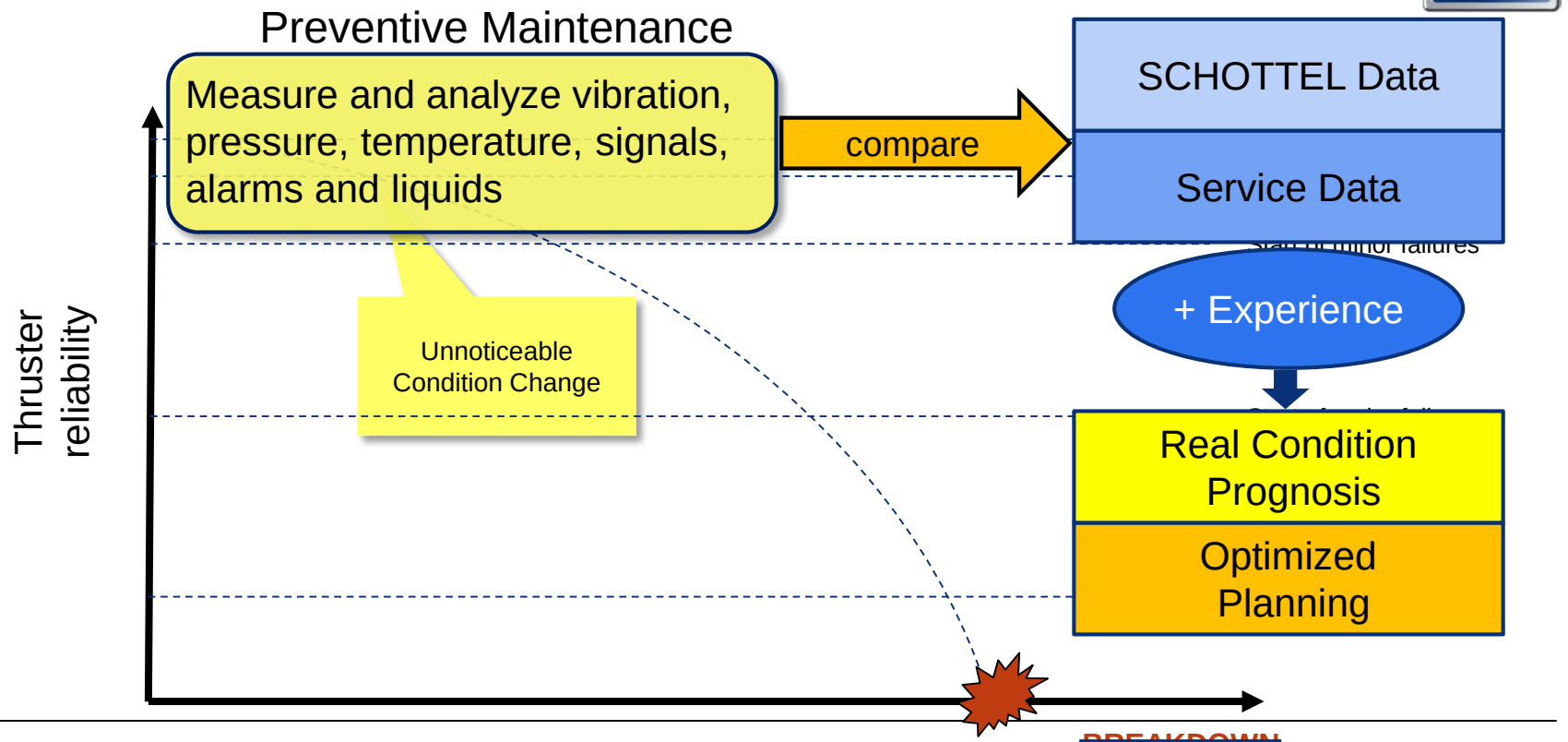
Complies with

ISO 281 / 16281	Dynamic load ratings and rating life
ISO 15312	Thermal speed rating
DIN 732	Thermally safe operating speed

