Condition monitoring

prevention against damages

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Oil mist detection today

Today's appearance of severe damages

Damages to main and aux engines (Source: The Swedish Club main & aux engine report 2018)

- **Main engine** claims account for 28% of all machinery claims and **34%** of the costs, with an average claims cost close to **USD 650,000**
- **Aux engine** claims account for 13% of the total machinery claim costs and **16%** of the volume, with an average claim cost of **USD 345,000**
  - The most expensive type of main engine damage is on crank shaft/bearings with an average cost of USD 1.2 million per claim
  - Lubrication oil related failure is the most common cause of damage for main engines
  - Incorrect maintenance and wrongful repair are the most common causes of damage for aux engines; poor lubrication oil management is also a major contributing factor

Oil mist related crankcase explosions: Significance and development
- Key components of the engines face increasing challenges, e.g.:
  - Conflict of oil consumption vs. friction losses for liner and piston bore interface
  - High bearing loads and the conflict of stiffness vs. weight

- Experience shows the importance of safety systems to avoid crankcase explosions is more present than ever before

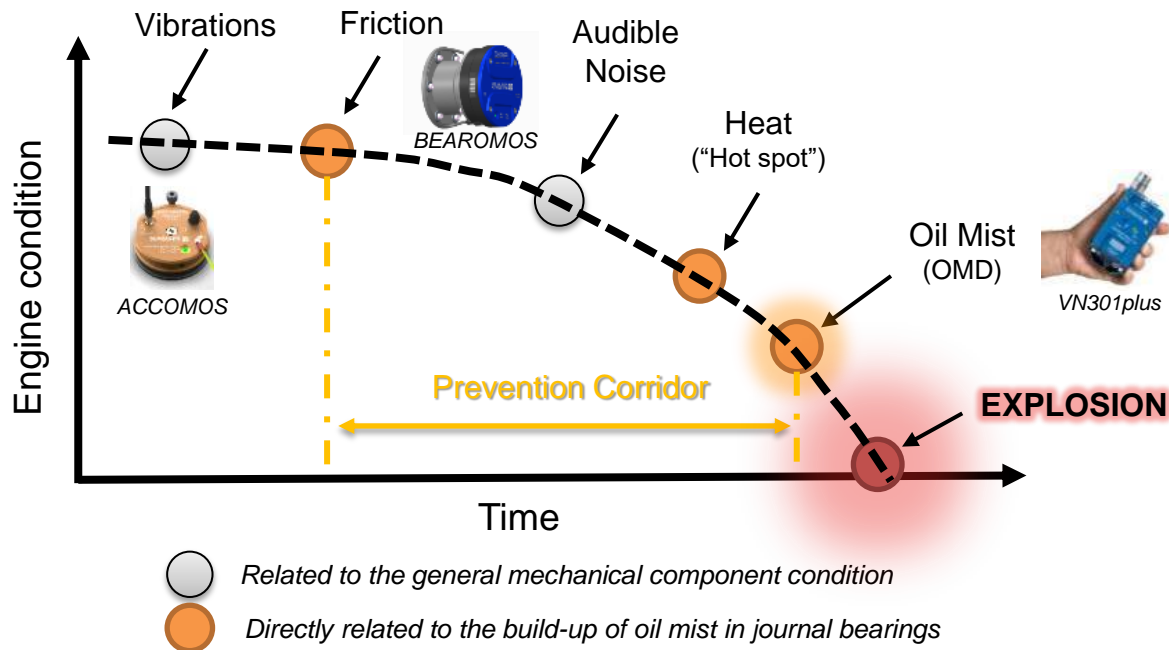SCHALLER AUTOMATION
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Condition monitoring approach

Development of mechanical failures over time

Increasing prevention corridor with additional condition monitoring
- Detection of mixed lubrication in journal bearings
- Detection of vibration anomalies

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ACCOMOS sensor

Motivation

- 3-axis acceleration sensor monitors mechanical vibrations at non-rotating parts in accordance with **DIN ISO 10816-6**

- Monitors permissible limit values of internal combustion engines having more than 100 kW but also other engine components, generators…

