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Permasense Non-Intrusive Corrosion Monitoring Solutions

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Why Monitor for Corrosion or Erosion?

- Corrosion and erosion happens
 - Well understood/measured: corrosion/erosion causes and mitigation
 - Process conditions
 - Fluid constituents
 - Abrasive solids
 - Corrosion inhibitors
 - Metallurgy
 - Not well understood: impact on the asset integrity
 - Rate of damage to asset
 - Variability of rate of damage from above factors
 - Leading to
 - **Conservative operations – poor profitability**
 - **Unplanned outages, and/or loss of containment**

Process Industry Challenges

Managing Safety, Integrity and Risk in a Tight Margin Environment

- Higher feedstock quality variability
- Higher plant availability requirements
- Longer runs between maintenance shutdowns
- Tighter Health, Safety and Environmental regulations
- Tighter CAPEX budgets
- Shortage of experienced inspectors



With Permasense data

**Increased safety
Increased reliability
Increased availability
Increased margin \$**

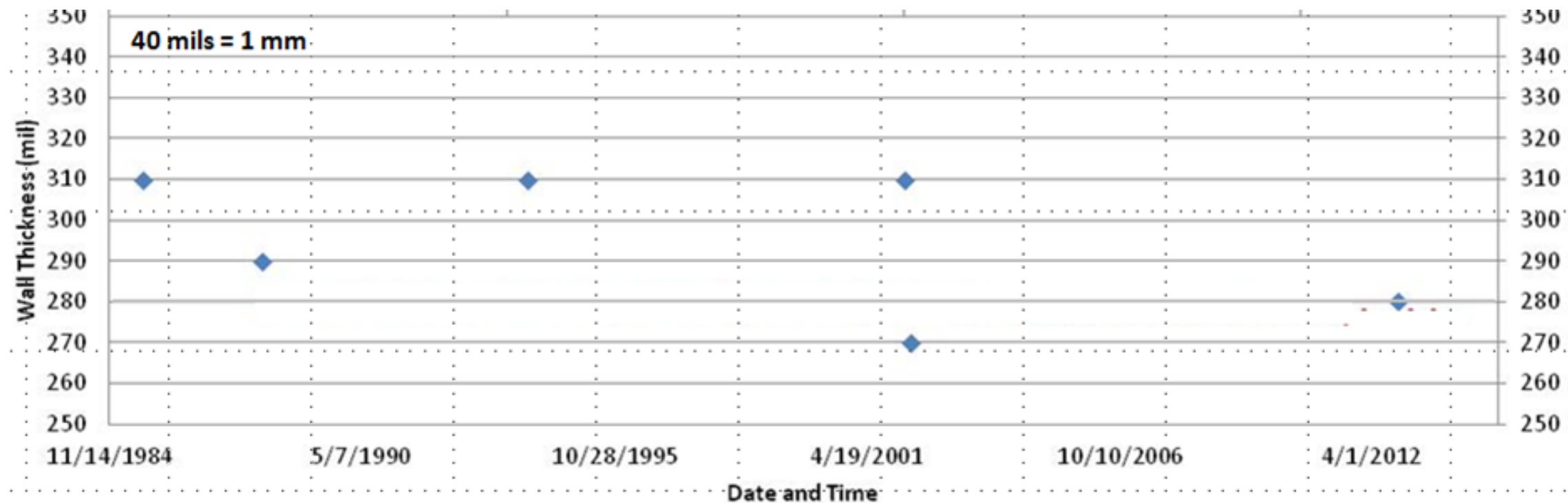
Without Permasense data

Leaks/ loss of containment

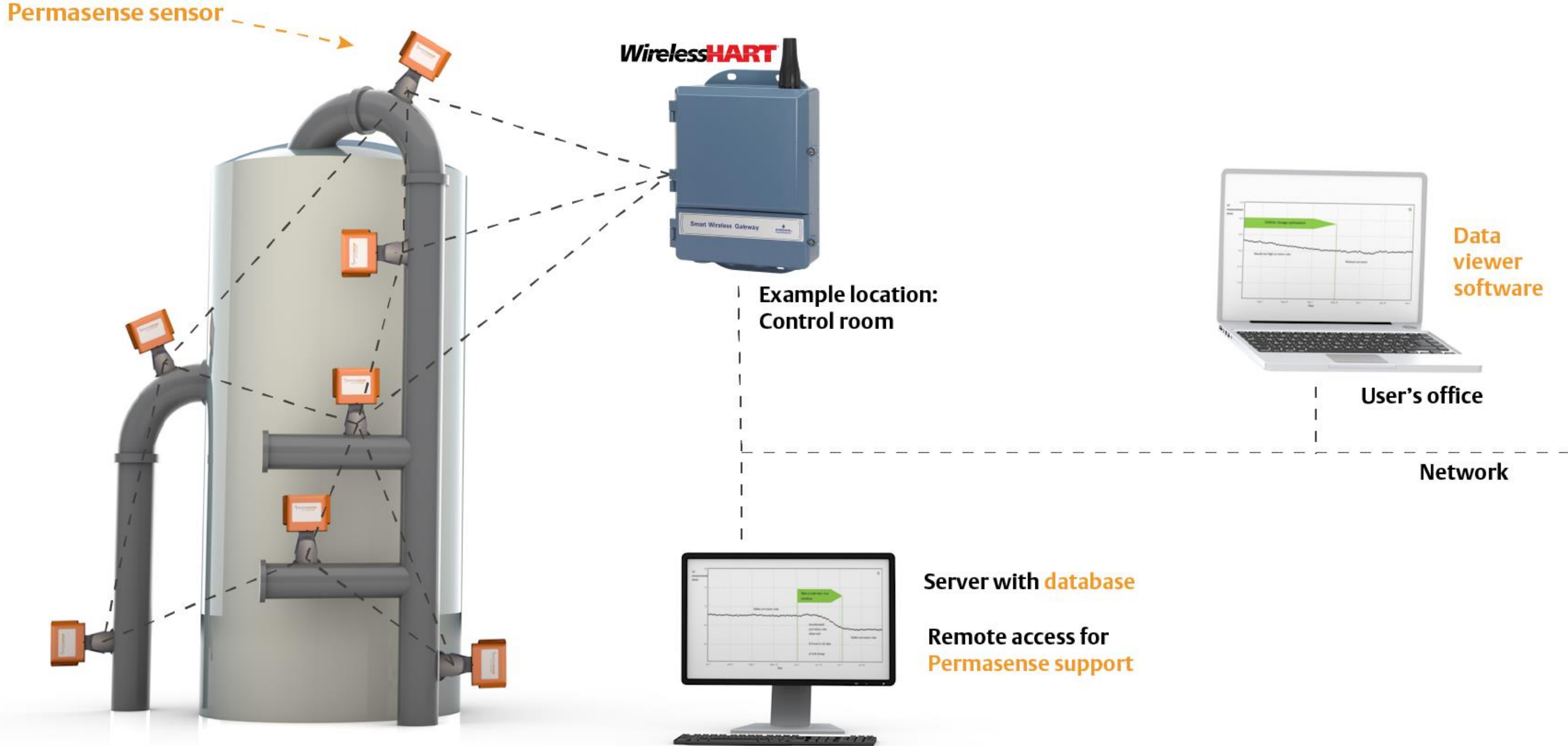
Overly conservative operations – poor profitability

