Asset Performance Management
APM Prognostics Guide

Document ID: APMDDB-0019-2301-00

APM Prognostics Version: 3.3.221130.0

January 2023

Legal Disclaimer

The product described in this documentation may be connected to, and/or communicate information and data via, a network interface, which should be connected to a secure network. It is your sole responsibility to ensure a secure connection to the network and to establish and maintain appropriate measures (such as but not limited to the installation of firewalls, application of authentication measures, encryption of data, installation of antivirus programs, and so on) to protect the product, the network, your systems, and the interface against any kind of security breach, unauthorized access, interference, intrusion, leakage, damage, or corruption or theft of data. We are not liable for damages or losses related to any such security breach, unauthorized access, interference, intrusion, leakage, damage, or corruption or theft of data.

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About This User Guide

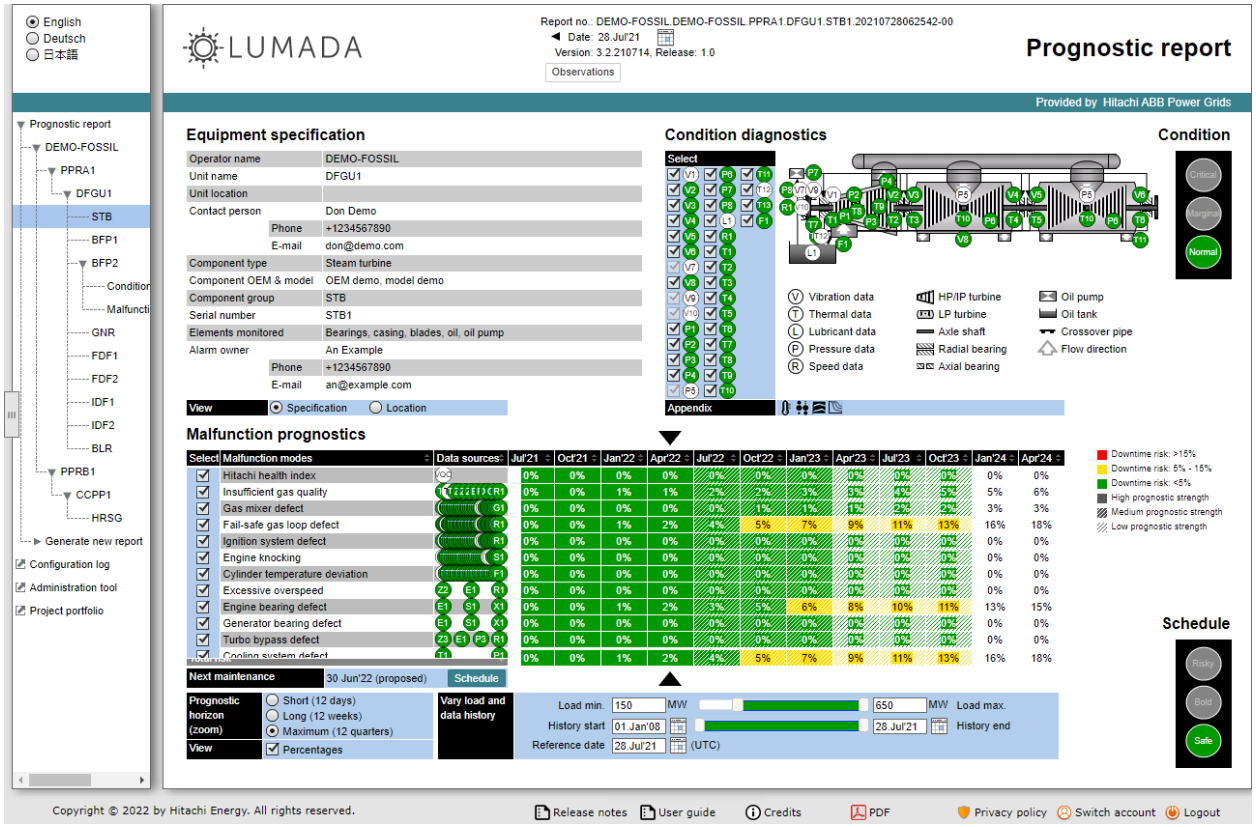
This user guide contains information about the prognostic capabilities of the APM Prognostics application. Operators of industrial assets can use this application to get information when their assets will experience complications or reach critical conditions. APM Prognostics allows for maintenance optimization, extending remaining useful life before maintenance can occur, and maximization of your assets to lower repair costs.

This guide also contains API document for APM Prognostics and sample Postman collections. For more information, see this chapter.

Chapter 1: APM Prognostics Overview

Application Overview

APM Prognostics is a web application with prognostic capabilities for industrial asset management. It can calculate asset condition and show an explicit prognostic horizon and risk profile. You can use this information to understand when in the future a malfunction of your asset is likely to occur. Based on the asset condition, you can make informed decisions about the asset maintenance planning to reduce unplanned downtime.



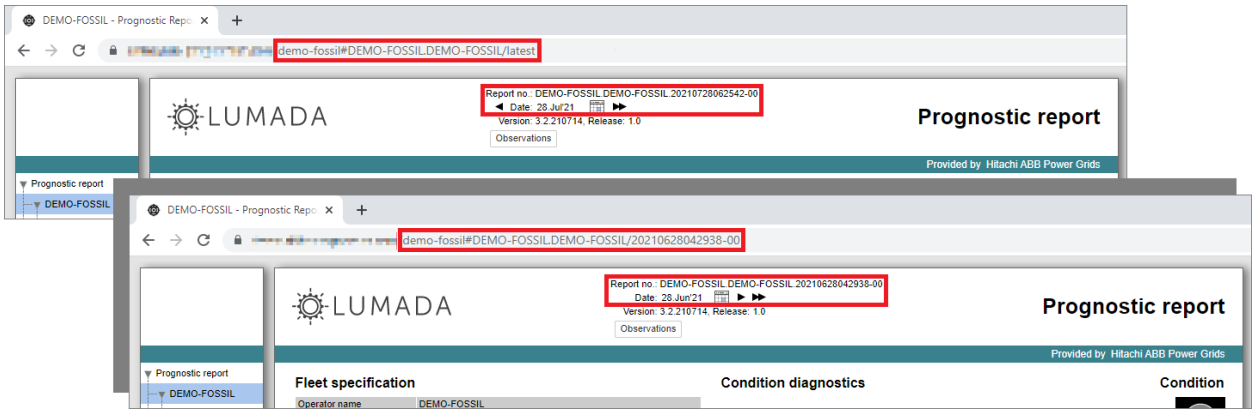
In the navigation panel on the left side, you can select a language for the interface of your application and a page that you want to see. The main pages are:

- Prognostic report
- Configuration log

  Note: This page is available only in English.

- Administration tool
- Project portfolio

These pages and individual reports in the Prognostic report page have dedicated links (URLs) that you can use to access them directly.



Roles

You control access to the APM Prognostics pages and options that are available in the pages by assigning roles to the application users. Most of the users will have roles that let them see and do tasks in the Prognostic report and Configuration log pages.

The APM Prognostics roles are:

- None – A user with this role has no access to APM Prognostics.
- Front End – A user with this role has access to prognostic reports.
- Config Doc Viewer – A user with this role can see configuration documents.
- Config Doc Editor – A user with this role can edit configuration documents.
- Admin – A user with this role can release configuration documents.

The roles are ordered from the lowest to the highest level of access that they give to users. The assignment of a certain role causes the assignment of the lower role as well. For example, a user with the Config Doc Editor role, has all the permissions of the Config Doc Viewer and Front End roles.

You can assign roles globally or per an operator. The per-operator assignment can only extend the user permissions, not restrict them. For example, if a user has the Config Doc Viewer role globally, you can only extend it to the Config Doc Editor or Admin role in scope of a specific operator. You cannot restrict it to the Front End or NONE roles.

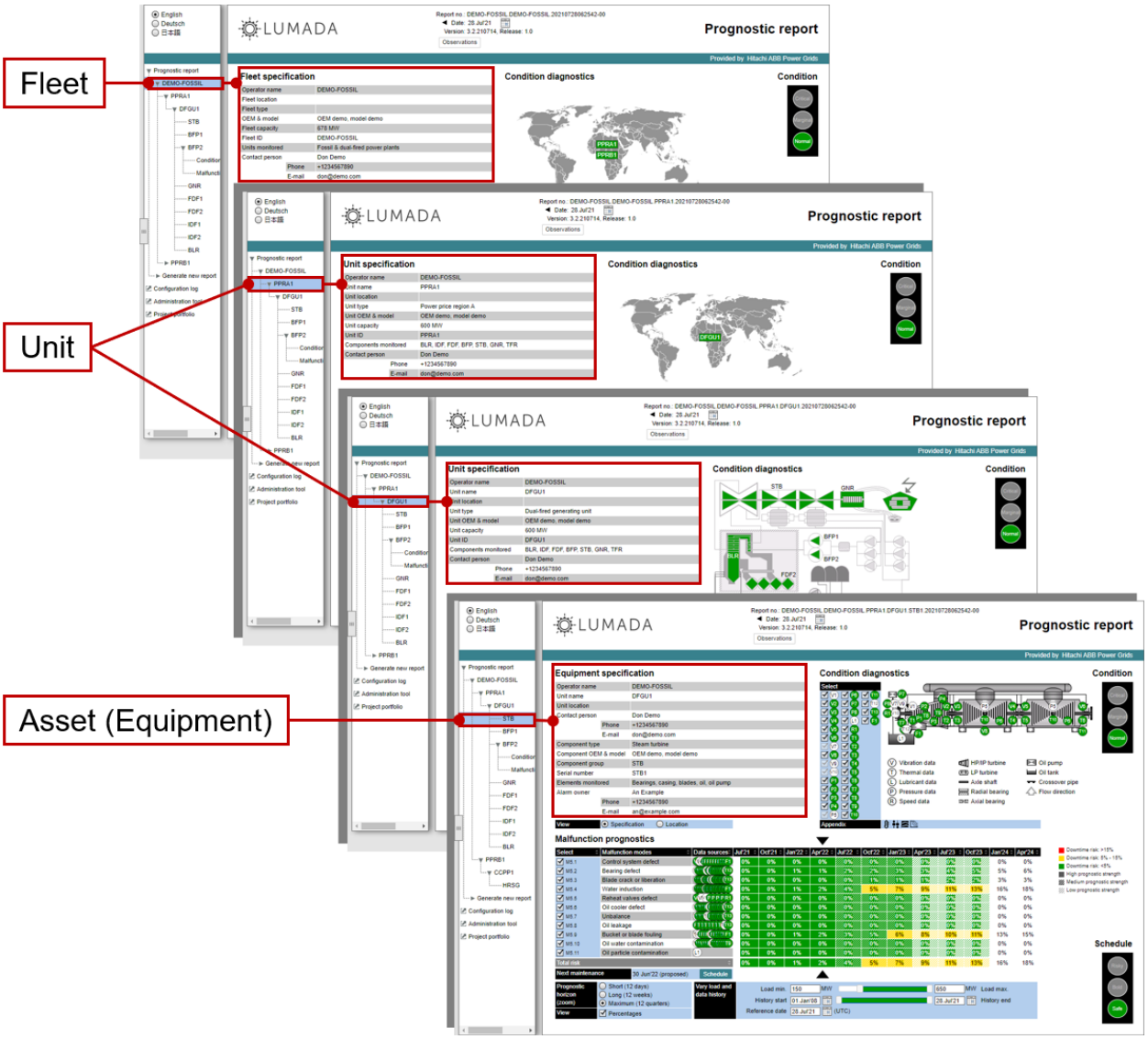
Important: Make sure that you do not grant external users the global access. A global role assignment that is higher than NONE gives a user the access to all the operators in the system. It includes the FTP access. When the users with the global Front End role or higher log into the FTP server, they can see the full list of operators along with all their data.

Prognostic report page

APM Prognostics offers objective, condition-based information on the remaining useful life (RUL) of assets and computed risk profiles over an explicit time horizon. It gives an overview of the condition diagnostics and malfunction prognostics. The report has several functions that let the asset operators to make significant cost savings in the following areas:

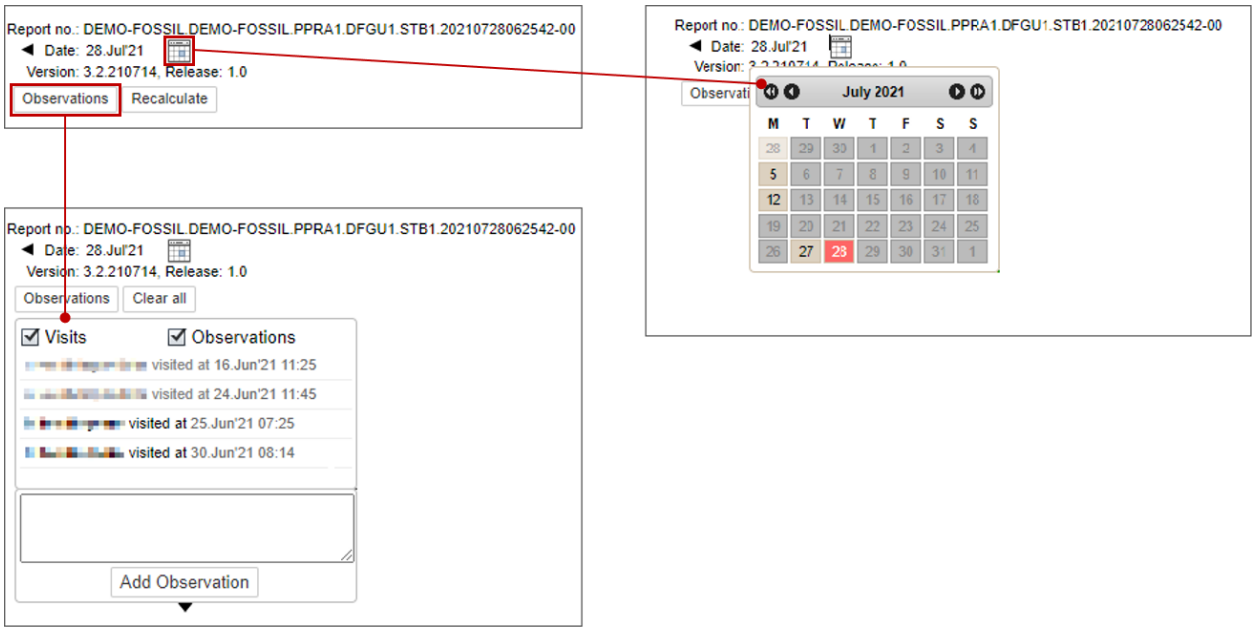
- Reduced preventive scope and frequency
- Shift of maintenance into periods with low maintenance costs
- Shift of maintenance into periods when revenue from production is low
- Reduction of the unscheduled maintenance and repair
- Better maintenance work order preparation
- Preemption of damages
- Reduction of redundancies

The prognostic report is hierarchical, you can view it for the entire fleet of assets, a unit in the fleet, or a particular asset (equipment) in a unit. When you configure this hierarchy, we recommend to use names that identify the name of the company and are related to how the asset fleet is organized in the company. Usually, the units are collections of assets in one location or close to each other. In some cases, it is necessary (and possible) to have more than three levels in the hierarchy. So for example, in more complex hierarchies, units can be also collections of other units, like in the hierarchy below. Note, that the lowest level in this hierarchy displays the most details.



At the top of the Prognostic report page, you can:

- See the number and date of the prognostic report.
- Click the **Calendar** icon to see a prognostic report from a different date.
- See the version and release number of your APM Prognostics instance.
- Click **Observations** to see who used your instance of APM Prognostics recently and if they left any comments by adding an observation.
- Click other buttons that appear only when you do some specified steps in APM Prognostics. For example, run simulations.



There are two main data inputs that have effect on what you see in the Prognostic report page. The first one is the configuration document (config doc) with static data like equipment specification, names of the malfunction modes, names and number of the data sources. For more information, see the Configuration log. The second one is the data about the assets from the measuring devices. This is the data that APM Prognostics uses to calculate the risk prognoses for the assets.

At the bottom of the Prognostic report page, you can:

- Download the release notes and user guide.
- See the third-party components that APM Prognostics uses.
- Convert this page into a PDF file.
- See the Hitachi Energy privacy policy.
- Switch the account or log out.

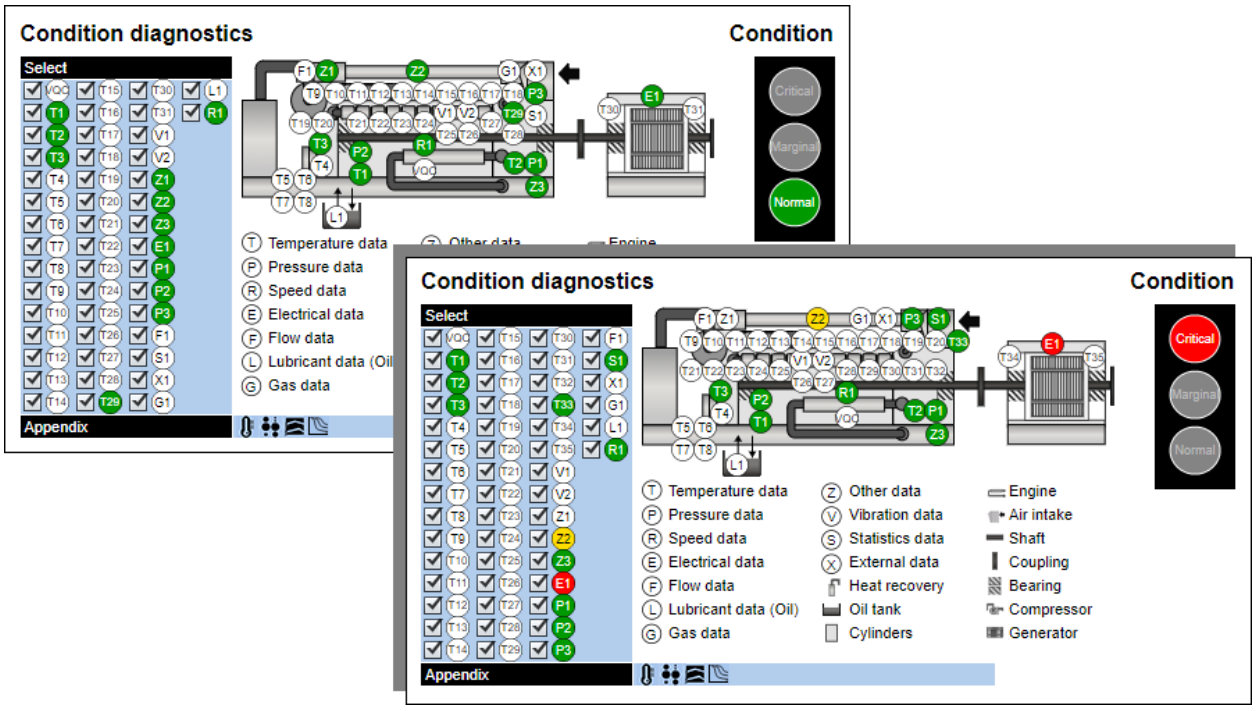
Note: The Convert option is available only for the Prognostic report. All the other options are available in the whole application.

Details of the Prognostic report page

The Prognostic report page is a customer-facing dashboard with information about the assets. There are several settings on this page that you can select to change what you see. To learn about all the options and settings, let us look at an example of a component level.

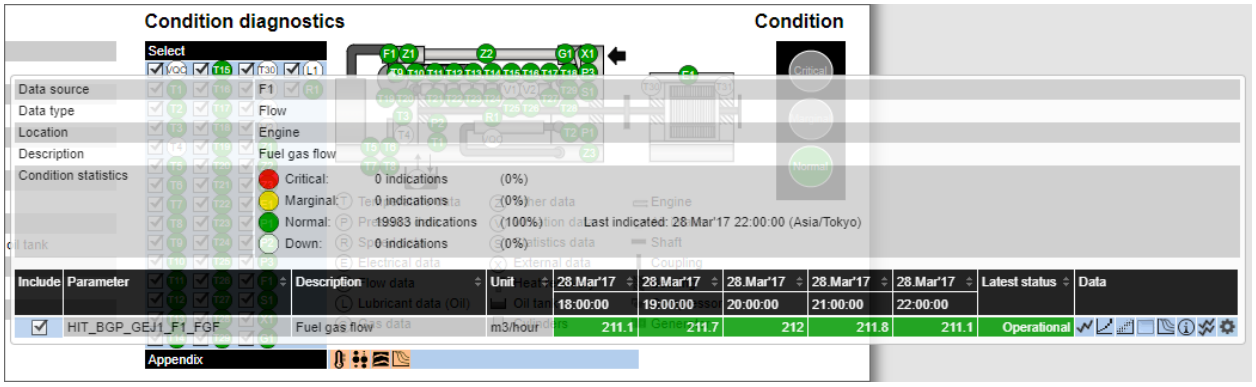
Condition diagnostics section

The Condition diagnostic section contains a referential diagram with a legend that explains its elements.



