Reference Manual
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Non-Intrusive Corrosion Reference Manual

ROSEMOUNT™

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Contents

1 Overview

This document provides information on set up and configuration of the Non-Intrusive Corrosion Application within Plantweb™ Insight. Prior to configuring your Non-Intrusive Corrosion Application, be sure to complete all steps in the Plantweb Insight Quick Start Guide. Some steps in the guide will be reiterated in this document in more detail.

The Plantweb Insight framework is a software deployed as a contained virtual machine. Desired applications are then installed to the Plantweb Insight framework like installation of an app on a mobile device.

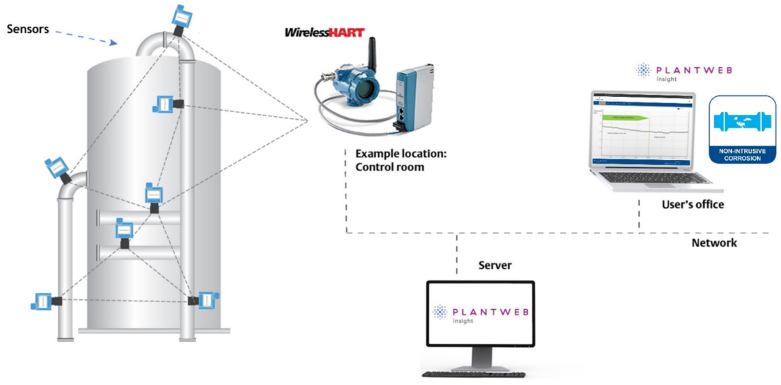
Failure to read and complete recommended actions in this guide will result in the system operating sub-optimally.

System overview

The Rosemount Wireless Permasense system comprises of three components:

1. Non-Intrusive sensors, which can be installed in the plant across a range of temperatures and materials.
2. A Smart Wireless Gateway or gateways which handle the sensor mesh network and communication between the devices.
3. A software application installed on a virtual host.
    a. Plantweb Insight is an industrial analytics solution which offers instant visibility to key assets.
    b. A variety of applications are available, including the Non-Intrusive Corrosion application which is compatible with all Rosemount Wireless Permasense sensors.

Figure 1-1: Rosemount Wireless Permasense solution overview



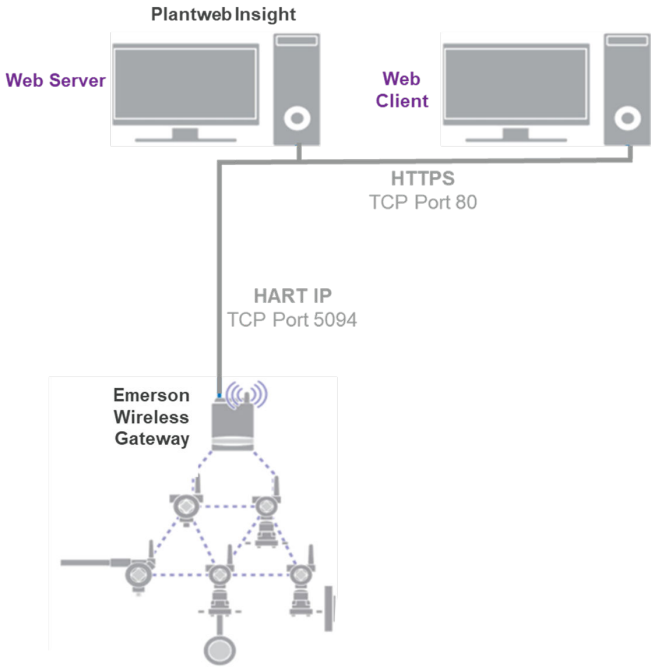
The software application is mandatory because it converts raw data, gathered from the sensors in the field, into actionable insights for user consumption. It also aggregates corrosion data and offers several methods for further connection of the data to other data sources, via industry standard protocols like OPC UA and Modbus TCP. This solution is preferred to

other solutions which produce corrosion data entirely on the device, as every software release can offer potential improvements to the data, as opposed to data processing improvements being tied to hardware development.

Reference Architectures

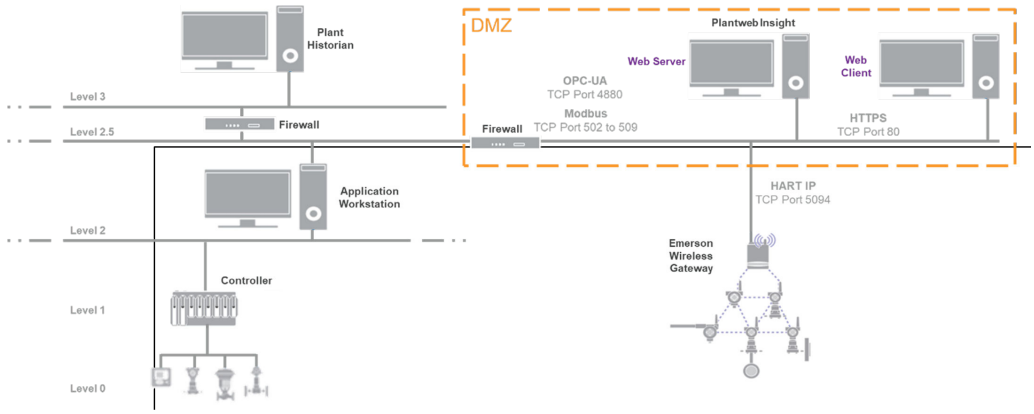
Below are sample architecture options for installing and configuring your Plantweb Insight corrosion system.