Traditional Corrosion Monitoring Approaches and Limitations

- Intrusive (ER probes)
 - Fast response (if real time data delivery – cabled or wireless)
 - Maintenance headaches
 - Indirect measurement
 - Locations fixed at build
- Manual UT inspection
 - Good snapshot of current equipment integrity
 - Very infrequent and poor repeatability, safety issues at high-temperatures
 - Normal UT measurements get confused by internal roughness

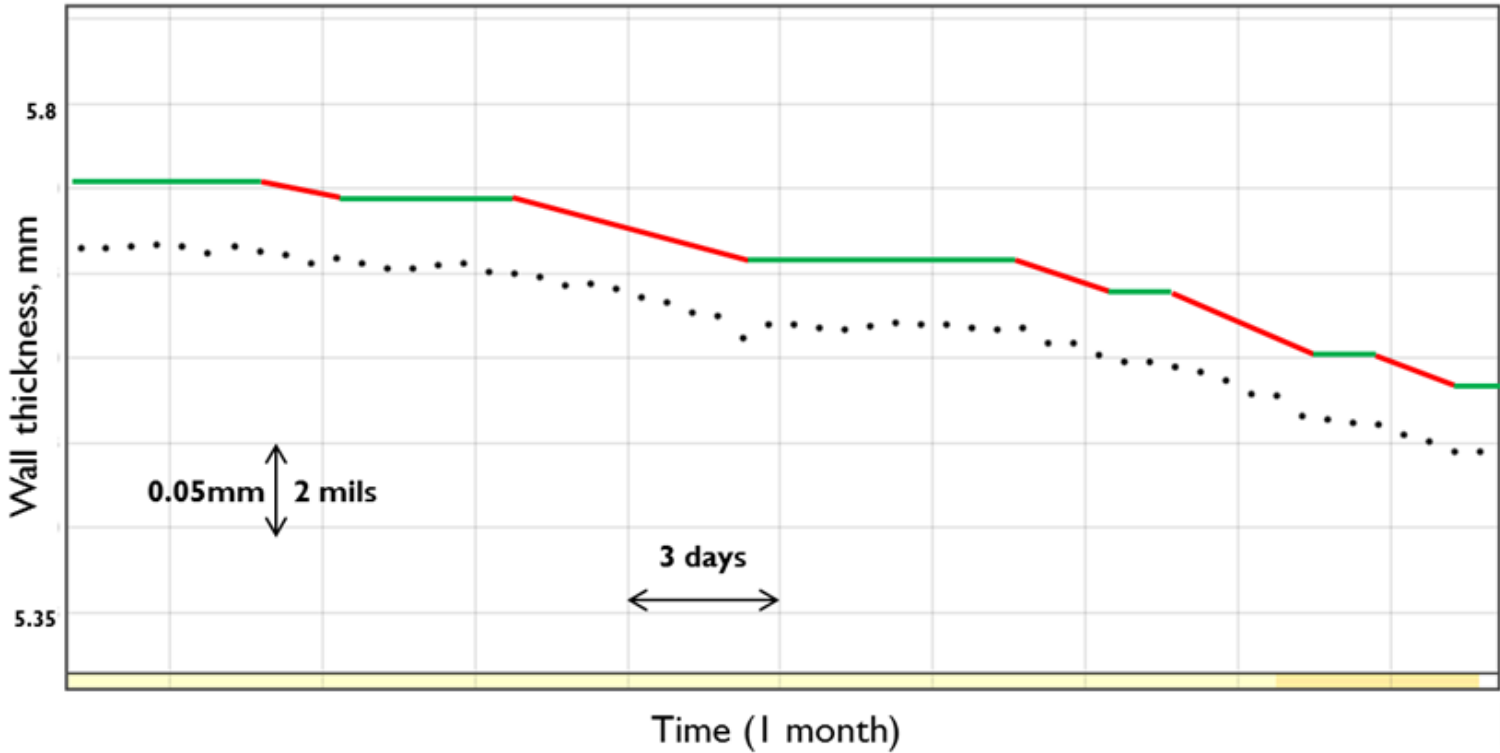


Fixed Non-Intrusive Sensors Deliver Continuous Wall Thickness Measurements of the Highest Quality Directly to Desk



Providing an Unparalleled *Quality* and *Frequency* of Data: Real Time Insight Into Asset Integrity, at Desk

Measure just
10s microns of
wall loss, as
the loss occurs
(<1 mil)



Non-intrusive ET210 Sensors Measure Through Coating – No Need to Remove External Protective Coatings