The circles on the diagram are data sources that supply information about the asset elements. The data sources usually represent measuring instruments that are on or in the asset and monitor its work and condition. The letter in the circle identifies the data source type, the numbers identify instances of a particular data source type.

You can hover over the diagrams to display tool tips with additional information. Additionally, when you are on the fleet or unit level, the diagrams have a drill-down option. You can click on the diagram elements to go to a lower hierarchy level.



During the normal operation (when the asset condition is normal), the data sources are highlighted green. It means that the latest data that was uploaded into APM Prognostics is in the operational range. When the data starts to be in the marginal range, the diagnostic condition of asset elements (and the asset itself) becomes worse and the data sources are highlighted yellow. Finally, when the data is in the critical range, the data sources are highlighted red.

The data source circles can also be white. It happens when:

- There is no data for the data source.
- The data that is available is below the threshold.
- The data is excluded from the solution.

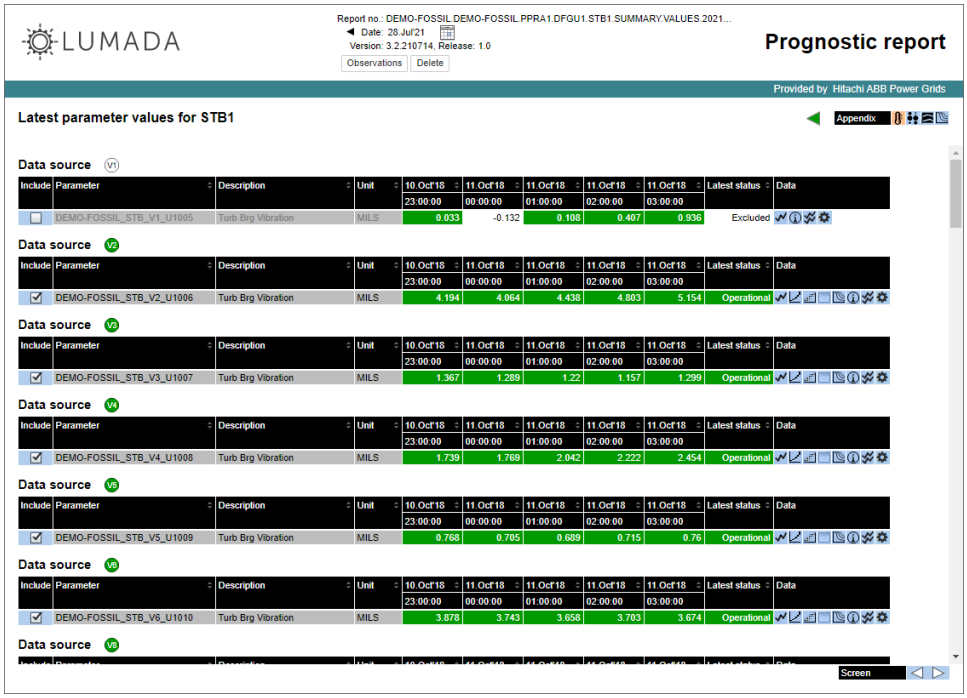
Additional visualizations in the Prognostic report page

In the bottom appendix in the Condition diagnostics section, you can click any of the icons to display additional information:

Note: The icons are available for you depending on the assigned roles. For more information, see Roles.

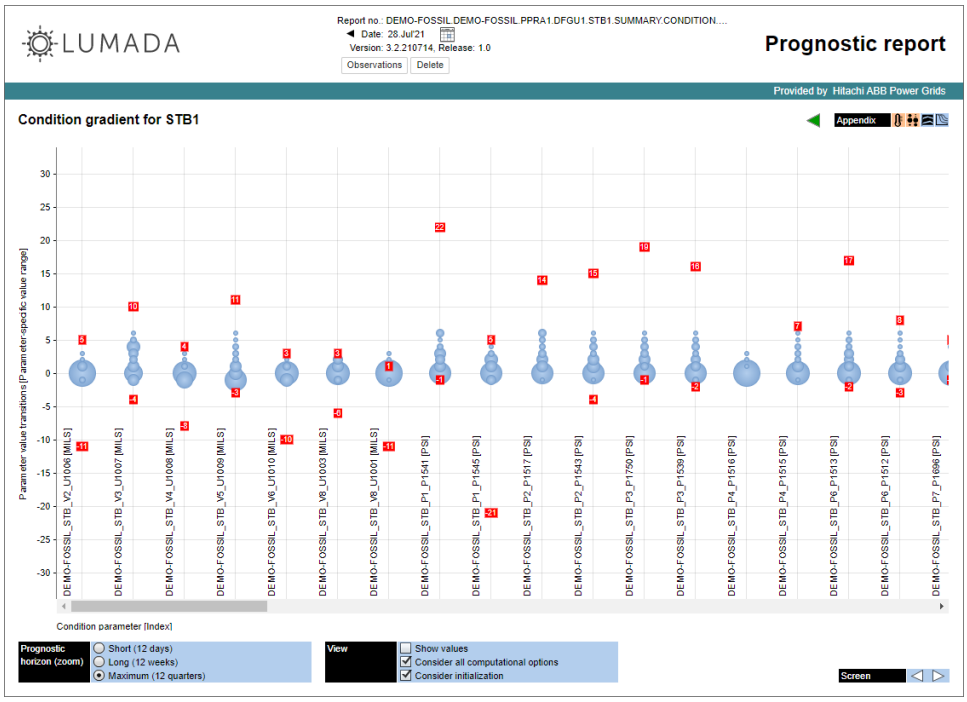
- Latest parameters values

  This page shows a table with an overview of the latest values of all parameters, grouped by the data source. The table identifies with colors: gray, green, yellow, red, and dark red which parameters are in the excluded, normal, marginal, severe, and critical ranges, respectively.



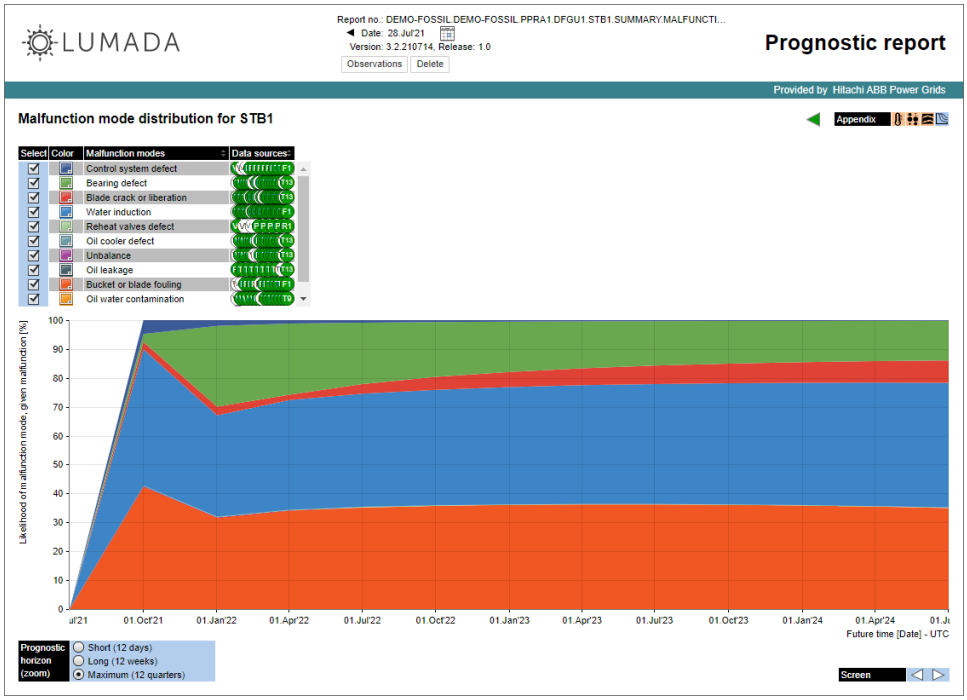
- Condition gradient

  This chart shows the transition probability from the current category to the next categories for all the parameters. The horizontal axis lists all parameters, while the vertical axis shows the maximum and minimum categories for all the parameters that can be reached (read squares with the white fonts) and circles with radius proportional to the probability of transition. This chart lets you do an in-depth technical analysis of the transitions, focused on the current parameter values.



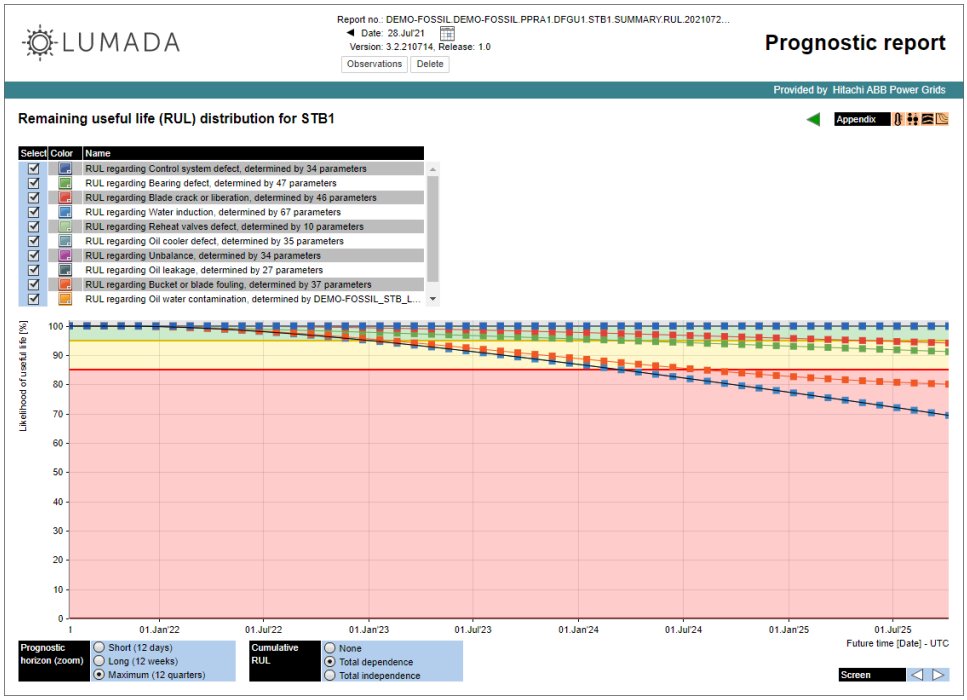
- Malfunction mode distribution

  This chart shows the prognosticated relative likelihood of the different malfunction given you have a malfunction. The sum of all likelihoods is 100%.



- Remaining useful life (RUL) distribution

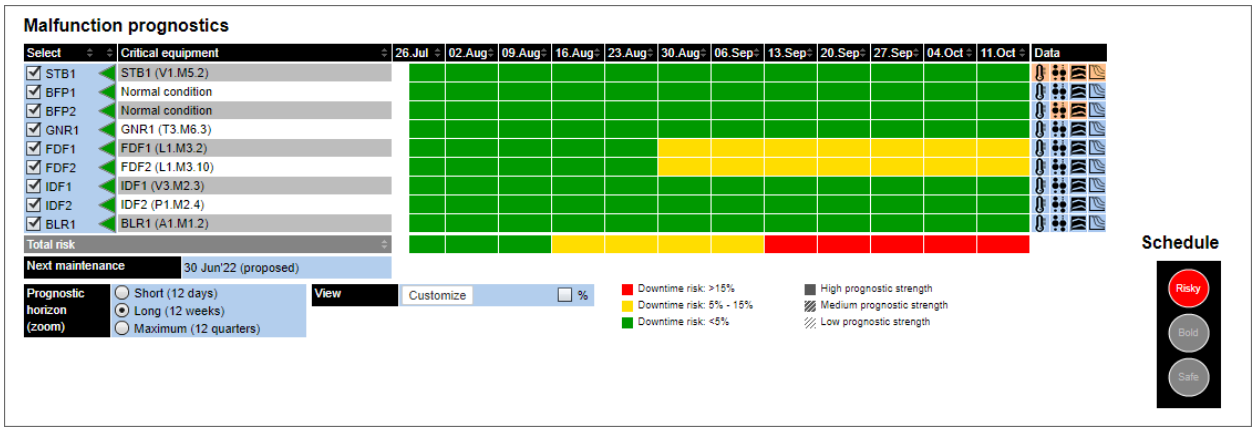
This chart displays, for each malfunction mode, the prognosis for the remaining useful life based on that malfunction. It shows which malfunction modes contribute to an accelerated reduction of RUL.



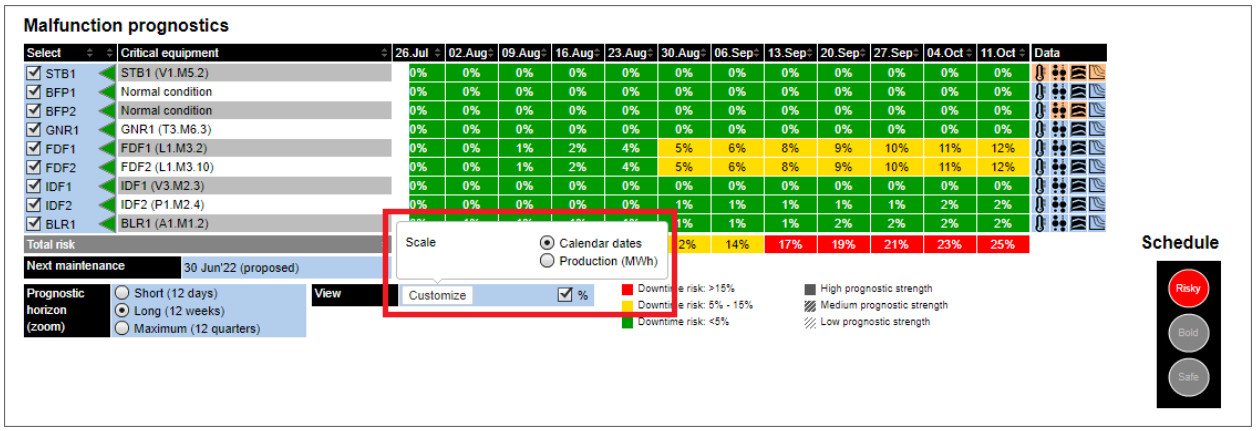
The Malfunction prognostics section

The Malfunction prognostics section shows how the asset condition (total risk) changes over time and a prognosis how it might change in the future. Such prognosis helps you determine the remaining time to the asset malfunction and mitigate risks related to this malfunction. For example, you can schedule maintenance activities with a higher precision or temporarily decrease asset utilization to extend the asset life. The asset condition and condition prognosis represent the asset malfunction likelihood that APM Prognostics displays in one of the three colors:

- Green (Safe)
- Yellow (Bold)
- Red (Risky)



For more detailed information, you can select the Percentages view. The malfunction likelihood is measured in percentages, where 0% indicates no likelihood of malfunction, 100% indicates the asset malfunction.



The columns that have dates in their headings show prognoses of how the malfunction modes change over time. Instead of the calendar dates, you can select a different scale if is available for your APM Prognostics instance. In the View section, you can click Customize and select a scale that you want to show.

On the left side of the chart, there is a list of malfunction modes for the individual asset. Similarly to the asset condition (total risk), they are measured in percentages. In the Data sources column, you can see which data sources (measuring devices or sensors) are correlated with the malfunction modes. In other words, APM Prognostics uses data from these devices to calculate the risk prognoses for the malfunction modes.

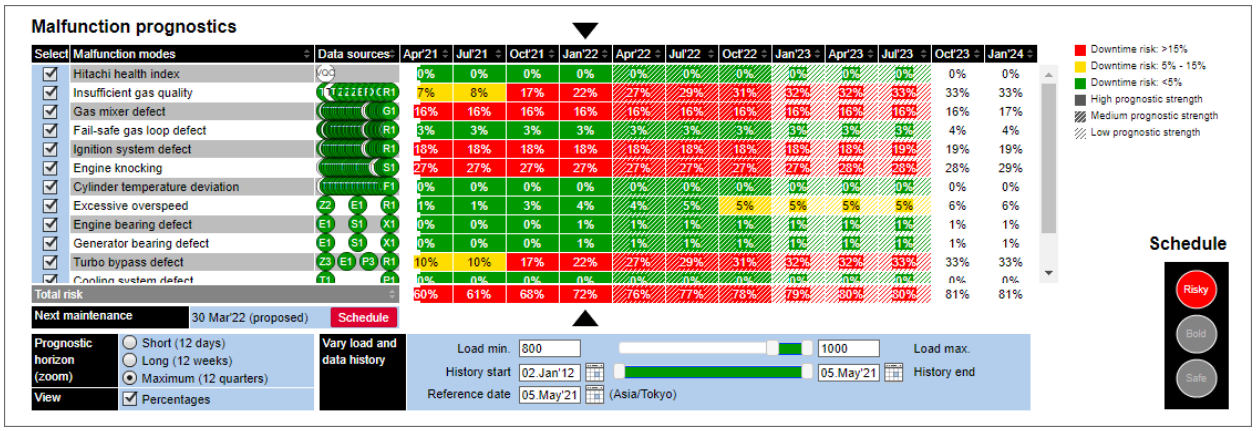
Malfunction modes impact the malfunction risk of the entire asset and are typically dependent on one another. With respect to cross-dependencies, the asset condition is defined as the maximum likelihood of any malfunction mode at any given time. When extending the scope from condition to risk and aggregating risk from asset component to unit level, the malfunction risk of your asset is as high as the highest malfunction risk of any of the asset components. You can define different risk computation levels in configuration document for each level.

Also, instead of defining the risk as the Maximum risk, you can also define it as Multiplied risk where the value of the asset risk is a sum of the malfunction risks. You do it in the configuration document.

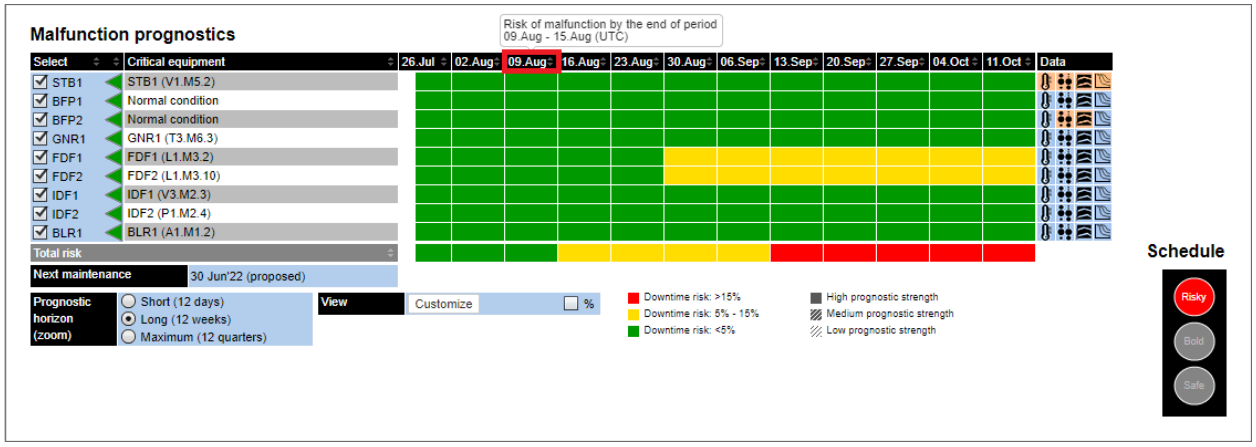
Available settings and options in the Malfunction prognostics sections

- In the Select column, you can select which malfunction modes you want to display on the chart.
- In the Prognostic horizon (zoom) section, you can select if you see the next 12 days or sample dates from the next 12 weeks or quarters.

  When you select the longest horizon for your asset prognoses, you can notice that at some point the strength for the malfunction prognoses and total risk decreases. In other words, based on the available data, the prognostic strength decreases. You can see the strength levels in the legends on the right side of the Malfunction prognostics section.



- For the Long and Maximum prognostic horizons, the date in the column heading identifies the start of a time period for which APM Prognostics calculates condition prognosis (risk malfunction). However, the risk that you see in a given cell is calculated for the end of this time period.



