Asset Strategy Optimization

GE VERNOVA

Contents

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Chapter

1

Overview

Topics:

Overview of the Asset Strategy Optimization (ASO) Module

This topic provides a listing of all overviews and high-level explanatory information to help you understand the Asset Strategy Optimization module.

The APM Asset Strategy Optimization (ASO) module extends the analytical capabilities of the Asset Strategy Management (ASM) module by providing the additional ability to:

- Define planned and unplanned resources for each Risk.
- Define Resources, such as spare parts and human resources, that are needed to perform actions.
- Define Time to Failure (TTF) and Time to Repair (TTR) information based on Monte Carlo simulation results.
- Integrate with the Reliability Analytics module
- Use a diagramming tool that allows you to represent the physical structure of pieces of equipment and locations.
- Define Global Events.

While ASO is its own separate module, it is intended to extend the capabilities available in ASM by providing a more detailed analysis of a particular strategy. You will, therefore, access ASO directly from an existing Asset Strategy, System Strategy, or Unit Strategy. In ASO, you can use the additional features in the preceding list to determine the most optimal strategy for a piece of equipment or location, which can then be viewed and managed further in ASM.

In other words, ASO and ASM work together to provide a more comprehensive view of your equipment and locations to help you determine the best way to manage them to reduce cost and risk. Many of the features in ASO work similarly to or exactly the way they work in Reliability Analysis.

Note: You can access ASO only if the ASM module is active.

Access the ASO Page

About This Task

The Asset Strategy Optimization module relies on an Asset, System, or Unit strategy created in Asset Strategy Management. You can access ASO either via an existing strategy that is linked to an optimization scenario, or via the strategy's **Optimize Strategy** feature, as described here.

Note: These instructions also apply to accessing Asset Strategy Optimization in Unit and System Strategies.

Procedure

1. Access the **ASM Overview** page.
2. Select the appropriate **Asset Strategies** tab that contains the strategy that you want to optimize. The **Asset Strategies** section appears, displaying a list of available Asset Strategies.
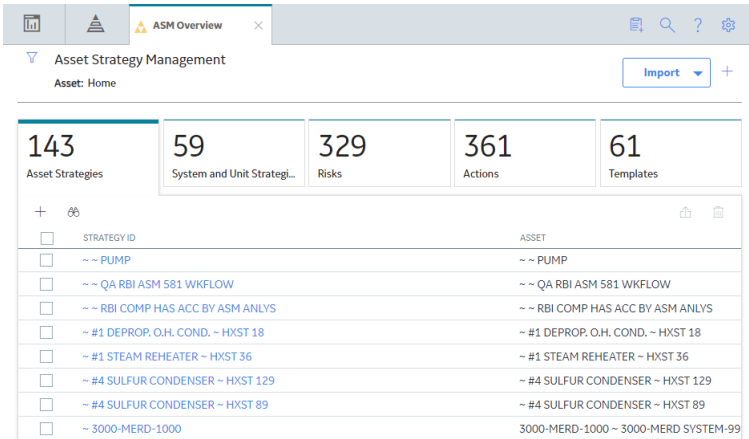
3. Select the Asset Strategy you want to optimize.
   The **Strategy Details** workspace for the selected Asset Strategy appears.

4. Select ⁝ , and then **Optimize Strategy**.

   Note: The ⁝ icon is available on the Asset, System, and Unit Strategy levels in ASM.

   In a new page, the **Analysis Summary** workspace for the selected Asset Strategy appears, displaying the **Summary** section.

ASO Workflow

The following steps represent a complete workflow for using ASO:

1. Open the Asset Strategy, System Strategy, or Unit Strategy from which you want to create an ASO Analysis.

2. Create an ASO Analysis from the strategy. When you do so, two scenarios will be created automatically:

   • An Active Scenario that represents the Active Strategy.
   • A Proposed Scenario that represents the Proposed Strategy.

3. Review the Diagram that was created automatically from the information in ASM, and modify as needed.

4. In the scenario that represents the Active Strategy:

   a. Provide values that will be used to yield accurate simulation results.
   b. Optimize Action intervals, define Resources, and define Global Events.

5. In the scenario that represents the Proposed Strategy:

   a. Provide values that will be used to yield accurate simulation results.

      Note: If the values provided are not accurate, the simulation will stop running, and the incorrect values will be highlighted in red until they are corrected.

   b. Optimize Action intervals, define Resources, and define Global Events.
   c. Add, modify, or remove Actions and Risks.

6. If the simulation results indicate that neither the Active Scenario nor the Proposed Scenario represents an acceptable strategy, suggest a new strategy. To do so, you can:

   • Modify the Proposed Scenario until it represents the suggested strategy.

     -OR-

- Create a new Scenario to represent the suggested strategy. You can create the new Scenario in either of the following ways:
  - Create it from scratch.
  - Create it by copying the existing Active or Proposed Scenario.
7. Run a simulation, and evaluate the simulation results.
8. In the Scenario that represents the suggested strategy:
   a. Provide values that will be used to yield accurate simulation results.
   b. Optimize Action intervals, define Resources, and define Global Events.
   c. Add, modify, or remove Actions and Risks.
   d. Run a simulation.
   e. Evaluate the simulation results.
9. If you are not satisfied with the simulation results from the scenario, continue suggesting new strategies (by modifying the Proposed Scenario or creating new scenarios), running simulations, and evaluating the simulation results until you are satisfied with them.
10. When you have determined which scenario represents the most acceptable strategy, if it is not already the Proposed Scenario, set it as the Proposed Scenario.
11. Navigate to ASM to continue managing the strategy as needed.

Chapter

2

Workflow

Topics:

APM Strategy: Asset Strategy Optimization Workflow

This workflow describes the process of determining the optimal strategy for a piece of equipment or location using additional features from ASM, which can then be viewed and managed further in ASM.

In the following workflow diagram, the blue text in a shape indicates that the corresponding description has been provided in the sections that follow the diagram. For more information, refer to the Interpreting the Workflow Diagrams topic in the APM Product Workflows documentation.

Note: For information on the personas associated with a APM module, refer to the APM Product Workflows documentation.

Asset Strategy Management (ASM)

Persona: Analyst

Strategies that are generated by ASM can be analyzed in ASO to compare scenarios and propose the optimal strategy to complete the ASM workflow.

Go to the ASM workflow.
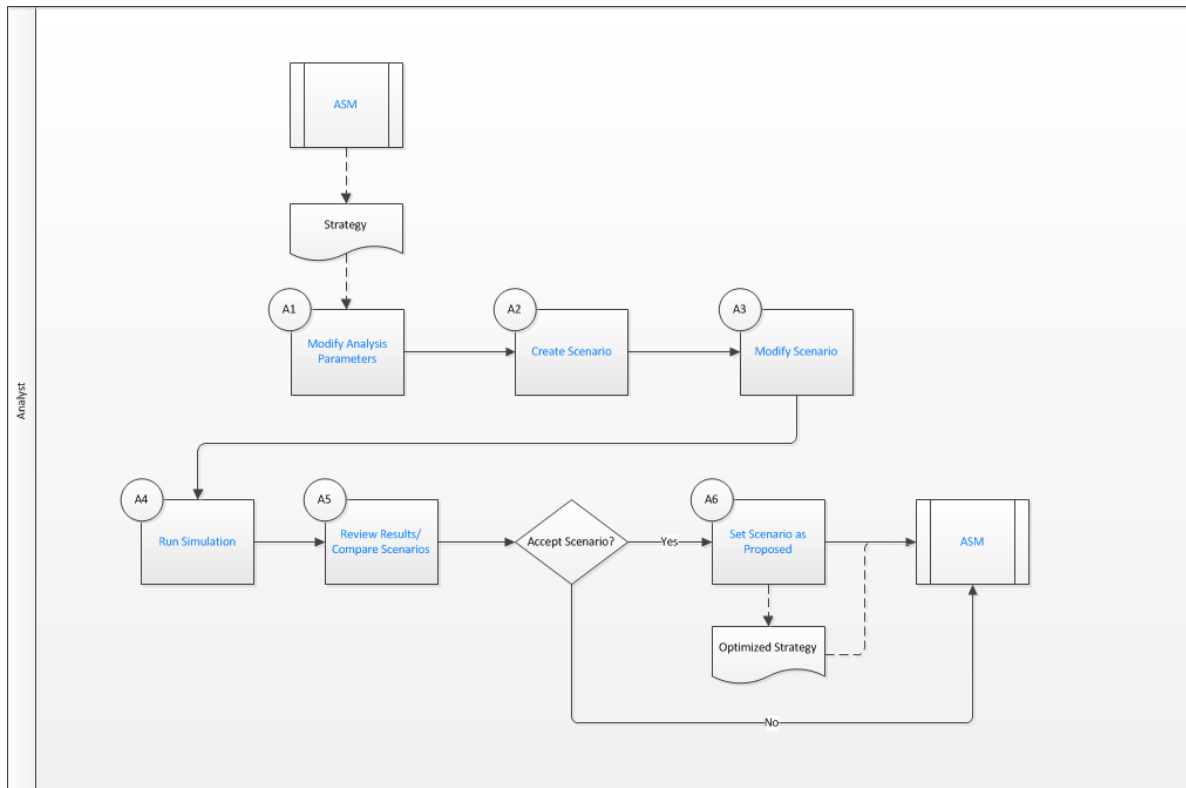
Modify Analysis Parameters

Persona: Analyst

Modify values as needed in the appropriate fields for the Analysis.

Create Scenario

Persona: Analyst

Create Active, Proposed, and additional scenarios.

Modify Scenario

Persona: Analyst

Modify risks and actions.

Run Simulation

Persona: Analyst

Run a simulation to assemble possible scenarios based on the strategy.

Set Scenario as Proposed

Persona: Analyst

Set the scenario as proposed and select Run Simulation again to export back to ASM.

Review Results/Compare Scenarios

Persona: Analyst

Review and compare the results of the simulated scenarios to determine the best scenario for your specific case.

Chapter

3

ASO Analyses

Topics:

About ASO Analyses

An ASO Analysis is a simulation-based module that works in concert with ASM to optimize the actions of your strategy.

About Components in an ASO Analysis

An Asset Strategy Optimization (ASO) analysis is made up of records and links as defined by the ASO Data Model. Specifically, an ASO analysis is a collection of Scenarios, Resources, and simulation results. An ASO analysis is represented by a System analysis record, which stores identifying information about the analysis and is linked to other records that make up the analysis.

Details

Beyond understanding an ASO analysis at the entity level, it is helpful to visualize it at a conceptual level, where groups of records and links make up the main elements of the analysis. These elements are described in the following list:

- Diagram: A logical, visual representation of the physical structure of equipment and locations, including the connections between them. Each ASO analysis contains one Diagram.

  Note: If you create an ASO analysis from an Asset Strategy, a Diagram will exist, but it will contain only an Asset element.

  A Diagram is represented by a System Subsystem record, which can be linked to System Subsystem, System Sensor, System Buffer, System Link, System Asset, and System Switch records. The items that these records represent are referred to as elements, which are simply the components that make up the Diagram itself.

- Scenario: A representation of one possibility for managing the risk and cost for a given piece of equipment or location. A Scenario is represented by a System Scenario record, which contains all the identifying information for the Scenario and is linked to other records that help define the Scenario. Each ASO analysis contains multiple Scenarios and will always contain at least the following Scenarios:

  ◦ Active Scenario
  ◦ Proposed Scenario
  ◦ Unmitigated Scenario

    Note: The Unmitigated Scenario cannot be manipulated in ASO. It represents the unmitigated strategy, or the strategy as it exists with only Risks and no Actions. The simulation results will include results for the Unmitigated Scenario, but you cannot modify the Unmitigated Scenario in ASO.

  An ASO analysis can contain additional Scenarios if you choose to create them. Except for the Unmitigated Scenario, each Scenario can contain the following components:

  ◦ Risk: A component that identifies a specific way that a piece of equipment or location can fail, specifies the consequences of the failure, and includes Time to Failure (TTF) and Time to Repair (TTR) distribution data. A Risk is represented by a System Risk record, which contains all of the identifying information for the risk.
  ◦ Action: A component that identifies a specific operation that can be performed against a piece of equipment or location. Actions include condition-based maintenance, procedures, redesigns, time-based maintenance, and training and may or may not mitigate Risks. Actions are represented by records in the System Condition Monitor, System Inspection, System Preventive Maintenance, or System Special Action families, which contain all the identifying information for the action.

- ◦ Global Event: A component that groups together actions that require a shutdown. Scheduling a Global Event can make a system more efficient by providing more time in which to run while still allowing maintenance and other actions to take place. A Global Event is represented by a System Global Event record, which contains all the identifying information for the Global Event.
- Resource: A component of an ASO analysis that associates a cost with an occurrence of an action or risk. Resources are represented by a System Resource record.
- Simulation Results: The outcome of running a simulation against all Scenarios included in a given ASO analysis. Simulation results are stored in System Element Result, System Action Result, or System Resource Result records, which are linked to the root System analysis record.

ASO Analysis Example

This topic provides an example of ASO analyses to explain how ASO analyses are created and used.

This ASO analysis example involves a water bottling facility. The water bottling facility is a unit, labeled the Water Bottling Unit. This unit contains two systems: Water Collection System and Bottling System. Each system contains equipment that work together to complete a single process.

