Corrosion Monitoring & Data Trending

2014 Corrosion Awareness Day – 26th August

ASSET INTEGRITY MONITORING

INTEGRITY & MAINTENANCE SOLUTIONS

Why Monitor corrosion?

- To help identify the location, rate and type of material loss (i.e. general corrosion, localized corrosion, erosion etc).
- To provide an early indication of potential problems (and allow proactive resolution).
- Reduce unplanned shutdowns and risk of hydrocarbon release.
- Increase confidence in plant integrity.
- Provide assurance of chemical performance / injection rates (cost / HSE benefits).
- To feed into RBI

Different Types of Monitoring

1 – Intrusive:

- Corrosion coupons
- Corrosion probes
- Erosion probes

2 – Non Intrusive

- Radiography
- Ultrasonic
- Electro-magnetic

Corrosion coupon

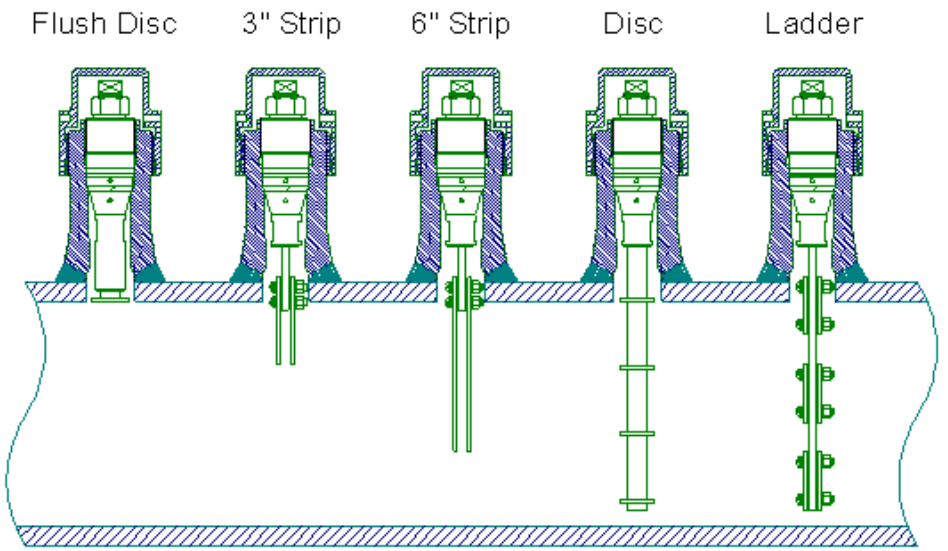
Direct system exposure

WEIGHT LOSS

$$\text{Corrosion Rate} = \frac{(\text{Initial Weight} - \text{Final Weight}) \times \text{Unit Factor}}{\text{Area} \times \text{Density} \times \text{Exposure Period}}$$

WITHIN CORROSION ALLOWANCE?
WALL THICKNESS?
SYSTEM LIFE EXPECTANCY?

Corrosion coupons



Types

- Disc
- Strip
- Ladder
- Scale
- Polymer
- Weld spec
- Any metallurgy

Benefits

- Low cost
- Tried, tested and well respected method
- Actual metal Loss measurement
- Visual – ability to analyse metal loss morphology (i.e. general, localised, MIC, erosion)
- Collection of other samples (scale / bugs)

Disadvantages

- Any corrosion may have occurred at the beginning or end of the exposure period however this can be offset by installing an adjacent probe to allow comparative trending and identification of when event occurred

Corrosion probes

What data do corrosion probes provide?

- Corrosion/ erosion rates dependant on element configuration
- Alarms / alerts for loss of inhibition / high loss rates
- Useful for trending in conjunction with coupons
- Optimisation of chemical does rates
- Optimal well bean up rates (minimise sand production)

Overview of most common probe types

Standard Electrical Resistance (ER):

Low cost, reliable and the most widely used probe. Provides general corrosion rates. Element thickness and fluid corrosivity dictate spaeed of response and frequency of required change-out. Those with spiral elements can be susceptible to negative trending in conditons where conductive scale is apparent (i.e. FeS)

As the exposed element loses metal through corrosion or erosion, its electrical resistance will increase – the change / ratio of this resistance to that of the protected element can be calculated into a corrosion rate

High Resolution

Operate on same principle as standrad ER technology however provide imporved response to process corrosivity due to element configuratrion and electronics.

Ideal for inhibitor performance monitoring / optimisation where rapid changes in fluid corrosivity need to be monitored quickly and closely.

Monitors and records temperature.

LPR:

Provides instantaneous corrosion rate, but requires conductive fluid and as such value in an offshore environment can be limited. Widely used in the laboratory for chemical screening where conditons are more favourable.

Overview of most common probe types

Galvanic

Used in water injection systems to monitor oxygen. This is achieved by measuring the galvanic current in the circuit between a steel and a brass electrode, which has been found to be particularly sensitive to the amount of oxygen in the water.

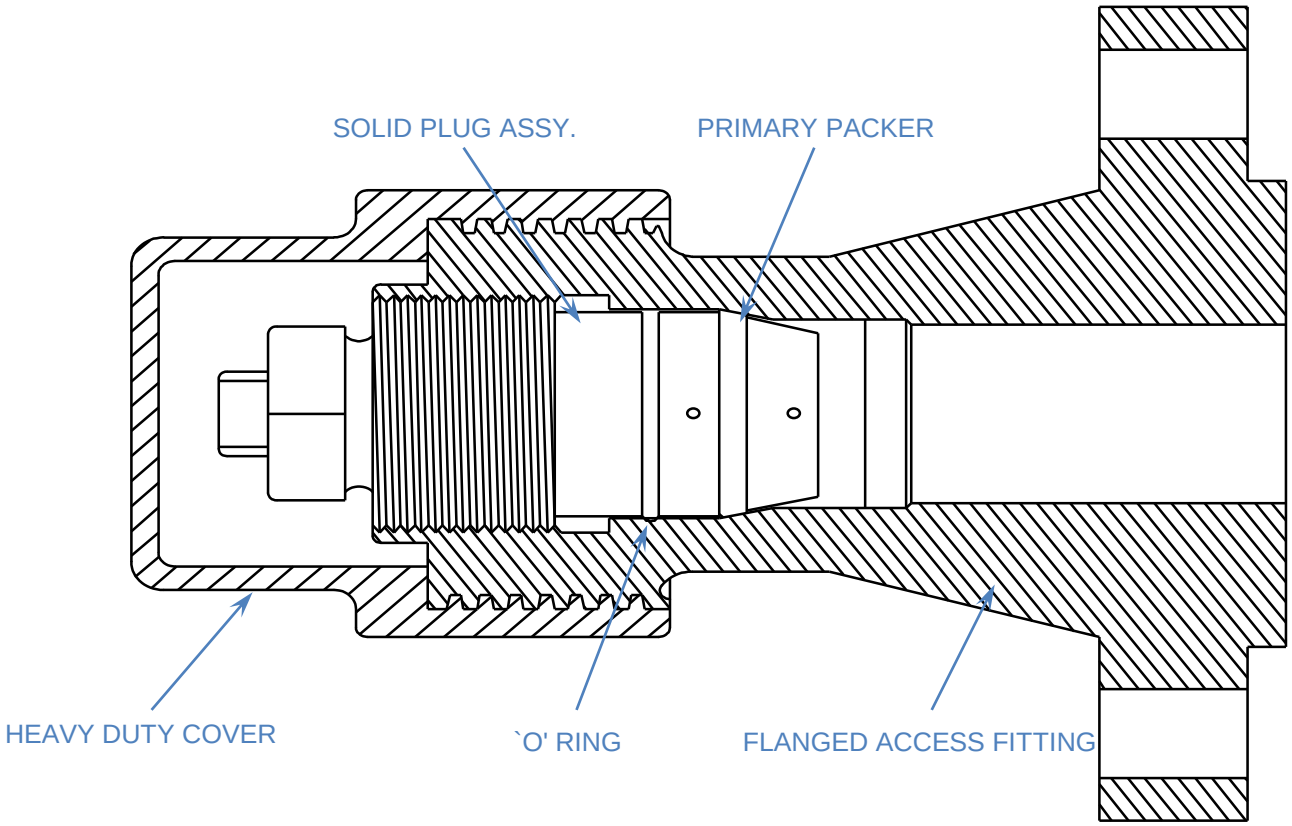
Other parameters affecting the galvanic current are temperature, product flow rate, and the amount and quality of coatings and corrosion products forming on the electrode surfaces. This can explain why galvanic current can be relatively high initially on installation of a probe when the electrodes are clean then as deposits build up on the electrodes the galvanic current drops off until a steady state is achieved.