- Mounting with extra-strong magnets allows installation within minutes

- Tested in accordance to DNVGL-CG-0339, CE conformity, IATA certificate, risk assessment in accordance to DIN EN ISO 12100
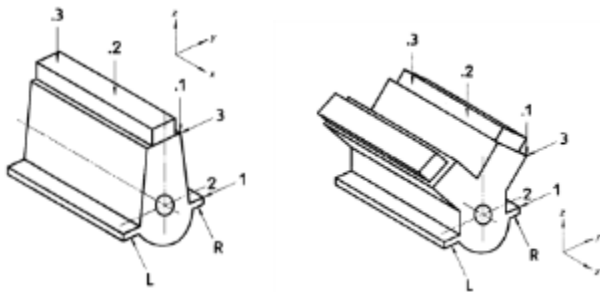
Source DIN ISO 10816-6

Displacement in um (RMS)	Velocity in mm/s (RMS)	Acceleration in m/s^2 (RMS)	Machine vibration classification						
			1	2	3	4	5	6	7
17,80	1,12	1,76	Normal / acceptable	Normal / acceptable	Normal / acceptable	Normal / acceptable	Normal / acceptable	Normal / acceptable	Normal / acceptable
28,30	1,78	2,79							
44,80	2,82	4,42							
71,00	4,46	7,01	Unsatis-factory						
113,00	7,07	11,10		Unsatis-factory					
178,00	11,20	17,60			Unsatis-factory				
283,00	17,80	27,90				Unsatis-factory			
446,00	28,20	44,20	Unaccept-able				Unsatis-factory		
710,00	44,80	70,10		Unaccept-able				Unsatis-factory	
1125,00	70,70	111,00			Unaccept-able	Unaccept-able			Unsatis-factory
1784,00	112,00	176,00					Unaccept-able	Unaccept-able	Unaccept-able

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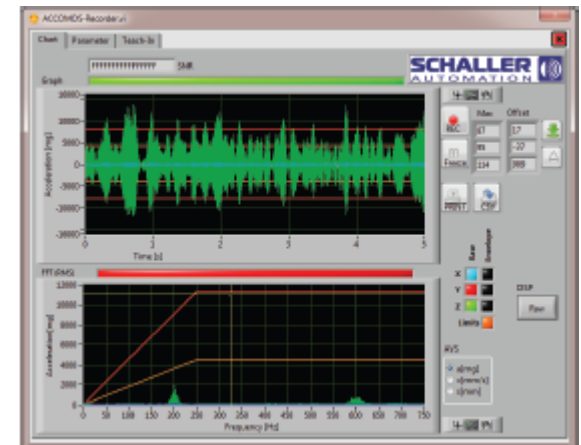SAFETY FOR YOU AND YOUR ENGINE

Detection of vibration: ACCOMOS

Motivation

- Effective solution for condition monitoring of vibration to detect critical operating conditions in an early stage of occurrence

Principle

- 3 axes acceleration sensor for large 2 and 4 stroke diesel, gas and dual fuel engines
- Monitor your engine according DIN ISO 10816-6

ACCOMOS

BUS cable connector

Ground cable connector

LED Indicator (vibration level) :