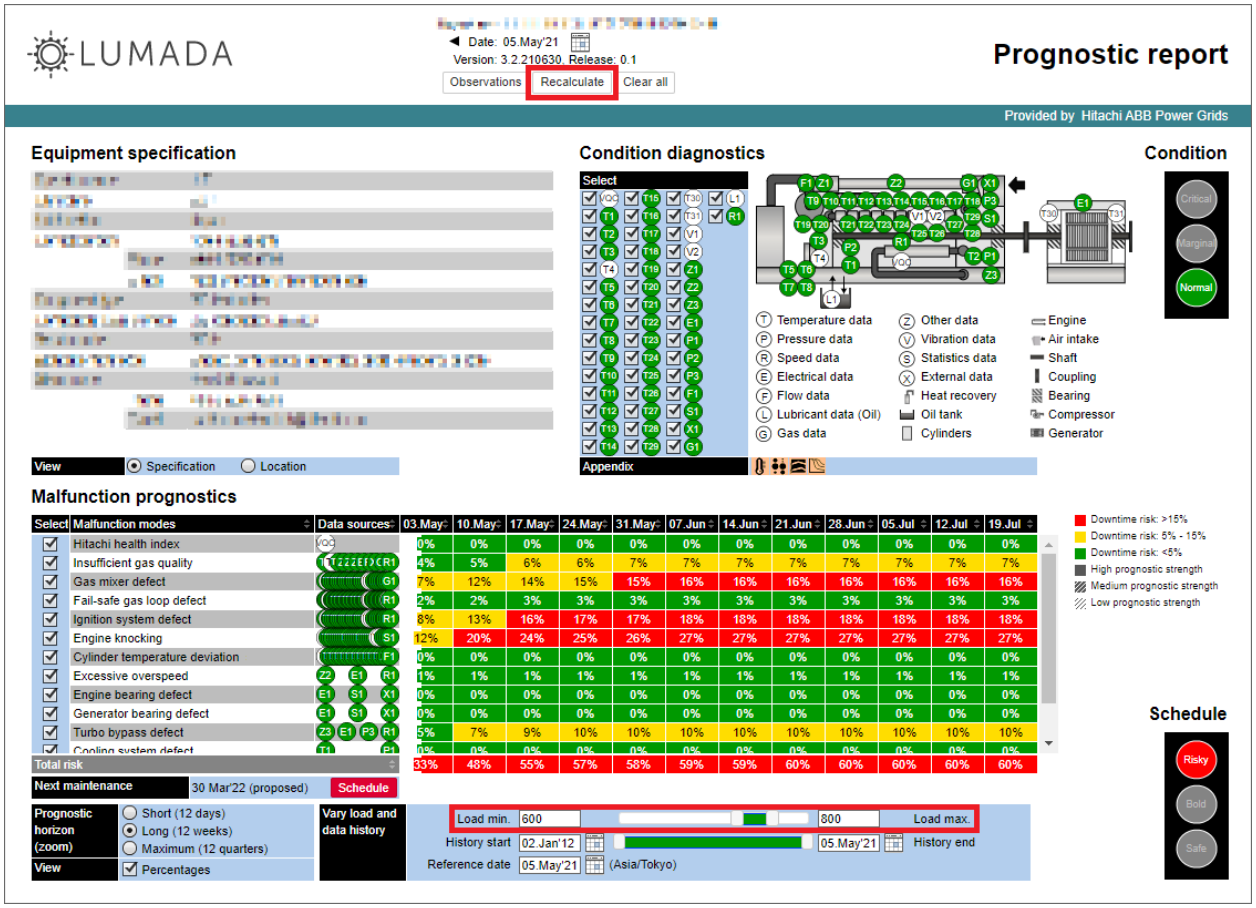
- When you schedule the next maintenance date, a black arrow shows at the top and bottom of a column with a date that is nearest to the maintenance date.

Simulations

Each asset has a referential parameter that we call **load parameter** and define it in the configuration document. This parameter corresponds to the main measurable feature or functionality of the asset. For example, in a wind turbine, it is a shaft speed that is expressed in rotations per minute; in a hydro-generator, it is active power that is expressed in Megawatts (MW).

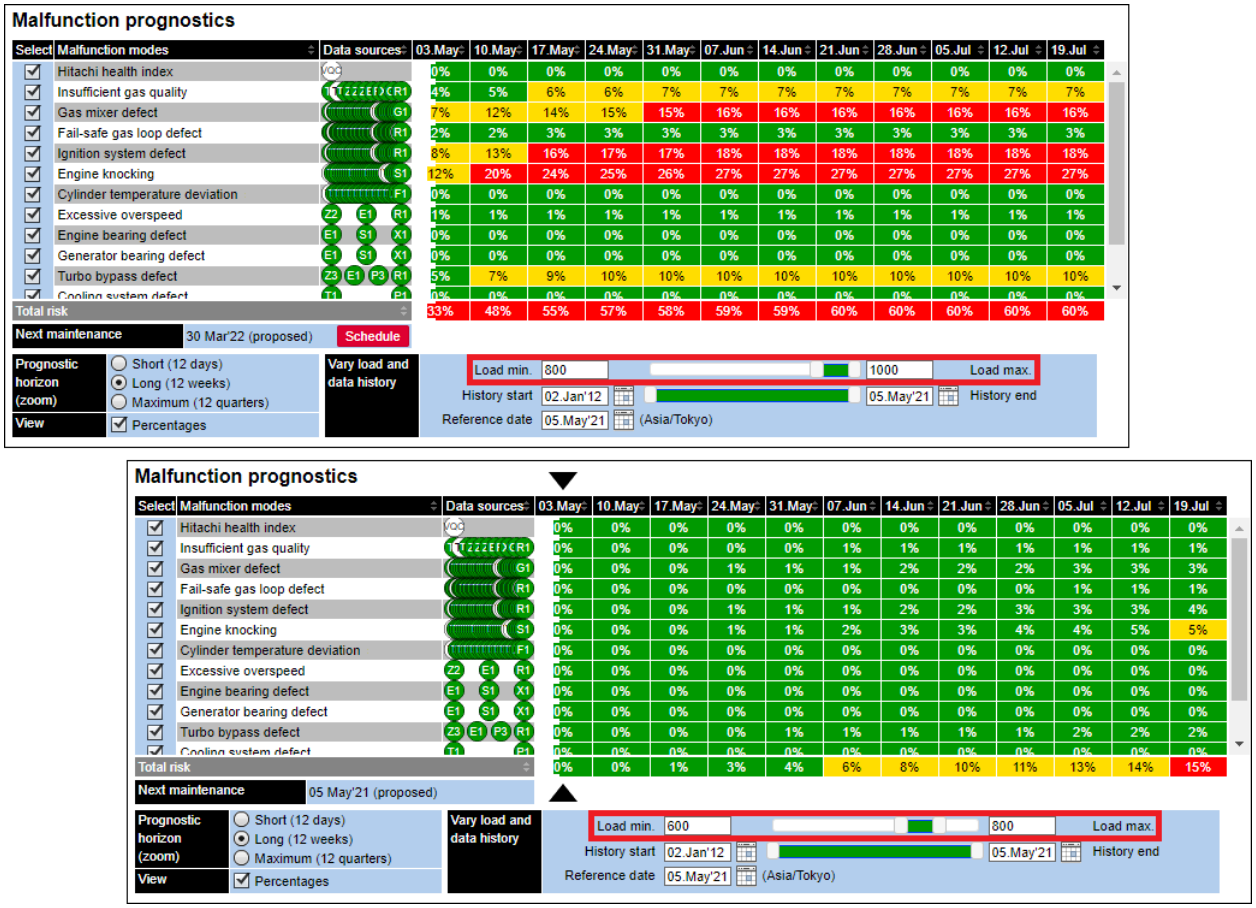
The load parameter has a dedicated interval of values (the range between **Load min** and **Load max**) that indicates normal operation range of the asset. For calculating a condition prognosis of the asset, APM Prognostics takes values of asset parameters only from the time periods when the value of the load parameter was between the minimum and maximum load. As a result, APM Prognostics excludes data that might blur condition prognosis. For example, you start the asset and it has not reached its normal operation mode yet. So, APM Prognostics does not consider the asset data until the values of the load parameter reach the load interval.

APM Prognostics lets you to simulate condition prognosis for assets to see how the condition prognosis changes for the asset when you change the load. You do this change in the **Vary load and data history** section and click **Recalculate** at the top of the page.



In our example, when the same gas engine asset operates within the load interval of 600 to 800 instead of 800 to 1000, the total risk of the asset becomes red on 19th July and is 15%, compared to 60% at the same date.

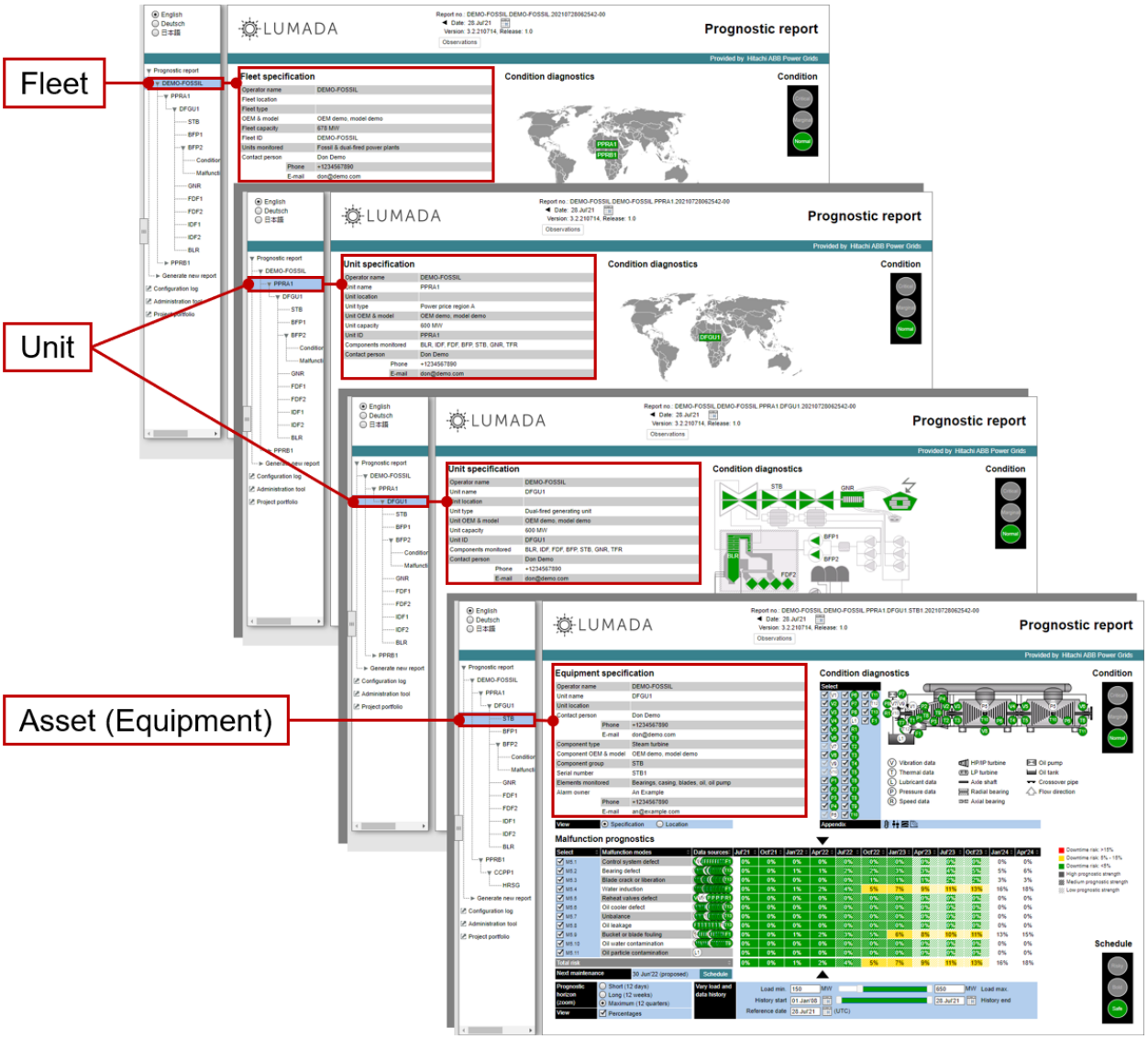
Such a small configuration change of the actual asset extends the time that is available for the asset maintenance and helps to prevent the asset failure.



You can also do a retrospective analysis on your historical data by changing the history interval (history start and history end). This way you can see what could be a result of the prognosis in the past under different operating conditions (load parameter). If you had asset failures in the past, this is a simple way to do a check that APM Prognostics would have prognosticated them based on the available data back then.

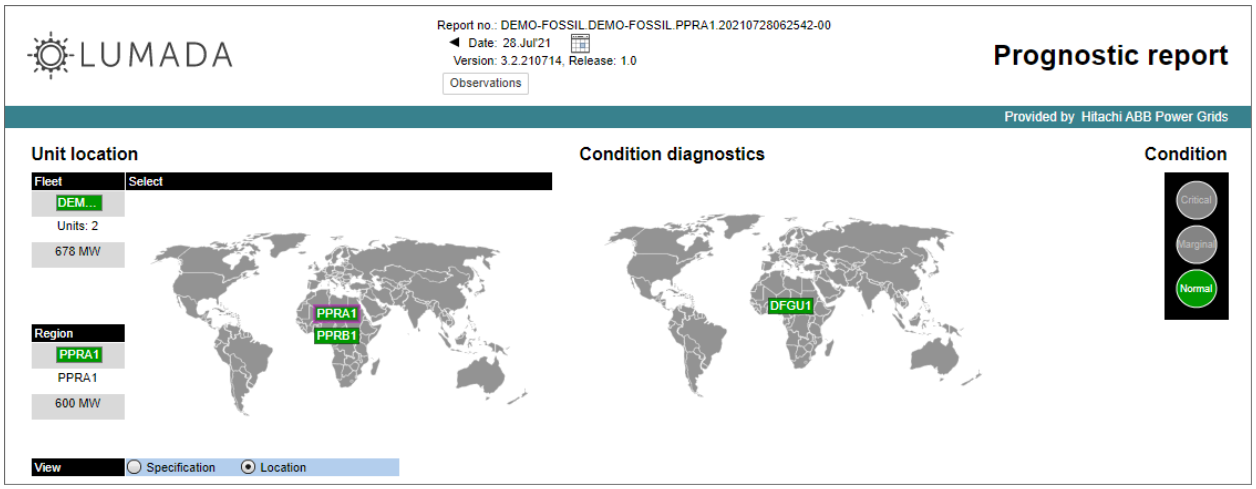
Equipment specification

It is a referential section in the Prognostic report page where you can see information about a particular asset. It is similar to an asset nameplate. When you select the Unit or Fleet level, the name of the section changes and it shows the specification for the selected level.

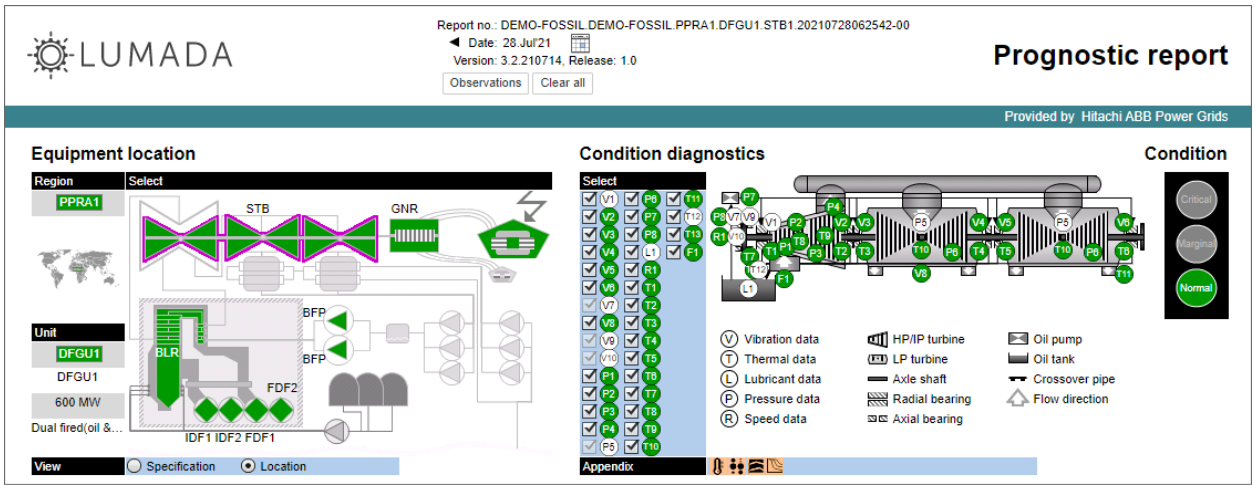


In some cases, it is necessary (and possible) to have more than three levels in the hierarchy. So for example, in more complex hierarchies, units can be also collections of other units, like in the hierarchy below.

For the unit and equipment levels, you can change the view of this section to the Location view and display where the unit is in the fleet



or where the equipment is in the unit.



Configuration log

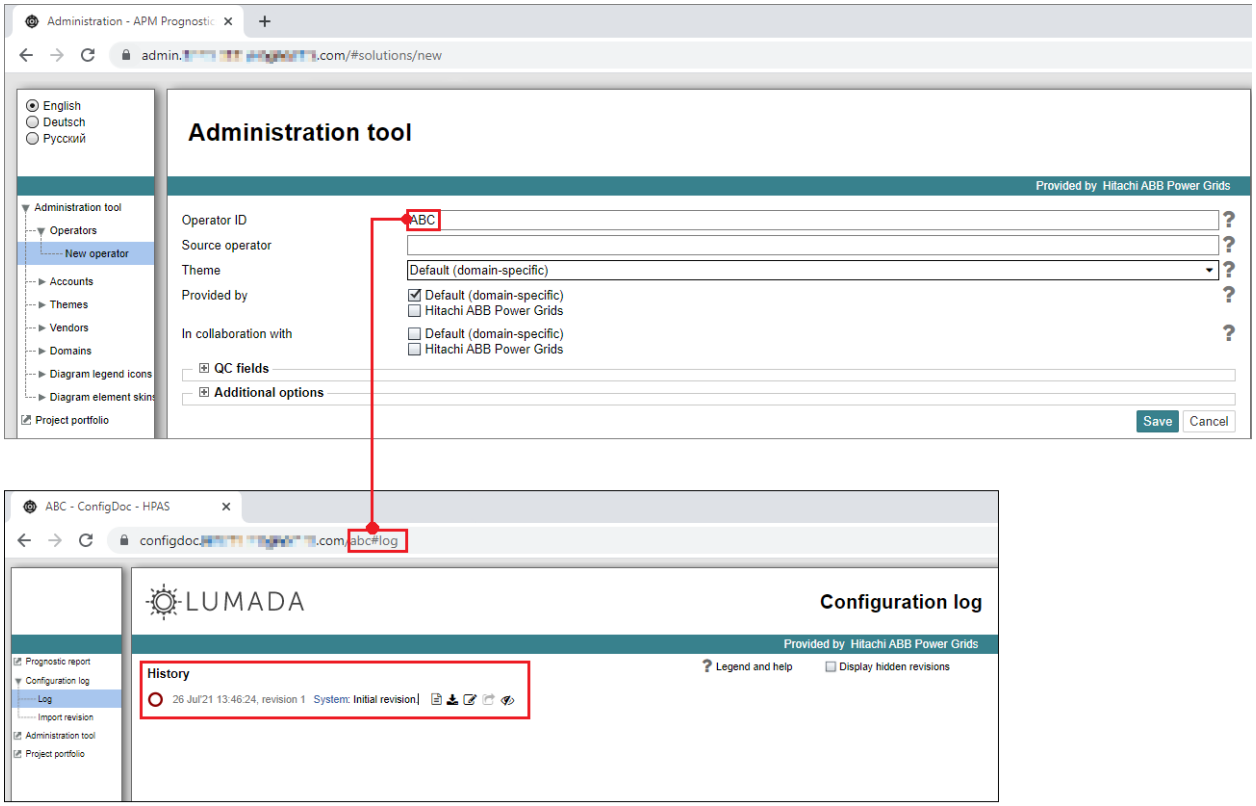
The Configuration log page is a place where you do the configuration of APM Prognostics models.

Note: This page is available only in English.