The Water Collection System contains the following equipment:

- Water Pump
- Water Tank

The Bottling System contains the following equipment:

- Filling Machine
- Capping Machine
- Labeling Machine

The unit, systems, equipment, and the process in which they are involved are illustrated in the following image.
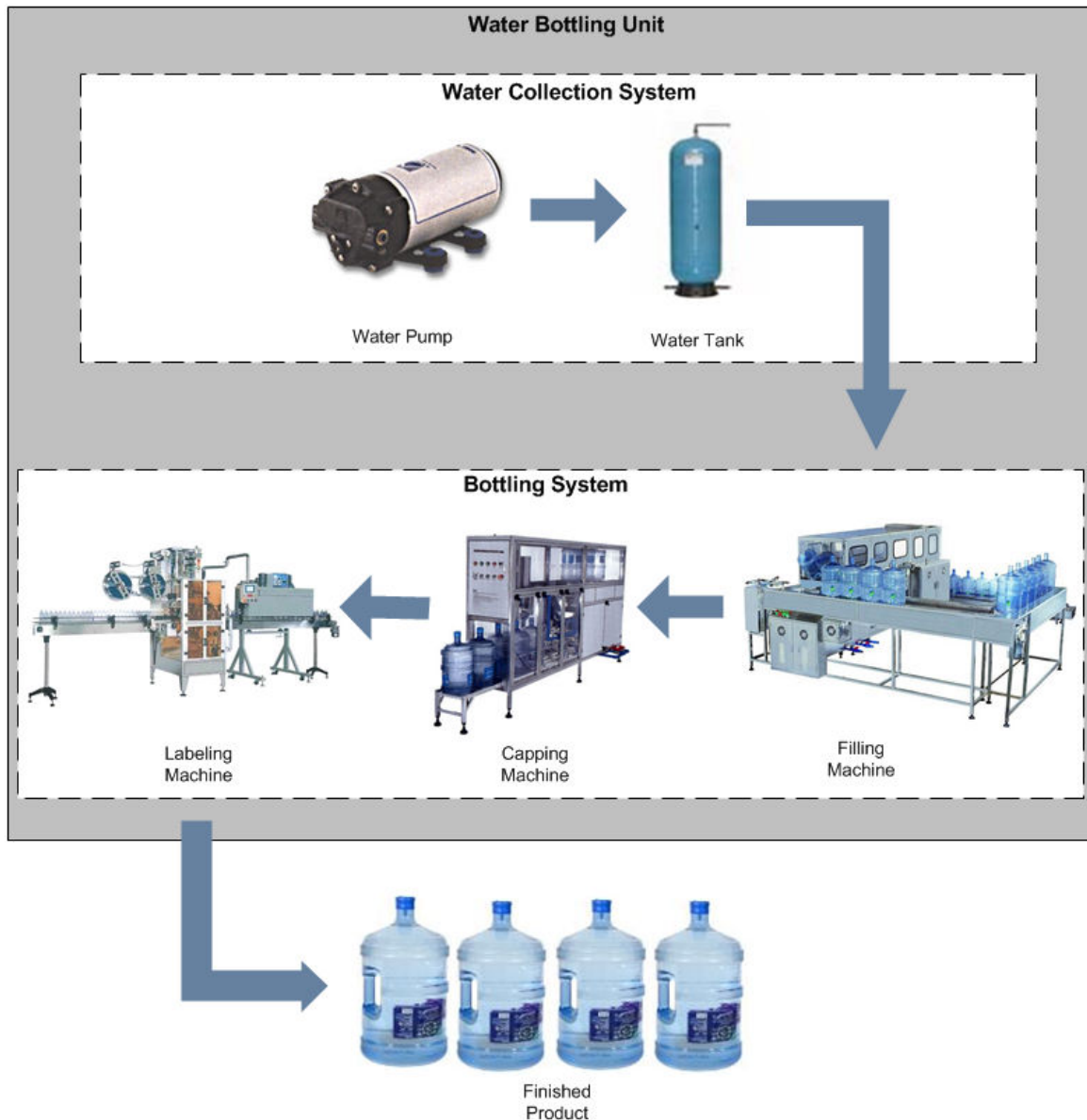
Note: In this example, the majority of the focus is at the Water Pump level.

An ASO analysis begins with an asset strategy, system strategy, or unit strategy. Our ASO analysis example includes the following strategies, where the indentation of the bullets indicates the structure of the strategies:

- Water Bottling Strategy (unit strategy)
  - Water Collection Strategy (system strategy)
    - Water Pump Strategy (asset strategy)
    - Water Tank Strategy (asset strategy)
  - Bottling Strategy (system strategy)
    - Filling Machine Strategy (asset strategy)
    - Capping Machine Strategy (asset strategy)
    - Labeling Machine Strategy (asset strategy)

Note: For this example, each asset strategy has an active strategy and a proposed strategy that are different from one another.

ASM Records and Links in Our Example

The following image shows the records and links that are used to create the association between the Unit Strategy, one of its System Strategies, one of its Asset Strategies (Water Pump Strategy), and the Asset Strategy's Action and Risk records.
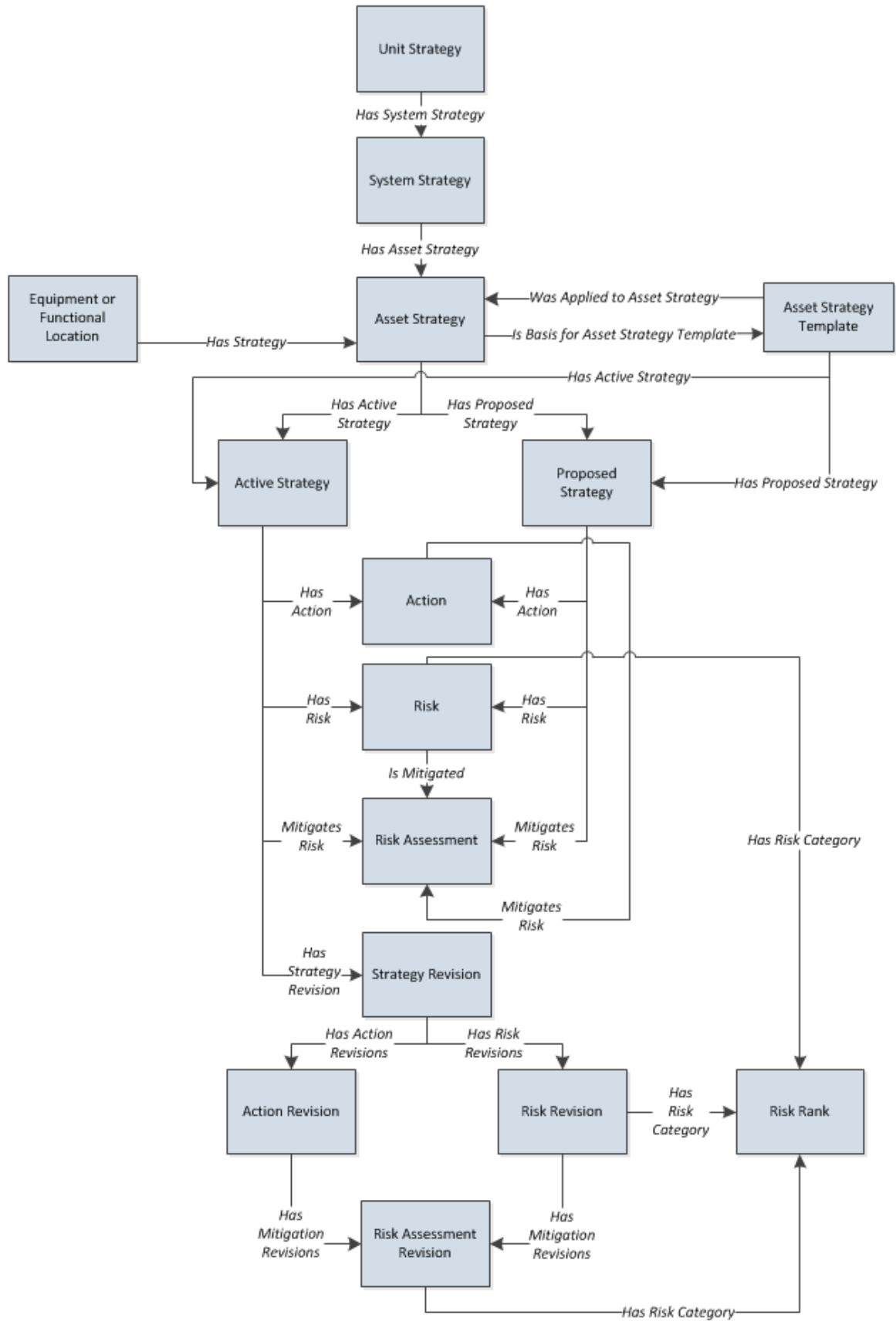
ASO Records and Links in Our Example

The following image illustrates existing records and links after the ASO Analysis is created. The colors in the image have the following meanings:

- **Orange:** Identifies two separate Water Bottling Strategy System Subsystem records, which represent the Diagram in the ASO Analysis.
- **Yellow:** Identifies two separate Water Collection Strategy System Subsystem records, which represent the Water Collection Strategy System Strategy.
- **Green:** Identifies two separate Water Pump Strategy System Asset records, which represent the Water Pump Strategy Asset Strategy.
- **Gray:** Identifies System Asset records that are part of the ASO Analysis but not the focus of this documentation.
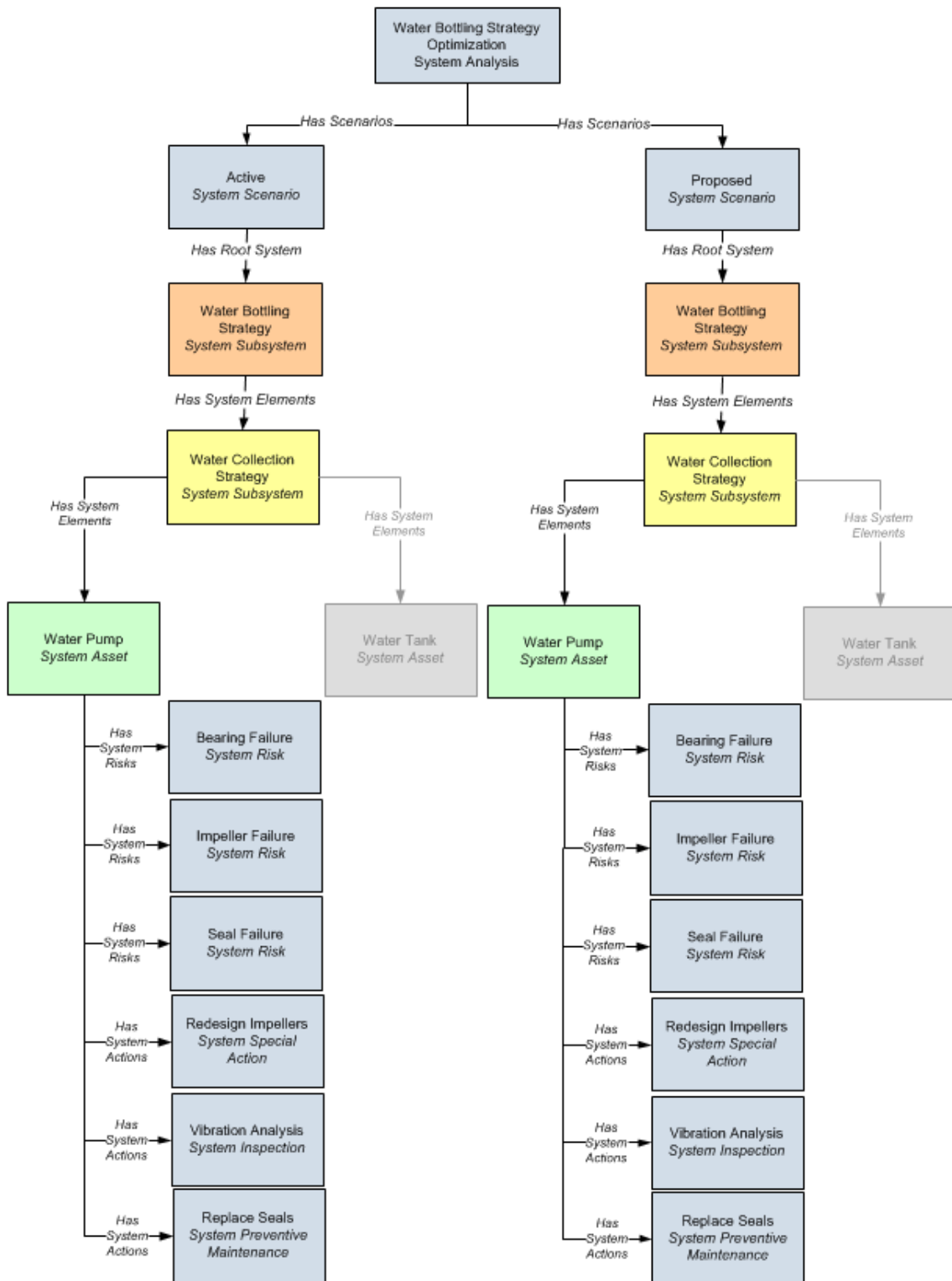
Example Data

The Equipment record Water Pump contains the following values:

- **Name:** Water Pump
- **Production Contribution:** 100
- **Fixed Cost:** 5000
- **Variable Cost:** 50
- **Variable Cost Units:** Per Hour
- **Lost Production Cost:** 0
- **Lost Production Cost Units:** Per Day

The Asset Strategy record that is linked to the Equipment record Water Pump contains the following values:

- **Strategy ID:** Water Pump Strategy
- **Description:** Asset Strategy for the Water Pump
- **Plan Length:** 5
- **Asset Name:** Water Pump
- **Asset Family:** Equipment

Active Strategy and Proposed Strategy

Action Data

The following table shows the example data stored in the Action records that are linked to the Active Strategy record with the ID Water Pump Strategy.

Action	Values
Redesign Impellers	**Name:** Redesign Impellers **Action Type:** Redesign (DSM) **Interval:** 2 **Interval Units:** Years **Nonrecurring:** Yes **Cost:** 1,600 **Shutdown Required:** Yes
Replace Seals	**Name:** Replace Seals **Action Type:** Time-Based Maintenance (Preventative) (PM) **Interval:** 2 **Interval Units:** Years **Nonrecurring:** No **Cost:** 2,000 **Shutdown Required:** Yes
Vibration Analysis	**Name:** Vibration Analysis **Action Type:** Condition-Based Maintenance (Predictive) (CM) **Interval:** 3 **Interval Units:** Weeks **Nonrecurring:** No **Cost:** 0 **Shutdown Required:** No

Risk Data

The following table shows the example data stored in the Risk records (and the corresponding Risk Assessment records) that are linked to the Active Strategy record with the ID Water Pump Strategy. It also shows which Action records represent actions that mitigate the risk.

Risk	Risk Values	Mitigating Action Values
Seal Failure	**Name:** Seal Failure **Unmitigated Risk Rank:** 150.6 **Unmitigated Financial Risk:** 690.00	**Name:** Replace Seals **Mitigated Risk Rank:** 3.6 **Mitigated Financial Risk:** 230.00
Bearing Failure	**Name:** Bearing Failure **Unmitigated Risk Rank:** 306 **Unmitigated Financial Risk:** 1,080.00	**Name:** Vibration Analysis **Mitigated Risk Rank:** 3.6 **Mitigated Financial Risk:** 360.00
Impeller Failure	**Name:** Impeller Failure **Unmitigated Risk Rank:** 156 **Unmitigated Financial Risk:** 165.00	**Name:** Replace Seals **Unmitigated Risk Rank:** 1.5 **Unmitigated Financial Risk:** 55.00

Action Data

The following table shows the example data stored in the Action records that are linked to the Proposed Strategy record with the ID Water Pump Strategy.

Note: Values that differ from the values in the corresponding Action record that is linked to the Active Strategy record are colored red.