CONDITION: Normal -green
Limit.1 -yellow
Limit.2 -red

Green: acceptable
Yellow: short term acceptable
Red: not acceptable

Ultra strong magnet

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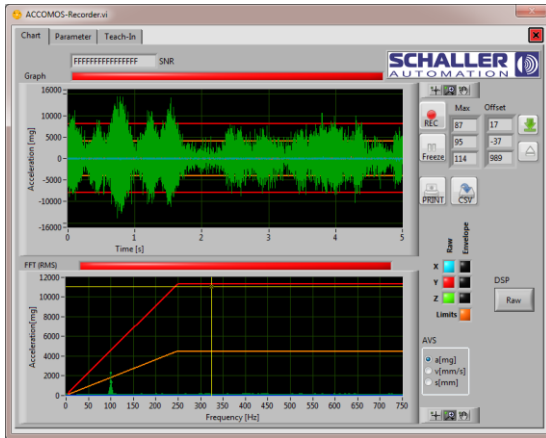AUTOMATION
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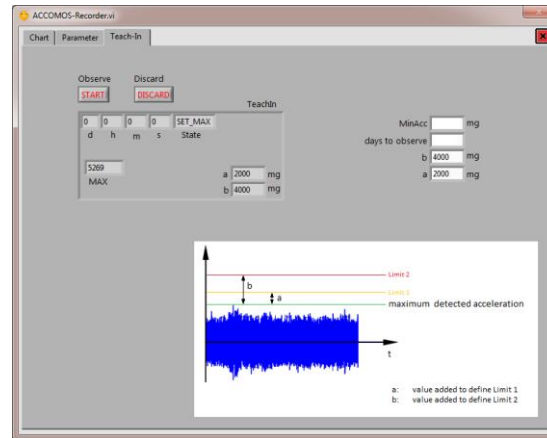
ACCOMOS Version 2 Software
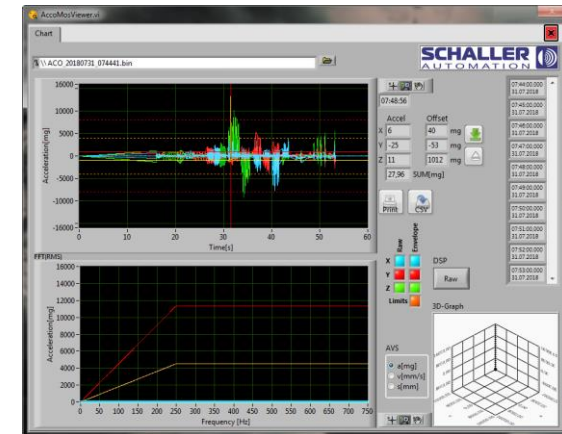
Software features/options

- Software has following features/options :
    - Life signal visualization
    - Teach In function
    - Data viewer (to analyze recorded data)

Life signal screen

Teach In screen

Data viewer

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Detection of vibration: ACCOMOS

Software

With the software you have following possibilities :

- System indicator (2) : R/Y/G
- Upper screen : Live signal of vibration and the limits (3)
- Lower screen : FFT Frequency spectrum of the sensor signal as square average (5)
  - To identify source of vibration
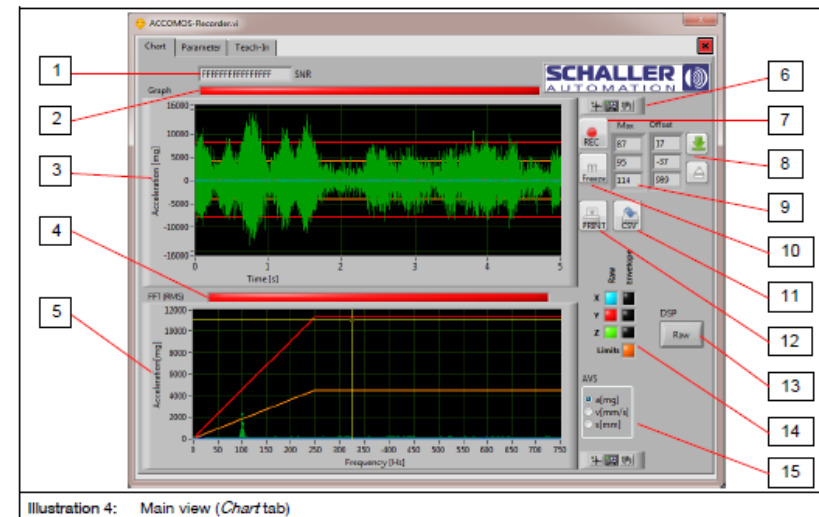- Possibility to record the signal (7)

