FilmTec™

DUPONT™

Manual | Reverse Osmosis

RO Operations Advisor Suite

Version 4

September 2026

Water Solutions

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1 Introduction to the RO Operations Advisor Suite

The RO Operations Advisor Suite is a suite of tools designed to help customers analyze their RO/NF plant operational data and provide recommendations for improved performance. It has the following components:

RO Cleaning Advisor: The RO Cleaning Advisor is designed to help customers analyze their historical plant performance to understand their cleaning effectiveness and types of fouling/scaling encountered as well as suggest an improved cleaning schedule.

RO Lifetime Advisor: The RO Lifetime Advisor is designed to help customers analyze their historical plant performance to understand long-term changes in performance and predict a potential replacement schedule.

The RO Operations Advisor Suite is currently available in the DuPont Water App environment. There are plans to offer this capability to process live data or to work as an API inside another software package.

This manual provides a detailed description of how to use the RO Operations Advisor Suite of tools. In addition:

- The user can get assistance by clicking on the information icons (ⓘ) in the tool.
- The user can get helpful tips on how to resolve some challenges by clicking on the question icon (?)

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2 How to run the RO Operations Advisor Suite

The RO Operations Advisor Suite can be used by following these steps:

a. Logging into the RO Operations Advisor (directly or through the WaterApp environment)
b. Creating a plant in the web tool corresponding to the physical water treatment plant
c. Uploading the plant performance data
d. Selecting the subset of data to be analyzed by picking the relevant columns
e. Confirming reference conditions
f. Defining CIP conditions (optionally, CIP history)
g. Confirming that the data is normalized, and if not, normalizing the data
h. Selecting which Advisor to run (Cleaning or Lifetime)
i. Performing the analysis through the selected Advisor
j. Generating results and reports

2.1 Accessing the RO Operations Advisor

2.1.1 Directly Accessing the RO Operations Advisor

The RO Operations Advisor is available at: RO Operations Advisor website . When users access the link, they arrive at a landing page. shown in Figure 1. The user can click on 'Try now' to get started .If the user was previously granted access to the tool, the user can then log in and access the tool as shown in Figure 2. Otherwise, the user would need to create an account by clicking on the "Sign up here" link to go to the sign-up page as shown in Figure 3. The user is encouraged to select "Resource Center Premium" as one of the choices before completing the signing up process. In the back end, the user request is processed, and an e-mail is sent to confirm receipt of the request, and another e-mail to confirm the access grant.

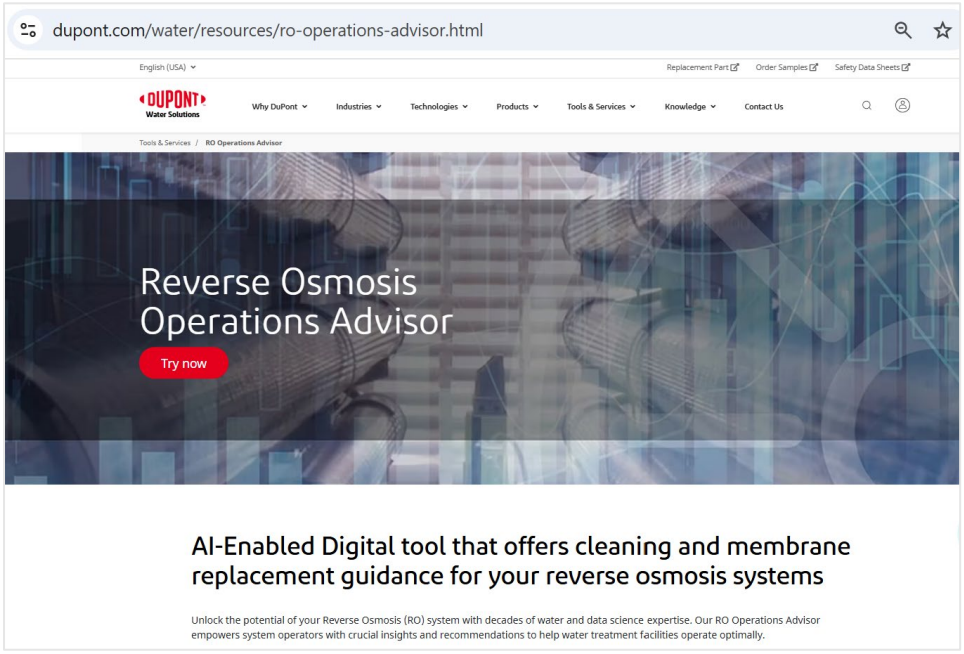


Figure 1: The RO Operations Advisor landing page

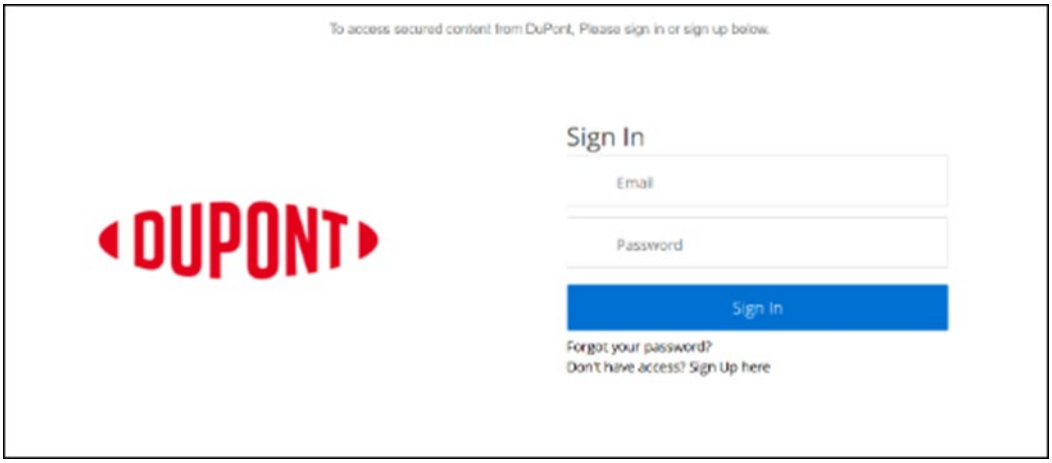


Figure 2: The RO Operations Advisor sign in page

Figure 3: User registration page for access to the RO Operations Advisor

2.1.2 Accessing the RO Operations Advisor through the WaterApp Environment

The Water App Environment is available https://dupontwaterapp.com/ or by navigating to the DuPont WaterApp from the DuPont Water Solutions website as shown in Figure 4 and Figure 5.

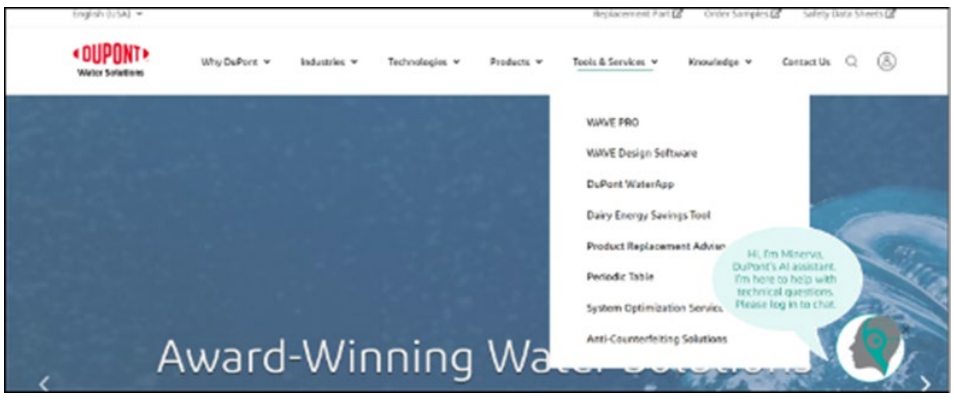


Figure 4: Navigation to the DuPont Water App from the DuPont Water Solutions website

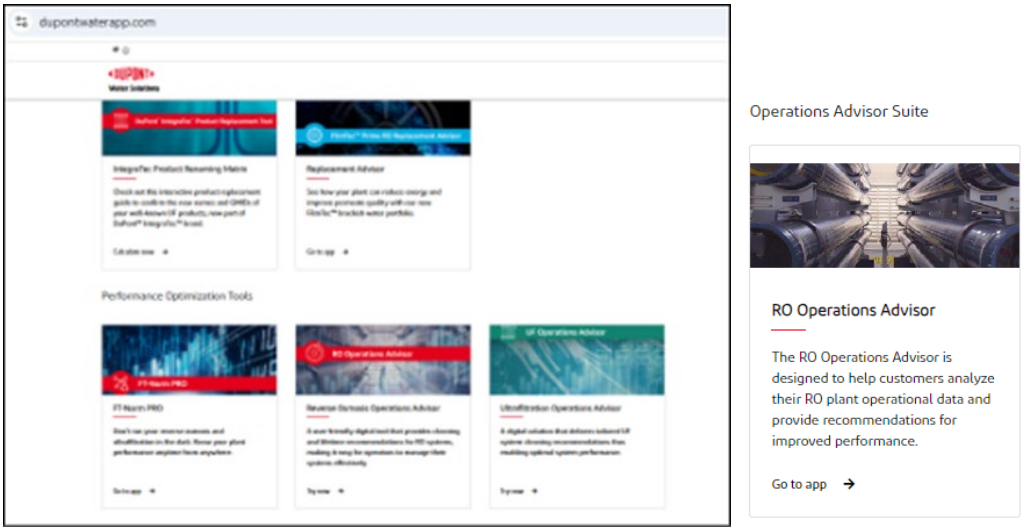


Figure 5: The RO Operations Advisor tile in the Water App

Clicking on "Try now" in the RO Operations Advisor tile would lead the user to a sign in page shown in Figure 2. If the user was previously granted access to the tool, the user can then log in and access the tool. Otherwise, the user would need to create an account by clicking on the "Sign up here" link to go to the sign-up page as shown in Figure 3. The user is encouraged to select "Resource Center Premium" as one of the choices before completing the signing up process.

2.2 Creating a plant in the web tool corresponding to the physical water treatment plant

The RO Operations Advisor Projects Page opens as shown in Figure 6. Users can see a Sample Plant by default on their screen.

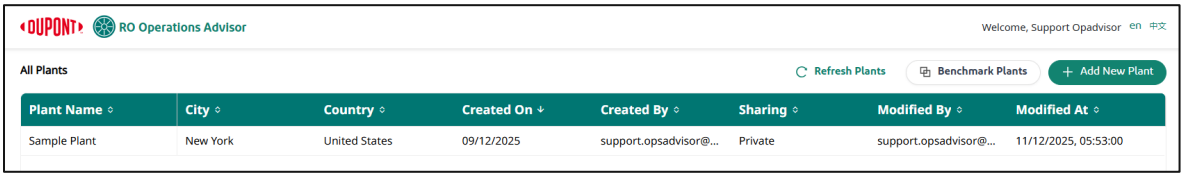
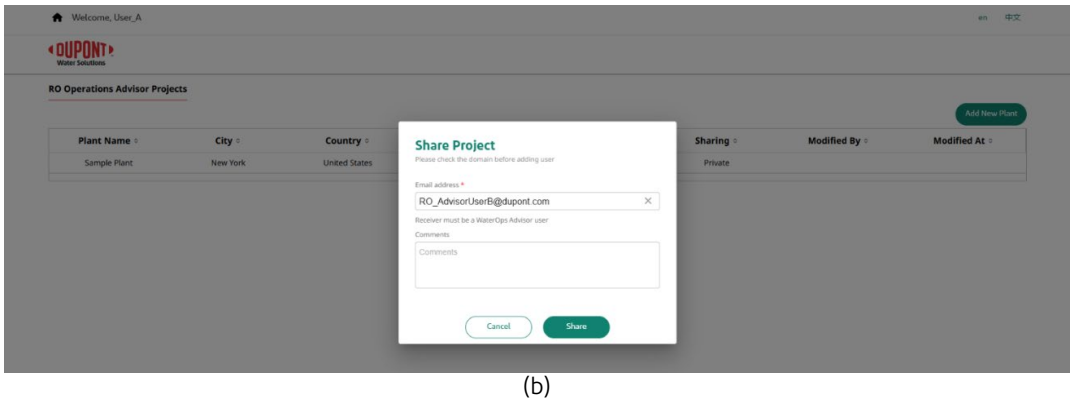


Figure 6: RO Operations Advisor Projects page

Note that the RO Operations Advisor allows the user to share projects with others by selecting a project of interest and clicking on the share icon as shown in Figure 7. The user can then specify the e-mail of the recipient. The recipient will receive an e-mail notification that a project is being shared with them and a link to the RO Operations Advisor.

(a)



(b)

Figure 7: Project sharing popup

2.2.1 Creating a new plant

Users can click on the Add New Plant in Figure 6 or Figure 7 to create a plant. The tool asks the user how many trains are in this plant as shown in Figure 8. Depending on the number of trains, the tool would generate a plant definition screen as shown in Figure 8. The number of trains is reflected in the "Number of trains" field in Figure 9.

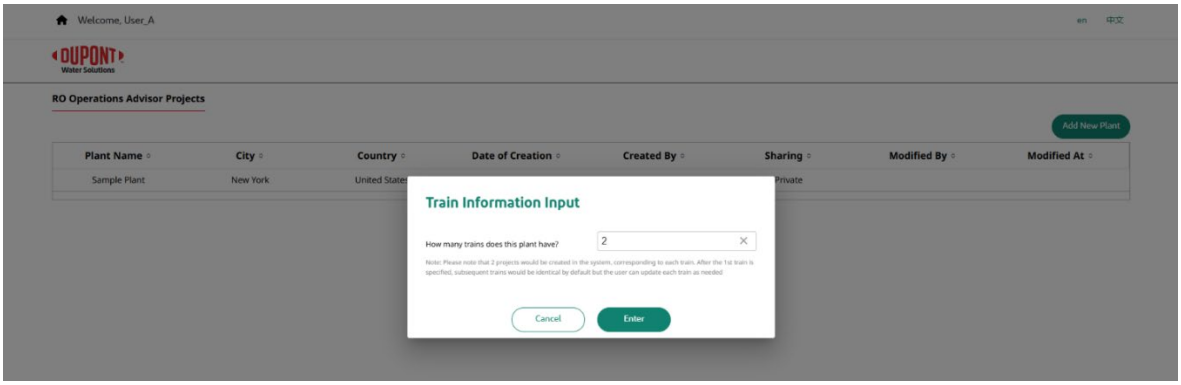


Figure 8: Train number popup

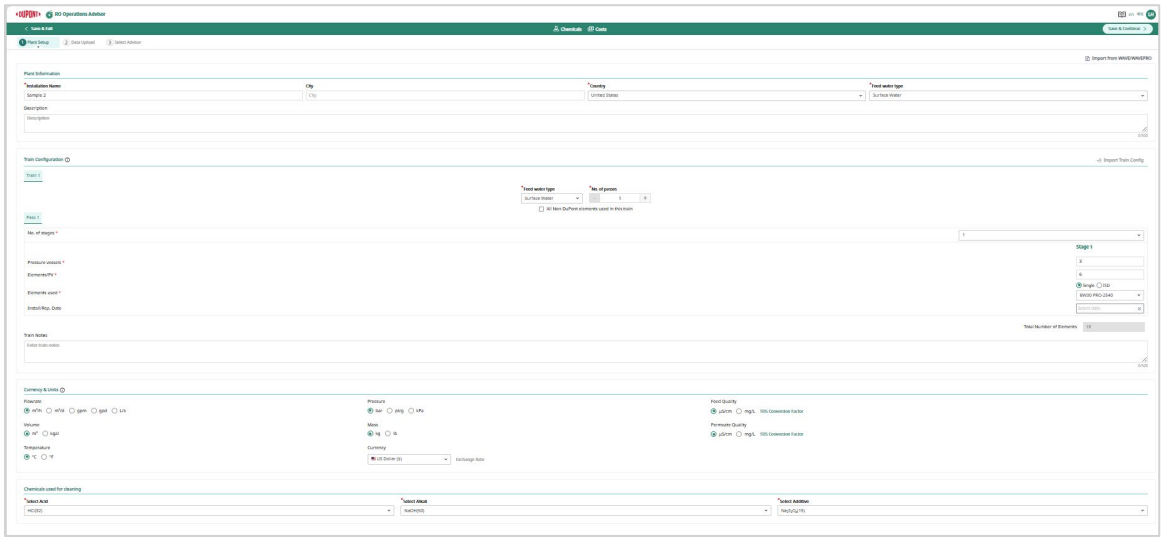


Figure 9: Plant setup window

The user is required to enter the plant name, country and water type. The plant name and country information are used to define the dataset. The water type is used to define some default variable values in the Lifetime Advisor. The Description and City Name fields are optional.

