

# WCM Vedlikeholdsleder

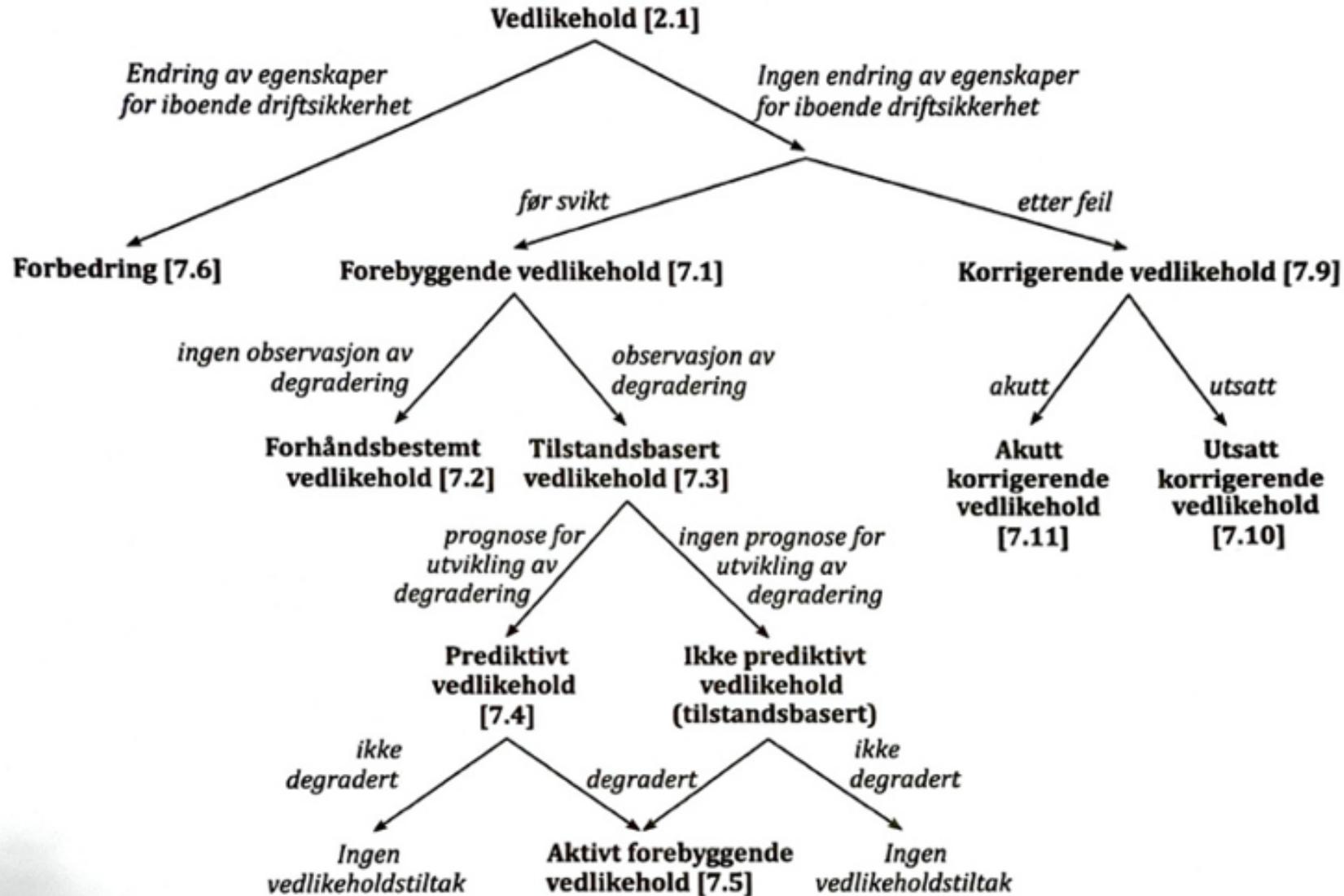
---

## 7.2 PdM som vedlikeholdskonsept

*Tommy Glesnes*



## 7.2 PdM som Vedlikeholdskonsept



Figur 1 Vedlikeholdsterminologi (NS-EN 13306, 2017)

### *Tilstandsbasert vedlikehold*

Forebyggende vedlikehold som omfatter vurdering av fysisk tilstand, analyse og mulige påfølgende vedlikeholdstiltak.