Illustration 4: Main view (*Chart* tab)
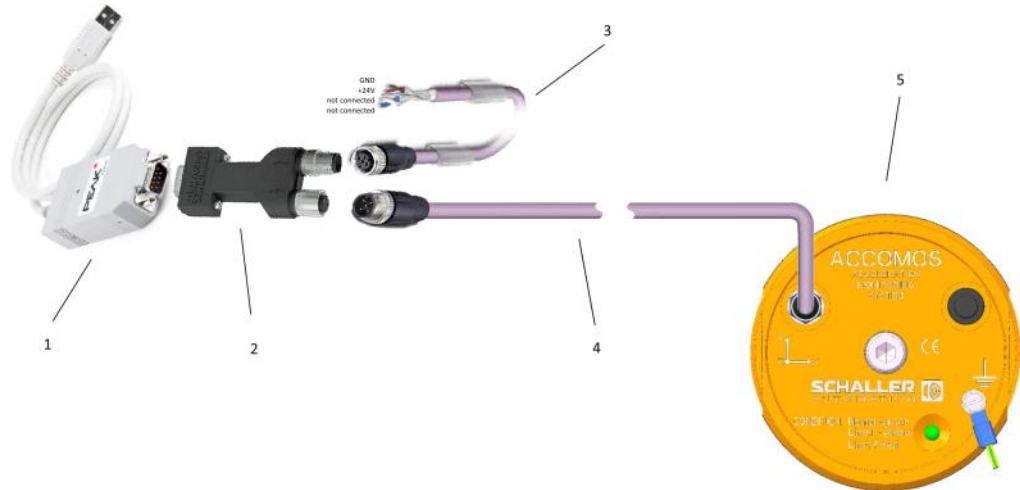
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Detection of vibration: ACCOMOS

Benefits

- Live-Monitoring of Deviation in normal vibration of the machine/engine

- One sensor for 3 Axes

- Permanent Installation within minutes – via ultrastrong magnets

- Suitable to monitor your engine according **DIN ISO 10816-6**

- RS 485 or CAN Bus

Detection of vibration: ACCOMOS

Multiple application

- On engines test cell for validation purpose

- Validation vibration profile during FAT, according DIN ISO 10816-6 or classification society

- Monitor the engine during sea trial

- Monitor engine vibration profile during service visit

  - Control profile in accordance to FAT results

  - Define if potential failure

- For end-user monitor engine after important engine work

- For fleet owner and engine maker remote engines → 4.0 industries

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Detection of vibration: ACCOMOS

Multiple source of vibration

Monitor your engine/machine to identify a vibration deviation **before severe damage**

- Cracks in engine frame

- Coupling damage

- Misalignment e.g. between engine and machine

- Engine/Machine Baseplate cracks

- Breaking Base dampers

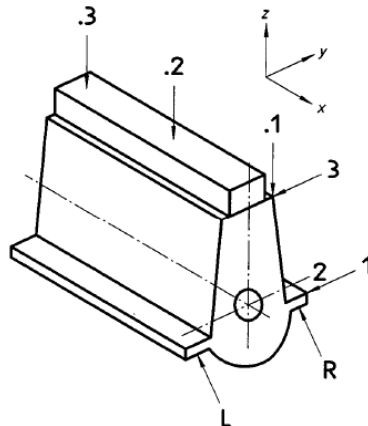- Many more failures linked to oscillating forces
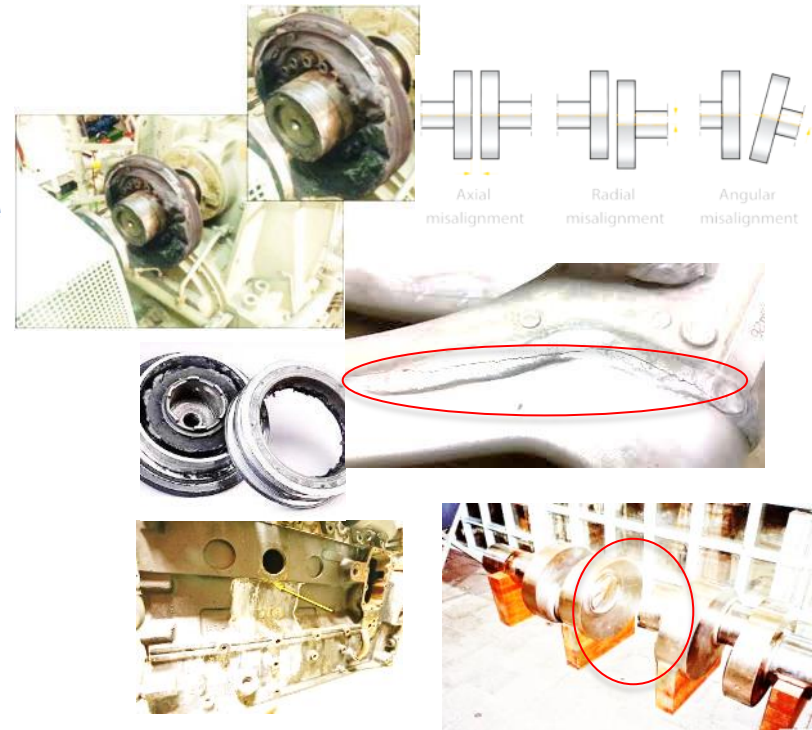
Detection of vibration: ACCOMOS