Figure 1-2: Reference standalone architecture



The standalone architecture includes a virtual host to run the Plantweb Insight application, connected to the Smart Wireless Gateway where the Rosemount Wireless Permasense sensors are connected. Finally, clients can view the data from a device connected to the same network using a web browser.

Figure 1-3: Reference DMZ architecture



The DMZ architecture is a suggested architecture for users who wish to access their Plantweb Insight system from anywhere on the network. This is the preferred option. The virtual host is connected to the same network as the web clients, who may be on a business network. Data can also be fed to other devices in the network such as a process historian when using this configuration.

1.1 New installation

- It is best practice to backup an image or snapshot of the VM prior to the installation of the Non-Intrusive Corrosion.
- Follow the instructions in the PW Quick Start Guide for the platform installation and return to this document following application installation. Do not refresh the page during the upload of an .asc file, as doing so will mean that you are no longer able to view the upload progress bar.

1.2 Upgrade a previous version of Non-Intrusive Corrosion application

- It is best practice to backup an image or snapshot of the VM prior to the upgrade of the Non-Intrusive Corrosion application.
- Backup the Non-Intrusive Corrosion database following the ‘Backup’ section in the Plantweb Insight quick start guide.
- Uninstall the previous version of the Non-Intrusive Corrosion App by navigating to **System Settings** → **Platform Settings** → **Manage Applications**, at the bottom of the page click ‘uninstall’ on the Non-Intrusive Corrosion application. Do not tick clean uninstall or you risk losing all historical data.
- Install the new version of the Non-Intrusive Corrosion App. It may take up to 30 minutes to complete before you can access the dashboard for the new version. Do not refresh the page during the upload of an .asc file, as doing so will mean that you are no longer able to view the upload progress bar.
  - If you are prompted to do so, log out and log back in.

- When each user first accesses the new version, it is recommended to clear the cache by pressing CTRL+F5 on the keyboard.

Migrating data from Permasense Data Manager Software

Do not connect a live gateway to the system before migrating data or it may result in data loss.

Erasing an existing dataset

It is not possible to delete any corrosion data from the Non-Intrusive Corrosion application. If you wish to remove the entire dataset, follow the uninstallation instructions in the Plantweb Insight Quick Start Guide.

2 Global settings

Global settings should be set before any asset configuration is completed. These settings apply to all assets within a specific application but do not change any settings within the Gateway or devices. Changing any of these settings can be done in the Settings tab.

Currently, the application is available in English only, but future versions will offer multiple languages.

Table 2-1: Units of measurement

Field	Description/use
Temperature units	Choose between Centigrade or Fahrenheit.
Linear measurement units	Choose between Millimetres or Inches.

3 How to organise your data

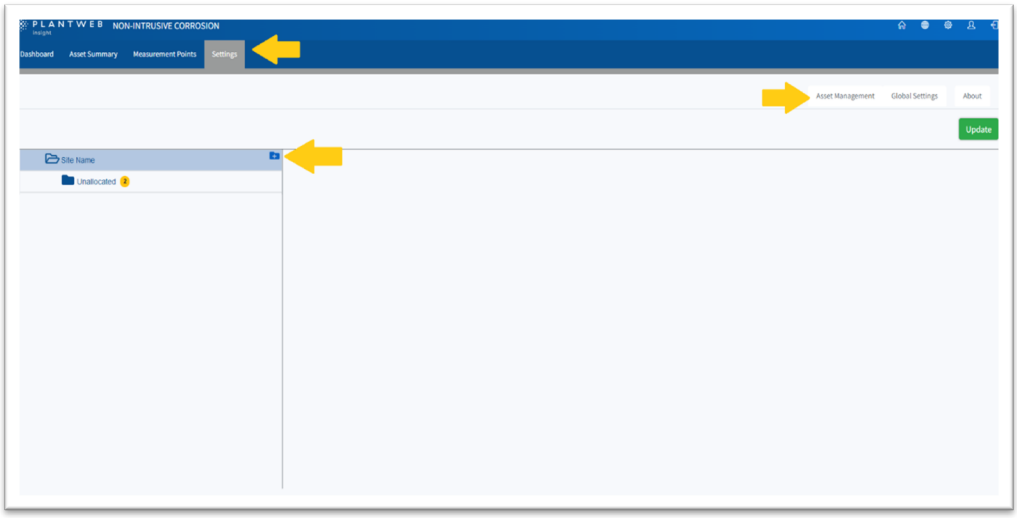
3.1 Creating an asset hierarchy

The Non-Intrusive Corrosion App allows you to set up an Asset structure (like a folder structure) to organise data from your sensors. At the top level is the site, which can then be split into units and subunits. Sensors can be assigned to any asset that does not have sub assets. Sensors that have not been assigned to an asset are found in the special asset “Unallocated”.

For multi-site customers, the top-level folders should be designated as the specific site locations. Any number of folders can be populated below this, allowing a high level of granularity if desired.

To set up the asset, go to Settings, Asset Management and select the add asset button to the right of the Site Name to start adding assets to reflect the structure of the site.