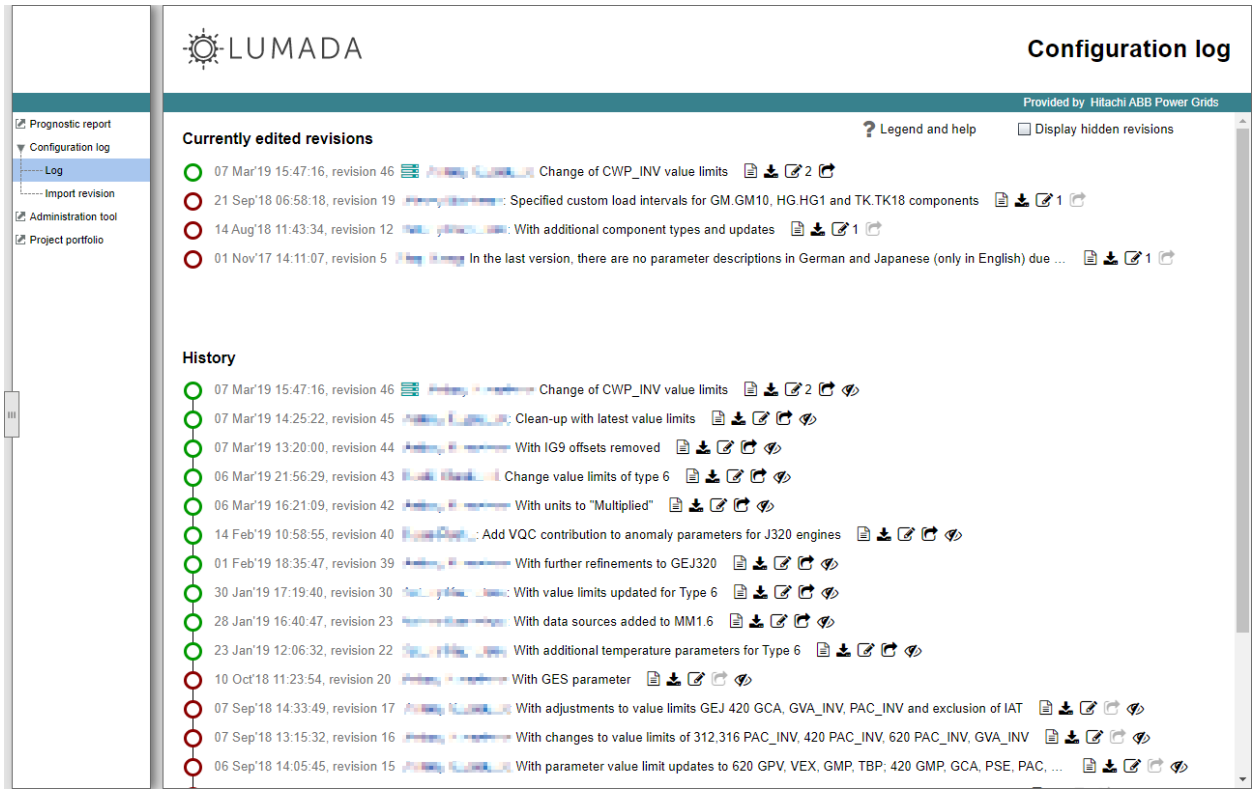
To use the Configuration log page on a brand new system, it is necessary to start from creating an operator in the Administration tool page. After you create an operator, APM Prognostics creates a special configuration log environment for that operator. In that special environment, the system automatically creates the initial revision with a configuration document that you can edit and modify. The access to the initial revision is online. The URL address for the configuration log has the format that follows:

configdoc.<domain_name>/<Operator_ID>#log

For example: configdoc.abb-prognostics.com/abc#log



APM Prognostics has a version control system for its configuration. On APM Prognostics instances that are in operation or in the process of configuration, in the Log page you can see more revisions of the configuration document that are related to your system. These revisions contain changes to the Prognostic report page and configuration of your system.



In the History section, you can see the chronological order of changes to your system (revisions). To see all of them, make sure that you select the **Display hidden revisions** option in the upper-right corner of the page.

By clicking the icons for each of the revisions, you can:

- Open the read-only view of the revision.
- Export the revision to a JSON file.

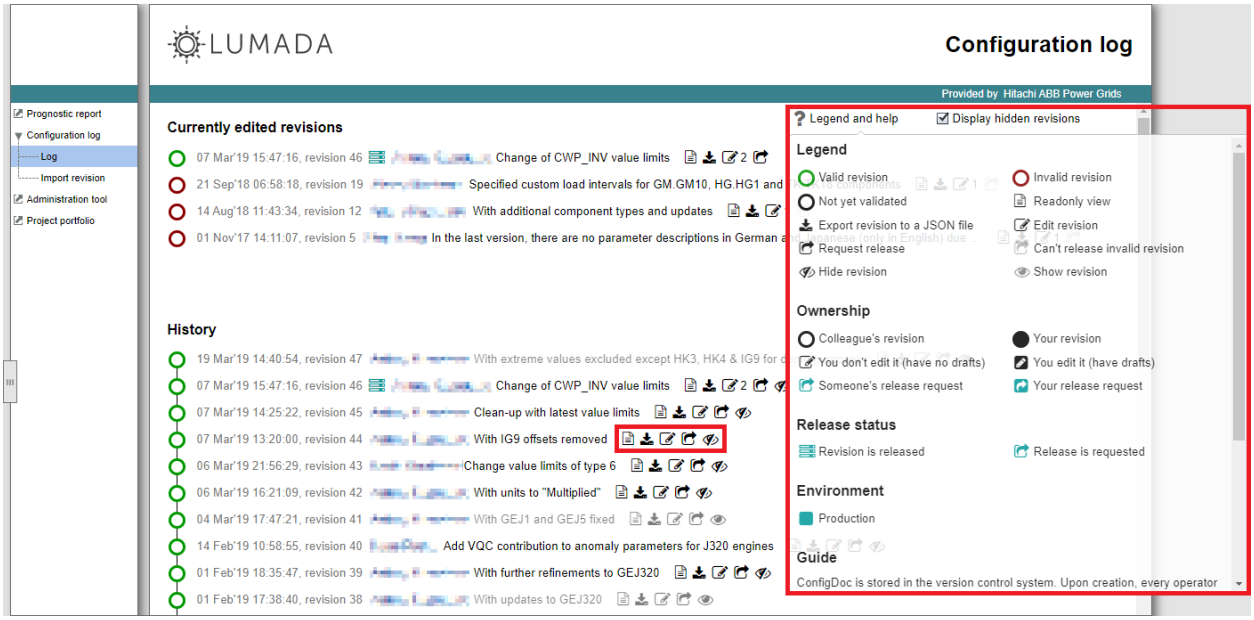
  You import a revision, in the Import revision page. For more information, see Importing a revision.
- Edit the revision.

  This option is available for users with at least the Config Doc Editor role. For more information, see Editing a revision.
- Release the revision.

  This option is available for users with the Admin role.
- Hide or show the revision in the History list.

  This option is available for users with at least the Config Doc Editor role. Editors of the configuration document might want to hide some of the revisions from the users with the Config Doc Viewer role. For more information, see Roles.

At the top of the page, there is a list of currently edited revisions.



To better understand the Log page, you can click **Legend and help** to display a tool tip with helpful information. There, you will see the explanation of the user interface elements and revision ownership. It is good to know that you can release only the valid revisions (drafts that pass the technical validation).

When you release a revision, the Prognostic report gets the updates immediately, for example, updates of the asset hierarchy and malfunctions. Changes like new parameters, thresholds for parameters, and correlations have an effect after you recalculate the prognostic report. Make sure that you do it after you release a revision.

Overview of the configuration and technical validation loop

Configuration of your APM Prognostics system follows a cycle that you can repeat to do changes or small adjustment of your system. The steps that you do are the same whether you create the very first revision or a new revision from an existing one.

Note: To configure a brand new system, it is first necessary to create an operator in the Administration tool page. After that, APM Prognostics creates a new configuration document that you can edit and modify.

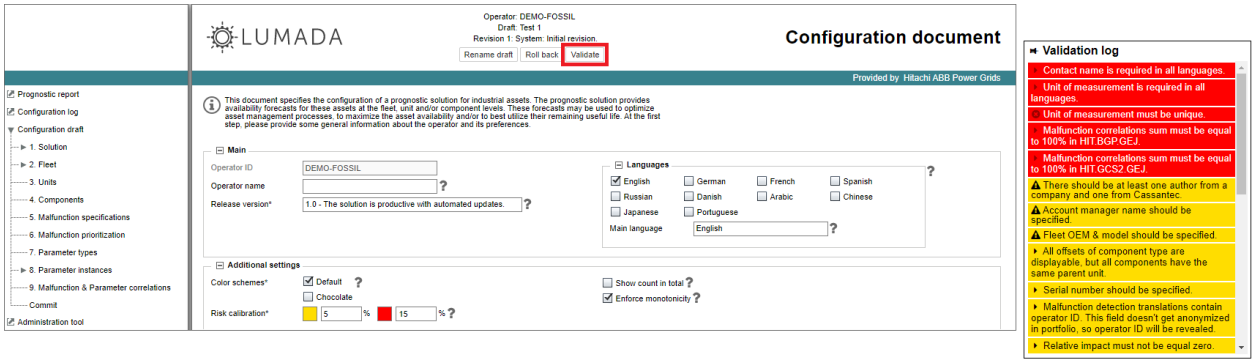
1. Select a revision with a configuration document and edit it.

   On an initial revision (or any other) in the Configuration log page, click the **Edit this revision** icon.

For more information about editing, see Editing a revision - preparing a configuration document.

2. Validate the revision draft.

   It is necessary to validate your revision draft at least before you want to commit it. You can also do it at any step of the configuration process.



When you do a technical validation of your revision draft, the Validation log shows in a new window and you can see all the errors and warnings in your configuration document. The warnings (in yellow) identify missing values in some parts of the configuration. Although we recommend to supply these values, you can still release a revision draft with these warnings, because they are not critical. The errors (in red) are the ones that you must repair. Click a warning or an error to open the related configuration step that contains it. After you repair all the errors, you can commit the revision draft to become a new release in the Configuration log page.

3. Commit the revision draft.

   The commit option is in the navigation panel on the left side below step 9. When you commit your revision draft, make sure that you enter a detailed commit message (it is typically equal to the name of the draft and will become a name of the revision after the commit) and refer to the changes that you made. To create a logical connection with other revisions in your system, you may select revisions that are considered merged to your new revision.

After you commit the revision draft, the Configuration manager can start another validation manually, the so called delivery validation. It is a process of aligning assets with the provided condition information.

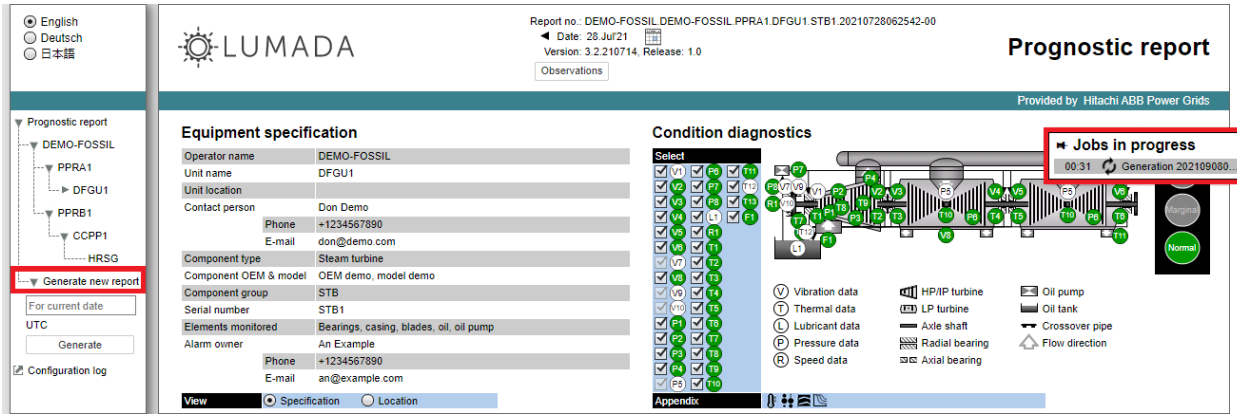
4. Release the revision.

   In the Configuration log, you can click the Release revision icons for revisions that are valid.

   See the Good to know section for more information.

5. Generate a new report.

   APM Prognostics applies some of the configuration changes automatically, for the rest of them it is necessary to generate a new report. You do it in the navigation panel of the Prognostic report page. This step is necessary after you release each configuration revision.



6. Review the report.

   Do a check that the configuration changes that you did are in the report and are correctly applied.

7. Validate the configuration retrospectively by doing some recalculations (simulations).

   The retrospective analysis is a popular validation technique where you do a historical forecast for a reference date in the past. For this validation, you select the date some weeks of months before an important event happened (for example, asset failure). Next, you run a simulation to verify that APM Prognostics would have identified the event with the correct mode and time to malfunction.

   The other thing that you can do as a part of this step is to generate a PDF report before you do the configuration changes and a PDF report after you apply your changes and regenerate the report. You will see the effect of the new configuration. If you use APM Prognostics for some time, it can happen that you want to adjust its configuration because something changes in your asset fleet or new or data is available for you. For more information, see Simulations.

   In the History section of the Configuration log page, you will see that APM Prognostics marks your revision with a black dot. We recommend to refresh this page at some small time intervals to see the validation result (the dot changing from black to green (if everything is correct) or red (if the technical validation failed). The size of the configuration document has an effect on the technical validation time. It can take seconds or even minutes before you get the validation results. For more information, click the Legend and help icon in the Log page.

8. Repeat the configuration process if necessary.

Good to know

When you work with revision releases, it is good for you to know that:

- You can release only one revision at a time.
- Any changes in the configuration document (config doc) take effect after you release them. In particular:
  - User Interface gets updated with the updated asset hierarchy.
  - Parameters get updated in the database. For the deleted parameters, their data gets deleted immediately. For the created parameters, you may now upload their data to the database (you can only upload data for parameters that exist in the database).
- If you generate a new report, it gets computed based on the new configuration.
- The release operation can not be reliably reverted. If a parameter was deleted on release, its data is gone. The data cannot be automatically recovered if you attempt to release the previously released revision.

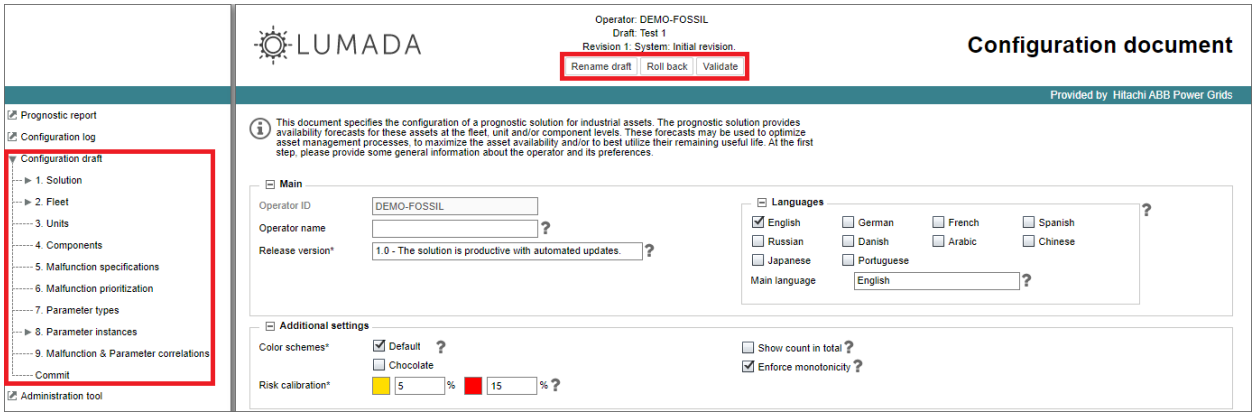
Chapter 2: Configuration

Configuration Overview

This chapter contains procedures that you can use to effectively manage your APM Prognostics instance.

Editing a revision - preparing a configuration document

With the Config Doc Editor role, you can edit the configuration of your APM Prognostics operator by editing an existing revision. APM Prognostics automatically creates the initial revision with a configuration document on an empty system after you create an operator. You can edit such revision to prepare the configuration document for your APM Prognostics operator. Every revision has a unique URL address that you can use for a direct access. You can also edit a revision that you or some other user created.



Note: The pages where you prepare the configuration document contain the **Question mark** icons that you can click to show more information or explanations of the given options. We recommend to read them at your convenience because APM Prognostics Guide does not contain all the information from these tool-tips.

In the page header, you can see some information about the draft that you edit, for example the revision from which it was created. You can also do the actions that follow:

- Rename the revision draft that you edit.
- Do a roll back and remove the draft from your system. When you do this action, you return to the Configuration log page.
- Validate the configuration document in your revision to make sure that the draft of the configuration document contains all the obligatory data and that you can release it to become a new revision.

The procedure of editing a revision has nine main steps. Steps 1, 2, and 8 are complex and contain several sub-steps. APM Prognostics automatically saves changes to the revision drafts that you edit to prevent the data loss. It is useful for the situation when you, for example, lose the Internet connection.

Prerequisites for creating a configuration document

Before you edit an initial revision to create your first configuration document, we recommend to prepare information about your asset fleet and the available data that you will use to configure your APM Prognostics instance.

We recommend to prepare the resources that follow:

- Specification of the asset hierarchy (unit and its components).
- Sketches of the units and components with identification of the physical location of the data sources (diagrams or schematic depiction is acceptable).
- Possible types of the critical malfunctions that occur in the components.
- Relevant alert and alarm levels of the measured parameters.
- Data history from at least 1 year (ideally 3–5 years) in the CSV or other machine-readable format.
  - Sampling rate at least hourly (average). Different rate is also acceptable.
  - Sampling point, for example, on the casing.
  - Process data, for example: temperature, speed, electrical, pressure, and flow.
  - Condition data, for example: vibration, lubricant analysis results, thermography, dissolved gas analysis results, and acoustic data.

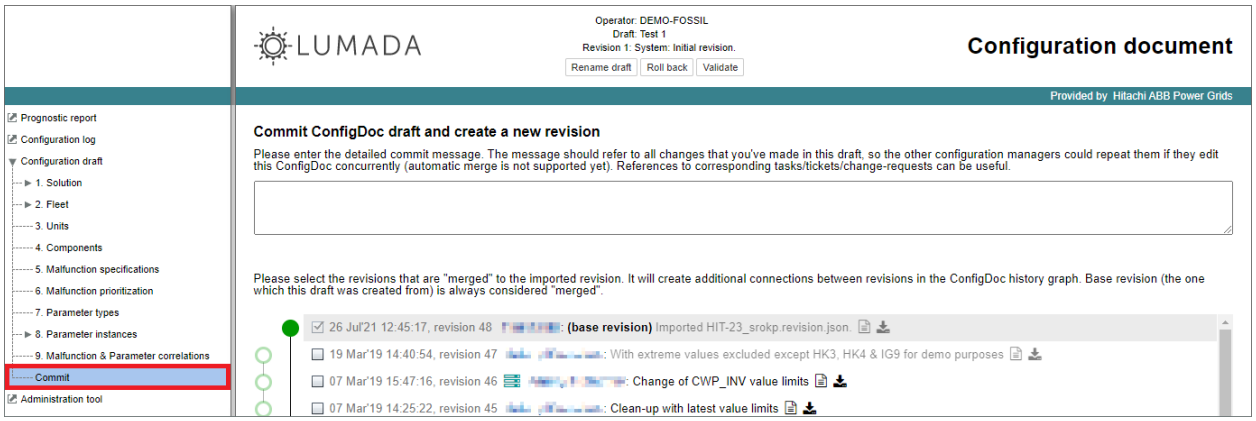
  For more details, speak with the Customer Experience support team.

Configuration steps

To learn more about the configuration steps, see the links that follow:

1. Solution
2. Fleet
3. Units
4. Components
5. Malfunction specification
6. Malfunction prioritization
7. Parameter types
8. Parameter instances
9. Malfunction & Parameter correlations

After you complete the configuration steps, you can commit your revision and release it. Next, you can recalculate the Prognostic report to contain the latest configuration changes.



Configuring the solution

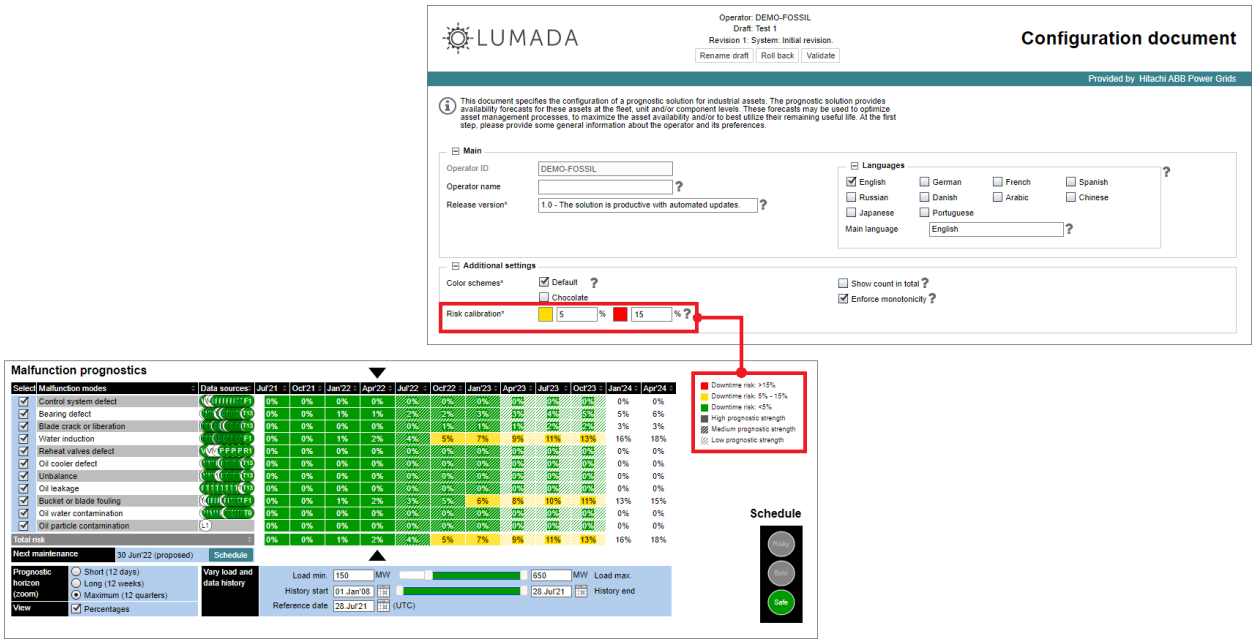
This step has five sub-steps where you can do the following tasks:

- In the **General** sub-step, you configure general settings of the solution, for example: operator name, languages, color schemes, and risk calibration. There are different release version that you can use for your APM Prognostics instance.

