Layers of Protection Analysis

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Chapter 1

Overview

Topics:

- Overview of the Layers of Protection Analysis (LOPA) Module
- Access the LOPA Overview Page
- LOPA Workflow

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Overview of the Layers of Protection Analysis (LOPA) Module

Layers of Protection Analysis (LOPA) is a type of risk assessment that helps you evaluate the frequency of occurrence of events that can cause a hazard, the likelihood of failure of independent layers of protection, and the consequences, to provide an estimate of risk associated with a scenario. LOPA is a fully quantitative assessment of risk and applicability of safeguards.

The Layers of Protection Analysis module is complementary to Hazards Analysis and SIL Assessment. It uses GE Digital APM core functionality to create and manage LOPA. The LOPA assessment can help in:

- Evaluating scenarios generated in the Hazard Analysis.
- Identifying safeguards that can act as an Independent Protection Layer (IPL).
- Determining the Safety Integrity Level (SIL) for Instrumented Functions.

You can use the integration between the Layers of Protection Analysis module and SIS Management module, and the integration between the Layers of Protection Analysis module and Hazards Analysis module, to centrally manage LOPA for various scenarios and safety systems.

Access the LOPA Overview Page

About This Task

By default, the hierarchy level is set to Home and the information that appears on the **LOPA Overview** page is related to all Hierarchy Levels, including records that are not associated with any Asset. You can filter the information that appears on the page based on a specific Asset by selecting on the upper-left corner of the page.

Procedure

In the **Applications** menu, navigate to the **INTEGRITY** section, and then select **Layers of Protection Analysis**.

The **LOPA Overview** page appears, displaying the following tabs:

- **Under Review**: Contains a list of LOPAs that are being reviewed and have not been approved. This sections contains the following columns of information:
  - **LOPA ID**: Contains the value from the LOPA ID field. You can select the link in the **LOPA ID** column to access the LOPA.
  - **Initiating Event**: Contains the value from the Initiating Event field.
  - **Frequency of Initiating Event**: Contains the value from the Frequency of Initiating Event field.
- **Approved**: Contains a list of LOPAs that are approved (i.e., in the Complete state). The section contains the same columns of information as the **Under Review** tab.

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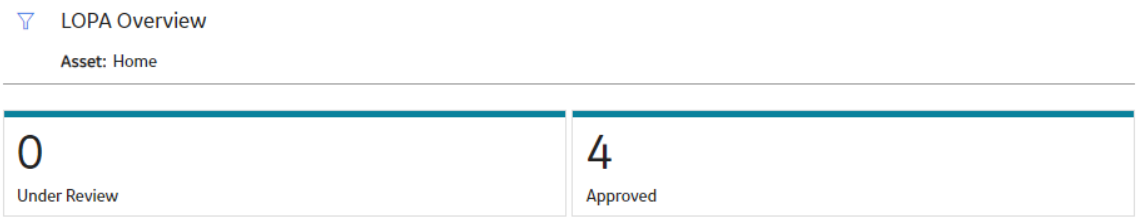

LOPA Workflow

This workflow provides the basic, high-level steps for using the Layers of Protection Analysis module. The steps and links in this workflow do not necessarily reference every possible procedure.

1. Create a Layers of Protection Analysis by defining the type of Initiating Event, the required mitigated consequence frequency, and the probability of the enabling event. You can also associate the LOPA with a Functional Location and an Equipment.
2. Create Conditional Modifiers and define their probabilities.
3. Create Safeguards by defining the Safeguard type and linking an Asset to the Safeguard.
4. Specify a Safeguard as an Independent Protection Layer (IPL).
5. Evaluate the results by viewing the summary in the **LOPA Summary** workspace of the LOPA.

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Chapter 2

Workflow

Topics:

- Layers of Protection Analysis: LOPA
- Create LOPA
- Define Enabling Event and Probability
- Conditional Modifiers?
- Define Conditional Modifiers
- Add IPLs and Link Assets
- Review SIL, PFD, and RRF Values
- SIL Assessment
- HAZOP Analysis
- What-If Analysis

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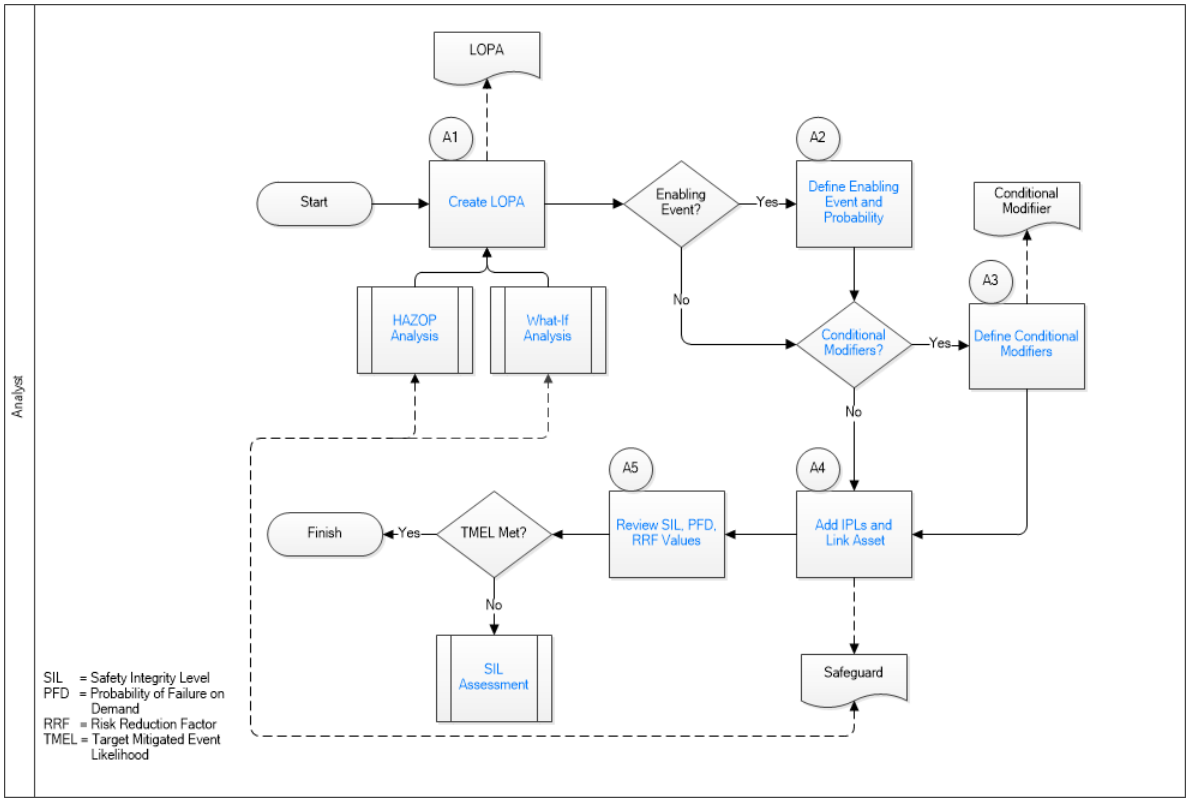
Layers of Protection Analysis: LOPA

This workflow describes the process of performing a Layer of Protection Analysis (LOPA) by defining the initiating event, frequency of event, consequence, enabling events, safeguards, and conditional modifiers.

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 GE Digital APM module, refer to the APM Product Workflows documentation.



1. Create LOPA on page 5
2. Define Enabling Event and Probability on page 6
3. Conditional Modifiers? on page 6
4. Define Conditional Modifiers on page 6
5. Add IPLs and Link Assets on page 6
6. Review SIL, PFD, and RRF Values on page 6
7. SIL Assessment on page 6
8. HAZOP Analysis on page 7
9. What-If Analysis on page 7

Create LOPA

Persona: Analyst

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Create a LOPA by defining the consequence, initiating event, initiating event frequency, and required mitigated consequence frequency. To define these values, you can refer to the plant history, trip event reports, or the expected frequency provided by the manufacturer. When you create a LOPA, you can also define the Risk Severity and Risk Category of the consequence. When you use the LOPA for SIL Assessment in a SIL Analysis, the severity and category of the risk defined in the LOPA is used to map the unmitigated risk of the scenario on a Risk Matrix.

Define Enabling Event and Probability

Persona: Analyst

For each enabling event, provide the details of the event and the probability of its occurrence. This value should be based on industry-accepted failure data for each device or system.

Conditional Modifiers?

Persona: Analyst

Determine if there are factors that can decrease the probability of the event. For example, if the event is releasing flammable gas into an explosive atmosphere, then the presence of an operator for only 12 hours a day can decrease the risk of injury.

Define Conditional Modifiers

Persona: Analyst

For each conditional modifier, create a Conditional Modifier record to define the probability.

Add IPLs and Link Assets

Persona: Analyst

Determine the Independent Protection Layers (IPLs) that have been set up to prevent a hazardous event from occurring or to reduce the severity of the event. These protective layers must meet the independence, specificity, dependability, and auditability requirements specified in IEC 61511. Link the IPL to an Equipment and a Functional Location that correspond to the asset that acts as an independent protection layer.

Review SIL, PFD, and RRF Values

Persona: Analyst

Review the Safety Integrity Level (SIL), Probability of Failure on Demand (PFD), and Risk Reduction Factor (RRF) values based on the guidelines specified in IEC 61511.

SIL Assessment

Persona: Analyst

Go to the SIL Assessment workflow.

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HAZOP Analysis

Persona: Analyst

Go to the HAZOP Analysis workflow.

What-If Analysis

Persona: Analyst

Go to the What-If Analysis workflow.

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Chapter 3

Performing LOPA

Topics:

- About Performing Layer of Protection Analysis (LOPA)
- About Safety Integrity Level (SIL)
- About Qualitative Risk Rank Mapping from LOPA
- About Integration Between Hazards Analysis and LOPA
- About Integration Between SIS Management and LOPA
- About Revision History
- Access a Layer of Protection Analysis
- Access the LOPA Summary
- Create a Layer of Protection Analysis
- Change the State of a LOPA
- Access Revision History of a LOPA
- Delete a Layer of Protection Analysis
- Copy a Layer of Protection Analysis

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About Performing Layer of Protection Analysis (LOPA)

LOPA can be used to make decisions regarding risk in a hazardous scenario. A scenario is an unplanned event that results in an undesirable consequence. LOPA is usually applied to determine if a scenario is within the risk tolerance criteria or if the risk must be reduced.

When you create a LOPA, you will define the following information:

- The risk or initiating event for which you are conducting the LOPA.
- The consequence that may occur if that risk is not prevented from proceeding into an undesirable scenario.
- The enabling events and conditions that can help in initiating the undesirable event.
- The frequency of occurrence of events.
- The tolerable frequency of occurrence of event.

Additionally, a LOPA can be linked to the following:

- Conditional Modifier
- Safeguard

Based on the values that you enter for the fields in LOPA, Conditional Modifiers, and Safeguards, the SIL value is calculated and stored in the Calculated SIL field in the LOPA. A summary of probabilities and frequency values for the LOPA and its associated records appear in the **LOPA Summary** workspace. Based on the summary, you can evaluate the scenario and make further decision on risk mitigation.

You can create a LOPA, and then link it to the following:

- A SIL Assessment for an Instrumented Function in SIS Management.
- A Cause-Consequence pair in Hazards Analysis.

If you have linked the LOPA with the SIL Assessment of an Instrumented Function, the SIL value calculated in the LOPA represents the target Safety Integrity Level that the Instrumented Function must achieve (i.e., the amount of risk reduction that the Instrumented Function must provide).

If the LOPA is linked to the Cause-Consequence pair in Hazards Analysis, then the SIL value determines if the safeguards that are currently in place reduce the risk to a tolerable level.

About Safety Integrity Level (SIL)

The SIL value is a measure of the reliability and availability of a safety system. It is the measurement of performance of a safety system under all the stated conditions within a stated period of time.

LOPA is a quantitative method for determining the SIL level for the safety system. The LOPA process uses information such as initiating event frequencies, the probabilities of failures of all safeguards, and the tolerable frequency of risk mitigation to determine the required probability of failure of the safety system. The required probability of failure is a number representing the probability that a safety system will fail in a dangerous scenario.

The SIL value for the safety system is determined by comparing the required probability of failure to the international standards of functional safety, defined in IEC 61508 and IEC 61511.

Based on the demand rate of the safety system, the SIL standards are classified into the following two types:

- Low Demand Mode: The demand rate of the safety system is less frequent than once per year. In these cases, the failure rate is measured by the average probability of failure on demand (PFD Avg).

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- High Demand or Continuous Mode: The demand rate of the instrumented function is more frequent than once per year. In this case, the failure rate is measured by the average probability of failure per hour (PFH).

As per the industry standards, the required probability of failure are related to one of the four safety integrity levels contained in the following table:

Safety Integrity Level (SIL)	Required Probability of Failure	
	Low Demand Mode Probability of Failure on Demand (PFD Avg)	High Demand or Continuous Mode Probability of Failure per Hour (PFH)
4	$\geq 10^{-5}$ to $< 10^{-4}$	$\geq 10^{-9}$ to $< 10^{-8}$
3	$\geq 10^{-4}$ to $< 10^{-3}$	$\geq 10^{-8}$ to $< 10^{-7}$
2	$\geq 10^{-3}$ to $< 10^{-2}$	$\geq 10^{-7}$ to $< 10^{-6}$
1	$\geq 10^{-2}$ to $< 10^{-1}$	$\geq 10^{-6}$ to $< 10^{-5}$

For example, if the required probability of failure for a safety system is 0.02, which is a value between 0.01 and 0.1, the Safety Integrity Level for the safety system is 1.

About Qualitative Risk Rank Mapping from LOPA

LOPA is used for quantitative assessment of the probability of occurrence of an incident or risk and for assessing the SIL value. With GE Digital APM, you can use the values calculated in LOPA to quantitatively assess the SIL and derive a qualitative risk rank mapping for an Instrumented Function in SIS Management. You can then create recommendations that can be promoted to Asset Strategy Management (ASM).

Details

GE Digital APM maps the quantitative values calculated using LOPA with the Risk Matrix configured for the site to which the LOPA belongs, and then assigns the unmitigated risk in the Risk Matrix. The following values in the LOPA are used to derive at the unmitigated risk rank:

- Risk Category: The value in the Risk Category field in the LOPA identifies the category of the driving risk associated with the initiating event. This value is mapped to the Risk Category in the Risk Matrix.
- Risk Severity: The value in the Risk Severity field identifies the severity of the impact and is mapped to the Consequence value in the Risk Matrix.
- Unmitigated Consequence Frequency: The value in the Unmitigated Consequence Frequency field is mapped to the Probability value in the Risk Matrix in one of the following ways:
  - The Probability that is equal to or less than the unmitigated consequence frequency is selected as the Probability for the Risk Matrix.
  - If the unmitigated consequence frequency is lower than the lowest Probability defined in the Risk Matrix, the lowest Probability is selected as the Probability for the Risk Matrix.

  Note: GE Digital APM assumes that you have created the Risk Matrix for your site using probability values that have been standardized to be measured in terms of years.

