Condition Based Maintenance

An Aker Solutions initiative within Integrity Management services.
Agenda

- Vision
- The challenge
- The alliance
- What is needed to realise CBM
  - Skills
  - Experience
- Solution example
- Support structure and organisation
- Proof of concept example
The vision of the Alliance is to provide a global service, utilising the complementary strengths of our individual companies and combining them into unmatched offerings of systems and services for asset management in the oil and gas industry.
The Challenge
Due to instrumentation and high bandwidth available, new O&G installations offer new opportunities for asset care and maintenance.

7 – 10% reduction per year?

Preventive maintenance

Corrective maintenance

Condition based maintenance

2010 2011 2012

How do you optimise your maintenance programs?
Improvement initiatives of oil & gas companies

Condition based maintenance (CBM)

- Major oil & gas companies worldwide are CBM concepts for critical systems & equipment
  - Remote condition monitoring (CM) of critical systems and equipment
  - Proactive instead of preventive maintenance processes

- The companies typically have been doing this in two steps
  - First facility or field specific CM centres, processes & solutions
  - Then corporate CM centers and common CM processes and solutions

- The leading companies now are planning to take both steps simultaneously
  - To standardize and scale its CM processes and solutions
  - To reduce implementation time and realize economies of scale
  - To use its CM expertise efficiently across facilities
Improvement initiatives of other companies
Significant business benefits

![Improvement potential chart]

- 35% improvement
- 15% improvement

50/50 split CBM & production optimization
- 10% improvement
- 3% improvement

Increased production
Reduced costs

Source: OLF, 2008

---

**Snorre field – rotating equipment**

- Effective operational time: 81 to 95%
- Equipment breakdown avoided
- Value creation 2005: 20 million USD
- Real time data available to everybody – everywhere
- Wide deployment of condition monitoring with onshore engineering support

**StatoilHydro**

**2007**

- Oil: 13,81 Mili. bbl
- Gas: 1129 Mill. Sm³
- 1.35 Bill USD

© 2008 Aker Solutions
Condition Based Maintenance is more than condition monitoring

Look at the total picture

- **People**
  - Attitude and behavior towards CBM
  - Communication – onshore/offshore/disciplines
  - Knowledge Management

- **Process**
  - Integrate onshore and site staff in CBM
  - Clear defined CBM KPI’s
  - Enhance Roles and Responsibility
  - PM review - get rid of unnecessary PMs

- **Technology**
  - CM tools easily gives status of plant and equipment
    - Enterprise network v/ Technical network
  - Many CM/PM tools - integrate
  - Common CBM portal
The Alliance
A partnership to solve an industry challenge
The alliance

**Customers**
- Operational philosophy
- Knowledge transfer

**IBM**
- Decision support/ (Role based portals)
- Information management
- Integration
- People & process

**SKF**
- Condition Monitoring of rotating equipment
- Diagnostics / Remote Center/ decision support
- Maintenance Strategy Review (RAM / RCM)
- Sensors / Wireless / Installation

**Aker Solutions**
- Technical Integrity
- Maintenance strategy and programs (CBM/RBI)
- Inspection static & structures
- Decision support
Capabilities of the alliance - CBM process

- 6. Recommendation decision: Events are registered and managed in accordance with a predefined process and a work order notification issued.
- 5. Condition development analysis: Probability for a failure or breakdown and criticality is evaluated and an event issued.
- 4. Technical condition management: Technical condition indicators (TCIs) are used for monitoring of the condition of equipment across facilities.
- 3. Condition monitoring and inspection: The equipment is monitored and inspected in accordance with strategy and plan.
- 2. Maintenance, monitoring and inspection planning: After selection of methods for monitoring of the condition of the equipment, plans for on- and offline monitoring and inspection of the equipment are developed.
- 1. Maintenance strategy development: RCM and RBI methods are used for development of maintenance strategies.
What is needed to realise the benefits of Condition Based Maintenance?
(and what the Alliance bring to the table)

SKILLS, EXPERIENCE & SOLUTIONS
Skills within the alliance
Multi Discipline skills

Maintenance engineering and management

Strategy development, Maintenance and inspection
Programme development
Criticality assessment, RAM, FMECA, RCM/ RBI RCA
Populate CMMS

Rotating and mechanical

Commissioning of new plant, FAT, Troubleshooting, RCA
CBM Baseline surveys, Knowledge of a wide range
Of CBM systems and techniques.

Static and structural

Inspection management:
Identify inspection strategy by means of RBI
Full range of NDE/NDT inspection methods
of valves, piping, vessels and structures
Multi Discipline skills

Information Systems

CMMS structuring and population for new installations, IT systems and infrastructure architects, Information Management specialists, Data and information security specialists, Asset lifecycle information, Development of web based reporting systems and development and support of various Condition Monitoring software based on clients’ needs.