Action	Values
Redesign Impellers	**Name:** Redesign Impellers **Action Type:** Redesign (DSM) **Interval:** 3 **Interval Units:** Years **Nonrecurring:** Yes **Cost:** 1,800 **Shutdown Required:** Yes
Replace Seals	**Name:** Replace Seals **Action Type:** Time-Based Maintenance (Preventative) (PM) **Interval:** 2 **Interval Units:** Years **Nonrecurring:** No **Cost:** 1,500 **Shutdown Required:** Yes
Vibration Analysis	**Name:** Vibration Analysis **Action Type:** Condition-Based Maintenance (Predictive) (CM) **Condition Monitoring Type:** Periodic **Interval:** 4 **Interval Units:** Weeks **Nonrecurring:** No **Cost:** 0 **Shutdown Required:** No

Risk Data

The following table shows the example data stored in the Risk records (and the corresponding Risk Assessment records) that are linked to the Proposed Strategy record with the ID Water Pump Strategy. It also shows which Action records represent actions that help mitigate the risk.

Note: Values that differ from the values in the corresponding Risk record that is linked to the Active Strategy record are colored red.

Risk	Risk Values	Mitigating Action Values
Seal Failure	**Name:** Seal Failure **Unmitigated Risk Rank:** 150.6 **Unmitigated Financial Risk:** 690.00	**Name:** Replace Seals **Mitigated Risk Rank:** 3.6 **Mitigated Financial Risk:** 225.00
Bearing Failure	**Name:** Bearing Failure **Unmitigated Risk Rank:** 306 **Unmitigated Financial Risk:** 1,080.00	**Name:** Vibration Analysis **Mitigated Risk Rank:** 3.2 **Mitigated Financial Risk:** 360.00
Impeller Failure	**Name:** Impeller Failure **Unmitigated Risk Rank:** 306 **Unmitigated Financial Risk:** 165.00	**Name:** Replace Seals **Unmitigated Risk Rank:** 1.5 **Unmitigated Financial Risk:** 55.00

Active Scenario and Proposed Scenario

Action Data

The following table shows the example data that is used in the Actions that are defined for the Water Pump Strategy and belong to the Active Scenario. Because the Active Scenario always reflects data that was mapped from ASM and these values cannot be changed, this table includes only the values that are specific to ASO and were not mapped from ASM.

Action	Mitigated Risk	Source	Values
Redesign Impellers	Impeller Failure	System Special Action	**Duration:** 2 **Duration Units:** Weeks **Replace Failure Consequence:** Yes **Replace TTF Distribution:** Yes
		System Risk Assessment	**Mitigated Unplanned Correction Cost:** 1000^1
		Weibull	**Name:** New TTF Distribution **Distribution Type:** Weibull **Time Unit:** Months **Beta:** 4 **Eta:** 48 **Gamma:** 0

Action	Mitigated Risk	Source	Values
Replace Seals	Seal Failure	System Preventive Maintenance	**Duration:** 1 **Duration Units:** Days
Vibration Analysis	Bearing Failure	System Inspection	**Duration:** 1 **Duration Units:** Hours **Detection Probability (%):** 90

Risk Data

The following table shows the example data that is used in the Risks that are defined for the Water Pump Strategy and belong to the Active Scenario. Note that this table includes only the values that are specific to ASO and were not mapped from ASM.

Risk	Mitigating Action	Source	Values
Seal Failure	Replace Seals	System Risk	**Last Failure:** 1/1/1999 12:00:00 AM
			Fixed Unplanned Correction Cost: 1500
			Variable Unplanned Correction Cost: 1000
			Variable Unplanned Correction Cost Units: Per Day
			Planned Correction Cost: 1000
			Planned Correction Duration: 12
			Planned Correction Duration Units: Hours
			Is Active: Yes
			Is Latent: No
			Failure Without Replacement: No
			Number of Subcomponents: 1
			PF Interval: 30
			PF Interval Units: Days
			Repair Immediately: Yes
			Percentage of PF Interval to Wait (%): 0
		Weibull	**Name:** TTF Distribution
			Distribution Type: Weibull
			Time Unit: Years
			Beta: 4
			Eta: 3
			Gamma: 0
			Enable Distribution Association: No
		Normal	**Name:** TTR Distribution
			Distribution Type: SingleValue
			Time Unit: Hours
			Value: 12
			Enable Distribution Association: No

Risk	Mitigating Action	Source	Values
Bearing Failure	Vibration Analysis	System Risk	**Last Failure:** 1/1/1999 12:00:00 AM **Fixed Unplanned Correction Cost:** 2000 **Variable Unplanned Correction Cost:** 1000 **Variable Unplanned Correction Cost Units:** Per Day **Planned Correction Cost:** 1000 **Planned Correction Duration:** 4 **Planned Correction Duration Units:** Hours **Is Active:** Yes **Is Latent:** No **Failure Without Replacement:** No **Number of Subcomponents:** 1 **PF Interval:** 6 **PF Interval Units:** Weeks **Repair Immediately:** Yes **Percentage of PF Interval to Wait (%):** 0
		Exponential	**Name:** TTF Distribution **Distribution Type:** Exponential **Time Unit:** Months **Value:** 60 **Enable Distribution Association:** No
		Exponential	**Name:** TTR Distribution **Distribution Type:** Exponential **Time Unit:** Hours **MTTR:** 8 **Enable Distribution Association:** No

Risk	Mitigating Action	Source	Values
Impeller Failure	Redesign Impellers	System Risk	**Last Failure:** 1/1/1999 12:00:00 AM
			Fixed Unplanned Correction Cost: 1500
			Variable Unplanned Correction Cost: 1000
			Variable Unplanned Correction Cost Units: Per Day
			Planned Correction Cost: 1000
			Planned Correction Duration: 4
			Planned Correction Duration Units: Hours
			Is Active: Yes
			Is Latent: No
			Failure Without Replacement: No
			Number of Subcomponents: 1
			PF Interval: 0
			PF Interval Units: Days
			Repair Immediately: Yes
			Percentage of PF Interval to Wait (%): 0
		Exponential	**Name:** TTF Distribution
			Distribution Type: Exponential
			Time Unit: Months
			Value: 24
			Enable Distribution Association: No
		Normal	**Name:** TTR Distribution
			Distribution Type: SingleValue
			Time Unit: Hours
			Value: 12
			Enable Distribution Association: No

Action Data

The following table shows the example data that is used in the Actions that are defined for the Water Pump Strategy and belong to the Proposed Scenario. Because you can change the values that were originally mapped from ASM to a Proposed Scenario, this table includes the values that are specific to ASO and those that were mapped from ASM. In our example, however, we have not changed these values from their original ASM values. To distinguish between the two types of values, values that were mapped from ASM are colored gray in the table.

Action	Mitigated Risk	Source	Values
Redesign Impellers	Impeller Failure	System Special Action	**Name:** Redesign Impellers **Action Type:** Redesign (DSN) **Action Cost:** 1600 **Interval:** 2 **Interval Units:** Years **Duration:** 1.5 **Duration Units:** Weeks **Shutdown Required:** Yes **One Time Action:** Yes **Replace Failure Consequence:** Yes **Replace TTF Distribution:** Yes
		System Risk Assessment	**Mitigated Unplanned Correction Cost:** 1000^1
		Weibull	**Name:** New TTF Distribution **Distribution Type:** Weibull **Time Unit:** Months **Beta:** 4 **Eta:** 48 **Gamma:** 0

Action	Mitigated Risk	Source	Values
Replace Seals	Seal Failure	System Preventive Maintenance	**Name:** Replace Seals **Action Type:** Time-Based Maintenance (Preventive) (PM) **Action Cost:** 2000 **Interval:** 2 **Interval Units:** Years **Duration:** .5 **Duration Units:** Days **Shutdown Required:** Yes **One Time Action:** No
Vibration Analysis	Bearing Failure	System Inspection	**Name:** Vibration Analysis **Action Type:** Condition-Based Maintenance (Predictive) (CM) **Condition Monitoring Type:** Periodic **Action Cost:** 0 **Interval:** 3 **Interval Units:** Weeks **Duration:** 1 **Duration Units:** Hours **Shutdown Required:** No **One Time Action:** No **Detection Probability (%):** 100

Risk Data

The following table shows the example data that is used in the Risks that are defined for the Water Pump Strategy and belong to the Proposed Scenario. Because you can change the values that were originally mapped from ASM to a Proposed Scenario, this table includes the values that are specific to ASO and those that were mapped from ASM. In our example, however, we have not changed these values from their original ASM values. To distinguish between the two types of values, values that were mapped from ASM are colored gray in the table.

Risk	Mitigating Action	Source	Values
Seal Failure	Replace Seals	System Risk	**Name:** Seal Failure **Last Failure:** 1/1/1999 12:00:00 AM **Fixed Unplanned Correction Cost:** 1500 **Variable Unplanned Correction Cost:** 1000 **Variable Unplanned Correction Cost Units:** Per Day **Planned Correction Cost:** 1000 **Planned Correction Duration:** 8 **Planned Correction Duration Units:** Hours **Is Active:** Yes **Is Latent:** No **Failure Without Replacement:** No **Number of Subcomponents:** 1 **PF Interval:** 30 **PF Interval Units:** Days **Repair Immediately:** Yes **Percentage of PF Interval to Wait (%):** 0
		Weibull	**Name:** TTF Distribution **Distribution Type:** Weibull **Time Unit:** Years **Beta:** 4 **Eta:** 3 **Gamma:** 0 **Enable Distribution Association:** No
		Normal	**Name:** TTR Distribution **Distribution Type:** SingleValue **Time Unit:** Hours **Value:** 12 **Enable Distribution Association:** No

Risk	Mitigating Action	Source	Values
Bearing Failure	Vibration Analysis	System Risk	**Name:** Bearing Failure **Last Failure:** 1/1/1999 12:00:00 AM **Fixed Unplanned Correction Cost:** 2000 **Variable Unplanned Correction Cost:** 1000 **Variable Unplanned Correction Cost Units:** Per Day **Planned Correction Cost:** 800 **Planned Correction Duration:** 2 **Planned Correction Duration Units:** Hours **Is Active:** Yes **Is Latent:** No **Failure Without Replacement:** No **Number of Subcomponents:** 1 **PF Interval:** 6 **PF Interval Units:** Weeks **Repair Immediately:** Yes **Percentage of PF Interval to Wait (%):** 0
		Exponential	**Name:** TTF Distribution **Distribution Type:** Exponential **Time Unit:** Months **Value:** 60 **Enable Distribution Association:** No
		Exponential	**Name:** TTR Distribution **Distribution Type:** Exponential **Time Unit:** Hours **MTTR:** 8 **Enable Distribution Association:** No

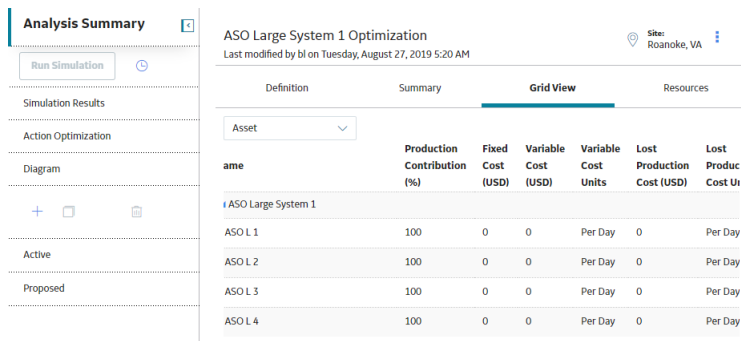| Risk	Mitigating Action	Source	Values
Impeller Failure	Redesign Impellers	System Risk	**Name:** Impeller Failure **Last Failure:** 1/1/1999 12:00:00 AM **Fixed Unplanned Correction Cost:** 1500 **Variable Unplanned Correction Cost:** 1000 **Variable Unplanned Correction Cost Units:** Per Day **Planned Correction Cost:** 600 **Planned Correction Duration:** 3 **Planned Correction Duration Units:** Hours **Is Active:** Yes **Is Latent:** No **Failure Without Replacement:** No **Number of Subcomponents:** 1 **PF Interval:** 0 **PF Interval Units:** Days **Repair Immediately:** Yes **Percentage of PF Interval to Wait (%):** 0
		Exponential	**Name:** TTF Distribution **Distribution Type:** Exponential **Time Unit:** Months **Value:** 24 **Enable Distribution Association:** No
		Normal	**Name:** TTR Distribution **Distribution Type:** SingleValue **Time Unit:** Hours **Value:** 12 **Enable Distribution Association:** No

Filter Analysis in Grid View

About This Task

Note: This procedure is only available in System and Unit Strategies.

Procedure

1. Access ASO.
2. In the **Analysis Summary**, select the **Grid View** tab.
   The **Grid View** workspace appears.

3. Use the drop-down menu to select the value that you want to filter. The following options are available:

   - **Asset**
   - **Buffer**
   - **Link**
   - **Subsystem**
   - **Switch**

   The value appears.

Modify Elements in Grid View

Procedure

1. Access ASO.
2. In the **Analysis Summary**, select the **Grid View** tab.
   The **Grid View** workspace appears.
3. In the appropriate row for the value that you want to modify, select ✏️.
   In the selected row, boxes appear.
4. Modify as needed, and when finished, select 💾.
   The value is modified and saved.

Modify the Analysis Definition

Procedure

1. Access ASO.
2. In the **Analysis Summary**, select the **Definition** tab.
   The **Definition** workspace appears.
3. Select ✎.

   The **Definition** datasheet appears.
4. As needed, enter values in the available fields.
5. Select 💾.
   The analysis **Definition** has been modified and saved.

Refresh All Distributions

Procedure

1. Access ASO.
2. Select ⋮ , and then select ↻.
   A message appears, asking you to confirm that you want to refresh all of the distributions in the analysis.
3. Select **Yes**.
   A message appears, confirming that the distribution refreshed successfully.

Delete an ASO Analysis

About This Task

Note: This procedure cannot be performed when the linked strategy is in a Pending Review state.

Procedure

1. Access ASO.
2. Select ⋮ , and then select 🗑.
   A message appears, asking you to confirm that you want to delete the analysis.
3. Select **Yes**.
   A message appears, confirming that the analysis is deleted. You are returned back to the ASM **Strategy Details** page.

Chapter

4

ASO Diagrams

Topics:

About ASO Diagrams

An ASO Diagram provides a visual representation of the Asset, System, or Unit scenario being modeled, as well as the means to navigate to the supporting analyses or elements. You can use the tools in this feature to add or remove subsets of your scenario.