Figure 3-1: Asset management



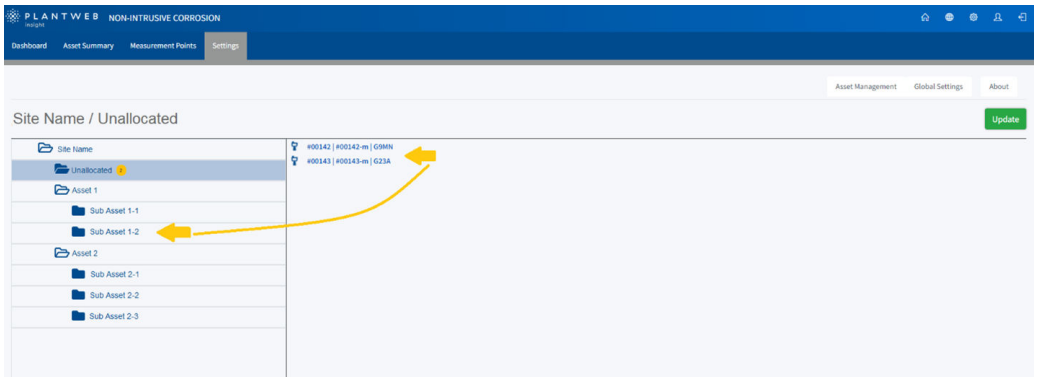
Note
You must click the Update button to save your changes.

3.2 Assigning sensors to assets

Once you have created your assets, sensors can be dragged and dropped from the “Unallocated” asset to their correct place in the asset hierarchy.

On the Asset Management page, click on the Unallocated asset to display the sensors on the right-hand pane. Click and drag the sensors to the correct assets in the asset hierarchy.

Figure 3-2: Arrange sensors in the asset hierarchy



Note
You must click the Update button to save your changes.

3.3 Adding Measurement Point information

Measurement Point information can be added on the graph view which can be accessed by clicking on the Measurement Points tab and clicking the link on the unique tag for the required measurement point. The Asset, Name and Unique Tag can be set by the user. The Sensor ID is the unique identifier that appears on the label of the sensors and cannot be changed.

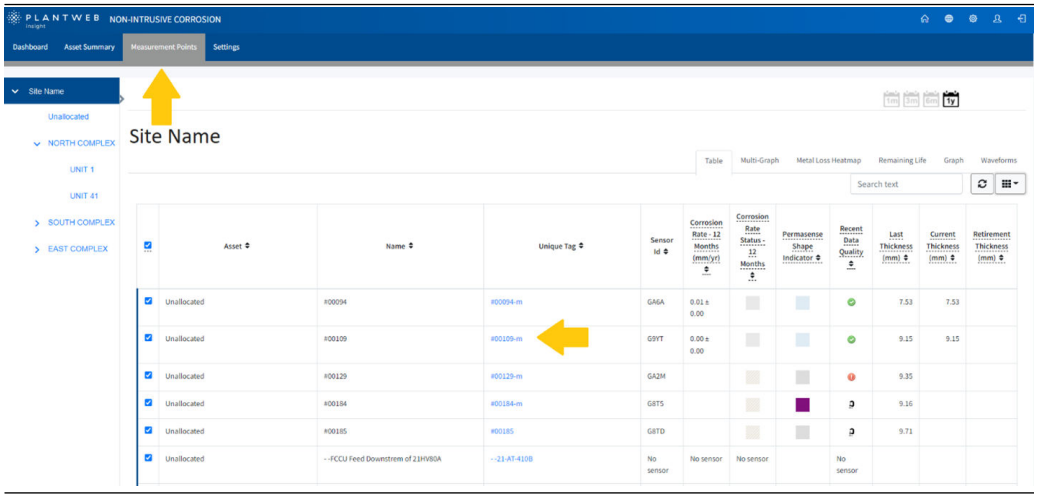


Figure 3-3: Graph view

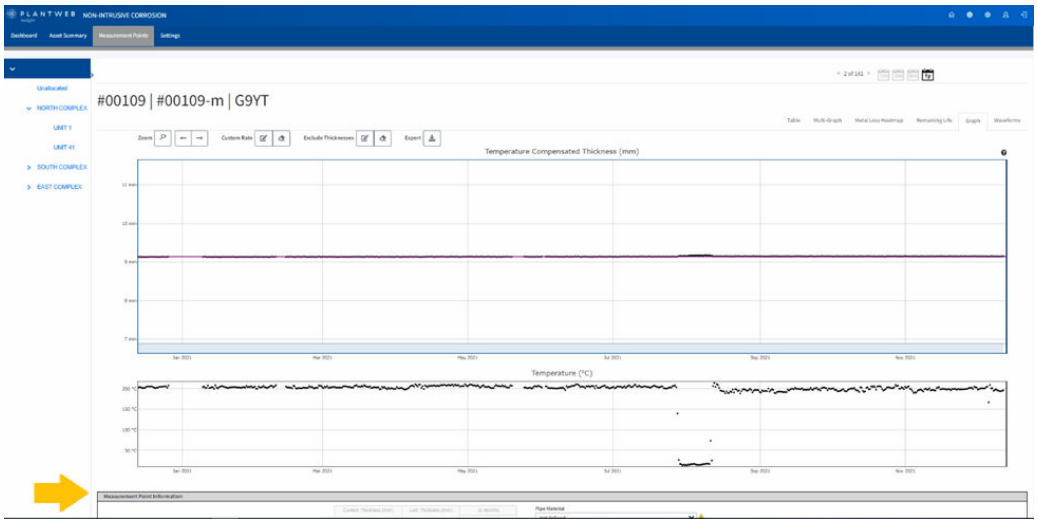
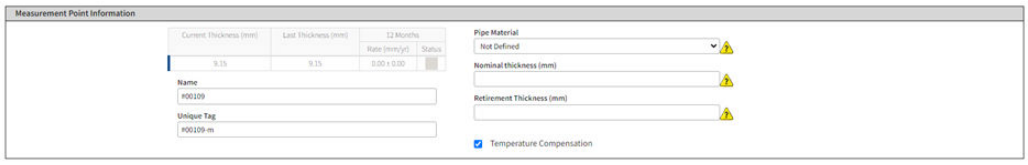