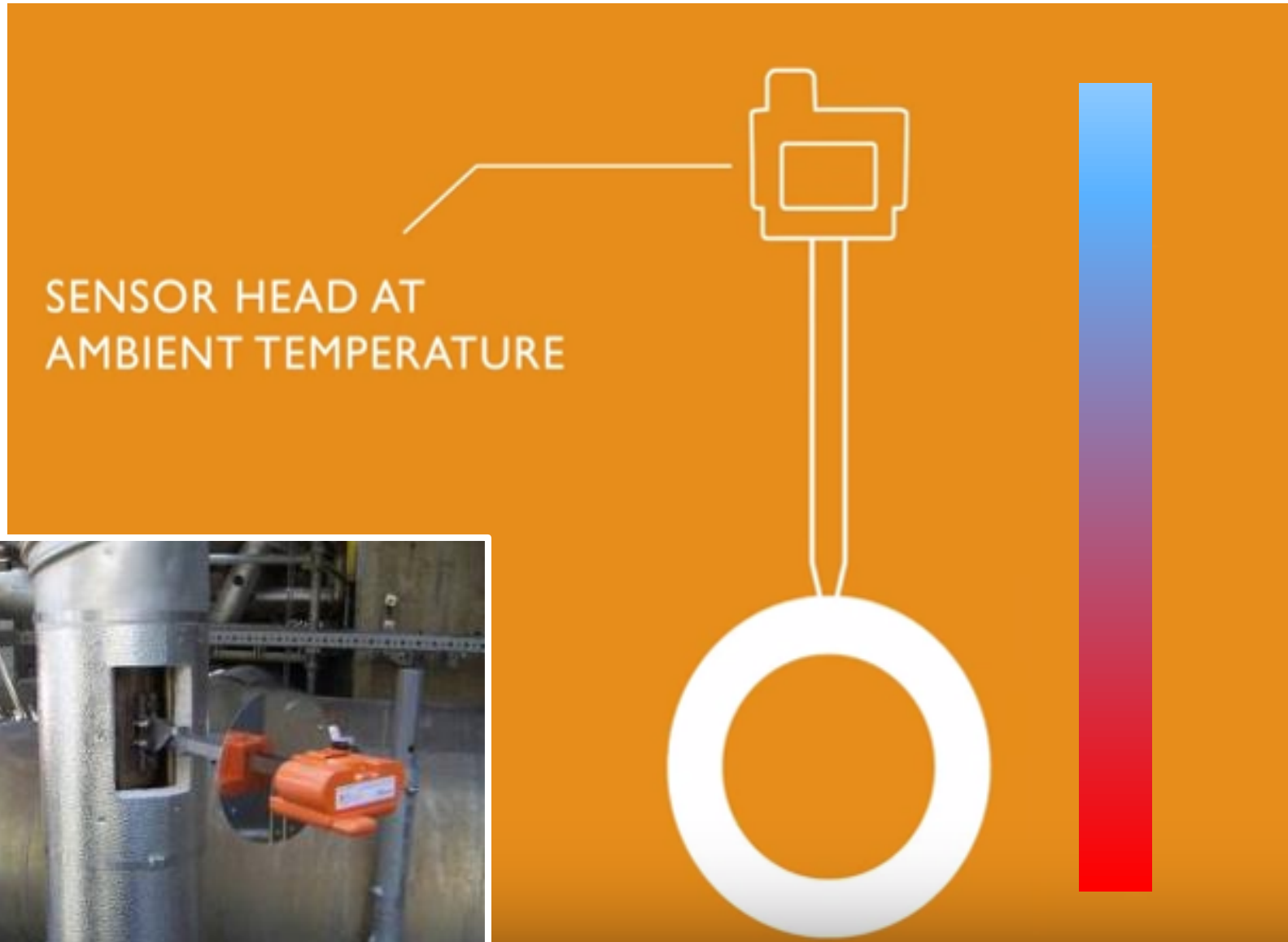


Ideal for low temperature units and CDU OVHDs

Magnetic mount, with plastic securing strap

Pipe operating up to 250 °F

Non-intrusive WT210 Sensor Design Enables Permanent Installation on the Hottest of Equipment (up to 1100 deg. F)