Note:

- An ASO Diagram is only available when working at the system or Unit scenario level.
- ASO only has one diagram that is shared across scenarios.
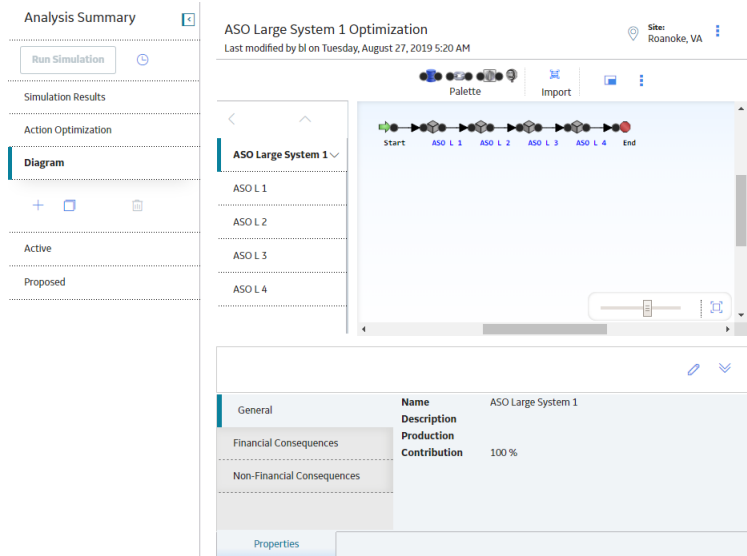
Access the ASO Diagram Workspace

Before You Begin

A Diagram represents the physical layout and construction of pieces of equipment and locations. A Diagram consists of a root System Subsystem record, which is linked to one or more System Subsystem, System Sensor, System Buffer, System Link, System Asset, and System Switch records that together make up the Diagram. When you create an ASO Analysis, the Diagram is created automatically using the strategy (and any strategies it contains) from which you created the analysis. Therefore, after you have created an ASO Analysis, there is no manual step required for creating a Diagram. You simply can build out the Diagram further by adding the necessary elements and connections.

Procedure

1. Access ASO.
2. In the **Analysis Summary** pane, select the **Diagram** tab.
   The **Diagram** workspace appears.

   The Diagram workspace contains the following features:

   - **Diagram Hierarchy** pane: Provides a hierarchical view of the elements that are included in the Diagram.
   - **Diagram Canvas:** Serves as an interactive drawing interface where you can build a Diagram. You can drag elements from the Diagram Palette pane to the Diagram Canvas to display the elements

within the Diagram. You can then rearrange the elements by dragging them to different locations on the Diagram Canvas.

- **Diagram Palette:** Displays the available Diagram elements that you can drag onto the Diagram Canvas to include in the Diagram.

  Note: The **Diagram Palette** feature is only available for System Strategies.

- **Properties:** Displays the information associated either with the entire Diagram or a selected element.

Access a Strategy Summary via an ASO Diagram

Procedure

1. Access the ASO Diagram workspace.
2. Select the node whose strategy you want to access.
   A red box appears around the selected node.
3. Select ⠇, and then select **View Strategy**.

   In a new tab, the Strategy Summary for the selected Strategy appears.

Import Asset and System Strategies into a Diagram

Procedure

1. Access the ASO Diagram Workspace.
2. Select ⊞.
   The **Search** window appears.
3. Select the check box next to each strategy that you want to import into the diagram, and then when finished, select **OK**.
   The imported strategies appear on the **Diagram Canvas**.

Copy and Paste Nodes in ASO Diagrams

Procedure

1. Access ASO.
2. In the left pane, select the **Diagram** tab.
   The **Diagram** workspace appears.
3. Select the node that you want to copy.
   A red box appears around the selected node.
4. Select ⠇, and then select ▭.
   A message appears, confirming that the selected node has been copied.
5. Select the place on the canvas where you would like to paste the selected node.
6. Select ⠇, and then select ▭.
   A message appears, confirming that the selected node has been pasted.

Delete Nodes in an ASO Diagram

Procedure

1. Access the ASO Diagram workspace.
2. Select the node that you want to delete.
   A red box appears around the selected node.
3. Select ⣿ and then select 🗑.
   A message appears, asking you to confirm that you want to delete the node.
4. Select **OK**.
   A message appears, confirming that the node is deleted.

Chapter
5

Global Resources

Topics:

About Global Resources

Global Resources are optional components in an Asset Strategy Optimization Analysis that represents physical parts or materials, such as spare bearings or seals, or human resources, such as mechanics or technicians, that you may want to use within the analysis.

Associating a Resource with an Action or Risk will create a System Resource Usage record, which is linked to the appropriate System Action or System Risk record, which will store information that specifies how the resource will be used (for example, the quantity and duration).

Search for Resources

Procedure

1. Access ASO.
2. Select the **Resources** tab.
   The **Resources** section appears.
3. Select 🔍.
   In the grid, filter boxes appear.
4. In the appropriate filter boxes, enter search information.
   Your results appear.

Add a New Resource

Procedure

1. Access ASO.
2. Select the **Resources** tab.
   The **Resources** section appears.
3. In the **Resources** section, select ＋.
   The Add New Resource Usage datasheet appears.
4. As needed, enter values in the available fields.
5. Select 💾.

   Your new resource is created. To return to the Resources section, select ＜.

Import Resources

Procedure

1. Access ASO.
2. Select the **Resources** tab.
   The **Resources** section appears.
3. Select ⎘.
   The **Resource Finder** window appears.

4. In the list of resources, select the check box next to each resource that you want to import.
5. Select **Import**.
   A message appears, notifying you of the import status. When the import is finished, a message appears, confirming that the import is successful.

Modify Resources

Procedure

1. Access ASO.
2. Select the **Resources** tab.
   The **Resources** section appears.
3. Select the resource that you want to modify.
   The resource is highlighted.
4. Select ✎.
   The **Add new Resource Usage** datasheet appears.
5. As needed, modify the available fields.
6. Select 🖫.
   A message appears, confirming that the resource was modified. To return to the Resources section, select ‹.

Delete Resources

Procedure

1. Access ASO.
2. Select the **Resources** tab.
   The **Resources** section appears.
3. Select the resource that you would like to delete.
   The resource is highlighted.
4. Select 🗑.
   A message appears, asking you to confirm that you want to delete the resource.
5. Select **OK**.
   A message appears, confirming that the delete was successful.

Chapter

6

Scenarios

Topics:

About Scenarios

ASO Scenarios share one analysis-level diagram, while System Reliability scenarios have their own.

Add a New ASO Scenario

Before You Begin

These instructions also apply to accessing Asset Strategy Optimization in Unit and System Strategies.

Procedure

1. Access ASO.

2. Select ✛.
   A message indicating that a new scenario has been created appears, and, in the pane, a tab labeled **New Scenario** appears.

3. Select 🖉 to edit the scenario information, which also includes changing the name of the scenario.

   When finished with the scenario, select 💾 to save.

   Note: If you would like the new scenario to become the Proposed scenario, select the **Set As Proposed** button in the workspace.

Copy a Scenario

Procedure

1. Access ASO.
2. In the **Analysis Summary** pane, select the Scenario that you would like to copy.
   The scenario is highlighted.
3. Select ⬚.
   A message appears, confirming that the scenario has been copied. The copy of the scenario appears in the **Analysis Summary** pane.
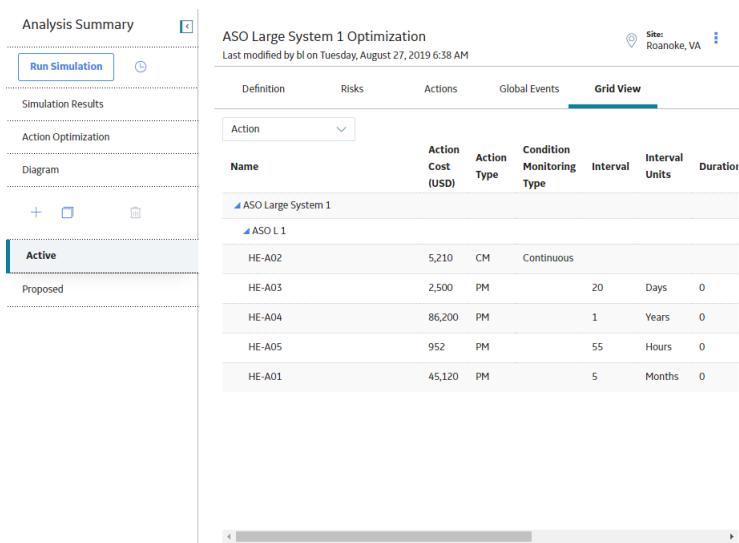
Filter Scenario in Scenario Grid View

About This Task

Note: This procedure only works with copied Scenarios, not Active or Proposed scenarios.

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Grid View** tab.
   The **Grid View** section appears.

3. Use the drop-down menu to select the value that you want to filter. the following options are available:
   - **Action**
   - **Distribution**
   - **Risk**

   The appropriate values appear in the grid.

Modify a Scenario in Grid View

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Definition** tab.
   The **Definition** section appears.
3. Select ✏️.
   In the section, boxes appear.
4. As needed, enter values in the available fields.
5. Select 💾.
   The Definition has been modified.

Modify a Definition in a Scenario

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Definition** tab.
   The **Definition** section appears
3. Select ✏️.
   In the section, boxes appear.
4. As needed, enter values in the available fields.
5. Select 💾.
   The Definition has been modified.

Delete a Scenario

Before You Begin

This instructions also apply to accessing Asset Strategy Optimization in Unit and System Strategies.

Procedure

1. Access ASO.
2. Select the scenario that you would like to delete.
3. Select ⋮ , and then select 🗑️.
   A message appears, asking you to confirm that you want to delete the strategy.

Chapter

7

Risks in a Scenario

Topics:

About Risks in a Scenario

In Asset Strategy Optimization, a Risk identifies one way in which an Asset can fail. If the Risk occurs, the piece of equipment or location will fail, and the system cannot run. In Asset Strategy Optimization Analyses, Risks are stored in System Risks, which can be linked to System Assets and System Switches.

After you create an Action in Asset Strategy Optimization, you can assign a single Risk or multiple Risks to that Action. When you assign a Risk to an Action, a link is created between a System Risk Assessment record, which stores the GUID of the mitigated Risk in the Risk GUID field, and the Action. This allows the Action to mitigate the Risk. An Action may mitigate a Risk by changing certain properties, such as failure consequences or the failure distribution, of the Risk.

Add Risks

About This Task

Important: This procedure does not work in an **Active** scenario.

Procedure

1. Access ASO.
2. In the pane, select a scenario.
3. In the scenario workspace, select the **Risks** tab.
   The **Risks** section appears, displaying a list of available risks.
4. In the **Risks** workspace, select ┼.
   The **New Risk** grid appears.

   Note: You need to be in the node level of the analysis for the ┼ to activate.
5. As needed, enter values in the available fields.
6. Select 💾.
   A message appears, confirming that the risk is saved.

   Note: In the **Proposed** scenario, a ⊕ will appear in the **Status** column to indicate that the risk has been added.

Filter Risks

Procedure

1. Access ASO.
2. In the scenario, and then, in the appropriate workspace, select the **Risks** tab.
   The **Risks** section appears, displaying a list of available risks.
3. Select ▽.
   In the grid, filter boxes appear.
4. In the filter box for any column, enter the information that you want to filter.
   Your results appear.

Show Mitigated Actions in a Risk

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Risks** tab.
   The **Risks** section appears, displaying a list of available risks.
3. Select the risk whose mitigating action you want to show.
   The risk is highlighted.
4. Select **Show Mitigated Action**.
   The Mitigated Actions appear.

Next Steps

- Assign a New Action to a Risk
- Assign an Existing Action to a Risk

Assign a New Action to a Risk

About This Task

Important: This procedure does not work in an **Active** scenario.

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Risks** tab.
   The **Risks** section appears, displaying a list of available risks.
3. Select the risk where you would like to assign a new action.
   The risk is highlighted.
4. Select **Show Mitigated Action**.
   The mitigated actions appear.
5. Select **Assign New Action**,
   The **Assign New Action** grid appear.
6. As needed, enter values in the available fields.
7. Select 💾.
   The new action is saved.

Assign an Existing Action to a Risk

About This Task

Important: This procedure does not work in an **Active** scenario.

Procedure

1. Access ASO.

2. Select a scenario, and then, in the workspace, select the **Risks** tab.
   The **Risks** section appears, displaying a list of available actions.
3. Select the risk to which you would like to assign an existing action.
   The risk is highlighted.
4. Select **Show Mitigating Action**.
   The mitigating actions appear.
5. Select **Assign Existing Actions**.
   The **Assign Existing Actions** grid appears.
6. Select the check box to the right of each risk that you want to add.
7. Select **Submit**.
   The existing actions are added.

Undo a Risk

About This Task

Important: This procedure does not work in an **Active** scenario.

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Risks** tab.
   The **Risks** section appears, displaying a list of available risks.
3. Select the risk that you would like to undo.
   The risk is highlighted.
4. Select ↰ .
   Your risk has been returned to its previous state.

Modify Risk Properties

About This Task

Important: This procedure does not work in an **Active** scenario.

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Risks** tab.
   The **Risks** section appears, displaying a list of available actions.
3. In the **Properties** pane, select ✎ and the modify the properties as needed.

   Note: In the **Proposed** scenario, a ✎ will appear in the **Status** column to indicate that the risk has been edited.
4. Select 💾 .
   Your changes have been saved.

Delete Risks

About This Task

Important: This procedure does not work in an **Active** scenario.

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Risks** tab.
   The **Risks** section appears, displaying a list of available risks.
3. Select the risk you want to delete.
   The risk is highlighted.
4. Select 🗑.

   Note: If the node is not selected on the correct level, the 🗑 button will not activate.

   A message appears, asking if you want to delete the risk.
5. Select **Yes**.
   A message appears, confirming that the risk is deleted.

   Note: In the **Proposed** scenario, a ⊖ will appear in the **Status** column to indicate that the risk has been deleted.

Manage Distribution Data for Risks

Reliability Distribution data (Time to Failure and Time to Repair) is associated with Risks. You have two options for defining distribution data for Risks. You can either enter distribution data manually, or associate distribution data from existing Reliability Distribution Analyses and Reliability Growth Analyses.

Define TTF and TTR Distribution Data Manually

About This Task

Time to Failure (TTF) and Time to Repair (TTR) are determined from the distribution data for the associated System Risk record. The TTF and TTR datasheets enable you to define these distribution datasets for your analysis.

Important: This procedure does not work in an **Active** scenario.

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Risks** tab.
   The **Risks** section appears, displaying a list of available risks.
3. Select the Risk whose distribution you want to define.
4. In the **Risks** section, in the grid, the row containing the Risk whose distribution data you want to define:

   • In the **TTF Distribution** column, select the link.
     -or-

- In the **TTR Distribution** column, select the link.

  The **TTF Distribution** or **TTR Distribution** window appears, depending on which link you clicked.

