ICorr Aberdeen Branch Welcomes

Chris Burke, BEng (Hons), MIET
Emerson Corrosion Monitoring Solutions

**EVALUATE RISK**

- **Intrusive**
  - Electrochemical (LPR, Galvanic)
  - Electrical resistance (ER)
  - Acoustic
  - Corrosivity
  - Corrosivity or erosion through metal loss
  - Solids detection

**Non- intrusive**

- Ultrasonic (UT)
- Field Signature Method (FSM)
- Wall thickness
- Actual metal loss, wall thickness

**MEASURE IMPACT**

- High sensitivity, quick response
- Wall thickness, area coverage

Corrosion Awareness Day 2018
>20,000 sensors in >180 facilities in >30 countries
>18 million wall thickness measurements delivered to desk, >170 million operating hours
Chris Burke
Upstream Sales Manager

- BEng (Hons) Electronic & Communication Engineering – Robert Gordon University
- Member of the Institute of Engineering and Technology
- 20+ years experience in the Oil and Gas Industry
- 15+ years Asset Integrity Experience:
  - Support Engineer - Roxar
  - Corrosion & Erosion Monitoring Engineer - ConocoPhillips
  - Senior Engineer – Oceaneering
  - Senior Project Engineer – SMS
  - Consultant – Sandman Engineering
  - Sales Manager - Permasense
PERMASENSE EQUIPMENT DEMONSTRATION

- PERMASENSE TECHNOLOGY
- DATA ACCURACY AND REPEATABILITY
- CHALLENGES FACING ULTRASONICS
- DATA TO DESK: DATAMANGER
- QUESTIONS
Permasense History

- **2005**: High temperature – waveguide / sensor technology prototype
- **2006-08**: Proving out of monitoring technology in BP Refineries
- **2011**: Exclusive agreement with BP finishes
- **2012**: Reference installations with all major oil companies
- **2013**: Reference applications across the oil and gas sector
- **2016**: Acquisition into Emerson

Imperial College of Science, Technology and Medicine
WT Technology - Unique High Temperature Capability

- Based on established ultrasound technology
  - Unique waveguide transducer
  - Permanent installation
- Install anywhere
  - Temperatures up to 600 C (1100°F), e.g. refinery crude unit pipework
  - Temperatures down to -180 C (-292°F), e.g. LNG plants
  - Intrinsically safe (Class1 Div1)
- Data to Desk
  - WirelessHART
  - 7-9 year battery life
  - Remotely adjustable data acquisition rate
  - Automated temperature and material compensation
  - Unique and patented processing to eliminate internal surface roughness effects and detect onset of corrosion activity
ET Technology – Magnetic Mountis, Measure Through Coatings

EMAT excites ultrasound directly in the metal sample – direct contact is not required.

External protective coating left in place.

Pipe wall.

1st backwall reflection
2nd backwall reflection
Subsequent backwall reflections

Time used for thickness measurement.

Magnetic mounting with secondary security strap.

Corrosion Awareness Day 2018
EMAT based sensor specifications

- Very low power
- Very simple, strong magnetic attachment
- Easy-fix retention strap
- 120°C/250°F maximum wall temperature
- Automated temperature and material compensation
- Advanced proprietary signal processing
Sensor for *Any* Location, Operating at *Any* Temperature

<table>
<thead>
<tr>
<th></th>
<th>Temperature range</th>
<th>Measurement technique</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Up to 120°C (248°F)</td>
<td>Ultrasound - EMAT</td>
</tr>
<tr>
<td></td>
<td>Up to 300°C (572°F)</td>
<td>Ultrasound - Waveguide</td>
</tr>
<tr>
<td></td>
<td>Up to 600°C (1100°F)</td>
<td></td>
</tr>
<tr>
<td>Sharing WirelessHART infrastructure - All data viewed in Data Manager, at desk</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
System Overview – Real Time Data to Desk

- **Measurement**
  - Permasense sensor

- **Communication**
  - Up to 100 sensors per gateway
  - Example location: Control room

- **Analytics**
  - Data viewer software
  - User’s office
  - Server with database
  - Remote access for Permasense support

**Easily installed, on-line. Typical size system installed in 3-4 days.**
Best Quality and Frequency of Thickness Measurements

- **Fast response to corrosion and/or erosion**
  - Excellent measurement repeatability affords detection and measurement of \( \approx 10 \) microns of metal wall loss
  - Regular data delivery (e.g. every 12 hours) allows detection of corrosion or erosion events within days

![Graph showing wall thickness change over time](image)
Significant Enhancement Over Traditional Manual Inspection

- **Permasense**: measurements every 12 hours within +/- 10 microns variation; catch onset of corrosion events within days
- **Manual UT inspection**: years between measurements with +/- 0.5-1.0 mm variation; corrosion rate calculation not possible, corrosion events missed
Turnaround Planning
Temperature Compensation Simplifies Data Interpretation

Uncompensated data

Temperature compensated data – easier to understand and interpret

Metal temperature measurements
Dealing With Internal Surface Roughness or Pitting

Permasense is unique in solving this challenge.

Roughness scattering affects all ultrasound-based thickness measurements.
Unique Advanced Signal Processing

- **Adaptive Cross Correlation, AXC**
  - Correlation where signal matches previous backwall signal most closely
  - Roughness scattering effect is overcome
- **Permasense Shape Indicator, PSI**
  - Correlation to previous backwall signal introduces backwall reflection and morphology change indicator
  - Early warning of the onset of localised corrosion / pitting

[Graph showing PSi scale with Total sulphur content (wt. %) over time from January to October.]