Corrosion Resistant Alloy (CRA) / Angles Head

Identical principle of operation to standard / high resolution ER however element is made from CRA. Any metal loss is therfore as a result of erosion. Often used in parallel with acoustic monitors (to provide both quantifcation of sand production and any associated erosion rates)

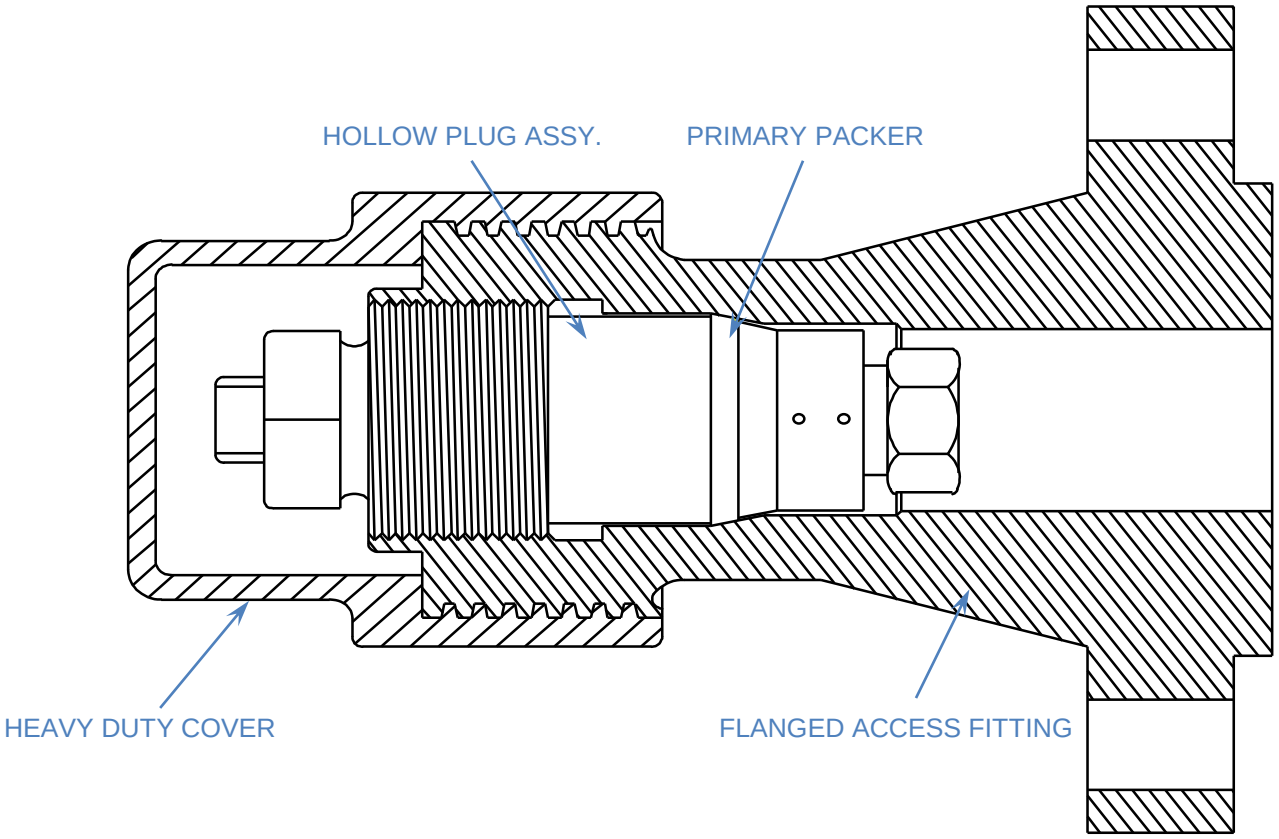
Access fitting types

Access fitting cross section – Solid plug



Flanged Access Fitting Assembly with solid plug, showing sealing arrangements.

Access fitting configuration – hollow plug



Flanged Access Fitting Assembly with Hollow Plug, showing sealing arrangements.

Access fitting orientation

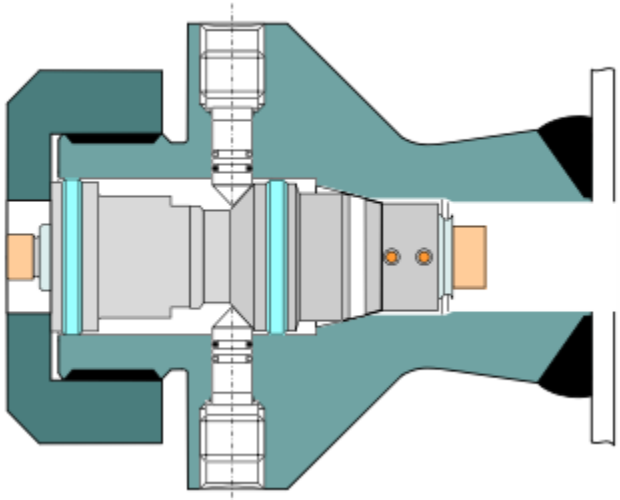
BOL = bottom of line (6 o clock position)
SOL = side of line (3 / 9 o clock position
TOL = top of line (12 o clock position)

Dictates type of device to be used

BOL = Flush (monitoring water phase)
TOL = Flush (monitoring wet gas lines)
TOL = Strip (monitoring water phase at bottom of line)

Mechanical Intrusive access systems

Hydraulic Intrusive access systems



On-line retrieval perceptions

Perceptions:

- "High risk" (breaking containment)
- "Unnecessary"
- "Can be left until shutdown"

Benefits of on-line retrieval

- Maintains integrity
- "Shutdown only" policy can result in locations not serviced for many years and integrity threat
- Reduces pressure on shutdown team during busy shutdown schedules (bedspace, scaffolding, personnel availability etc...)
- Allows collection of swabs for MIC assessment allowing full picture of microbial activity to be built using both sessile and planktonic methods
- Routine access points can be used for chemical optimisation purposes.
- Regular servicing allows lubrication of all parts and reduces risk of seizure
- Allows proactive management of corrosion probes (replace before failure = maximum uptime)

On-line retrievals - Facts

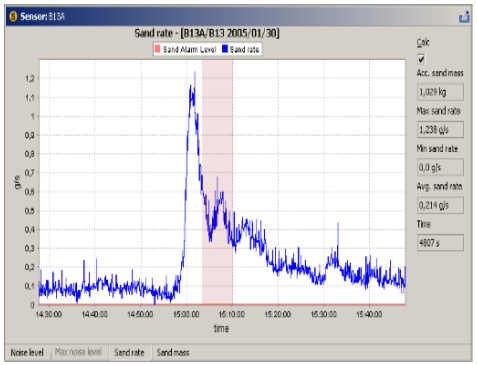
Retrieval of intrusive monitoring devices on-line is safe providing:

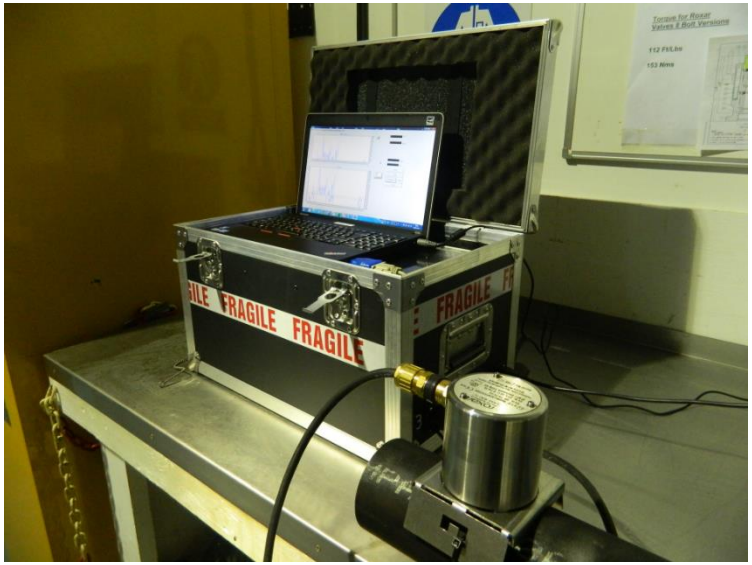
- Only competent personnel undertake the work
- A 2 person (fully trained) retrieval team is used
- A risk assessment is carried out at every location (sand, access, scaffold, manual handling, access / egress)
- Back pressurization techniques MUST always be used
- Pressure retaining covers should be installed at all locations to provide an additional isolation
- All locations should be kept on a record to ensure regular servicing (including chemical injection quills)
- Locations with no service history should be serviced under shutdown

Sand and solids monitoring

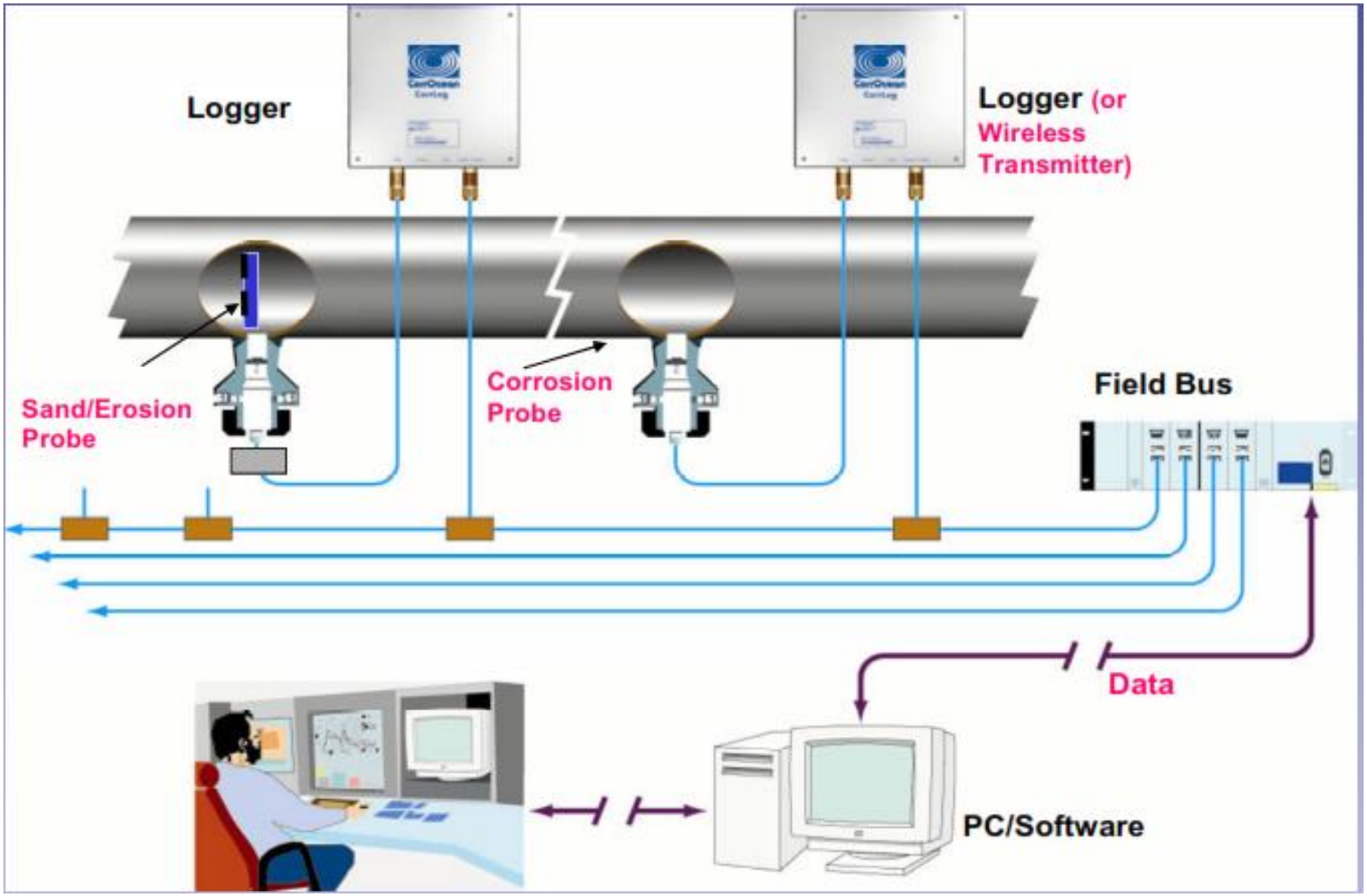
Intrusive and acoustic devices for measuring erosion and sand levels

- Real time / immediate detection of sand particles within any process flow
- Enables optimisation of production, controlled well bean up as a result minimises exposure of of plant to erosion
- Easy installation, minimal maintenance giving quantitative results (grams per minute/day)
- Fully portable allowing installation at different locations
- Can be used alongside intrusive technology to provide sand production and associated erosion rates
- Fully portable design allows testing of individual wells – no requirement to 'hard wire' or permanent install
- Can also be hard wired to DCS / onshore (alarms)