  The release version shows how prepared the configuration document is, it also has an effect on some parts of the application business logic and validation rules. You will usually increase this version when you complete the specified configuration steps. The higher the version is, the more restrictive validation rules are. For more information, click the **Question mark** icon for the Release version field.

  You supply the operator name to provide more information about the Operator ID of your APM Prognostics. Usually the Operator ID is an abbreviation of your company for convenience. We recommend to make it two or three letters long, for example HIT for Hitachi.

  In the Additional settings section, you do the risk calibration for the risk levels in the Malfunction prognostics section in the Prognostic report page. You set these values depending on your assets. For example, the assets in the mining industry can have much higher risk tolerance levels than the assets in a nuclear plant.



- In the **Contacts** sub-step, you supply information about the contact persons and alarm owners for your assets. You will see this data in the Equipment specification section in the Prognostic report page if you assign these persons to assets in the Units step.
- In the **Authors** sub-step, you supply referential information about the persons who are responsible for the configuration of your APM Prognosticsinstance. This information is not visible in the Prognostic report page.
- In the **Scope** sub-step, you can supply referential information about the configuration of your APM Prognostics instance. This information is not visible in the Prognostic report page.
- In the **Units of measurement** sub-step, you supply all the units of measurement that you want to use in your APM Prognostics instance. You will use the list of units of measurement to define parameter types in the Parameters types step.

Skip the **Diagram legend icons** and **Diagram elements skins** sub-steps. They were optional in the configuration process. We stopped developing these options.

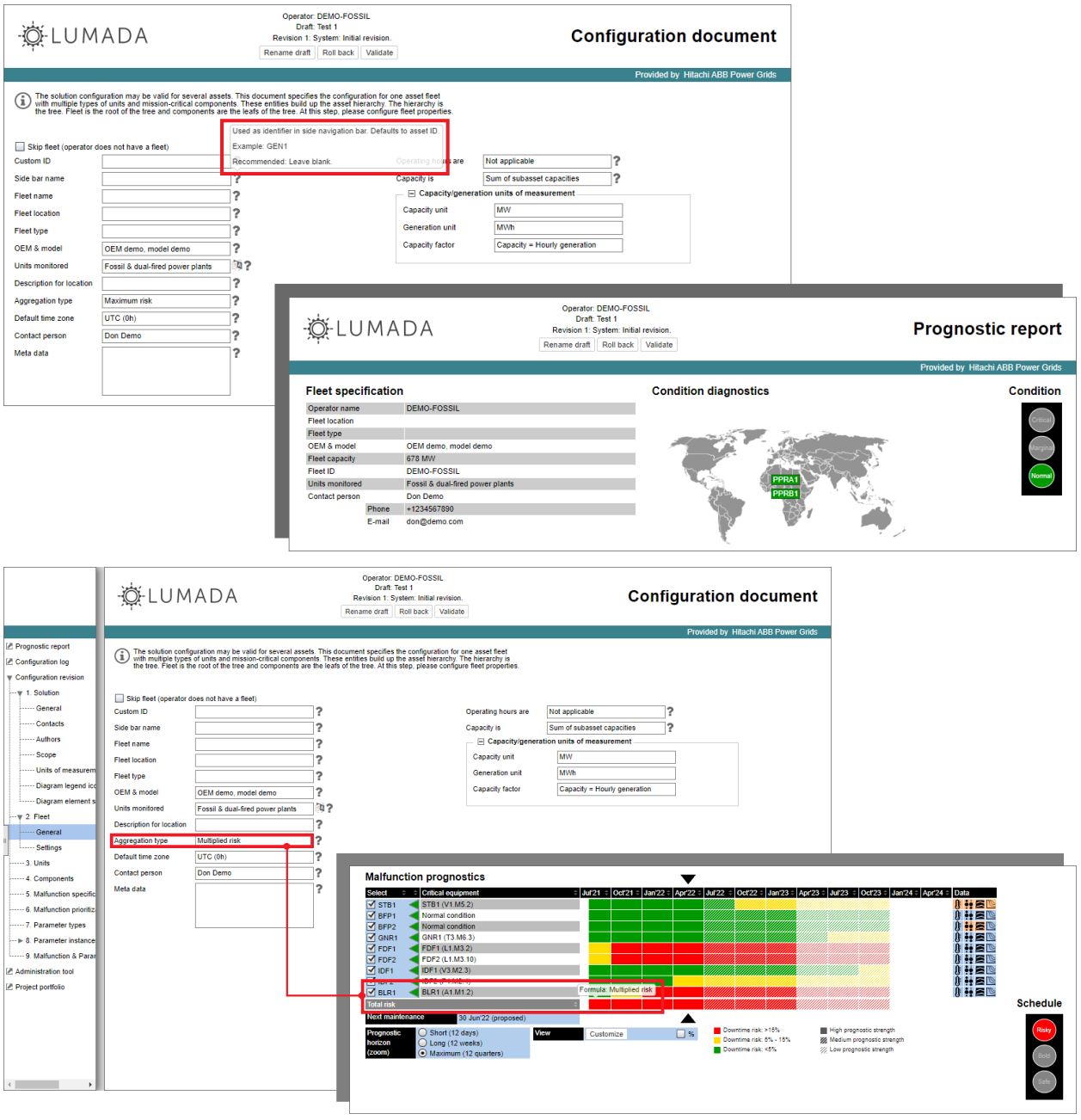
Configuring the fleet

When you configure the fleet, supply values for the fields according to the recommendations that you can see by clicking the **Question mark** icon.

> **Note:** If you do not have a fleet, you can ignore this step by selecting **Skip fleet**. When you skip the fleet, remember to select a default time zone. It is an obligatory setting when you configure this step.

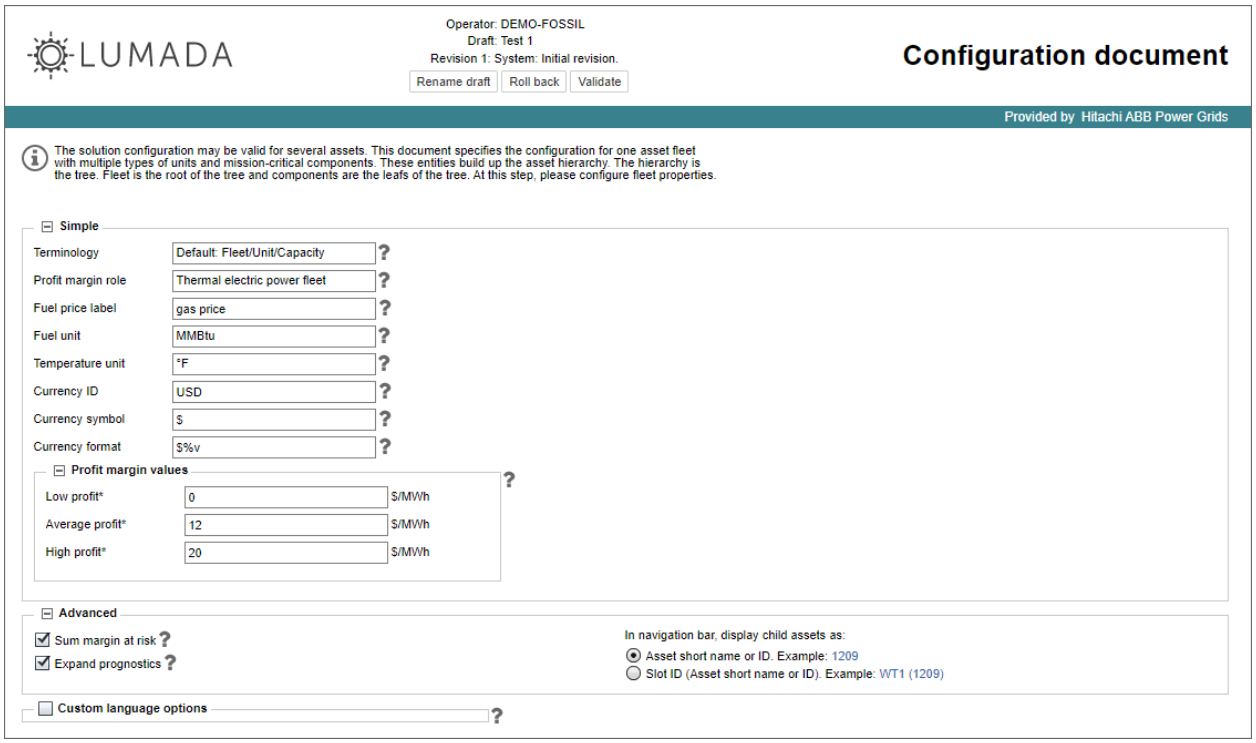
This step has two sub-steps where you can do the following tasks:

- In the **General** sub-step, you can configure general settings of the fleet. Most of the information that you supply here you will see it in the Fleet specification in the Prognostic report page.



The other settings that you can find here are settings for the fleet and unit capacity.

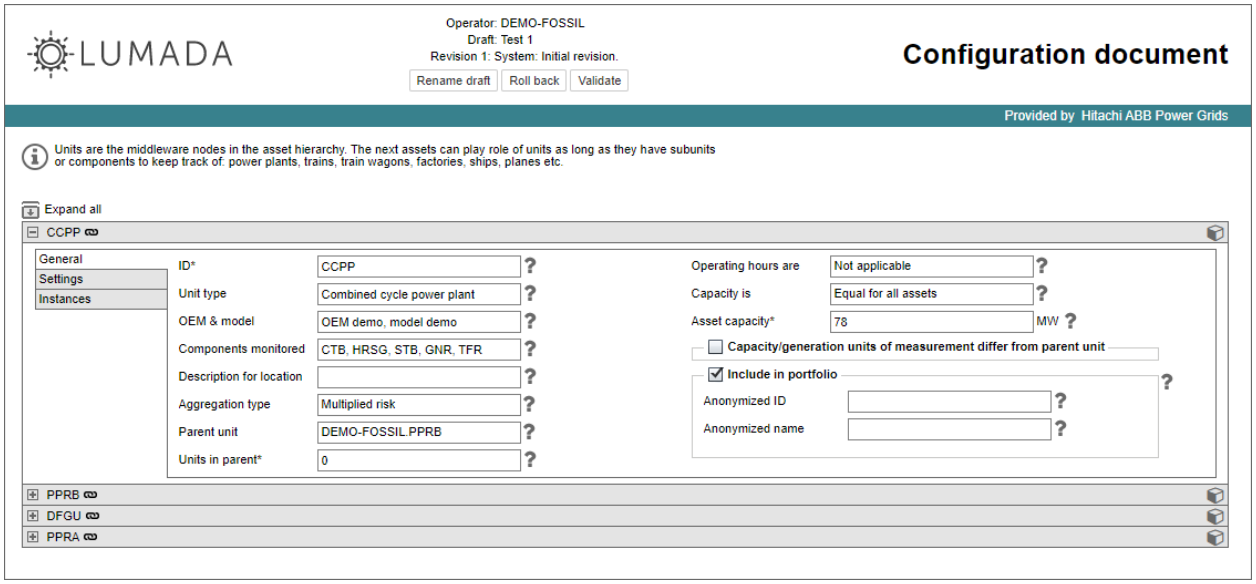
- In the **Settings** sub-step, you can supply other fleet settings. In most configurations, the advanced sections are not necessary. If you want, you can customize the language options for the fleet and units.



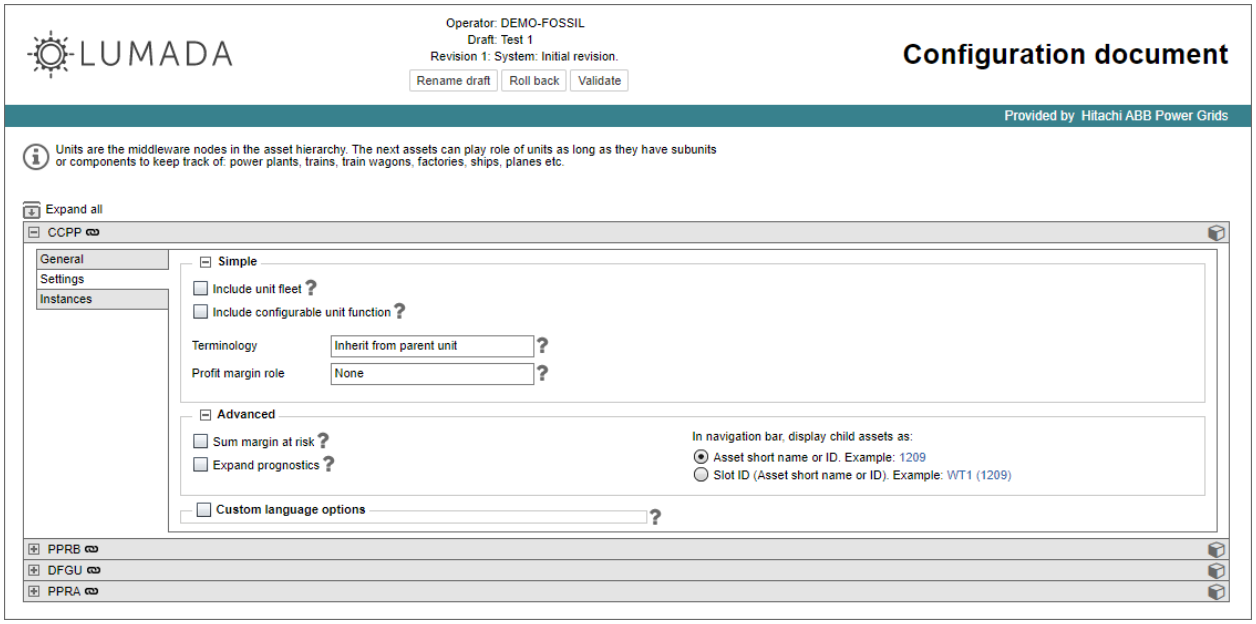
Configuring the units

When you configure the units, supply values for the fields according to the recommendations that you can see by clicking the **Question mark** icon.

In the **General** tab, you can configure general settings per unit. Most of the information that you supply here you will see it in the Unit specification in the Prognostic report page.



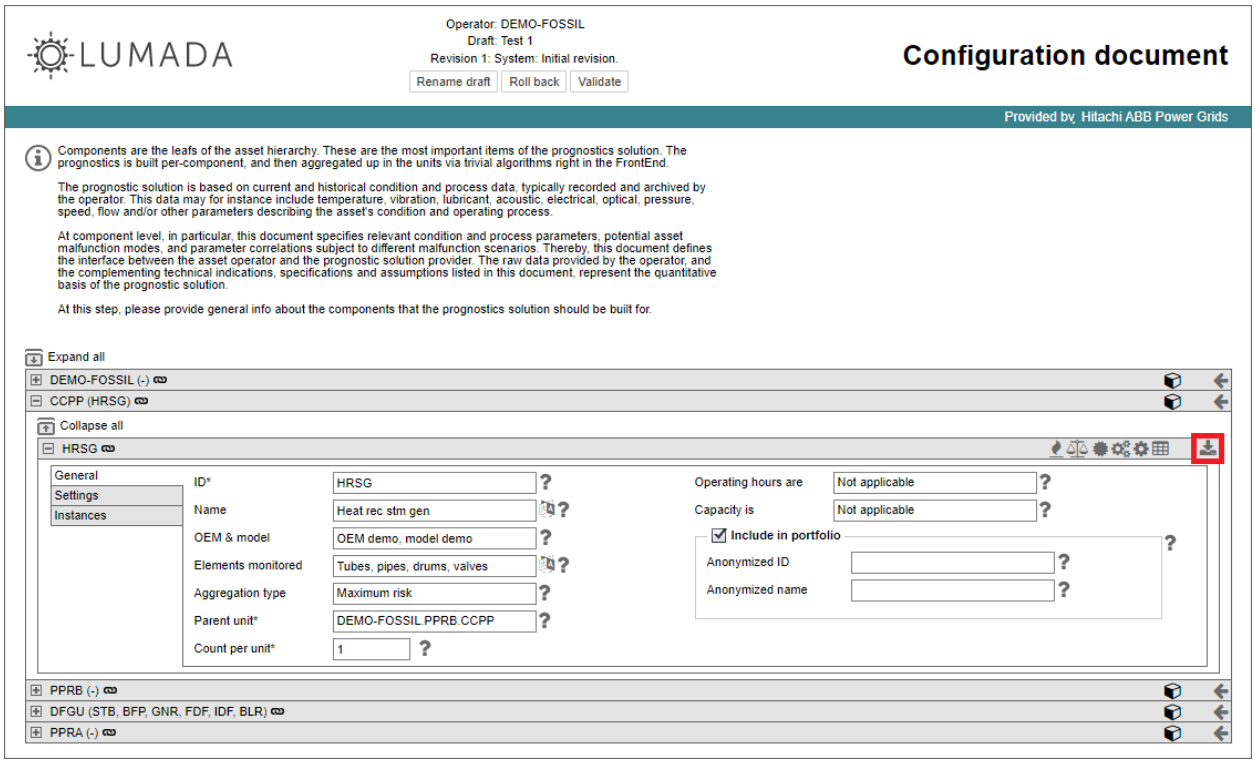
In the **Settings** tab, you can supply other unit settings. In most configurations the advanced sections are not necessary.



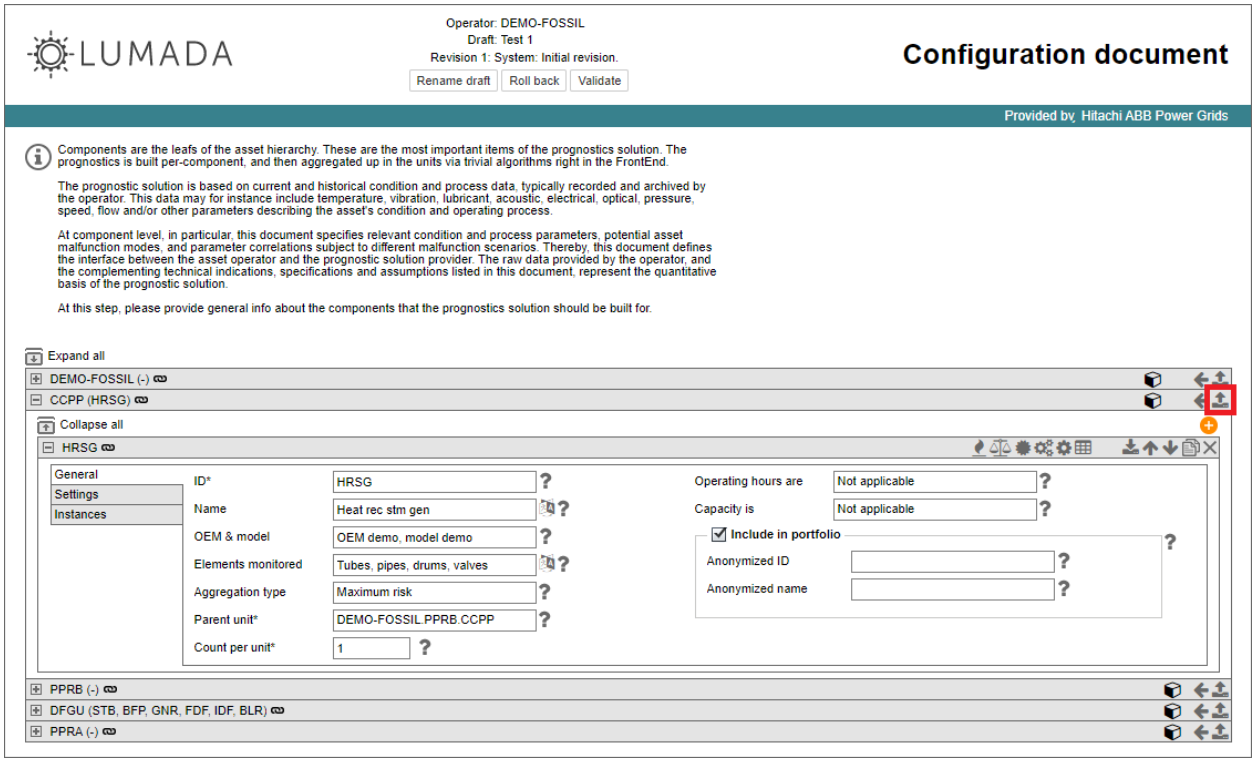
In the **Instances** tab, you can assign specific features for particular Unit instances, for example, the side bar name, different contact person, or different time zone. You can also create Orphan Unit instances to assign them to different Parent units.

Configuring the components

In this step, you can export the component by clicking the **Export** icon in the upper-right corner.



Next, you can import such component in some other revision where this component is necessary. To import a component, you must open the revision in the edit mode.



In the **General** tab, you can configure general settings per component. Most of the information that you supply here you will see it in the Component specification in the Prognostic report page. It is necessary to supply two attributes in this step: the ID of the component and the Parent unit. In the Parent unit field, you supply the asset type hierarchy (the name of the fleet and unit(s) for the component).