Based on the Probability and Consequence values, GE Digital APM identifies the unmitigated risk rank associated with the selected Risk Category. A Risk Assessment record, which stores details such as the driving risk category and the unmitigated risk rank value, is created and linked to the LOPA.

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If you assess the SIL value for an Instrumented Function using a LOPA that is linked to a Risk Assessment, and then create a recommendation for the Instrumented Function, the **Mitigated Risk** section appears in the Recommendation. In the **Mitigated Risk** section, the following details appear:

- **Total Risk**: Contains the unmitigated risk rank stored in the Risk Assessment associated with the LOPA.
- **Driving Risk**: Contains the Risk Category that you selected in the LOPA.
- **Driving Risk Threshold**: Indicates the Risk Threshold value for the unmitigated risk rank.

On the Risk Matrix, in the Risk Category that you selected in the LOPA, the icon appears on the cell corresponding to the unmitigated risk rank. You can then select the mitigated risk rank for the category.

Example: Unmitigated Consequence Frequency Falls Between two Probability values

Suppose that you have configured a Risk Matrix for Site X with the following values in Risk Probability records for the Risk Category Operations:

Risk Probability Name	Probability	Failure Interval	Failure Interval Units
Frequent	1	1	years
Probable	0.1	10	years
Possible	0.01	100	years
Remote	0.001	1000	years
Improbable	0.0001	10000	years

In Site X, suppose that you created a LOPA with the following details:

- Risk Category = Operations
- Risk Severity = High
- Unmitigated Consequence Frequency = 0.005

For the above example, the probability value in the Risk Matrix that is less than the unmitigated consequence frequency is 0.001. Therefore, on the Risk Matrix, the unmitigated risk will be mapped to the cell corresponding to Probability value 0.001 and Consequence value High.

Example: Unmitigated Consequence Frequency is Lower than the Lowest Probability value

Suppose that you have configured a Risk Matrix for Site X with the following values in Risk Probability records for the Risk Category Operations:

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Risk Probability Name	Probability	Failure Interval	Failure Interval Units
Frequent	5	.2	years
Probable	1	1	years
Possible	0.3	3.33	years
Remote	0.1	10	years
Improbable	0.05	20	years

In Site X, suppose that you created a LOPA with the following details:

- Risk Category = Operations
- Risk Severity = Medium
- Unmitigated Consequence Frequency = 0.001

For the above example, the unmitigated consequence frequency is lower than the lowest probability value (i.e., 0.05) in the Risk Matrix. Therefore, on the Risk Matrix, the unmitigated risk will be mapped to the cell corresponding to Probability value 0.05 and Consequence value Medium.

About Integration Between Hazards Analysis and LOPA

Integration between Hazards Analysis and LOPA helps in analyzing the risk in a hazardous scenario and developing appropriate Safeguards to mitigate the risk.

You can create or link a LOPA with a Consequence in Hazards Analysis (i.e., a HAZOP or a What If Analysis). When you create or link a LOPA with a Consequence, the following information is mapped from the Cause to the LOPA:

- **LOPA ID:** The value in the LOPA field is auto-populated in the format of Hazard Analysis ID~Node ID~Consequence ID. The LOPA ID field is trimmed to 255 characters if the formatted ID length exceeds 255 characters.
- **Cause Type:** The value in the CCPS Cause Type field from the Hazards Cause is mapped to the Initiating Event Type field in the LOPA.
- **Cause Frequency:** The value in the Cause Frequency (per year) field from the Hazards Cause is mapped to the Frequency of Initiating Event field in the LOPA.
- **Cause ID:** The value in the Cause ID field from the Hazards Cause is mapped to the Description of the Initiating Event field in the LOPA.
- **Enabling Event or Condition Description:** The value in the Enabling Event or Condition Description field from the Hazards Cause is mapped to the value in the Enabling Event or Condition Description field in the LOPA.
- **Enabling Event or Condition Probability:** The value in the Enabling Event or Condition Probability field from the Hazards Cause is mapped to the value in the Enabling Event or Condition Probability field in the LOPA.
- **Functional Location ID:** The value in the Functional Location ID field from the Hazards Cause is mapped to the value in the Functional Location ID field in the LOPA.

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- **Equipment ID:** The value in the Equipment ID field from the Hazards Cause is mapped to the value in the Equipment ID field in the LOPA.

When you create or link a LOPA with a Consequence, the following information is mapped from the Hazards Analysis Consequence to the LOPA:

- **Unacceptable Consequence:** The value in the Consequence ID field from the Hazards Consequence is mapped to the Unacceptable Consequence field in the LOPA.

When you create or link a LOPA with a Consequence, the following information is mapped from the unmitigated risk to the LOPA:

- **Risk Category:** The value in the Driving Risk from the unmitigated assessment linked to Hazard Analysis Consequence is mapped to the Risk Category field in the LOPA.
- **Risk Severity:** The value in the Driving Risk Threshold from the unmitigated assessment linked to Hazard Analysis Consequence is mapped to the Risk Severity field in the LOPA.

Note: All the above fields in LOPA, except LOPA ID, will be updated if any of the corresponding fields are updated in either cause, consequence, or unmitigated risk.

Hence, though you create or link a LOPA from a Consequence, the LOPA is performed on a Cause-Consequence pair. For each Cause-Consequence pair, you can perform a LOPA.

Safeguard sharing between Hazards Analysis and LOPA

When you create or link a LOPA with a Consequence in Hazards Analysis, the Safeguards that are associated with the LOPA are automatically linked to the Consequence for which you performed the LOPA. Similarly, the Safeguards that are associated with the Consequence are automatically linked to the LOPA.

You can modify a Safeguard only if the Hazards Analysis and the LOPA with which the Safeguard is associated are in the Planning state.

When you unlink a LOPA from the Consequence in Hazards Analysis, GE Digital APM system creates copies of the Safeguards associated with the LOPA, and then links them to the Consequence. The copied Safeguards appear in the **Hazards Worksheet** of the Hazards Analysis.

Illustration

The following image shows the data mapping between Hazards Analysis and LOPA.

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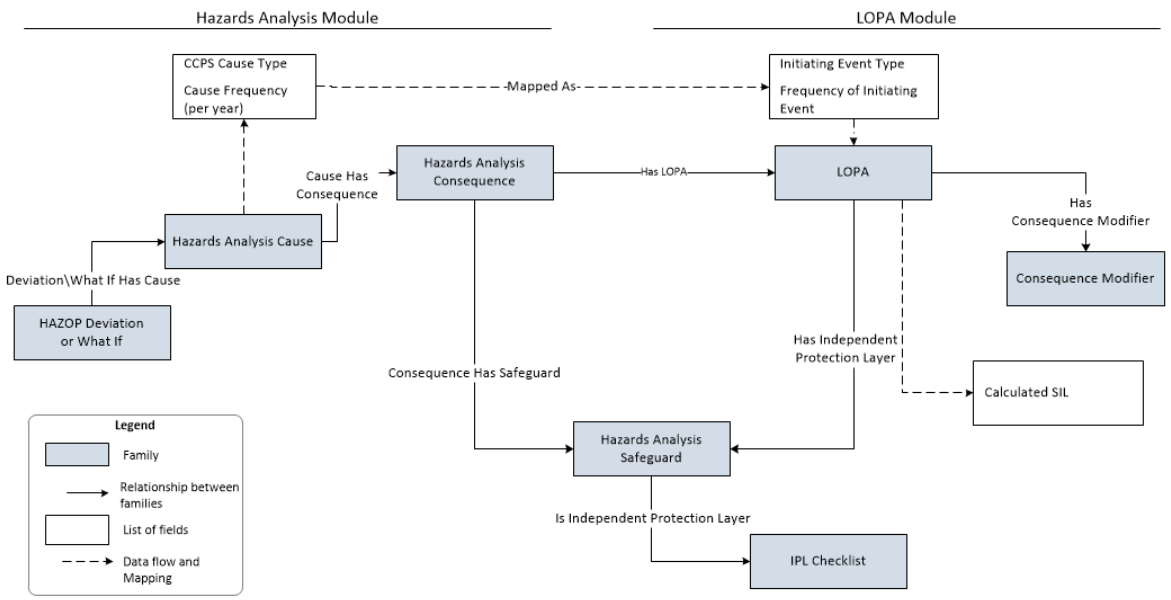

About Integration Between SIS Management and LOPA

Integration between SIS Management and LOPA helps in assessing the SIL level for Instrumented Functions.

To assess the SIL level for an Instrumented Function using LOPA:

1. Perform a LOPA for the risk that the instrumented function is designed to mitigate. A LOPA record will be created.
2. Approve the LOPA by changing the state of the LOPA to Complete.
3. In the **SIL Assessment** section of the Instrumented Function, link the LOPA in the LOPA Assessment datasheet. A LOPA Assessment record is created by mapping the following values from the LOPA record that you linked.

This field in LOPA Assessment:	...is populated with the value in this field from LOPA:
Linked LOPA ID	LOPA ID
Frequency of Initiating Event	Frequency of Initiating Event
Mitigated Consequence Frequency	Mitigated Consequence Frequency
Required Mitigated Consequence Frequency	Required Mitigated Consequence Frequency
Required Probability of Failure	Required PIF PFD
Risk Reduction Factor (RRF)	Required PIF Risk Reduction Factor
Unmitigated Consequence Frequency	Unmitigated Consequence Frequency
Total IPL PFD	Total IPL PFD
Selected SIL Level	Calculated SIL

If the LOPA is associated with a Risk Assessment, then a copy of the Risk Assessment is created and linked with the LOPA Assessment.

4. You can then associate the LOPA Assessment with an Instrumented Function. GE Digital APM system populates the following values in the **SIL Assessment** section of the Instrumented Function based on the values in the LOPA Assessment:

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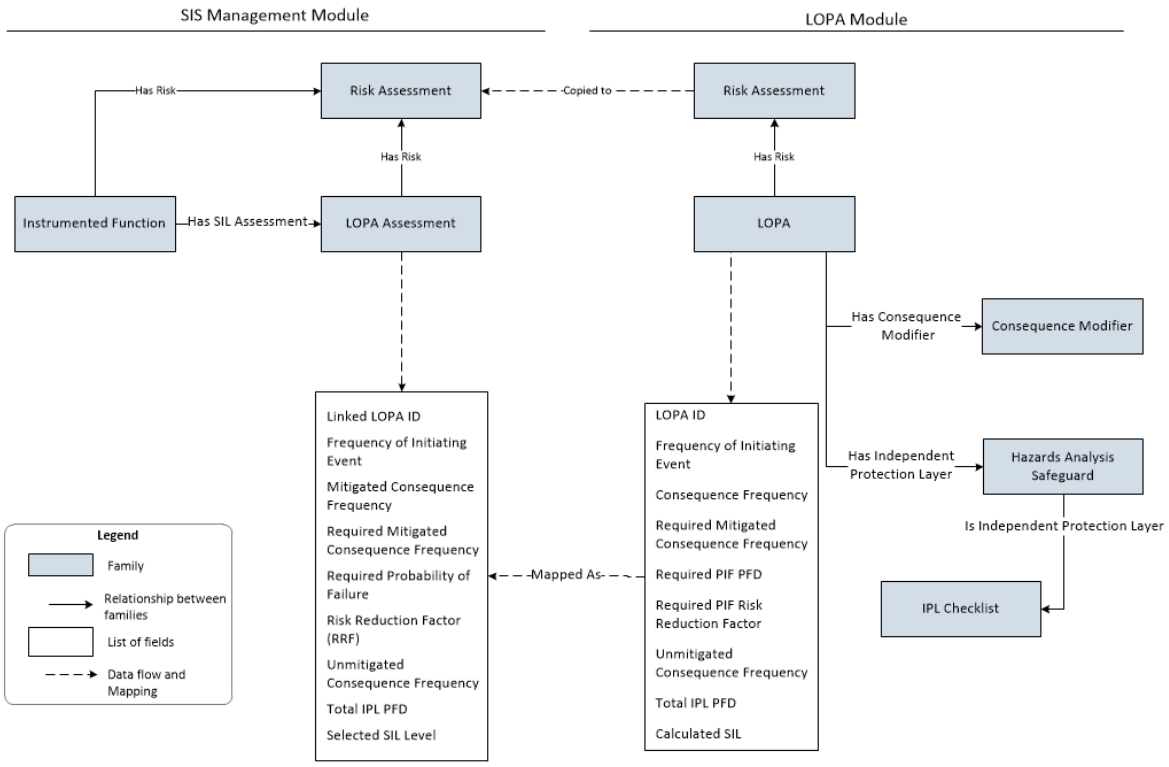
This field in Instrumented Function:	...is populated with the value in this field from LOPA Assessment:
Selected SIL Level	Selected SIL Level
Required Probability of Failure	Required Probability of Failure
Risk Reduction Factor	Risk Reduction Factor (RRF)

The Instrumented Function is linked to the Risk Assessment associated with the LOPA Assessment.

Illustration

The following image illustrates the data mapping between LOPA and LOPA Assessment.



About Revision History

The Revision History feature allows you to manage the revisions made for an entire LOPA analysis. When you perform a LOPA analysis, you link records from multiple families to the LOPA, which represents the entire analysis. When you complete an analysis (i.e., the analysis has been approved), you will change the state of the LOPA to Complete. When you do so, a snapshot of the LOPA and each record linked to it is saved as a LOPA Revision record.

In other words, after the record state for the LOPA is changed to Complete, one Revision record is created for each record that is linked to the LOPA. Records for the following families are created:

- LOPA Revision: One record for the LOPA.
- Hazards Analysis Consequence Revision: One record for each Conditional Modifier associated with the LOPA.
- Hazards Analysis Safeguard Revision: One record for each Safeguard associated with the LOPA

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- IPL Checklist Revision: One record per IPL criteria that is associated with each Safeguard associated with the LOPA.

A Revision family contains all the fields that are in the source family. Each Revision record stores the values for all the fields in the source record as it appeared when the state of the LOPA was changed to Complete.

If you re-evaluate the LOPA, and then change the state of the LOPA to Complete, a second set of Revision records will be created, and so on. The number of revisions performed on the LOPA appears in the upper-right corner of the **LOPA Summary** workspace for the LOPA, which you can select to access the Revision History. When you select the **Show Changes** button for a record, a list of values in the preceding revision record and a list of values for all the fields that were modified (i.e., values in the latest revision record) are displayed.

Access a Layer of Protection Analysis

Procedure

1. Access the **LOPA Overview** page.
2. On the **LOPA Overview** page, select one of the following tabs:
   - **Under Review**: Select this tab if you want to view a LOPA record that is being reviewed and has not been approved.
   - **Approved**: Select this tab if you want to view a LOPA record that is in Complete state.

   A list of LOPAs appears based on the tab that you selected.
3. In the **LOPA ID** column, select the link for the LOPA that you want to view.

   The **LOPA Summary** workspace appears, displaying the **Definition** and **Summary** tabs. The **Definition** tab is selected by default, displaying the datasheet for the selected LOPA.

   Note: As needed, you can modify the values in the available fields, and then select to save your changes. You can modify values for a LOPA only if the record in the Planning state.

   The following tabs appear in the pane to the left of of the **LOPA Summary** workspace:

   - **Conditional Modifiers**: Contains a list of Conditional Modifiers associated with the LOPA.
   - **Safeguards and IPLs**: Contains a list of Safeguards associated with the LOPA.