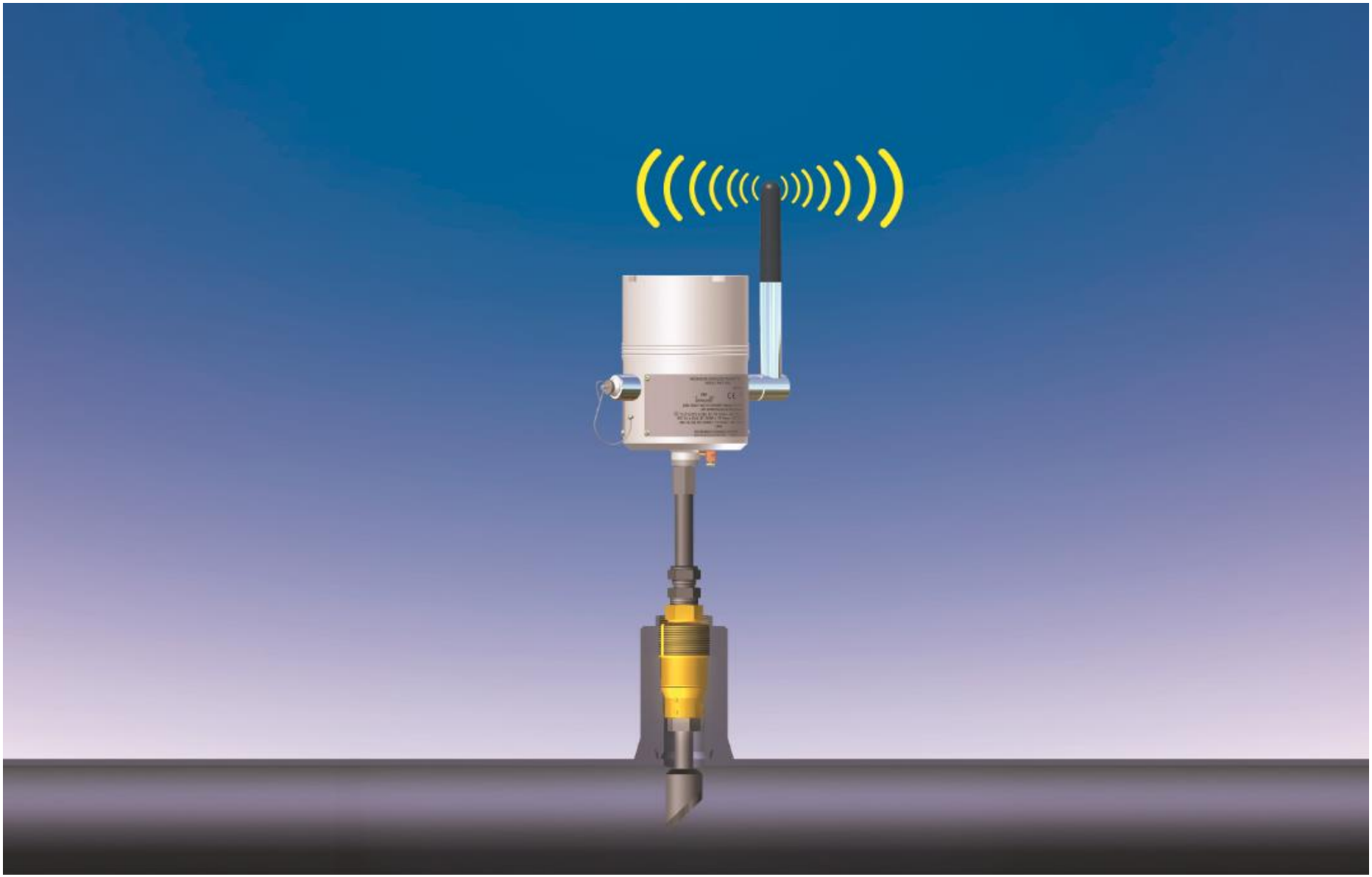




Corrosion probes – data collection / transfer



Corrosion probes – data collection - Wireless



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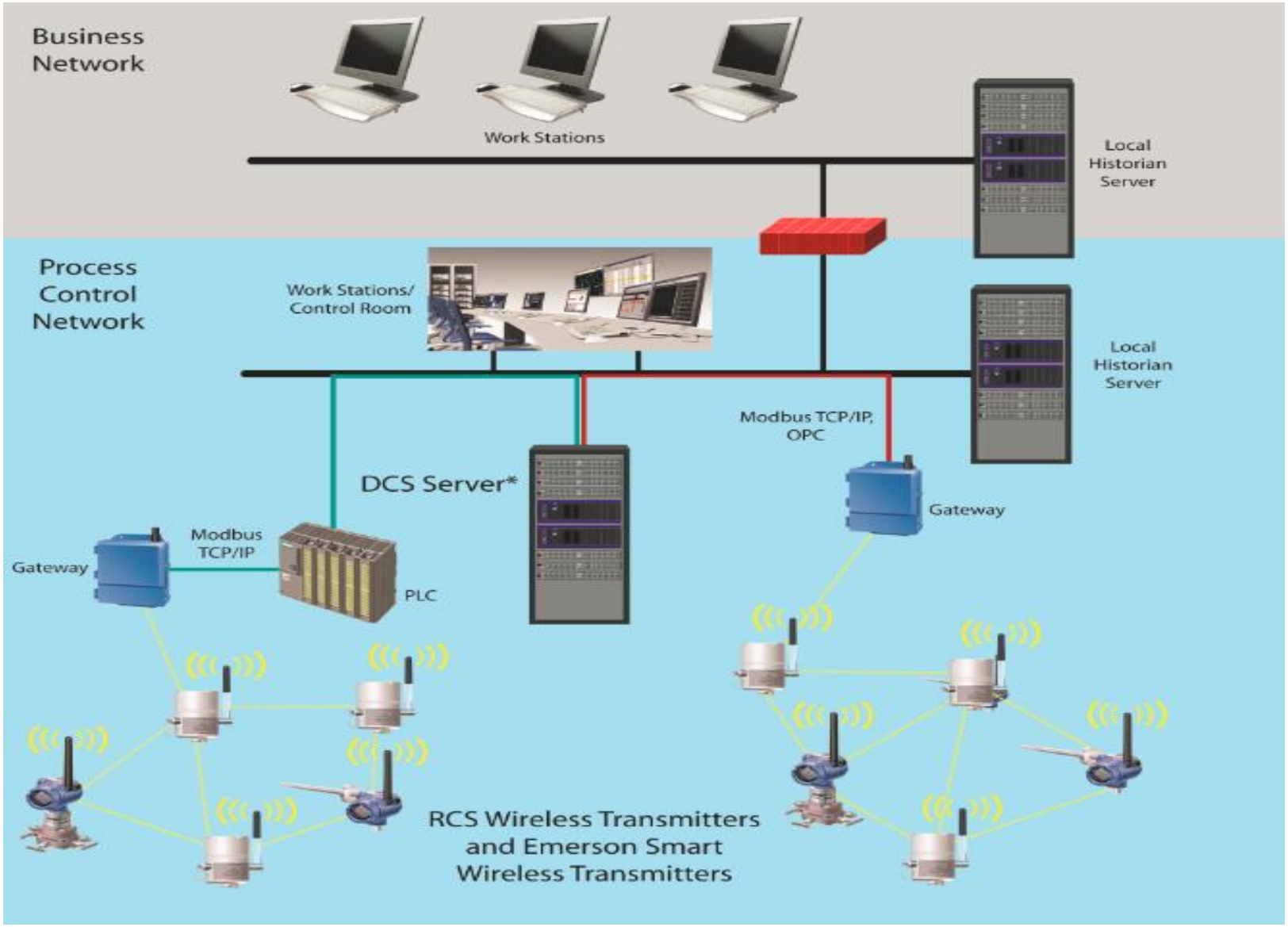
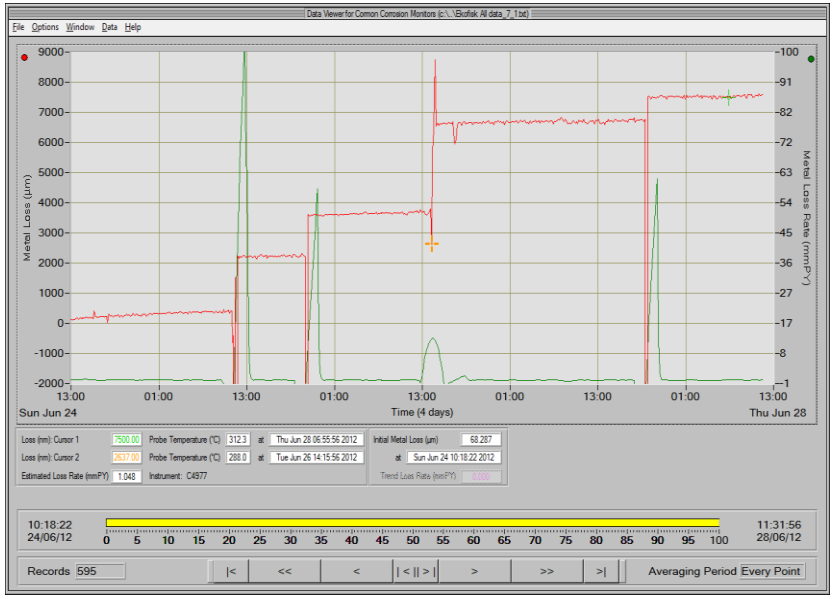
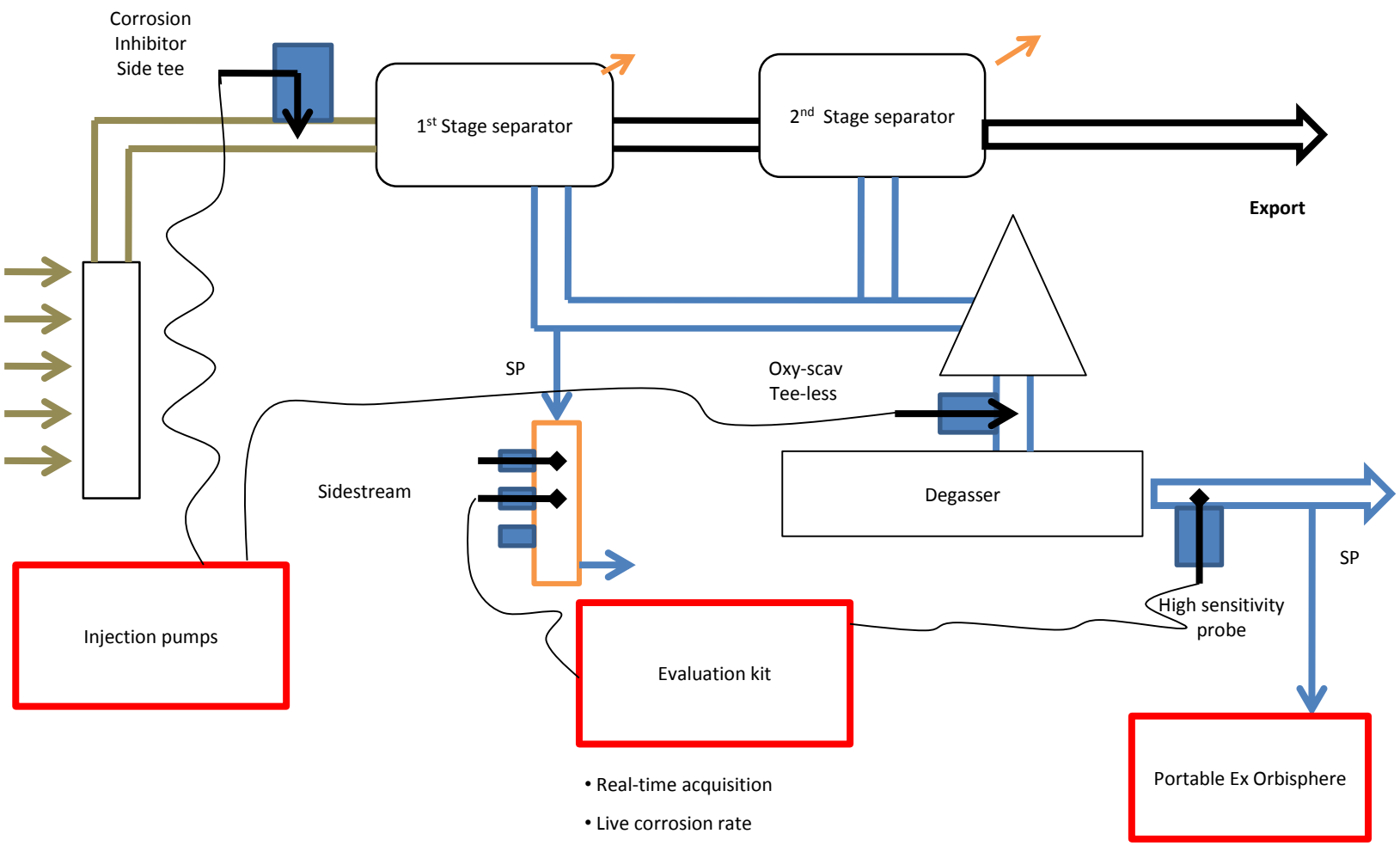