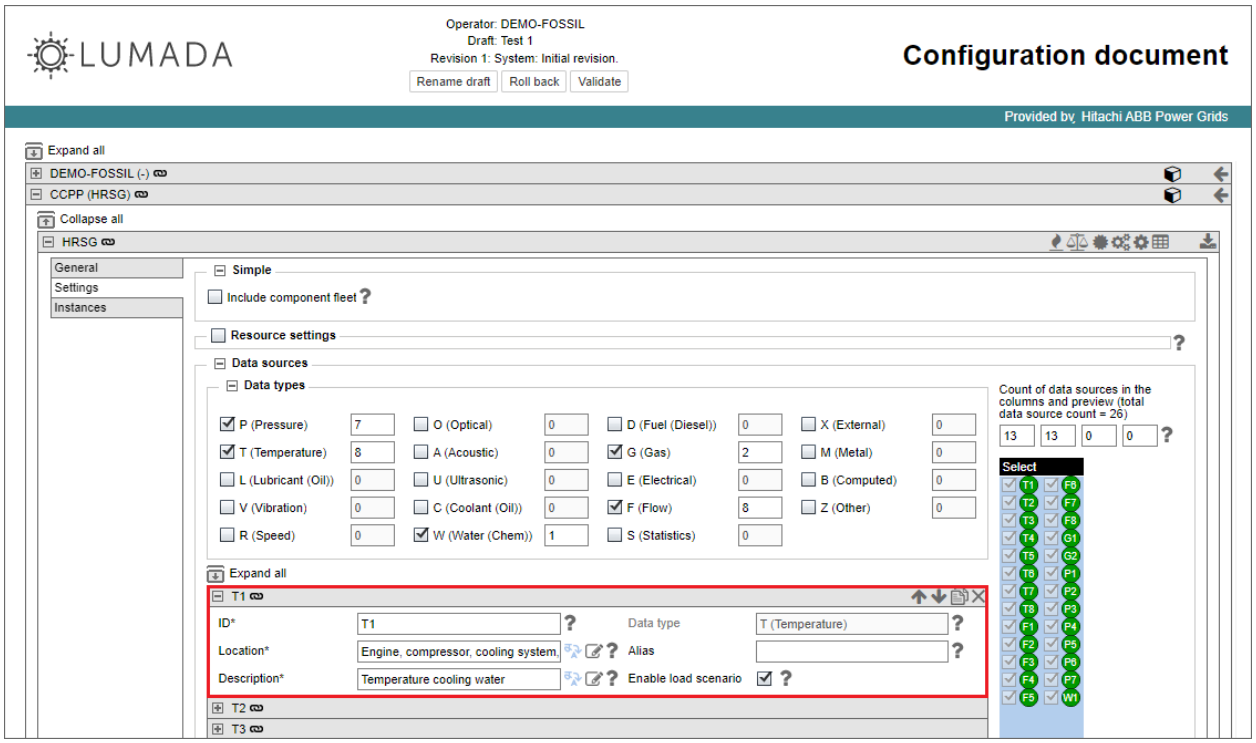
In the **Settings** tab, you:

- Select the data sources and their quantity to display them in the Condition diagnostics section in the Prognostic report page.
- Set how you want to display the data sources in columns.
- Supply details of each data source.

> **Note:** Make sure that the **Enable load scenario** option has the correct setting.

By default, the **Enable load scenario** option is selected. With such setting, APM Prognostics takes values from the data source only from the time periods when the value of the load parameter was between the minimum and maximum load. The load parameter has a dedicated interval of values (the range between Load min and Load max) that indicates normal operation range of the asset.

A good example for this setting is the Vibration data source. When you start an asset (machine) and it does not reach its normal operation mode, the vibration data is unreliable and might blur the condition prognosis. However, you will clear the **Enable load scenario** option for the Lubricant data source because the value of the load parameter is not related with this data source. The lubricant has an effect even when the asset is in the stand-by mode.

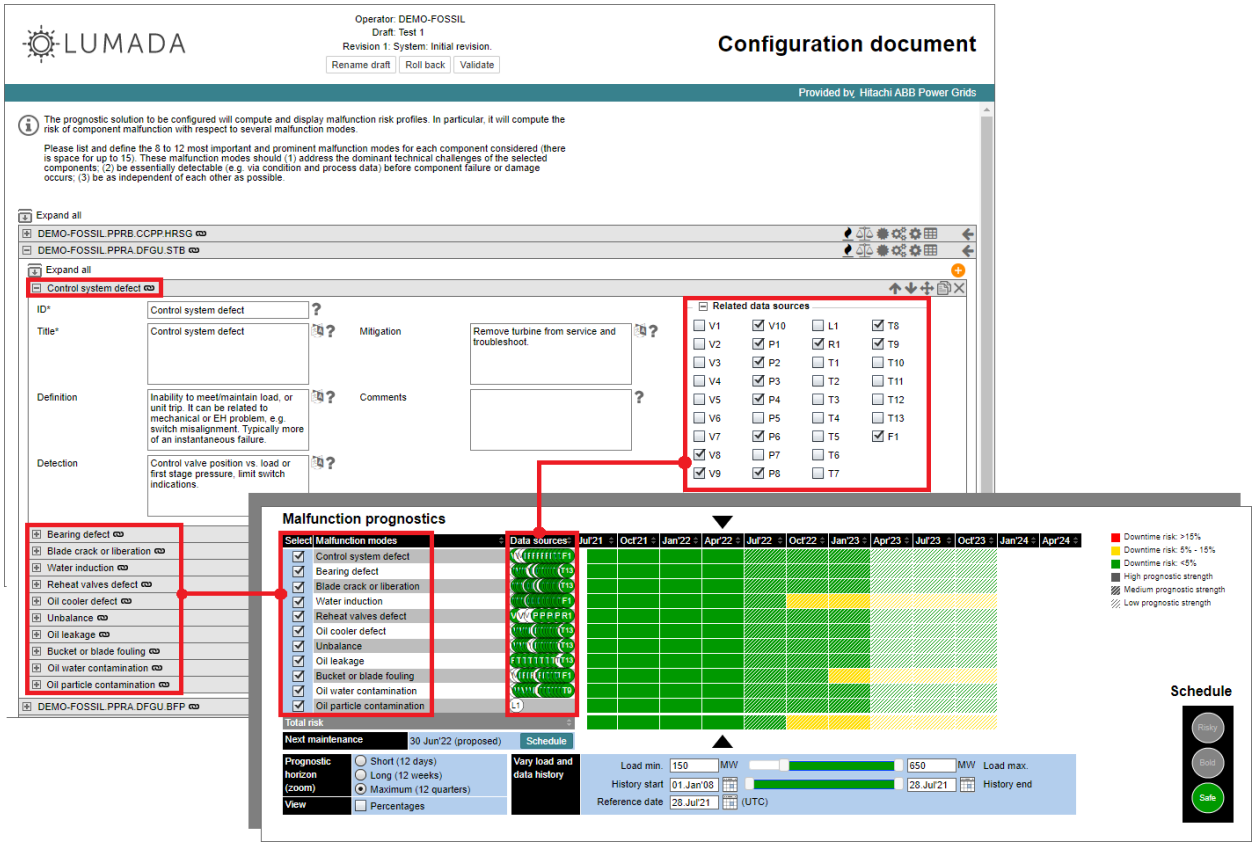


In the **Instances** tab, you create Orphan instances of components of similar type and add component-specific features to them (such as the side bar name, abbreviation, serial number, time zone). If all component types are in the same Unit, the count per unit in the General tab has to be adjusted to the number of similar component types.

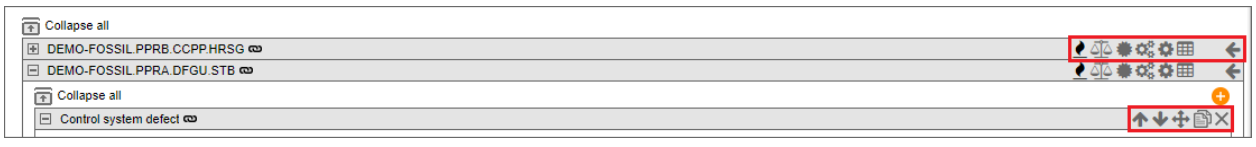
Configuring the malfunction specification

In this step, you can add malfunction modes for each component that are the most important or frequent failures that can occur in your asset. We recommend to add about 8 to 12 malfunction modes but you can add up to 15 for one component type. When you add malfunction modes, make sure that they follow the MECE principle – they are mutually exclusive and collectively exhaustive. In short, there can be no two or more malfunction modes for the same component failure, only one. The malfunction modes that you have represent all possible failures that can occur.

When you have your malfunction modes, you select which data sources supply data that has effect on a particular malfunction mode. This is a preliminary correlation, you can do a change to these settings in step Configuring the malfunction and parameter correlations.



In the upper-right corner of each component, you can click the icons to move to other steps in the configuration revision. These icons are general navigation options that are available when you prepare the configuration document.

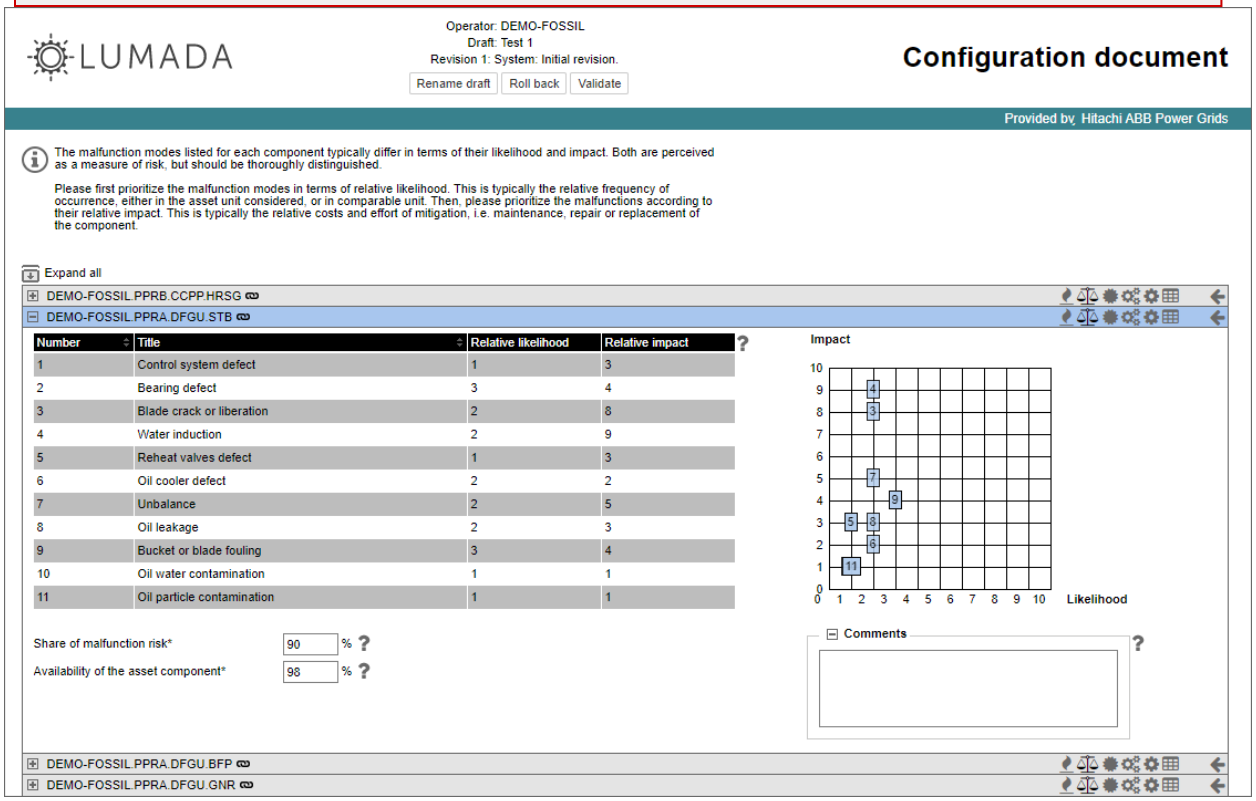


In the upper-right corner of each malfunction mode, you have the edit options that let you reorder, move, clone, and delete malfunctions. They are also available in other parts of APM Prognostics.

Configuring the malfunction prioritization

In this step, you set the likelihood and impact of the malfunction modes on the scale from 0 (very low) to 10 (very high). You set these two attributes to identify how possible it is that a malfunction mode occurs in the component and the mitigation cost that this occurrence causes, respectively.

Note: When you have a long list of malfunction modes and you want to add new ones, identify the malfunction modes with the very low likelihood and impact (0 or 1). These malfunction modes might be the first ones that you remove in favor of malfunction modes that occur more frequently and have higher impact.



There are two more settings in this step:

- **Share of malfunction risk** – This setting identifies how much effect the malfunction modes have on the total asset risk. By default, it is 80%. It means that factors other than malfunction modes have effect on the asset deterioration in 20%.
- **Availability of the asset component** – This setting identifies how much time during a year the asset is in operation. With this setting at 95%, it means that 5% of the year, the asset is off (for example, for maintenance).

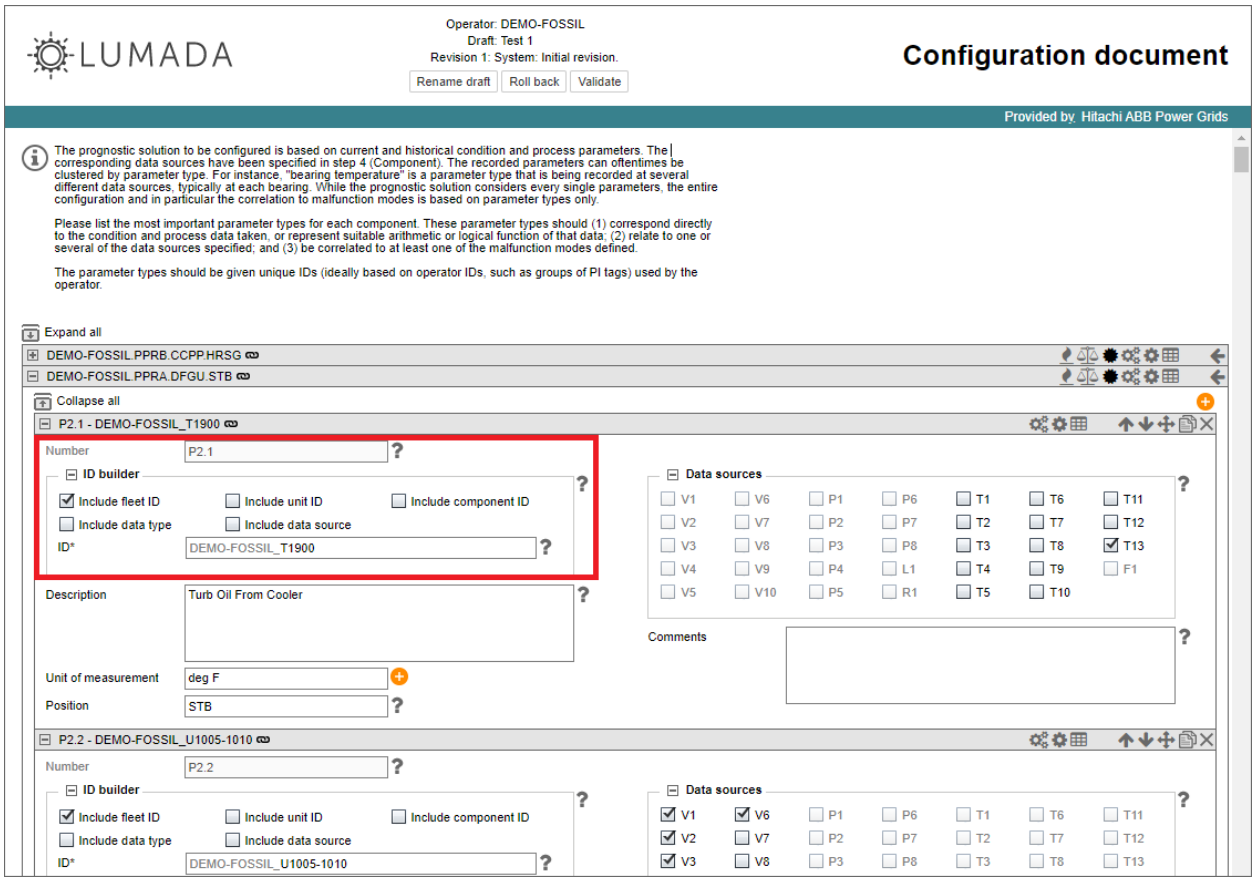
Configuring the parameter types

In this step, you add parameter types to group parameters by their data source, unit of measurement, thresholds, or correlations, because these properties are often shared across multiple parameters.

When you add a new parameter type, a number is automatically assigned to it. You must supply the ID of the parameter type by using the ID builder and selecting at least one data source.

Note: Parameter IDs can and frequently change to some internal abbreviations that are meaningful for the customers. For example, these can be the KKS codes, the identification system for power plants that identifies power plants, sections of plants, and items of equipment in any kind of power plants according to task, type, and location.

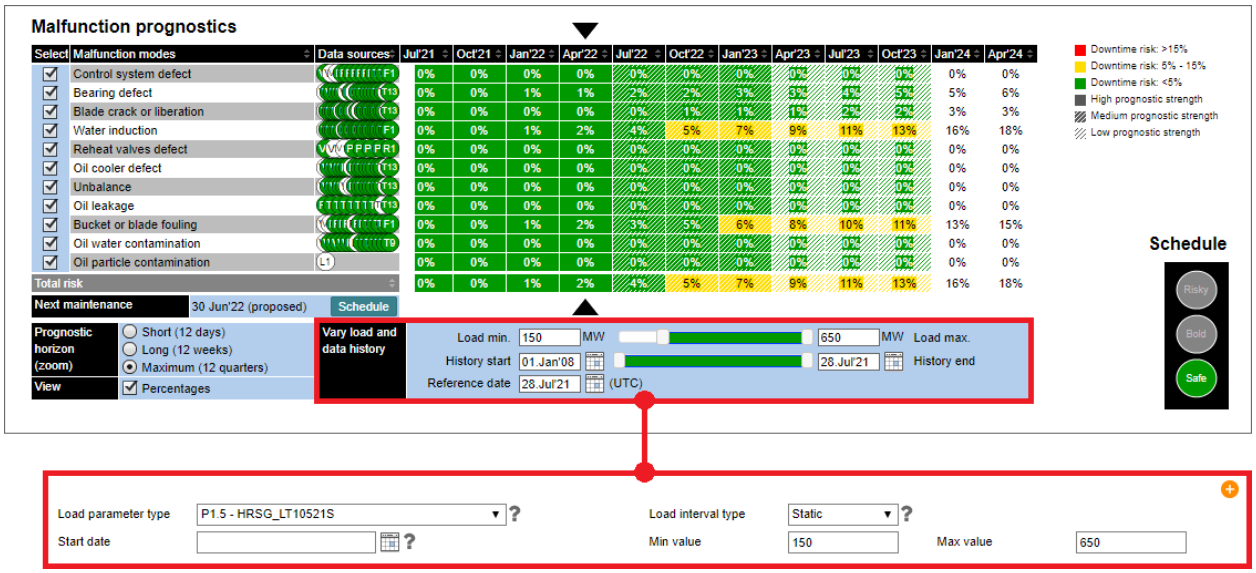
A data source (typically equals to one sensor) might have several parameter types that might have several parameter instances. Make sure to add a description of the parameter type (details that describe what parameter it reflects), a unit of measurement, and its position (it typically coincides with position of the data source/sensor).



In the upper-right corner of each component and parameter type, you can click the icons to move to other steps in the configuration revision. These icons are general navigation options that are available when you prepare the configuration document.

Also, in the upper-right corner of each parameter type, you have the edit options. They are available in several parts of APM Prognostics.

Under the list of parameter types, you have an option to select one of them as the load parameter. You will use this parameter in the Malfunction prognostics section in the Prognostic report page. For more information, see Simulations.



Make sure to select a load parameter for all the component types. When you configure the load intervals, you can select static ones (fixed min and max values that you add manually) or you can disable them (automatically include the min and max values from the load parameter as boundaries).