Access the LOPA Summary

This topic describes how to access the LOPA Summary workspace, which provides an overview of frequencies and probability values associated with various calculations in LOPA.

Before You Begin

- Create a Layer of Protection Analysis.
- Create Conditional Modifiers that you want to associate with the LOPA.
- Create Safeguards and specify if they are IPLs.

Procedure

1. Access the LOPA whose summary you want to view.
2. In the **LOPA Summary** workspace, select **Summary**.

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The **Summary** section appears, displaying summary information for the LOPA and the associated Conditional Modifiers and Safeguards.

The **Summary** section contains the following information:

- **Initiating Event**: Contains the description of the Initiating Event and the frequency of occurrence of the initiating event.
- **Enabling Event or Condition**: Contains the description of the enabling event and the probability of occurrence of the enabling event.
- **Frequency of Unmitigated Consequence**: Contains the frequency of occurrence of the Consequence before any Safeguards and IPLs are considered.
- **Conditional Modifiers**: Contains the Conditional Modifier ID and the probability of occurrence of the Conditional Modifier. One row appears for each Conditional Modifier that is associated with the LOPA.
- **Safeguards and IPLs**: Contains the Safeguard ID and the probability that the Safeguard will fail on demand (PFD). One row appears for each Safeguard that is associated with the LOPA.

Create a Layer of Protection Analysis

About This Task

This topic describes how to create a LOPA via the **LOPA Overview** page. You can also create a LOPA from a Consequence in Hazards Analysis, which is then automatically linked to the Consequence.

Procedure

1. Access the **LOPA Overview** page.
2. On the **LOPA Overview** page, select the **Under Review** tab.
   A list of LOPAs appears.
3. In the upper-left corner of the **Under Review** section, select .
   A blank datasheet for LOPA appears, displaying the **Definition** section.
4. As needed, enter values in the available fields.
5. In the upper-right corner of the **Definition** section, select .
   The LOPA is created.

Results

- If you selected a value in the Risk Category and Risk Severity fields, then a Risk Assessment record is created and linked with the LOPA. The Risk Assessment record stores details about the unmitigated risk, which will be used for qualitative risk analysis of an Instrumented Function.

Next Steps

- Link the LOPA to a Consequence in Hazards Analysis. For more information, refer to the Hazards Analysis section of the documentation.

  -or-
- Assess the SIL value of an Instrumented Function using the LOPA. For more information, refer to the SIS Management section of the documentation.

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Change the State of a LOPA

This topic describes how to change the state of a LOPA, while assigning the state of the LOPA to the appropriate user.

Before You Begin

If a LOPA is used for SIL assessment of an Instrumented Function, a LOPA Assessment record is created and associated with the LOPA. When you change the state of a LOPA to Complete, the associated LOPA Assessment is also updated. Any change to the LOPA Assessment will also affect the associated Instrumented Function and Protective Instrument Loops. Therefore, if the LOPA is linked to a LOPA Assessment of an Instrumented Function in a SIL Analysis, then to change the state of the LOPA to Complete, the SIL Analysis and the associated PILs must be in a modifiable state.

- The SIL Analysis must be in the Planning state.
- The Protective Instrument Loops associated with the Instrumented Function must be in the Design state.

About This Task

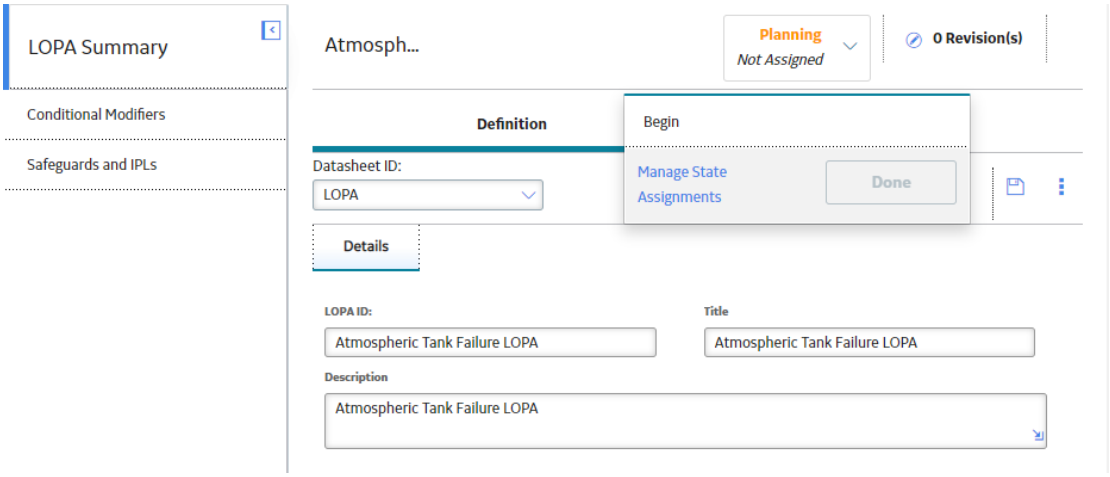
Important: You can modify the state for a LOPA only if you are an administrator or a user who belongs to the State Configuration Role configured for that state.

Procedure

- Change the State of a LOPA that is not Linked to a LOPA Assessment.

  1. Access the LOPA whose state you want to change.
  2. In the upper-right corner of the **LOPA Summary** workspace, select the button that indicates the current state of the LOPA. For example, if the current state of the LOPA is Planning, select **Planning**.

     A menu appears, displaying the list of operations that you can perform on the LOPA to change its state.



Note: You can view the states assigned to various users by selecting the **Manage State Assignments** link. If not already done, you can assign the next state of the LOPA to the appropriate user, and then select **Done**.

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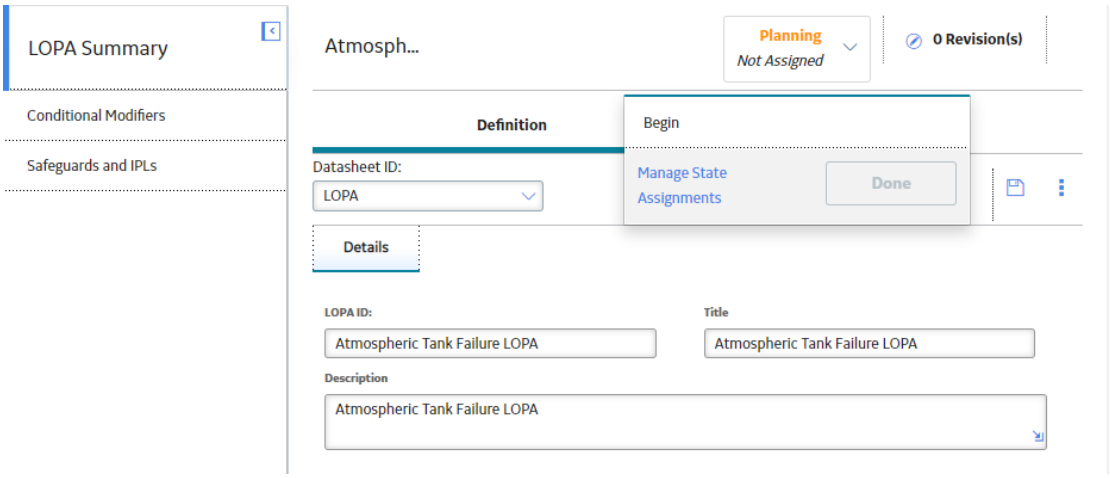
3. Select the necessary operation that will change the state of the LOPA, and then select **Done**. For example, if you want to change the state of the LOPA from Planning to Active, select **Begin**, and then select **Done**.

   The state of the LOPA is changed.

- Change the State of a LOPA that is Linked to a LOPA Assessment

1. Access the LOPA whose state you want to change.
2. In the upper-right corner of the **LOPA Summary** workspace, select the button that indicates the current state of the LOPA. For example, if the current state of the LOPA is Planning, select **Planning**.

   A menu appears, displaying the list of operations that you can perform on the LOPA to change its state.



   Note: You can view the states assigned to various users by selecting the **Manage State Assignments** link. If not already done, you can assign the next state of the LOPA to the appropriate user, and then select **Done**.

3. Select the necessary operation that will change the state of the LOPA, and then select **Done**. For example, if you want to change the state of the LOPA from Planning to Active, select **Begin**, and then select **Done**.
   If the LOPA is in the Pending Approval state and you selected the operation **Accept**, a message appears, indicating that when you change the state of the LOPA to Complete, the changes to the LOPA will update the values in the associated LOPA Assessment and the Protective Instrumented Loops.

   a. Select **OK**.
      If the associated SIL Analysis is not in the Planning state or the associated Protective Instrument Loops are not in the Design state, a message appears, stating that the state of the LOPA cannot be changed.
   b. Select **OK**.
      The state of the LOPA is not changed.

   -or-

   If the LOPA is not in Pending Approval state, the state of the LOPA is changed.

Results

- When you change the state of a LOPA to Complete, the number of revisions for the LOPA is incremented by one, and appears in the upper-right corner of the **LOPA Summary** workspace.

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- For each revision, a Revision record is created for the LOPA, and its associated Conditional Modifiers and Safeguards.
- If you changed the state of LOPA linked to a LOPA Assessment of an Instrumented Function in a SIL Analysis to Complete, then the values in the associated LOPA Assessment and Risk Assessment are updated based on the values in the LOPA. If linked to a LOPA Assessment of an Instrumented Function in a SIL Analysis, the following records are also updated:
  - Instrumented Functions with which the LOPA Assessment is linked.
  - Protective Instrument Loops associated with the Instrumented Functions.

Access Revision History of a LOPA

Procedure

1. Access the LOPA for which you want to access the revision history.
2. In the upper-right corner of the page, select **Revisions**.
   A list of revisions for the LOPA appears.
3. For the row that contains the revision that you want to access, in the **Revision Name** column, select the link.
   The LOPA Revision datasheet for the selected revision appears, displaying the details of the LOPA for that revision. The **Conditional Modifiers** tab and the **Safeguards and IPLs** tab appears in the left pane.
4. If you want to view the changes that have been made for the LOPA, in the upper-right corner of the page, select **Show Changes**.
   The **Changes For Selected Datasheet** window appears, displaying a list of values in the preceding LOPA Revision record and a list of values in the latest LOPA Revision record for the selected LOPA.
5. If you want to view the changes that have been made for conditional modifiers associated with LOPA, perform the following steps:
   a) In the left pane, select **Conditional Modifiers**.
      In the left pane, the Conditional Modifier records that are associated with the LOPA appear.
   b) Select the record for which you want to view the revision, and then, in the upper-right corner of the page, select **Show Changes**.
      The **Changes For Selected Datasheet** window appears, displaying a list of values in the preceding Conditional Modifier Revision record and a list of values in the latest Conditional Modifier Revision record for the selected Conditional Modifier.
6. If you want to view the changes that have been made for safeguards and IPLs associated with LOPA, perform the following steps:
   a) In the left pane, select **Safeguards and IPLs**.
      In the left pane, the Safeguard records that are associated with the LOPA appear.
   b) Select the record for which you want to view the revision, and then, in the upper-right corner of the page, select **Show Changes**.
      The **Changes For Selected Datasheet** window appears, displaying a list of values in the preceding Safeguard Revision record and a list of values in the latest Safeguard Revision record for the selected Safeguard. The window also contains the old and new values for the IPL Checklist criteria associated with the Safeguard.

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Delete a Layer of Protection Analysis

Procedure

1. Access the LOPA that you want to delete.
2. On the upper-right corner of the LOPA datasheet, select , and then select **Delete**.

   Note: You can delete a LOPA only if the LOPA is in the Planning state.

   A confirmation message appears, asking you if you want to delete the LOPA.

   Note: When you delete a LOPA, the relationship with the associated Consequence Modifiers and Safeguards is removed.
3. Select **Yes**.

   The LOPA is deleted.

   Note: If you delete a LOPA linked to a Hazards Analysis, the Safeguards created in LOPA remain associated with the Hazards Analysis.

Copy a Layer of Protection Analysis

Procedure

1. Access the **LOPA Overview** page.
2. In the **Under Review** or **Approved** section, select the check box that corresponds to the LOPA that you want to copy.

   Note: You can also copy the LOPA from the **LOPA Summary** page. To copy the LOPA from the **LOPA Summary** page, select on the upper-right corner of the **LOPA Summary** page.
3. On the upper-right corner of the **Under Review** or **Approved** section, select .

   Note:

   - The Copy icon ( ) is enabled only when you select one LOPA at a time. If you select more than one LOPAs from the list, then the Copy icon will be disabled.
   - When you copy a LOPA, the associated Consequence Modifiers and Safeguards is also copied and relationship is created between new Consequence Modifiers and Safeguards to the new LOPA.
   - Link to functional location and equipment is not copied for LOPA.
   - Link to function location, equipment and instrumented function will not be copied for safeguard.

   The LOPA is copied and added in the **Under Review** section.

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Chapter 4

Conditional Modifiers

Topics:

- About Conditional Modifiers
- Access a Conditional Modifier
- Create a Conditional Modifier
- Delete a Conditional Modifier

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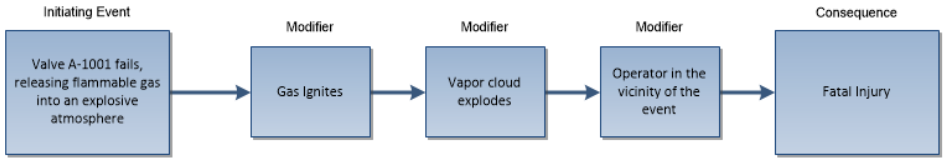
About Conditional Modifiers

A conditional modifier is an action or event that can reduce the probability of an undesirable event. Details about a conditional modifier are stored in Consequence Modifier records, which are linked to LOPA records. Based on the modifier type that you selected when you create a Conditional Modifier, the probability of occurrence of the modifier is determined using the default probabilities defined in the Consequence Adjustment Probabilities record for the modifier type.

The product of probability of occurrence of conditional modifier and initiating event frequency is referred to as Unmitigated Consequence Frequency on the Conditional Modifier datasheet.

Example

Suppose that the SIL analysis team is conducting a LOPA to investigate the risk scenario illustrated in the following diagram, where each box represents a part of the scenario, and each label indicates the family that stores the relevant information:



When Valve A-1001 fails, flammable gas is released into the atmosphere. If the flammable gas reaches a potential ignition source (e.g., electric switch, motor), causing a vapor cloud explosion in the vicinity of the operator, it could cause a fatal injury.

In this risk scenario, the fatal injury is a consequence of the valve failure, and the following events or actions are the conditional modifiers:

- The flame igniting
- The vapor cloud exploding
- The operator being in the vicinity of the explosion

Since these actions and events appear within the risk scenario, the probability associated with the consequence occurring is increased exponentially. In other words, if the operator was not in the vicinity of the blast, the probability of fatal injury would be less. By examining the granular events that are associated with a risk, the SIL analysis team can more accurately assess the SIL value for the safety system.