Chemical monitoring

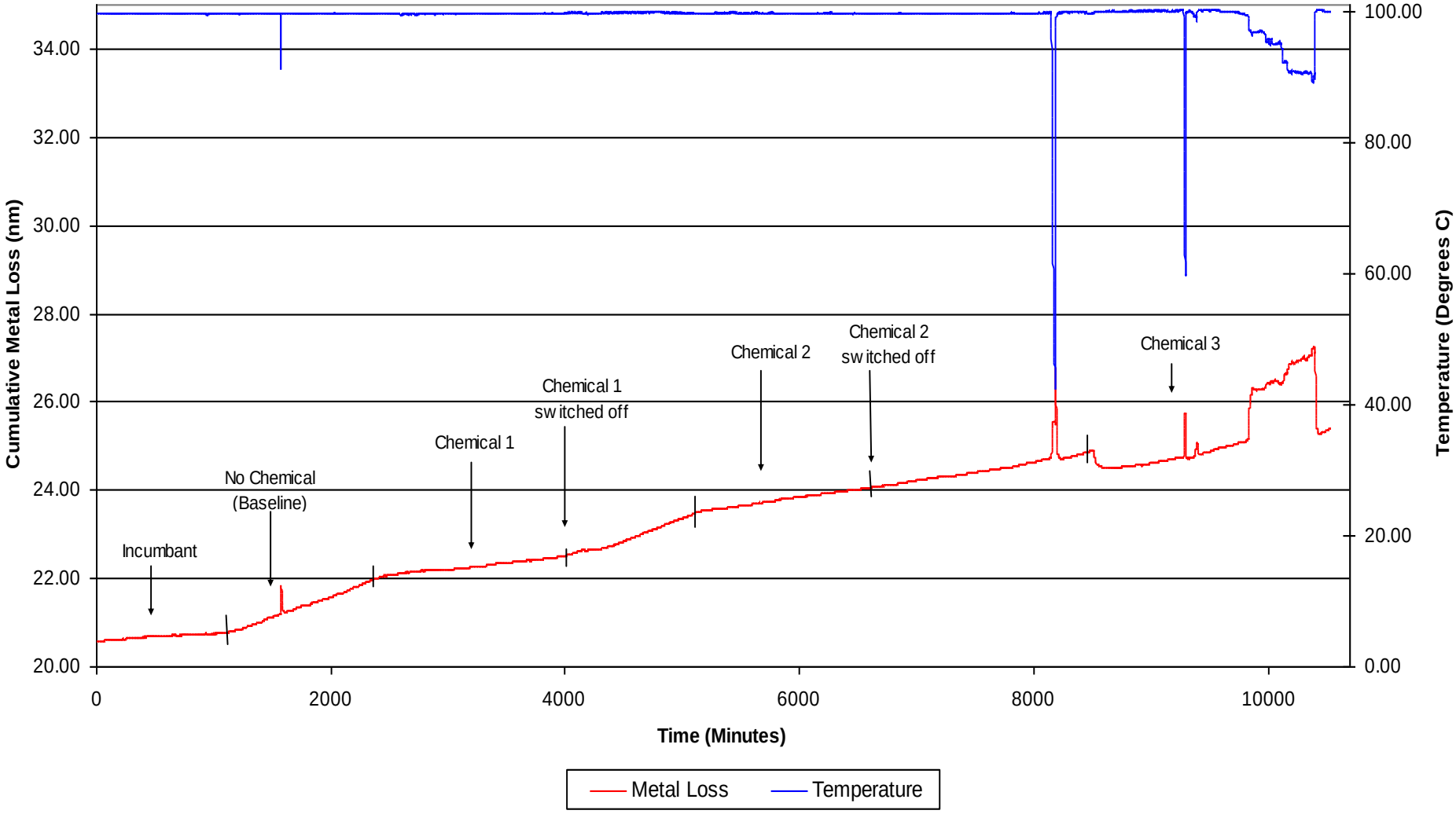
- Are you dosing enough chemical (sufficient corrosion protection / control of dissolved 0_2)?
- Are you dosing too much chemical (increased chemical spend / OiW issues)?
- Temporary installation either via access fitting or sidestream