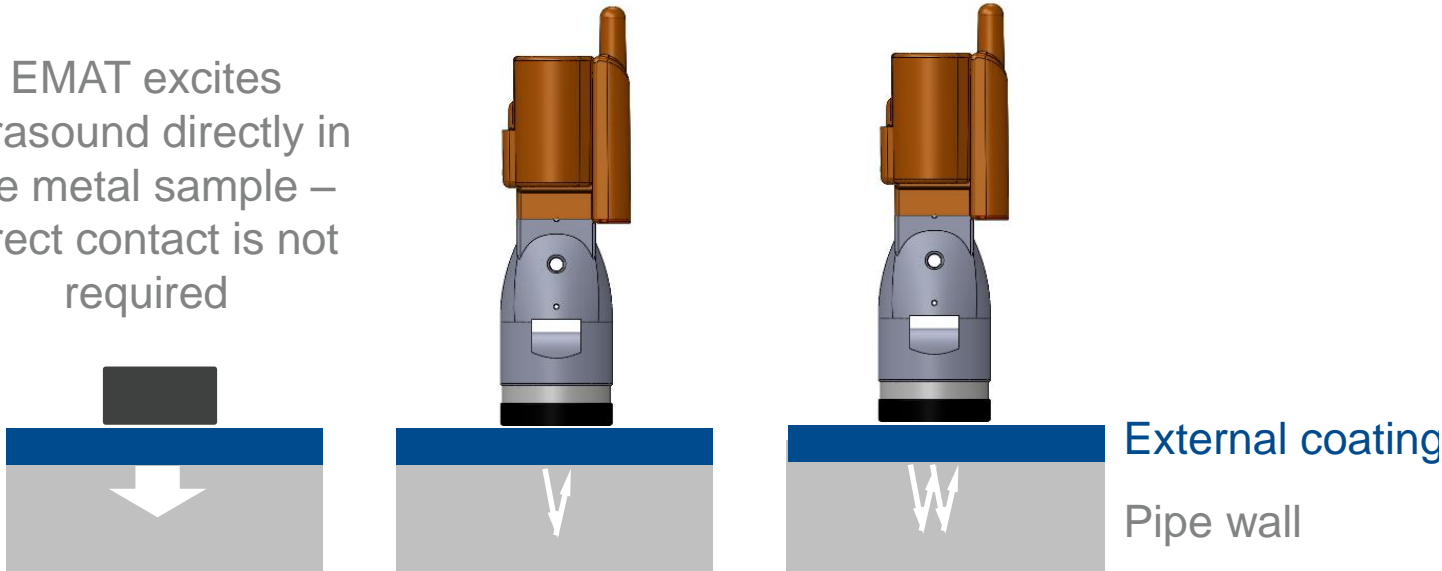


Ideal for refineries: CDU and VDU bottoms

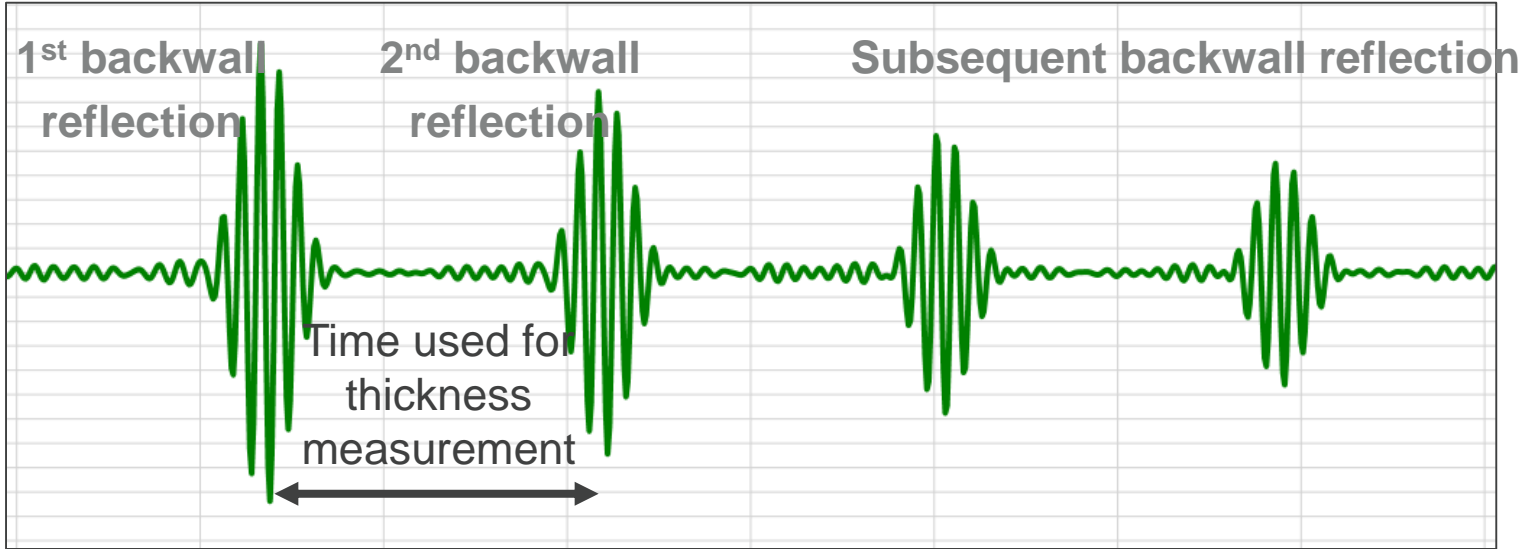


Sensors use proven ultrasonic principles. Permanent attachment improves measurement quality over manual inspection

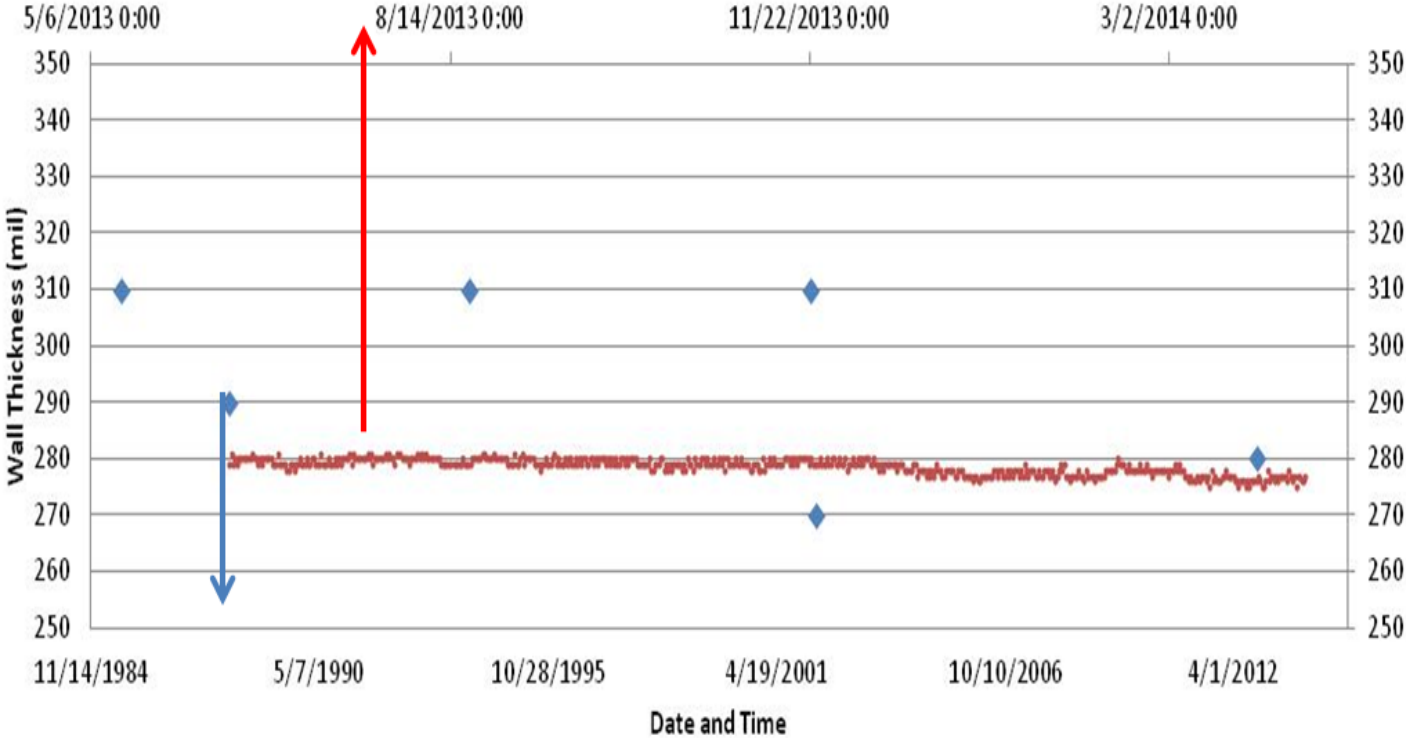
EMAT excites ultrasound directly in the metal sample – direct contact is not required