The number of trains defined by the user in the previous step (Figure 8) is now used to facilitate the system definition.

2.2.2 Defining the system configuration

Based on the defined number of trains, tabs would appear as shown in Figure 10 corresponding to each train.

For each train, the user would need to define the variables seen in Table A1. While the fields are populated by default, the user can specify these variables manually or import a WAVE or WAVE PRO design file to import the values directly. Some of the limits in the RO Configuration are shown in Table 2.

Users can import configurations from WAVE or WAVE PRO designs by clicking on the 'Import from WAVE/WAVE PRO' link at the top right corner of Plant Setup page (Figure 9). This would lead to the popup shown in Figure 10 (a), Users can drop in the relevant WAVE/PRO file or navigate to the appropriate folder. Once the right file is uploaded, the popup shown in Figure 10 (b) appears. Users can proceed to extract the configuration, which leads to another screen where the user confirms details of what is being imported from the WAVE/PRO file (Figure 10 (c)) and assigns the configuration to the right train (Figure 10 (d)). This assignment is a required step.

Please note that users can import units, currencies, utility costs and a chemical library from the WAVE/PRO file.

For manual specification of the configuration, the user can fill in the fields in Figure 9 as described in Table 1. provides the defaults and limits of some of the fields.

Table 1: Definition of the system configuration using a manual approach or importing a WAVE/PRO file

Variable	Manual Definition	WAVE/PRO Import
The number of passes	This is set at 1 by default . The value is limited to 1,2,or 3,in accordance to limits in WAVE/PRO. It can be edited by the user. If there are multiple passes, more tabs would appear corresponding to each pass	this is taken from the selected WAVE/PRO design file
the number of stages for each pass:	This is set at 1 by default and is limited to integers between 1 and 8. It can be edited by the user. If there are multiple stages, additional columns of fields will appear in the tab corresponding to the pass	
the number of pressure vessels for each stage of each pass	This is set to 3 by default and is limited to integers between 1 and 100000 in accordance to limits in WAVE/PRO. It can be edited by the user	
the number of elements per pressure vessel for each stage of each pass	This is set to 6 by default and is limited to integers between 1 and 8 n accordance to limits in WAVE/PRO. It can be edited by the user.	

Variable	Manual Definition	WAVE/PRO Import
RO/NF Elements used	Here the user can start by defining whether or not the pressure vessel includes a single type of element (by selecting the 'single' radio button, which is selected by default') or has a mix of element types (by selecting the 'ISD' radio button). Selecting the ISD radio button leads to the 'Edit ISD' button (as shown in Figure 9). On clicking the 'Edit ISD' button, a popup screen appears in which the user can select the element at each position (as shown in Figure 10). The background colors in the ISD popup of Figure 11 correspond to an element type. The popup populates the dropdown from left to right by default, with users able to specify a different element type per position if desired Users can specify the RO/NF element from a dropdown menu of DuPont elements or by writing the name of the element in the box (for non-DuPont elements). Users can indicate that non-DuPont elements are used throughout the train by checking the box "All non-DuPont elements used in this train". Users have to manually enter the names of non-DuPont elements.	this is taken from the selected WAVE/PRO design file However, WAVE/PRO design files only contain DWS elements – thus the user would have to manually define configurations that include non-DWS elements
Installation/ Replacement Dates	The installation/replacement date is optionally defined for each stage. The values would be needed for the Lifetime Advisor. This date is also used to set the period based on which the Cleaning Advisor would generate predictions. It is populated by default to be the earliest date for which data is available. In the Lifetime Advisor, the tool would examine the data to identify a potential replacement date and suggest this date as an entry to the user. The user can enter a specific installation /replacement date	This information is not recorded in WAVE/PRO files and needs to be entered manually

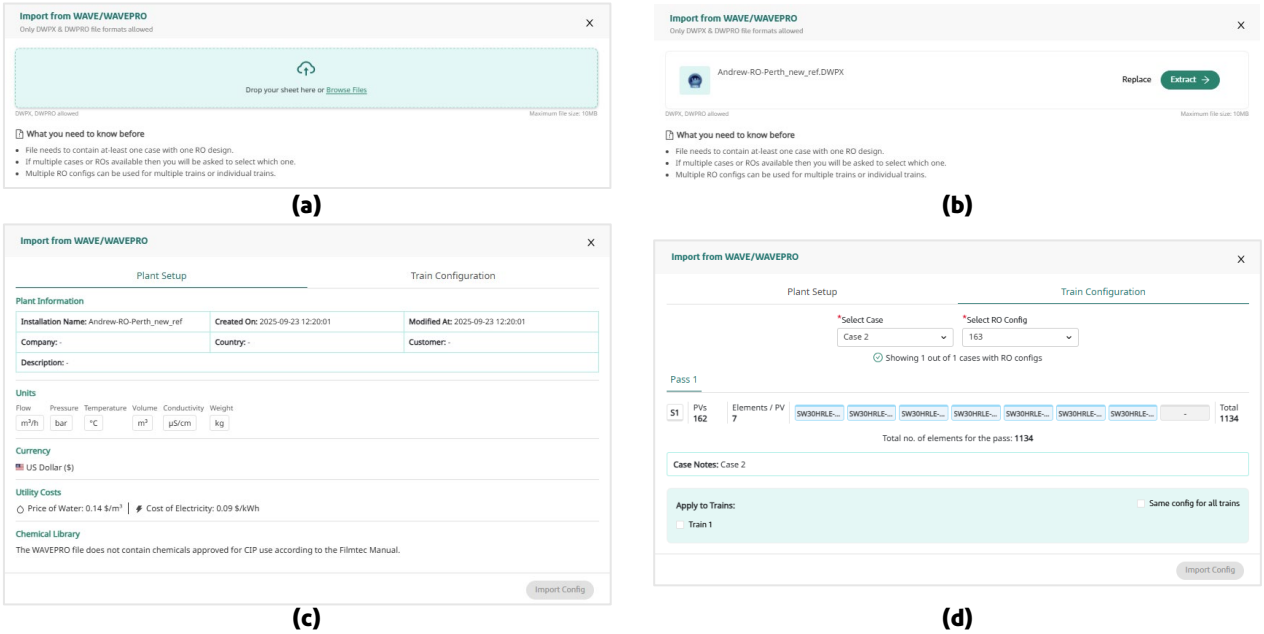


Figure 10: Popup for importing a system configuration from a WAVE/PRO file

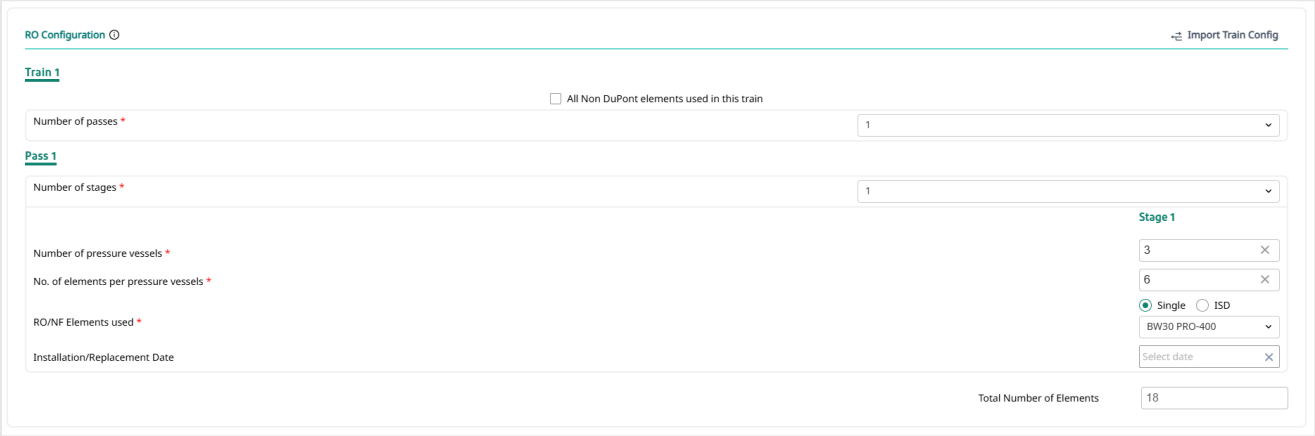


Figure 11: RO Configuration window

Figure 12: ISD Configuration window

Table 4 describes the limits and default values for the various fields used to define the RO/NF system configuration

Table 2: RO/NF System Configuration input fields: defaults and limits

Variable	Default and [Range]	Variable	Default and [Range]
Number of trains	**1** [1, 20]	Number of pressure vessels in a stage	**3** [1, 100000]
Number of passes	**1** [1, 3]	Number of elements per pressure vessel	**6** [1, 8]
Number of stages	**1** [1, 3]		

Importing Train Configurations

If users have defined the configuration of one train, they can import the configuration details (the number of passes/stages/pressure vessels/elements and the element types) for other trains. The first step would be to click on the 'Import train details' link in Figure 11. This would lead to the popup screen as shown in Figure 13. Users can specify the 'source' train and multiple 'destination' trains.

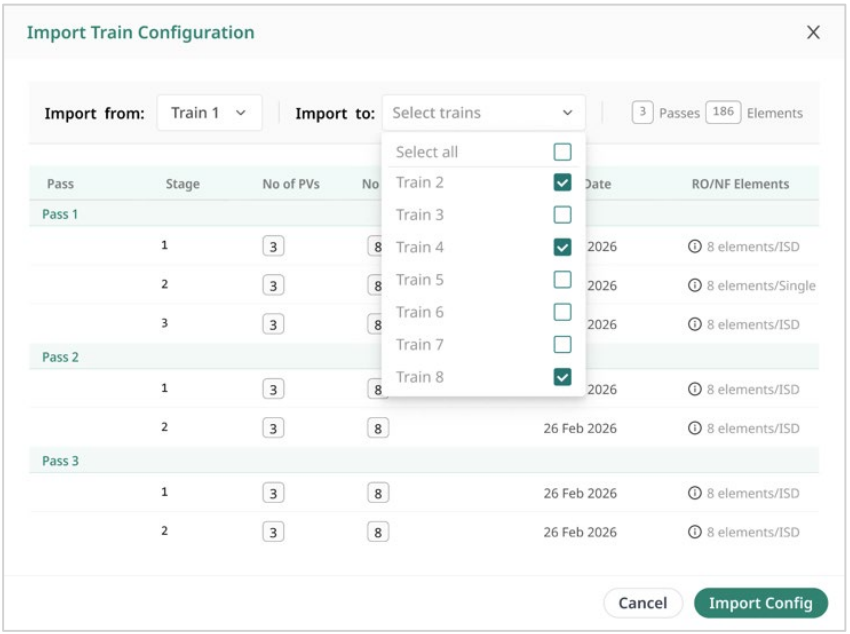


Figure 13: The Import Train Configuration window

The tool would go through the definition of each train to ensure that all required fields are populated before the user can proceed to the next screen (Data Setup).

2.2.3 Selecting Currencies and Units

The Currency/Units section (shown in Figure 9) allows the user to specify the units of measure to be used in the upcoming analysis. The user should ensure that the same units are being used in the data to avoid unit conversion issues. However, if the user wants to regenerate the results e.g. in the Prediction/Recommendation section, with a different set of units, the user can do so by returning to this screen and rerunning the analysis.

The user has the option to use conductivity or TDS values to define feed and permeate quality (concentration). There are default values for converting between the two units – however the user can update conversion factors.

Similarly the user has a choice between three currencies for cost calculations: USD, EURO and RMB. The exchange rate can be adjusted by the user.

The user can import a WAVE/PRO file and import the corresponding currencies and units as well.

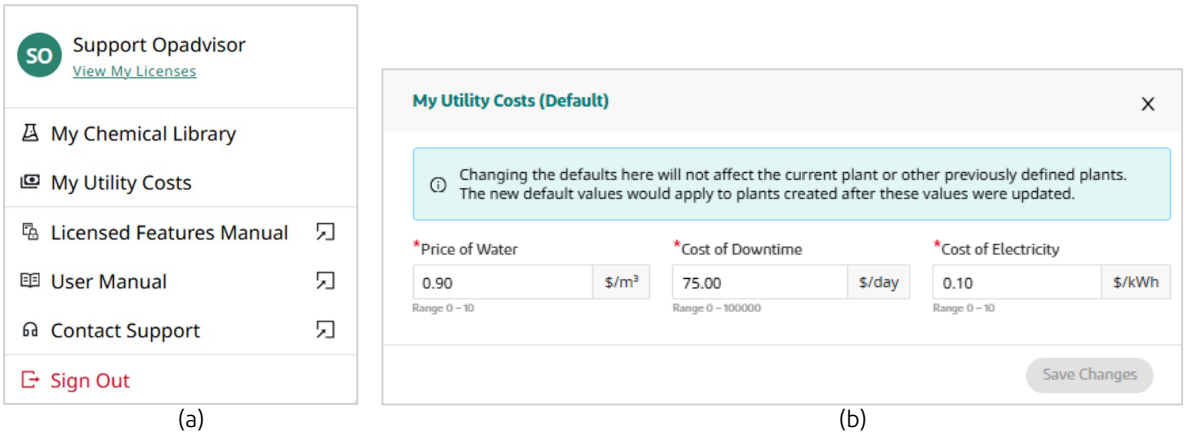
2.2.4 Specifying Costs

The costs of energy, downtime and chemicals, as well as the price of water, can be specified in the tool. They are grouped into utility costs (electricity, water, downtime) and chemical costs. All of these fields have default values.

Specification of chemical costs are described along with the specification of chemicals in the next section.

Users can define a set of utility cost values that can be used by default for all their future projects by clicking on their profile button at the top right corner of the screen as shown in Figure 14(a). Clicking on 'My Utility Costs' brings up Figure 14(b).

Alternatively, users can click on the 'Costs' button in the green ribbon shown in Figure 8, which leads to the Plant Utility Cost popup shown in Figure 15. Please note that the user can make the plant utility costs their default utility costs by clicking on 'Use the above utility costs as the new default values'.



(a) (b)

Figure 14: Default Utility Cost value specification (a) Profile access (b) My Utility Costs popup

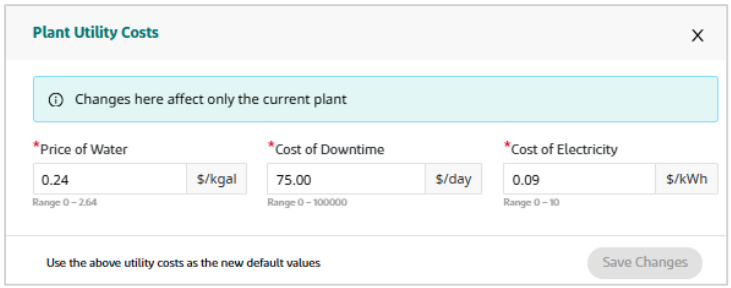


Figure 15: Plant Utility Cost value specification

2.2.5 Specifying Chemicals

Users can now pick the chemicals they intend to use. The chemicals were selected from the FilmTec™ Manual and include

- For acid CIPs: citric acid, hydrochloric acid, oxalic acid, phosphoric acid, sulfamic acid, sodium hydrosulfite (CIP Additive)
- For alkali CIPs: sodium hydroxide, sodium carbonate, sodium dodecyl sulfate (CIP Additive), tetrasodium EDTA (CIP Additive)

Users can define a set of utility cost values that can be used by default for all their future projects by clicking on their profile button at the top right corner of the screen as shown in Figure 14(a). Clicking on 'My Chemical Library' brings up Figure 16. Please note that chemical costs are specified per unit type (e.g. $/kg). Users can edit individual rows.

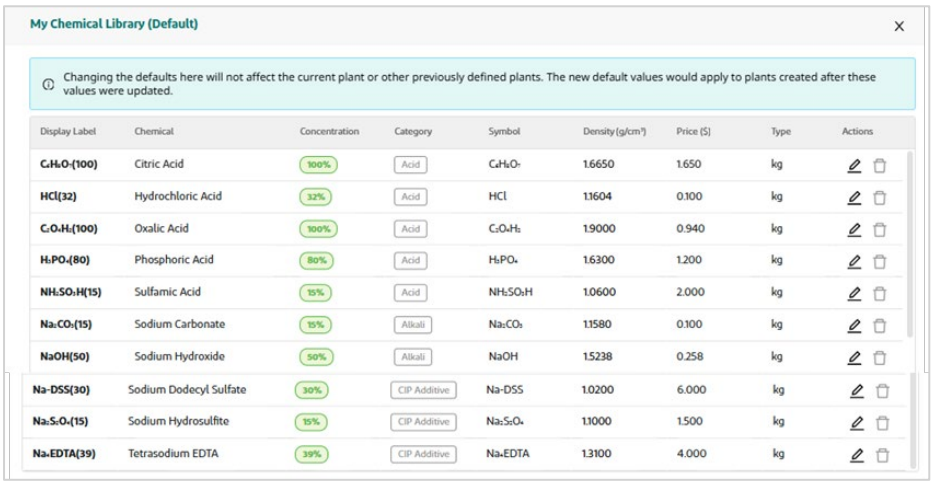


Figure 16: Default My Chemical Library specification

Alternatively, users can click on the 'Chemicals' button in the green ribbon shown in Figure 9, which leads to the Plant Chemicals popup shown in Figure 17. Please note that the user can make the plant chemical library their default chemical library by clicking on 'Use the above plant chemical costs and other values as the new default values.