In this example, consider the following values:

- Probability of the operator being present in the vicinity of blast = 0.5 (i.e., 50%)
- Frequency of failure of Valve A-1001 = 0.2

For the above values, the Unmitigated consequence frequency of the scenario is calculated as follows:

- Probability of the operator being present in the vicinity of blast x Frequency of failure of Valve A-1001 = 0.5 x 0.2 = 0.1

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Access a Conditional Modifier

Before You Begin

- As needed, modify the Consequence Adjustment Probabilities records, which store the default probability for each modifier type.

Procedure

1. Access the Layer of Protection Analysis (LOPA) that is linked to the Conditional Modifier that you want to access.
2. In the left pane, select **Conditional Modifiers**.
   The **Conditional Modifiers** workspace appears, displaying a list of Conditional Modifiers linked to the LOPA.
3. In the **Consequence Modifier ID** column, select the link for the Conditional Modifier that you want to access.
   The datasheet for the Conditional Modifier appears.

   Note: As needed, you can modify the values in the available fields, and then select to save your changes. You can modify values for a Conditional Modifier only if the associated LOPA datasheet is in the Planning state.

Create a Conditional Modifier

Before You Begin

- Create a Layer of Protection Analysis (LOPA).
- As needed, modify the Consequence Adjustment Probabilities records, which store the default probability for each modifier type.

Procedure

1. Access the LOPA for which you want to create a Conditional Modifier.
2. In the left pane, select **Conditional Modifiers**.
   The **Conditional Modifiers** workspace appears, displaying a list of Conditional Modifiers linked to the LOPA.
3. In the upper-left corner of the workspace, select .
   A blank datasheet for the Conditional Modifier appears.
4. As needed, enter values in the available fields.
5. On the upper-right corner of the datasheet, select .
   The Conditional Modifier is created and associated with the LOPA.

Results

- In the **Conditional Modifiers** workspace, the Conditional Modifier that you created appears in the list of records.
- The unmitigated consequence frequency value and mitigated consequence frequency value for the LOPA are recalculated.
- The summary of the LOPA is updated with the details of the Conditional Modifier.

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Delete a Conditional Modifier

About This Task

You can delete a Conditional Modifier only if the associated LOPA record is in the Planning state.

Procedure

1. Access the Layer of Protection Analysis (LOPA) that is associated with the Conditional Modifier that you want to delete.
2. In the left pane, select **Conditional Modifiers**.
   The **Conditional Modifiers** workspace appears, displaying a list of Conditional Modifiers linked to the LOPA.
3. Select the row containing the Conditional Modifier that you want to delete.
4. In the upper-right corner of the **Conditional Modifiers** workspace, select .
   The **Delete Modifier** dialog box appears, asking you to confirm that you want to delete the Modifier.
5. Select **OK**.
   The Conditional Modifier is deleted.

Results

- The unmitigated consequence frequency value and mitigated consequence frequency value for the LOPA are recalculated to remove the effect of the deleted Conditional Modifier.
- The details of the Conditional Modifier is removed from the summary of the LOPA.

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Chapter 5

Safeguards and IPLs

Topics:

- About Safeguards and Independent Protection Layers (IPL)
- About Identifying an Independent Protection Layer
- Access a Safeguard
- Create a Safeguard
- Assess if a Safeguard is an Independent Protection Layer (IPL)
- Delete a Safeguard

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About Safeguards and Independent Protection Layers (IPL)

Safeguard

A safeguard is a safety instrumented system or any other safety device that prevents a risk from occurring or lowers the probability or severity identified by the risk assessment. Safeguard can also be an action performed by a person (e.g., operator response to an alarm). In GE Digital APM, Safeguards can be linked to an asset.

Independent Layer of Protection

When a safeguard is independent of the performance of other Safeguards, or the initiating event, the safeguard is considered as an Independent Protection Layer (IPL). An independent layer of protection is external to any other layer of protection or safety instrumented system. All independent layers of protection are safeguards, but not all safeguards are independent layers of protection. To be specified as an IPL, a Safeguard must satisfy a set of criteria.

The effectiveness of an independent layer of protection is quantified in terms of its probability of failure on demand (PFD), which is a numeric value that represents the probability that the independent layer of protection will fail to perform its specified safety function when required.

The following three types of IPLs are defined in the GE Digital APM:

- Active IPL: An active IPL is a device or system that changes from one state into another in response to a change in process activity. For example, a pressure relief device is an active IPL that opens when there is an abnormal change in the pressure inside a vessel and remains open until the pressure in the vessel reduces to a value below the settings in the pressure relief device.
- Passive IPL: A passive IPL can achieve its risk reducing function without the requirement to take any action or change the state of the system. For example, detonation arrestors and blast-walls are passive IPLs that reduce the risk.
- Human IPL: Human IPLs involve the dependence on operators or other staff to take action to prevent an undesired consequence, in response to alarms or following a routine check of the system.

Active, Passive, and Human IPLs are further classified as IPL Sub Types, and are defined in the Active IPL family, Passive IPL family, and Human IPL family, respectively. For each subtype defined in the Active IPL, Passive IPL, and Human IPL families, the probability of failure on demand (PFD) value is also defined. Based on your selection of the IPL Type and the IPL Sub Type, the PFD for the Safeguard is determined from the Active IPL, Passive IPL, or Human IPL records.

The PFD values for each of Safeguard that is an IPL is multiplied to populate the Total IPL PFD field in LOPA. These values also modify the unmitigated and mitigated consequence frequency values in the LOPA.

About Identifying an Independent Protection Layer

You must assess the independence of the safeguards to determine if the safeguard can be qualified as an IPL. You must create one Safeguard for each layer of protection that exists. In the IPL Checklist section of the **Safeguards and IPLs** workspace, a set of criteria appear as questions. To be classified as an IPL, a Safeguard must meet all the criteria listed in the **IPL Checklist** section. These criteria can be modified in the administrative settings for LOPA.

By default, the following criteria are defined for the IPL Checklist and are required to be true for a safeguard to be considered as an independent protection layer:

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- The safeguard must be independent of the initiating event such that a failure associated with the risk will not cause the safeguard to fail.
- The safeguard must be testable and verifiable using an industry standard (e.g., a risk based inspection).
- The safeguard must be specific in detecting a potential hazard and taking action to prevent the hazard from occurring.
- The safeguard must be capable and available at least 90 percent of the time.
- The safeguard must increase the Risk Reduction Factor (RRF) of the LOPA to a value greater than or equal to 10.

To determine if a Safeguard is an IPL, you must select the criteria that are true for the Safeguard. If all the criteria are true for a Safeguard, the Safeguard is classified as an IPL. The IPL Type field, IPL Sub Type field, and PFD field are enabled. When you select the IPL Type and the IPL Sub Type, the corresponding PFD value for the IPL is automatically populated.

When the IPL is saved, the Total IPL PFD field in the LOPA is updated with the calculated PFD value. If there are more than one IPLs for the same LOPA, then the Total IPL PFD is calculated by multiplying the values in the PFD fields of each Safeguard associated with the LOPA. These values also modify the unmitigated and mitigated consequence frequency values in the LOPA.

Example

Suppose that in a hazardous scenario a high pressure separator releases liquid to downstream equipment. If the liquid level in the high pressure separator decreases to a certain level, pressure could be released to downstream equipment and cause it to rupture. In this scenario, a controller monitors the liquid level. If the level gets too low, the controller closes a valve so that the pressure is not released to downstream equipment.

The low level alarm is an independent layer of protection for this scenario because it meets all of the following criteria:

- The safeguard is independent because if the first controller fails, the low level alarm has independent process connections and independent BPCS hardware from the failed controller.
- The safeguard is auditable because the low level alarm can be routinely inspected.
- The safeguard is capable because it is available at least 90 percent of the time.
- The safeguard is specific because the alarm detects potential hazards by measuring the liquid level and will alert the operator when the potential failure is detected.

The low level alarm coupled with an operator response can reduce the risk associated with the hazards scenario and can be considered an IPL.

For the above example, in GE Digital APM, the following IPL related information would be stored in the record for the low level alarm Safeguard:

- IPL Type: Active IPL
- IPL Sub Type: Basic Process Control System
- PFD: 0.1
- Total IPL PFD value for the LOPA: 0.1

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Access a Safeguard

Procedure

1. Access the Layer of Protection Analysis that is linked to the Safeguard that you want to access.
2. In the left-pane, select **Safeguards and IPLs**.
   The **Safeguards and IPLs** workspace appears, displaying a list of safeguards linked to the LOPA.
3. In the **Safeguard ID** column, select the link for the Safeguard that you want to access.
   The **Safeguards and IPLs** workspace appears, displaying the **Definition** and **IPL Checklist** tabs. The **Definition** tab is selected by default, displaying the datasheet for the selected Safeguard.

   Note: As needed, you can modify the values in the available fields, and then select to save your changes. You can modify values for a Safeguard only if the associated LOPA is in the Planning state. Additionally, if you have linked the LOPA to a Consequence in Hazards Analysis, you can modify the Safeguard only if the Hazards Analysis is also in the Planning state.

Create a Safeguard

Before You Begin

- Create a Layer of Protection Analysis.

About This Task

This topic describes how to create a Safeguard.

Note: You can create a Safeguard only if the associated LOPA is in the *Planning* state. Additionally, if the LOPA is linked to a Consequence in Hazards Analysis, you can create a Safeguard only if the Hazards Analysis is also in the Planning state.

Procedure

1. Access the Layer of Protection Analysis for which you want to create a Safeguard.
2. In the left pane, select **Safeguards and IPLs**.
   The **Safeguards and IPLs** workspace appears, displaying a list of safeguards linked to the LOPA.
3. In the upper-left corner of the workspace, select
   A blank datasheet for the Safeguard appears, displaying the **Definition** section.
4. As needed, enter values in the available fields.
5. In the upper-right corner of the workspace, select .
   The Safeguard is created and linked to the selected LOPA.

Next Steps

- Specify a Safeguard as an Independent Protection Layer (IPL)

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Assess if a Safeguard is an Independent Protection Layer (IPL)

Before You Begin

- Create a Safeguard.
- As needed, modify the Active IPL, Passive IPL, or Human IPL records, which store the default probability for each IPL Sub Type.

Procedure

1. Access the Safeguard that you want to assess to determine whether it is an IPL.
2. Select the **IPL Checklist** tab.
   The **IPL Checklist** section appears, displaying a set of criteria to identify if the Safeguard is an IPL.
3. In the **IPL Checklist** section, next to each criteria that is applicable for the selected Safeguard, select the check box.
   The **IPL Type** box and the **IPL Sub Type** box are enabled.

   Note: The **IPL Type** box and the **IPL Sub Type** box are enabled only if the check box for all the criteria in the **IPL Checklist** section is selected.
4. As needed, select values in the available fields.
5. In the upper-right corner of the workspace, select .
   The Safeguard is specified as an IPL.

Results

- Based on your selection in the IPL Type and IPL Sub Type fields, the Probability of Failure on Demand (PFD) value is calculated for the safeguard.
- In the **Summary** section of the **LOPA Summary** workspace, the **Probability** column for the row containing the Safeguard is updated with the calculated PFD value.
- In LOPA, the Total IPL PFD field is updated with the calculated PFD value. If there are more than one IPL for the same LOPA, then the Total IPL PFD value is calculated by multiplying the values in the PFD field of each Safeguard associated with the LOPA.

Delete a Safeguard

About This Task

Note: You can delete a Safeguard only if the associated LOPA is in the Planning state. Additionally, if you have linked the LOPA to a Consequence in Hazards Analysis, you can delete the Safeguard only if the Hazards Analysis is also in the Planning state.

Procedure

1. Access the Layer of Protection Analysis that is associated with the Safeguard that you want to delete.
2. In the left pane, select **Safeguards and IPLs**.
   The **Safeguards and IPLs** workspace appears, displaying a list of Safeguards linked to the LOPA.
3. Select the row containing the Safeguard that you want to delete.
4. In the upper-right corner of the **Safeguards and IPLs** workspace, select .

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The **Delete IPL/Safeguard** dialog box appears, asking you to confirm that you want to delete the safeguard or IPL.

5. Select **OK**.
   The Safeguard is deleted.

Results

- If the deleted Safeguard was an IPL, then the Total IPL PFD field on the LOPA datasheet is updated with the recalculated PFD value to remove the effect of the deleted Safeguard.
- If you have linked the LOPA to a Consequence in Hazards Analysis, the Safeguard that you deleted in the LOPA is also removed from the **Hazards Worksheet** of the Hazards Analysis.

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Chapter 6

Admin

Topics:

- LOPA Admin Page
- Query Paths
- IPL Checklists
- Active IPLs
- Passive IPLs
- Human IPLs
- Initiating Events
- Consequence Probabilities

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LOPA Admin Page

Access the LOPA Admin Page

Procedure

In the **Applications** menu, navigate to **ADMIN** > **Application Settings** > **Layers of Protection Analysis**.

The **LOPA Admin** page appears, displaying the **Query Paths** workspace.

Query Paths

About Query Paths

On the **LOPA Overview** page, when you select the tabs in the workspace, the following queries are executed:

- LOPA Under Review Query: This query retrieves a list of LOPA that are not in the Complete state. This query is executed when you select the **Under Review** tab on the **LOPA Overview** page, and populates the **Under Review** section with the list of LOPA that is retrieved.
- LOPA Approved Query: This query retrieves a list of LOPA that are in the Complete state. This query is executed when you select the **Approved** tab on the **LOPA Overview** page, and populates the **Approved** section with the list of LOPA that is retrieved.

You can, however, specify different search queries for LOPA by replacing the default queries.

Specify Different Query Path

About This Task

This topic describes how to specify different search queries for LOPA by replacing the default queries.

Procedure

1. Access the **LOPA Admin** page.
2. In the **Query Paths** workspace, next to the query that you want to replace, select the **Select** button.
   The **Select a query from the catalog** window appears.
3. Navigate to the folder that contains the query that you want to specify.
4. Select the query that you want to specify, and then select **Open**.
   In the box corresponding to the query that you want to replace, the complete path to the query that you selected appears.
5. In the upper-right corner of the **LOPA Admin** page, select **Save**.
   The default query is replaced by the query that you selected.

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IPL Checklists

About IPL Checklist

A safeguard is a safety instrumented system or any other safety device that prevents a risk from occurring or lowers the probability or severity identified by the risk assessment. When a safeguard is independent of the performance of other Safeguards, or the initiating event, the safeguard is called an Independent Protection Layer (IPL).

All independent layers of protection are safeguards, but not all safeguards are independent layers of protection. To be classified as an IPL, the Safeguard must meet a predefined set of criteria. In the Application Settings for LOPA, you can configure the criteria that a safeguard must meet to be classified as an IPL. By default, the following criteria are defined in GE Digital APM database:

- Is the IPL Independent of the initiating cause of the hazardous scenario?
- Is the IPL Specific in that has the ability to detect the hazardous scenario?
- Is the IPL Auditable with applicable industry standard?
- Is the IPL Capable with respect to its availability?
- Is the Risk Reduction Factor (RRF) >= 10?

In the Application Settings for LOPA, you can add any additional criteria that a Safeguard must satisfy to be classified as an IPL. You can also delete any criteria that is not required to be true for a Safeguard to be designated as an IPL. To modify the criteria, you must be a user belonging to the Security Group MI SIS Administrator or MI HA Administrator.