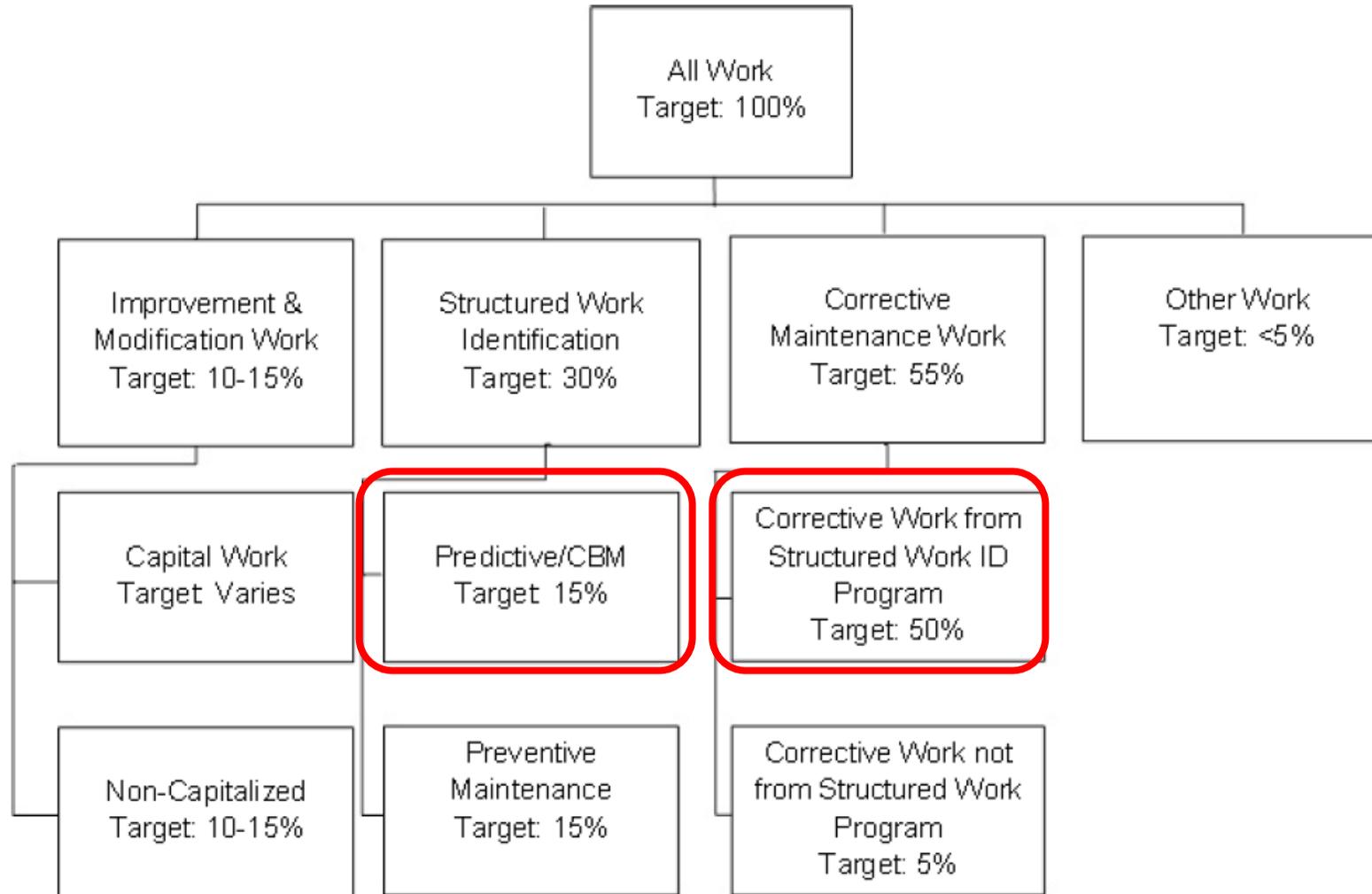
### *Prediktivt vedlikehold*

Tilstandsbasert vedlikehold som utføres etter en prognose utledet av gjentatt analyse eller kjente egenskaper og evaluering av de vesentlige parameterne for degradering av enheten.

## COMPONENT DEFINITIONS [SMRP]

### **Condition Based Maintenance**

An equipment maintenance strategy based on measuring the condition of equipment against known standards in order to assess whether it will fail during some future period and taking appropriate action to avoid the consequences of that failure. **The condition of the equipment could be measured using condition monitoring, statistical process control, equipment performance or through the use of human senses.** The terms condition based maintenance (CBM), on-condition maintenance and predictive maintenance (PdM) can be used interchangeably.



## Eksempler på KPI'er for CBM / PdM

Condition Based Maintenance Cost (%) =  
[Condition Based Maintenance Cost (\$) / Total Maintenance Cost (\$) ] × 100

Condition Based Maintenance Hours (%) =  
(Condition Based Maintenance Labor Hours / Total Maintenance Labor Hours) × 100

PM & PdM Effectiveness =  
Number of PM & PdM Corrective Work Orders Necessary / Number of PM & PdM Corrective  
Work Orders Written

### SAMPLE CALCULATION

A given plant has total maintenance hours for the month of 3,753 hours of straight time and 47 hours of overtime. Oil samples drawn by a contract sampling crew consumed 196 hours, and the monthly scheduled vibration readings by operators consumed another 24 hours. The total hours from condition based maintenance work orders totaled 876 hours.

Condition Based Maintenance Hours (%) =  
(Condition Based Maintenance Hours / Total Maintenance Labor Hours) × 100  
Condition Based Maintenance Hours (%) = [(196 + 876) / (3753 + 47)] × 100  
Condition Based Maintenance Hours (%) = (1072 / 3800) × 100  
Condition Based Maintenance Hours (%) = 0.282 × 100  
Condition Based Maintenance Hours (%) = 28.2%

According ISO 13373-1:2002

Vibration condition monitoring can provide information for the following purposes:

- to increase equipment protection;
- to improve safety for personnel;
- to improve maintenance procedures;
- to detect problems early;
- to avoid catastrophic failures;
- to extend equipment life;
- to enhance operations.

INTERNATIONAL  
STANDARD

ISO  
13373-1

First edition  
2002-02-15

Condition monitoring and diagnostics of  
machines — Vibration condition  
monitoring —

Part 1:  
General procedures

*Surveillance des conditions et diagnostic des machines — Surveillance  
relative aux conditions des vibrations —*  
*Partie 1: Procédures générales*



Reference number  
ISO 13373-1:2002(E)

© ISO 2002

### According Lloyd's Register



Condition Monitoring and Condition Based Maintenance is considered best practice as the principle means of managing assets.



- MCBM\* is applicable to all surveyable items
- Due dates are removed and the system audited annually.
- MCBM enables the machinery intelligence gathered using a well structured CBM strategy to be used as a basis for survey credit.
- MCBM removes the requirement for carrying out un-necessary planned maintenance and component replacement.
- MCBM supports a living criticality assessment and review process
- MCBM demonstrates accepted best practice and is an award that shows a clear commitment to reliability.
- MCBM will demonstrate compliance in excess of TMSA 4, ISM 10, and remains in line with existing IACS guidance etc.

*ShipRight*

*Design and construction*

**Machinery Planned  
Maintenance and Condition  
Monitoring**

Linked Supporting Service

March 2013

Lloyd's  
Register

\* MCBM Machinery Condition Based Maintenance



# Machinery CM (Condition Monitoring)

Information to owners/operators  
with a condition based maintenance strategy

Due to the increased focus on machinery-related issues, DNV has developed Machinery CM, intended for owners/operators with an implemented CBM (Condition Based Maintenance) strategy. DNV believes that condition based maintenance is the optimal strategy for maintaining machinery. Providing both safety, operational and financial benefits.

Machinery CM is a survey arrangement based on audits of an implemented and approved CM programme.