PREVENTIVE MAINTENANCE



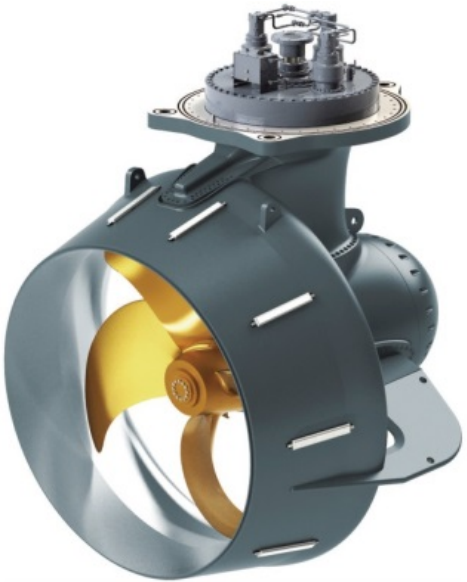
PREVENTIVE MAINTENANCE



CONDITION MONITORING

Diagnostic System „S-COM“

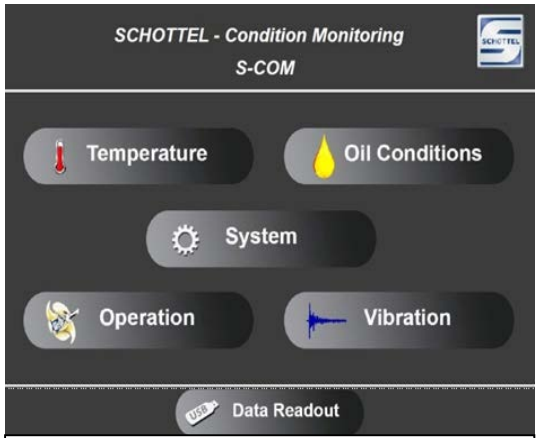
SRP 9000 LSU



Parameters

- Temperature
- Vibration
- Saturation of water in oil
- Particle in oil
- Thruster speed
- Thruster steering angles

S-COM
(SCHOTTEL Condition Monitoring)