Library

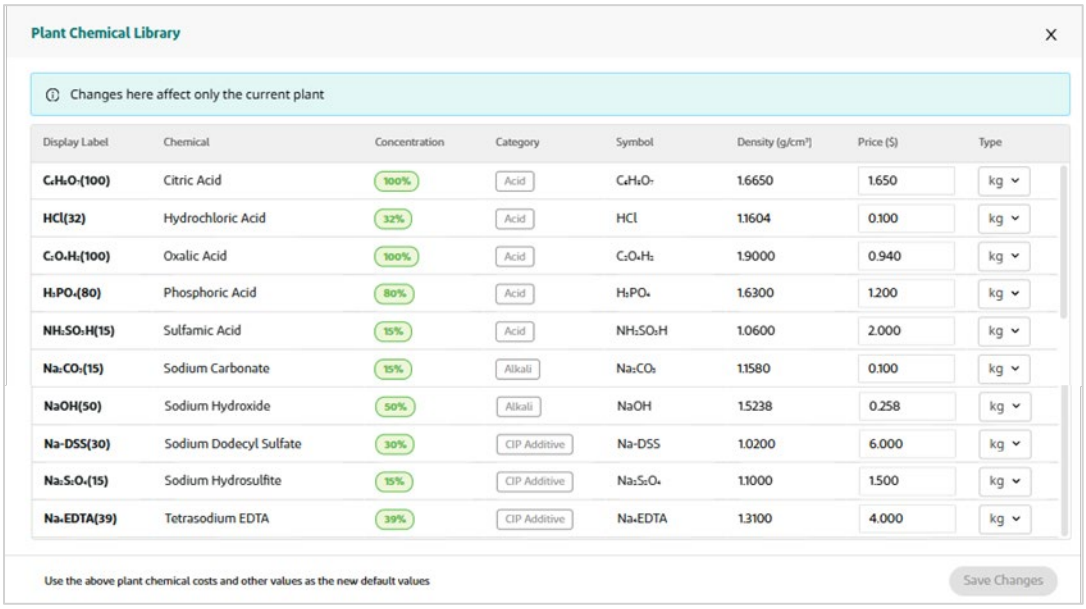


Figure 17: Plant Chemical Library specification

Users can select the chemicals for each category from the dropdown lists at the bottom of Figure 9. Currently only one chemical can be selected per category.

If the "Save & Exit" button is clicked in Figure 9, the user is returned to Projects page. If the "Save & Continue" button is clicked, in Figure 9, the user continues to the Data Setup screen.

2.3 Upload the plant performance data

Once a user completes the plant definition, the user can: upload the dataset, set reference conditions, specify CIP information, check for normalization and normalize data (if needed) on one screen. For a new plant, when the user clicks on 'Save & Continue' in the Plant Setup screen, the screen in Figure 18 is shown.

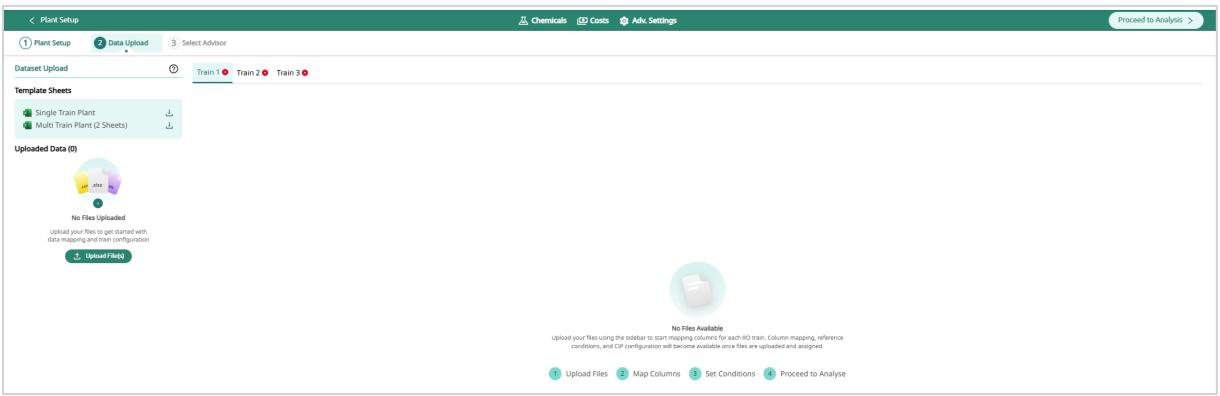


Figure 18: The Dataset Upload window for new plants

The user must upload a data file in the left panel. Once a data file is uploaded, the view changes as shown in Figure 19 to:

- allow the user to specify the data file and sheet in that datafile that corresponds to each train
- for the selected data file and sheet, specify the columns corresponding to the required fields

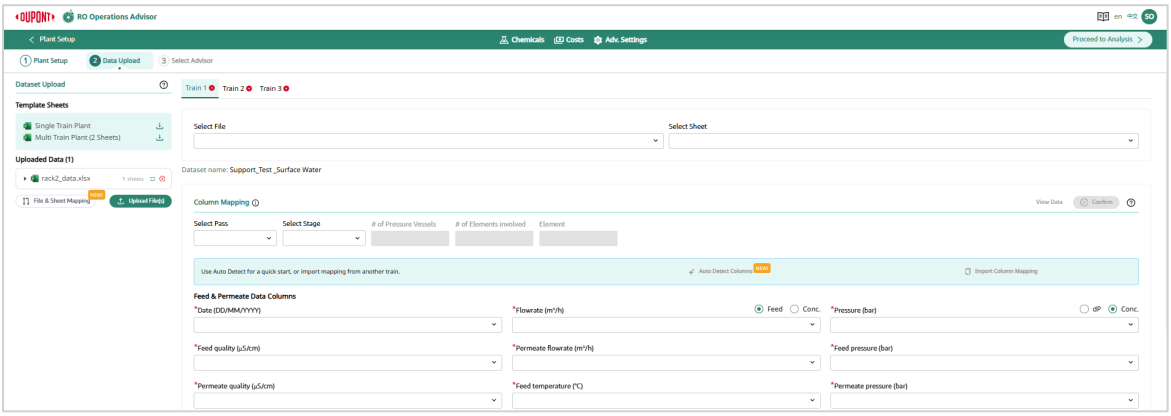


Figure 19: The Dataset Upload window after a data file is uploaded

If the data file has multiple tabs, the tool detects the tabs and informs the user that the tool would convert each tab to a separate file (Figure 20) and asks the user to select in which tab should be used. Currently all relevant data for that train must be in the same tab.

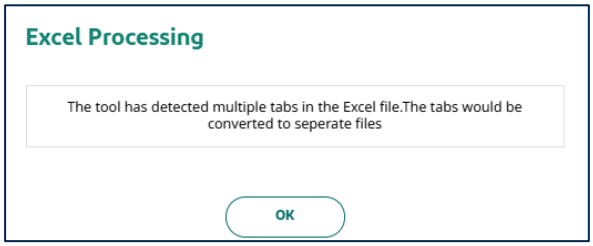


Figure 20: Excel tab identification popup

There are some requirements in the data file:

- The file needs to be in xls, xlsx or csv format
- The file needs to include the following variables:
- The date
- Feed or concentrate flowrate
- Feed pressure
- Feed quality (in TDS or conductivity)
- Feed temperature
- Permeate flowrate
- Permeate pressure
- Permeate quality (in TDS or conductivity)
- Concentrate pressure or pressure drop
- It is highly recommended to remove '/', µ, 0C or similar characters from column names.

The RO Operations Advisor can handle data from multiple stages or passes if the data is complete, i.e. if feed data for a stage/pass is used, the permeate data for the same stage/pass should be available.

Once the data is uploaded, a Dataset name is assigned based on the username (used to log into the tool), plant name, and water type. This dataset name is then used within the tool.

Sometimes it might be necessary to copy-paste the data into a blank .xlsx file. Links to blank templates are provided as shown in Figure 18 and Figure 19. This may not be necessary in most cases.

2.4 Selecting the subset of data to be analyzed by picking the relevant columns

Once the dataset is uploaded, the tool will identify columns that contain data and place them in a dropdown list as shown in Figure 21. The user is expected to select the right columns corresponding to the variables mentioned in the previous section. The dropdown lists enable searching for key words (e.g. 'permeate') to help identify the right columns. The user can optionally define which train, pass and stage the selected columns correspond to.

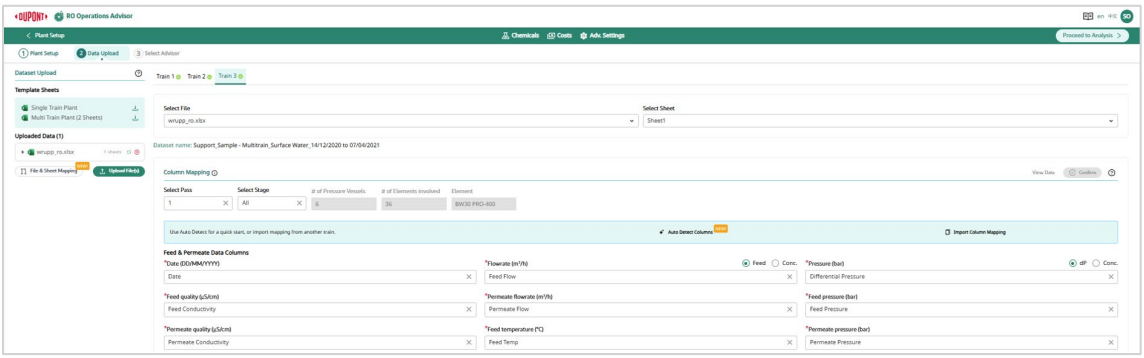


Figure 21: Column selection section

For multi-train configurations, users can import column mappings from one train to another. Once a user defines the column mapping for one train (e.g. for Train 1), the user can then select another train and click on 'Import column mapping' as shown in Figure 22. This leads to the popup shown in Figure 23.

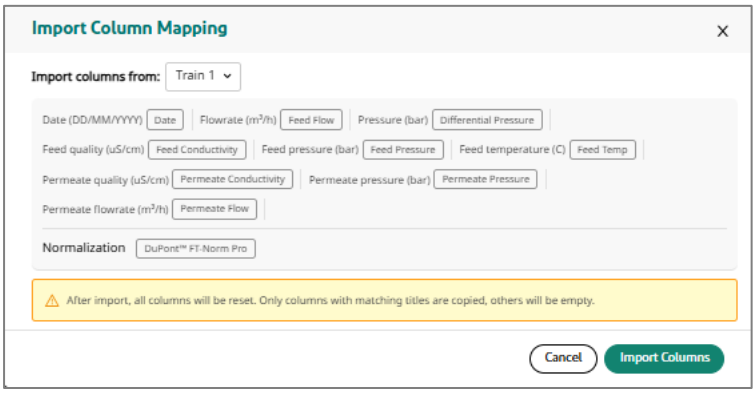


Figure 22: Import column mapping popup

Alternatively, users can perform a bulk mapping of files, sheets and columns by clicking on 'File & Sheet Mapping' in Figure 22. This leads to the popup screen shown in Figure 24.

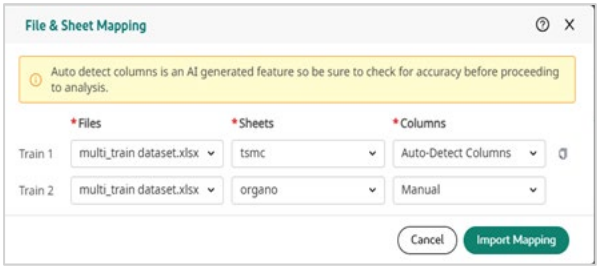


Figure 23: File & Sheet mapping popup

Please note that the user can manually map the columns or auto-detect the relevant columns in that sheet using AI. The user is expected to check the column mapping after autodetection.

Based on the identification of a train, pass and stage, the number of elements involved can be calculated. The user can click on 'View Data' as shown in Figure 22. This would enable generation of a popup table (Figure 24) that gives the user an opportunity to review the column selection and the data.

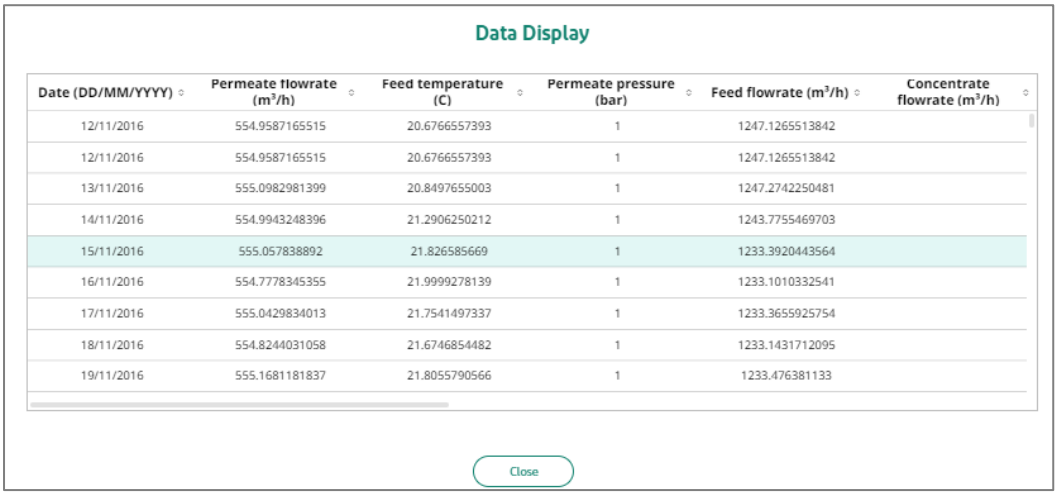


Figure 24: Data display popup

The user needs to complete the column mapping for every train and click on 'Confirm' before proceeding to the next section.

2.5 Normalization

The RO Operations Advisor requires the use of normalized values. This is accomplished in one of two ways:

- The user selects columns from the dataset that contain normalized values
- The user generates normalized values within the tool (by default)

The user can select one of these options as shown in Figure 25. By default, the tool would generate normalized values using the FTNORM routine.

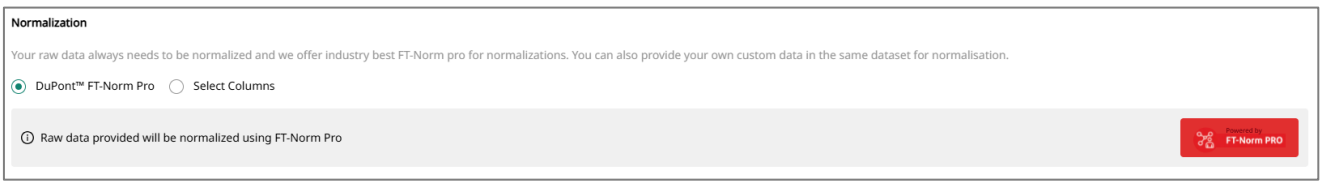


Figure 25: Selection of the Normalization approach

If the user chooses to select columns that contain normalized data, the tool allows the user to select the right columns from the data as shown in Figure 26. The tool would check the values to make sure that they are not too different from the corresponding FTNORM values. If they are, FTNORM values would be used in the analysis. However, if the user selected DuPont FT NORM PRO, the tool records this selection and waits to perform the normalization once the Reference Conditions are specified.

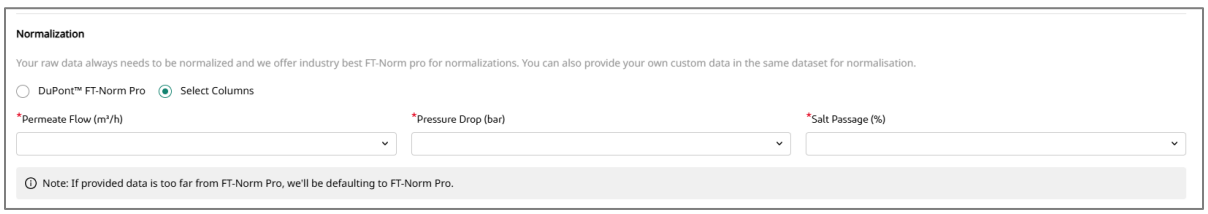


Figure 26: Selection of columns of normalized values

The Normalized Values are available for download as shown in Figure 38.