Organisational Change

Strategy and change management consultants
Develop and implement changes to work processes and people behaviour.
Experience
Experience with Condition, Performance and Health monitoring tools and techniques

- The Alliance has substantial experience within condition surveillance of all types of mechanical and static equipment. Our area of competence covers the entire spectrum of data processing and analyzing.

- The Alliance has worked on highly sophisticated models for decision support for CM and CBM.
  - Event early warning, Residual Lifetime algorithms, 4D visualization

- Joint R&D initiatives:
  - The Statoil TAIL IO R&D project.
  - Involvement in NTNU/SINTEF/IFE IO Centre research programme
Experience – examples of tools/techniques

Within maintenance management

- Maintenance Strategy Review development and planning
- Risk and Reliability Analysis (RBI Analysis, FMECA, RCM/SRCM, RAM)
- Criticality assessment
- Quality assurance and HSE inspections

Within CBM systems and Services (Rotating Equipment)

- Vibration analysis, RCA, Bearing analysis, ultrasonic monitoring
- Thermography, performance monitoring, Flow measurement
- Specialist services
Experience – examples of tools/techniques

Within CBM Systems and Services (Static Equipment)

- All common NDT in-service inspection methods
- Advanced NDT Technologies: e.g. Eddy currant, Phased array, etc.
- Non Intrusive Inspection of Pressure Vessels and Tanks
- Structural Inspection Management Programme

Analysis Tools

- Bently Nevada System 1, ADRE, Datamanager 2000
- Prüftechnik Omnitrend, SKF @ptitude Monitoring Suite
- Olympus TomoView, Eclips ESBeamTool
- AkerSolutions Scale Mapping Thermographic Analysis Tool
Experience – with relevant Information Systems

CMMS

- A large consulting practice working with implementing and supporting information systems associated with Asset Management. All 3 alliance partners have used and are currently users of a number of Computerized Maintenance Management Systems.

Business Intelligence – Data warehouse – Role based Portals

- The Alliance has the necessary toolkits (software and databases) and skills to provide the right information to the right people/systems at the right time.

Integration plant - enterprise

- IBM's Integrated Information Framework (IIF) integrates real-time information across multiple source systems.

- IIF is a key component to enable the overall asset view, to combine Condition Indicators at several levels, and a foundation for new applications and analyses.
Experience – with specialised Information Systems

- Coabis is Aker Solutions’ software product for corrosion management, inspection management and comprehensive integrity management. [http://www.coabis.com/](http://www.coabis.com/)

- Pyramid is the Aker Solutions FMECA, RCM and RBI software tool. Developed over the last six years to assist engineers build optimal maintenance programmes for the Oil & Gas industry.

- Delmia 4D simulation and planning software (Dassault Systéme).

- Documented Solutions Program. DSP allows the client to document savings by the CBM program.

- The Aker Solutions owned First Interactive engineering development software:
  - Xfactor drilling visualisation.
## Track record

<table>
<thead>
<tr>
<th>Company</th>
<th>Client</th>
<th>Project</th>
<th>Year</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Alliance</td>
<td>StatoilHydro</td>
<td>TAIL IO R&amp;D project</td>
<td>2006-2009</td>
<td>Develop leading edge technology within Integrated Operations</td>
</tr>
<tr>
<td>The Alliance</td>
<td>Aker Drilling</td>
<td>CBM Study</td>
<td>2008</td>
<td>CBM implementation</td>
</tr>
<tr>
<td>Aker Solutions/ IBM</td>
<td>ConocoPhillips</td>
<td>Greater Ekofisk area development (GEAD)</td>
<td>2008 -</td>
<td>FEED study, including integrated operations (IO) development</td>
</tr>
<tr>
<td>SKF Norge</td>
<td>BP</td>
<td>Ula, Valhall, Tambour</td>
<td>1993 - Present</td>
<td>CBM Contract</td>
</tr>
<tr>
<td>SKF Norge</td>
<td>Exxon Mobil</td>
<td>North Se Production (NSP)</td>
<td>1999 - Present</td>
<td>Cross border CBM Contract</td>
</tr>
<tr>
<td>SKF Norge</td>
<td>Conoco Phillips</td>
<td>Tor, 2/4X,J,K,H</td>
<td>1997 - Present</td>
<td>Provide systems, Trouble shooting</td>
</tr>
<tr>
<td>Aker Solutions</td>
<td>StatoilHydro</td>
<td>Tampen V&amp;M</td>
<td>1996 -</td>
<td>MMO Frame agreement</td>
</tr>
<tr>
<td>Aker Solutions</td>
<td>StatoilHydro Shell, BP</td>
<td>Various</td>
<td>1998-</td>
<td>Condition Monitoring of Static Equipment using Advanced NDT Technologies</td>
</tr>
<tr>
<td>Aker Solutions</td>
<td>ConocoPhillips</td>
<td>Eldfisk redevelopment study</td>
<td>2006-2009</td>
<td>Lifetime extension – Technical condition and maint. strategy</td>
</tr>
<tr>
<td>IBM</td>
<td>Major footprint in global oil &amp; gas industry, Maximo</td>
<td>200x -</td>
<td>General</td>
<td></td>
</tr>
<tr>
<td>IBM</td>
<td>Major footprint in the Oil &amp; Gas industry</td>
<td>SAP implementations</td>
<td>199x-</td>
<td>General</td>
</tr>
</tbody>
</table>