Recorded ET sensor waveform

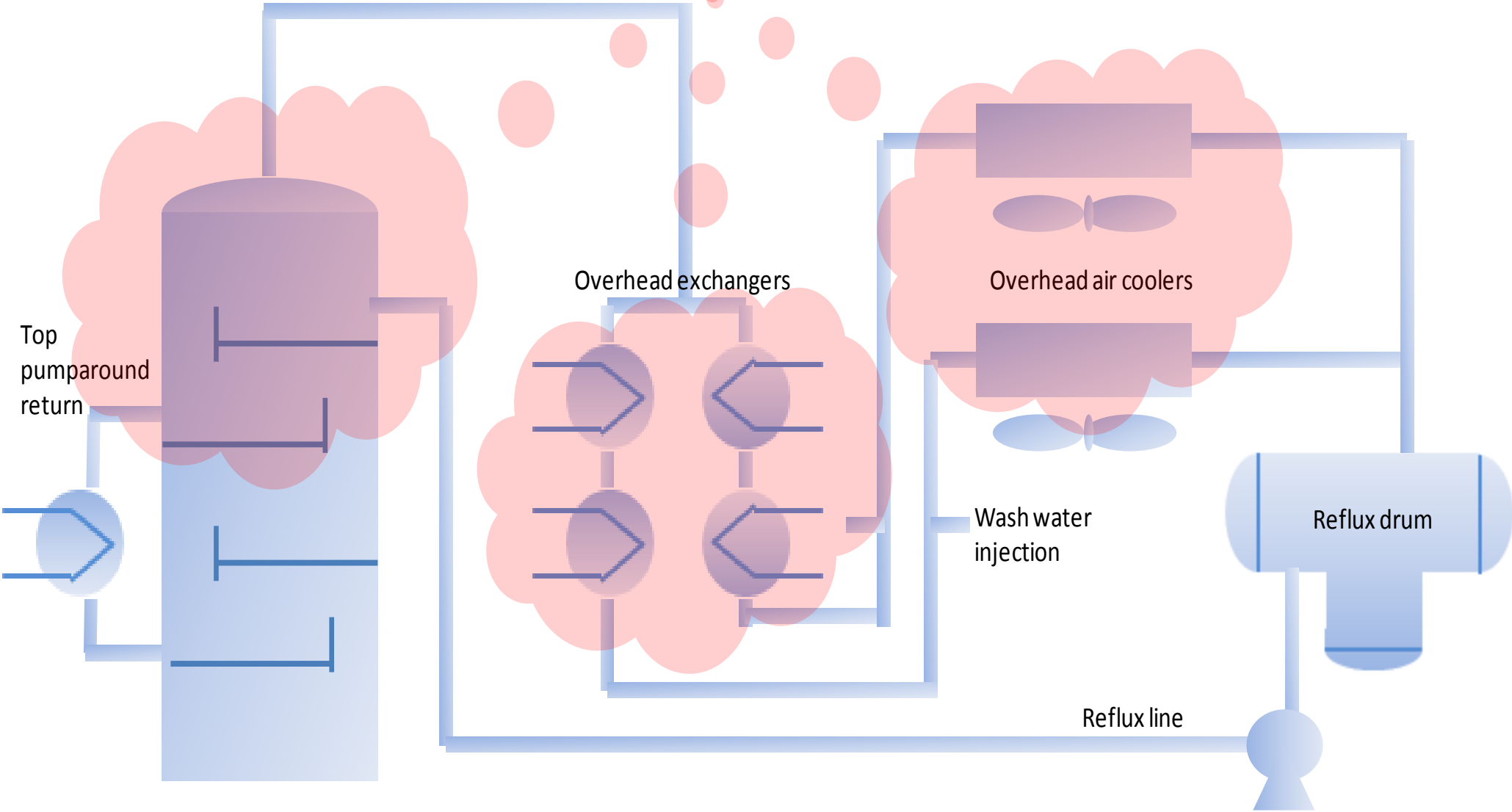


Thickness as a Function of Time

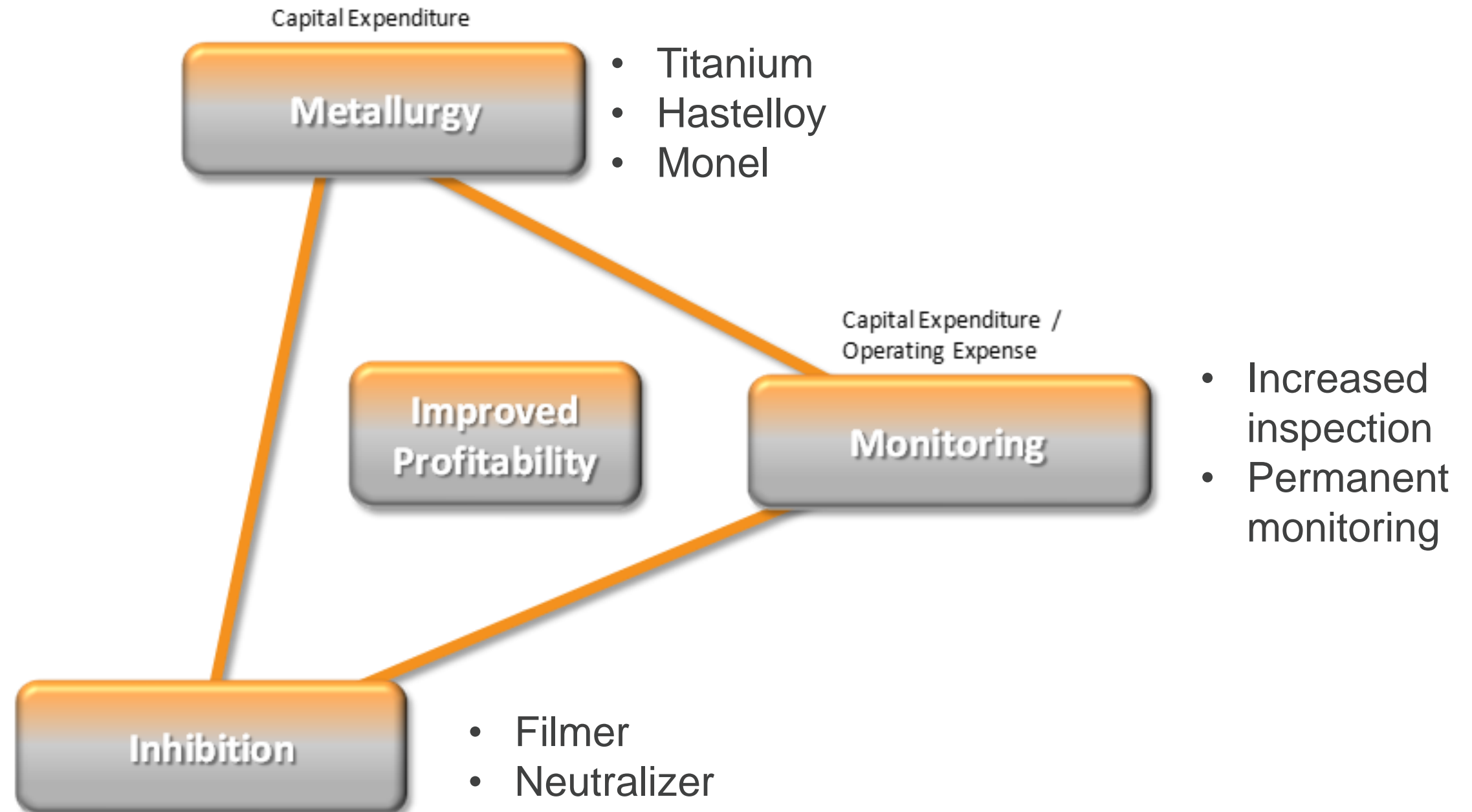


Corrosion in CDU OVHDs