All ships operating under Machinery CM<sup>1)</sup> will have unique and "ship-specific" operational criteria. The minimum requirements for equipment and systems are presented stipulated by DNV.

Owners/operators must be operating according to a CBM strategy when they apply for Machinery CM. Machinery CM allows the manager to adjust maintenance intervals based on the condition monitoring of applicable components.

>>>

<sup>1)</sup> See DNV rules for classification of ships Pt.7 Ch.8 Sec E and Classification Note 10.2 "Guidance for condition monitoring" for detailed information.

### BENEFITS FOR OWNERS/OPERATORS

- Assessment of the Condition Based Maintenance scheme as implemented.
- Flexibility, Machinery CM is a survey arrangement tailor-made for owners utilising Condition Based Maintenance.
- Avoid opening up selected machinery components and optimise maintenance intervals with class acceptance.
- 3rd party verification of the present machinery status continuously updated.

### Hvorfor Tilstandsbasert vedlikehold?

Primært: Redusere kostnadene i vedlikeholdsprogrammet, gjennom;

- Økt tilgjengelighet – oppetid
- Redusere planlagt nedetid
- Redusere u-planlagt nedetid
  - Unngå havari, og følgeskader
- Redusere reservedelslager
- Mindre vedlikehold / vedlikehold når det er behov.
- Vite tilstanden på maskinparken

By improving reliability

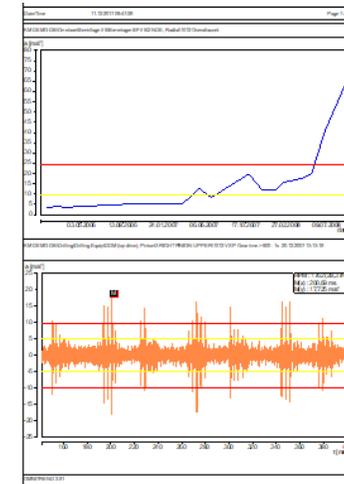


### Oversikt over programmet:

#### Analysis



#### CM Reports & Maintenance recommendations



#### Reliability reports



#### Instrument, sensor & data acquisition

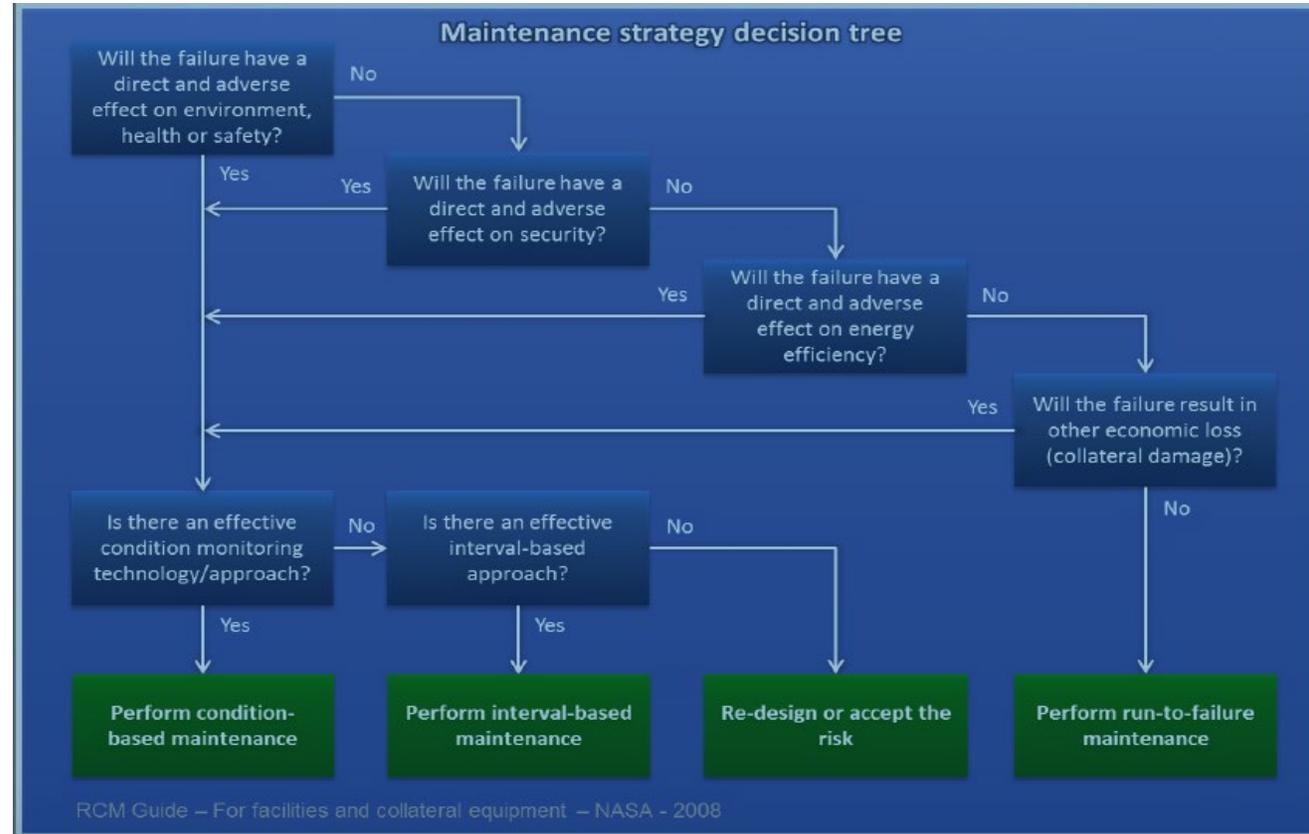
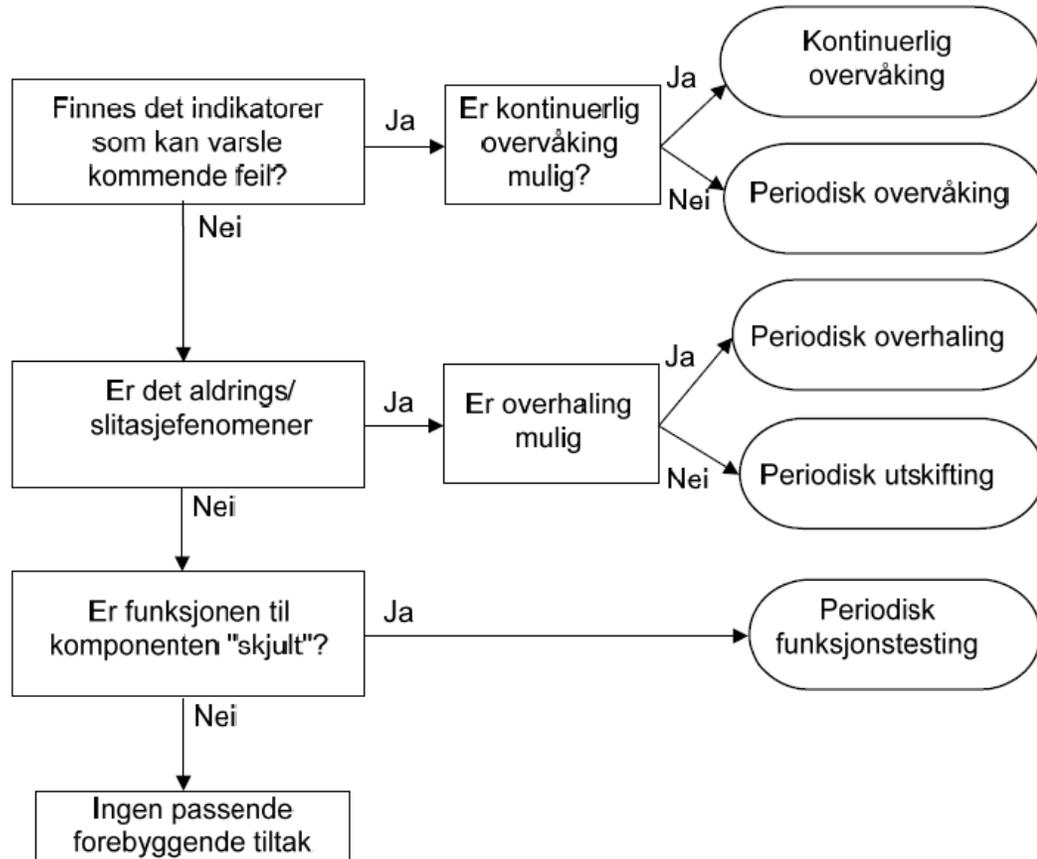