2.6 Confirming reference conditions

Once the Column selections are finalized, the user is asked to confirm the Reference Conditions values as shown in Figure 27. The Reference Conditions are used to calculate Cleaning Effectiveness values and as inputs to the FTNORM routine (if needed). By default, the first values from the selected columns are used but the user can change these values.

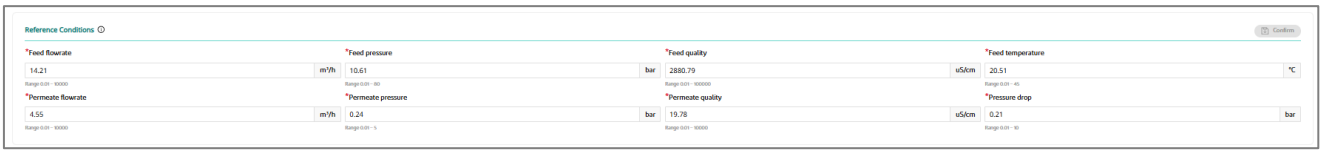


Figure 27: Reference Conditions section

2.7 Data Append

Sometimes users may wish to append new data to their existing dataset. The RO Operations Advisor allows users to append new data by clicking on the 'Append Data' button as shown in Figure 28. This would lead to a popup as shown in Figure 29.

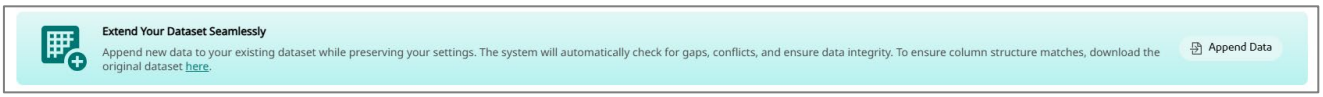


Figure 28: Data append section

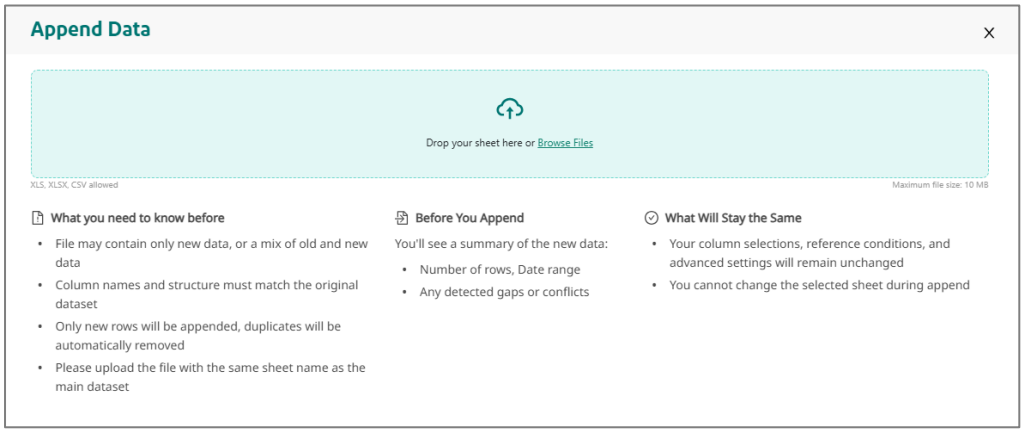


Figure 29: Data append popup

The user is expected to maintain the same data format and column names as the original dataset. The user can even download and open the original dataset to ensure consistency. The user can keep appending data as needed, however:

- The tool would check for overlaps and allow the user to select between the new and old data
- If there is an excessive time gap between the old and new data, the tool would detect it and may block the data append

2.8 Entering CIP Information

2.8.1 Specifying Default CIP Information

Users need to specify default CIP information that can be used to calculate plat performance. This is especially relevant for future CIPs for which details would not be available currently. The default CIP details are shown in Table 3 and in Figure 30. By default, it is assumed that the user would perform an alkali CIP followed by an acid CIP.

Table 3: Default CIP Values

CIP Type	Amount (kg/CIP)	pH	Temperature (°C)	Soak Duration (hr)
Acid [HCl]	0.5 [0.01, 4032000]	1	25 [20, 100]	10 [1, 48]
Alkali [NaOH]	0.9 [0.01, 7200000]	12	25 [20, 100]	10 [1, 48]
Additive [$Na_2S_2O_4$]	0 [0.01, 100]	7	25 [20, 100]	10 [1, 48]

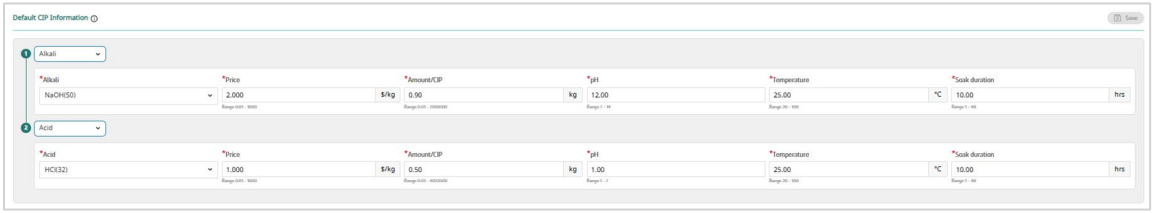


Figure 30: Default CIP information section

Please note the dropdown list shown in Figure 30. As indicated in the FilmTec™ Manual, combinations of chemicals are often used in CIP steps. The tool allows the user to define CIP steps in which the RO/NF elements are soaked in one or more chemicals at a given pH and temperature for a given soak period. The combinations of CIP steps can be considered a CIP sequence. The following CIP sequences are currently allowed in the tool:

- Acid
- Acid + Additive (or acid solution)
- Alkali
- Alkali + Additive (or alkali solution)
- Acid → Alkali
- Alkali→ Acid
- Acid → Alkali + Additive (or acid → alkali solution)
- Acid + Additive → Alkali (or acid solution → alkali)
- Acid + Additive→ Alkali + Additive (or acid solution→ alkali solution)
- Alkali→ Acid + Additive (or alkali→ acid solution)
- Alkali + Additive → Acid (or alkali solution → acid)
- Alkali + Additive→ Acid + Additive (or alkali solution → acid solution)

2.8.2 Specifying CIP Patterns

Users have three options of specifying the CIP history of the plant:

- Uploading a file that contains the CIP history
- Specifying a recurrent CIP pattern
- Adding CIPs one by one

The RO Operations Advisor can identify historical CIPs without the above options – however there are some instances in which users might desire to specify their historical CIPs. These options presented in Figure 31.

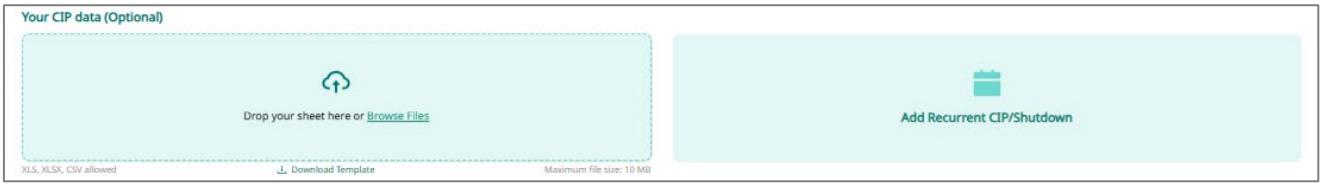


Figure 31: CIP history specification options

Note that:

- Choosing to upload a CIP history or specifying a recurrent CIP pattern would mean that the tool would skip the CIP identification step. Instead, calculations such as Cleaning Effectiveness determination, fouling type identification and CIP prediction/recommendation would be performed based on the user specified CIPs.
- This section becomes active only after the relevant data column selections are confirmed
- The ability to add CIPs one by one is currently available only in later pages, not on this page
- The following fields need to be populated for the tool to accept the uploaded CIP history

Uploading a file that contains the CIP history of the plant

The user can drop in a file in the designated area (as shown in Figure 31) or navigate to a folder that contains the file of interest. The user is encouraged to download a template, populate it, and navigate to the populated template (or drop it in the designated area) . The user would then see a warning like what is shown in Figure 32

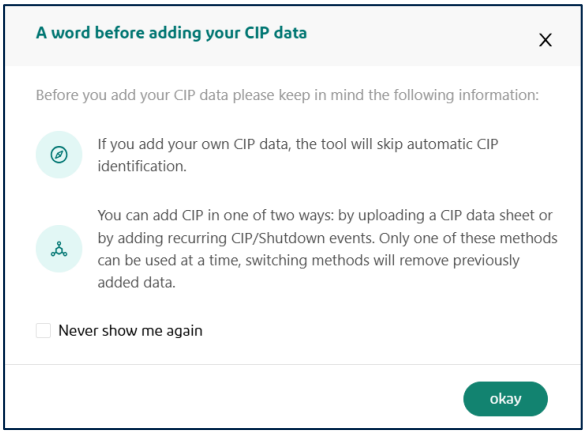
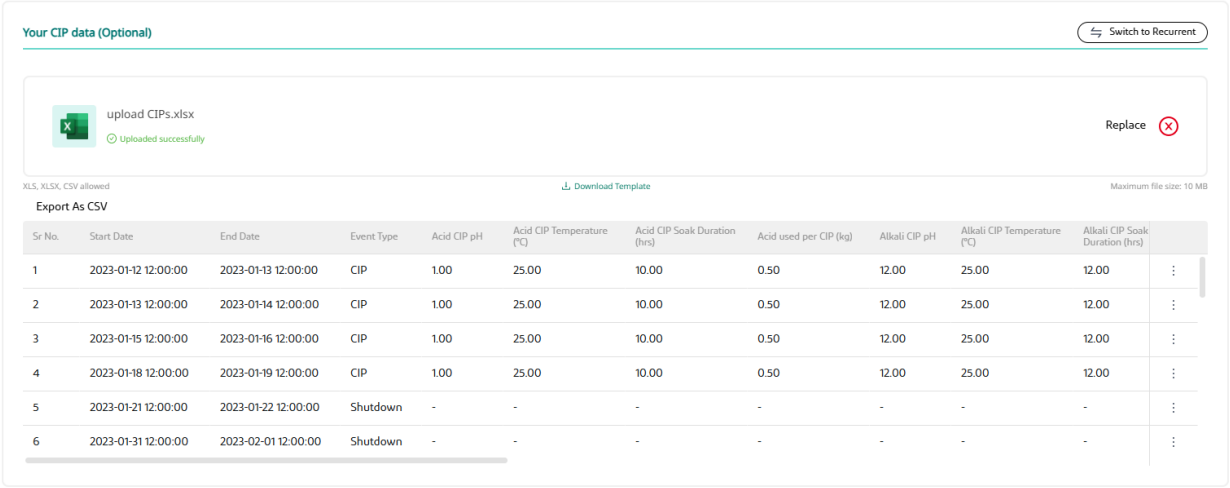


Figure 32: CIP history specification popup – file upload

Note that:

- If the user chooses to upload a populated template, the user can't use the recurrent CIP approach.
- The tool provides a way to switch between uploading a CIP history file and defining a recurrent CIP schedule
- The following fields need to be populated for the tool to accept the uploaded CIP history
- Dates: CIP start date, CIP end_date,
- CIP type: acid, alkali, combined
- Whether acid, alkali or solutions are used
- Amounts: acid used per CIP, alkali used per CIP, additional chemical per CIP (0 is acceptable)
- pH: acid CIP pH, alkali CIP pH, CIP solution pH (7 is acceptable)
- Temperatures: acid CIP temp, alkali CIP temp, CIP solution temp (25 is acceptable)
- Durations: acid CIP duration, alkali CIP duration, CIP solution duration (0 is acceptable)
- Chemical names: acid name, alkali name, solution chemical name,

Once the user clicks ok, the view changes to what is shown in Figure 33.



Sr No.	Start Date	End Date	Event Type	Acid CIP pH	Acid CIP Temperature (°C)	Acid CIP Soak Duration (hrs)	Acid used per CIP (kg)	Alkali CIP pH	Alkali CIP Temperature (°C)	Alkali CIP Soak Duration (hrs)
1	2023-01-12 12:00:00	2023-01-13 12:00:00	CIP	1.00	25.00	10.00	0.50	12.00	25.00	12.00
2	2023-01-13 12:00:00	2023-01-14 12:00:00	CIP	1.00	25.00	10.00	0.50	12.00	25.00	12.00
3	2023-01-15 12:00:00	2023-01-16 12:00:00	CIP	1.00	25.00	10.00	0.50	12.00	25.00	12.00
4	2023-01-18 12:00:00	2023-01-19 12:00:00	CIP	1.00	25.00	10.00	0.50	12.00	25.00	12.00
5	2023-01-21 12:00:00	2023-01-22 12:00:00	Shutdown	-	-	-	-	-	-	-
6	2023-01-31 12:00:00	2023-02-01 12:00:00	Shutdown	-	-	-	-	-	-	-

Figure 33: CIP history specification by uploading a file

Defining a recurrent CIP pattern

The user can define a current CIP pattern by clicking on 'Add Recurrent CIP/Shutdown' button in Figure 31 and defining the pattern in as shown in Figure 34. Figure 32 might reappear as a reminder.

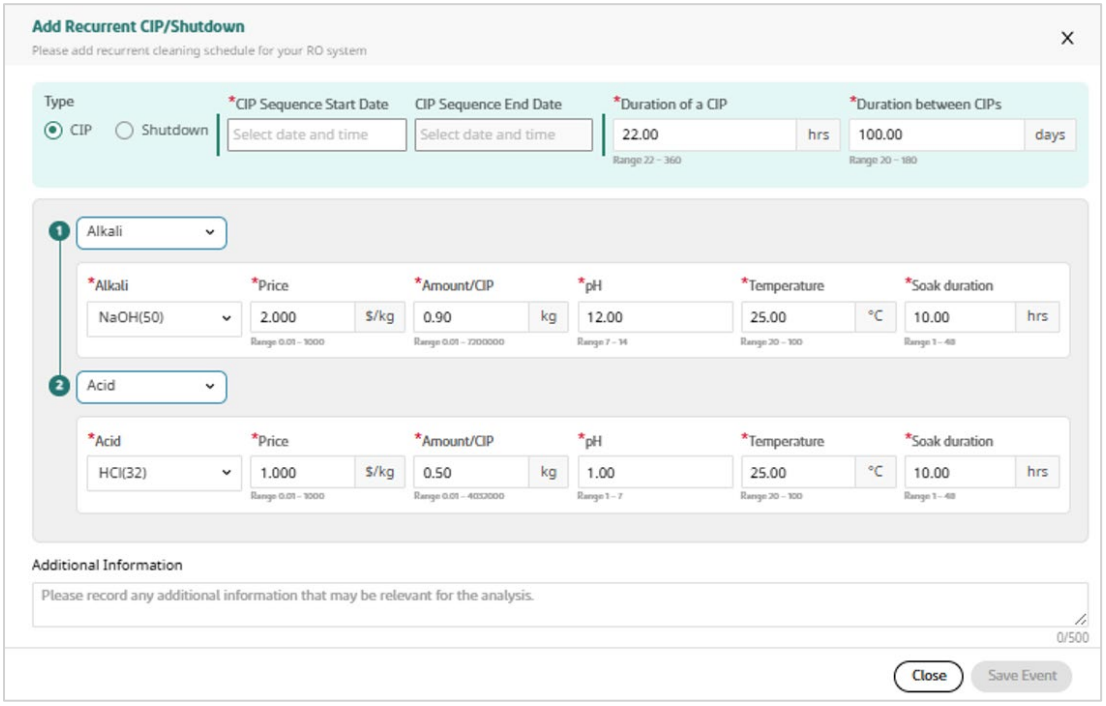


Figure 34: Recurrent CIP/Shutdown pattern definition

Note

- If the user chooses the recurrent CIP approach, they would not be able to upload a populated template,
- The recurrent CIP approach can be used to define CIPs in the future

Adding a CIP one by one

The user can define CIPs one by one as shown in Figure 35.