Typical trial set-up



Data example



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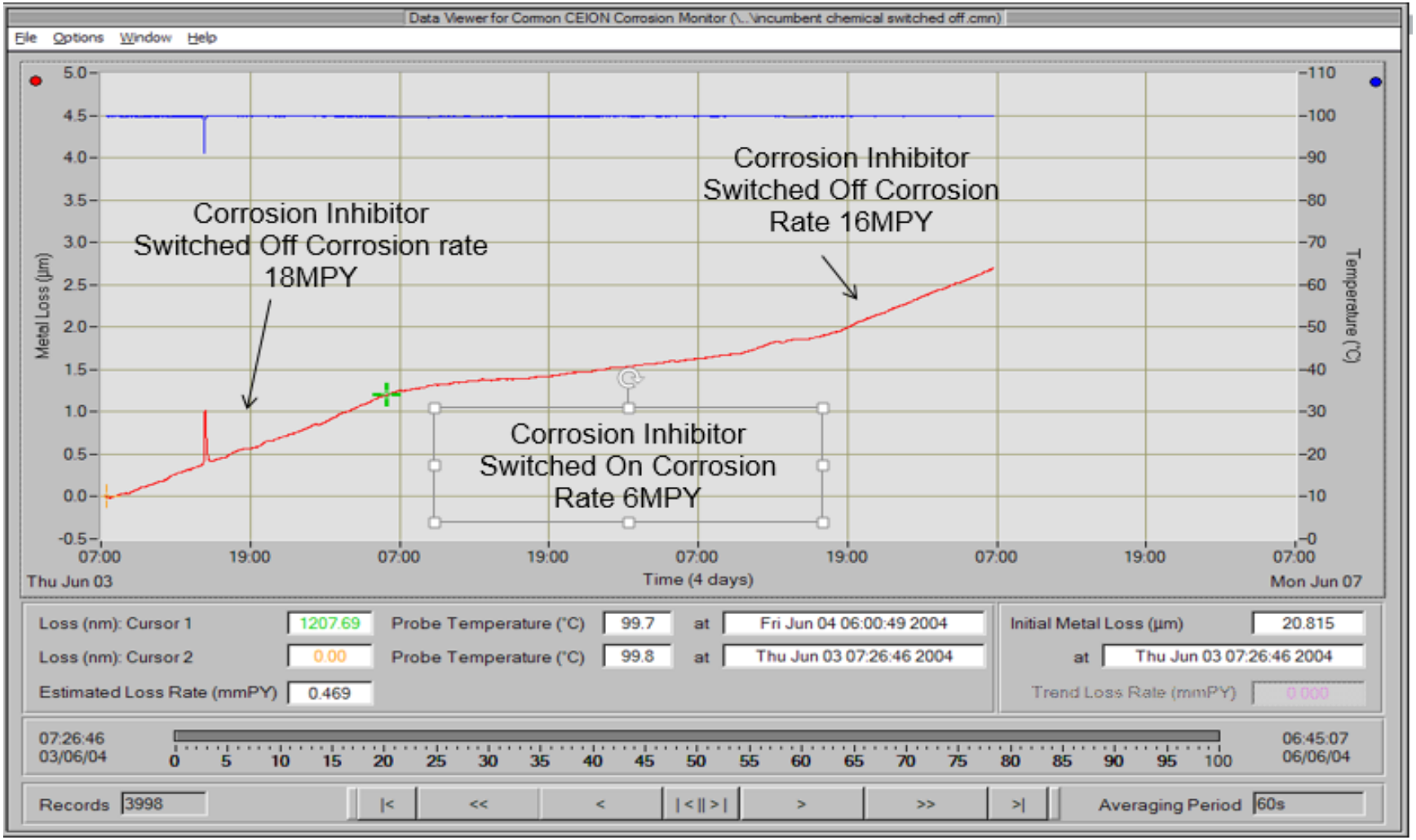
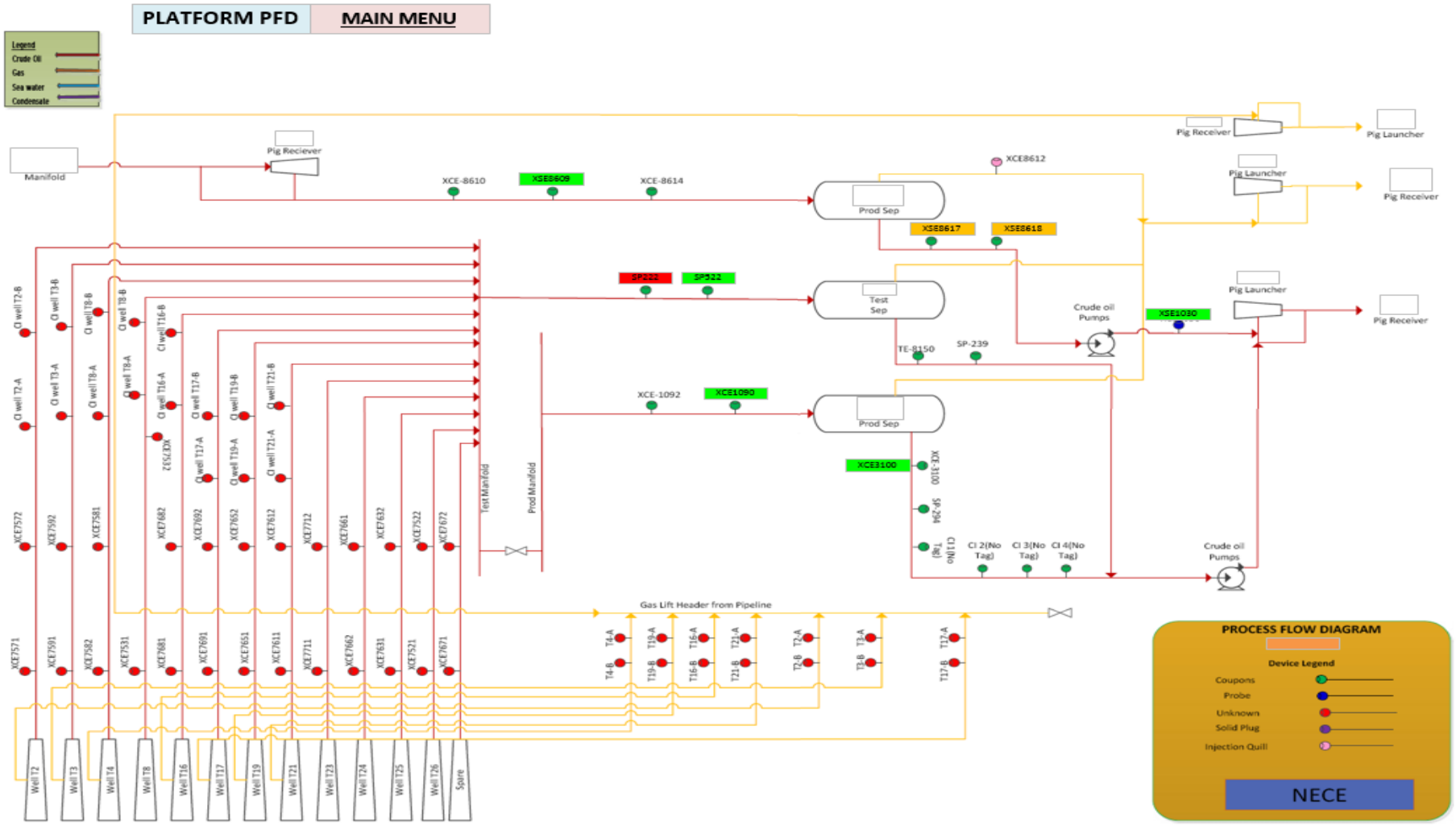
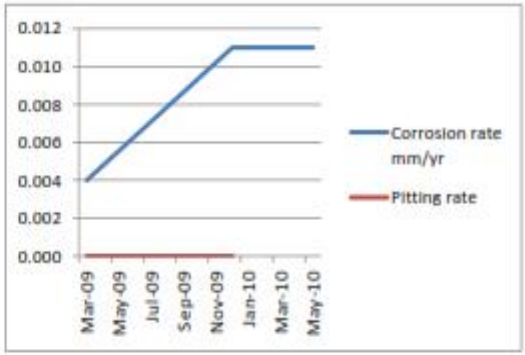


Data management and trending



Data management and trending

Platform	Arbroath
Tag Number	SP-522
Description	Test Man / Test Sep V8010
Status	Live
P&ID Number	AAPG-L-0220/012-D-AB01
Line Number	14"-OC-20039-F-PP
Module	Cellar Deck / Well Bay
Line Operating Pressure	120 psi
Line Temperature	
Process in Line	Oil
Pipespool Size	14"
Orientation of Line	Vertical
Material of Line	Carbon Steel
Type of Access Fitting	Flarweld
Orientation of Access Fiting	SOVL
Protective Cover Fitted	2 Hole HDC c/w BV & PG
Shutdown Required	No
Scaffold Requirements	None Required
Obstruction Distance	No Obstruction
Grating Restrictions	No
Retrieval Tool	25" Tool
Carrier Plug Installed	S/S Solid
Monitoring Device	Coupon
Coupon Type	3" Strip C1018
Coupon Holder Length	250mm
Probe Type	N/A
Probe Length (mm)	
Probe Connection (Pin Type)	N/A
Probe code	
Probe serial	
Logger Type	N/A
Logger Serial	
Sample Check	
Date of last Service	



Mechanism	Corrosion Rate (mm/year)			
	Low	Moderate	High	Severe
General	Below 0.025	0.025 to 0.126	0.127 to 0.254	Above 0.254
Pitting	Below 0.127	0.127 to 0.201	0.202 to 0.381	Above 0.381