#### Machine types & forcing frequencies



Continues  
improvement

### RCM beslutningslogikk:



### Er det enkelt å håndtere?



## 7.2 PdM som Vedlikeholdskonsept

### ISO 17359 - Condition monitoring and diagnostics of machines — General guidelines

This international standard sets out guidelines for the general procedures to be considered when *setting up a condition monitoring programme* for machines and includes references to associated standards required in this process. This standard is applicable to all machines.

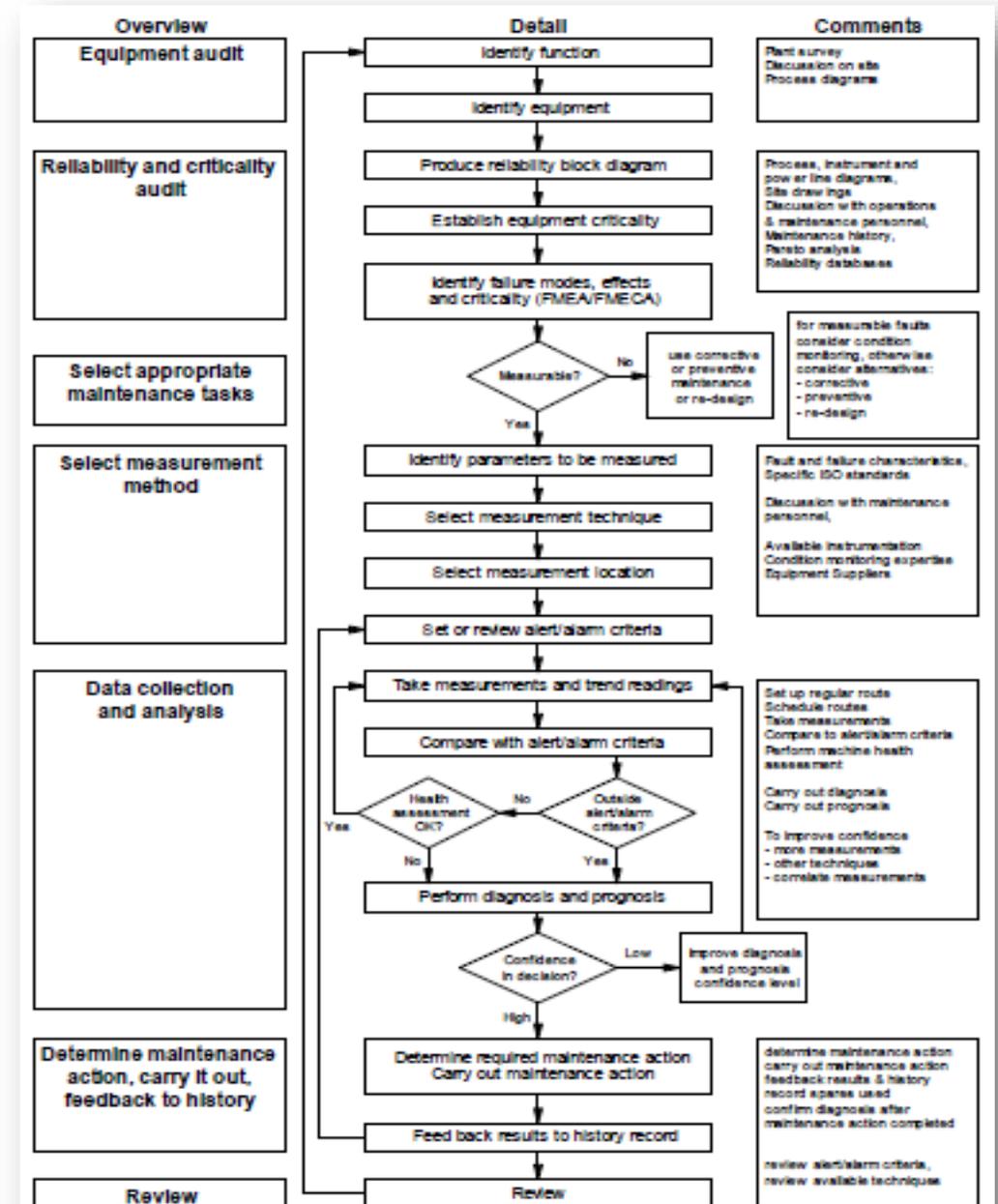
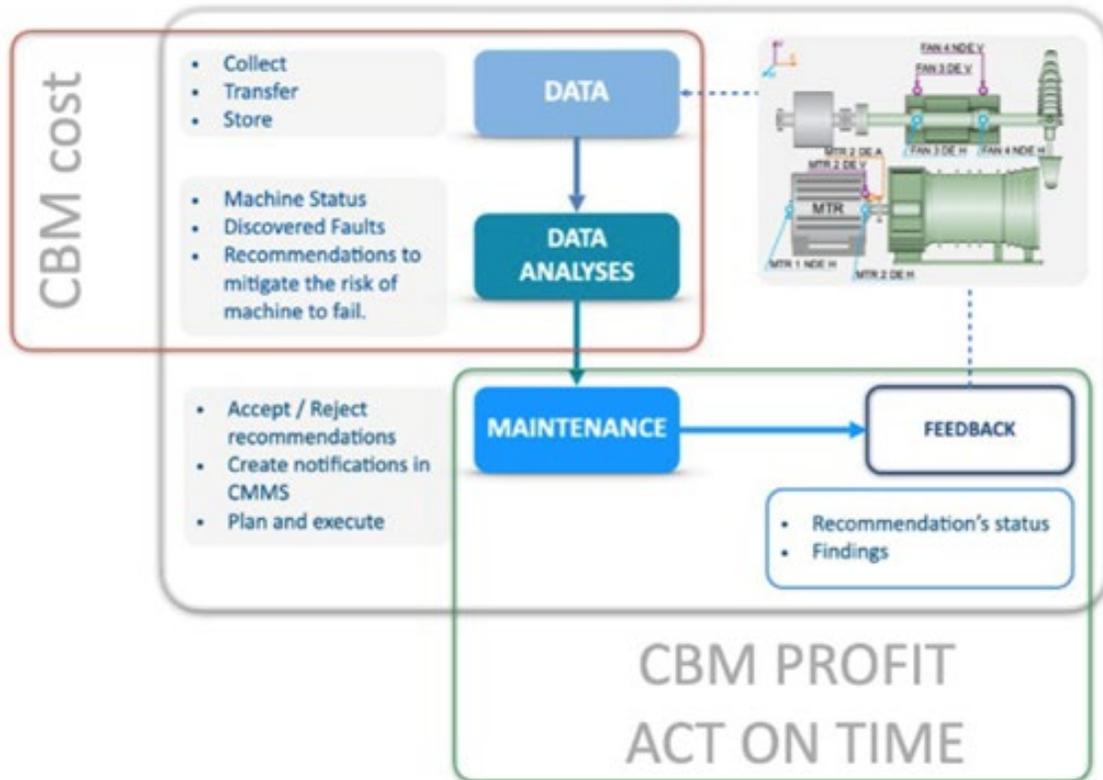