Figure 3-4: Measurement Point information



Measurement Points should be updated with a Name to describe more precisely where the sensor has been installed, such as “Elbow 2, 12 o’clock”. You can also update the Unique Tag to match the instrument tag or specific corrosion/thickness monitoring location reference (CML/TML). This is the value used when exporting data out of the system into third party systems as referenced in the Exporting data to external systems.

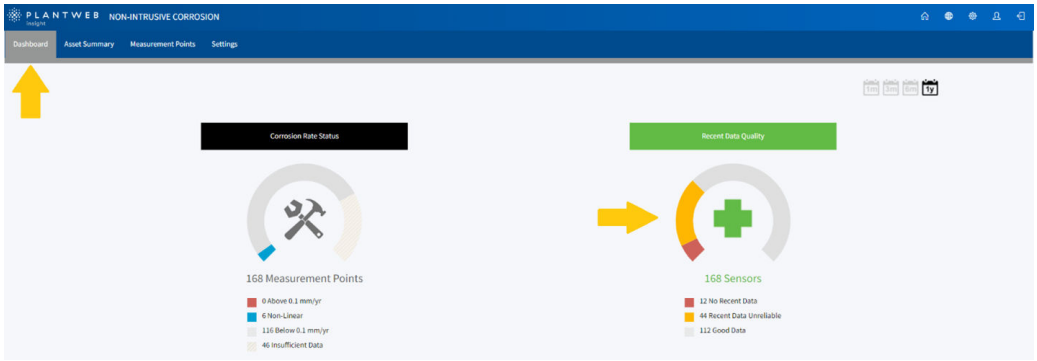
To benefit from Temperature Compensation, you must select the appropriate pipe material. If the Pipe Material is left as the default value of “Not Defined”, it will be treated as Carbon Steel.

To be able to use the Remaining Life features, you must also add the nominal thickness and the retirement thickness for each measurement point.

4 How to check the status of your Permasense sensors

The Dashboard shows a breakdown of the statuses of all your Permasense sensors on the Recent Data Quality horseshoe.

Figure 4-1: Dashboard recent data quality

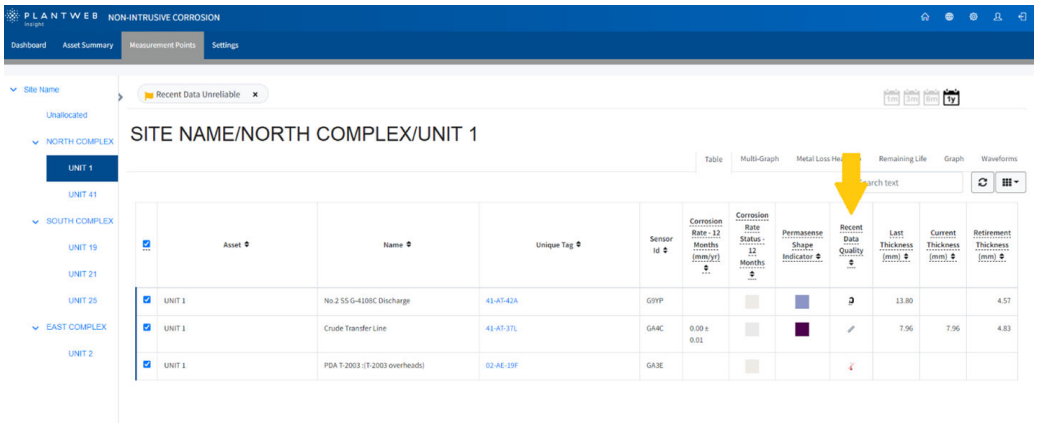


You can click on a coloured area of either the horseshoe or the legend below to display the measurement points with sensors with the selected status.

Recent data quality status	Description
No recent data	No data has been received in the last 3 or more days. This is most likely caused by issues with the wireless network causing the sensor to stop sending data. Refer to wireless troubleshooting in your gateway manual. Alternatively, the power modules in the devices could require replacement. Complimentary Plantweb Insight applications such as Power Management or Network Management can help to diagnose the issue. Permasense sensors purchased after May 2021 with a minimum version of firmware version 59 are required for compatibility with the Power Management application.
Recent data unreliable	Data has been received from the sensor, but it could not be used to determine a reliable thickness. See the Recent data unreliable categories information in the following section to understand more.
Good data	No action needed.

For more information on what is causing sensors with Recent Data Unreliable to have that status, click on the coloured area of the horseshoe, or the entry on the legend below, and review the icon in the "Recent Data Quality" column of the Measurement Points Table view.