Configuring the parameter instances

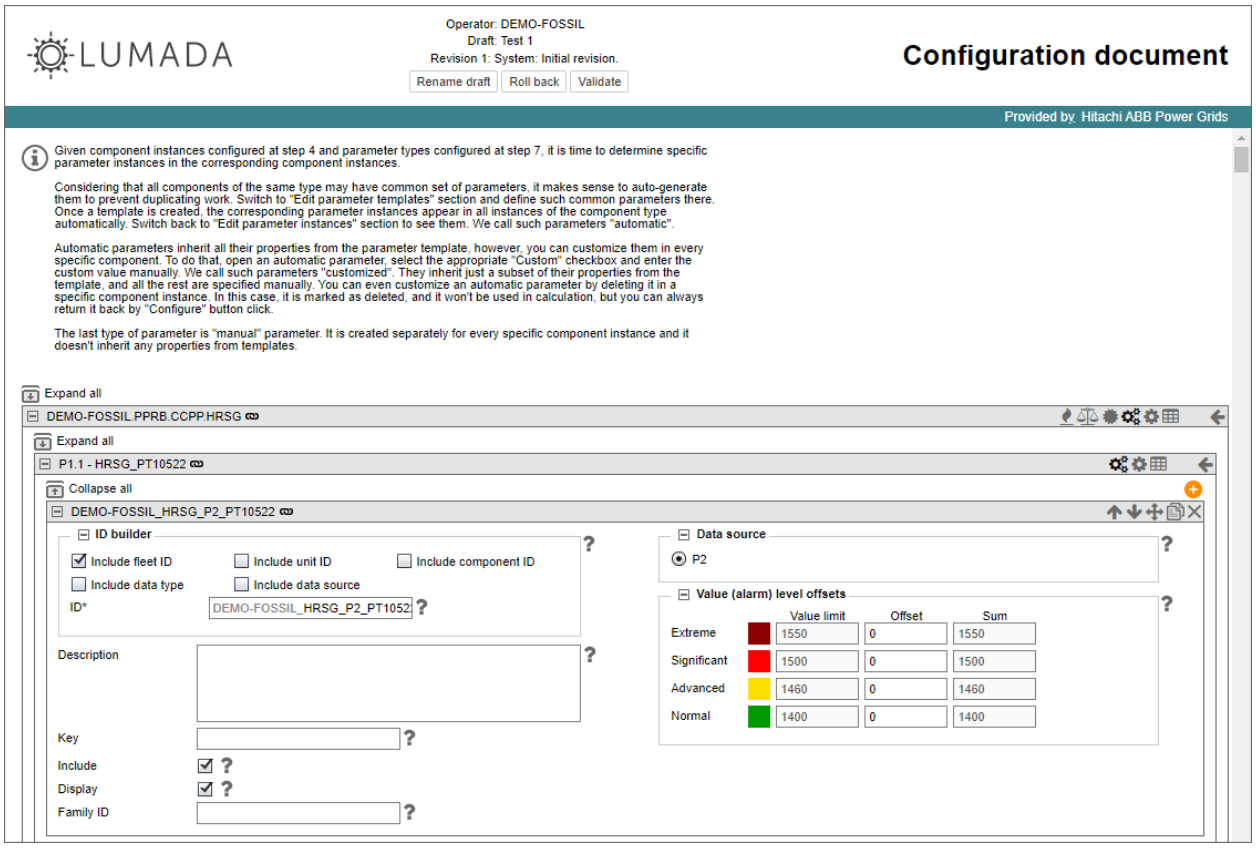
You can configure the parameter instances by doing tasks in one of the following sub-steps:

- **Edit parameter templates**
- **Edit parameters grouped by component instance**
- **Edit parameters grouped by parameter type**

Note: We recommend to use the **Edit parameter templates** option as your first choice. It is for the situation when you have the same components with similarly structured raw data. When you use the other two options, you introduce customizations that prevent the export of the configuration document to another APM Prognostics instance.

In the **Edit parameter grouped by component instance** sub-step, you browse the available components and edit parameters instances per parameter type.

In the **Edit parameters grouped by parameter type** sub-step, you browse the available parameter types and edit parameters instances per component.



When you add a new parameter instance, you must supply the ID of the parameter instance by using the ID builder. The ID builder automatically provides an option that you can use while creating new parameter instances. The data sources that you selected in the previous steps, you must also select them in this step. However, you can only select a single data source for a parameter instance. In special cases, there is an offset option, so that offsets can be provided for a particular parameter instance of the component type.

Note: APM Prognostics uses the parameter Key value as the external ID during the model export to Lumada APM.

In this step, you also provide a key that is the identifier or formula of the parameter in the raw data. The key is a unique identifier that maps raw data to the parameter instance. It is a reference of raw data for the Data transformer that uses it as identification during the data load.

Important: When a key in a raw parameter contains a comma and you reference the parameter key in a derivative parameter expression, it is necessary to put the backslash (\) sign before the comma. APM Prognostics uses comma as a separator between different references. To compensate for backslash special meaning, you must place two backslashes in order to refer a raw parameter key that contains a backslash. For example:

- Raw parameter key: distance,from\coast
- Inverted parameter: B!INV:distance\,from\\coast

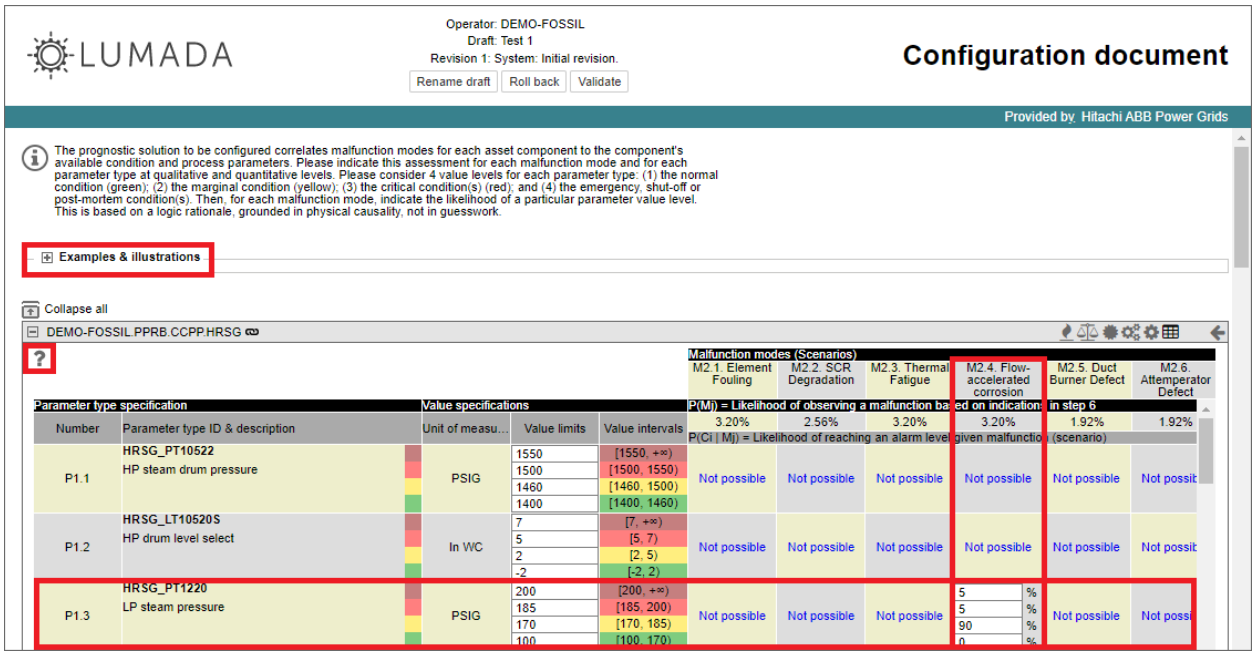
The description in the parameter instance overwrites the description in parameter type. If you do not want to include a parameter instance in the prognosis calculation, clear the **Include** option. Also, if you do not want to display a parameter in the Prognostic report, clear the **Display** option.

In this step you also supply value (alarm) level offsets for each parameter instance.

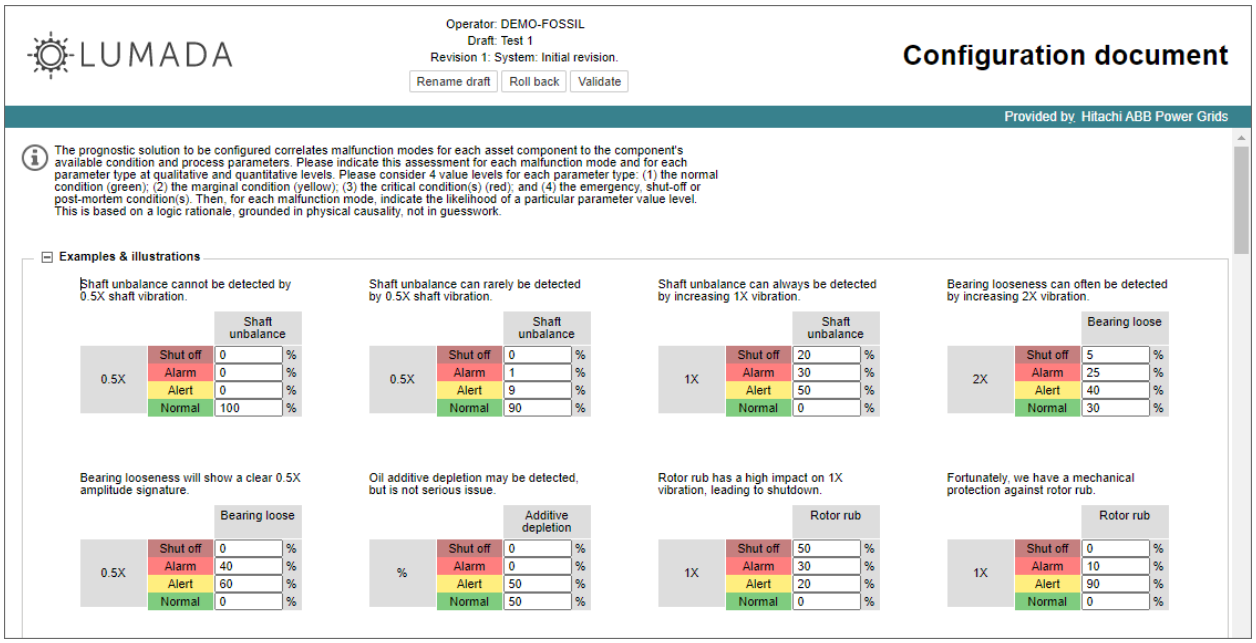
Configuring the malfunction and parameter correlations

In this step, you configure the correlation between the malfunction modes and parameters types. In the columns, you have all the malfunction modes. All the rows are parameter types.

When you want to set a correlation, you click the Not possible cell at the intersection of a parameter type and a malfunction mode. For the four value intervals (alarm levels) you supply values from 0 – 100 % to identify the likelihood of the parameter reaching a particular level when the malfunction mode occurs. The sum of the four values must be 100%. The higher the value, the higher the likelihood of reaching the alarm level.



To help you understand these settings, you can unfold the **Examples & illustrations** section to see sample correlations and their explanations. You can also click the Question mark icon in the upper-left corner for information how to navigate in the tables and edit them.



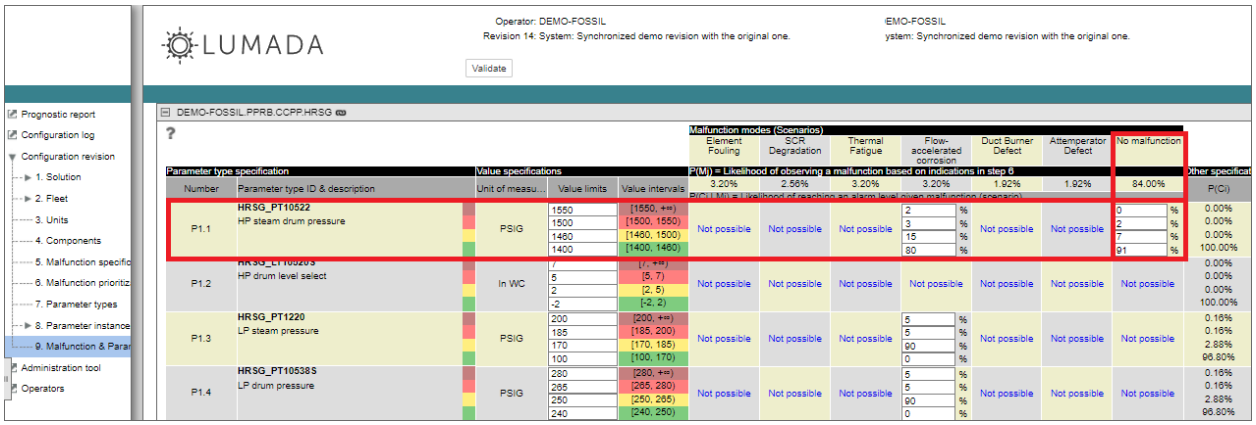
When you finish step 9, commit your revision in the Navigation panel. Until you release the revision, the changes that you commit do not have an effect on your system.

Fine-tuning a model

When you do a configuration of your model, you can test it during the validation phase (that is part of deployment) based on the customer data. If it is necessary to fine-tune the model, the Configuration manager can do the steps that follow:

1. Do a check and adjust the parameter thresholds in one of these steps:
   - **Value limits** column for parameter types in the Malfunction & Parameter correlations step.
   - **Value level offsets** in the Parameter instances step.
2. Do a check and apply data cleansing methods or introduce additional derivative parameters to indicative parameter values.
3. Do a check and adjust the correlation between malfunctions and parameters. For more information, see Configuring the malfunction and parameter correlations.
4. Set the **No malfunction** correlation in the Configuring the malfunction and parameter correlations step.

   The values that you set here identify the probability that a component can still be operational even when an indicative parameter reaches certain values and crosses certain set thresholds.



In the example above, when **there is no significant risk (no malfunction)**, there is:

- 91% chance that the value of the HP steam drum pressure is Normal (green).
- 7% chance that the value of the HP steam drum pressure is Advanced (yellow).
- 2% chance that the value of the HP steam drum pressure is Significant (red).

Important: This is a setting for users who have expert knowledge about the component and configuration process. APM Prognostics assigns high risk levels for a particular malfunction mode already when parameter values reach the yellow (not to mention the red or dark red) threshold. If you supply any values in the **No malfunction** column for ranges other than green, APM Prognostics will reduce risk levels for malfunction mode prognostic result when the parameter reaches these thresholds.

Good practices

Here is a set of recommendations for you when you start to use APM Prognostics:

- When you work with revisions, do not create too many draft instances. Make sure that you use unique names for your drafts that are related to your release process of APM Prognostics. Remember to do a rollback of the unnecessary revisions.
- When you add parameters, make sure you add clear descriptions. Do not use the parameter ID in the description or abbreviated texts.
- When you select the load parameter for a fleet of comparable units, be consistent with the parameter that you select, its unit of measurement and value level.

Importing a revision

When you create a revision of a configuration document, it can become a template for a new system configuration or a new operator. When you have the same types of industrial assets, such templates make configuration of new APM Prognostics instances faster and easier. For example, you can have a library with reusable configurations that you import and use with your assets. Sometimes it can be necessary to do small

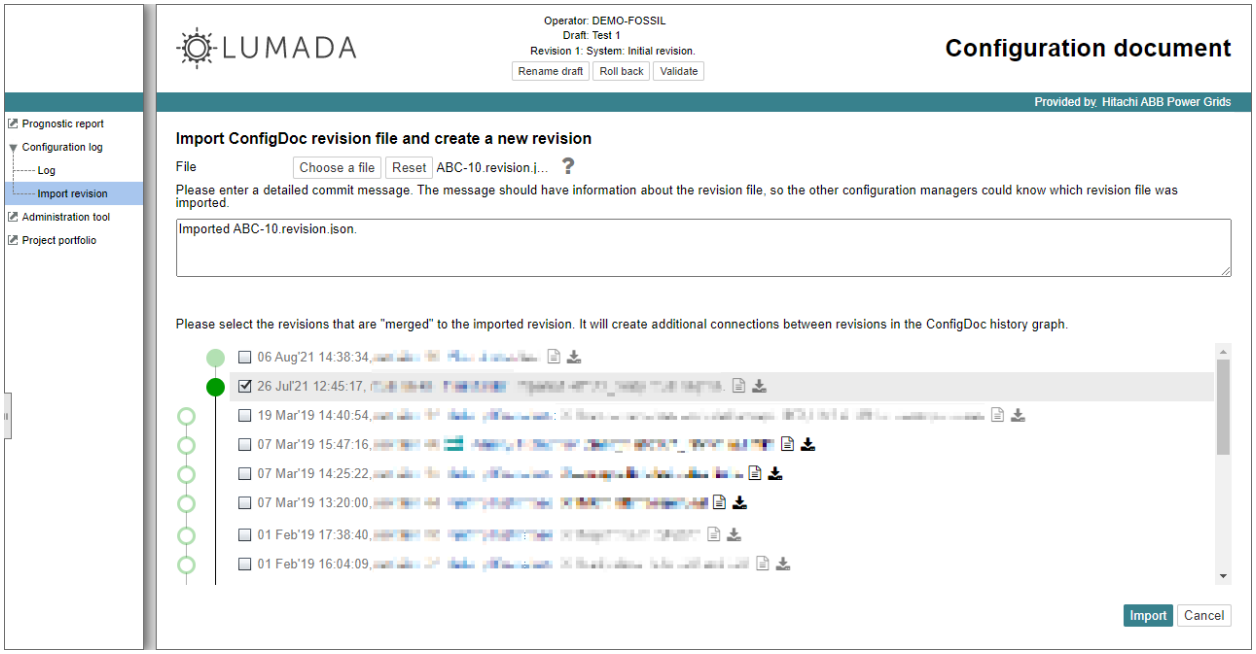
changes or adjustments in the configuration document, but it is still faster than to create a new configuration document from the beginning.

APM Prognostics has a simple import wizard for revisions that users with at least the Config Doc Editor role can use.

> **Note:** APM Prognostics also lets you export and import components. If it is not necessary for you to import full revisions, you can import components. For more information, see Configuring the components.

Procedure

1. In the navigation panel of the Configuration log page, click **Import revision**.
2. Click **Choose a file** and select a revision that you want to import.
3. Enter a detailed commit message for the revision.
4. Select the revisions that are merged with the imported revision.



5. Click **Import**.

6. Your revision shows in the History section of the Configuration log page.

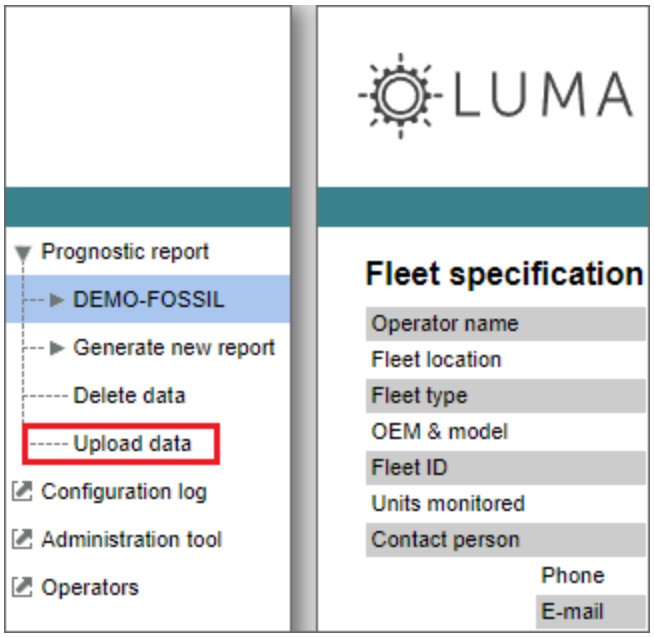
When the solid black dot changes into an empty green dot, you can release this revision by clicking the **Release this revision** icon for this revision. After you release a revision, APM Prognostics makes some of the changes immediately, for example, asset hierarchy, and malfunctions. Changes like new parameters, thresholds for parameters, and correlations have an effect after you recalculate the prognostic report.

Chapter 3: API

APM Prognostics API

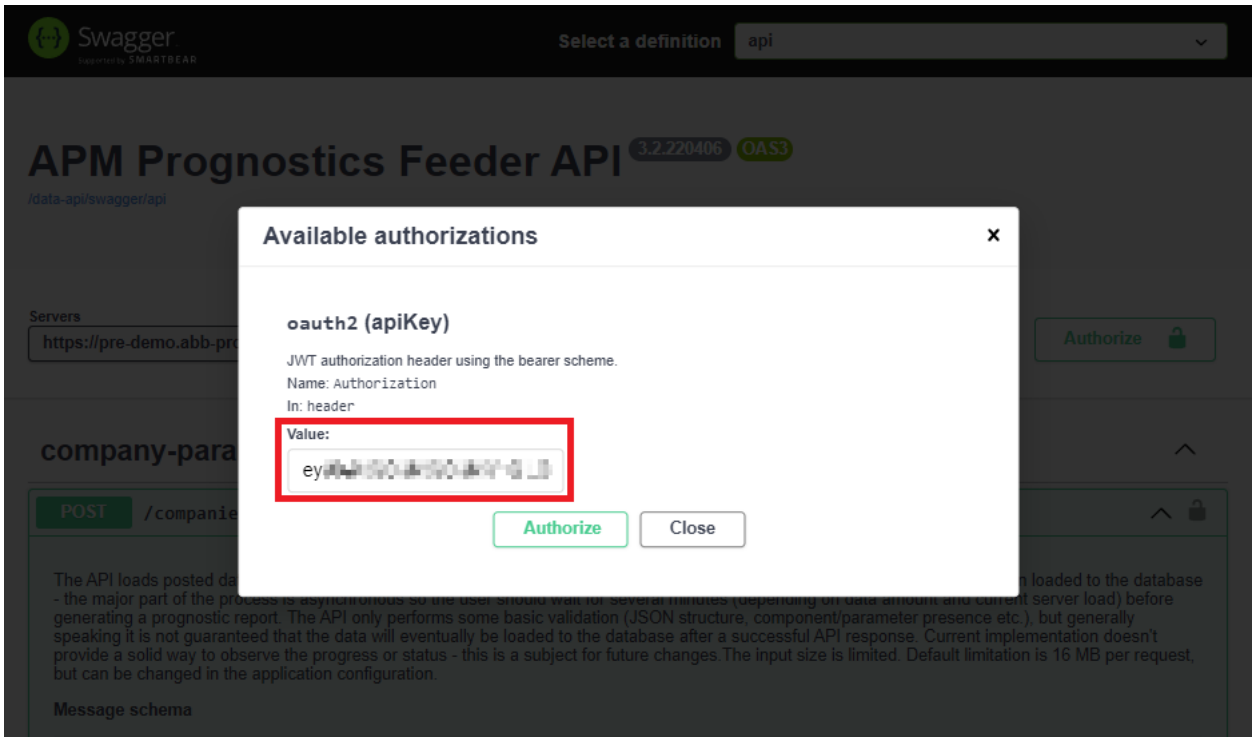
Feeder API in Swagger

We created APM Prognostics Feeder API in Swagger that loads the posted data to the database. Users with the Admin role can go to Swagger by clicking **Upload data** in the navigation panel.