Date	Corrosion rate mm/yr	Pitting rate
Mar-09	0.004	0.00
Dec-09	0.011	0.00
May-10	0.011	

Notes:
New 250 mm coupon holder installed.
Current Coupon weights:
L9091-37.505 /L9092-37.2491
Current coupon instll date - 05 may 2010

LINK

MAIN MENU

PFD

P&ID

Plot Plan

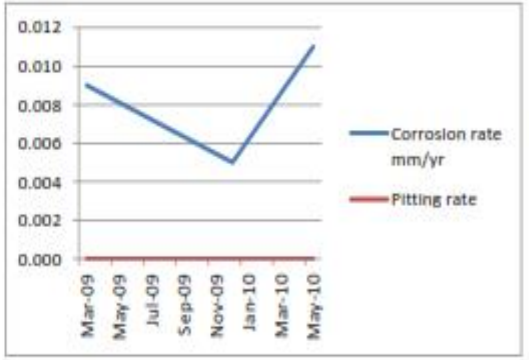
Oil Related

Location Status

HDC Cap & History

Data management and trending

Platform	**Arbroath**
Tag Number	XSE-3100
Description	Prod Sep V8090 Oil Outlet
Status	Live
P&ID Number	AAPG-L-0220/014-B-AB03
Line Number	8"-OC-20032-B-PP
Module	Cellar Deck
Line Operating Pressure	120 psi
Line Temperature	
Process in Line	Oil
Pipespool Size	8"
Orientation of Line	Vertical
Material of Line	Carbon Steel
Type of Access Fitting	Flarweld
Orientation of Access Fiting	SOVL
Protective Cover Fitted	2 Hole HDC c/w BV & PG
Shutdown Required	No
Scaffold Requirements	None Required
Obstruction Distance	No Obstruction
Grating Restrictions	No
Retrieval Tool	25" Tool
Carrier Plug Installed	S/S Solid
Monitoring Device	Coupon
Coupon Type	3" Strip C1018
Coupon Holder Length	125mm
Probe Type	N/A
Probe Length (mm)	
Probe Connection (Pin Type)	N/A
Probe code	
Probe serial	
Logger Type	N/A
Logger Serial	
Sample Check	
Date of last Service	



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Pitting	Below 0.127	0.127 to 0.201	0.202 to 0.381	Above 0.381

Date	Corrosion rate mm/yr	Pitting rate
Mar-09	0.009	0.00
Dec-09	0.005	0.00
May-10	0.011	0.00

Notes:

Dec 09 - Commisioned with new 3" Strip Coupons

LINK

MAIN MENU

PFD

P&ID

Plot Plan

Oil Related

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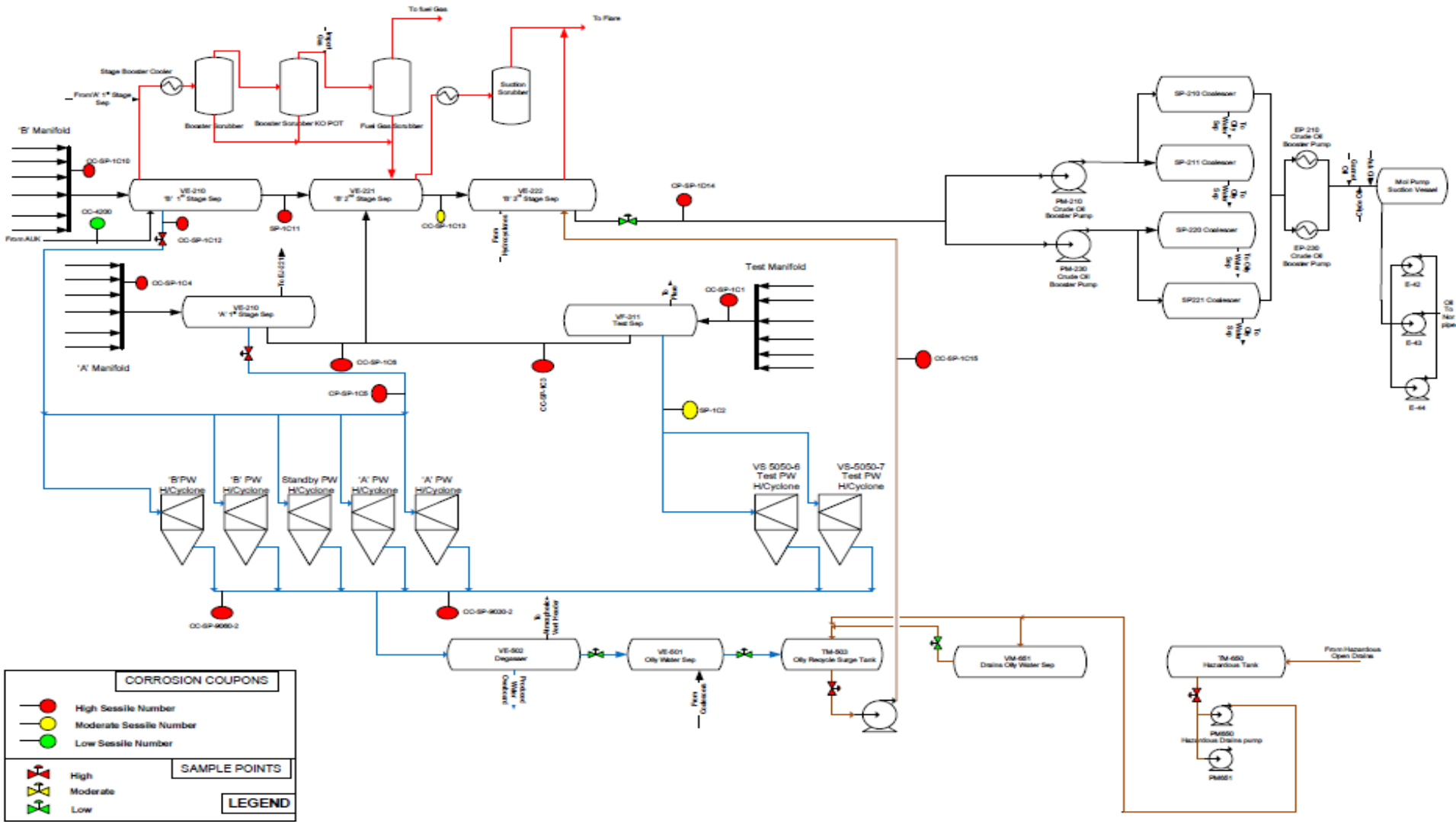
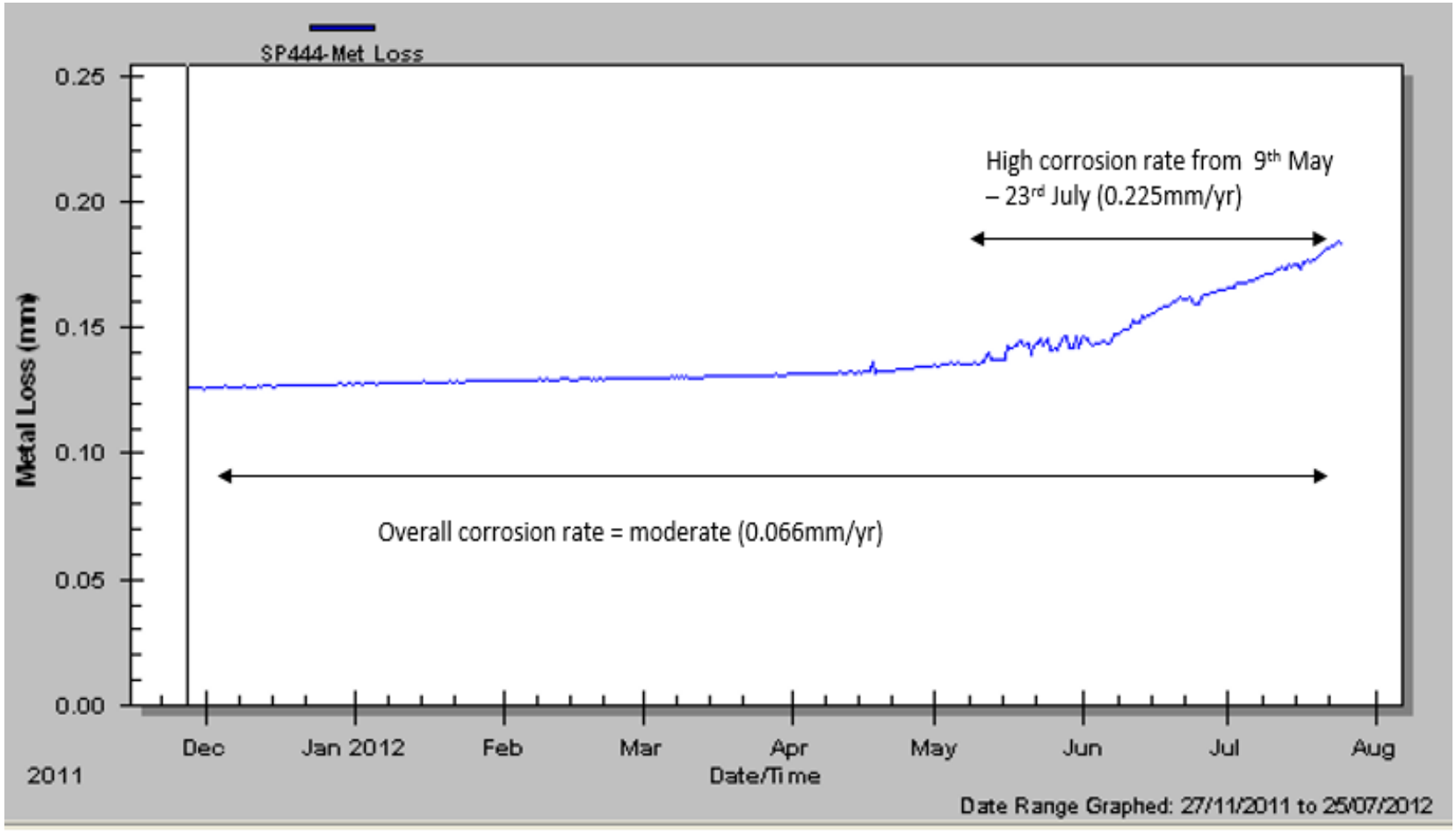
Data management and trending