Figure 4-2: Measurement points table view



Recent data unreliable categories

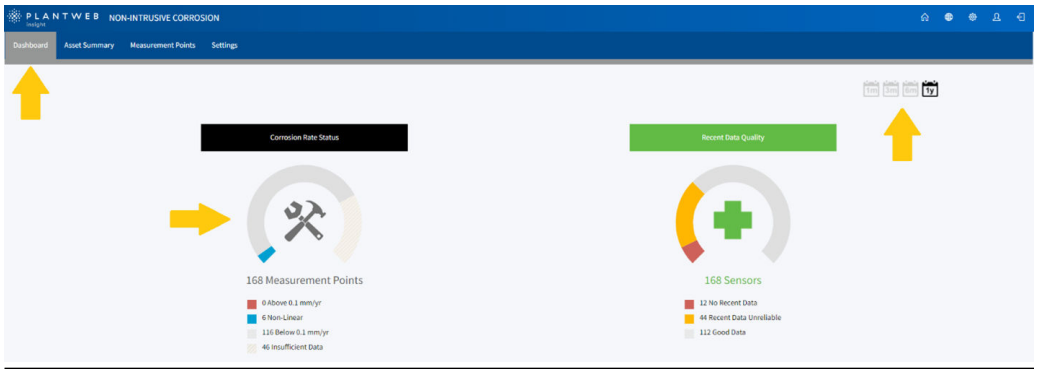
Icon	Name	Description
	Low amplitude	Waveforms do not have the expected characteristics. Examine the sensor to check that it is properly installed and not damaged or covered in dirt. Damaged sensors will need to be replaced.
	Unreliable thickness	Waveforms show distortion caused by changes to the metal surface (roughness or scale layer build up). The calculated thickness will be unreliable. Additional sensors may need to be installed in the area to be able to provide reliable measurements during periods of change.
	Unreliable temperature	Temperatures recorded are outside of the expected range and thermocouple failure is likely. If temperatures are inaccurate, turn off temperature compensation on the Graph view to improve results. Damaged sensors will need to be replaced.
	Data received	No data has been received in the last 3 or more days. This is most likely caused by issues with the wireless network causing the sensor to stop sending data. Refer to wireless troubleshooting in your gateway manual. Alternatively, the power modules in the devices could require replacement. Complimentary Plantweb Insight applications such as Power Management or Network Management can help to diagnose the issue.

5 Understand your corrosion

5.1 Site level breakdown

The dashboard shows a corrosion rate status breakdown for all measurement points with sensors currently attached.

Figure 5-1: Dashboard corrosion rate status



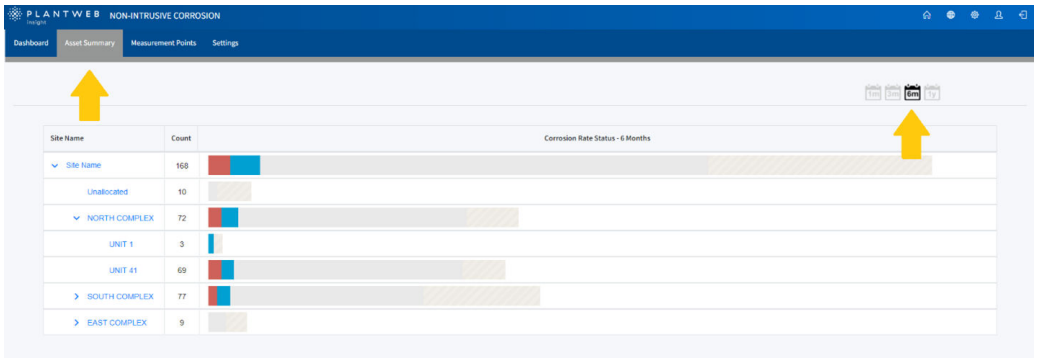
You can click on a coloured area of either the horseshoe or the legend below to display the measurement points with corrosion rates that have the selected status. The period over which corrosion is measured is selected using the calendar control on the top right.

Corrosion rate status	Description
Above 0.1 mm/year	High corrosion detected. The line of best fit through the measurements for the selected period shows a rate of 0.1 mm/year or more.
Non-Linear	The data for the selected period is not a good fit to a straight line. Look at the data for these measurement points for more information. Variation in measurements may be because of waveform distortion caused by changes to the metal surface (roughness or scale layer build up). Additional sensors may need to be installed in the area to be able to provide reliable measurements during periods of change. Alternatively, the data could be non-linear due to varying rates of corrosion over the selected period.
Below 0.1 mm/year	Low corrosion detected. The line of best fit through the measurements for the selected period shows a rate of less than 0.1 mm/year.
Insufficient data	There are less than the minimum number of measurement events or the number of days spanned by the data is below the minimum number of days for the selected period. Refer to the Glossary for the minimum number of measurement events required. This may be because a sensor has only been recently installed or the sensor may have stopped sending data.

5.2 Asset level breakdown

Corrosion Status is broken down by asset on the Asset Summary.