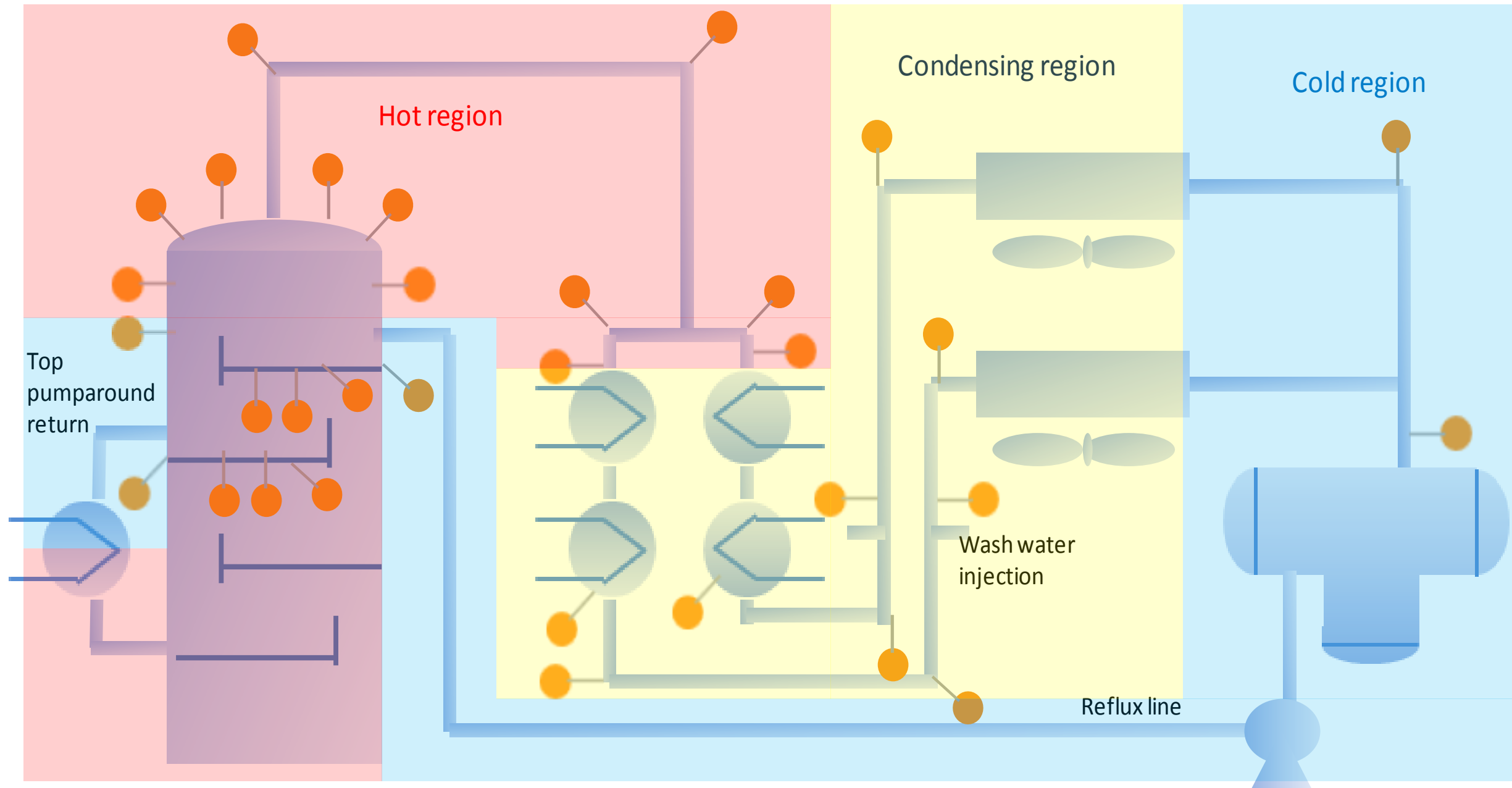
High Risk Locations



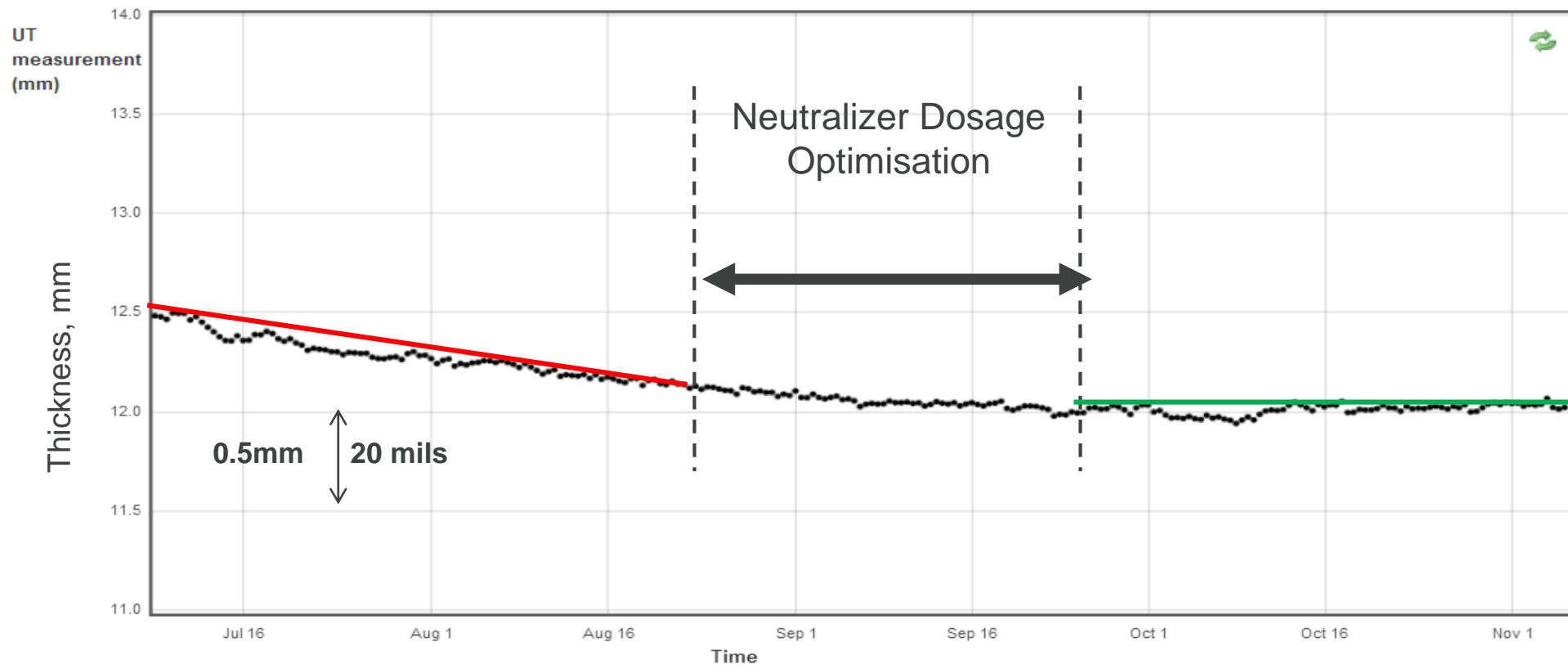
Corrosion Management in CDU OVHDs