Installation rule

The installation of ACCOMOS is based on DIN ISO 10816-6

1 sensor per engine at critical place. Defined based DIN ISO.

Figure 1 — Example of a vertical in-line machine

Key

Sides of measurement	L	Left-hand when facing the coupling flange
	R	Right-hand when facing the coupling flange
Levels of measurement	1	Machine end of mounting
	2	Crankshaft level
	3	Top edge of frame
Measurement points related to machine length	.1	Coupling end
	.2	Mid-machine
	.3	Free end of machine
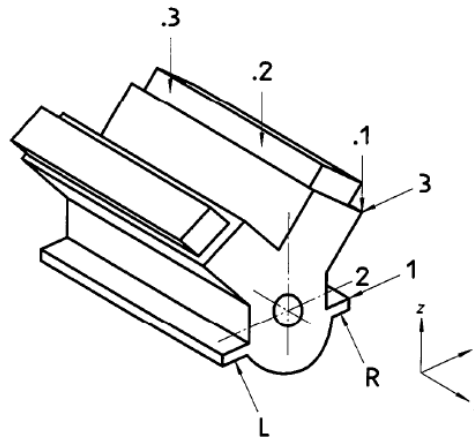
NOTE — See figure 1 for key.

Figure 2 — Example of a multicylinder Vee machine
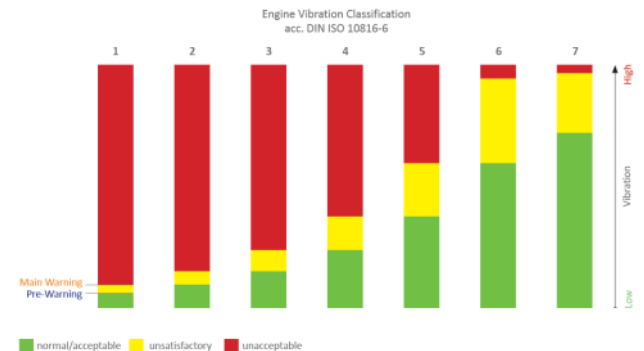
Source: DIN ISO 10816-6

Table A.1 — Vibration classification numbers and guide values for reciprocating machines

Vibration severity grade	Maximum values of overall vibration measured on the machine structure			Machine vibration classification number						
	Displacement μm (r.m.s.)	Velocity mm/s (r.m.s.)	Acceleration m/s² (r.m.s.)	1	2	3	4	5	6	7
				Evaluation zones						
1,1	17,8	1,12	1,76							
1,8	28,3	1,78	2,79	A/B						
2,8	44,8	2,82	4,42		A/B	A/B				
4,5	71,0	4,46	7,01				A/B	A/B	A/B	
7,1	113	7,07	11,1	C						A/B
11	178	11,2	17,6		C					
18	283	17,8	27,9			C				
28	448	28,2	44,2				C			
45	710	44,6	70,1	D	D			C		
71	1125	70,7	111			D	D		C	
112	1784	112	176					D		C
180									D	D

Key to zones

A: The vibration of newly commissioned machines would normally fall within this zone.
B: Machines with vibration within this zone are normally considered acceptable for long-term operation.
C: Machines with vibration within this zone are normally considered unsatisfactory for long-term continuous operation. Generally, the machine may be operated for a limited period in this condition until a suitable opportunity arises for remedial action.
D: Vibration values within this zone are normally considered to be of sufficient severity to cause damage to the machine.

