Increasing Uptime and Plant Reliability by Deploying Asset Monitoring Solutions

Eloy Gasperin, Technical Leader
MISTRAS Group
Agenda

- Benefits of Monitoring
- Acoustic Emission
  - Transformers
  - Valves
  - Boiler tube leaks
  - Pressure Vessels
  - Stator Vane Cracking
  - High Energy Piping
- Ultrasonic Thickness Monitoring
- Metal Loss Detector
Benefits Of Monitoring

✓ More data available, better idea of condition of the asset
✓ Allows the user to see correlation with operating parameters
✓ Reduces the costs of multiple trips to evaluate the asset
✓ Information provided in real time, early detection of potential problems allows better planning
Acoustic Emission

Shape and characteristics (ranges for specific AE features) vary depending on the mechanism producing the emission.
Asset Monitoring Installations ~1700

1,040 Valves
230 Transformers
- GSU
- Transmission
- Distribution
55 ACTMS
- Combustion Turbines
323 AMS
- Power Boilers
- HRSG
- Feed water heaters
- Recovery Boilers

25 Bridges
8 Pressure Vessels
- Reactors
- Columns
- Separators
4 High Energy Piping

Other applications:
- PIPES – Thickness, corrosion
- Cranes
- Blast Furnace
- Flexible risers
- Above Ground Storage tank
- Generators, motors, HV Cables - NEW

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What Are We Detecting?

**TRANSFORMERS**
- Electrical faults (Partial Discharge and/or Arcing)
- Thermal faults
- Mechanical Faults

**BOILER/HRSG**
- Tube Leaks
- Sootblower effectiveness, stuck sootblowers
- Leaking valves
- Slag/pluggage
- Damaging backpass vibration
- Aspirating and cooling leaks
- SCR horn operation

**COMBUSTION TURBINES**
- Crack growth on stationary blade
- Rubbing
- Clashing
- Foreign object damage

**BRIDGES**
- Wire break in post tensioned concrete and cable structures.
- Strain, rotation, acceleration, displacement. Steel fatigue, crack detection.
- Concrete micro fracture detection.
- Structural health.

**PRESSURE VESSELS**
- Local overstressed areas
- Crack growth and/or corrosion products decohesion

**HIGH ENERGY PIPING**
- Micro and macro cracks

**VALVES**
- Through-valve loss

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DEFECTS:

- ELECTRICAL (Partial Discharge, Arcing)
- THERMAL
- MECHANICAL
Source Location
Acoustic Emission On-Line Monitoring System

Power Transformers
✓ 24/7 Monitoring
✓ Short term or permanent

OLM Webpage
Utility’s Data Center: OPC or MODBUS
Remote Access
http://monitor.transformer.clinic/
Case Study

Case 6 On IEEE STD. C57.127, 2018

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Case Study

Case 6 On IEEE STD. C57.127, 2007
Valves

✔ 5-10% of valves suffer through-valve leakage.
✔ 1-2% of these passing valves are responsible for 75% of total losses.
✔ Real-time on-line valve leak detection and quantification.
✔ Instant response when a valve leaks or sticks.
✔ Enables monitoring of difficult to reach valves.
✔ Can be connected to the plant DCS with a suitable galvanic or zener barrier.
Boiler Tube Leak Monitoring

Acoustic signals are obtained from processes such as formation\growth of cracks, leaks, and variables such as load.
## Sensor Location Layout

<table>
<thead>
<tr>
<th>Sensor</th>
<th>EL</th>
<th>Description</th>
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<tbody>
<tr>
<td>1/2</td>
<td>2</td>
<td>South / North Lower Slope</td>
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<tr>
<td>3/4</td>
<td>3</td>
<td>Front Lower South / North Furnace</td>
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<tr>
<td>5/6</td>
<td>3</td>
<td>Rear Lower South / North Furnace</td>
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<tr>
<td>7/8</td>
<td>5</td>
<td>Front Upper South / North Furnace</td>
</tr>
<tr>
<td>9/10</td>
<td>5</td>
<td>Rear Upper South / North Furnace</td>
</tr>
<tr>
<td>11/12</td>
<td>6</td>
<td>South / North Furnace Nose Arch</td>
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<tr>
<td>13/14</td>
<td>7</td>
<td>Front South / North SH Div. Panels</td>
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<tr>
<td>15/16</td>
<td>7</td>
<td>Lower South / North SH/RH Pend. Platen</td>
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<tr>
<td>17</td>
<td>8</td>
<td>Upper South SH/RH Pend. PL</td>
</tr>
<tr>
<td>18</td>
<td>8</td>
<td>Upper North SH/RH Pend. PL</td>
</tr>
<tr>
<td>19</td>
<td>8</td>
<td>South SH Pend. Spaced Assy.</td>
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<tr>
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<td>8</td>
<td>North SH Pend. Spaced Assy.</td>
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<td>22</td>
<td>7</td>
<td>North Upper Backpass</td>
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<tr>
<td>23</td>
<td>7</td>
<td>South Horiz. RH/Lower Backpass</td>
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<td>7</td>
<td>North Horiz. RH/Lower Backpass</td>
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<td>25</td>
<td>7</td>
<td>South Eco. /Lower Backpass</td>
</tr>
<tr>
<td>26</td>
<td>7</td>
<td>North Eco. /Lower Backpass</td>
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<tr>
<td>27</td>
<td>9</td>
<td>South Penthouse</td>
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<td>28</td>
<td>9</td>
<td>North Penthouse</td>
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<td>31</td>
<td>Deck</td>
<td>FW Heater #1</td>
</tr>
<tr>
<td>32</td>
<td>Deck</td>
<td>FW Heater #2</td>
</tr>
</tbody>
</table>