Figure 5-2: Asset summary

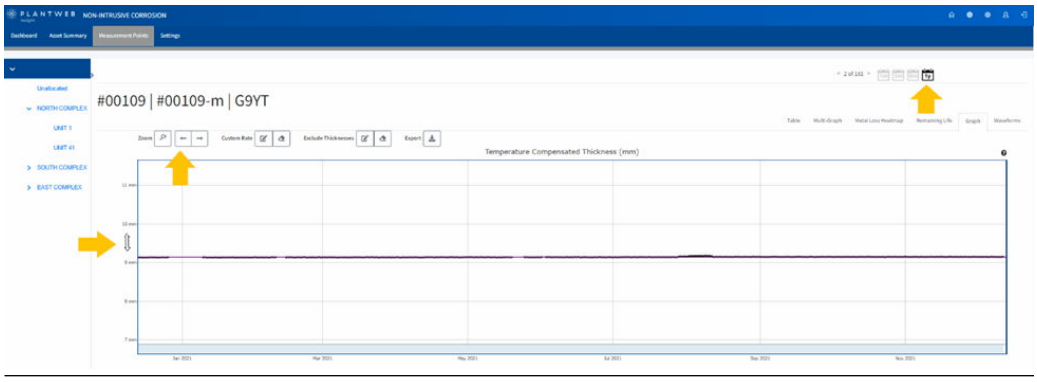


The data presented on the Asset Summary will be a summary of the data for the period selected using the calendar control on the top right. You can click on an asset name to display the measurement points in an asset, or you can click on a coloured area of the chart to display only the measurement points in the asset that have the selected status.

5.3 Viewing a single Measurement Point

Information for a single measurement point can be seen on the Graph view. The information initially shown will be for the period selected with the calendar control. You can adjust the data being shown using the calendar controls, the zoom controls or by hovering over the axis until a double headed arrow appears and then clicking and dragging the arrow. If you hover at the corner of the graph, you will get a diagonal double headed arrow. Clicking and dragging on this arrow allows you to move both axes at the same time.

Figure 5-3: Changing the range of data displayed



5.3.1 Blank graph and missing values

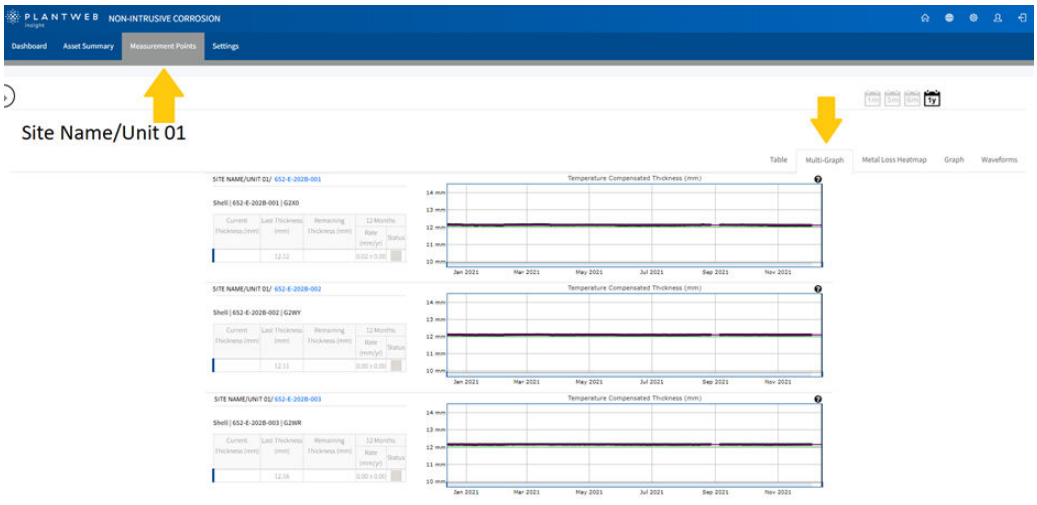
If the graph is blank, the data is likely to be outside of the range displayed. Zoom out to see older data or higher/lower thicknesses. Zooming out is possible by hovering your cursor in the corners of the graph, and dragging when the icon appears.

For each measurement point, values are calculated such as corrosion rates. Where there is insufficient data to calculate a value, it will usually be displayed as blank. For example, if you only have 6-months' data, the 12-month corrosion rate will be blank.

5.4 Determining whether corrosion is general or localised

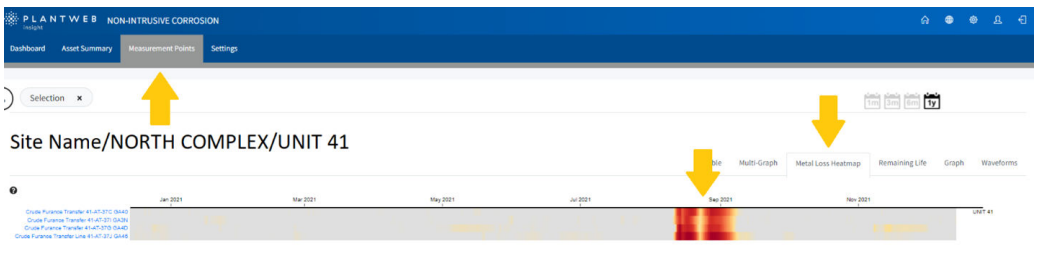
The corrosion at different measurement points can be compared either using Figure 5-4 or Figure 5-5 to see whether changes happened at the same time across several measurement points.

Figure 5-4: Multi graph view



The Multi graph view above shows that there has been no activity over the period displayed.