NOTE — Vibration values for reciprocating machines may tend to be more constant over the life of the machine than for rotating machines. Therefore zones A and B are combined in this table. In future, when more experience is accumulated, guide values to differentiate between zones A and B may be provided.

Engine Vibration Classification acc. DIN ISO 10816-6

Main Warning
Pre-Warning

normal/acceptable   unsatisfactory   unacceptable

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Detection of vibration: ACCOMOS

Technical data

Power supply	9-36 VDC
Consumption	Max. 110 mA
Temperature range	-25°C to +85°C
Measure range	+/- 16 000 mG
Frequency range	0-750 Hz (1500Hz for CAN BUS possible)
Sensitivity	4 mG
Data transfer	Digital via RS485 or CAN
Weight	400g
Diameter	89,5 mm

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Detection of vibration: ACCOMOS
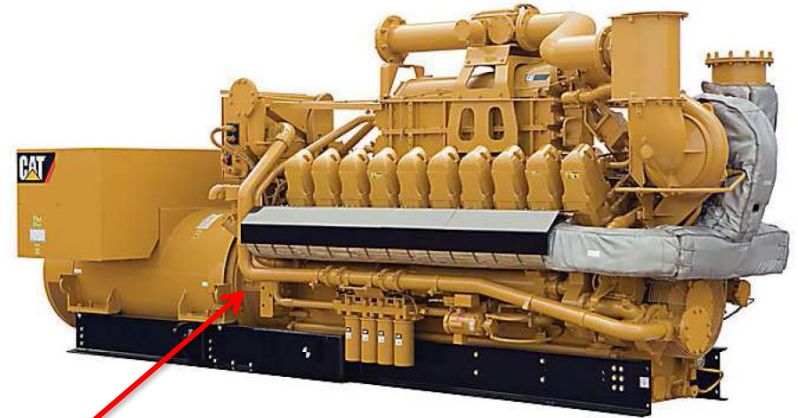
Scope of delivery
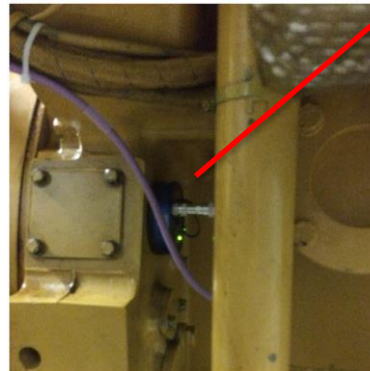
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ACCOMOS : field application