Figure 1 — Condition monitoring procedure flowchart



## Litt om kostnader og besparelser

# The cost CBM Information.



CAPEX of implementing vibration data collection technology in Euro.

	Per CM Point	Per Functional Location (Machine)	For a Site with 50 machines
Smart Data IoT Logger (Data collection from operators)	15	75	3 750
Single channel IoT sensors (WiFi network required)	300	1 500	75 000
Traditional on-line system (8 channel modules)	1 500	7 500	375 000

OPEX of receiving regular information (reports) based on the collected data.

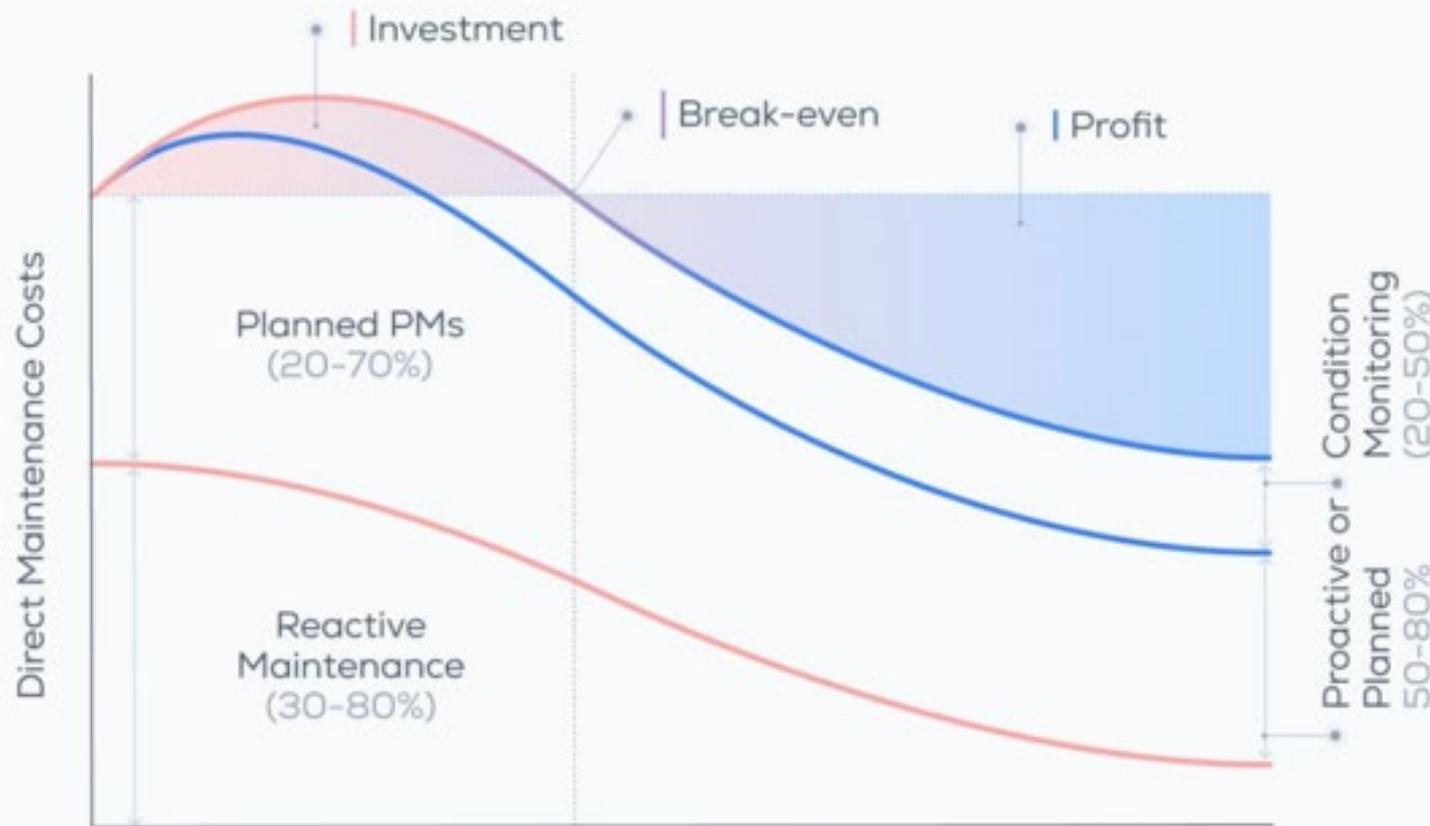
The price range and quality of data analyses are broad. Different business models are available, from analyses per CM Point to analyses per quarter.