Independent system
No connection and influence
at thruster control

CONDITION MONITORING

Necessary components of an underwater mountable unit

SRP 9000 LSU

power train

lubrication

hydraulic

water saturation

speed pick-up

particle sensor

acceleration sensor

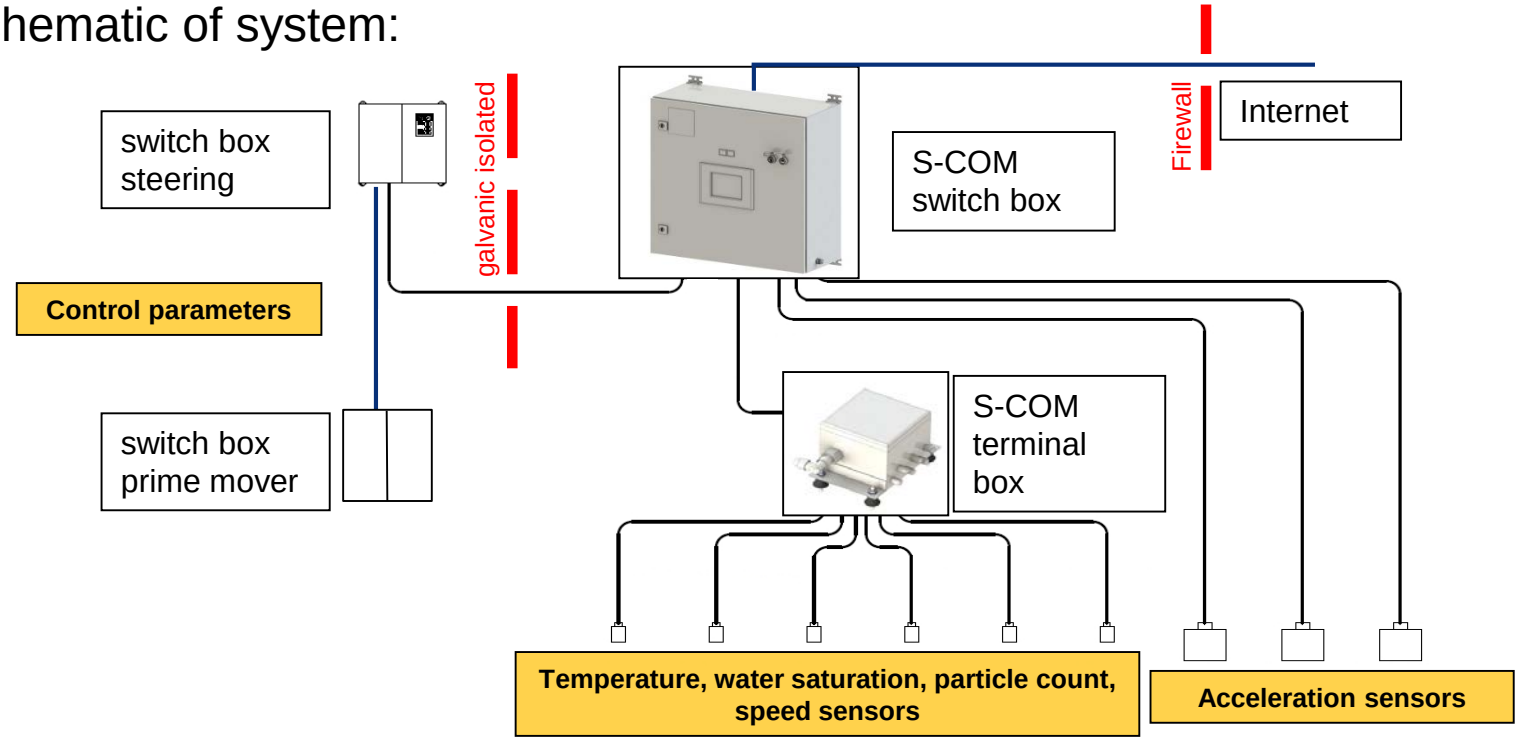
temperature sensor

monitoring display

S-COM switch box

CONDITION MONITORING

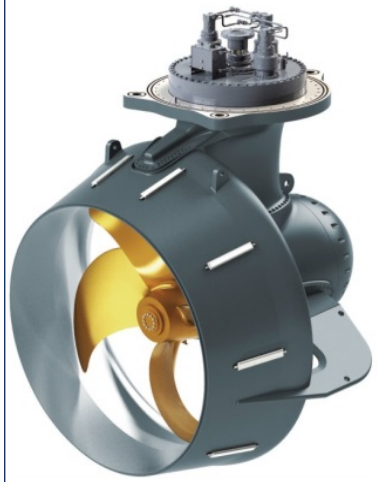
Schematic of system:



CONDITION MONITORING

Examples for monitored parameters

SRP 9000 LSU



power train

water saturation

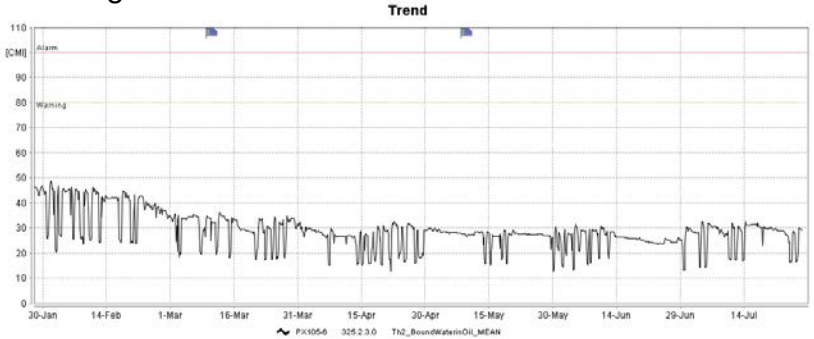
speed pick-up

particle sensor

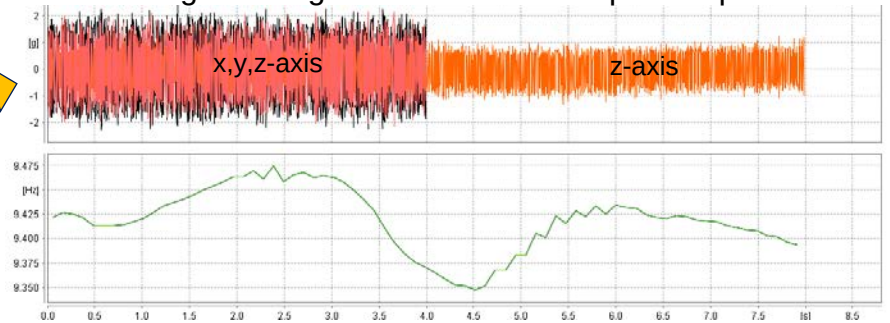
acceleration sensor

temperature sensor

e.g. water saturation in oil:



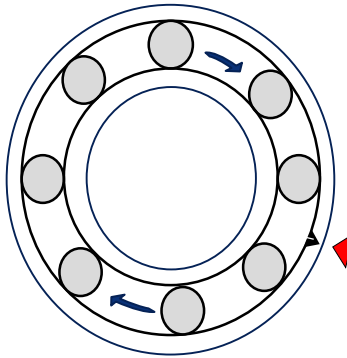
e.g. time signal acceleration at specific rpm:



CONDITION MONITORING

Detection of bearing defects:

Each roller bearing has specific defect frequencies depending on the geometry

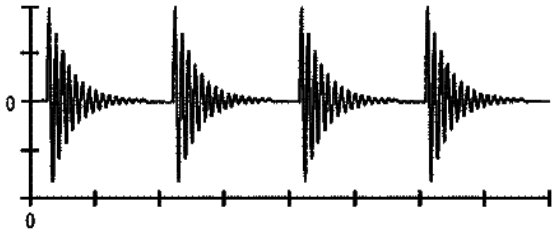


$$fR = \frac{Dm * n}{Db * 60} * \left(1 - \left(\frac{Db}{Dm}\right)^2 * \cos^2\beta\right)$$

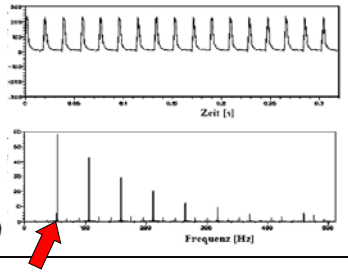
$$fI = \frac{n * z}{2 * 60} * \left(1 + \left(\frac{Db}{Dm}\right) * \cos\beta\right)$$

$$fO = \frac{n * z}{2 * 60} * \left(1 - \left(\frac{Db}{Dm}\right) * \cos\beta\right)$$