- Customer : City of Saarbrücken (D)
- Engine type : CAT G3520C
- Fuel type : Gas (coal gas)
- Application : Powergen for load
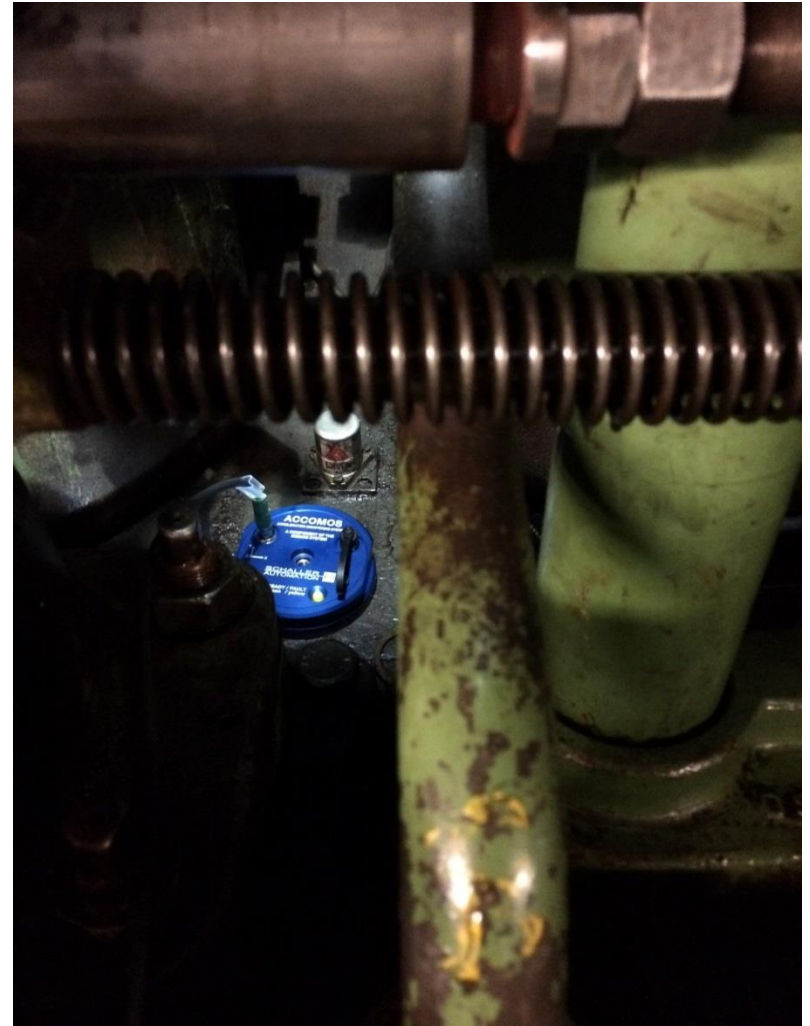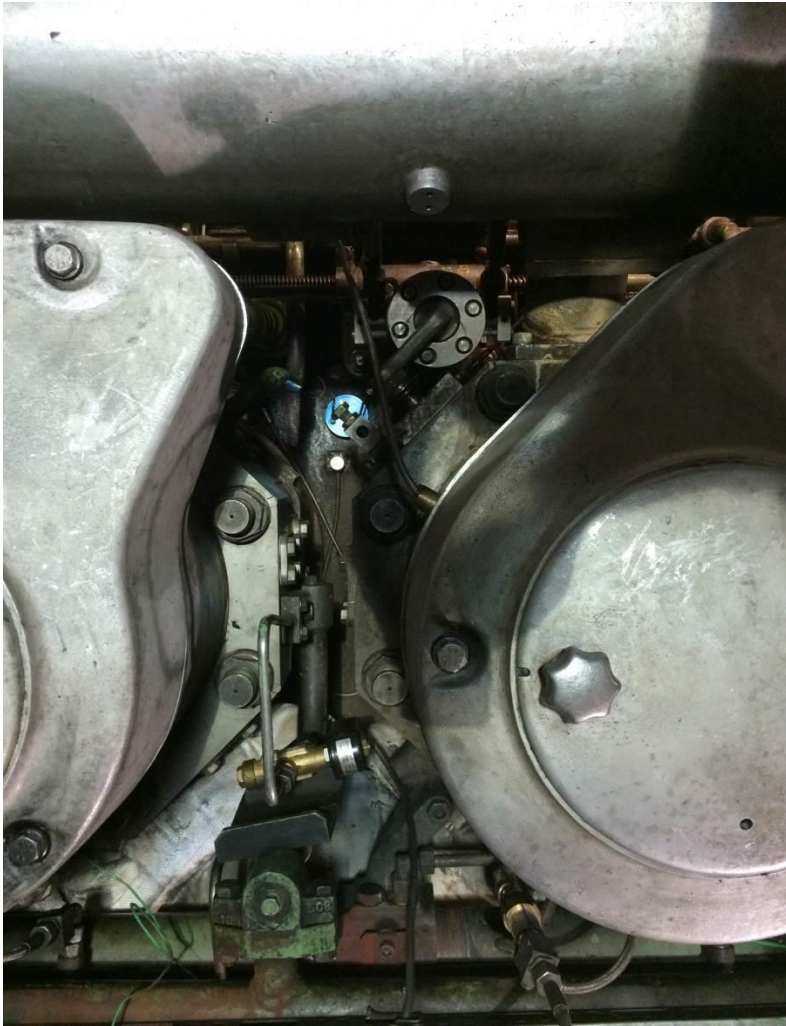- Installation since : 12/2017
- Working hours : 8300 hours w/o issues

CAT G3520C

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ACCOMOS : field application

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ACCOMOS : field application

Installation example

Monitoring of vibration profile on 4-stroke engine test bench.