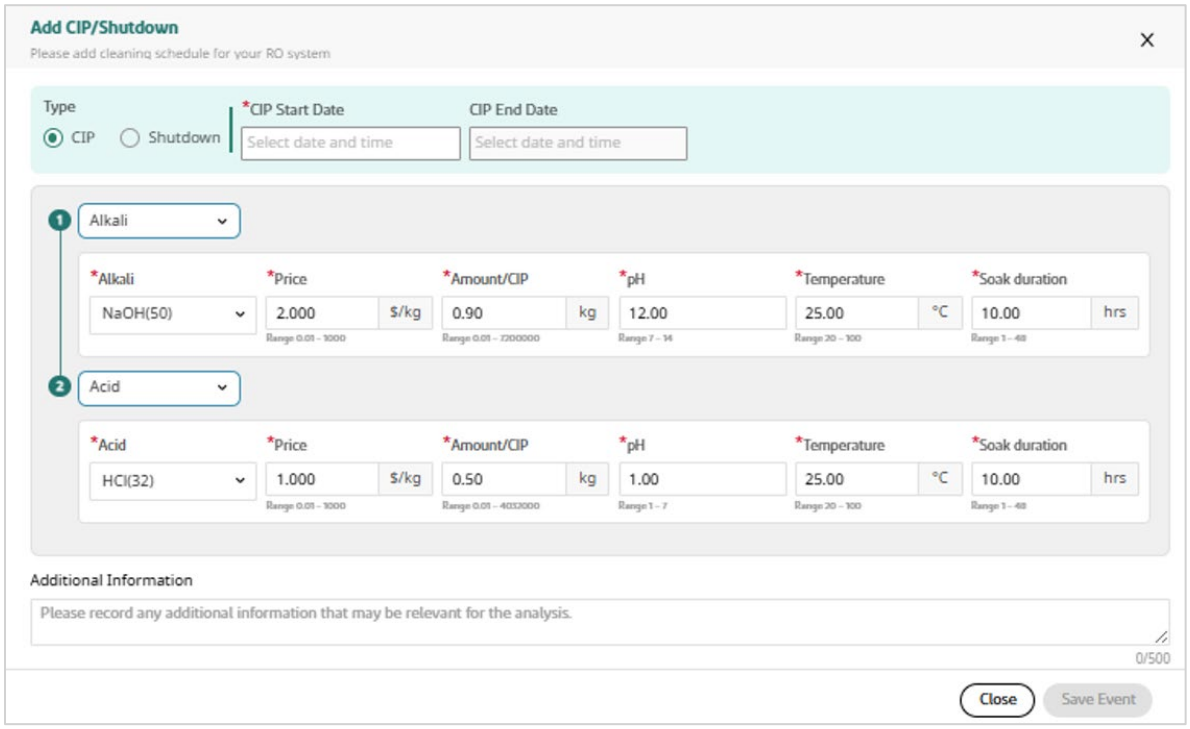


Figure 35: One by one CIP/Shutdown definition

2.9 Advanced Settings for Outlier Removal, CIP & Shutdown Identification

The user can update some settings by clicking on the 'Advanced Settings' button shown in Figure 18, Figure 19 or Figure 21. This lets the user customize the analysis for the data set. The Advanced Settings popup window is shown in Figure 36. A discussion of what each setting means is provided in Table 4.

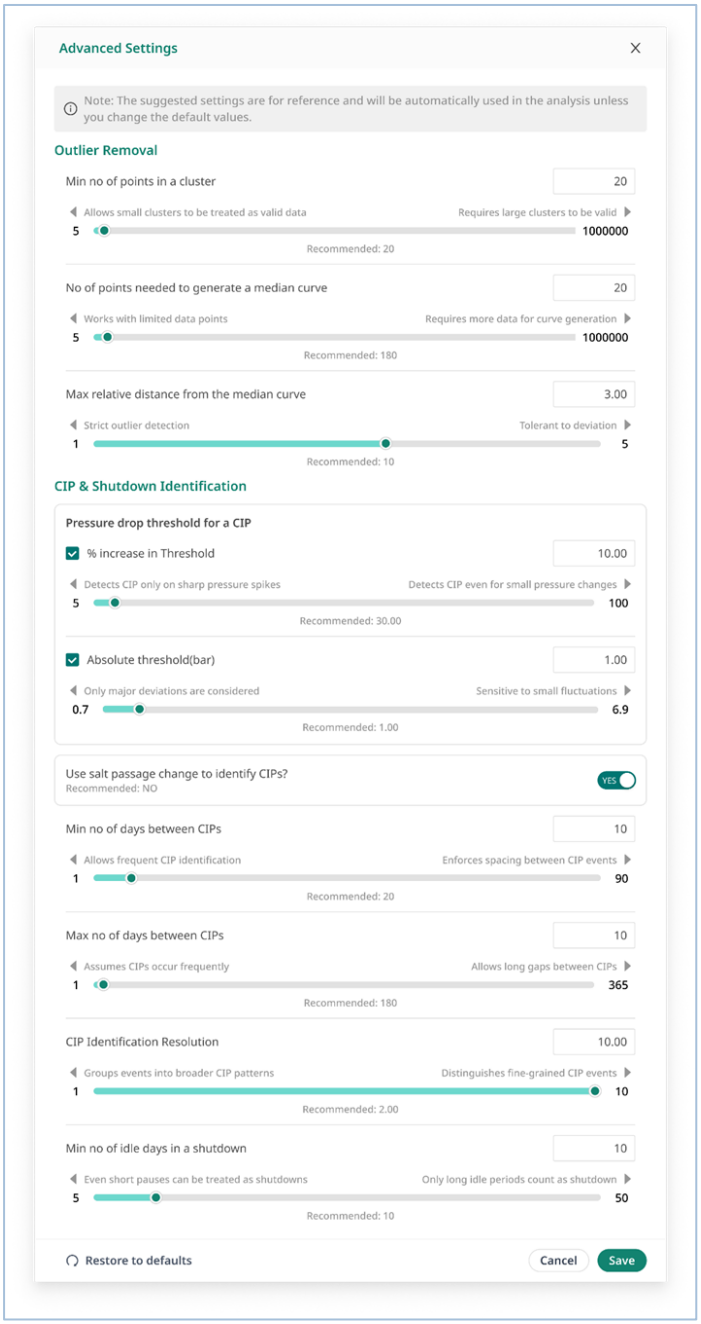


Figure 36: The Advanced Settings window for Outlier Removal, CIP & Shutdown Identification

Table 4: Advanced Settings for Outlier Removal, CIP & Shutdown Identification

Relevant Function	Advanced Setting	Default and [Range]	Note
Outlier Removal	Minimum number of points in a cluster	**20** [5, 10^6]	This is used to distinguish between true outliers and a shift in the dataset. Increasing this value would remove more outliers
	Number of points needed to generate a median curve	**20** [5, 10^6]	This is used to detect trends in data. Increasing this value may result in a smoother curve
	Maximum relative distance from the median curve	**3** [1, 5]	This is used to help decide which points are true outliers. Increasing this value may allow more variation in the data
CIP & Shutdown Identification	Pressure drop threshold for a CIP: (%) increase	**10** [5, 100]	Pressure drop increases below this threshold may not be considered CIPs. Raising this threshold may result in fewer CIPs
	Pressure drop threshold for a CIP: absolute (bar)	**1** [0.7, 6.9]	Pressure drop increases below this threshold may not be considered CIPs. Raising this threshold may result in fewer CIPs
	Use salt passage change to identify CIPs?	**No** Yes/No	Salt passage change may help detect some CIPs – however enabling this may result in more CIPs
	Minimum number of days between CIPs	**20** [1, 90]	These are used for both CIP identification and prediction/recommendation. Increasing the minimum or decreasing the maximum may result in fewer CIPs being identified.
	Maximum number of days between CIPs	**180** [1, 365]	
	CIP Identification Resolution	**5** [1, 10]	This constant sets how aggressively the tool classifies potential CIPs as actual CIPs. As this number increases, more CIPs are identified
	Minimum number of idle days in a shutdown	**20** [5, 50]	This helps to distinguish between a CIP and a shutdown. Increasing this value may mean fewer CIPs are identified.

2.10 Proceeding to Analysis

Once the required fields are populated, the 'Proceed to Analysis' button becomes active and the user may proceed to the next step. The tool checks to make sure that all the steps are completed. If not a message similar to the one in Figure 37 may appear . The user can click on 'Back to Plant Design' to return to the previous page.

Figure 37: Unsaved data message

2.11 Behind the scenes – Data Cleaning

Two data cleaning steps and a data aggregation step are taken behind the scenes as the user moves to the next screen:

2.11.1 Removal of physically inconsistent points

In this step, the tool removes rows that have the following:

- missing values
- NaN, #no value or similar values
- negative values
- the feed flow is less than or equal to the concentrate flow
- the feed flow is less than or equal to the permeate flow
- the feed pressure is less than or equal to concentrate pressure
- the feed pressure is less than or equal to permeate pressure
- the net driving pressure (NDP) is less than or equal to zero

In this case NDP = feed pressure – 0.5 (feed pressure – concentrate pressure) - permeate pressure - feed osmotic pressure + permeate osmotic pressure

Osmotic pressure is calculated using the routines used in FTNORM.

2.11.2 Removing outliers

The tool identifies outliers using a proprietary method and removes them from the data. This would ensure that subsequent steps would run smoothly.

2.11.3 Data Aggregation

In some cases, a large dataset is generated if data at high frequency (e.g. 1 datapoint per minute) is collected over a sufficiently large time (e.g. 1 year, which leads to 525, 600 datapoints). This can cause some operations, like CIP Prediction/ Recommendation or the Cleaning Effectiveness calculation, to take an excessively long time. Thus, the tool internally performs the following operations:

- If the dataset frequency is more than 1/h (e.g. 1/10 minutes) and
- the time interval is more than 1 year, and the data is aggregated to a daily basis
- The time interval is less than 1 year, the data is aggregated to an hourly basis
- otherwise, the data is not aggregated

The processed data is available to download as a tab in the final report generated by the Cleaning and Lifetime Advisors.

2.12 Selecting which Advisor to run (Cleaning or Lifetime)

The data upload, column selection and cleaning were common to both the Cleaning and Lifetime Advisors. Once the data is prepared, it can be used in either Advisor. The user can make the choice by clicking on the desired “Go to app → shown in Figure 38 below. Users can complete their analysis of one Advisor to be routed to the other Advisor. Please note that this screen allows the user to switch to a different train, to download the normalized values or return to the Edit Plant page.

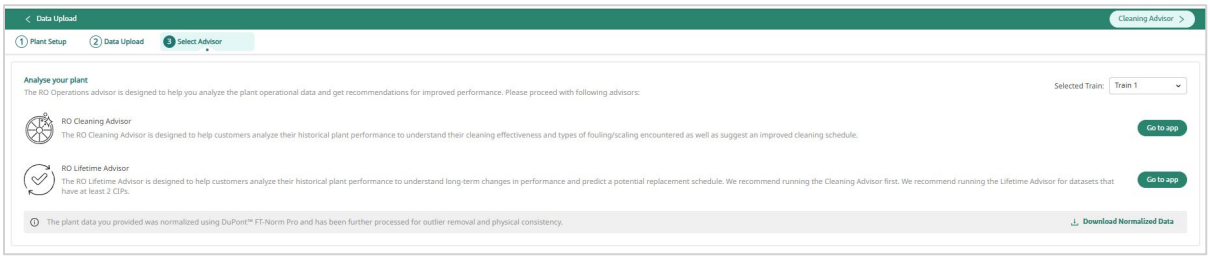


Figure 38: Selection between the RO Cleaning Advisor and the RO Lifetime Advisor

2.13 Performing the analysis through the selected Advisor

2.13.1 Performing the analysis through the RO Cleaning Advisor

Here is a brief description of how the RO Cleaning Advisor works:

- The normalized plant performance data is processed to remove outliers and physically inconsistent points.
- The user is asked to provide additional information, such as the cost of electricity, chemicals, downtime and the price of water. The user can also provide historical CIPs and details around them, including starting points and CIP conditions.
- A statistical routine is then run on the normalized and cleaned normalized plant performance data to detect CIPs and plant shutdowns. The user can confirm the accuracy of the results and make adjustments e.g. add /delete/edit CIPs and shutdowns
- Once the CIPs and shutdowns are confirmed, the user can calculate Cleaning Effectiveness values, which reflects how much of the initial (startup) system performance was recovered by cleaning
- The user can further identify the fouling/scaling modes that most likely caused the identified CIPs using a combination of domain knowledge and statistical methods
- The tool then leverages the previous history of CIPs, fouling types, plant data trends and cleaning practices to predict upcoming CIPs and shutdowns within a specific period (forecast window).
- Based on the prediction of CIPs and shutdowns, the tool can then identify an improved CIP schedule that would maximize the total financial benefits over the forecast window

Analysis through the RO Cleaning Advisor includes the following steps

- System Performance Data Input: this involves confirming the inputs in the previous steps and providing additional information
- CIP Identification: this step identifies the CIPs performed on the plant from the supplied data and includes user entered CIPs
- Cleaning Effectiveness Calculation: this step calculates Cleaning Effectiveness values for each CIP
- Fouling & Scaling Type Identification: this step identifies the types of fouling and scaling experienced by the plant from the supplied data
- CIP Prediction & Recommendation: this step predicts upcoming CIPs based on historical trends and recommends a CIP schedule that minimizes overall cost

The progress through these steps can be seen in the banner shown at the top of the RO Cleaning Advisor (Figure 39). The current position of the user is indicated by the dark green text.

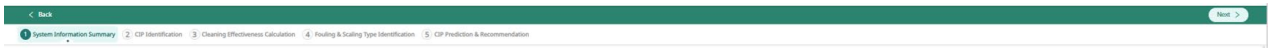


Figure 39: Progress banner in the RO Cleaning Advisor

2.13.1.1 System Information Summary

The System Information Summary screen is shown in Figure 40. This involves confirming the input in the previous steps (plant Information, selected section of the plant, settings) and providing additional information, namely:

- Cost information: energy, chemical, water and downtime costs
- Default CIP information: pH, temperature, amount and duration values
- CIP and Shutdown information: dates and CIP conditions

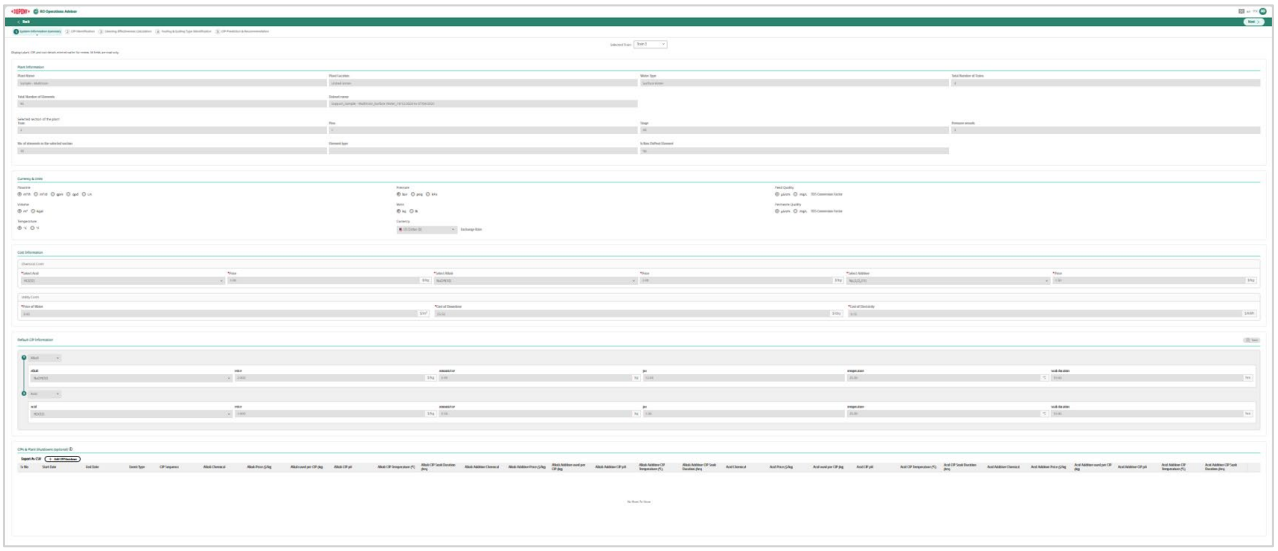


Figure 40: System Information Summary screen for the RO Cleaning Advisor

Users can add CIP/Shutdown information by clicking on the "Add CIP/Shutdown" button, which will lead to a popup screen shown in Figure 35. The user can populate the fields and click on "Save Event" to save the user entered CIP/shutdown. Note that if the user has specified CIPs in previous steps (e.g. using the bulk upload or recurrent CIP option), those CIPs would appear in the CIP section.

The user can switch between different trains from this screen.

2.13.1.2 CIP Identification

This step identifies the CIPs performed on the plant from the supplied data and includes user entered CIPs as shown in Figure 41. User identified CIPs are indicated by vertical red lines. The user can add CIPs or shutdowns by clicking on the Add CIP/Shutdown button. The user can also delete or edit CIPs/shutdowns by clicking the 3 dots at the right end of the row. While only Normalized Permeate Flow, Normalized Pressure Drop and Normalized Salt Passage are plotted here, the user can plot additional variables by clicking on the dropdown to select them.