Corrosion coupons

- 2 x coupons removed from Hydrocyclone Outlet
- Severe corrosion and pitting rates measured

Corrosion probe data



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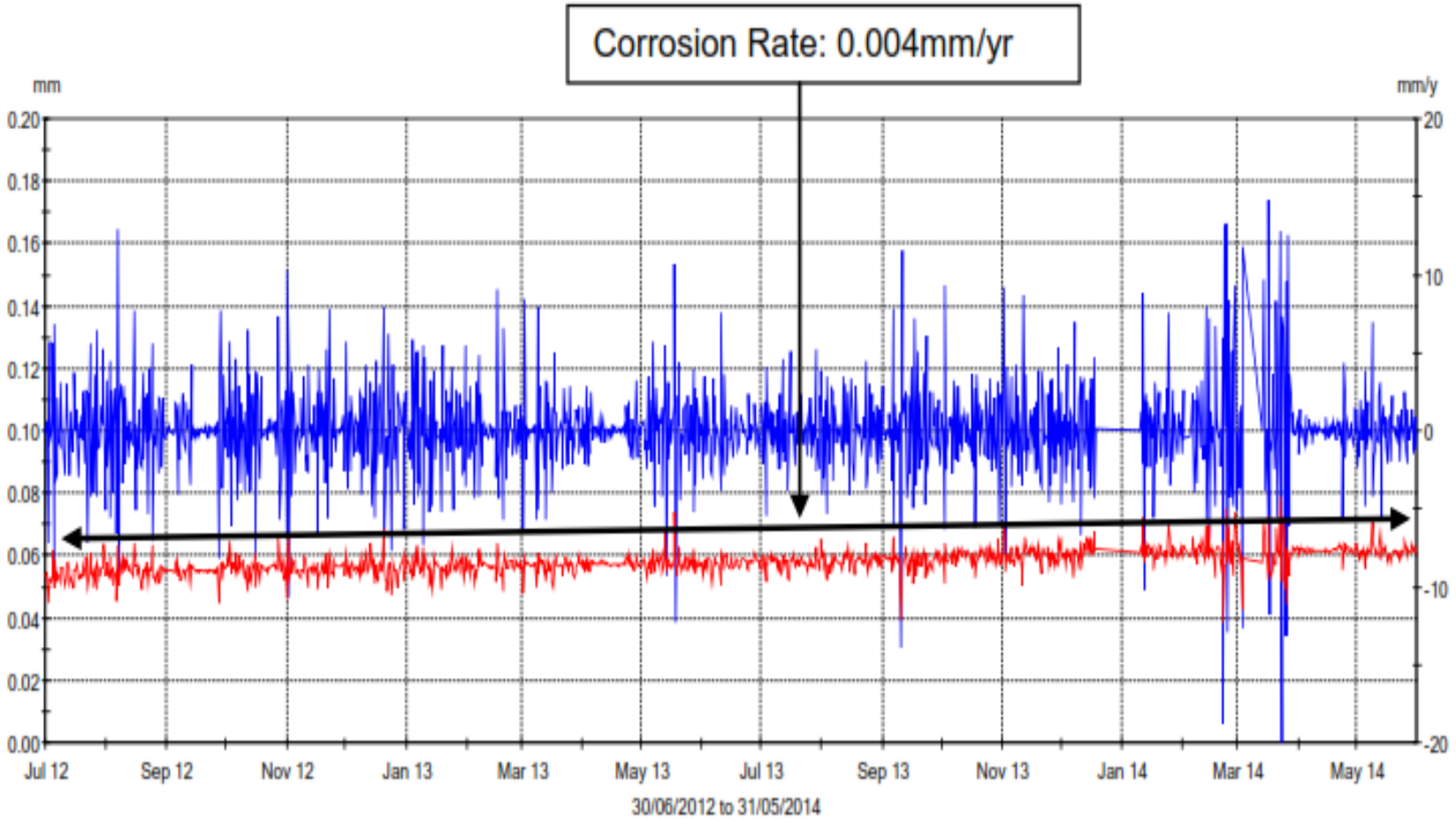

Data management and trending

ONLINE CORROSION MONITORING RESULTS

1. WEIGHT LOSS COUPONS

System	Removed Dec 09			Removed Nov 10 / Feb 11			Removed Aug / Dec 11		
	Corrosion Rate mm/yr	Max Pit Depth (microns)	Pitting Rate mm/yr	Corrosion Rate mm/yr	Max Pit Depth (microns)	Pitting Rate mm/yr	Corrosion Rate mm/yr	Max Pit Depth (microns)	Pitting Rate mm/yr
Water Injection Pumps to Water Injection Header	0.386	285	0.200	0.104	10	0.047	0.214		0.126
Water Injection Pumps to Water Injection Header	0.609	300	0.211	0.101	10	0.047	0.180		0.252
Production Separator Oil Inlet	0.003						0.002		
Production Separator Oil Inlet	0.003						0.002		
Gas Lift	0.001			0.002			0.003		
Gas Lift	0.001			0.002			0.003		
Test Sep Inlet	0.019			0.003			0.004		
Test Sep Inlet	0.018			0.004			0.004		
Test Sep Outlet	0.003			0.003			0.011		
Test Sep Outlet	0.003	125	0.089	0.003			0.009		
1st Stage Sep Oil Inlet	0.005			0.006			0.009		
1st Stage Sep Oil Inlet	0.006			0.007			0.009		
MOL Export	0.594		N/A				0.435		N/D
MOL Export	0.850		N/A				0.527		N/D

Reporting

Take into account data from many sources to facilitate decision making and provide bigger picture / feed into RBI.

- Corrosion coupons
- Corrosion probes
- Microbiology (sessile and planktonic)
- On-going bio-film monitoring (sidestream)
- Dissolved Oxygen monitoring
- Chemical analysis
- NDT

Questions?