The Feeder API is also available directly at this URL address:

{{baseUrl}}/data-api/public/swagger-ui/index.html?url=/data-api/swagger/api-docs



Authorization is necessary for this Swagger API, so you must supply the **ID token** for your APM Prognostics environment to use it. For information how to obtain the ID token, see the *Getting an access token by using account credentials* procedure in the Authentication section.

Internal API

APM Prognostics has API that is designed for the internal usage in the application. At your own discretion, you can also use some of these methods for integrations between APM Prognostics and 3rd-party systems, platforms, or tools. When you use APM Prognostics API, make sure that the integrations are on top of the generic HTTP(S) protocol. APM Prognostics API does not follow the REST conventions. Do not use any integration tools that require accurate REST implementations.

Important: APM Prognostics API changes constantly. If you decide to use any of the methods on a production environment, read APM Prognostics release notes regularly to learn about the coming changes. We supply such information two weeks in advance.

To show and explain APM Prognostics API, we use Postman and special collections that contain all the API methods in APM Prognostics. These collections will help you understand our API and use it correctly. For more information, see the sections that follow:

- Authentication
- Using APM Prognostics API
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Authentication

A service account is necessary to have access and use APM Prognostics API. When the service account is registered in the associated OpenID Connect provider, you can get an access token to authenticate the service requests in the APM Prognostics application.

In the SaaS delivery model, only the application vendor can create the service account for you. Open a ticket in Salesforce (or contact the Customer Experience support team) and describe who wants the service account and why. It is also necessary to describe the requested access permissions, for example operator names and access level: prognostics reports (read/write), ConfigDoc (read/write/release).

When an account is ready, you get a login request URL and parameters. The request returns a JSON file with the `access_token` field. You must send the value of this field as the `idToken` parameter value with every request to APM Prognostics API. As a result, the application authenticates the service account correctly.

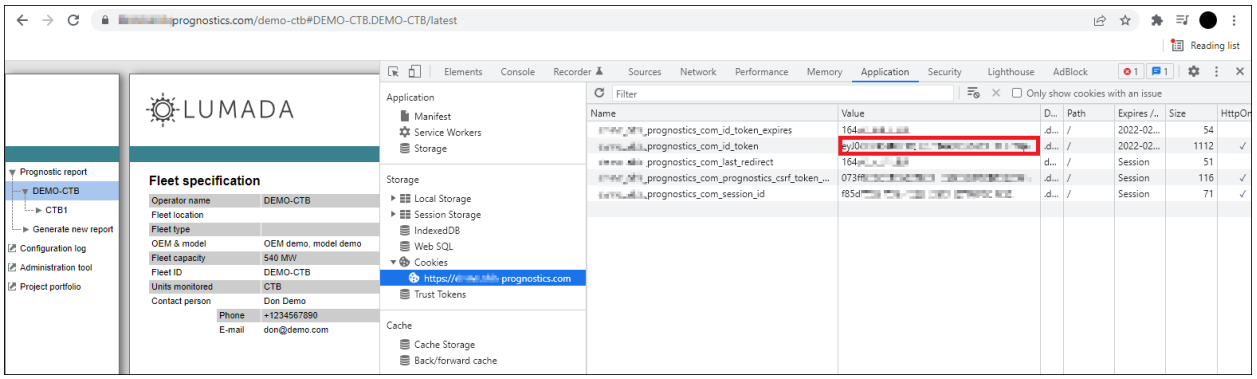
The token expires depending on the configuration of the OpenID Connect provider (AAD: 1 hour, Keycloak: 15 minutes). Make sure to refresh it on a regular basis. You can identify the token expiration event by the `"authenticationError": true` response field.

Note: We recommend to change the service account secrets regularly (at least every 3 months). The change is also necessary when the secrets are or might be compromised, and when a person who manages or uses them leaves the company.

If you do not have a service account, you can get the access token by using your account credentials. You can use it only to do a functional test of APM Prognostics API.

Getting an access token by using account credentials

1. Log in to APM Prognostics in the Chrome or Firefox browser by using your user account credentials.
2. Open the browser developer tools. For example, press the F12 key.
3. In the **Application** tab, click **Cookies** > **https://<Your_domain_name>**.
4. Find a cookie with the **id_token** suffix.

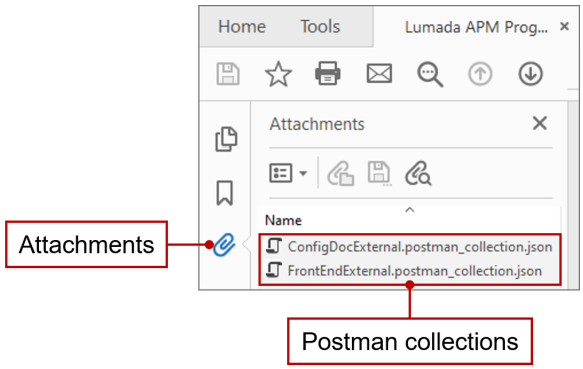


5. Double click its value and copy it to your clipboard.

   This is the value for the `idToken` parameter that you send with every request to APM Prognostics API.

Using APM Prognostics API

Before you start using APM Prognostics API on your own, we recommend to use our Postman collections first. You can download these collections from the attachment section in this guide. Import these collections into Postman and authenticate yourself to use the API methods that you select.



Last update date of the Postman collections in this section: 1st March 2022.

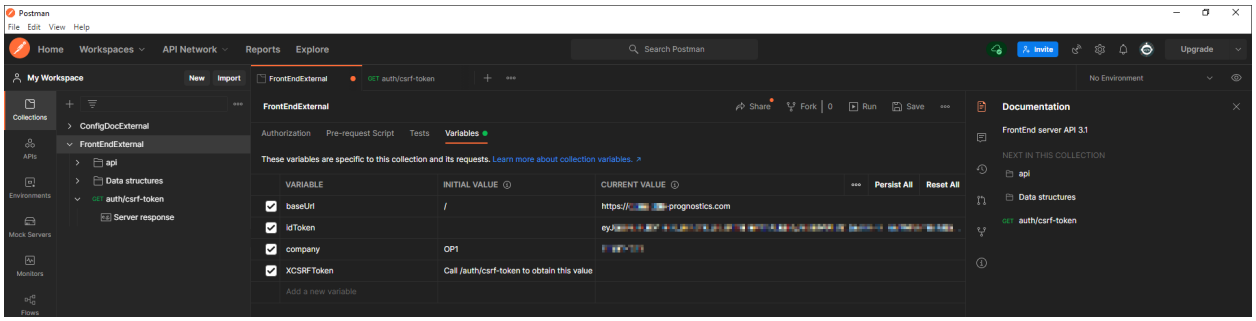
Procedure:

In this procedure, you will use Postman HTTP client that you can download here.

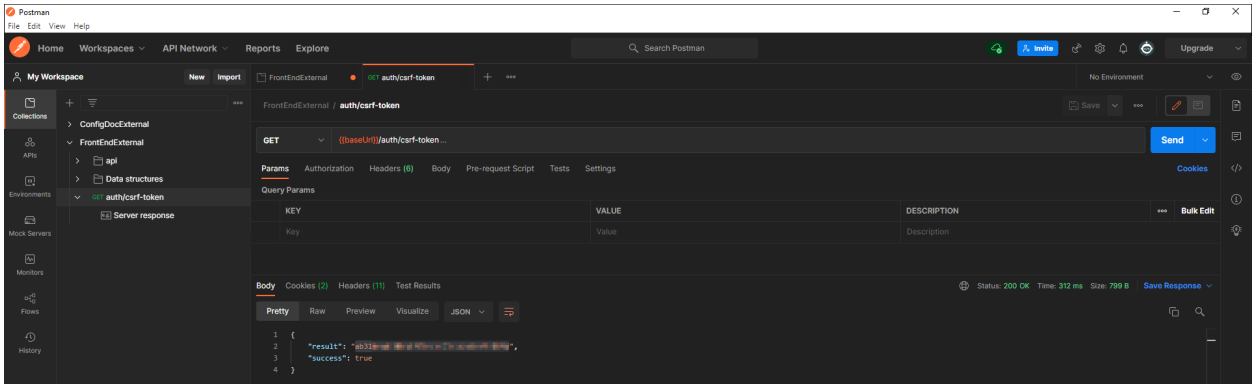
> **Note:** Postman is a 3rd party tool that is only an aid to illustrating how APM Prognostics API works. You can continue to use API with this tool or select a different one. If you find any problems or look for more information about the 3rd party tool that you select to use, it is necessary to see the official 3rd party documentation or contact their customer support.

1. Import Postman collections. For more information, see the official documentation about Importing and exporting data.
2. Click the FrontEnd or ConfigDoc collection to configure it.

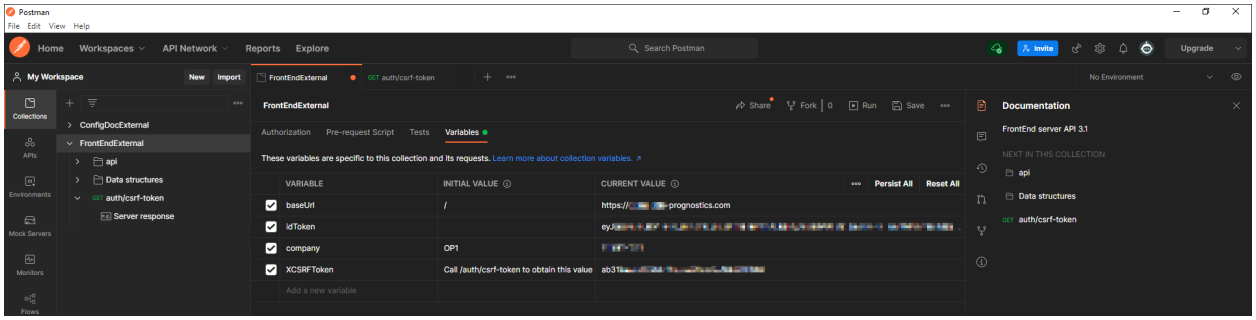
   It is necessary to configure both of the collections if you want to use all the API methods.
3. In the **Variables** tab, supply values for the variables that follow:
   - **baseUrl** – URL address of your APM Prognostics system.
   - **idToken** – Authentication token. For more information, see Authentication.
   - **company** – Name of your operator. For more information, see Configuration log.



4. Save the collection.
5. Go to the **GET auth/csrf-token** method and click **Send** to generate a CSRF token.
6. Copy the CSRF token from the **Body** section.



7. Return to the **Variables** tab and paste the CSRF token as the value for **XCSRFToken** variable.



8. Save the collection.

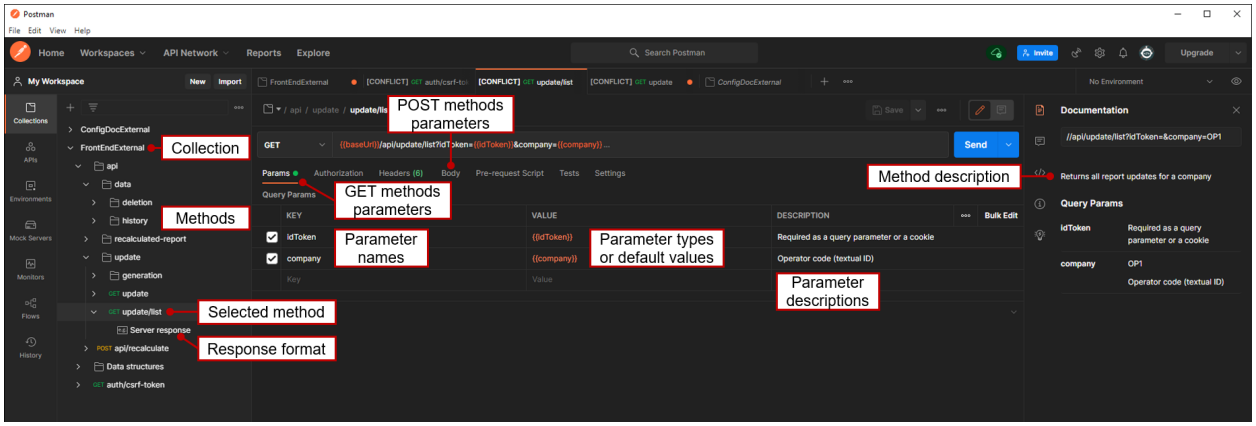
You are ready to use the methods in APM Prognostics API that are available for you (see Explanation of the Postman collections). For more information, see Examples.

Explanation of the Postman collections

Depending on your access level, you can use up to two API collections:

- FrontEndExternal – Contains methods to generate and retrieve prognostic reports, obtain raw data history, delete data, manipulate UI elements. The basic (FRONT_END) access level is necessary to use this collection.

- ConfigDocExternal – Contains methods to fetch, push or release ConfigDocs. The access to the ConfigDoc (CONFIG_DOC_VIEWER, CONFIG_DOC_EDITOR) is necessary to use this collection.



Each Postman collection contains two folders:

- api or cd-api (depending on the collection) – Contains a full hierarchy of external API methods, their URLs, parameters, descriptions, and the response format.
- Data structures – Contains full specifications of all data structures used in the API method responses.

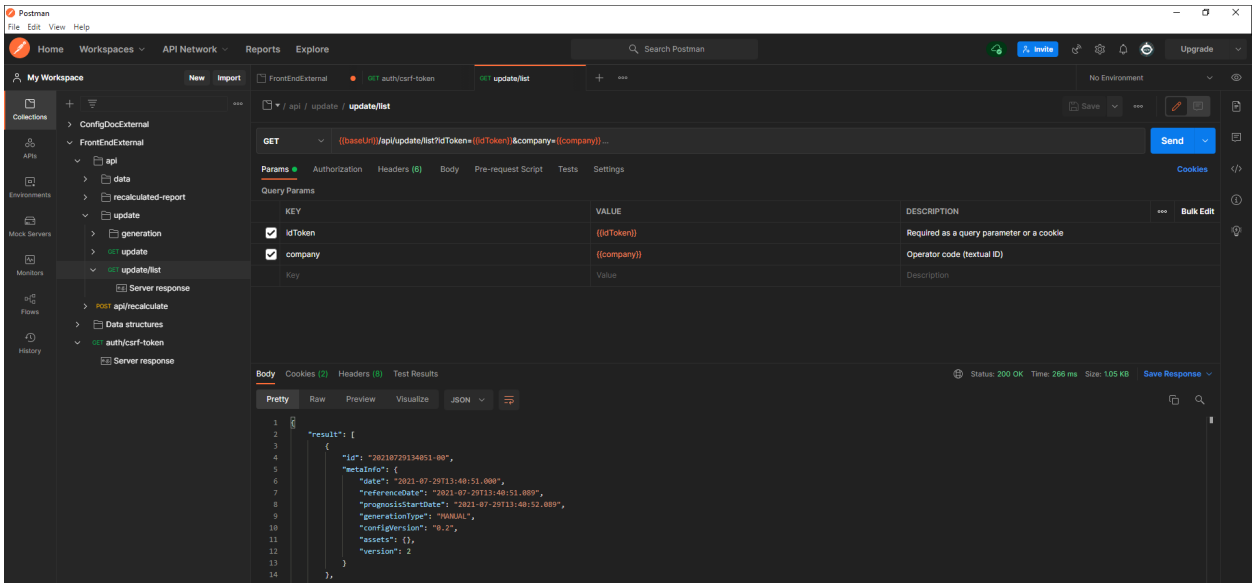
Examples

In this section, you will see how to use two of the most commonly used methods: **GET update/list** and **GET update**. Use them to download all prognostic report updates for an operator and details for a prognostic report update that you select.

GET update/list – Downloading all the prognostic report updates for an operator

Before you start, make sure that the FrontEndExternal collection is configured. For more information, see Using APM Prognostics API. The variables in the **Params** tab for the GET update/list method get values from the **Variables** tab in the FrontEndExternal collection.

1. In Postman, click **FrontEndExternal** > **api** > **update** > **GET update/list**.
2. Click **Send**.
3. In the **Body** section, see all the prognostic report updates.

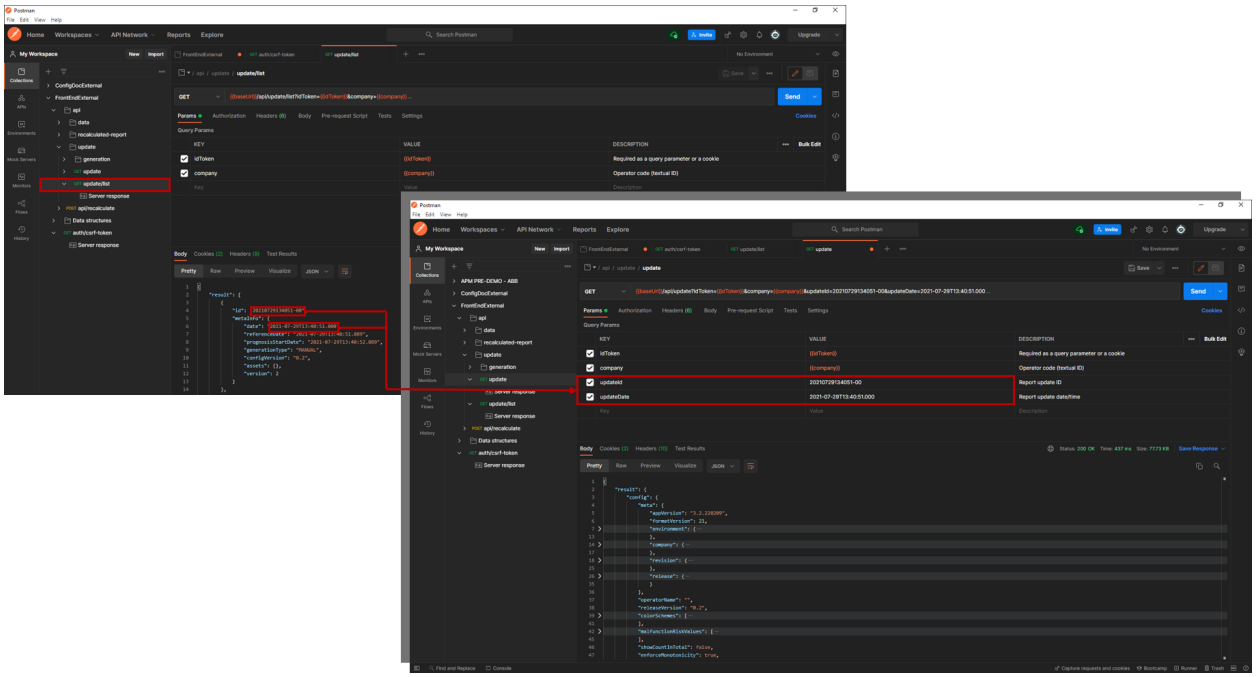


4. Copy the value of the `id` and `date` parameters to use them with the GET update method.

GET update – Downloading details of a prognostic report udpate

Before you start, make sure that the FrontEndExternal collection is configured. For more information, see Using APM Prognostics API. Some of the variables in the **Params** tab for the GET update method get values from the **Variables** tab in the FrontEndExternal collection. The rest of the values will be in the response body of the **GET update/list** API method.

1. In Postman, click **FrontEndExternal** > **api** > **update** > **GET update**.
2. In the **Params** tab, supply values for:
   - **updateId** – Report update ID.
   - **updateDate** – Report update date/time.



3. Click **Send**.
4. In the **Body** section, see all the details of the prognostic report. You can see the Configdoc and prognostic matrix for every component.

Good to know

Every API method returns a JSON response with information if the API call was successful or not:

- Success:

```
{
  "success": true,
  "result": ...
}
```

- Error:

```
{
  "success": false,
  "error": "...",
  "message": "...",
  ... // potentially some other fields that describe the error details
}
```

Known issue:

Every API method returns the **200 OK** status code even for errors. It is necessary to see the JSON response to identify the API calls that have errors.