The list of criteria that you define in the **IPL Checklist** workspace, appears on the **IPL Checklist** section of the Safeguard datasheet when you create a new Safeguard. To specify that a Safeguard is an IPL, all the criteria that are in the **IPL Checklist** section of the Hazards Analysis Safeguard datasheet must be satisfied. When you select the check boxes for all the criteria, the IPL related fields are enabled for modification. You can then specify values in the IPL Type and IPL Sub Type fields in the **IPL Checklist** section, based on which the PFD value for the Safeguard will be automatically populated.

Access a Criteria Configured for the IPL Checklist

Procedure

1. Access the **LOPA Admin** page.
2. In the left pane, select **IPL Checklist**.
   The **IPL Checklist** workspace appears, displaying a list of criteria defined for a Safeguard to be specified as an IPL.
3. In the row for the criteria that you want to access, in the **Preference Name** column, select the link.
   The page for the selected criteria appears, displaying the datasheet for the record.

   Note: As needed, modify values in the available fields, and then select to save your changes.

Configure Criteria for the IPL Checklist

About This Task

This topic describes how to configure criteria for the IPL Checklist, which appears in the **IPL Checklist** section of the Safeguard datasheet.

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Note: You can configure criteria for the IPL checklist only if you are a user belonging to the Security Group MI SIS Administrator or MI HA Administrator.

Procedure

1. Access the **LOPA Admin** page.
2. In the left pane, select **IPL Checklist**.
   The **IPL Checklist** workspace appears, displaying a list of criteria defined for a Safeguard to be specified as an IPL.
3. In the upper-left corner of the workspace, select .
   A blank datasheet for Asset Safety Preferences appears.
4. As needed, enter values in the available fields.
5. In the upper-right corner of the workspace, select .
   The criteria is configured for the IPL Checklist.

Results

- When you add a new Safeguard to a LOPA, the criteria that you included appears on the **IPL Checklist** section of the Safeguard datasheet.

Delete a Criteria from the IPL Checklist

About This Task

This topic describes how to delete a criteria from the IPL Checklist.

Note: You can delete a criteria from the IPL checklist only if you are user belonging to the Security Group MI SIS Administrator or MI HA Administrator.

Procedure

1. Access the **LOPA Admin** page.
2. In the left pane, select **IPL Checklist**.
   The **IPL Checklist** workspace appears, displaying a list of criteria defined for a Safeguard to be specified as an IPL.
3. Select the row that contains the criteria that you want to delete.
4. In the upper-right corner of the workspace, select .
   The **Delete IPL Criteria** dialog box appears, asking if you want to delete the criteria.
5. Select **OK**.
   The criteria is deleted from the IPL Checklist.

Results

- When you add a new Safeguard to a LOPA, the criteria that you deleted does not appear on the **IPL Checklist** section of the Safeguard datasheet.

  Note: The criteria that you deleted would still appear in the **IPL Checklist** section of existing Safeguards that you created using the criteria.

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Active IPLs

About Active IPLs

An active IPL is a device or system that changes from one state to another in response to a change in process activity. For example, a pressure relief device is an active IPL that opens when there is an abnormal change in the pressure inside a vessel and remains open until the pressure in the vessel reduces to a value below the settings in the pressure relief device.

In LOPA, you can create an Active IPL record for each type of active IPL. This record stores the recommended probability of failure on demand (PFD) of the active IPL device or system. The PFD value indicates the likelihood that the active IPL system will fail to perform its safety function when required. The Active IPL records populate the IPL Sub Type field in the **IPL Checklist** section of the Safeguard, which is of type Active IPL.

Default Active IPL Records

By default, the following Active IPL records are available in GE Digital APM:

Active IPL ID	Lower Range	Upper Range	Default Value
Rupture disc	1E-05	0.1	0.01
Relief Valve	1E-05	0.1	0.01
Basic Process Control System	0.01	0.1	0.1

Access an Active IPL

Procedure

1. Access the **LOPA Admin** page.
2. In the left pane, select **Active IPL**.
   A list of available Active IPLs appears.
3. In the **Active IPL ID** column, select the link for the Active IPL that you want to access.
   In the Record Manager, the page for the selected record appears, displaying the datasheet for the record.

   Note: To modify the Active IPL, as needed, modify values in the available fields, and then select to save your changes. The values in the existing Safeguards that have used the modified Active IPL will not be affected by the changes. If you want to apply the changes to an existing Safeguard, in the **IPL Checklist** section of the Safeguard, in the **IPL Sub Type** box, you must reselect the Active IPL that you modified.

Create an Active IPL

Before You Begin

- For the Active IPL that you want to create, you must create a system code in the MI_ACTIVE_IPL System Code Table. The System Code Table populates the **Active IPL ID** box. When you create the Active IPL, in the **Active IPL ID** box, you must select the value that you entered in the System Code Table.

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Procedure

1. Access the **LOPA Admin** page.
2. In the left pane, select **Active IPL**.
   A list of available Active IPLs appears.
3. In the upper-left corner of the workspace, select .
   A blank datasheet for Active IPL appears.
4. As needed, enter values in the available fields.
5. In the upper-right corner of the workspace, select .
   The Active IPL record is created.

Results

- In the **IPL Checklist** section of the Safeguard of type Active IPL, the Active IPL that you created appears in the list of values in the **IPL Sub Type** box.

Delete an Active IPL

Before You Begin

- Before you can delete an Active IPL, you must delete the corresponding System Code that you created in the MI_ACTIVE_IPL System Code Table.

Procedure

1. Access the **LOPA Admin** page.
2. In the left pane, select **Active IPL**.
   A list of available Active IPLs appears.
3. In the row for each Active IPL that you want to delete, select the check box.

   In the upper-right corner of the workspace, the button is enabled.
4. Select .
   The **Delete Active IPL** dialog box appears, asking you to confirm that you want to delete each selected Active IPL.
5. Select **OK**.
   Each selected Active IPL is deleted.

Results

- In the **IPL Checklist** section of the Safeguard of type Active IPL, the Active IPL that you deleted does not appear in the list of values in the **IPL Sub Type** box.

  Note: The values in the existing Safeguards that have used the deleted Active IPL will not be affected when you delete the Active IPL record.

Passive IPLs

About Passive IPLs

A passive IPL can achieve its risk reducing function without the requirement to take any action or change the state of the system. For example, detonation arrestors and blast walls are passive IPLs that reduce the risk.

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In LOPA, you can create a Passive IPL record for each type of passive IPL. This record stores the recommended probability of failure on demand (PFD) of the passive IPL device or system. The PFD value indicates the likelihood that the passive IPL system will fail to perform its safety function when required. The Passive IPL records populate the IPL Sub Type field in the **IPL Checklist** section of the Safeguard, which is of type Passive IPL.

Default Passive IPL Records

By default, the following Passive IPL records are available in GE Digital APM:

Passive IPL ID	Lower Range	Upper Range	Default Value
Blast-wall/Bunker	0.001	0.01	0.001
Fireproofing	0.001	0.01	0.01
Open Vent	0.001	0.01	0.01
Underground Drainage System	0.001	0.01	0.01
Flame/Detonation Arrestors	0.001	0.1	0.01
Dike	0.001	0.01	0.01
Inherently Safe design	1E-06	0.1	0.01

Access a Passive IPL

Procedure

1. Access the **LOPA Admin** page.
2. In the left pane, select **Passive IPL**.
   A list of available Passive IPLs appears.
3. In the **Passive IPL ID** column, select the link for the Passive IPL that you want to access.
   In the Record Manager, the page for the selected record appears, displaying the datasheet for the record.

   Note: To modify the Passive IPL, as needed, modify values in the available fields, and then select to save your changes. The values in the existing Safeguards that have used the modified Passive IPL will not be affected by the changes. If you want to apply the changes to an existing Safeguard, in the **IPL Checklist** section of the Safeguard, in the **IPL Sub Type** box, you must reselect the Passive IPL that you modified.

Create a Passive IPL

Before You Begin

- For the Passive IPL that you want to create, you must create a System Code in the MI_PASSIVE_IPL System Code Table. The System Code Table populates the **Passive IPL ID** box. When you create the Passive IPL, in the **Passive IPL ID** box, you must select the value that you entered in the System Code Table.

Procedure

1. Access the **LOPA Admin** page.

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2. In the left pane, select **Passive IPL**.
   A list of available Passive IPLs appears.
3. In the upper-left corner of the workspace, select +.
   A blank datasheet for Passive IPL appears.
4. As needed, enter values in the available fields.
5. In the upper-right corner of the workspace, select .
   The Passive IPL record is created.

Results

- In the **IPL Checklist** section of the Safeguard of type Passive IPL, the Passive IPL that you created appears in the list of values in the **IPL Sub Type** box.

Delete a Passive IPL

Before You Begin

- Before you can delete a Passive IPL, you must delete the corresponding System Code that you created in the MI_PASSIVE_IPL System Code Table.

Procedure

1. Access the **LOPA Admin** page.
2. In the left pane, select **Passive IPL**.
   A list of available Passive IPLs appears.
3. In the row for each Passive IPL that you want to delete, select the check box.

   In the upper-right corner of the workspace, the button is enabled.
4. Select .
   The **Delete Passive IPL** dialog box appears, asking you to confirm that you want to delete each selected Passive IPL.
5. Select **OK**.
   Each selected Passive IPL is deleted.

Results

- In the **IPL Checklist** section of the Safeguard of type Passive IPL, the Passive IPL that you deleted does not appear in the list of values in the **IPL Sub Type** box.

  Note: The values in the existing Safeguards that have used the deleted Passive IPL will not be affected when you delete the Passive IPL record.

Human IPLs

About Human IPLs

Human IPLs are IPLs that require operators or other staff to take action to prevent an undesired consequence, in response to alarms or following a routine check of the system.

In LOPA, you can create a Human IPL record for each type of human IPL. This record stores the recommended probability of failure on demand (PFD) of the human IPL. The PFD value indicates the likelihood that the Human IPL will fail to perform its safety function when required. The Human IPL

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records populate the IPL Sub Type field in the **IPL Checklist** section of the Safeguard, which is of type Human IPL.

Default Human IPL Records

By default, the following Human IPL records are available in GE Digital APM:

Human IPL ID	Lower Range	Upper Range	Default Value
Human Action with BPCS/ alarm-4 min response time	0.01	1	0.1
Human Action with >10 min response time	0.1	1	0.1
Human Action with >40 min response time	0.01	0.1	0.1

Access a Human IPL

Procedure

1. Access the **LOPA Admin** page.
2. In the left pane, select **Human IPL**.
   A list of available Human IPLs appears.
3. In the **Human IPL ID** column, select the link for the Human IPL that you want to access.
   In the Record Manager, the page for the selected record appears, displaying the datasheet for the record.

   Note: To modify the Human IPL, as needed, modify values in the available fields, and then select to save your changes. The values in the existing Safeguards that have used the modified Human IPL will not be affected by the changes. If you want to apply the changes to an existing Safeguard, in the **IPL Checklist** section of the Safeguard, in the **IPL Sub Type** box, you must reselect the Human IPL that you modified.

Create a Human IPL

Before You Begin

- For the Human IPL that you want to create, you must create a system code in the MI_HUMAN_IPL System Code Table. The system code populates the **Human IPL ID** box. When you create the Human IPL, in the **Human IPL ID** box, you must select the value that you entered in the System Code Table.

Procedure

1. Access the **LOPA Admin** page.
2. In the left pane, select **Human IPL**.
   A list of available Human IPLs appears.
3. In the upper-left corner of the workspace, select .
   A blank datasheet for Human IPL appears.
4. As needed, enter values in the available fields.
5. In the upper-right corner of the workspace, select .
   The Human IPL record is created.

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Results

- In the **IPL Checklist** section of the Safeguard of type Human IPL, the Human IPL that you created appears in the list of values in the **IPL Sub Type** box.

Delete a Human IPL

Before You Begin

- Before you can delete a Human IPL, you must delete the corresponding System Code that you created in the MI_HUMAN_IPL System Code Table.

Procedure

1. Access the **LOPA Admin** page.
2. In the left pane, select **Human IPL**.
   A list of available Human IPLs appears.
3. In the row for each Human IPL that you want to delete, select the check box.
   In the upper-right corner of the workspace, the button is enabled.
4. Select .
   The **Delete Human IPL** dialog box appears, asking you to confirm that you want to delete each selected Human IPL.
5. Select **OK**.
   Each selected Human IPL is deleted.

Results

- In the **IPL Checklist** section of the Safeguard of type Human IPL, the Human IPL that you deleted does not appear in the list of values in the **IPL Sub Type** box.

  Note: The values in the existing Safeguards that have used the deleted Human IPL will not be affected when you delete the Human IPL record.

Initiating Events

About Initiating Events

Initiating events represent the various types of causes that can result in a hazardous scenario. In LOPA, you can create an Initiating Event record for each type of initiating cause. When you create a LOPA, these records are used to populate the frequency of occurrence of the Initiating Event.

Default Initiating Event Records

By default, the following Initiating Event records are available in GE Digital APM:

Initiating Event ID	Lower Boundary	Upper Boundary	Default Value
Gasket/packing blowout	1E-06	0.01	0.01
LOTO(lock-out-tag-out)	0.0001	0.001	0.001
Unloading/loading hose failure	0.01	1	0.01

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Initiating Event ID	Lower Boundary	Upper Boundary	Default Value
Cooling water failure	0.01	1	0.01
Atmospheric tank failure	1E-05	0.001	0.001
Crane load drop	0.0001	0.001	0.0001
Piping residual failure-100m-Full Breach	1E-06	1E-05	1E-05
Pump seal failure	0.01	0.1	0.1
Piping leak(10% section)-100m	0.0001	0.001	0.001
Pressure Vessel Residual Failure	1E-07	1E-05	1E-06
Large external fire(aggregate causes)	0.001	0.01	0.01
Safety valve opens spuriously	0.0001	0.01	0.01
BPCS instrument loop failure	0.01	1	0.1
Regulator failure	0.1	1	0.1
Operator failure	0.0001	0.1	0.01
Small external fire(aggregate causes)	0.01	0.1	0.1
Lightning strike	0.0001	0.001	0.001
Third party intervention(external impact by backhoe, vehicle, etc.)	0.0001	0.01	0.01
Turbine/diesel engine overspeed with casing breach	0.0001	0.001	0.0001

Access an Initiating Event

Procedure

1. Access the **LOPA Admin** page.
2. In the left pane, select **Initiating Events**.
   A list of available Initiating Events appears.
3. In the row for the Initiating Event that you want to access, in the **Initiating Event ID** column, select the link.
   In the Record Manager, the page for the selected record appears, displaying the datasheet for the record.

   Note: To modify the Initiating Event, as needed, modify values in the available fields, and then select to save your changes. The values in the existing LOPA and Hazards Analysis Cause records that have used the modified Initiating Event, will not be affected by the changes.

   - If you want to apply the changes to an existing LOPA, on the LOPA datasheet, in the **Initiating Event Type** box, you must reselect the Initiating Event that you modified.

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- If you want to apply the changes to an existing Cause, on the Hazards Analysis Cause datasheet, in the **CCPS Cause Type** box, you must reselect the Initiating Event that you modified.