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Finishing Superheat Leak

1st step increase when leak begins
2nd step increase
3rd step as leak grows and secondary damage occurs
4th step increase
Offline
Normal after start-up

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Finishing Superheat Leak

DMW crack causing secondary damage
Pressure Vessels

- Safety
- Reliability
- Longevity
- Economics
- Compliance

The Procedure:
- Techniques for Sensing
- Techniques for Analyzing
- Guidelines to Determine Nature, Severity and Location of Structural Defects
- Criteria to use as a Basis for Assessing Structural Integrity
- Guidelines for Loading (depending on vessel type and history)

Significance
AE can detect defects and damage through a variety of failure modes
Pressure Vessel Data Interpretation

Intensity Analysis

- Expanded Data Base
- Signature Analysis
- Source Correlation
- Individual Channel Evaluation
Pressure Vessels

Crack Locations

Sensor Positions

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Online Detection of Stator Vane Cracking Using AE

GE F-Class Gas Turbine

✓ Compressor Stator vanes
✓ Alternate with Rotor blades
✓ Largest in the front
✓ Numbered from 0 through 17
  ✓ i.e. S0, S3
Stator Vane Cracking Using AE

Turbine B crack cluster location

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High-Energy Piping (HEP)

- Creep
- Fatigue
- Thermal fatigue
- Creep-fatigue
- Microstructural instability
- Flow-accelerated corrosion

**AE is the best possible technology to:**

- Detect signals as micro and macro cracking occur
- Easily deployed for continuous monitoring
High-Energy Piping (HEP)

- All channels receive data all the time
- Less likely to lose sudden crack jumps
- It requires higher count of channels in the system
Ultrasonic Thickness Monitoring

- Very good accuracy of readings
- Not necessary to have personnel access
- Can be used at High Temperature (up to 550 °C)
- Identify corrosion issues at an early stage
- Improved corrosion management

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# Ultrasonic Thickness Monitoring

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>KEY FEATURES</th>
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<tbody>
<tr>
<td>Non-intrusive design and installation</td>
<td>Single Channel Pulser and Receiver</td>
</tr>
<tr>
<td>Highly precise readings</td>
<td>Four Channel Multiplexer for 4 Single or Dual Crystal Transducers</td>
</tr>
<tr>
<td>High temperature functionality</td>
<td>Receiver: 20 - 70 dB Gain, 1 MHz - 8 MHz Bandwidth</td>
</tr>
<tr>
<td>Self-organizing and self-healing network</td>
<td>Pulser: Square Wave</td>
</tr>
<tr>
<td>Increased reading intervals</td>
<td>Smart Sensor Network Wireless Communication</td>
</tr>
<tr>
<td>Improved corrosion management &amp; detection equipment</td>
<td>Ultra Low Power - 5 year Battery Life</td>
</tr>
<tr>
<td>Reduced installation costs (no welding or wires required)</td>
<td>Intrinsically Safe Certified</td>
</tr>
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</table>
Ultrasonic Thickness Monitoring

Transducers

- Dual crystal transducer
- Operating temperature up to 150 °C
- Thickness measurement range between 0.1” to 2.5”
- Gel or glue coupling

- Single element transducer
- Built-in thermocouple for temperature compensation
- Operating temperature up to 350 °C
- Thickness measurement range between 0.1” to 0.9”
- Dry coupling (metal foil)
Ultrasonic Thickness Monitoring

Web Application Management Portal (WAMP)
Metal Loss Detector (MLD)

- A novel type of sensor for monitoring and measuring on-line corrosion in process piping and vessels with high sensitivity
- System connects to existing or new WirelessHART networks.
- Measurements are made available for analysis through the monitoring host software suite
- Provides continuous automated monitoring of piping in corrosive environments and early detection of unexpected corrosion rates
- Allows rapid evaluation of risk while piping systems remain online
Metal Loss Detector

- Based on Tuning Fork Principle
- Two probes are required, a reference probe and a measurement probe.
- Probes compensate for temperature, flow, and pressure variations, so measurements are not affected by non-corrosion environmental conditions
- High Temperature – up to 450° C.
- High Pressure Operation
- Long Life – 6 years at corrosion rate of 10 mpy
- High Resolution – 0.3 mil
- Usable in conductive and non-conductive environments
- Almost 6 years of in-service experience & data
Metal Loss Detector (MLD)

Basic Configuration

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Metal Loss Detector

Trending of Corrosion Rates

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Summary

Multiple applications have been developed in collaboration with asset owners, in order to:

- Ensure safe operation of assets
- Determine the condition of the asset at the time of evaluation
- Extend inspection intervals
- Identify necessity and level of inspection follow up
THANK YOU

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