Figure 5-5: Metal loss heatmap

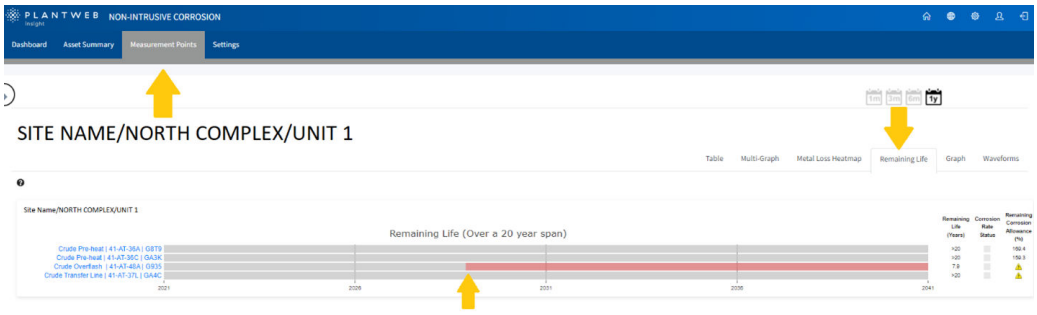


The Metal loss heatmap above shows a period where there is activity at all the Measurement Points at the same time.

6 Planning site maintenance

The Remaining Life View (Figure 6-1) shows when each measurement point is predicted to reach its Retirement Thickness. The remaining life is calculated by projecting the line of best fit forward in time until it meets the Retirement Thickness. Each data period has its own corrosion rate and so could predict a different remaining life.

Figure 6-1: Remaining Life view



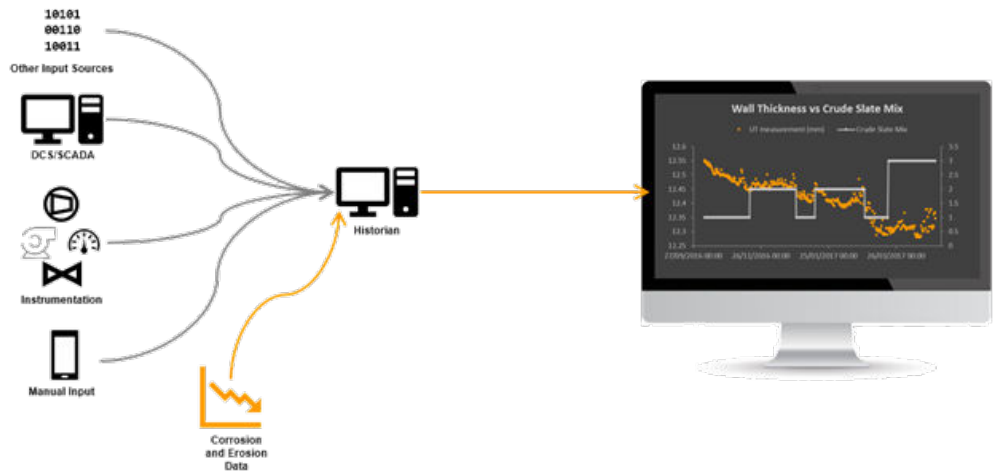
The Remaining Life view shows one Measurement Point with less than 20 years before the retirement thickness will be reached. Unless processing conditions are changed, maintenance should be planned for before the predicted retirement date.

7 Exporting data to external systems

Data export is used to bring wall thickness and corrosion data into third party historians or control systems. This is beneficial when performing root cause analysis to understand why corrosion happened at a specific time, for example by correlating to a specific process variable. Permasense corrosion and erosion data is powerful in its' native form; with reliable, accurate wall thickness information at your fingertips, you have more insight than ever before into the condition of your facility.

Considerable value can also be gained from considering this data not as an 'island' of data, but rather as another information source to plug in to your process historian.

Permasense corrosion and erosion data has been shown to be invaluable when optimising processes in your facility. Multiple case studies from our global install base have shown the value of correlating your wall thickness data with process data.



There are three methods of data export from the Non-Intrusive Corrosion application: Modbus TCP, OPC UA and a REST API.

This section covers configuring Modbus TCP or OPC UA clients to read or import Non-Intrusive Corrosion data. It is designed to be consumed by IT or process personal, looking to import corrosion data to their process historian, DCS, data lake, or other enterprise data storage solution. For information on using the REST API, please reach out to your Emerson representative for further information.

Before exporting data to external systems, make sure that you have first set up the asset hierarchy as detailed in the Creating an asset hierarchy, and assigned the unique tags you want to each measurement point, as per the Adding Measurement Point information.

7.1 Modbus® export

1. Modbus Transmission Control Protocol (TCP) outputs are predefined in the Non-Intrusive Corrosion application for every device. See table below.

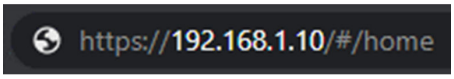
Variable	Variable Path
Thicknesses	
Compensated Thickness	compensated_wall_thickness
Uncompensated Thickness	uncompensated_wall_thickness
Permasense Shape Indicator	Permasense_shape_indicator
Corrosion Rates	
1 Month	1_month_corrosion_rate
3 Month	3_month_corrosion_rate
6 Month	6_month_corrosion_rate
12 Month	12_month_corrosion_rate
Temperatures	
Ambient Temperature	sensor_head_temperature
Pipe Temperature	pipe_temperature
Sensor Troubleshooting	
Peak Detection	peak_detection_error
Temperature Compensation	temperature_compensation_error
Low Amplitude	low_amplitude

Note
Registers are only generated when sensor data is available. E.g. 12-month corrosion rate will not populate until a rate can be calculated.