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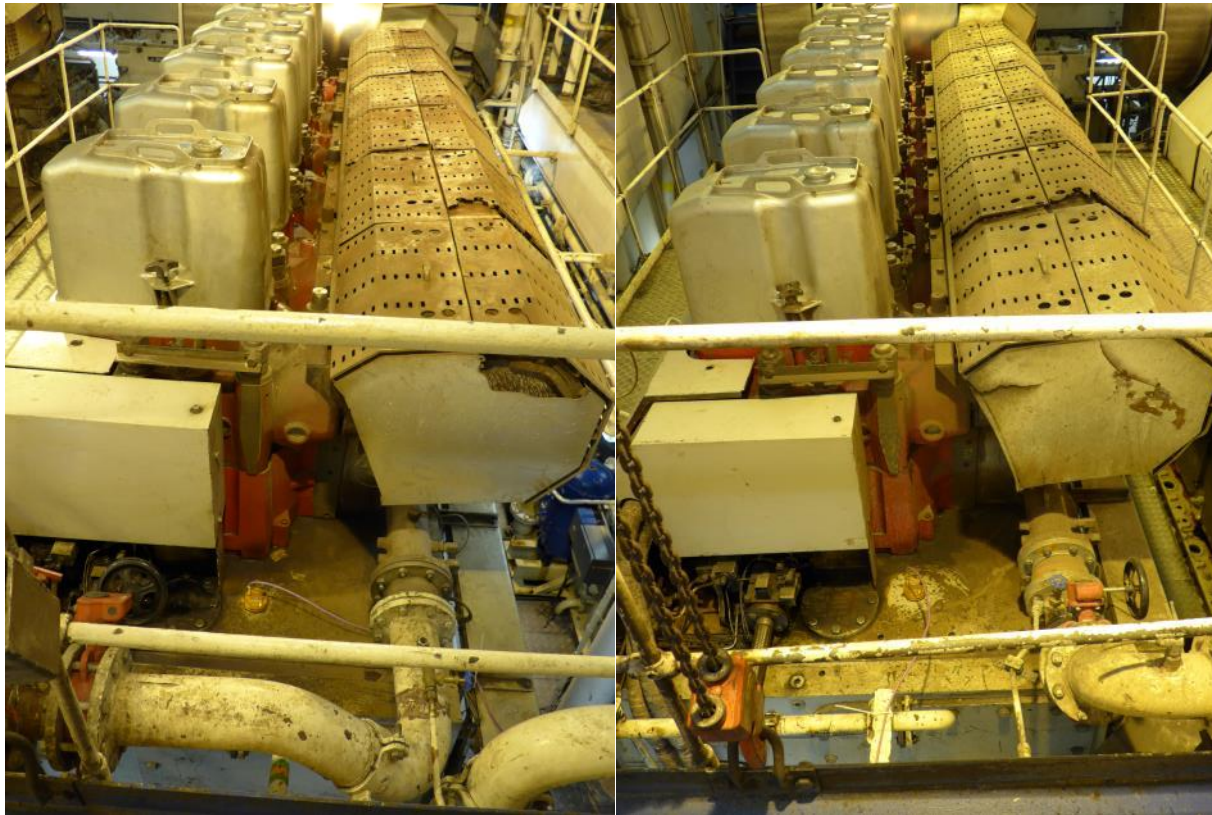SAFETY FOR YOU AND YOUR ENGINE

ACCOMOS : field application

Installation example

Monitoring of 4 engines (4-stroke) on a ferry in Europe

ACCOMOS : field application

Installation example

Monitoring of vibration profile on 4-stroke engine, power plants.

Power plant Bliestal (D)

Power plant Saarbrücken (D)

Marine college Flensburg (D)

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