5. Select ✏️

6. When done, select 💾.
   A message appears, confirming that your new distribution data is saved.

Associate Existing Distribution Data with Risks

Before You Begin

- As an alternative to entering distribution data manually for Risks, you can associate distribution data from existing Reliability Growth Analyses and Reliability Distribution Analyses. When you enter data manually, you can choose any values that you desire for your distribution data, but when you associate existing distribution data with Risks, you use data stored in actual Reliability Growth or Reliability Distribution Analyses.
- After existing distribution data has been associated with a Risk, you can update the information periodically. When you associate the distribution data, the Entity Key and Family Key of the Reliability Distribution and Reliability Growth Analysis are stored in the System Risk record, thereby establishing a connection between the two records that allows for future updates. This way your ASO Analysis uses the most current information available to calculate the simulation results.
- You will also need an active Reliability Analytics license to perform this procedure.

  Note: TTR and TTF Distributions can be defined for all scenarios. Also, you can associate Reliability analyses for Active and Non-active scenarios.

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace of your choice, select the **Risks** tab.
   The **Risks** section appears, displaying a list of available risks.
3. In the **Risks** section, in the grid, select the Risk with which you want to associate distribution data.
   The risk is highlighted.
4. Select **Associate Distribution**.
   The **Search** window appears.
5. In the **Look In** drop-down menu, select the group that you would like to search.
6. In the **Linked To** drop-down menu, select the group you would like linked to the search.

   Note: If you have selected All Families as an option, the **Linked To** drop-down menu may not be populated.

7. In the search box, enter the criteria you want to search for, and select 🔍.
   Your results appear.
8. Select the appropriate risk, and then select **OK**.
   A message appears, confirming that the record has been updated.

Risks to Reset

About This Task

The **Risks to Reset** column displays a number representing the number of additional Risks that will be reset following a planned or unplanned correction of the Risk in that row. The number appears as a hyperlink, which you can select to access the Risks to Reset subsection, where you can manage the

additional Risks that will be reset in the simulation following a planned or unplanned correction of the source Risk.

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Risks** tab.
   The **Risks** section appears, displaying a list of available risks.
3. In the row for the Risk that you want to reset, select the link in the **Risks to Reset** column.
   The **Risks to Reset** subsection appears.
4. In the **Selected** column, select the check box next to each risk that you want to include.
5. Select 🖫.
   The **Risks** grid reappears, with an updated number in the appropriate **Risks to Reset** column.

Modify Qualitative Consequence in Risk

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Risks** tab.
   The **Risks** section appears, displaying a list of available Risks.
3. In the **Risks** section, in the grid, in the row containing the Risk whose qualitative consequence you want to define, select the link in the **Qualitative Consequence** column.

   The **Qualitative Consequence** subsection for the selected Risk opens.
4. Select ✎ , and then modify the available fields.
5. Select 🖫.
   A message appears, confirming that the consequence has been saved. To return to the **Risks** section, select ‹ .

Refresh Distribution Data

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Risks** tab.
   The **Risks** section appears, displaying a list of available risks.
3. In the **Risks** section, in the grid, select the Risk that you want to refresh.
   The risk is highlighted.
4. Select ⟳.
   A message appears, asking you to confirm refreshing the distribution.
5. Select **OK**.
   The distribution has been refreshed.

Manage Planned Resource Usage

When modeling resource usage in a simulation scenario, resource time and costs are consumed as Risks are mitigated. Resources are therefore added against Risks and are modeled in the form of planned (for scheduled maintenance) and unplanned (for unscheduled risk-related events).

Search for Planned Resource Usage in Risks

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Risks** tab.
   The **Risks** section appears, displaying a list of available risks.
3. Select the Risk whose planned resource usage you want to search for.
   The risk is highlighted.
4. In the Risks section, in the grid, in the row containing the Risk whose planned resource usage you want to search for, select the link in the **Planned Resource Usages** column.

   The **Planned Resource Usages** subsection for the selected risk opens.

5. Select 👓.
   In the grid, filter boxes appear.
6. In the filter box for any column, enter search information.
   Your results appear.

Add a Planned Resource Usage in Risks

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Risks** tab.
   The **Risks** section appears, displaying a list of available risks.
3. Select the Risk whose planned resource usage you want to add.
   The risk is highlighted.
4. In the **Risks** section, in the grid, in the row containing the Risk whose planned resource usage you want to add, select the link in the **Planned Resource Usages** column.

   The **Planned Resource Usages** subsection for the selected risk opens.

5. In the **Planned Resource Usages** subsection, select ➕.
   The **Add New Resource Usage** datasheet appears.
6. As needed, enter values in the available fields.

7. Select 💾.

   A message appears confirming that your new resource usage has been added. Select ⟨ to return to the **Planned Resource Usages** subsection.

Add Existing Planned Resource Usage in Risks

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Risks** tab.
   The **Risks** section appears, displaying a list of available risks.

3. Select the Risk to which you want to add existing planned resource usage.
   The risk is highlighted.
4. In the **Risks** section, in the grid, in the row containing the Risk to which you want to add existing planned resource usage, select the link in the **Planned Resource Usages** column.

   The **Planned Resource Usages** subsection for the selected risk opens.

5. Select .
   The **New Resource Usage from Existing Resources** window appears.
6. As needed, modify the available fields.
7. Select **Finish**.
   The new resource appears in the **Planned Resource Usages** subsection.

Modify Planned Resource Usage in Risks

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Risks** tab.
   The **Risks** section appears, displaying a list of available risks.
3. Select the Risk whose planned resource usage you want to modify.
   The risk is highlighted.
4. In the **Risks** section, in the grid, in the row containing the Risk whose planned resource usage you want to modify, select the link in the **Planned Resource Usages** column.

   The **Planned Resource Usages** subsection for the selected risk opens.

5. Select the planned resource usage that you want to modify.
   The resource usage is highlighted.

6. Select , and then, as needed modify the appropriate fields.

7. Select .
   A message appears, confirming that the resource has been modified, and the **Planned Resource Usages** subsection appears.

Delete Planned Resource Usage in Risks

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Risks** tab.
   The **Risks** section appears, displaying a list of available risks.
3. Select the Risk whose planned resource usage you want to delete.
   The risk is highlighted.
4. In the **Risks** section, in the grid, in the row containing the Risk whose planned resource usage you want to delete, select the link in the **Planned Resource Usages** column.

   The **Planned Resource Usages** subsection for the selected risk opens.

5. Select the existing resource that you want to delete.
   The resource is highlighted.

6. Select .
   A message appears, asking you to confirm that you want to delete the resource.
7. Select **OK**.
   A message appears, confirming that the selected resource is deleted.

Search for Unplanned Resource Usage in Risks

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Risks** tab.
   The **Risks** section appears, displaying a list of available risks.
3. Select the Risk whose unplanned resource usage you want to define.
   In the **Risks** section, in the grid, in the row containing the Risk whose planned resource usage you want to define, select the link in **Unplanned Resource Usages** column.

   The **Unplanned Resource Usages** subsection for the selected risk opens.

4. Select 🔍.
   In the grid, filter boxes appear.
5. In the filter box for any column, enter search information.
   Your results appear.

Add an Unplanned Resource Usage in Risks

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Risks** tab.
   The **Risks** section appears, displaying a list of available risks.
3. Select the Risk whose unplanned resource usage you want to add.
   The risk is highlighted.
4. In the **Risks** section, in the grid, in the row containing the Risk whose planned resource usage you want to add, select the link in the **Unplanned Resource Usages** column.
   The **Unplanned Resource Usages** subsection for the selected risk opens.

5. In the **Unplanned Resource Usages** subsection, select ＋.
   The **Add New Resource Usage** datasheet appears.
6. As needed, enter values in the available fields.

7. Select 💾.

   A message appears confirming that your new resource usage has been added. Select ⟨ to return to the **Unplanned Resource Usages** subsection.

Add Existing Unplanned Resource Usage in Risks

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Risks** tab.
   The **Risks** section appears, displaying a list of available risks.
3. Select the Risk to which you want to add existing unplanned resource usage.
4. In the **Risks** section, in the grid, in the row containing the Risk to which you want to add existing unplanned resource usage, select the link in the **Unplanned Resource Usages** column.

   The **Unplanned Resource Usages** subsection for the selected risk opens.

5. Select 🔎 .
   The **New Resource Usage from Existing Resources** window appears.

6. As needed, modify the available fields.
7. Select **Finish**.
   The new resource appears on the **Unplanned Resource Usages** subsection.

Modify Unplanned Resource Usage in Risks

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Risks** tab.
   The **Risks** section appears, displaying a list of available risks.
3. Select the Risk whose unplanned resource usage you want to define.
   The risk is highlighted.
4. In the grid in the **Risks** workspace, in the row containing the Risk whose planned resource usage you want to define, select the link in the **Unplanned Resource Usages** column.
   The **Unplanned Resource Usages** grid for the selected risk opens.
5. Select the resource usage that you want to modify.
   The resource usage is highlighted.
6. Select 🖉.
   Modify the appropriate fields.
7. Select 💾.
   A message appears, confirming that the resource has been modified, and returns you to the **Unplanned Resource Usages** grid.

Delete Unplanned Resource Usage in Risks

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Risks** tab.
   The **Risks** section appears, displaying a list of available risks.
3. Select the Risk whose unplanned resource usage you want to delete.
4. In the **Risks** section, in the grid, in the row containing the Risk whose planned resource usage you want to delete, select the link in the **Unplanned Resource Usages** column.

   The **Unplanned Resource Usages** grid for the selected risk opens.
5. Select the resource usage that you want to delete.
   The resource usage is highlighted.
6. Select 🗑.
   A message appears, asking you to confirm that you want to delete the resource.
7. Select **OK**.
   A message appears, confirming that the selected resource is deleted.

Chapter

8

ASO Actions

Topics:

About ASO Actions

After you create an Action in a Asset Strategy Optimization Analysis, you can assign a single Risk or multiple Risks to that Action. When you assign a Risk to an Action, a link is created between a System Risk Assessment record, which stores the GUID of the mitigated Risk in the Risk GUID field, and the Action. This allows the Action to mitigate the Risk. An Action may mitigate a Risk by changing certain properties, such as failure consequences or the failure distribution, of the Risk.

Actions mitigate Risks in different ways depending on the type of Action that is assigned to the Risk. The different types of Actions mitigate Risks in the following ways:

- **Preventive Maintenance Action:** Can mitigate the Time to Fail (TTF) distribution of the Risk by increasing the maximum operating time of the Risk, as defined by the fields in the Distribution record that defines the TTF distribution associated with the Risk. For example, the Replace Seal Action in Scenario B of the Asset Strategy OptimizationExample of a System Reliability Analysis mitigates the Seal Failure Risk by creating more operating time by replacing the existing seals, which have a smaller amount of operating time, with new seals that have a larger amount of operating time.
- **Condition Monitor or Inspection Action:** Can mitigate the consequences of failure by fixing potential failures before they occur. This allows proactive repairs, or planned corrections, to be made to the system instead of fixing a failure using an unplanned correction. Planned corrections can consume less Resources and lower the costs of a Scenario. For example, the Vibration Analysis Action in Scenario B of the Asset Strategy Optimization Example of a System Reliability Analysis mitigates the Bearing Failure Risk by identifying a potential Bearing Failure and executing a planned correction, which requires less Resources and less Resource usage than executing an unplanned correction.
- **Special Action:** Can mitigate the failure consequences of the Risk, as defined in the Fixed Unplanned Correction Cost field of the System Risk record, and the TTF distribution, as defined by the Distribution record that represents the TTF distribution associated with the Risk. For example, the occurrence of the Redesign Impeller Action in Scenario B of the Asset Strategy Optimization Example of a System Reliability Analysis mitigates the Impeller Failure by reducing the fixed unplanned correction cost and extending the TTF distribution of the Impeller Failure Risk.

Add Actions

About This Task

Important: This procedure does not work in an **Active** scenario.

Procedure

1. Access ASO.

2. Select a scenario, and then, in the workspace, select the **Actions** tab.
   The **Actions** section appears, displaying a list of available actions.

3. In the **Actions** section, select ＋.
   The **New Action** grid appears.

   Note: You need to be in the node level of the analysis for the ＋ to activate.

4. As needed, enter values in the available fields.

5. Select 💾.
   The action is saved.

Note: In the **Proposed** scenario, a ⊕ will appear in the **Status** column to indicate that the action has been added.

Filter Actions

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Actions** tab.
   The **Actions** section appears, displaying a list of available actions.
3. Select ▽.
   In the grid, filter boxes appear.
4. In the filter box for any column, enter search information.
   Your results appear.

Show Mitigated Risks in Actions

About This Task

Show Mitigated Risks in Actions enables the user to view the Risks being mitigated by each selected Action, without having to return to the source strategy.

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Actions** tab.
   The **Actions** section appears, displaying a list of available actions.
3. Select the action whose mitigated risks you want to show.
   The action is highlighted.
4. Select **Show Mitigated Risk**.

   The mitigated risks appear. You can select ⟨ to return to the Actions section.

Next Steps

- Assign a New Risk to an Action
- Assign an Existing Risk to an Action

Assign a New Risk to an Action

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Actions** tab.
   The **Actions** section appears, displaying a list of available actions.
3. Select the action to which you want to assign a new risk.
   The action is highlighted.
4. Select **Show Mitigated Risk**.
   The mitigated risks appear.

5. Select **Assign New Risk**.
   The **Assign New Risk** grid appears.
6. As needed, enter values in the available fields.
7. Select 🖫.
   The new risk is saved.

Assign an Existing Risk to an Action

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Actions** tab.
   The **Actions** section appears, displaying a list of available actions.
3. Select the action to which you want to assign an existing risk.
   The action is highlighted.
4. Select **Show Mitigated Risk**.
   The mitigated risks appear.
5. Select **Assign Existing Risk**.
   The **Assign Existing Risk** grid appears.
6. Select the check box for each risk that you want to add.
7. Select **Submit**.
   The selected risks are added.

Modify Qualitative Consequences in Actions

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Actions** tab.
   The **Actions** section appears, displaying a list of available actions.
3. In the **Actions** section, in the grid select the action whose qualitative consequence you want to modify.
   The action is highlighted.
4. Select **Show Mitigated Risk**.
   The mitigated risks appear.
5. In the row for the qualitative consequence that you want to modify, select the link in the **Qualitative Consequence** column.
   The **Qualitative Consequence** subsection appears.
6. To edit the qualitative consequence, in the subsection, select ✏, and then modify the values in the available fields.
7. Select 🖫.
   The qualitative consequence has been modified and saved.

About Action Optimization

Action Optimization allows you to optimize a group of https://www.ge.com/digital/documentation/predix-apm/latest/reliability-analytics-system-reliability-actions.html#overview-ra-about-actions associated

with an analysis to determine the optimum interval at which to perform an inspection or preventative maintenance.