© 2008 Aker Solutions
Solution Example
Role based web portal for maintenance operations

Typical Desktop

Tag List

Document List

Condition Indicators
SKF, AkerSolutions

Maintenance history
(SAP, STAR, Maximo etc)

Data from
Intergraph, SAP, Inspection

Condition Indicators
WI System
Condition Monitoring and Technical Condition Indicators
Technical condition of static equipment

Example of degradation profile
Technical condition of rotating equipment

- SKF @ptitude Monitoring Suite software provides users with trending, detailed analysis, and reporting and enables plant-wide sharing of information.
CBM – Key Performance Indicator’s (KPI’s)

- Top level:
  - One Plant Overview indicator

- Overview - function:
  - HSE: Accidents / hours without / RUH
  - Production: According to plan / production loss
  - Plant Maintenance: Condition / Regularity / Shutdown / Availability
  - Subsea: Production / Well
  - Transport: Pipes status

- System: Technical condition indicators
  - Indicator per system

- Equipment:
  - Indicator per equipment/equipment group
An integrated view on production and maintenance
Support structure
Support organisation and structure

- A tailored support organisation may be put up according to the clients needs and requirements. We have the capability to build a complete support group with the following properties:
  - Single point of contact.
  - Support organized under ITIL (industry best practise) work processes with
    - 1st line Service Desk
    - 2nd line Problem solving
    - 3rd line Vendor Support
  - 24*7 Availability
  - Integrated at Clients office and/or own support centres
  - Support centres will staffed with maintenance specialists, engineers etc. all according to your needs.

- For systems which we do not have necessary skill level now, we will do training and/or other measures to meet the required service level.

- Through this support centre we will also be able to offer training to Client personnel and contractors
How to get started?
Proof of concept
CBM Pilot

- **Scope:**
  - One group of critical equipment - i.e. Water Injection Pumps

- **Definitions:**
  - Performance and technical indicators aligned with the Maintenance philosophy/strategy

- **Time Period:**
  - Start pilot – be ready to production start.

- **Access to source data:**
  - We need access to data sources; DCS Historian, CMMS, CM, Technical Doc., Instrument Index

- **Pilot infrastructure**
  - Run pilot in IBM Stavanger CoE, access data through SOIL or internet

- **Deliverables:**
  - Portal for presentation of the Use Cases available on Internet or Soil
  - Integration of data sources (available on SOIL/Internet)
  - Calculation and aggregation and condition indicators and measurements
Conceptual sketch

Presentation layer:
- Portal with information levels; Field, Platform, System and Equipment

Business Logic layer:
- Processing of information before presentation i.e. calculation of performance indicators and technical indicators, aggregation, analysis, predictions, trending,

Integration Layer:
- Capture data from all systems

Presentation Layer
Business Logic Layer
Integration Layer

RT measurements, Alarms/Events
Work Orders, Drawings, Data Sheets

DCS
CM
CMMS
Techn. Info
Portal Information Levels

- **Field units/installations**
  Traffic light indication of the aggregated Technical Condition

- **Platform Systems**
  Traffic light indication on each System’s Technical Condition

- **Equipment**
  Detail illustration of equipment with real-time measurements and indicators

- **Instrument**
  All measurements and calculated condition indicators for specific instrument
Example Use Case 1 – Field View

Alfa Field

Beta Field
Example Use Case 2 – System View

Information provided:

- Inspection history and planned
- Maintenance history
- Active Work Orders
- Drawings; ISO, P&ID
- Criticality analysis
- RBI analysis
Example Use Case 3 – Equipment view

Information provided:

- Inspection history and planned
- Maintenance history
- Active Work Orders
- Drawings; ISO, P&ID
- RT Measurements; Speed, amp, press, temp, flow
- Bearing parts number
- Details for the pump-wheel
- Product Data Sheet - KW etc.
- Degradation and failure history
- Criticality analysis
- RBI analysis
Example Use Case 4 - Collaboration

**Functionality:**
- Share work panels
  Onshore – Offshore
- Link to Vendor and upload of info – RT access
- Task follow-up
  - Assign, status, deadline, history
- Notification creation
A partnership to solve an industry challenge