Create an Initiating Event

Before You Begin

- For the Initiating Event that you want to create, you must create a system code in the INIT_EVENT System Code Table. The System Code Table populates the **Initiating Event ID** box. When you create the Initiating Event, in the **Initiating Event ID** box, you must select the value that you entered in the System Code Table.

Procedure

1. Access the **LOPA Admin** page.
2. In the left pane, select **Initiating Events**.
   A list of available Initiating Events appears.
3. In the upper-left corner of the workspace, select +.
   A blank datasheet for Initiating Event appears.
4. As needed, enter values in the available fields.
5. In the upper-right corner of the workspace, select .
   The Initiating Event record is created.

Results

- On the LOPA datasheet, the Initiating Event that you created appears in the list of values in the **Initiating Event Type** box.
- On the Hazards Analysis Cause datasheet, the Initiating Event that you created appears in the list of values in the **CCPS Cause Type** box.

Delete an Initiating Event

Before You Begin

- Before you can delete an Initiating Event, you must delete the corresponding System Code that you created in the INIT_EVENT System Code Table.

Procedure

1. Access the **LOPA Admin** page.
2. In the left pane, select **Initiating Events**.
   A list of available Initiating Events appears.
3. In the row for each Initiating Event that you want to delete, select the check box.
   In the upper-right corner of the workspace, the button is enabled.
4. Select .
   The **Delete Initiating Events** dialog box appears, asking you to confirm that you want to delete each selected Initiating Event.
5. Select **OK**.
   Each selected Initiating Event is deleted.

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Results

- On the LOPA datasheet, the Initiating Event that you deleted does not appear in the list of values in the **Initiating Event Type** box.
- On the Hazards Analysis Cause datasheet, the Initiating Event that you deleted does not appear in the list of values in the **CCPS Cause Type** box.

  Note: The values in the existing LOPA and Hazards Analysis Cause records that have used the deleted Initiating Event will not be affected when you delete the Initiating Event record.

Consequence Probabilities

About Consequence Probabilities

Consequence Probabilities represent the probability of occurrence of various modifier types and are stored in the Consequence Adjustment Probability records. When you create a Conditional Modifier in LOPA, these records are used to populate the probability for the selected modifier type.

Default Consequence Adjustment Probabilities Records

By default, the following Consequence Adjustment Probabilities records are available in GE Digital APM:

Modifier ID	Default Value
Probability of Ignition	0.5
Probability of Escape and Incident	0.5
Others	0.5
Probability of person present	0.5

Access a Consequence Probability

Procedure

1. Access the **LOPA Admin** page.
2. In the left pane, select **Consequence Probabilities.**
   A list of available Consequence Probabilities appears.
3. In the row for the Consequence Probability that you want to access, in the **Modifier ID** column, select the link.
   In the Record Manager, the page for the selected record appears, displaying the datasheet for the record.

   Note: To modify the Consequence Probability, as needed, modify values in the available fields, and then select to save your changes. The values in the existing Conditional Modifiers that have used the modified Consequence Probability will not be affected by the changes. If you want to apply the changes to an existing Conditional Modifier, on the Consequence Modifier datasheet, in the **Type** box, you must reselect the Consequence Probability that you modified.

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Create a Consequence Probability

Before You Begin

- For the Consequence Probability that you want to create, you must create a system code in the MI_CONSQ_ADJ_PROB System Code Table. The System Code Table populates the **Modifier ID** box. When you create the Consequence Probability, in the **Modifier ID** box, you must select the value that you entered in the System Code Table.

Procedure

1. Access the **LOPA Admin** page.
2. In the left pane, select **Consequence Probabilities**.
   A list of available Consequence Probabilities appears.
3. In the upper-left corner of the workspace, select .
   A blank datasheet for Consequence Adjustment Probabilities appears.
4. As needed, enter values in the available fields.
5. In the upper-right corner of the workspace, select .
   The Consequence Probability is created.

Results

- On the Consequence Modifier datasheet, the Consequence Probability that you created appears in the list of values in the **Type** box.

Delete a Consequence Probability

Before You Begin

- Before you can delete a Consequence Probability, you must delete the corresponding System Code that you created in the MI_CONSQ_ADJ_PROB System Code Table.

Procedure

1. Access the **LOPA Admin** page.
2. In the left pane, select **Consequence Probabilities**.
   A list of available Consequence Probabilities appears.
3. In the row for each Consequence Probability that you want to delete, select the check box.

   In the upper-right corner of the workspace, the button is enabled.
4. Select .
   The **Delete Consequence Probability** dialog box appears, asking you to confirm that you want to delete each selected Consequence Probability.
5. Select **OK**.
   Each selected Consequence Probability is deleted.

Results

- On the Consequence Modifier datasheet, the Consequence Probability that you deleted does not appear in the list of values in the **Type** box.

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Note: The values in the existing Consequence Modifiers that have used the deleted Consequence Probability will not be affected when you delete the Consequence Probability.

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Chapter 7

Deployment and Upgrade

Topics:

- Deployment
- Upgrade

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Deployment

Deployment

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

Upgrade

Upgrade

Refer to the upgrade information here Upgrade or Update LOPA to V5.0.2.0.0.

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Chapter 8

Reference

Topics:

- General Reference
- Family Field Descriptions
- Catalog Items

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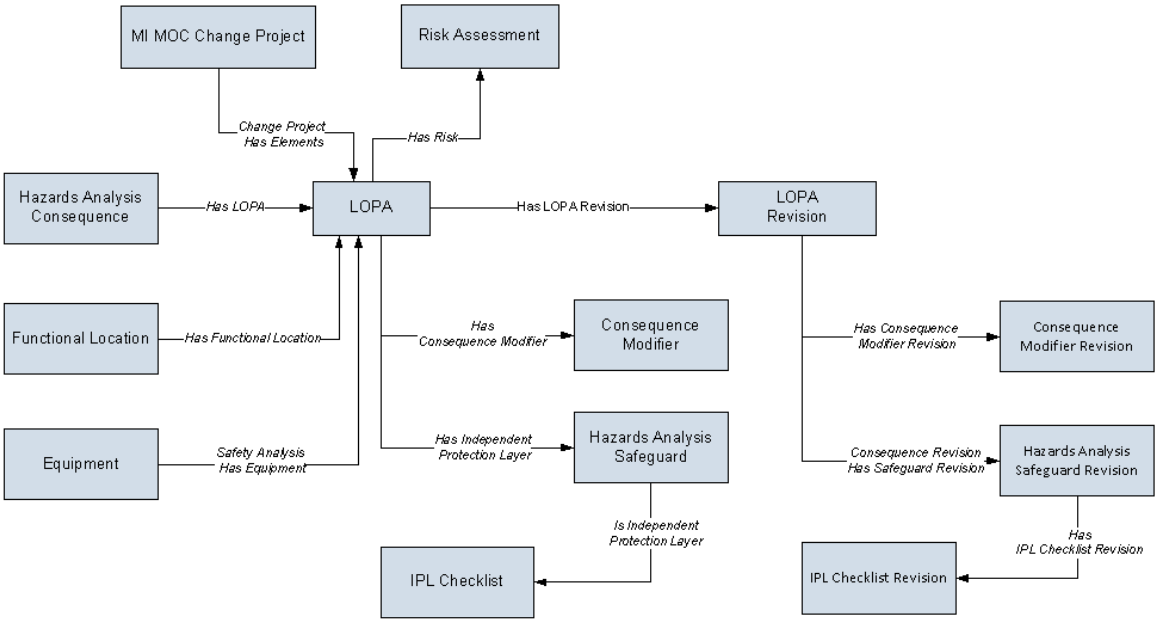
General Reference

LOPA Data Model

The following diagram shows how the families used in LOPA are related to one another.



Note: In the diagram, boxes represent entity families and arrows represent relationship families that are configured in the baseline database. You can determine the direction of the each relationship definition from the direction of the arrow head: the box from which the arrow originates is the predecessor, and the box to which the arrow head points is the successor.

The Has LOPA relationship between Hazards Analysis Consequence and LOPA is used only if you create or link a LOPA with a Consequence in Hazards Analysis.

Apart from the families shown in the data model, the following families are also used in LOPA to populate certain fields in datasheets:

- Initiating Event
- Active IPL
- Human IPL
- Passive IPL
- Consequence Adjustment Probability
- Safety Integrity Level

LOPA Security Groups

The following table lists the baseline Security Groups available for users within this module, as well as the baseline Roles to which those Security Groups are assigned.

Important: Assigning a Security User to a Role grants that user the privileges associated with all of the Security Groups that are assigned to that Role. To avoid granting a Security User unintended privileges, before assigning a Security User to a Role, be sure to review all of the privileges associated with the

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Security Groups assigned to that Role. Also, be aware that additional Roles, as well as Security Groups assigned to existing Roles, can be added via Security Manager.

Security Group	Roles
MI HA Administrator	MI HA Administrator MI Safety Admin
MI HA Facilitator	MI HA Facilitator MI Safety Admin MI Safety Power MI Safety User
MI HA Member	MI HA Member MI Safety Admin MI Safety Power MI Safety User
MI HA Owner	MI HA Owner MI Safety Admin MI Safety Power
MI Hazards Viewer	MI APM Viewer MI Hazards Viewer MI Safety Admin MI Safety Power MI Safety User
MI SIS Administrator	MI Safety Admin MI SIS Administrator
MI SIS Engineer	MI Safety Admin MI Safety Power MI Safety User MI SIS Engineer

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Security Group	Roles
MI SIS User	MI Safety Admin MI Safety Power MI Safety User MI SIS User
MI SIS Viewer	MI APM Viewer MI Safety Admin MI Safety Power MI Safety User MI SIS Engineer MI SIS Viewer

The baseline family-level privileges that exist for these Security Groups are summarized in the following table.

Family	MI HA Administrator	MI HA Facilitator	MI HA Member	MI HA Owner	MI Hazards Viewer	MI SIS Administrator	MI SIS Engineer	MI SIS User	MI SIS Viewer
Entity Families									
Active IPL	View, Update, Insert, Delete	View	View	View	View	View, Update, Insert, Delete	View	View	View
Asset Safety Preferences	View, Update, Insert, Delete	View	View	View	View	View, Update, Insert, Delete	View	View	View
Consequence Adjustment Probability	View, Update, Insert, Delete	View	View	View	View	View, Update, Insert, Delete	View	View	View
Consequence Modifier	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View	View	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View
Consequence Modifier Revision	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View	View	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View

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Family	MI HA Administrator	MI HA Facilitator	MI HA Member	MI HA Owner	MI Hazards Viewer	MI SIS Administrator	MI SIS Engineer	MI SIS User	MI SIS Viewer
Hazards Analysis Safeguard	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View, Update, Insert, Delete	View	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View
Hazards Analysis Safeguard Revision	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View, Update, Insert, Delete	View	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View
Human IPL	View, Update, Insert, Delete	View	View	View	View	View, Update, Insert, Delete	View	View	View
Initiating Event	View, Update, Insert, Delete	View	View	View	View	View, Update, Insert, Delete	View	View	View
IPL Checklist	View, Update, Insert, Delete	View	View	View	View	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View
IPL Checklist Revision	View, Update, Insert, Delete	View	View	View	View	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View
LOPA	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View	View	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View
LOPA Revision	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View	View	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View
Passive IPL	View, Update, Insert, Delete	View	View	View	View	View, Update, Insert, Delete	View	View	View
Safety Integrity Level	None	None	None	None	None	View, Update, Insert, Delete	View	View	View
Relationship Families									

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Family	MI HA Administrator	MI HA Facilitator	MI HA Member	MI HA Owner	MI Hazards Viewer	MI SIS Administrator	MI SIS Engineer	MI SIS User	MI SIS Viewer
Consequence Revision Has Safeguard Revision	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View, Update, Insert, Delete	View	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View
Has Consequence Modifier	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View	View	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View
Has Consequence Modifier Revision	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View	View	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View
Has Functional Location	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View, Update, Insert, Delete	View	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View
Has Independent Protection Layer	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View	View	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View
Has IPL Checklist Revision	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View, Update, Insert, Delete	View	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View
Has LOPA	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View	View	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View
Has LOPA Revision	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View	View	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View

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Family	MI HA Administrator	MI HA Facilitator	MI HA Member	MI HA Owner	MI Hazards Viewer	MI SIS Administrator	MI SIS Engineer	MI SIS User	MI SIS Viewer
Has Risk	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View, Update, Insert, Delete	View	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View
Is Independent Protection Layer	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View, Update, Insert, Delete	View	View, Update, Insert, Delete	View, Update, Insert, Delete	View	View

LOPA URLs

There is one URL route associated with LOPA: `asset-safety/lopa`. The following table describes the various paths that build on the route, and the elements that you can specify for each.

Element	Description	Accepted Value(s)	Notes
`asset-safety/lopa/admin`: Displays the **LOPA Admin** page.			
`asset-safety/lopa/overview`: Displays the **LOPA Overview** page.			
`asset-safety/lopa/<EntityKey>`: Displays the **LOPA Summary** workspace of the LOPA with the specified Entity Key.			
<EntityKey>	Specifies the Entity Key of the LOPA that you want to access.	Any numeric Entity Key that corresponds to an existing LOPA.	This value is required to access an existing LOPA and its related records (i.e., Safeguards and Conditional Modifiers) from a URL.
`asset-safety/lopa/overview/<AssetKey>`: Displays the **LOPA Overview** page. The information on the page is filtered by the asset specified by the Asset Key.			
<AssetKey>	Specifies the Asset Key of the asset based on which you want to filter information on the **LOPA Overview** page.	Any numeric Asset Key that corresponds to an existing asset.	None
`asset-safety/lopa/revision/lopa/<EntityKey>`: Displays the **Revision History** workspace of the LOPA with the specified Entity Key.			
<EntityKey>	Specifies the Entity Key of the LOPA whose Revision History you want to access.	Any numeric Entity Key that corresponds to an existing LOPA.	This value is required to access the Revision History of an existing LOPA and its related records (i.e., Safeguards and Conditional Modifiers) from a URL.

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URLs

Example URL	Destination
`asset-safety/lopa/2996482`	The **LOPA Summary** workspace of the LOPA with the Entity Key 2996482.
`asset-safety/lopa/overview/64251832823`	The **LOPA Overview** page appears. In the **Under Review** and **Approved** section, the list of LOPAs associated with the asset whose Asset Key is 64251832823 and with all assets within the hierarchy level of the specified asset appears.
`asset-safety/lopa/revision/lopa/2996482`	The **Revision History** workspace of the LOPA with the Entity Key 2996482.

LOPA System Code Tables

The following table lists the System Code Tables that are used by the Layers of Protection Analysis module.

Table ID	Table Description	Function
INIT_EVENT	Initiating events for LOPA	Populates the Initiating Event ID field in Initiating Event records.
MI_CONSQ_ADJ_PROB	Consequence Adjustment Probabilities	Populates the Modifier ID field in the Consequence Adjustment Probabilities records.
MI_IPL_TYPES_SAFEGUARD	Types of IPL	Populates the Type field in the Safeguard record.
MI_ACTIVE_IPL	Types of Active IPL	Populates the Active IPL ID field in Active IPL records.
MI_PASSIVE_IPL	Types of Passive IPL	Populates the Passive IPL ID field in Passive IPL records.
MI_HUMAN_IPL	Types of Human IPL	Populates the Human IPL ID field in Human IPL records.
MI_HAZOP_SAFEGUARD_TYPE	Types of Safeguards	Populates the Safeguard Type field in the Safeguard record.