2. Modbus TCP registers and tags are automatically populated in Plantweb Insight and cannot be changed. The Modbus TCP port for Plantweb Insight is 502.
3. Registers and codes can be found in each app by going to the app Settings (Global Settings) and then selecting Download Modbus Mapping.
4. A CSV file will open with the listed registers and tags.

7.2 OPC UA export

1. Identify the Plantweb Insight server IP address or domain name.
   This can be done by browsing to Plantweb Insight in the browser and verifying the address in the URL bar.



2. OPC UA server provides an endpoint URL for both secure and insecure connections. Users need to set the correct URL on the client-side to make sure the connection can establish successfully. The URL format is:
   opc.tcp://<opcua_server_ip>:<port>/OpcUAServer

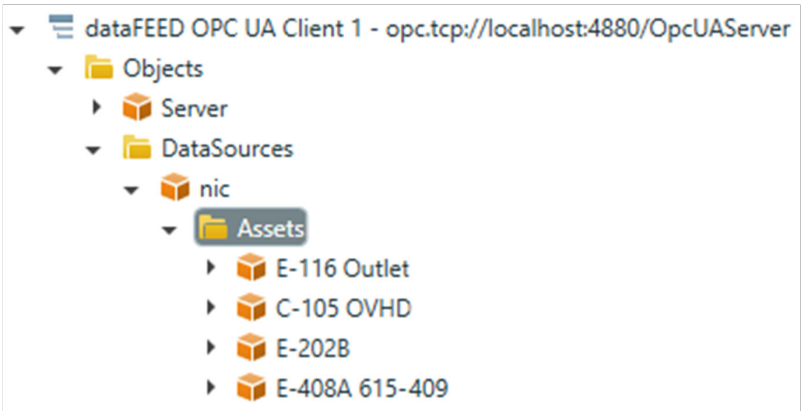
- Insecure endpoint URL example. Default insecure connection port is 4880

opc.tcp://<opcua_server_ip>:4880/OpcUAServer

- Secure endpoint URL example . Default secure connection port is 4884

opc.tcp://<opcua_server_ip>:4884/OpcUAServer

3. Replacing the <opcua_server_ip> with your server IP address or domain name and choosing either the insecure or secure port will give you your fully formed URL. For example:
   opc.tcp://192.168.1.10:4880/OpcUAServer
4. Asset variables are published from applications and organized by application and asset.
   Non-Intrusive Corrosion asset variables hierarchy inside OPC UA server:



Note
The OPC structure shown above is built only when data is available. Tags for uncalculated variables may be missing until they are calculated. Upon system restart, a new measurement must be taken before the OPC UA register is repopulated.

5. The variable path for asset variables is shown below.

Variable	Variable path
Thicknesses	
Compensated thickness	Objects/DataSources/Non-Intrusive Corrosion/Assets/<tag>/ compensated_wall_thickness
Uncompensated thickness	Objects/DataSources/Non-Intrusive Corrosion/Assets/<tag>/ uncompensated_wall_thickness
Permasense shape indicator	Objects/DataSources/Non-Intrusive Corrosion/Assets/<tag>/ Permasense_shape_indicator

Corrosion rates	
1 Month	Objects/DataSources/Non-Intrusive Corrosion/Assets/<tag>/ 1_month_corrosion_rate
3 Month	Objects/DataSources/Non-Intrusive Corrosion/Assets/<tag>/ 3_month_corrosion_rate
6 Month	Objects/DataSources/Non-Intrusive Corrosion/Assets/<tag>/ 6_month_corrosion_rate
12 Month	Objects/DataSources/Non-Intrusive Corrosion/Assets/<tag>/ 12_month_corrosion_rate
Temperatures	
Ambient temperature	Objects/DataSources/Non-Intrusive Corrosion/Assets/<tag>/ sensor_head_temperature
Pipe temperature	Objects/DataSources/Non-Intrusive Corrosion/Assets/<tag>/pipe_temperature
Sensor troubleshooting	
Peak detection	Objects/DataSources/Non-Intrusive Corrosion/Assets/<tag>/ peak_detection_error
Temperature compensation	Objects/DataSources/Non-Intrusive Corrosion/Assets/<tag>/ temperature_compensation_error
Low amplitude	Objects/DataSources/Non-Intrusive Corrosion/Assets/<tag>/low_amplitude

Note
Refer to Adding Measurement Point information to set up asset and tag values. The default asset is ‘unallocated’ and the default tagging begins as ‘#00001’ and continues numerically.

8 Glossary

8.1 Corrosion rate calculation thresholds

Corrosion Rates are calculated using linear regression from which we get a gradient (corrosion rate) and a 95% confidence interval which gives an assessment of how well the data fits a straight line.

Period	Minimum number of Measurements	Minimum days spanned by Measurements	Acceptable Confidence Limit
1m	50	27	0.8
3m	75	81	0.3
6m	150	162	0.05
1y	304	329	0.02
All Data	50	Not applicable	Not applicable

If there are less than the minimum number of measurements in the period, or if the number of days between the first and last measurement in the period is less than the minimum number of days spanned, no corrosion rate will be calculated, and the corrosion rate status will be “Insufficient Data”.

If the 95% confidence interval is greater than the acceptable confidence limit, the corrosion rate status will be “Non-Linear”.

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For more information: **Emerson.com**

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