For more information, refer the https://www.ge.com/digital/documentation/predix-apm/latest/reliability-analytics-system-reliability-actions.html#about-action-optimization and https://www.ge.com/digital/documentation/predix-apm/latest/reliability-analytics-system-reliability-actions.html#run-action-optimization sections of the Reliability analytics.

Undo Actions

About This Task

Important: This procedure does not work in an **Active** scenario.

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Actions** tab.
   The **Actions** section appears, displaying a list of available actions.
3. Select the action that you want to undo.
   The action is highlighted.
4. Select ↰.
   Your action has been returned to its previous state.

Modify Action Properties

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Actions** tab.
   The **Actions** section appears, displaying a list of available actions.
3. In the **Properties** pane, select ✎ .

   Note: In the **Proposed** scenario, a ✐ will appear in the **Status** column to indicate that the action has been edited.
4. Select 💾.
   Your changes have been saved.

Delete Actions

About This Task

Important: This procedure does not work in an **Active** scenario.

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Actions** tab.

The **Actions** section appears, displaying a list of available actions.

3. Select the action you want to delete.
   The action is highlighted.

4. Select 🗑.

   Note: If the node is not selected on the correct level, the 🗑 button will not activate.
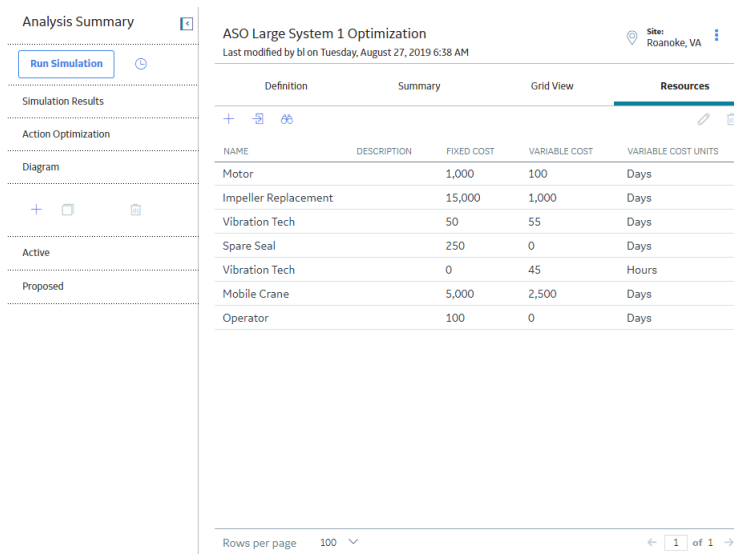
   A message appears, asking if you want to delete the action.

5. Select **Yes**.
   A message appears, confirming that the action is deleted.

   Note: In the **Proposed** scenario, a ⊖ will appear in the **Status** column to indicate that the action has been deleted.

Manage Resources in Actions

This feature enables the user to manage the Resources required to complete the risk-mitigating Actions for the scenario. The following is an example of a resource table in ASO.

Search for a Resource in Actions

Procedure

1. Access ASO.

2. Select a scenario, and then, in the workspace, select the **Actions** tab.
   The **Actions** section appears, displaying a list of available actions.

   Note: Actions will only appear in the grid if the attached asset strategy is not in a draft state.

3. In the row for the action that you want to search for resources, select the link in the **Resource Usage** column.
   The **Resource Usage** subsection appears.

4. Select ▽.
   In the grid, filter boxes appear.

5. In the filter box for any column, enter search information.
Your results appear.

Add a Resource to Your Action

Before You Begin

This procedure will work in both Active and Proposed scenarios.

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Actions** tab.
The **Actions** section appears, displaying a list of available actions.
3. In the row for the action to which you want to add resources, select the link in the **Resource Usage** column.
The **Resource Usage** subsection appears.
4. In the **Resource Usage** subsection, select ╋.
The **Add New Resource Usage** datasheet appears.
5. As needed, enter values in the appropriate fields. When finished, select 🖫.
The new resource is added to the action.

Add an Existing Resource in Actions

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Actions** tab.
The **Actions** section appears, displaying a list of available actions.
3. In the row for the action to which you want to add resources, select the link in the **Resource Usage** column.
The **Resource Usage** subsection appears.
4. Select ⟳ .
The **New Resource Usage from Existing Resources** window appears.
5. Enter values in the available fields, and then select **Finish**.
Your new action appears in the **Resource Usage** subsection.

Modify Resources in Actions

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Actions** tab.
The **Actions** section appears, displaying a list of available actions.
3. In the row for the action whose resources you want to modify, select the link in the **Resource Usage** column.
The **Resource Usage** subsection appears.
4. Select the resource that you would like to modify.
The resource is highlighted.

5. Select ✏️ .
   The **Edit Resource Usage** subsection appears.

6. As needed, modify the values in the available fields, and then select 💾.
   A message appears, confirming that the resource has been modified.

Delete a Resource in Actions

Procedure

1.
2. Select a scenario, and then, in the workspace, select the **Actions** tab.
   The **Actions** section appears, displaying a list of available actions.
3. In the row for the action from which you want to delete a resource, select the link in the **Resource Usage** column.
   The **Resource Usage** subsection appears.
4. Select the resource that you want to delete.
   The resource is highlighted.
5. Select 🗑️.
   A message appears, asking you to confirm that you want to delete the resource.
6. Select **OK**.
   A message appears, confirming that the resource has been deleted.

Chapter

9

ASO Global Events in a Scenario

Topics:

About Global Events in a Scenario

A Global Event is an optional component of a Scenario that groups together Actions requiring a shutdown so that they will be performed at the same time, thereby maximizing availability. Global Events may be either date-driven or Action-driven.

A Global Event is an optional component of an Asset Strategy Optimization Scenario that groups together Actions requiring a system shutdown so that they will be performed at the same time, thereby maximizing the availability of the system.

When you create a Global Event, you select Actions that may be rescheduled and performed as part of the Global Event. The execution of the selected Actions is called a Global Event. To be performed with the Global Event, Actions must occur during the time period defined by the Max Delay and Max Advance values in the System Global Event record. Actions assigned to the Global Event that are performed outside of this time period will not be included in the Global Event, and their occurrence is not affected by the occurrence of the Global Event. The next occurrence of any recurring Actions that have been rescheduled and performed as part of a Global Event will be performed according to the values in the Interval and Interval Units fields in the Asset Strategy Optimization Action record.

Search for Global Events

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Global Events** tab.
   The **Global Events** section appears.
3. Select 🔍.
   In the grid, filter boxes appear.
4. In the filter box for any column, enter search information.
   Your results appear.

Add Global Events

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Global Events** tab.
   The **Global Events** workspace appears.
3. In the **Global Events** section, select ＋.
   The **New Global Event** datasheet appears.
4. As needed, enter values in the available fields.
5. Select 💾.

   Your new global event is added. To return to your analysis, select ＜.

Align Actions in ASM

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Global Events** tab.
   The **Global Events** workspace appears.
3. In the **Global Events** section, in the grid, select the global event you want to align.
   The selected global event is highlighted.
4. Select **Show Actions to Align**.
   The **Align Actions** subsection appears.
5. Select **Add/Edit Actions**.
   The **Actions** grid appears with available Actions listed on the left.
6. In the **Select Actions From** grid, select the check box next to each action that you want to assign to your global event.
   The actions are highlighted.
7. Select ⬆.
   A message appears, confirming the actions were moved, and the actions appear in the **Selected Actions** grid.
8. When finished, select ‹ to return to the **Global Events** section.

Modify Global Events

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Global Events** tab.
   The **Global Events** section appears.
3. In the **Global Events** section, in the grid, select the global event that you want to modify.
   The event is highlighted.
4. Select ✎.
   The **Edit Global Event** datasheet appears.
5. As needed, enter values in the available fields.
6. Select 💾.

   Your global event has been modified and saved. To return to your analysis, select ‹.

Delete Global Events

Procedure

1. Access ASO.
2. Select a scenario, and then, in the workspace, select the **Global Events** tab.
   The **Global Events** section appears.
3. In the **Global Events** section, in the grid, select the global event that you want to delete.

The event is highlighted.

4. Select 🗑.

A message appears, asking you to confirm that you want to delete the global event.

5. Select **Yes**.

A message appears, confirming that the global event is deleted.

Chapter
10

Simulations

Topics:

About Simulations

For a proposed scenario in ASO to be adopted into a strategy in ASM it is necessary to ensure that what the user is viewing in ASM represents the latest scenario data from ASO. The view from ASM is updated automatically each time a simulation is run. If the strategy in ASM does not represent the latest modifications in the proposed ASO scenario the user will be prompted of the need to rerun the simulation. It will not be possible to propose changes to the linked strategy until this is done.

The Run Simulation feature enables the user to exercise the scenarios created in ASO to the defined timeframe. Using a Monte Carlo simulation engine, when complete the user will be presented with a set of results which are based on a most probable outcome within a defined level of confidence. Before a simulation can be successfully run, all mandatory data fields must be fully populated.

About the ASO Simulation Results Workspace

When you run a Monte Carlo simulation, the APM system analyzes statistics about cost, performance, and reliability from the iterations of the Scenarios to calculate the simulation results.

The data is presented in the **Analysis Summary** workspace and the Asset Strategy Optimization Simulation Results workspace for the selected Asset Strategy.

The **ASO Simulation Results** workspace displays the following information:

Elements

This section displays specific results for the elements that exist in the simulation. The following columns of information are displayed in the grid:

- **Element:** Displays a hierarchy that lists the components in the simulation.
- **Failures:** The average number of times the selected item failed during the analysis period for all iterations of the Scenario to which it belongs.
- **Downtime (Days):** The average number of days that the selected item was out of service due to failures or shutdowns for all iterations of the Scenario to which it belongs.
- **Cost ($):** The average total cost of the selected item for all iterations of the Scenario to which it belongs. This includes the cost of any items that belongs to the item, lost production costs, fixed costs, variable costs, action costs, planned or unplanned correction costs, and Resource costs.
- **Action Cost:** The total average expended cost due to Planned Maintenance Actions occurring over the simulation period.
- **Lost Production Cost (USD):** The average total cost of lost production over the analysis period as a result of downtime for the selected equipment and action.
- **Planned Correction Cost (USD):** The average total maintenance cost of planned corrections over the analysis period. A planned correction takes place to mitigate the occurrence of a Risk.
- **Unplanned Correction Cost (USD):** The average total maintenance cost of unplanned corrections over the analysis period. Note, An unplanned correction takes place following the occurrence of a Risk.
- **Risk:** The total of all Unmitigated Risk values for the simulation period.
- **Environment Risk:** The total of Unmitigated Environmental Risk values for the simulation period.
- **Operations Risk:** The total of Unmitigated Operations Risk values for the simulation period.
- **Safety Risk:** The total of Unmitigated Safety Risk values for the simulation period.
- **Availability (%):** The average percentage of the time that the selected item was available and running for the Scenario to which it belongs.

- **Next Failure (Days):** The average amount of time, in days, from the analysis Start Date until the next failure occurs for the selected item.
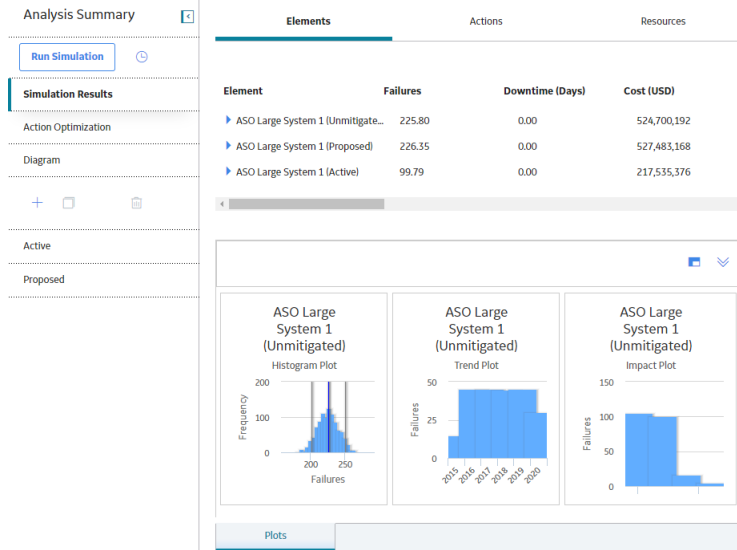
Actions

This section displays specific results for each action that exists in the simulation. The following columns of information are displayed in the grid:

- **Action:** Provides a hierarchy that displays the actions that exist in a simulation. The actions appear below the element in the diagram to which they belong.
- **Occurrences:** The average number of occurrences of the action from all iterations of the Scenario to which it belongs.
- **Cost ($):** The average cost of the action, including any Resources used by the action, for the Scenario to which it belongs.
- **Detected Failures:** The average number of potential failures detected in advance by the action. This result is calculated only for inspection and condition monitoring actions, which are the only actions that can detect potential failures.

Resources

This section displays specific results for each Resource that exists in a System Reliability Analysis. The following columns of information are displayed in the grid:

- **Resource:** Displays a hierarchy that shows the Resources that exist in the selected simulation. The Resources appear below the Scenario to which they belong.
- **Occurrences:** The average number of times the Resource is used during the simulation period.

  Note: For System Resource records in which the Count Occurrences field is set to False, the value in this column will be 0 (zero).
- **Time (Days):** The average amount of time, in days, accumulated by the Resource.
- **Cost ($):** The average cost accrued by the Resource.
- **Planned Correction Resource Cost (USD):** The resource cost incurred while conducting planned maintenance.
- **Unplanned Correction Resource Cost (USD):** The resource cost incurred while conducting unplanned maintenance.

By selecting a cell in any of these three sections, you can view more detailed information in the following graphs:

Histogram

While the grids in the Simulation Results workspace display average values, it can be helpful to understand the specific values that were used to calculate the averages. The Histogram Plot shows the distribution of the actual values from all iterations that were used to calculate the average value.

The distribution of the actual values spreads across a series of data ranges, which are called bins and are represented by columns on the Histogram Plot. When an actual value from an iteration falls into a bin, it is included in the associated column. The higher the column is in the chart, the more values have fallen into the bin.

Note: The number of columns that appear in the Histogram Plot is determined by the value in the Histogram Bins field in the root System Analysis record.
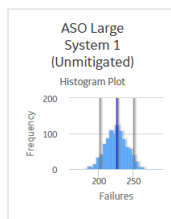
Additional values are represented by the following lines in the Histogram Plot:

Optimistic Value: Leftmost gray vertical line in the Histogram Plot. This line represents the lower level of the confidence interval.

Realistic Value: Blue line in the Histogram Plot. This line represents the median value, which is the median value of the values from the iterations of the Scenario.

Note: If the median value falls in between two values, then the larger value will be used as the Realistic value.

Pessimistic Value: Rightmost gray vertical line in the Histogram Plot. This line represents the upper level of the confidence interval.