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About Calculations in LOPA

Calculating Unmitigated Consequence Frequency

Unmitigated Consequence Frequency = Frequency of Initiating Event x Probability of occurrence of Enabling Event x Probability of occurrence of Conditional Modifier

Where,

- Frequency of Initiating Event is the value in the Frequency of Initiating Event field in LOPA.
- Probability of occurrence of Enabling Event is the value in the Enabling Event/Conditional Probability field in LOPA.
- Probability of occurrence of Conditional Modifier is the product of value in Probability field of all the Conditional Modifiers associated with the LOPA.

If Enabling Event/Condition Probability field is blank, a default value of 1 will be used in the calculation.

Calculating Total IPL PFD

Total IPL PFD = Product of value in PFD field of all the Safeguards associated with the LOPA

Calculating Mitigated Consequence Frequency

Mitigated Consequence Frequency = Unmitigated Consequence Frequency x Total IPL PFD

Where,

- Unmitigated Consequence Frequency is the value in the Unmitigated Consequence Frequency field in LOPA
- Total IPL PFD is the product of value in the PFD fields of all the Safeguards associated with the LOPA

If there are no IPLs associated with the LOPA, then Mitigated Consequence Frequency is equal to the Unmitigated Consequence Frequency.

Calculating Required PIF PFD

Required PIF PFD = Required Mitigated Consequence Frequency / Mitigated Consequence Frequency

Where,

- Required Mitigated Consequence Frequency is the value in Required Mitigated Consequence Frequency in LOPA.
- Mitigated Consequence Frequency is the value in the Mitigated Consequence Frequency field in LOPA.

Calculating Required PIF Risk Reduction Factor

Required PIF Risk Reduction Factor = 1/ Required PIF PFD

Where,

- Required PIF PFD is the value in Required PIF PFD field in LOPA.

Calculated SIL Value

This value is derived based on the industry standard for SIL values.

Example of Calculations in LOPA

The following table contains the data used in the example and only lists fields that are required and contain a value.

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Field	Value
Suppose that you create a LOPA with the following values:	
LOPA ID	Lopa_Example
Unacceptable Consequence	Explosion
Initiating Event Type	Gasket/packing blowout
Frequency of Initiating Event	0.01
Required Mitigated Consequence Frequency	1E-05 (i.e., 0.00001)
Fields that are automatically populated in LOPA	
Unmitigated Consequence Frequency	0.01
Mitigated Consequence Frequency	0.01
Required PIF Risk Reduction Factor	1000
Required PIF PFD	0.001
Calculated SIL	2
Create a Conditional Modifier with the following values:	
Conditional Modifier ID	Modifier1
Type	Probability of Ignition
Probability	0.5
Fields that are updated in LOPA after adding a Conditional Modifier	
Unmitigated Consequence Frequency	0.005
Mitigated Consequence Frequency	0.005
Required PIF PFD	0.002
Required PIF Risk Reduction Factor	500
Calculated SIL	2
Create a Safeguard and specify as IPL with the following values:	
Safeguard ID	Safeguard1
IPL Type	Human IPL
IPL Sub Type	Human Action with >10 min response time
PFD	0.1

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Field	Value
Fields that are updated in LOPA after adding a Safeguard that is an IPL	
Total IPL PFD	0.1
Unmitigated Consequence Frequency	0.005
Mitigated Consequence Frequency	0.0005
Required PIF PFD	0.02
Required PIF Risk Reduction Factor	50
Calculated SIL	1

LOPA State Management

The following states are configured for the LOPA family:

- Planning: Indicates that the analysis is in the Planning state. You can modify or delete a LOPA and its related records (i.e., Conditional Modifiers and Safeguards) only if the LOPA is in Planning state. Additionally, if you have linked the LOPA to a Consequence in the Hazards Analysis, then to add or modify a Safeguard, the Hazards Analysis with which the Consequence is associated must also be in the Planning State.
- Active: Indicates that the LOPA is active.
- Review: Indicates that the LOPA has been sent for review.
- Pending Approval: Indicates that the LOPA has been reviewed and is awaiting approval.
- Complete: Indicates that the analysis is approved. After the state of the LOPA is changed to Complete:
    - A LOPA Revision is created, which stores a snapshot of the LOPA when the state was changed to Complete.
    - The number of revisions for the LOPA is incremented by one, and appears in the upper-right corner of the **LOPA Summary** workspace.
    - If the LOPA is linked to a LOPA Assessment in an Instrumented Function, then the values in the associated LOPA Assessment are updated based on the values in the LOPA.

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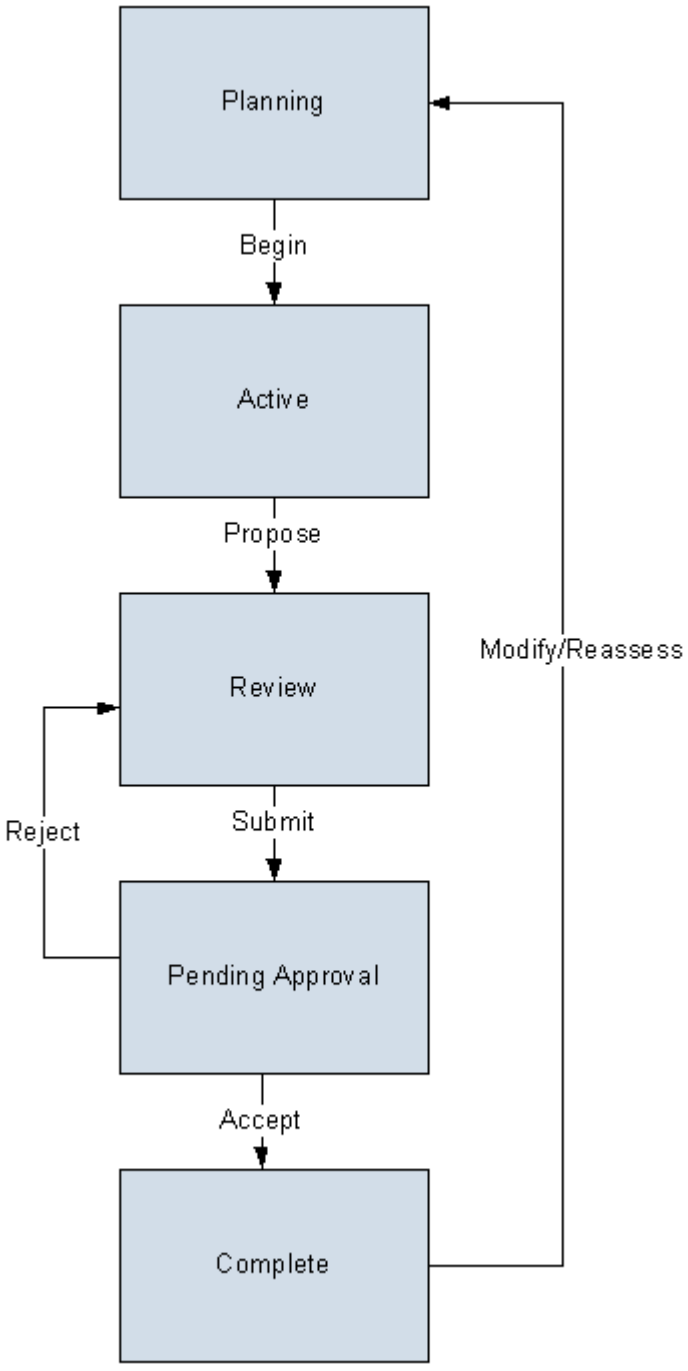
Illustration of LOPA State Configuration



State Configuration Roles

The following table lists the baseline states, the operation that can be performed on each state, and the State Configuration Roles assigned to each state:

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State	Operation	User Role
Planning	Begin	MI Safety Admin, MI Safety Power, MI Safety User
Active	Propose	MI Safety Admin, MI Safety Power, MI Safety User
Review	Submit	MI Safety Admin, MI Safety Power, MI Safety User
Pending Approval	Accept	MI Safety Admin, MI Safety Power
	Reject	
Complete	Modify/Reassess	MI Safety Admin, MI Safety Power

LOPA Site Filtering

Site filtering in LOPA is achieved by specifying a site on the **Definition** section of a LOPA and that site assignment is applied to all the related records. Users must have privileges for the relevant site to access records for the specified site. Users can be assigned to one or many sites. They will be able to see only the records that are assigned to their site(s) or those that are global records.

Site filtering is enabled for the following families:

- LOPA: When you create a LOPA, you can assign it to any site. After you save the changes, you cannot modify the site for the LOPA.
- Consequence Modifier: A Conditional Modifier will inherit the site from the associated LOPA.
- Hazards Analysis Safeguard: A Safeguard will inherit the site from the associated LOPA.

Example

Consider an organization that has three sites, Site X, Site Y, and Site Z and contains the following records:

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

Scenario 1: User assigned to only Site X

When this user accesses the **LOPA Overview** page, the user will be able to see the records that are assigned to Site X:

- LOPA 1: Assigned to Site X

The user will also be able to see the Consequence Modifiers and Safeguards associated with LOPA 1.

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

When this user accesses the **LOPA Overview** page, the user will be able to see the records that are assigned to Site X and Site Y:

- LOPA 1: Assigned to Site X
- LOPA 2: Assigned to Site Y

The user will also be able to see the Consequence Modifiers and Safeguards associated with LOPA 1 and LOPA 2.

Scenario 3: Super User

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When this user accesses the **LOPA Overview** page, the user will be able to see the records that are assigned to any of the sites:

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

The user will also be able to see the Consequence Modifiers and Safeguards associated with LOPA 1, LOPA 2, and LOPA 3.

Scenario 4: Hazop or What If Analysis Assigned to Site X

When the user searches for LOPA to link with the Consequence for a Hazop or What If analysis assigned to Site X, the user will be able to see the LOPA records that are assigned to Site X:

- LOPA 1: Assigned to Site X

Scenario 5: Instrumented Function Assigned to Site X

When the user searches for LOPA to link with an SIL Assessment of an Instrumented Function assigned to Site X, the user will be able to see the LOPA records that are assigned to Site X:

- LOPA 1: Assigned to Site X

Family Field Descriptions

Active IPL Records

Active IPL records store information about the probability of failure of various types of active IPLs. This topic provides an alphabetical list and description of the fields that exist for the Active IPL family. The information in the table reflects the baseline state and behavior of these fields.

Important: The records in this family can be modified only by users who belong to the Security Groups MI SIS Administrator or MI HA Administrator.

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.

Field	Data Type	Description	Behavior and Usage
Active IPL ID	Character	Identifies the type of Active IPL.	This field appears a list that is populated by the MI_ACTIVE_IPL System Code Table.
Default Value	Numeric	Indicates the default probability that the Active IPL will fail to mitigate the risk.	You can enter a value manually.

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Field	Data Type	Description	Behavior and Usage
Lower Range	Numeric	Indicates the lower range for the probability that the Active IPL will fail to mitigate the risk.	You can enter a value manually.
Upper Range	Numeric	Indicates the upper range for the probability that the Active IPL will fail to mitigate the risk.	You can enter a value manually.

Asset Safety Preferences Records

Asset Safety Preferences records are used to store information about the criteria that a Safeguard must meet to be classified as an IPL. This topic provides an alphabetical list and description of the fields that exist for the Asset Safety Preferences family and appear on the Asset Safety Preferences datasheet. The information in the table reflects the baseline state and behavior of these fields. You can modify the records in this family only if you belong to the Security Group MI SIS Administrator or MI HA Administrator.

This family is not enabled for site filtering, which means that records in this family can be accessed by any user with the appropriate license and family privileges. For more information, refer to the Sites section of the documentation.

Field	Data Type	Description	Behavior and Usage
Preference Category	Character	Indicates the type of preference that you are defining.	This field is automatically populated with the following value: IPL. **Important:** You must not modify the value in this field.
Preference Name	Character	Indicates the name for the IPL criteria.	You can enter a value manually.
Preference Value	Character	Indicates the criteria that you want to configure for a Safeguard to be identified as an IPL.	You can enter a value manually. This field appears in the **IPL Checklist** section of the Safeguard datasheet.

Consequence Adjustment Probabilities Records

Consequence Adjustment Probability records are used to determine the probability that a conditional modifier event may occur, thereby adjusting the frequency of unmitigated consequence. This topic provides an alphabetical list and description of the fields that exist for the Consequence Adjustment Probability family and appear on the Conditional Modifier datasheet. The information in the table reflects the baseline state and behavior of these fields. These records in this family can be modified only by users who belong to the Security Groups MI SIS Administrator or MI HA Administrator.

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.

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Field	Data Type	Description	Behavior and Usage
Default Value	Numeric	Indicates the default value for probability of occurrence of the conditional modifier.	You can enter a value manually.
Modifier ID	Character	Identifies the type of conditional modifier.	This field appears a list that is populated by the MI_CONSQ_ADJ_PROB System Code Table.

Consequence Modifier Records

Consequence Modifier records store details about conditional modifiers (i.e., an event or action that can increase or decrease the probability that a risk may occur if not mitigated). This topic provides an alphabetical list and description of the fields that exist for the Consequence Modifier family and appear on the Conditional Modifier datasheet. The information in the table reflects 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.

Field	Data Type	Description	Behavior and Usage
Conditional Modifier ID	Character	The identification for the conditional modifier.	The value entered in this field must be unique. This field is required.
Description	Character	The description of the conditional modifier.	You can enter a value manually.

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Field	Data Type	Description	Behavior and Usage
Modifier Type	Character	The type of conditional modifier.	This field is required. This field is labeled **Type** on the Consequence Modifier datasheet. This field is populated with the value in the Modifier ID field of Consequence Adjustment Probabilities records.
Probability	Numeric	The probability that the conditional modifier can occur.	This field is disabled on the datasheet. Based on your selection in the Type field on the Consequence Modifier datasheet, this field is populated with the value in the Default Value field in the Consequence Adjustment Probability record. This value is multiplied by the value in the Enabling Event/ Condition Probability field on the Layer of Protection Analysis (LOPA) datasheet to calculate the final probability for the initiating event.

Hazards Analysis Safeguard Records

Hazards Analysis Safeguard records store details on safeguards that can be used to mitigate the risk. If the safeguard is an IPL, then these records also store the details of the IPL Type and the corresponding PFD value. This topic provides an alphabetical list and description of the fields that exist for the Hazards Analysis Safeguard family. These fields appear on the Hazards Analysis Safeguard datasheet and in the **IPL Checklist** section of the **Safeguards and IPLs** workspace. The information in this table reflects the baseline state and behavior of these fields. This list is not comprehensive.

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.