## 7.2 PdM som vedlikeholdskonsept

Ny teknologi – innen ultralyd

### Kostnadsbesparelser:

#### Implementation Curve



De færreste utnytter fullt potensiale av PdM.

Store besparelser på å optimalisere vedlikeholdet

Pluss; potensielt enorme besparelser i forhold til å unngå havari og nedetid.

### Minimer nedetid

En X % reduksjon i uplanlagt nedetid er ikke bare et mål; det er en forpliktelse til effektivitet og kostnadsbesparelser.

### Maksimer tilgjengeligheten

Å heve utstyrtilgjengeligheten til Y% sikrer at ressursene dine er klare til å prestere, noe som fører produktiviteten til himmels.

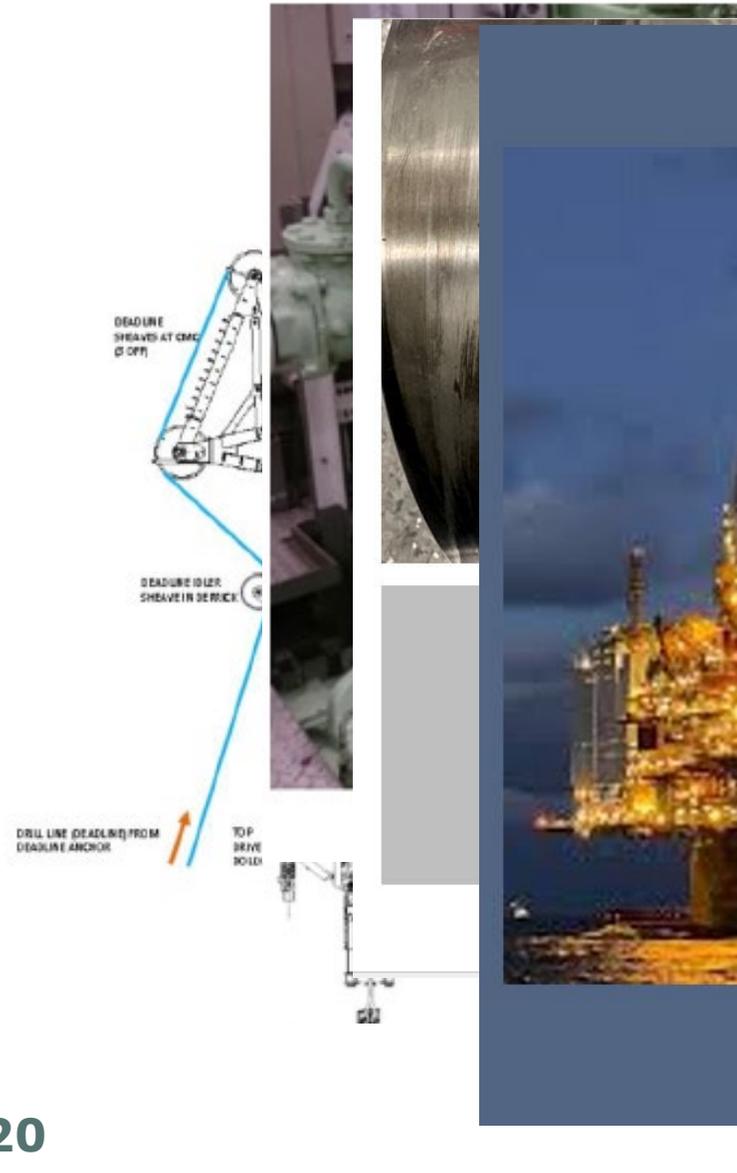
### Kutt vedlikeholdskostnadene

Å kutte vedlikeholdskostnadene med Z % er ikke bare et operasjonelt mål; det bør være et strategisk krav.

## Eksempler på kostnadsbesparelser

## 7.2 PdM som Vedlikeholdskonsept

World Class  
Maintenance



## 7.2 PdM som Vedlikeholdskonsept

**MOWI Rensefisk, Øygarden.**  
Ljesøyvegen, 5337 Rong

**SITE STATUS (Live)**  
Good

**SITE ALARM SCORE (Live)**  
0

**MACHINES**  
Varmepumpe 1  
Varmepumpe 2

**LATEST SITE HEALTH (30 DAYS)**  
0 Critical  
0 Warning  
2 OK  
0 Offline

**SITE OVERVIEW**  
Machines | 2  
Sensors | 2  
Gateways | 1

**TOP ALARMS (WEEKLY)**  
Varmepumpe 1

**Asset Management & Predictive Solutions**

**Frequency Spectrum Graph:** Acceleration - rms (g) vs Frequency (Hz). Peaks are labeled with bearings: B110-01, B110-02, B110-03, B110-04, B110-05, B110-06. A table shows: Freq: 1 156.32, Acceleration: 1.04, Orders: 3.14.