Trend

While the grids in the Simulation Results workspace display average values, understanding the specific values that make up the average can be helpful as well. The Trend Plot shows the average value for each analysis time interval, as defined by the value in the Time Analysis Type field in the root System Analysis record. If the Time Analysis Type field is set to:

- **Yearly:** The Cost Trend Plot will display the Cost Trend for each year in the simulation period.
- **Monthly:** The Cost Trend Plot will display the Cost Trend for each month in the simulation period.
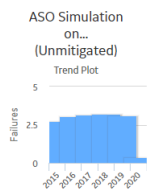
Impact

While the grids in the Simulation Results workspace display average values, understanding the values that make up the average can be helpful as well. The Impact Plot shows how the average failure value is calculated as a total of the individual Risk failure averages.

Note: This plot is not shown for the Reliability column in the Elements, Actions, or Resources section.

Important:

If the analysis does not have complete, valid information for the simulation, a message will appear, indicating that the information in the simulation needs to be corrected. The incorrect fields will be highlighted in red until the simulation has been corrected and saved.

Maintaining Synchronization between the Asset Strategy and the Linked Analysis in ASO

When the optimization process is initiated from ASM, the contents of the Asset Strategy are transferred to the ASO module and the strategy in ASM is placed in Simulation mode. An Active scenario and a proposed scenario are then created in ASO.

The purpose of the Active scenario is to retain a visible record of the source strategy in ASO, for comparison purposes, while the proposed scenario provides a copy to be modeled under various proposed changes, the results of which will be shown in the simulation results, and in ASM.

When changes are made to the source strategy in ASM or to the proposed scenario in ASO, these are not immediately reflected in the linked module, i.e., synchronization is not automatic. The contents of the two modules are synchronized each time a Monte Carlo simulation is run.

When a simulation run is initiated all scenarios (Active, Proposed and copies) are subjected to Monte Carlo simulation, for which valid simulation data will need to be added via the scenario grids. If insufficient or invalid data is preventing simulation from running the user is taken to each scenario in turn to complete the necessary data, with mandatory entries being indicated by a red icon and a count showing on the scenario tab in the left navigation pane.

When the simulation run has been completed the contents of the proposed scenario are reflected in ASM, which is placed in a modified state. If initial synchronization, based on the proposed scenario in ASO, has not taken place, or the proposed scenario has been modified in ASO since the last simulation run, the user will not be permitted to make changes to the source strategy in ASM via Risk Analysis. Here the user will be notified on Risk Analysis and Review Strategy pages of the need to rerun the simulation and a hyperlink provided on these pages to initiate the Simulation run.

Note: The above restrictions on modifying a strategy in ASM do not apply to the Risk and Actions pages. Any additions or modifications to actions and Risks will be captured in the Active and Proposed scenarios in ASO when the user selects **Run Simulation** in ASM. It is important that the hyperlink provided in the Risk Analysis and Review Strategy pages in ASM is used at this point since changes in ASM will not be captured if the Simulation is run from ASO. If the user chooses to run the Simulation from ASO the modified strategy will be overwritten with the simulation results from the proposed scenario before these changes had been captured and run in the ASO Analysis.

Run a Simulation in ASO

Procedure

1. Access ASO.
2. In the pane, select **Run Simulation**.
   Below the **Run Simulation** button, a progress bar appears, displaying the progress of the simulation.

   Note: Underneath the progress bar, you have the option to end the simulation by selecting ✕.

   Important:

   If the analysis does not have complete, valid information for the simulation, a message will appear, indicating that the information in the simulation needs to be corrected. The incorrect fields will be highlighted in red until the simulation has been corrected and saved.

Rerun an ASO Simulation in ASM

About This Task

When an Asset, System or Unit strategy is in simulation mode the charts in the **Risk Analysis** and **Review Strategy** pages reflect the results of the last simulation for the proposed scenario in ASO, in turn derived from the strategy in ASM. Any changes to the strategy will therefore render the chart views out of date and it will be necessary to rerun the simulation to update them.

Procedure

1. Access the **ASM Overview** page.
2. Select an asset strategy that has been optimized.

   Note: When making changes to an Asset Strategy, the changes will only be reflected in the linked optimization scenarios when the simulation has been rerun.

   The **Strategy Details** workspace for the selected asset strategy opens.

3. As needed, modify the asset strategy, and then select 💾.
4. In the pane, select the **Review Strategy** tab.
   The **Review Strategy** workspace appears.

5. At the top of the workspace, underneath the name of the strategy, a message appears, indicating that the values for the simulation have been modified.
   To rerun your simulation, select **Run Simulation**.
6. In a new tab, the ASO Analysis Summary appears, and the simulation automatically runs.

   Important:

   If the analysis does not have complete, valid information for the simulation, a message will appear, indicating that the information in the simulation needs to be corrected. The incorrect fields will be highlighted in red until the simulation has been corrected and saved.

Chapter

11

Deployment and Upgrade

Topics:

Deployment

Deployment

Refer to the deployment information here Deploy ASO for the First Time.

Upgrade

Upgrade

Refer to the upgrade information here Upgrade or Update ASO to V5.1.4.0.0.

Chapter

12

Reference

Topics:

General Reference

ASO Site Filtering

In Asset Strategy Optimization, users will only see global data and strategy data related to their assigned sites.

Tip: For more information, refer to the Site Filtering section of the documentation.

When asset and unit strategies are optimized in ASO, the ASO analyses are locked with the site they inherit from the strategy. So, once the ASO analysis inherits a strategy, subsequent strategies added to that analysis must be of the same site.

If you have optimized a global strategy, you cannot add an asset with a site if the strategy has already been optimized.

Example

Consider an organization that has three sites, Site X, Site Y, and Site Z. The following strategies receive the specified site assignments:

- Strategy 1: Assigned to Site X
- Strategy 2: Assigned to Site Y
- Strategy 3: Assigned to Site Z

Scenario 1: User assigned to only Site X

When creating an ASO analysis, the user will only be able to assign the ASO analysis to Site X and will only be able to add strategies of the same site if it is a system or unit strategy being optimized.

Scenario 2: User assigned to both Site X and Site Y

When creating an ASO analysis, the user will be able to assign the ASO analysis to Site X or Y and will only be able to add strategies of the same site to that ASO analysis.

Scenario 3: User with access to all sites

When creating an ASO analysis, the user will be able to assign the ASO analysis to Site X, Y, or Z, and will only be able to add strategies of the same site to that ASO analysis.

ASO URLs

There is one URL route associated with Asset Strategy Optimization: **/strategy/aso**. The following table describes the various paths that build on the route, and the elements that you can specify for each.

ASM URLs

Element	Description	Accepted Value(s)	Notes
<AnalysisKey>	Specifies which ASO Analysis that you want to view.	The Entity Key of the selected System Analysis Record.	
<Summary>	Identifies the page that you want to display.	Analysis	When the analysis appears, the **Analysis** workspace page is displayed by default.

Example URLs

Example URL	Destination
/strategy/asm/aso/analysis/64253128637/summary	Opens the ASO Analysis containing the System Analysis record with the Entity Key 64253128637.

ASO Data Model

The following diagram illustrates how the families are related to one another within the ASO data model. Boxes and arrows represent entity families, relationship families, and associated relationship definitions. Note that in the following image:

- Gray arrows and boxes represent families that exist in the ASO data model but are not currently used in any ASO workflows. These may require customization.
- Black arrows and boxes families that are configured in the baseline database. These do not require customization for baseline usability.

System Analysis data model diagram showing entity relationships:

- **Unit Strategy** —Has Associated Strategy→ **System Analysis**
- **System Strategy** —Has Associated Strategy→ **System Analysis**
- **Asset Strategy** —Has Associated Strategy→ **System Analysis**
- **Equipment and Functional Location** —Has Reliability→ **System Analysis**
- **System Analysis** —Has System Resources→ **System Resource**
- **Equipment and Functional Location** —Has Recommendations→ **Reliability Recommendation** —Has Recommendations→ **System Analysis**
- **System Analysis** —Has System Results→ **System Element Result**
- **System Analysis** —Has System Results→ **System Action Result**
- **System Analysis** —Has System Results→ **System Resource Result**
- **System Analysis** —Has Scenarios→ **System Scenario**
- **System Scenario** —Has Root System→ **System SubSystem (Diagram)**
- **System SubSystem (Diagram)** —Has System Elements→ **System SubSystem (Subsystem)**
- **System SubSystem (Diagram)** —Has Global Events→ **System Global Event**
- **System SubSystem (Diagram)** —Has System Elements→ **System Sensor**
- **System SubSystem (Diagram)** —Has System Elements→ **System Buffer**
- **System SubSystem (Diagram)** —Has System Elements→ **System Link**
- **System SubSystem (Diagram)** —Has System Elements→ **System Asset**
- **System Link** —Has System Actions→ **System Action**
- **System Action** —Has Resource Usages→ **System Resource Usage**
- **System Action** —Has System Optimization→ **System Action Optimization**
- **System Action** —Has Risk Assessments→ **System Risk Assessment**
- **System Risk Assessment** —Has Mitigated TTF Distribution→ **Distribution**
- **System Asset** —Has System Risks→ **System Risk**
- **System SubSystem (Diagram)** → **System Switch**
- **System Switch** —Has System Risks→ **System Risk**
- **System Switch** —Has System Actions→ **System Action**
- **System Action** —Has Resource Usages→ **System Resource Usage**
- **System Action** —Has System Optimization→ **System Action Optimization**
- **System Action** —Has Risk Assessments→ **System Risk Assessment**
- **System Risk Assessment** —Has Mitigated TTF Distribution→ **Distribution**
- **System Risk** —Has TTF Distribution→ **Distribution**
- **System Risk** —Has TTR Distribution→ **Distribution**
- **System Risk** —Has Planned Resource Usages→ **System Resource Usage**
- **System Risk** —Has Unplanned Resource Usages→ **System Resource Usage**
- **System Risk** (right) —Has TTF Distribution→ **Distribution**
- **System Risk** (right) —Has TTR Distribution→ **Distribution**
- **System Risk** (right) —Has Planned Resource Usages→ **System Resource Usage**
- **System Risk** (right) —Has Unplanned Resource Usages→ **System Resource Usage**

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While interpreting the image, note that:

- While only one System Scenario box appears in the image, each ASO Analysis will contain multiple System Scenario records.
- The image contains two System SubSystem boxes because in an ASO Analysis, System SubSystem records serve two purposes:
  - They identify the Diagram. Each ASO Analysis contains only one Diagram, but per Scenario, the database contains two separate System SubSystem records to represent this Diagram. In other words, for each Scenario that exists in the analysis, the set of System SubSystem records that represent the Diagram is duplicated. So, for an analysis that contains only an Active Scenario and Proposed Scenario, four identical System Subsystem records will exist. Two of the records will be linked to the Active Scenario record, and two of them will be linked to the Proposed Scenario record. Whenever a change is made to the properties of the Diagram itself, the APM system updates all System SubSystem records that represent the Diagram so that they are always identical.

    Note: The APM system creates two identical System subsystem records to represent the Diagram because the ASO and Reliability Analysis modules share code and in Reliability Analysis, each analysis can have multiple Diagrams.
  - They identify subsystems within the Diagram. In an ASO Analysis, the Diagram can contain multiple subsystems. Per Scenario, the database contains two separate System SubSystem records to represent a single subsystem in the Diagram. In other words, for each Scenario that exists in the analysis, the set of System SubSystem records that represent a subsystem within the Diagram is duplicated. So, for an analysis that contains only an Active Scenario and a Proposed Scenario, if the Diagram contains only one subsystem, four identical System SubSystem records will exist to represent this subsystem. Two of the records will be linked to the Active Scenario record, and two of them will be linked to the Proposed Scenario record. Whenever a change is made to the properties of the subsystem element via the Diagram, the APM system updates all System SubSystem records that represent that subsystem so that they are always identical.

    In other words, because each ASO Analysis must have an Active Scenario and a Proposed Scenario at all times, each ASO Analysis will contain at least four System SubSystem records, where these System SubSystem records represent the Diagram. Two of these records will be linked to the Active Scenario record, and two of them will be linked to the Proposed Scenario record. As additional Scenarios are created, other identical sets of System SubSystem records are created and linked to those Scenario records to represent the Diagram. In addition, if the Diagram includes subsystems, per Scenario, the ASO Analysis will contain two additional System SubSystem records to represent those subsystems.
- The System SubSystem family is related to the System SubSystem family through the Has System Elements relationship. In the image, the System SubSystem box that contains the text Diagram in parentheses represents the Diagram. The System SubSystem box that contains the text Subsystem in parentheses represents subsystems within the Diagram. This distinction is made so that you can see that the System Global Event record is linked to the System SubSystem records that represents the Diagram.

  Note: In ASO Analyses, all System SubSystem records are linked to the successor System Element records. The boxes are separated in the image only to clarify the Has Global Events relationship.

ASO Records

ASO Records

The following tables provide alphabetical lists and descriptions of the fields that exist in Asset Strategy Optimization. The information in the tables reflect the baseline state and behavior of these fields.

This family is enabled for site filtering, which means that records in this family can be assigned to a specific site and will only be accessible to users who are assigned to the same site and have the appropriate license and family privileges. For more information, refer to the Sites section of the documentation.

Note: The site key for an ASO analysis is locked with the site key of the strategy. You can only import asset and system strategies of the same site as the analysis.

System Condition Monitor

System Condition Monitor records store details about continuous, condition-based maintenance Actions. The following table provides an alphabetical list and description of the fields that exist for the System Condition Monitor family. The information in the table reflects the baseline state and behavior of these fields.

Field	Data Type	Description	Behavior and Usage
Action Cost	Number	A number that specifies the cost associated with any materials or personnel needed to complete the Action. For System Condition Monitor records, this value represents a one-time expense that is incurred when the Action is started. By default, this field contains the value 0.	On the System Condition Monitor datasheet, this field appears as a text box. You can remove the default value and enter a number directly in the **Action Cost** cell.
Action Type	Character	The category into which the Action can be classified. By default, this field contains the value Condition-Based Maintenance (Predictive) (CM) .	This field is disabled on the System Condition Monitor datasheet.
Condition Monitoring Type	Character	Indicates whether the Action occurs continuously or periodically. By default, this field contains the value Continuous.	This field is disabled on the System Condition Monitor datasheet.
Description	Text	Additional information about the Action.	On the System Condition Monitor datasheet, this field appears as a text box with a button. You can enter you own value directly in the **Description** cell or select the button to view the Text Editor.