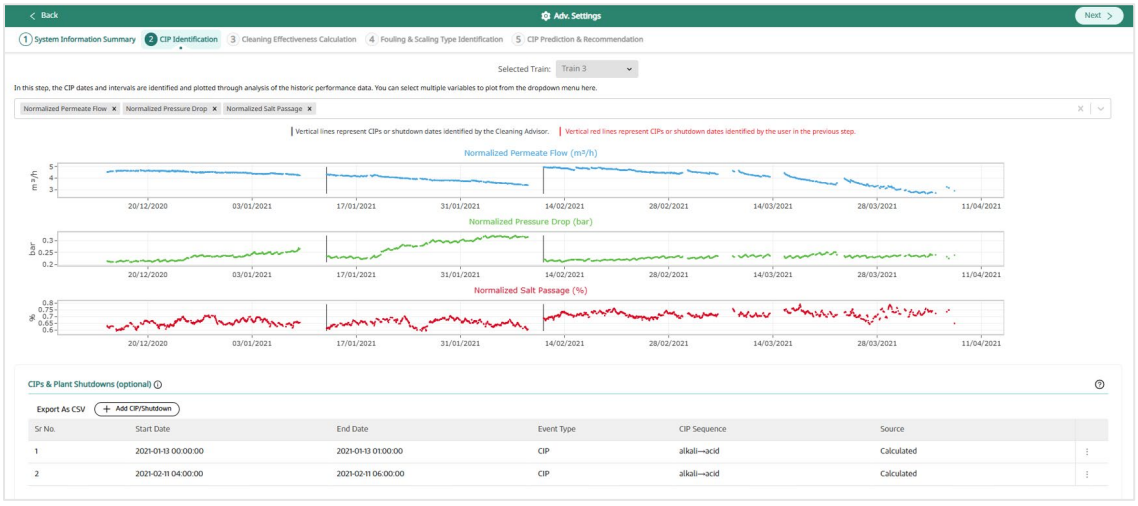


Figure 41: CIP Identification tab

The user can see the list of identified CIPs/shutdowns in the final report. The user can also download the plots by hovering over the top right corner of the plots and selecting “Download plot as .png”. Please note that the separate .png plots may look different vs the plots on the CIP Identification tab due to axis scaling – thus screen captures are another way to duplicate the plots.

The Advanced Settings link in the CIP Identification page leads to the section of the Advanced Settings seen in the Data Setup page, Figure 36, Figure 42 and Table 4. Users can add CIPs here as described in Figure 35.

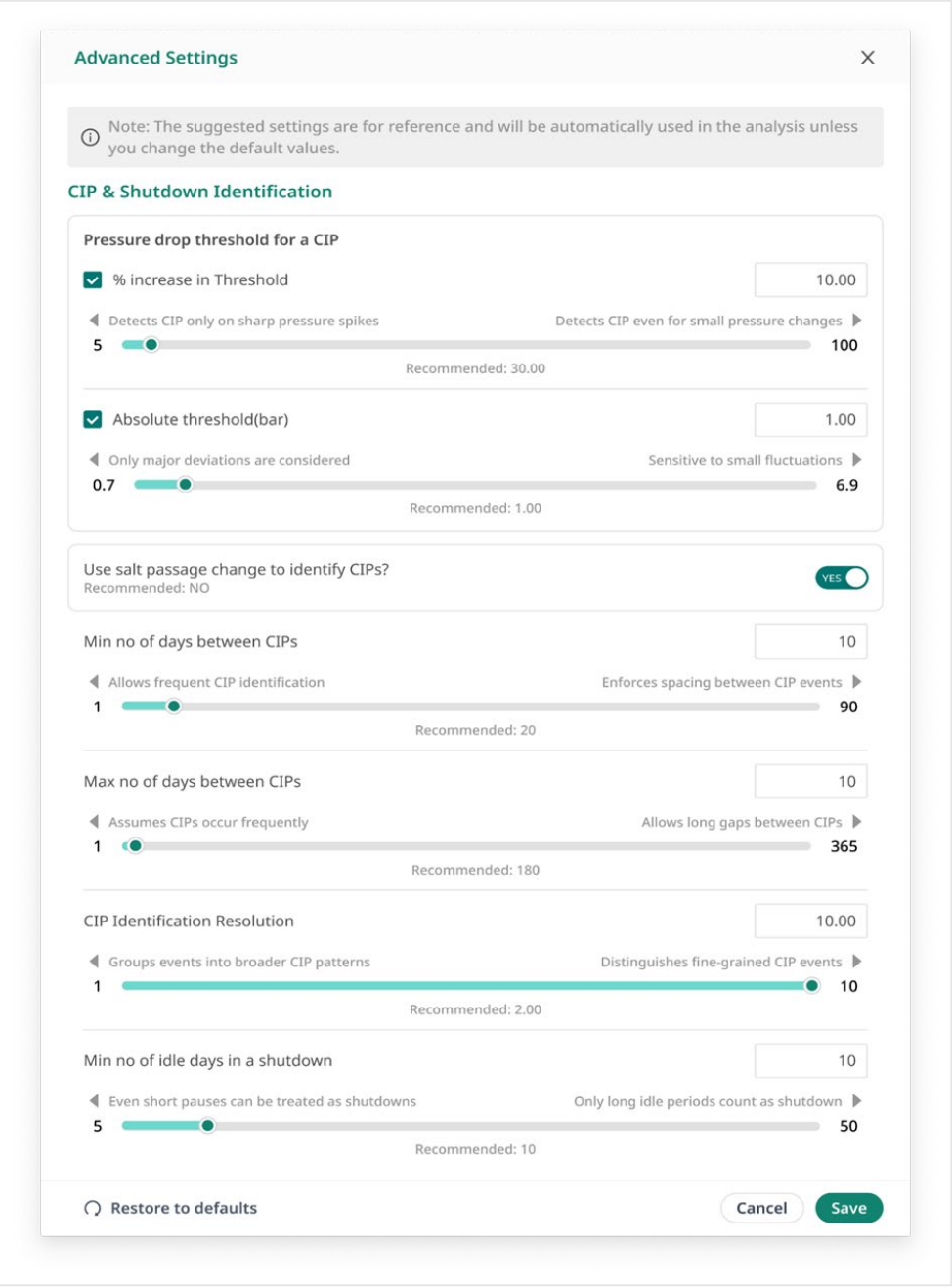


Figure 42: The Advanced Settings window for CIP & Shutdown Identification

The user can proceed to the next screen by clicking on the “Next >” button at the top of the screen. The user can return to the previous screen by clicking on “< Back”.

2.13.1.3 Cleaning Effectiveness Calculation

This step calculates Cleaning Effectiveness values for each CIP. Cleaning Effectiveness is defined here as:

$$Cleaning\ Effectiveness\ (a\ CIP\ , a\ variable) = \frac{(value\ of\ the\ variable\ before\ the\ CIP - \ value\ of\ the\ variable\ after\ the\ CIP)}{(value\ of\ the\ variable\ before\ the\ CIP - \ value\ of\ the\ variable\ at\ reference\ conditions)}$$

Essentially, Cleaning Effectiveness calculates how effectively a cleaning was able to return the parameter values to the reference conditions. 100% indicates exactly matching the reference conditions.

The variables considered here are normalized permeate flow, normalized pressure drop and normalized salt rejection. Taking normalized pressure drop as an example, assume that:

- pressure drop at reference conditions = 10 psi
- normalized pressure drop before a CIP = 30 psi
- normalized pressure drop after a CIP = 20 psi

The Cleaning Effectiveness for this CIP for normalized pressure drop = (30-20)/(30-10) = 10/20 = 50%

Cleaning Effectiveness values for normalized permeate flow, normalized pressure drop and normalized salt rejection are shown in Figure 43,. The tool also identifies the types of fouling/scaling encountered (more detail in the next section).

The tool uses stabilized data after a CIP to calculate the Cleaning Effectiveness.

- If the data did not stabilize, Cleaning Effectiveness values may not be calculated – and the corresponding cells in the table are populated by ' * '. The tool tries to minimize the occurrence of such values by adjusting the stabilization period on a CIP by CIP basis as needed.
- If the performance improved beyond the target (reference conditions), this condition is marked in the table with 'E'. The user is urged to ensure that the right reference conditions were selected and that this improvement was not due to factors such as oxidation or mechanical damage.
- If values before the CIP were better than the reference condition, this condition is marked in the table with 'R'. The user is urged to consider adjusting the reference condition and account for other factors such as recent replacements.
- If the performance got worse after the CIP, this condition is marked in the table with 'W'. The user is urged to review the cleaning effectiveness settings and the cleaning procedure (e.g. chemical selection, dosage, soak duration) used for that CIP.

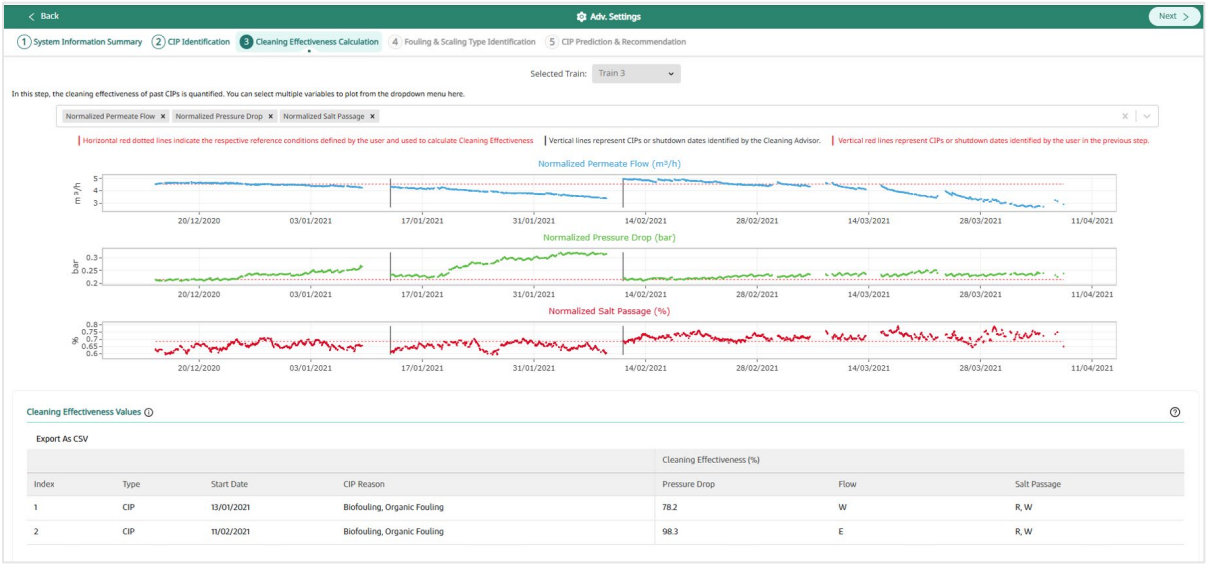


Figure 43: Cleaning Effectiveness Calculation tab

The user can see the list of identified CIPs/shutdowns along with the corresponding fouling/scaling types and Cleaning Effectiveness values in the final report. The user can also download the plots as png files or take screenshots to capture the plots.

Advanced Settings

Cleaning Effectiveness calculations also have Advanced Settings as shown in Figure 44 and explained in Table 5.

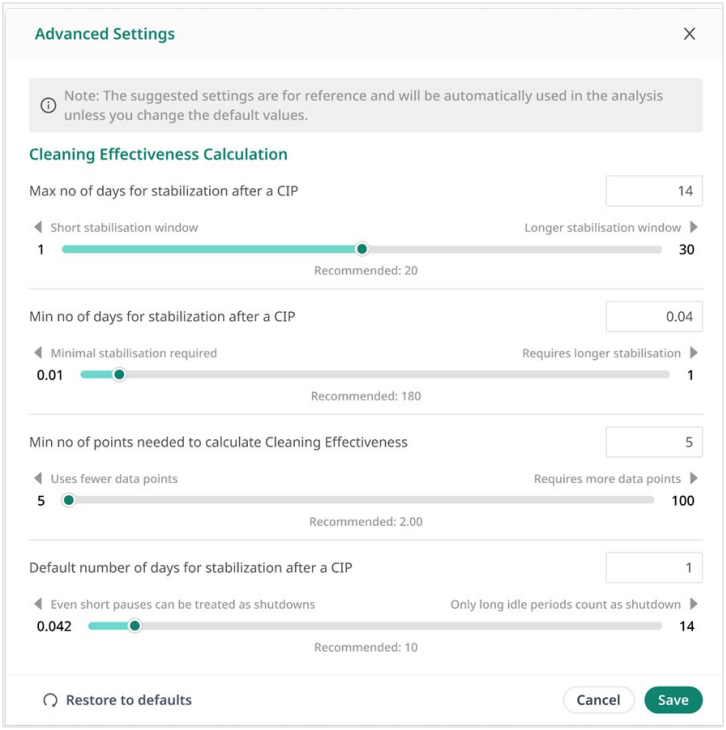


Figure 44: The Advanced Settings window for Cleaning Effectiveness Calculation

Table 5: Advanced Settings for Cleaning Effectiveness Calculation

Relevant Function	Advanced Settings variable	Default and Range	Meaning
Cleaning Effectiveness Calculation	Maximum number of days for stabilization after a CIP	**14** [1, 30]	These set a ceiling and floor on how far out the tool needs to look after a CIP to see if the system has stabilized. If the system has not stabilized, a Cleaning Effectiveness (CE) value is not reported. Lowering the ceiling or raising the floor may result in fewer CE values.
	Minimum number of days for stabilization after a CIP	**0.04** [0.01, 1]	
	Minimum number of points needed to calculate Cleaning Effectiveness	**20** [5, 100]	After stabilization, an average over several datapoints is used to calculate Cleaning Effectiveness. Increasing the number of points can provide more representative values.
	Default number of days for stabilization after a CIP	**10**	The system starts from a default number of days for stabilization after a CIP. A higher value may mean more representative values.

The user can proceed to the next screen by clicking on the "Next >" button at the top of the screen. The user can return to the previous screen by clicking on "< Back".

2.13.1.4 Fouling & Scaling Type Identification

This step identifies the types of fouling and scaling experienced by the plant from the supplied data. The tool distinguishes between the following: biofouling, organic fouling, particulate fouling, scaling or no fouling as described in Table 6. A proprietary method was developed to distinguish between the modes above and provide a relative score (out of 100%). As shown in Figure 45, primary and secondary reasons for the CIP or shutdowns (in other words, fouling/scaling types) are identified – thus the % values may not add up 100% in the table. The tool even identifies ongoing fouling or scaling types.

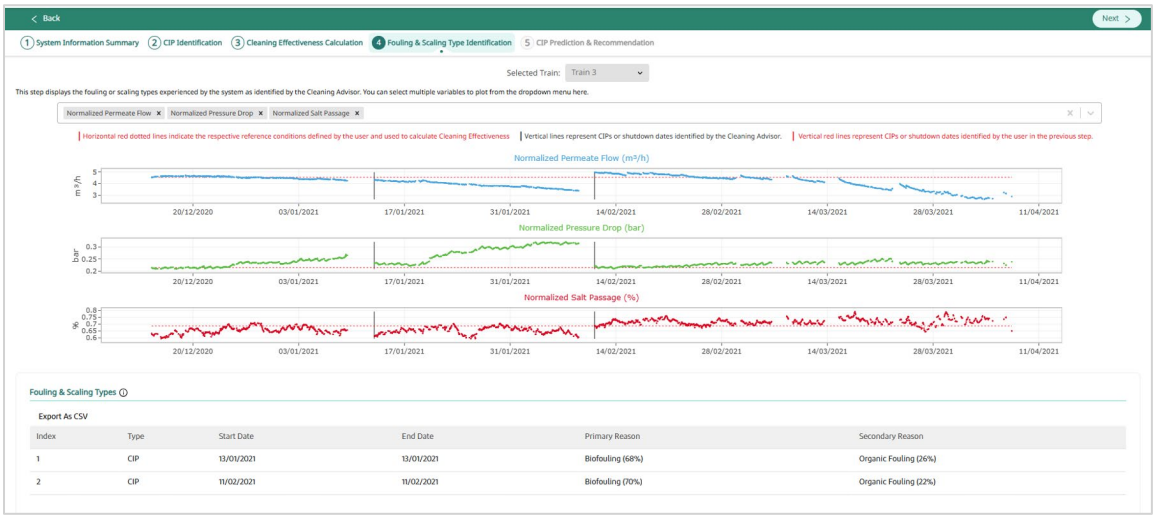


Figure 45: Fouling & Scaling Type Identification

In addition, the tool can identify membrane failure modes that are not addressed by cleaning: oxidation, membrane leakage, integrity failure or compaction as described in Table 6. A proprietary method was developed to distinguish between the modes above and provide a relative score (out of 100%). The relative scores for these failure modes are also aggregated to 100%. The tool identifies only the top 2 failure modes – thus the % values may not add up 100% in the table.