**Time-series Amplitude Graph:** Amplitude (g) vs Time (ms). Shows a significant spike in October 2024.

**Detailed Vibration Signal:** Acceleration (normalised) vs Time (ms). Period: 6.40 ms, Frequency: 9370.17 CPM / 156.17 Hz.

**DE lager, Mowi. Deres analyse var spot-on, som vanlig 🙌**

**Sensoteq Cloud**

## 7.2 PdM som Vedlikeholdskonsept



### Oppsummert:

Tilstandsbasert vedlikehold vil gi en enorm kostnadsbesparelse når det er implementert korrekt og brukes på riktig utstyr.

- Kritikalitet på utstyr
- Kostnad på nytt utstyr / reparasjon (LCC)
- Det skjer mye nytt på markedet for tiden, særlig innen trådløse sensorer og AI-powered analyse.

**Noen eksempler hvor tilstandskontroll ikke nødvendigvis  
reduserer vedlikeholdskostnader**

Hei Tommy,

Viser til hyggelig tlf samtale og sender ved bilder + tegning av gir samt utklipp over vibrasjonsmåling.

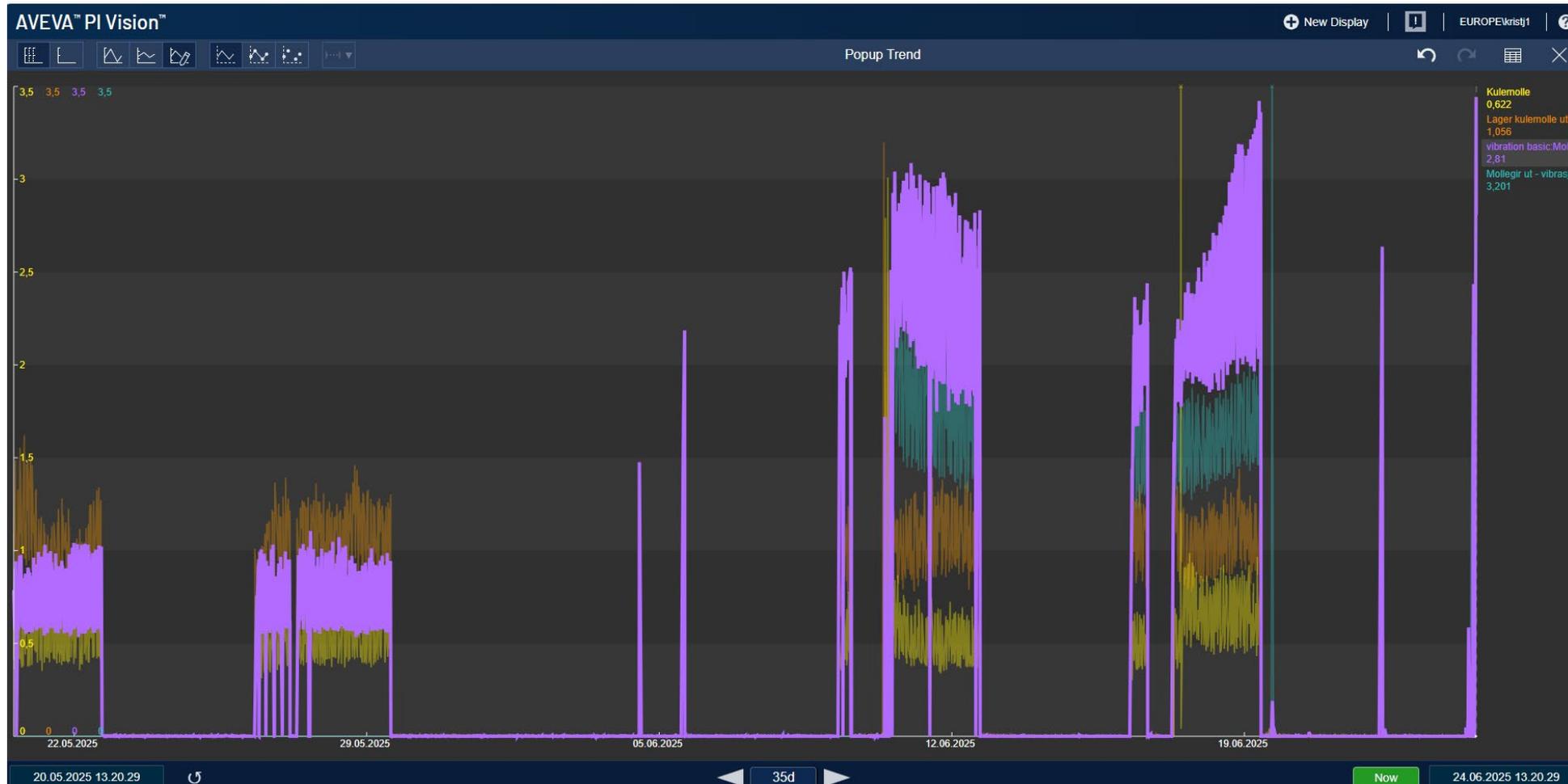
Vi har forsøkt med lagerbytte på gir, men med samme resultat.

Vi må finne feilkilden og rette det opp ASAP. Havari her må ikke skje.

