Shell SmartConnect
Improving Reliability and Production in Shell Oil & Gas Facilities

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Brussels, Belgium

Gert Hoefakker
Team Lead Shell SmartConnect
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Reserves: Our use of the term “reserves” in this presentation means SEC proved oil and gas reserves.

Resources: Our use of the term “resources” in this presentation includes quantities of oil and gas not yet classified as SEC proved oil and gas reserves. Resources are consistent with the Society of Petroleum Engineers 2P and 2C definitions.

Organic: Our use of the term Organic includes SEC proved oil and gas reserves excluding changes resulting from acquisitions, divestments and year-average pricing impact.

Resources plays: Our use of the term ‘resources plays’ refers to tight, shale and coal bed methane oil and gas acreage.

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Agenda

- What is SmartConnect?
- Why did Shell develop its own toolkit?
- Levels of “smartness”
- Application on gas turbines
- Future growth
Introduction
Introduction

- Gert Hoefakker, Team lead Shell SmartConnect
- 26 years in Condition & Performance Monitoring
- 17 years with Brüel & Kjær Vibro
- 9 years with Shell
What is SmartConnect
What is SmartConnect

- What it is: An integrated, enterprise-wide surveillance and condition monitoring system

- What it does: Leverages existing data and turns it into actionable information
  Predicts and avoids failures through real-time decision support and getting more performance from existing operations
  Integrates reliability data to forecast future plant performance (for existing assets and future projects)
  Integrates other vendor systems to deliver a single analysis of the data through one web portal
  Uses existing instrumentation, control systems, vibration monitoring hardware, data historians and follows global Shell IT standards

- Where it’s used: Approximately 6000 rotating pieces of equipment covered to date.
  Deployed in Downstream, Upstream, LNG/XTL and piloting on Tanker fleet
  Developments ongoing for non Rotating Equipment
Global presence

Total rotating equipment deployed > 6000
Why did Shell develop its own toolkit?
The need for a new approach

High-technology monitoring systems have been around for years...why do failures still occur?

Traditional systems focus on the damage and are often:

- Overcomplicated and badly embedded in IT infrastructure with poorly understood limitations (Data security and network issues)
- Designed by diagnostic (i.e. vibration) specialists, not facility operators
- Looking for damage, rather than seeking to prevent failure
- Lacking ownership
Remote monitoring & diagnostics target

- Early Detection of Incipient Failure
- Traditional target of Condition Monitoring
- Failure – potentially "catastrophic" or consequential damage

Operating Window
Management of all equipment!

Manage Equipment condition till intervention

Extra Reliability

Minimum Acceptable Condition

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Levels of "smartness"

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
</table>
| Level 0 | No Equipment Information  
Ignorance is Costly! |
| Level 1 | Run Status, % Utilization & Reliability tracking  
Know Your Downtime Dollars! |
| Level 2 | Actual vs. Potential Performance  
Improve Your Performance – Maximize Output! |
| Level 3 | Know The Mechanical Health of Your Equipment  
Optimize Your Maintenance Intervals! |
| Level 4 | Understand Your Equipments Dynamic Behaviour  
Enhanced Mechanical Knowledge! |
| Level 5 | Understand Your Equipment Historic Performance  
Achieve and Sustain Top Quartile Performance! |
## Level 1: Run status

### L1-Run Status

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<th>Service</th>
<th>Uptime %</th>
<th>Hours</th>
<th>Train</th>
<th>Uptime %</th>
<th>Hours</th>
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Level 2: Performance monitoring
Level 3: Health monitoring
Level 4: Diagnostics
Level 5: Statistics and Assessments
Application on gas turbines
Gas turbine performance
Gas turbine performance
Gas turbine OEM interfaces in SmartConnect
Future growth
Wear is not the dominant cause of failure

Equipment does not die: it is killed...

Many failures are caused by operating window violations, operational issues and auxiliaries, including those involving:

- fuel quality
- combustion air quality
- Lubrication
- control mismatches
- off-design operation
- contamination (solids)
- seal failures
- liquid carry-over and fouling
- surge control
- valve problems

Non core Rotating Equipment Engineer issues, requires multi-disciplinary approach to solve
Air cooled heat exchanger
Pressure Vessels
Questions and Answers