The user can see the list of identified CIPs/shutdowns along with the corresponding fouling/scaling/failure types in the final report. The user can also download the plots as png files or take screenshots to capture the plots.

Table 6: Types of Fouling /Scaling/Failure and Identification Guidelines

Fouling Type	**Description**	**Pressure Drop**	**Permeate Flow**	**Salt Passage**
Biofouling	growth of micro-organisms on the membrane or feed spacer	increases	constant	increases
Organic Fouling	accumulation of organic materials on the membrane or feed spacer	constant	decreases	decreases
Particulate Fouling	accumulation of colloidal or suspended solids on the membrane or feed spacer	increases	decreases	increases
Scaling	precipitation of dissolved species on the membrane or feed spacer	increases	decreases	increases
No strong reason	This is the output when there is no strong evidence of any fouling type			
Failure Mode	**Description**	**Pressure Drop**	**Permeate Flow**	**Salt Passage**
oxidation	chemical attack on membrane polymer	constant	decreases	Increases
membrane leakage	physical damage or seal failure	constant	constant	increases
integrity failure	severe breach or rupture of membrane barrier	constant	increases	increases
compaction	membrane compression under high pressure	decreases	decreases	constant

The user can proceed to the next screen by clicking on the “Next >” button at the top of the screen. The user can return to the previous screen by clicking “< Back”.

2.13.1.5 CIP Prediction & Recommendation

This step predicts upcoming CIPs based on historical trends and recommends a CIP schedule that minimizes overall cost. This is initiated by the user entering a Forecast Window, which is the window of time in which the user is interested in understanding, as shown in Figure 46. As the Forecast Window increases, so does the potential error in predictions – thus the Forecast Window is limited at the high end.

Once the Forecast Window is entered, the user can click on "Predict & Recommend". This would generate:

- A table of predicted CIP dates along with the expected fouling/scaling types
- A table of recommended CIP dates, along with the expected fouling/scaling types
- A projection of net financial benefits, broken up by energy cost, chemical cost, downtime cost and water production impact
- A comparison of the projected minima and maxima for feed pressure, pressure drop, permeate flow and permeate conductivity with default failure thresholds (to indicate that using the Recommended CIP Schedule would not cause a failure within the forecast window)

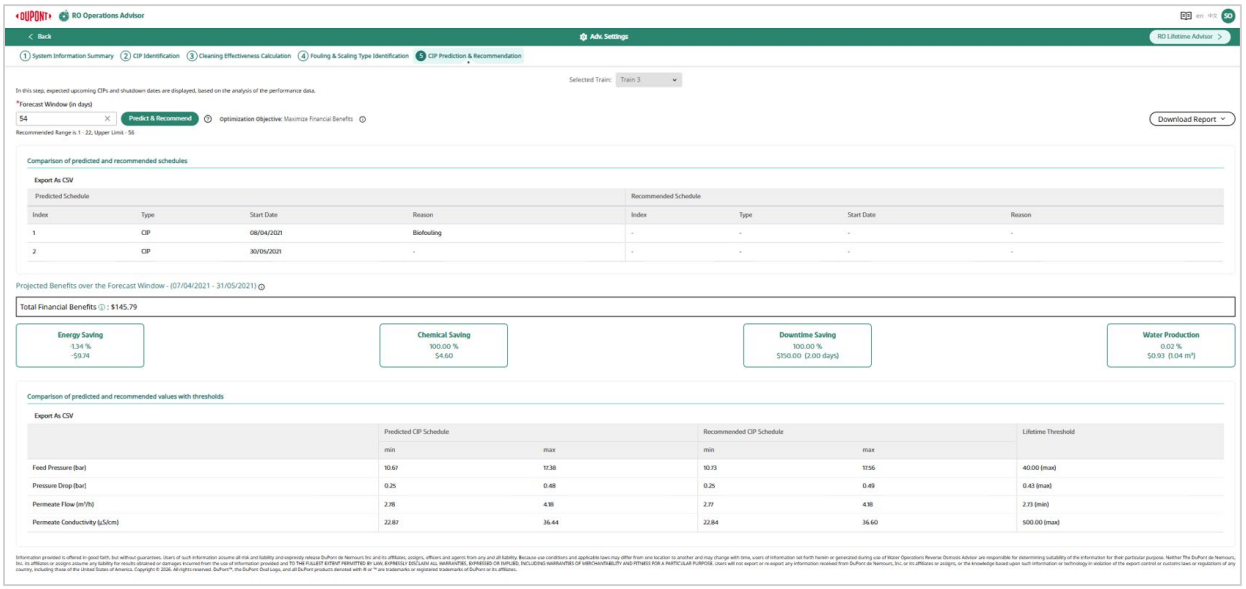


Figure 46: CIP Prediction & Recommendation screen

The user can save the information by clicking on the "Export to Excel" button. This will collect similar reports from the other tabs to generate one Excel report. Alternatively, the user can generate an Excel or Word report by clicking on the Generate Report button as shown in Figure 46. The Excel report would include the processed data (after normalization and outlier removal) in one of the tabs.

Users can modify the relevant Advanced Settings as shown in Figure 47 and Table 7.

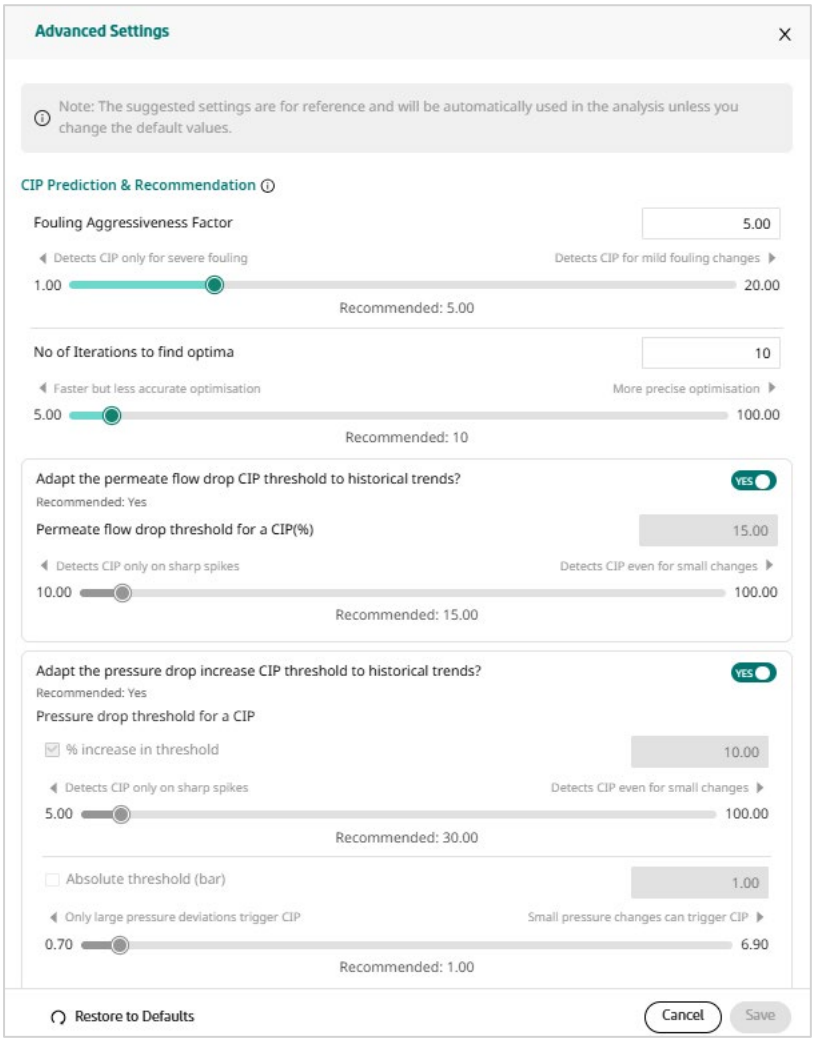


Figure 47: The Advanced Settings window for CIP Prediction and Recommendation

Table 7: Advanced Settings for CIP Prediction & Recommendation

Relevant Function	Advanced Settings variable	Default and Range	Meaning
CIP Prediction & Recommendation	Fouling Aggressiveness Factor	**5** [1, 20]	This factor captures the long-term fouling trend used in the CIP Prediction and recommendation algorithm. Higher values mean that CIPs may be more frequent
	Number of iterations to find optima	**10** [5, 100]	The algorithm uses an iterative routine to predict and recommend CIPs. Additional iterations may yield better results but would take more time
	Adapt the permeate flow drop CIP threshold to historical trends?	**Yes** Yes/No	The permeate flow drop CIP threshold is a user modifiable setting. However, the tool can adaptively determine the threshold from the data for best results.
	Permeate flow drop threshold for a CIP (%)	**10** [10, 100]	This measure describes how much permeate flow must decrease (in %) to trigger a CIP prediction. Increasing this % would result in fewer predicted CIPs.
	Adapt the pressure drop increase CIP threshold to historical trends?	**Yes** Yes/No	The tool can adaptively determine the pressure drop increase threshold from the data for potentially more accurate results.
	Pressure drop threshold for a CIP (%)	**10** [5, 10]	This measure describes how much pressure drop must increase (in %) to trigger a CIP prediction. Increasing this % would result in fewer predicted CIPs.
	Absolute Threshold for Pressure Drop (bar)	**1** **[0.7, 6.9]**	This threshold helps define the predicted CIP based on exact values of normalized pressure drop. Increasing this threshold would result in fewer predicted CIPs.
	Salt Passage Increase Threshold for a CIP (%)	**10** [10, 100]	This measure describes how much salt passage must increase (in %) to trigger a CIP prediction. Increasing this % would result in fewer predicted CIPs
	Adapt the salt passage increase CIP threshold to historical trends?	**Yes** Yes/No	The tool can adaptively determine the salt passage increase threshold from the data for potentially more accurate results.
	Perform additional simulations to improve accuracy?	**No** Yes/No	The algorithm can continue to look for more optima using more advanced methods if 'Yes' is chosen – however these methods require more time.
Optimization Objective	**Maximize financial benefit** Maximize product Minimize energy cost		The tool can start with the predicted solution and reposition the CIPs based on the user requirement.
Lifetime Prediction	Cumulative Failure Probability Threshold (%)	**95** [50, 100]	This measure models the possibility of system failure due to multiple reasons

The user can proceed to the Lifetime Advisor by clicking on the "RO Lifetime Advisor >" button at the top of the screen. The user can return to the previous screen by clicking "< Back".

Note:

- Shutdowns are predicted but not used in CIP prediction. A recommendation on future shutdowns is not provided
- The tool keeps track of the duration of historical CIPs and estimates how long a future CIP will take. The estimate of the downtime cost would change with the downtime duration estimate.
- There is a progress indicator (1-100 %) that appears when the system is predicting and recommending CIPs. This % corresponds to steps in the computation and not necessarily computational time – thus the system might spend more time at some intermediate points (e.g. 1%, 3%, 95%) vs others

2.13.2 Performing the analysis through the RO Lifetime Advisor

Here is a brief description of how the RO Lifetime Advisor works:

- The normalized plant performance data is processed to remove outliers and physically inconsistent points.
- The user is asked to provide information on physical thresholds that impact the lifetime of the element: maximum feed pressure, maximum pressure drop, maximum permeate TDS/quality and minimum permeate flow. In addition, the user can input values for membrane age and a standard warranty period. Installation/Last Replacement Day is a required input. It is populated from the RO System Configuration – if not specified, it may be estimated by the tool. The tool further asks if the RO/NF system is under warranty – and prompts the user to contact their DWS contact if so
- The user enters a forecast window to check if any of the thresholds are crossed within that time window
- A statistical routine is then run to first model the feed pressure, pressure drop, permeate flow and permeate quality/TDS changes with time based on the data – then to project these models into the forecast window. A parallel routine projects a cumulative probability of failure based on a combination of factors (e.g. high temperature + high pressure, excessive cleanings).
- If the projected values cross the provided thresholds, the date at which they cross these thresholds are noted. If the maximum permeate TDS/quality threshold is exceeded, the tool also provides potential explanations e.g. oxidation, mechanical damage

Analysis through the RO Lifetime Advisor includes the following steps

- System Performance Data Input: this involves confirming the inputs in the previous steps and providing additional information
- Forecast of Lifetime Threshold Dates: this step identifies the dates at which various thresholds are exceeded along with potential explanations

2.13.2.1 System Information Summary

The System Information Summary screen for the RO Lifetime Advisor is shown in Figure 48. This involves confirming the input in the previous steps (plant Information, selected section of the plant, settings) and providing additional information, namely:

- Installation/Replacement Date: populated by default
- Check if the system is under warranty
- Lifetime Thresholds: maximum feed pressure, maximum pressure drop, maximum permeate quality/TDS, minimum permeate flow
- Standard membrane age: populated by default
- Standard warranty period: populated by default

Note:

- A default maximum feed pressure is provided based on the FilmTec™ Manual guidelines.
- Default maximum pressure drop, maximum permeate quality/TDS and minimum permeate flow values are provided based on the Reference Conditions
    - If the user enters a startup pressure drop value, by default the maximum pressure drop should be 2x the startup pressure drop value
- The Reference Condition Permeate Flow is used as the Designed Permeate Flow by default. The minimum permeate flow is initially calculated as 60% of the designed permeate flow
- The user can switch between different trains from this screen.

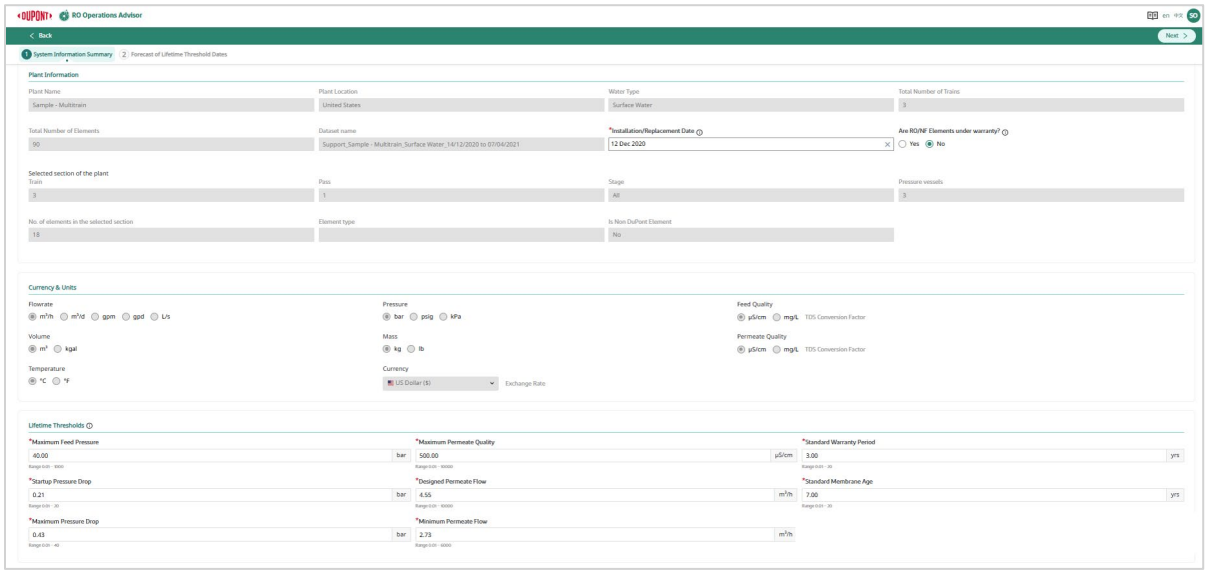


Figure 48: System Information Summary screen for the RO Lifetime Advisor

2.13.2.2 Forecast of Lifetime Threshold Dates

This step predicts the dates at which various thresholds are exceeded along with potential explanations where possible, as shown in Figure 49. It is expected that the user will use that information to plan upcoming replacements if necessary.