Field	Data Type	Description	Behavior and Usage
Detection Probability	Number	A number representing the probability that the Action will identify a potential failure resulting from any Risk assigned to that Action and correct the potential failure.	On the datasheet, this field appears as a box labeled **Detection Probability (%)**. You remove the default value and enter a number directly in the cell. For an Action with no assigned Risks, any value stored in this field will be ignored. For example, a System Condition Monitor record with the Detection Probability value 50 has a 50% chance of identifying a potential failure resulting from a Risk. In other words, the Action will detect one out of two potential failures resulting from any Risks assigned to the Action. By default, this field contains the value 100.
GUID	Character	A value that uniquely identifies the record within an ASO Analysis. The value that exists in this field is generated automatically by APM and should not be modified as it is required for the proper functioning of ASO.	By default, this field is disabled and not included on the datasheet.
Mandatory	Logical	This field is not used in ASO.	N/A
Name	Character	The name of the Action.	On the datasheet, this field appears as a text box. You can enter your own value directly in the Name cell. This value is used to identify Actions in ASO Analyses. For instance, by default the **Name** column appears in the grid in the **Actions** pane for the Asset Strategy Optimization **Scenarios - Actions** page and displays values that exist in the Name field to identify the System Action records that are displayed in the grid.

System Inspection

System Inspection records store details about periodic, condition-based maintenance Actions. The following table provides an alphabetical list and description of the fields that exist for the System Inspection family. The information in the table reflects the baseline state and behavior of these fields. This list is not comprehensive.

Field	Data Type	Description	Behavior and Usage
Action Cost	Number	A number that specifies the cost associated with any materials or personnel needed to complete the Action. For System Inspection records, this value represents an expense that is incurred every time the Action occurs. By default, this field contains the value 0.	On the System Inspection datasheet, this field appears as a text box. You can remove the default value and enter a number directly in the **Action Cost** cell.
Action Type	Character	The category into which the Action can be classified. By default, this field contains the value Condition-Based Maintenance (Predictive) (CM).	This field is disabled on the System Inspection datasheet.
Condition Monitoring Type	Character	Indicates whether the Action occurs continuously or periodically. By default, this field contains the value Periodic.	This field is disabled on the System Inspection datasheet.
Description	Text	Additional information about the Action.	On the System Inspection datasheet, this field appears as a text box with a button. You can enter you own value directly in the Description cell or select the button to view the Text Editor.

Field	Data Type	Description	Behavior and Usage
Detection Probability	Number	A number representing the probability that the Action will identify a potential failure resulting from any Risk and correct that failure before it occurs. For an Action with no assigned Risks, any value stored in this field will be ignored.	On the System Inspection datasheet, this field appears as a box labeled **Detection Probability** (%). You can remove the default value and enter a number directly in the cell. An Action can detect a potential failure only when the Action occurs during a Risk's PF Interval, as defined by the value in the PF Interval and PF Interval Units fields in the System Risk record. If the Action does not occur during the PF Interval, the Action cannot identify the potential failure, and the value in the Detection Probability field will be ignored. To make the Action occur during the PF Interval of a Risk, you can manually modify the values in the PF Interval and PF Interval Units fields of the System Risk record, or you can optimize the Action. For example, setting the Detection Probability to 50 would indicate that the Action has a 50% chance of identifying a potential failure resulting from any risk if the Action occurs during the PF Interval of the Risks. In other words, the Action will detect one out of two potential failures resulting from any Risks assigned to the Action when the Action occurs during the PF Interval of the Risks.

Field	Data Type	Description	Behavior and Usage
Duration	Number	A number that, combined with the value in the Duration Units field, identifies the total time required to complete the Action. For example, if the value in the Duration field is 4 and the value in the Duration Units field is Hours, then the Action will take four hours to complete. This field contains the value 0 by default.	On the System Inspection datasheet, this field appears as a text box. You can remove the default value and enter your own value directly in the Duration cell.
Duration Units	Character	The time units associated with the value in the Duration field. By default, this field contains the value Days.	On the System Inspection datasheet, this field appears as a list with a blank caption and contains the following units: Minutes, Hours, Days, Weeks, Months, or Years. You can select a value from this list.
GUID	Character	A value that uniquely identifies the record within an ASO Analysis. The value that exists in this field is generated automatically by the APM system and should not be modified as it is required for the proper functioning of ASO.	This field is disabled and not included on the datasheet by default.
Interval	Number	A number that, combined with the value in the Interval Units field, indicates how often the Action will occur. For example, if the value in the Interval field is 4 and the value in the Interval Units field is Months, then the Action will occur every four months during the simulation period. This field contains the value 1 by default.	On the System Inspection datasheet, this field appears as a text box. You can remove the default value and enter your own value directly in the **Interval** cell.
Interval Units	Character	The time units associated with the value in the Interval field. By default, this field contains the value Days.	On the System Inspection datasheet, this field appears as list with a blank caption and contains the following units: Minutes, Hours, Days, Weeks, Months, or Years.
Mandatory	Logical	This field is not used in ASO.	N/A

Field	Data Type	Description	Behavior and Usage
Name	Character	The name of the Action.	On the System Inspection datasheet, this field appears as a text box. You can enter your own value directly in the **Name** cell. This value is used to identify Actions in the ASO Analyses. For instance, the **Name** column appears by default in the grid in the **Actions** pane on the Asset Strategy Optimization **Scenarios** - **Actions** page and displays values that exist in the Name field to identify the System Action records that are displayed in the grid.

Field	Data Type	Description	Behavior and Usage
One Time Action	Logical	Indicates whether the Action will occur one time or will be repeated more than once.	On the System Inspection datasheet, this field appears as a check box labeled **One Time Action**. This check box is cleared by default, indicating that the Action will occur more than once. You can select this check box to indicate that an Action will occur one time. For example, an Action to inspect the vibration level of a pump might occur several times a year. In this case, the **One Time Action** check box in the corresponding System Inspection record would be clear. An Action to inspect a newly installed pump for any installation errors might occur only once, however, in which case the **One Time Action** check box in the corresponding System Inspection record would be selected.

Field	Data Type	Description	Behavior and Usage
Shutdown Required	Logical	Indicates whether the Action requires the piece of equipment or location to be shut down in order for the Action to be completed or can be completed while the piece of equipment or location is running.	On the System Inspection datasheet, this field appears as a check box labeled Shutdown Required. This check box is clear by default, indicating that the piece of equipment or location does not need to be shut down for the Action to be completed. You select this check box to indicate that the piece of equipment or location must be shut down for the Action to be completed. For example, an Action to inspect the vibration level of a pump could be completed while the pump is running, so the **Shutdown Required** check box would be clear. An Action to inspect the internal components of a pump would be completed while the pump is not running, so the **Shutdown Required** check box would be selected.

System Preventative Maintenance

System Preventive Maintenance records store information about time-based maintenance Actions. The following table provides an alphabetical list and description of the fields that exist for the System Preventive Maintenance family. The information in the table reflects the baseline state and behavior of these fields.

Field	Data Type	Description	Behavior and Usage
Action Cost	Number	A number that specifies the cost associated with any materials or personnel needed to complete the Action. For System Preventive Maintenance records, this value represents an expense that is incurred every time the Action occurs.	On the System Preventive Maintenance datasheet, this field appears as a text box. You can remove the default value and enter a number directly in the **Action Cost** cell.
Action Type	Character	The category into which the Action can be classified. By default, this field contains the value Time-Based Maintenance (Preventive) (PM).	This field is disabled on the System Preventive Maintenance datasheet.
Condition Monitoring Type	Character	This field is not used for System Preventive Maintenance records.	This field is disabled on the System Preventive Maintenance datasheet.
Description	Text	Additional information about the Action.	On the System Preventive Maintenance datasheet, this field appears as a text box with a button. You can enter you own value directly in the **Description** cell or select the button to view the Text Editor.
Duration	Number	A number that, combined with the value in the Duration Units field, identifies the total time required to complete the Action. For example, if the value in the Duration field is 4 and the value in the Duration Units field is Hours, then the Action will take four hours to complete. By default, this field contains the value 0.	On the System Preventive Maintenance datasheet, this field appears as a text box. You can remove the default value and enter your own value directly in the **Duration** cell.
Duration Units	Character	The time units associated with the value in the Duration field.	On the System Preventive Maintenance datasheet, this field appears as a list with a blank caption and contains the following options: Minutes, Hours, Days, Weeks, Months, and Years.

Field	Data Type	Description	Behavior and Usage
GUID	Character	A value that uniquely identifies the record within an ASO Analysis. The value that exists in this field is generated automatically by the APM system and should not be modified as it is required for the proper functioning of ASO.	By default, this field is disabled and not included on the datasheet.
Interval	Number	A number that, combined with the value in the Interval Units field, indicates how often the Action will occur. For example, if the value in the Interval field is 4 and the value in the Interval Units field is Months, then the Action will occur every four months during the simulation period. By default, this field contains the value 1.	On the System Preventive Maintenance datasheet, this field appears as a text box. You can remove the default value and enter your own value directly in the **Interval** cell.
Interval Units	Character	The time units associated with the value in the Interval field.	On the System Preventive Maintenance datasheet, this field appears as list with a blank caption and contains the following options: Minutes, Hours, Days, Weeks, Months, and Years.
Mandatory	Logical	This field is not used in ASO.	N/A
Name	Character	The name of the Action.	On the System Preventive Maintenance datasheet, this field appears as a text box. You can enter your own value directly in the **Name** cell. This value is used to identify Actions in the ASO Analyses. For instance, the **Name** column appears by default in the grid in the Actions pane on the Asset Strategy Optimization **Scenarios - Actions** page and displays values that exist in the Name field to identify the System Action records that are displayed in the grid.

Field	Data Type	Description	Behavior and Usage
One Time Action	Logical	Indicates whether the Action will occur one time or will be repeated more than once.	On the System Preventive Maintenance datasheet, this field appears as a check box labeled **One Time Action**. By default, this check box is cleared, indicating that the Action will occur more than once. You can select this check box to indicate that an Action will occur only once. For example, an Action to inspect the vibration level of a pump might occur several times a year. In this case, the **One Time Action** check box in the corresponding System Inspection record would be cleared. An Action to inspect a newly installed pump for any installation errors might occur only once, however, in which case the **One Time Action** check box in the corresponding System Inspection record would be selected.

Field	Data Type	Description	Behavior and Usage
Shutdown Required	Logical	Indicates whether the Action requires the piece of equipment or location to be shut down for the Action to be completed.	On the System Preventive Maintenance datasheet, this field appears as a check box labeled **Shutdown Required**. By default, this check box is cleared, indicating that the piece of equipment or location does not need to be shut down for the Action to be completed. You can select this check box to indicate that the piece of equipment or location must be shut down for the Action to be completed. For example, an Action to inspect the vibration level of a pump could be completed while the pump is running, so the **Shutdown Required** check box would be clear. An Action to inspect the internal components of a pump would be completed while the pump is not running, so the **Shutdown Required** check box would be selected.

System Special Action

System Special Action records store information about procedural, redesign, or training Actions. The following table provides an alphabetical list and description of the fields that exist for the System Special Action records. The information in the table reflects the baseline state and behavior of these fields.

Field	Data Type	Description	Behavior and Usage
Action Cost	Number	A number that specifies the cost associated with any materials or personnel needed to complete the Action. For System Special Action records, this value represents an expense that is incurred every time the Action occurs.	On the System Special Action datasheet, this field appears as a text box. You can remove the default value and enter a number directly in the **Action Cost** cell.
Action Type	Character	The category into which the Action can be classified.	This field is disabled on the System Special Action datasheet.
Condition Monitoring Type	Character	This field is not used for System Special Action records.	This field is disabled on the System Special Action datasheet.

Field	Data Type	Description	Behavior and Usage
Description	Text	Additional information about the Action.	On the System Special Action datasheet, this field appears as a text box with a button. You can enter you own value directly in the Description cell or select the button to view the Text Editor.
Duration	Number	A number that, combined with the value in the Duration Units field, identifies the total time required to complete the Action. For example, if the value in the Duration field is 4 and the value in the Duration Units field is Hours, then the Action will take four hours to complete. By default, this field contains the value 0.	On the System Special Action datasheet, this field appears as a text box. You can remove the default value and enter your own value directly in the Duration cell.
Duration Units	Character	The time units associated with the value in the Duration field.	On the System Special Action datasheet, this field appears as a list with a blank caption and contains the following options: Minutes, Hours, Days, Weeks, Months, and Years.
GUID	Character	A value that uniquely identifies the record within an ASO Analysis. The value that exists in this field is generated automatically by the APM system and should not be modified as it is required for the proper functioning of ASO.	This field is disabled and not included on the datasheet by default.
Interval	Number	A number that, combined with the value in the Interval Units field, indicates how often the Action will occur. For example, if the value in the Interval field is 4 and the value in the Interval Units field is Months, then the Action will occur every four months during the simulation period. By default, this field contains the value 1.	On the System Special Action datasheet, this field appears as a text box. You can remove the default value and enter your own value directly in the **Interval** cell.

Field	Data Type	Description	Behavior and Usage
Interval Units	Character	The time units associated with the value in the Interval field.	On the System Special Action datasheet, this field appears as list with a blank caption and contains the following options: Minutes, Hours, Days, Weeks, Months, and Years.
Mandatory	Logical	This field is not used in ASO.	N/A
Name	Character	The name of the Action.	On the System Special Action datasheet, this field appears as a text box. You can enter your own value directly in the **Name** cell. This value is used to identify Actions in ASO Analyses. For instance, the **Name** column appears by default in the grid in the **Actions** pane on the Asset Strategy Optimization **Scenarios - Actions** page and displays values that exist in the Name field to identify the System Action records that are displayed in the grid.

Field	Data Type	Description	Behavior and Usage
One Time Action	Logical	Indicates whether the Action will occur one time or will be repeated more than once.	On the System Special Action datasheet, this field appears as a check box labeled **One Time Action**. This check box is selected by default, indicating that the Action will only occur once. You can clear this check box to indicate that an Action will occur more than once. For example, an Action to inspect the vibration level of a pump might occur several times a year. In this case, the **One Time Action** check box in the corresponding System Inspection record would be cleared. An Action to inspect a newly installed pump for any installation errors might occur only once, however, in which case the **One Time Action** check box in the corresponding System Inspection record would be selected.

Field	Data Type	Description	Behavior and Usage
Shutdown Required	Logical	Indicates whether the Action requires the piece of equipment or location to be shut down in order for the Action to be completed.	On the System Special Action datasheet, this field appears as a check box labeled **Shutdown Required.** By default, this check box is selected, indicating that the piece of equipment or location must be shut down for the Action to be completed. You can clear this check box to indicate that the piece of equipment or location does not need to be shut down for the Action to be completed. For example, an Action to inspect the vibration level of a pump could be completed while the pump is running, so the **Shutdown Required** check box would be cleared. An Action to inspect the internal components of a pump would be completed while the pump is not running, so the **Shutdown Required** check box would be selected.