Corrosion Monitoring System for CDU OVHDs



Case Study 1: Corrosion Inhibition Optimization

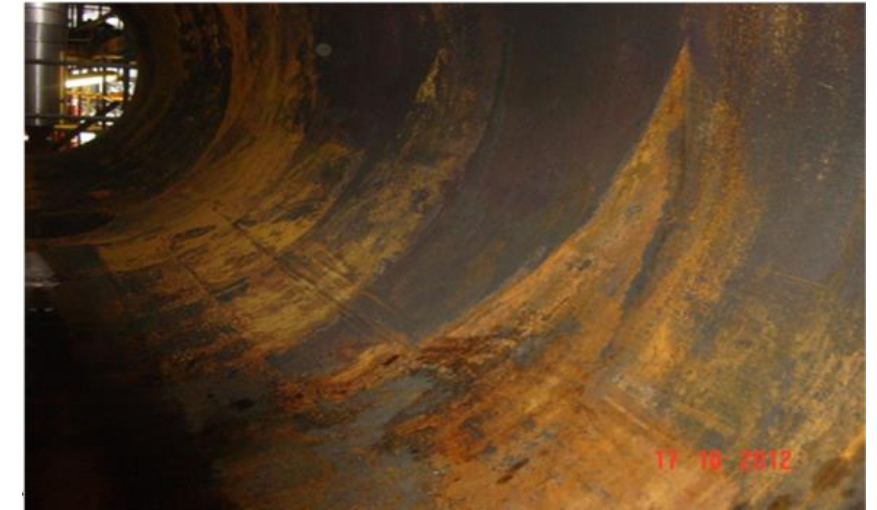
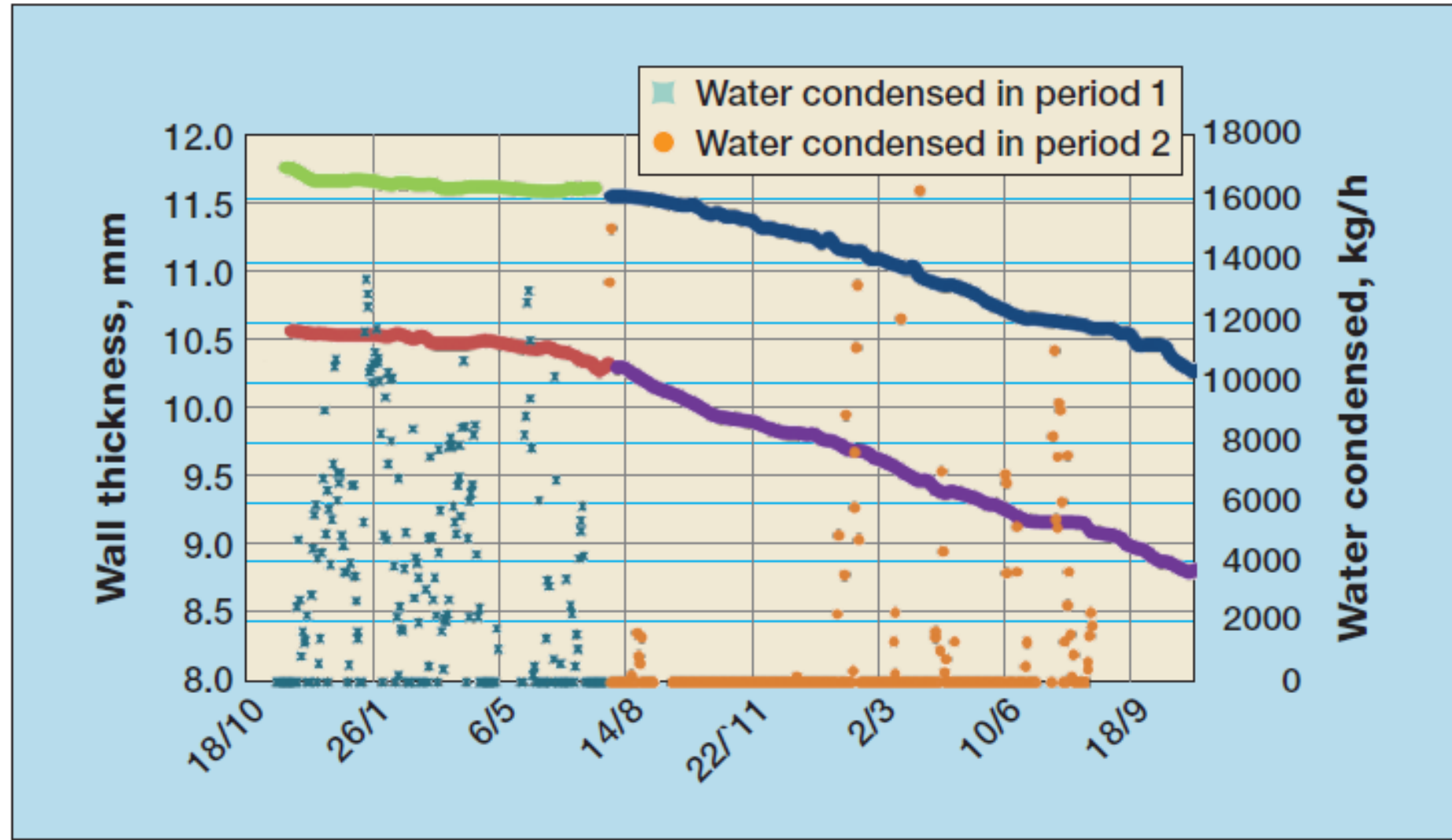