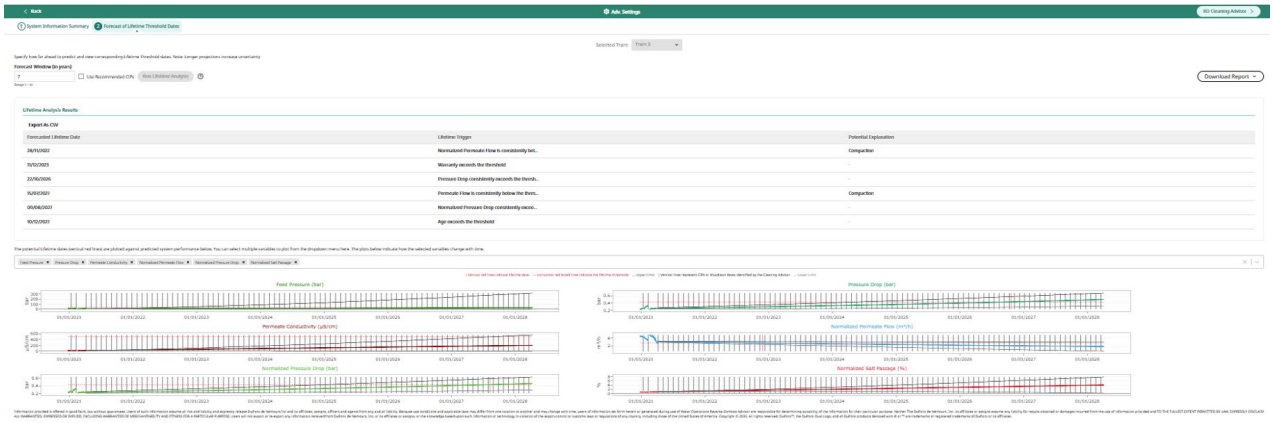


Figure 49: Forecast of Lifetime Threshold dates

After the user enters the Forecast Window and clicks on 'Run Lifetime Analysis', the results are shown in a tabular and graphical format as seen in Figure 49. The user can generate an overall report (in Word or Excel), and the plots can be copied over to other locations. The user can also transition to the Cleaning Advisor from this tab. Table 8 shows the Lifetime Threshold Triggers and potential explanations that the tool can currently provide.

Please note that users can switch between looking at the Lifetime predictions using the predicted CIPs and Lifetime predictions using the recommended CIPs (based on the last selection of objective function) by checking the 'Use Recommended CIPs' box.

The Lifetime Advisor tool also has Advanced Settings. The user may note that CIPs are predicted and displayed in the Lifetime plots. Thus, the same Advanced Settings screen as Figure 47 and Table 7 are used.

Table 8: Lifetime Threshold Triggers and potential explanations

Lifetime Trigger	Potential Explanation
Feed Pressure is higher than the limit	
Pressure drop is higher than the limit	
Permeate Quality is higher than the limit	Oxidation
	Membrane Integrity Failure
Permeate Flow is lower than the limit	Compaction
Cumulative Probability of Failure is above the limit	
Age exceeds the limit	
Warranty Period is exceeded	

Note:

- The tool reports dates at which the thresholds are consistently exceeded. This is a balance between the very first time the predicted values cross the corresponding threshold and the long-term trend. This generates a more conservative estimate.
- The Cumulative Probability of Failure considers factors such as extended operation at elevated temperature, excessive number of CIPs performed on the element and similar factors to describe the likelihood of an element failure
- The Lifetime Advisor leverages the Cleaning Advisor. Essentially, parts of the Cleaning Advisor are run in the background in the Lifetime Advisor. The two tools use the same underlying model to perform projections
- There is a progress indicator (1-100%) that appears when the system is predicting future performance. This % corresponds to steps in the computation and not necessarily computational time – thus the system might spend more time at some intermediate points (e.g. 1%, 3%, 95%) vs others

2.14 Performing Benchmarking Analysis

Users can now compare results from multiple plants or different trains in the same plant. This is generally how it works:

- The user generates reports for multiple plants (or multiple trains in the same plant) using the Cleaning Advisor, the Lifetime Advisor or both
- The user then selects plants (and/or trains) for which reports have been generated and asks the tool to generate a Benchmarking report.
- The tool generates a Benchmarking Report in Excel that compares:
- Values from a Cleaning Advisor report of one train (or plant) vs at least one other train (or plant)
- Values from a Lifetime Advisor report of one train (or plant) vs at least one other train (or plant)

To do this, the user would need to go to the Plants page and select 'Benchmark Plants' as shown in Figure 50.

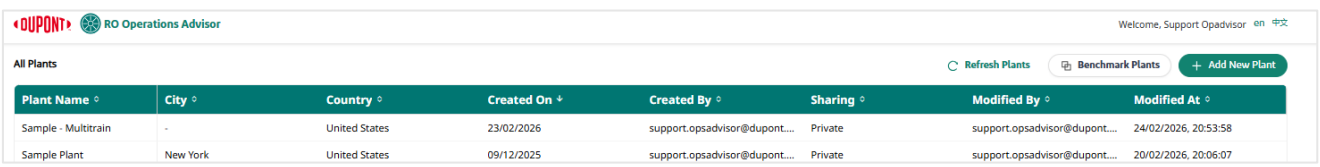


Figure 50: Projects page

Clicking the 'Benchmark Plants' button changes the Plant view to the structure seen in Figure 51.

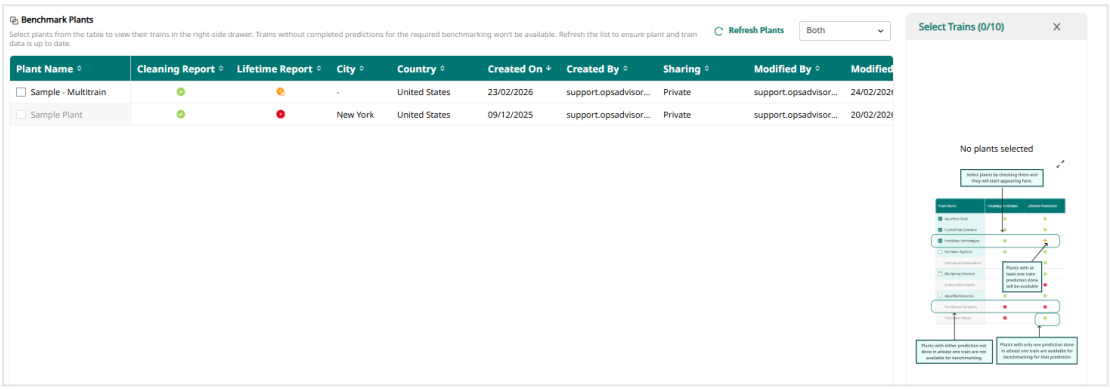


Figure 51: The Plant Benchmarking view before plant selection

As seen in Figure 51:

- The user can filter for plants which have at least one train with a Cleaning Advisor or Lifetime Advisor report by using the dropdown list in the top ribbon
- The filtered plants have additional indicators:
- A green dot under Cleaning or Lifetime indicates that all the trains in that plant have reports from the respective Advisor
- An orange under Cleaning or Lifetime indicates that at least one of the trains in that plant has a report from the respective Advisor
- A red dot under Cleaning or Lifetime indicates that none of the trains in that plant have reports from the respective Advisor
- The user can select which plants to compare by clicking on the checkbox to the left of the plant name
- Once the plants are selected, the user can select the specific trains within the selected plants as shown in Figure 52. The user can select at most 10 trains to benchmark against each other.

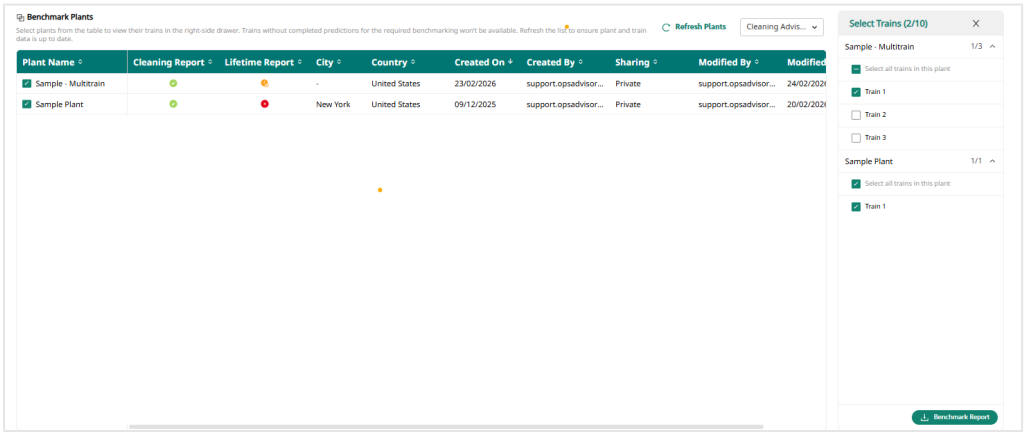


Figure 52: The Plant Benchmarking view after plant selection

After the trains are elected, the user can click on “Benchmark Report” to generate the Benchmarking report. The user can exit the Benchmarking view by clicking on the DuPont icon at the top left corner of the screen.

2.15 Understanding the Reports

Users can generate multiple reports from the RO Operations Advisor Suite as described in Table 9 below. "S" indicates that space is left in the report for an SME to generate content. Please note that if the user has the appropriate license, Recommendations may get automatically generated by the tool. Please refer to Section 2.16 to learn more about licenses.

Table 9: RO Operations Advisor Suite report types and components

Report Component	Cleaning Advisor		Lifetime Advisor		Benchmarking
	Word	Excel	Word	Excel	Excel
Cover Page	Y		Y		
System Information (e.g. # of passes/stages)	Y	Y	Y	Y	
Cost Settings	Y	Y			
Advanced Settings	Y	Y	Y	Y	
Reference Conditions	Y	Y			
Failure Thresholds			Y	Y	
Historic CIPs & Shutdowns	Y	Y			Y
Cleaning Effectiveness	Y	Y			Y
Fouling/Scaling Type	Y	Y			Y
Predicted CIPs	Y	Y			Y
Recommended CIPs	Y	Y			Y
Predicted Failure Threshold Dates			Y	Y	Y
Optimization Results (e.g. Financial Benefits)	Y	Y			Y
Summary	Y		Y		
Recommendations	S		S		
Normalized Data		Y		Y	
Predicted Performance (Values)	Y			Y	
Plots	Y		Y		

2.16 Understanding Licenses

The RO Operations Advisor additional features to users who have been granted licenses for those features. Some licenses are available to specific users or companies and would not be described further in this Manual. Others are available upon request.

The features currently available for licensing include:

- AI – Recommendations Generator: This feature analyzes past and projected RO system performance and generates FilmTec Manual-based recommendations to address current and future challenges. The user may then edit the recommendations
- Special RO Elements: This feature provides access to licensed elements which can be used to define the RO configuration. These elements may appear in the dropdown list or may be used in a WAVE/PRO design that is then imported into the RO Operations Advisor. The following categories of elements are available:
- Lithium Recovery Elements: these elements can be used to design processes in WAVE/PRO for lithium recovery. If data is available from such processes, that data may be processed in the RO Operations Advisor.
- MLD Elements: these elements can be used to design processes in WAVE/PRO for Minimum Liquid Discharge (MLD). If data is available from such processes, that data may be processed in the RO Operations Advisor.
- SWBR Elements: these elements can be used to design processes in WAVE/PRO for Sea Water Brine Recovery (SWBR). If data is available from such processes, that data may be processed in the RO Operations Advisor.

This feature effectively imports WAVE PRO licenses – thus a user that has access to the elements described above in WAVE PRO would automatically have access in the RO Operations Advisor

Requesting Licenses

This is the current process for licensable features that are made available:

- Approved RO Operations Advisor users receive an email announcement about a newly licensed ROOA feature. The email contains a **"Request License"** link.
- The users click on the “Request License” link, which opens a DuPont license request page, implemented through the existing Contact Us platform) as shown in Figure 53 . The request page is pre-populated with:
- Request Type = License Request
- Application = RO Operations Advisor
- License Type (when known)
- The users complete a short questionnaire that includes:
- Business justification
- Location
- Expected usage
- Additional feature-specific questions
- The requests are submitted.
- A designated RO Operations Advisor administrator reviews the requests and approves or rejects it.
- After approval, the licenses are assigned to the users. The users get confirmation e-mails that the license has been granted.
- Users log into the RO Operations Advisor and see the licensed feature as described in Table 10

Outside of the current process, users can still request licenses via their DuPont representative. Help on how to use these licensed features is available as shown in Figure 54. Table 10 describes how the user can confirm whether the licensed features are available. This table would expand as more features are developed and deployed.

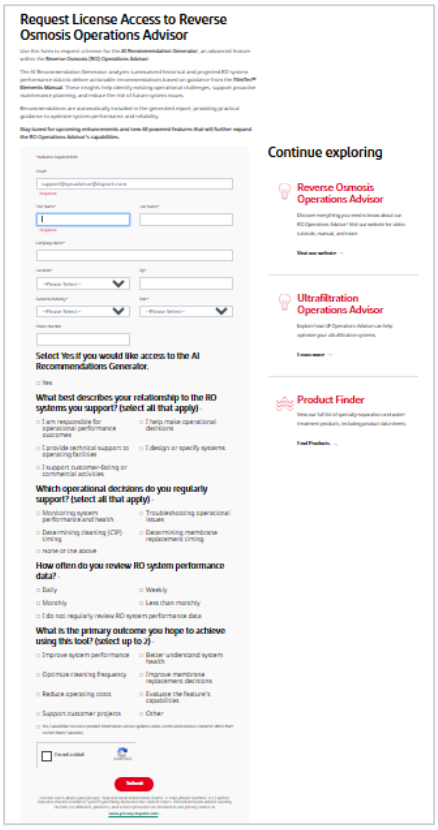
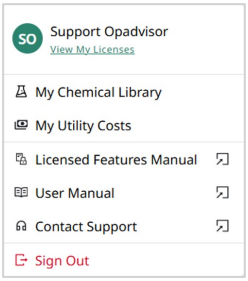
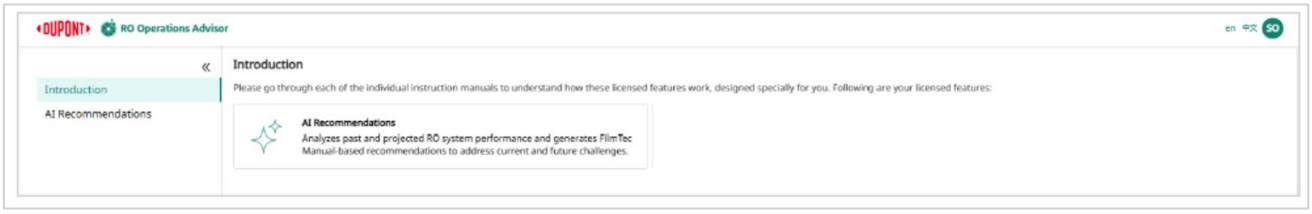


Figure 53: The RO Operations Advisor License Request Form



(a)



(b)

Figure 54: The User Profile (a) and Licensed Feature Help Content (b)

Table 10: Licensed Features and where users can see them

Feature	Help Content	Reports	Other
AI Recommendation Generator	Visible in the Licensed Features manual window as shown in Figure 54 (b)	Recommendations sections are populated automatically	

3 Frequently Asked Questions

Q **The RO Cleaning Advisor takes a long time to generate predictions and recommendations. Is there a way to address it?**

A Due to the inherent complexity of the modeling, predictions and recommendations take some time. The user can try reducing the number of iterations or using a smaller dataset for faster results.

Q **What is the difference between a CIP and a shutdown in the tool?**

A Both a CIP and a shutdown are considered process interruptions or plant downtime. In this tool, we consider a CIP as a process interruption for the sole purpose of cleaning the RO/NF system. We consider a shutdown as a process interruption that is primarily due to other factors e.g. maintenance. It is understood that operators may take advantage of a shutdown to perform a CIP – thus we do calculate Cleaning Effectiveness values even for shutdowns. The user can reclassify a shutdown as a CIP to improve the accuracy of the prediction and recommendation

Q **Does the RO Operations Advisor examine the details of what happens during a CIP?**

A The RO Operations Advisor currently collects information on the details of what happens during a CIP (e.g. soak duration, pH, temperature, chemicals) but it does not currently analyze these details.

Q **What are the primary and secondary fouling types and how are they determined?**

A The tool identifies trends generally associated with different types of fouling or scaling to determine which type is occurring. If trends corresponding to more than one type of fouling/scaling is identified, the tool uses a scoring function to determine which type is the primary (highest score) and which one is the secondary. In this version of the tool, at most two types of fouling/scaling are displayed

Q **What are the various features in the graphs (e.g. zoom, pan, lasso, box, autoscale) and how do I use them effectively?**

A Those features are from an external plugin feature called Plotly. Please consult the resources here: https://plotly.com/chart-studio-help/tutorials/

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Have a question? Contact us at:
www.dupont.com/water/contact-us

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Form No. 45-D04999-en, Rev 4
September 2026