race frequency

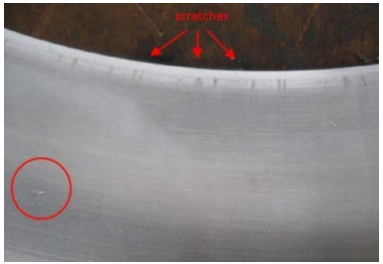


signal preparation in S-COM



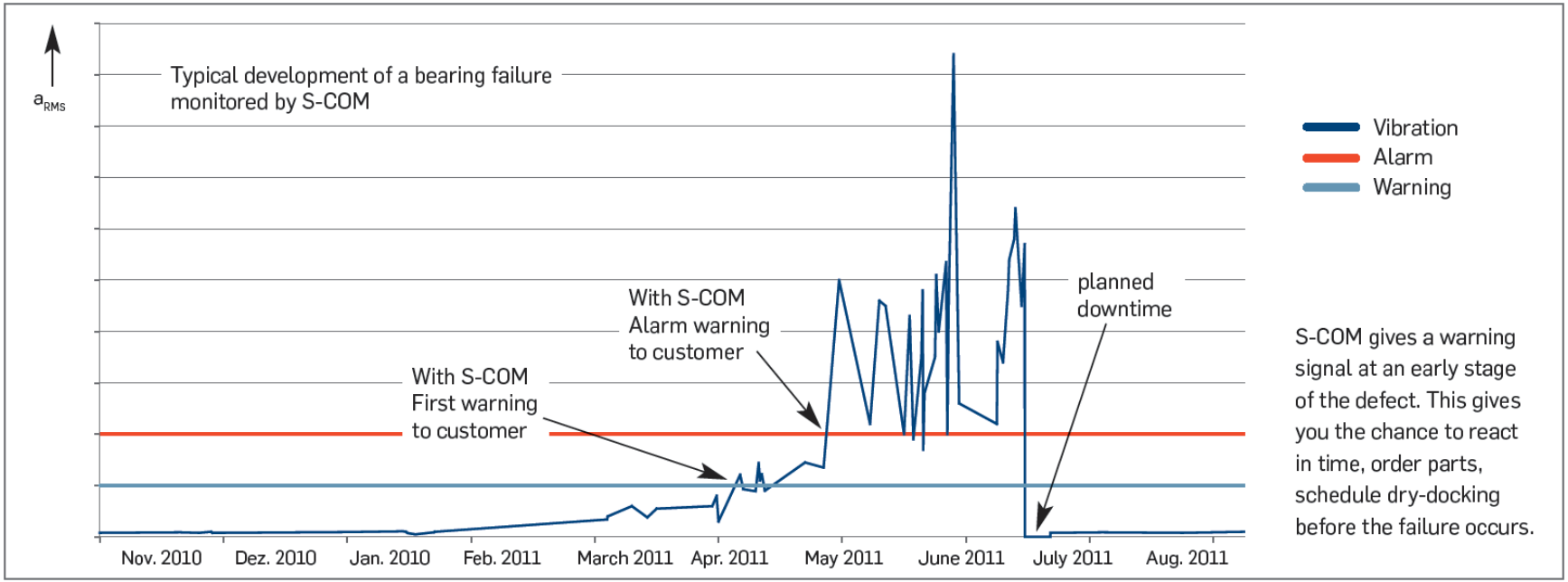
(outer race frequency) fO

Identification of typical defect frequencies



CONDITION MONITORING

Development of bearing defects



CONDITION MONITORING

Vessel

S-COM
on board

Operator

Data Connection

V-SAT
(Satellite)
Ship Server,…

3 G
(Cell-Phone)
UMTS, HSDPA,…

Manually

Data Transfer

E-Mail
FTP

E-Mail
FTP

E-Mail
USB-Stick

SCHOTTEL

Server

S-COM

✓***Analysis***

✓***Automatic 24/7 event support***

✓***Periodic Report***

CONDITION MONITORING

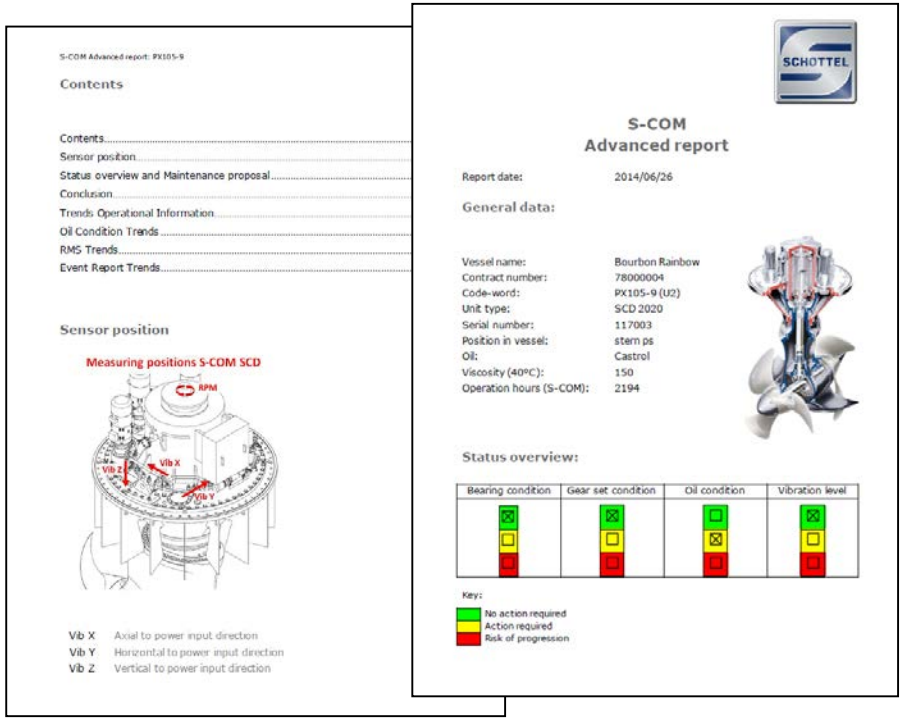
Monitoring Report:

Content:

- General project data
- Status overview
- Summary
- Log Book
- Maintenance proposal

Issued:

- Periodical reports
(e.g. every 3, 6, 12 months)
- On request by customer
- Automatic event reporting when the “alarm” level was reached



TYPICAL APPLICATIONS

RIVERCRUISER VIKING
4 x SCHOTTEL STP 200 FP

DOUBLE-ENDED FERRY BERGENSFJORD
4 x SCHOTTEL Combi Drive Type SCD 2020

128 T BP OFFSHORE TUG LUZ DE MAR
2 x SCHOTTEL Rudder Propeller Type SRP 3040 CP

PSV BOURBON MISTRAL
2 x SCHOTTEL Combi Drive Type SCD 2020

EXAMPLE FROM THE FIELD

PSV vessel with S-COM operating in the Gulf of Guinea, next Benin

- S-COM detected bearing failure at upper gear box
- Customer contacted and repair solution agreed
- Service engineer sent with spares for the exchange of the failed bearing
- Job done within few days

© George Saunders

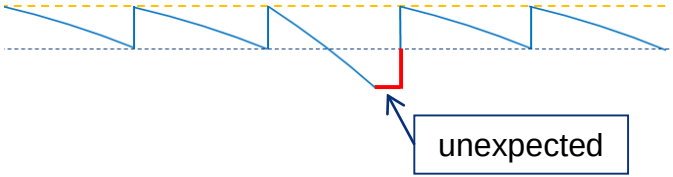
SUMMARY

Current situation:

- Maintenance in regular fixed intervals

- Dismantling even if not required

- Unexpected repair and downtime in case of damage

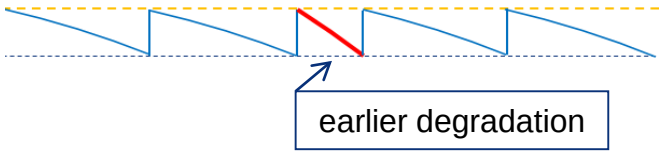


- Short-term planning of docking times
- Short-term, unexpected staff assignment
- Loss of job or business

SUMMARY

Situation with S-COM:

- Condition based maintenance
- Early detection of damages



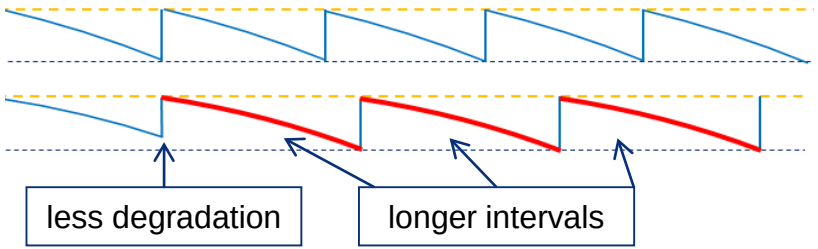
- Dismantling in case of indication of wear / damages
- Running systems are not touched
- improved planning of dockings, better coordination
- short ‘off hire’ period for customers

SUMMARY

Situation with S-COM:

- advance warning to avoid emergencies
- specific maintenance recommendation or repair advices
- scheduled docking

- Increased knowledge of operating conditions due to data recording (speed, load, steering angle, etc.)
- Increase of maintenance intervals possible



THANKS !