[Graph showing Adaptive Cross Correlation, AXC with data points for 0.2 mm/y (7 mpy) and 0.5 mm/y (22 mpy).]
Arrays of Sensors for Localised Corrosion

- No. of sensors required decreases as % of area monitored exhibiting corrosion activity increases
- Choose area monitored to maximise % showing activity

Examples of localised corrosion attack

Example: 25% of area experiences corrosion attack. 10 sensors give 95% confidence of detection
Data Manager: Data Visualisation and Analytics

### Classification for each address

<table>
<thead>
<tr>
<th>Address</th>
<th>3 Months</th>
<th>Diagnostic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demo Refinery (excluding Repeaters address)</td>
<td>[\text{classification data}]</td>
<td>[\text{diagnostic data}]</td>
</tr>
<tr>
<td>VBU</td>
<td>[\text{classification data}]</td>
<td>[\text{diagnostic data}]</td>
</tr>
<tr>
<td>CDU</td>
<td>[\text{classification data}]</td>
<td>[\text{diagnostic data}]</td>
</tr>
<tr>
<td>HVU</td>
<td>[\text{classification data}]</td>
<td>[\text{diagnostic data}]</td>
</tr>
<tr>
<td>CDU 2</td>
<td>[\text{classification data}]</td>
<td>[\text{diagnostic data}]</td>
</tr>
<tr>
<td>HVU 2</td>
<td>[\text{classification data}]</td>
<td>[\text{diagnostic data}]</td>
</tr>
</tbody>
</table>

Click here to see all 26 test points exhibiting *linear* wall loss.
Click here to see all 15 test points at this address.

User defined address structure

Click here to see all 52 location graphs at this address.
## Data Manager: Data Visualisation and Analytics

### User defined test point ID and name

### Classification of activity at each test point

### Click here to view graph of measurements

### #22 Crude Heater (F-2) Desalted Crude Outlet Test Points

#### Status Summary

<table>
<thead>
<tr>
<th>Address</th>
<th>Analysis Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>REFINERY &gt; #2 CRUDE &gt; #22 CRUDE HEATER (F-2) DESALTED CRUDE OUTLET</td>
<td>Logged in as: administrator</td>
</tr>
</tbody>
</table>

#### Number of Test Points: 8

<table>
<thead>
<tr>
<th>Rec.</th>
<th>Unique ID</th>
<th>Name</th>
<th>MAC Address</th>
<th>Remaining Thickness (mm)</th>
<th>Last (mm)</th>
<th>Rate through all data (mm/yr)</th>
<th>Classification</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>32AT9501C</td>
<td>3900</td>
<td>10057217C</td>
<td>4.67</td>
<td>7.62</td>
<td>0.00 ±0.00</td>
<td><strong>Green</strong></td>
<td><img src="icon1" alt="Actions" /></td>
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<tr>
<td>2</td>
<td>32AT9501H</td>
<td>3895</td>
<td>10057217H</td>
<td>3.65</td>
<td>5.60</td>
<td>0.02 ±0.00</td>
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<tr>
<td>3</td>
<td>32AT9501E</td>
<td>388C</td>
<td>10057217E</td>
<td>4.29</td>
<td>7.29</td>
<td>0.04 ±0.00</td>
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<tr>
<td>4</td>
<td>32AT9501D</td>
<td>3800</td>
<td>10057217D</td>
<td>3.96</td>
<td>5.95</td>
<td>0.04 ±0.00</td>
<td><strong>Blue</strong></td>
<td><img src="icon4" alt="Actions" /></td>
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<tr>
<td>5</td>
<td>32AT9501F</td>
<td>382A</td>
<td>10057217F</td>
<td>3.17</td>
<td>7.18</td>
<td>0.04 ±0.00</td>
<td><strong>Blue</strong></td>
<td><img src="icon5" alt="Actions" /></td>
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<tr>
<td>6</td>
<td>32AT9501G</td>
<td>3799</td>
<td>10057217G</td>
<td>2.16</td>
<td>5.10</td>
<td>0.01 ±0.00</td>
<td><strong>Red</strong></td>
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<tr>
<td>7</td>
<td>32AT9501A</td>
<td>3796</td>
<td>10057217A</td>
<td>3.74</td>
<td>6.73</td>
<td>0.03 ±0.00</td>
<td><strong>Green</strong></td>
<td><img src="icon7" alt="Actions" /></td>
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<tr>
<td>8</td>
<td>32AT9501B</td>
<td>377F</td>
<td>10057217B</td>
<td>7.86</td>
<td>5.50</td>
<td>0.05 ±0.01</td>
<td><strong>Green</strong></td>
<td><img src="icon8" alt="Actions" /></td>
</tr>
</tbody>
</table>

#### Data recently received

#### Remaining wall thickness to retirement

#### Rate calculated with confidence bound

**NB:** Users can switch between Metric and Imperial units.
Data Manager: Data Visualisation and Analytics

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Data Manager: Data Visualisation and Analytics

Local high corrosion rates detected by multiple sensors at the same address

Local high corrosion rate detected by a single sensor at a particular address

Little to no corrosion detected by sensors at this address

Corrosion activity spikes after shutdown

Constantly high corrosion rates detected across multiple sensors at the same address (Naphtha/Reflux)

Unique to Permasense technology
THANK YOU FOR YOUR ATTENTION
ANY QUESTIONS?