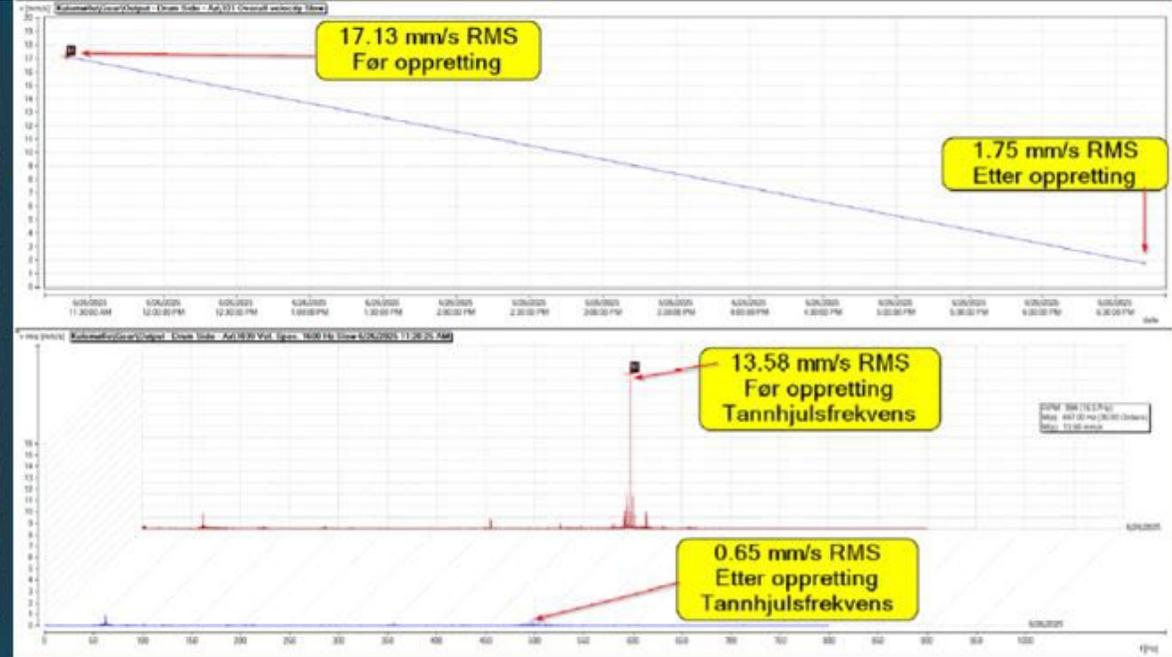
Kan ikke du ringe meg når du har kikket litt på dette?



## 7.2 PdM som Vedlikeholdskonsept



## 7.2 PdM som Vedlikeholdskonsept



AS FOUND:



### 8.1 Kobling imellom gir og mølle



Observert:

Koblingen imellom gir og mølle viser stor slitasje på gummien. Flere viste like stor slitasje som den visualisert på bilde over. Gummiene var også veldig hard, noe som tyder på slitasje.

## Example from Pump in Gas Purification

### Continuous Vibration Measurement with IoT Sensor

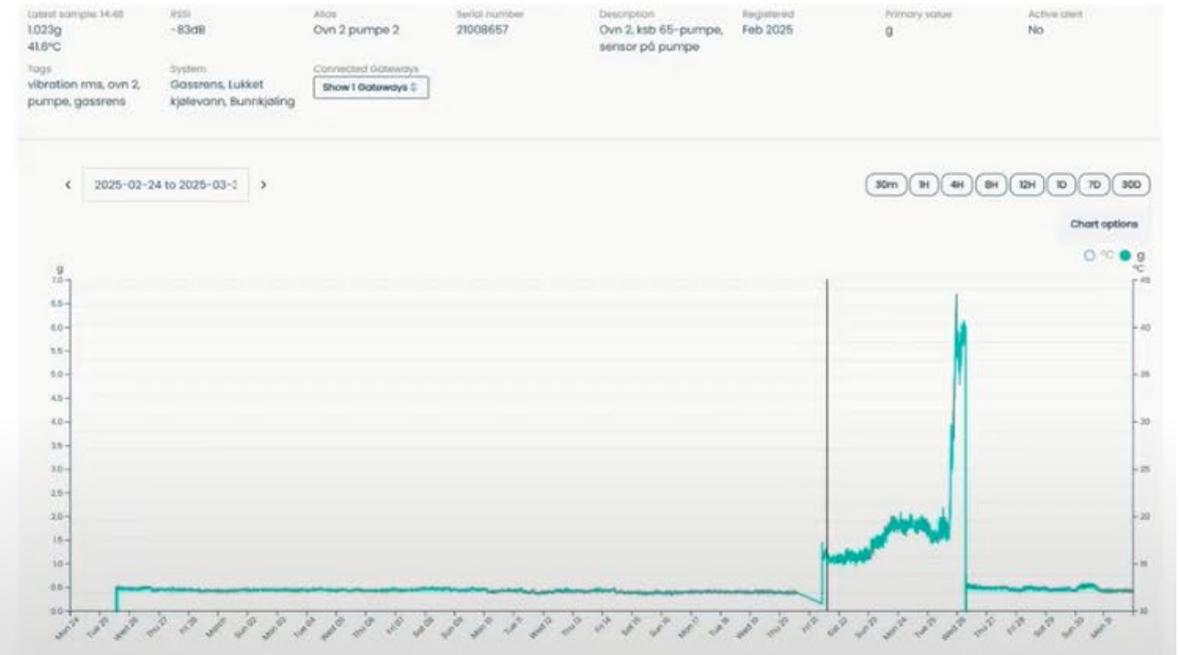
- Same asset and graph, with two more weeks of data
- Rule triggered notification on March 22<sup>nd</sup>
- Investigation done by maintenance team
  - Assumed early detection of failure
  - Checked that spare pump is available
  - Planned for replacement of pump



## Example from Pump in Gas Purification

### Continuous Vibration Measurement with IoT Sensor

- Same asset and graph, with another week of data
- Vibrations continued to increase
- Pump replaced March 26<sup>th</sup>
- Planned maintenance
  - reduced cost of replacing pump
  - lead to no unplanned downtime



**Vibrasjons sensorer med begrenset sample rate har begrenset hvilke feil de kan detektere**

**Det er mange årsaker til økt vibrasjon og støy. Dersom en ikke har mulighet til å stille en diagnose på hvorfor en har økning så vil en gjøre mange feile beslutninger.**

**Argumentet for å bruke «rimelige» sensorer på maskiner som ikke så kostbar og ikke så kritisk, bør vurderes opp mot Run To Failure. (kostnytte)**

**Takk – det avslutter denne presentasjonen.**

---

Spørsmål?