- High corrosion rate measured: 48 mils/year
- Neutralizer dosage adjusted using feedback from Permasense sensors over 1 month
- Corrosion rate *stabilised*

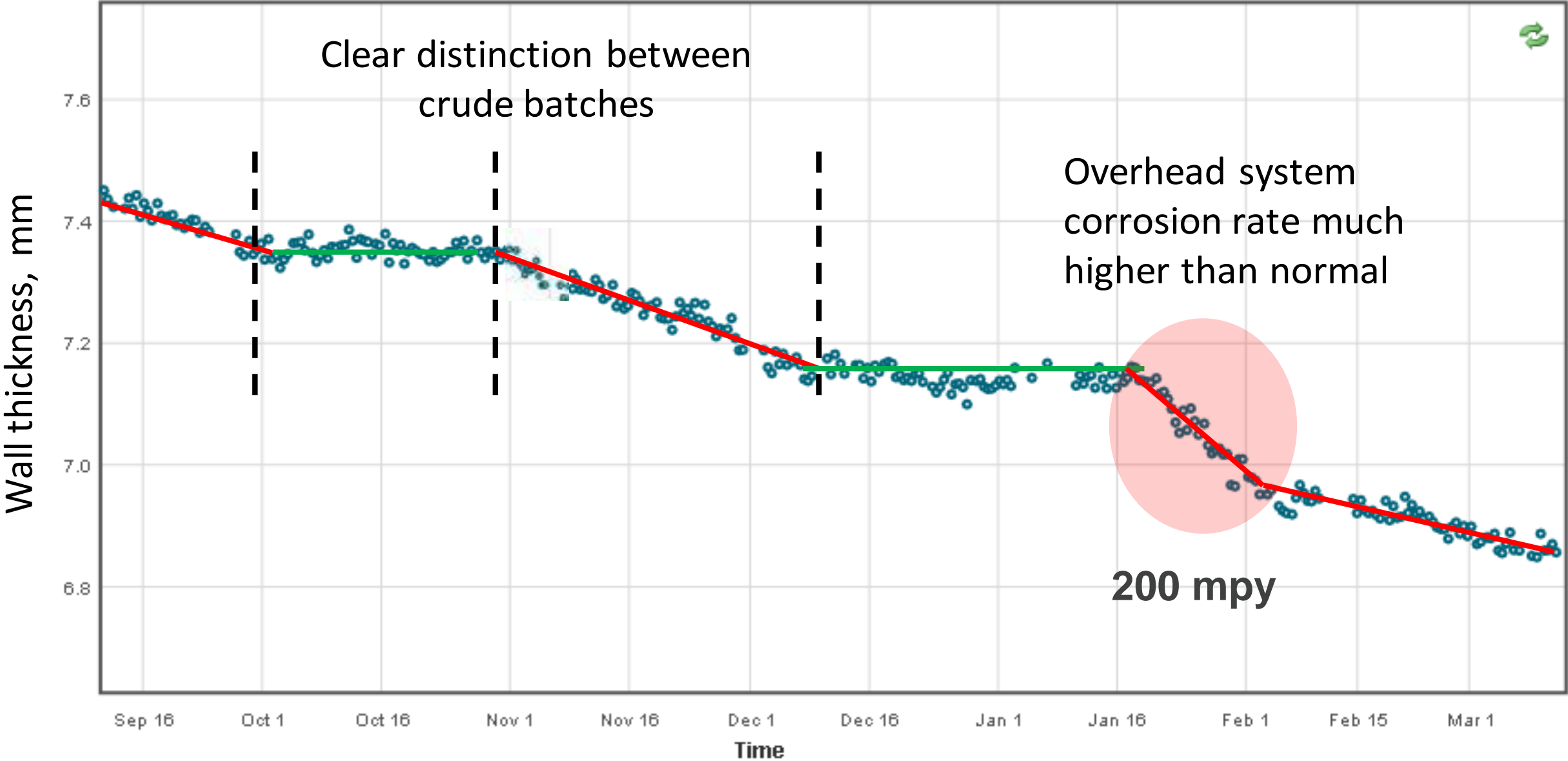


Case study 2: Crude Unit Overheads – Root Cause Analysis

European refinery – monitoring shell of overhead shell and tube condensers



Case Study 3: Tracking Organic Chlorides in Crude Batches



Better Asset Integrity Data Drives More Profitable Operations

- Permasense System delivers wall thickness measurements continuously from locations where access is costly, dangerous or physically restricted
- WirelessHART data transmission facilitates cost effective, rapid online installation
- Operators get more accurate and timely understanding of the asset integrity and corrosion or erosion rates
- Data provides insight into the impact of changing operations on corrosion rates in CDU OVHDs
- Data supports more effective risk-based decision making about
 - Opportunity crude / LTO processing
 - Optimising chemical inhibition
 - Improving shutdown/maintenance timing and planning