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Field	Data Type	Description	Behavior and Usage
Equipment ID	Character	The identification of the Equipment that is linked to the Safeguard through the Safety Analysis Has Equipment Relationship family.	You can select an Equipment to associate with the Safeguard. When you associate an Equipment with the Safeguard, the Functional Location to which the Equipment belongs is automatically associated with the Safeguard, and appears in the **Functional Location ID** box on the datasheet.
Equipment Key	Numeric	The Entity Key of the Equipment whose ID appears in the Equipment ID field.	This field does not appear on the datasheet by default.
Functional Location ID	Character	The identification of the Functional Location that is linked to the Safeguard through the Has Functional Location Relationship family.	You can select a Functional Location to associate with the Safeguard.
Functional Location Key	Numeric	The Entity Key for the Functional Location whose ID appears in the Functional Location ID field.	This field does not appear on the datasheet by default.
IF ID	Character	The ID of the Instrumented Function that is linked to the Safeguard.	You can select an Instrumented Function to associate with the Safeguard.
IF Key	Numeric	The Entity Key for the Instrumented Function whose ID appears in the IF ID field.	This field does not appear on the datasheet by default.
IPL Credits	Numeric	Indicates the order of magnitude by which the independent protection layer reduces the risk.	You can select a value from 1 through 10 from the drop-down list box. This field appears in the **IPL Checklist** section of the **Safeguards and IPLs** workspace.
IPL Reference Key	Numeric	The Entity Key for the Independent Layer of Protection that is linked to the Hazards Analysis Safeguard.	This field does not appear on the datasheet by default.

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Field	Data Type	Description	Behavior and Usage
IPL Sub Type	Character	Indicates the classification of the independent layer of protection that you selected in the IPL Type field in the Safeguard records.	This field is disabled by default, indicating that the safeguard is not an independent layer of protection. If the safeguard is an independent layer of protection, then this field is enabled. This field is populated based on your selection in the IPL Type field of the Safeguard datasheet: • If the value in the IPL Type field is Active IPL, this field is populated as defined in the Active IPL record. These values are retrieved using the Catalog query `Public \Meridium \Modules \Hazards Analysis \Queries \Active IPL List`. • If the value in the IPL Type field is Passive IPL, this field is populated as defined in the Passive IPL record. These values are retrieved using the Catalog query `Public \Meridium \Modules \Hazards Analysis \Queries \Passive IPL List`. • If the value in the IPL Type field is Human IPL, this field is populated as defined in the Human IPL record. These values are retrieved using the Catalog query `Public \Meridium \Modules \Hazards Analysis \Queries \Active IPL`

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Field	Data Type	Description	Behavior and Usage
PFD	Numeric	A number representing the probability that the independent layer of protection will fail to mitigate the risk.	By default, this field is disabled. Based on you selection in the IPL Sub Type field, this field is populated with the value in the Default Value field of one of the following record: • Active IPL record if the value in the IPL Type field is Active IPL. • Passive IPL record if the value in the IPL Type field is Passive IPL. • Human IPL record if the value in the IPL Type field is Human IPL. This field appears on the **IPL Checklist** section of the **Safeguards and IPLs** workspace.
IPL Type	Character	Indicates the type of risk reduction that is provided by the independent layer of protection.	You can select one of the following values in this field: • Consequence Reducing IPL • Frequency Reducing IPL This field is labeled as **Risk Reduction Type** and appears on the **IPL Checklist** section of the **Safeguards and IPLs** workspace.
Safeguard Comment	Text	A comment about the safeguard.	You can enter a value manually.
Safeguard Description	Text	A detailed description of the safeguard.	You can enter a value manually.
Safeguard ID	Character	The identification of the safeguard.	You can enter a value manually. This field is required.

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Field	Data Type	Description	Behavior and Usage
Safeguard Type	Character	The type of the safeguard.	This field contains the description of the system codes that exist in the MI_HAZOP_SAFEGUARD_TYPE System Code Table. You can select a value from the following options: • Process Design • Process Control System • PSV • Operations • Deluge System • Fire Alarm • Process Alarm • SIS
Sequence Number	Numeric	A number that represents the position in which the Safeguard appears in the grid, relative to the other Safeguards that are linked to the same Consequence.	This field is used to populate the Safeguard Number field. This field does not appear on the datasheet by default.
Type	Character	If the safeguard is an independent layer of protection , this value indicates the type of risk the independent layer of protection mitigates.	By default, this field is disabled, indicating that the safeguard is not an independent layer of protection. If the safeguard is an independent layer of protection, then this field is enabled. This field contains the description of the system codes that exist in the MI_IPL_TYPES_SAFEGUARD System Code Table. You can select a value from the following options: • Active IPL • Passive IPL • Human IPL This field is labeled IPL Type in the **IPL Checklist** section of the Safeguard datasheet.

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Field	Data Type	Description	Behavior and Usage
LOOP ID	Character	Key of the Protective Instrument Loop selected in the Safeguard.	This field will load all the protective instrument loops present in the instrumented function of the safeguard.
Loop PFH	Numeric	Loop PFH from the PIL linked in the safeguard.	Loop PFH from the PIL linked in the safeguard. This field is disabled to update and you can update by selecting the refresh button ( ) or when the loop is changed in the safeguard.
Loop PFD Avg	Numeric	Loop PFD Average from the PIL linked in the safeguard.	The Loop PFD Average from the PIL linked in the safeguard. This field is disabled to update and you can update by selecting the refresh button ( ) or when the loop is changed in the safeguard.

Human IPL Records

Human IPL records store information about the probability of failure of various types of human IPLs. This topic provides an alphabetical list and description of the fields that exist for the Human IPL family. The information in the table reflects the baseline state and behavior of these fields.

Important: The records in this family can be modified only by users who belong to the Security Groups MI SIS Administrator or MI HA Administrator.

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.

Field	Data Type	Description	Behavior and Usage
Default Value	Numeric	Indicates the default probability that the Human IPL will fail to mitigate the risk.	You can enter a value manually.
Human IPL ID	Character	Identifies the type of Human IPL.	This field appears a list that is populated by the MI_HUMAN_IPL System Code Table.

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Field	Data Type	Description	Behavior and Usage
Lower Range	Numeric	Indicates the lower range for the probability that the Human IPL will fail to mitigate the risk.	You can enter a value manually.
Upper Range	Numeric	Indicates the upper range for the probability that the Human IPL will fail to mitigate the risk.	You can enter a value manually.

Initiating Event Records

Initiating Event records are used to determine the frequency of occurrence of an initiating event. This topic provides an alphabetical list and description of the fields that exist for the Initiating Event family and appear on the LOPA datasheet. The information in the table reflects the baseline state and behavior of these fields.

This family is not enabled for site filtering, which means that records in this family can be accessed by any user with the appropriate license and family privileges. For more information, refer to the Sites section of the documentation.

Field	Data Type	Description	Behavior and Usage
Default Value	Numeric	Indicates the default value for the frequency of the Initiating Event.	You can enter a value manually. This field populates the following fields: • Frequency of Initiating Event field on the LOPA datasheet • Cause Frequency (per year) field on the Hazards Analysis Cause datasheet.
Initiating Event ID	Character	Identifies the type of Initiating Event.	This field appears a list that is populated by the INIT_EVENT System Code Table.
Lower Boundary	Numeric	Indicates the lower boundary value for the frequency of the Initiating Event.	You can enter a value manually.
Upper Boundary	Numeric	Indicates the upper boundary value for the frequency of the Initiating Event.	You can enter a value manually.

IPL Checklist Records

IPL Checklist records store your selection for the criteria that are used to determine if a Safeguard is an IPL. The IPL Checklist family is linked to the Safeguard family using the Is Independent Protection Layer relationship family. This topic provides an alphabetical list and description of the fields that exist for the IPL Checklist family. The information in this table reflects the baseline state and behavior of these fields.

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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.

Field	Data Type	Description	Behavior and Usage
IPL Criteria	Character	Describes the criteria that can be used to determine if the safeguard can be considered an IPL.	This field contains a value from the list of criteria that you configured for IPL Checklist.
IPL Criteria Value	Boolean	Indicates if the criteria described in the IPL Criteria field is true for the safeguard.	By default, this field is cleared. If the field is selected, then the criteria is true for the safeguard.

LOPA Records

LOPA records store details about the LOPA that they represent. This topic provides an alphabetical list and description of the fields that exist for the LOPA family and appear on the LOPA datasheet, unless otherwise specified. The information in the table reflects the baseline state and behavior of these fields. This list is not comprehensive.

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.

Field	Data Type	Description	Behavior and Usage
Analysis Type	Character	The type of the analysis that you are performing.	This field does not appear on the datasheet and is populated automatically with the value LOPA.
Calculated SIL	Numeric	The SIL value that is required to mitigate the risk that is associated with the Consequence to which this LOPA is linked.	This field is disabled and populated with the SIL value that is associated with the value in the Required PIF PFD field.
Comments	Text	Additional information about the LOPA.	You can enter a value manually.
Description	Text	A description for the LOPA.	You can enter a value manually.
Description of Initiating Event	Character	A description of the initiating event that is specified in the Initiating Event Type field.	You can enter a value manually.

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Field	Data Type	Description	Behavior and Usage
Enabling Event/Condition Description	Character	A description of the enabling event, which is a condition that must occur simultaneously with an initiating event to allow the specific cause for a scenario to propagate to a consequence. (e.g., an explosive atmosphere acts as an enabling event that can increase the probability of the flammable gas being released).	This field does not appear on the datasheet.
Enabling Event/Condition Probability	Numeric	A number that represents the probability of occurrence of the enabling event. This value is used to determine the probability of an unmitigated event occurring.	You can enter a value manually. The value must be greater than 0 and less than or equal to 1. For example, if the equipment operates only for nine months a year, then provide a value of 0.75 in this field. This value is multiplied by the value in the Frequency of Initiating Event field to determine the value in Unmitigated Consequence Frequency field. If this field is empty, a default value of 1 will be used in that calculation.
Equipment ID	Character	A unique value that identifies the Equipment that you want to link to the LOPA.	You can select an Equipment to associate with the LOPA. After you select an Equipment, the Equipment Technical Number appears as a link in this field. You can select the link to access the datasheet for the Equipment. When you create a LOPA from a Hazards Analysis Consequence, this field is populated with the Equipment Technical Number of the Equipment that is linked to the corresponding Hazards Analysis Cause record.

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Field	Data Type	Description	Behavior and Usage
Equipment Key	Numeric	The Entity Key of the Equipment that is linked to this Instrumented Function.	This field does not appear on the datasheet. When you link an Equipment to the LOPA, the details of the Equipment are retrieved based on the value in this field.
Frequency of Initiating Event	Numeric	A number representing the number of times per year that the initiating event specified in the Initiating Event Type field will occur.	This field is disabled. A baseline rule exists to populate this field with the default value of frequency specified in the Initiating Event record based on your selection in the Initiating Event Type field. This value is multiplied by the value in the Enabling Event/ Condition Probability field to determine the value in Unmitigated Consequence Frequency field.
Functional Location ID	Character	A unique value that identifies the Functional Location that is linked to the LOPA.	You can select a Functional Location to associate with the LOPA. After you select a Functional Location, the Functional Location ID appears as a link in this field. You can select the link to access the datasheet for the Functional Location. When you create a LOPA from a Hazards Analysis Consequence, this field is populated with the Functional Location ID of the Functional Location that is linked to the corresponding Hazards Analysis Cause record.
Functional Location Key	Numeric	The Entity Key of the Functional Location that is linked to this LOPA.	This field does not appear on the datasheet. When you link a Functional Location to the LOPA, the details of the Functional Location are retrieved based on the value in this field.

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Field	Data Type	Description	Behavior and Usage
Initiating Event Type	Character	A brief description of the event that could cause the risk that is described in the Unacceptable Consequence field to be mitigated.	This field with the values in the Initiating Event ID field in the Initiating Event records. If the Frequency of Initiating Event field does not contain a value, then a value is required in this field. When you create a LOPA from a cause-consequence pair in the Hazards Analysis module, this field is disabled and populated automatically with the value in the CCPS Cause Type field in the associated Consequence.
LOPA ID	Character	The ID for the Layer of Protection Analysis.	This field is required and must be unique among all the LOPA records linked to an instrumented function. You can enter your own value manually. The value in this field appears in the list of assessments for an instrumented function and is used to distinguish the LOPA from the others.
Mitigated Consequence Frequency	Numeric	Indicates the frequency of the mitigated consequence (i.e., the frequency of consequence after layers of protection have been added).	This field is disabled and populated automatically. The value is calculated by multiplying the value in the Unmitigated Consequence Frequency field by the value in the Total IPL PFD field.

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Field	Data Type	Description	Behavior and Usage
Required Mitigated Consequence Frequency	Numeric	The maximum allowable frequency at which the initiating event can occur for the risk that is described in the Unacceptable Consequence field.	This field is required. This field appears in the LOPA **Definition** section of the LOPA datasheet as a list and contains the following hard-coded values: • 1E-04 • 1E-05 • 1E-06 You can select a value from the list or enter your own value that is greater than 0 (zero). If you modify this value to be less than 0 (zero), a message will appear, and when you select OK, the modified value will revert to its original value. If you enter a value other than the baseline values in the list, it will then be added to the list.
Required PIF PFD	Numeric	A number representing the target probability that a failure will occur.	This field is disabled and populated automatically. This value is calculated automatically by dividing the value in the Required Mitigated Consequence Frequency field by the value in the Mitigated Consequence Frequency field. This value is used to determine the values in the Required PIF Risk Reduction Factor and Calculated SIL Level fields.
Required PIF Risk Reduction Factor	Numeric	A number representing the factor by which the risk should be reduced.	This field is disabled and populated automatically with the inverse of the value in the Required PIF PFD field.

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Field	Data Type	Description	Behavior and Usage
Risk Category	Character	The category of the driving risk associated with the initiating event.	This field appears as a list that is populated with the values in the Category Name field in Risk Category records associated with the Risk Matrix for the site to which the LOPA belongs. **Note:** This field does not contain the Financial Risk Category associated with the Risk Matrix. If you change the value in this field, you must reselect a value in the Risk Severity field.
Risk Severity	Character	The level of severity of the driving risk associated with the initiating event.	This field appears as a list that is populated with the values in the Description field in Consequence records associated with the category that you selected in the Risk Category field.
Total IPL PFD	Numeric	The PFD value that is associated with all the IPLs in place for this consequence.	This field is disabled and populated in the **Definition** section of the LOPA datasheet. The value is calculated by multiplying the values in the PFD fields of each Independent Layer of Protection associated with the LOPA together.
Unacceptable Consequence	Character	A description of the risk for which you are conducting the Layer of Protection Analysis.	This field is populated with the value in the Consequence Description field in the associated Instrumented Function. You can modify this value if needed.
Unmitigated Consequence Frequency	Numeric	Indicates the frequency of unmitigated consequence (i.e., the frequency consequence before the layers of protection have been added).	This field is disabled and populated automatically. This value is calculated by multiplying the value in the Frequency of Initiating Event field by the value in the Enabling Event/Condition Probability field.

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Safety Integrity Level Records

Safety Integrity Level records are used to determine the SIL value and contain the boundary values for the required probability of failures for different safety integrity levels. This topic provides an alphabetical list and description of the fields that exist for the Safety Integrity Level family. The information in the table reflects the baseline state and behavior of these fields. This list is not comprehensive.

This family is not enabled for site filtering, which means that records in this family can be accessed by any user with the appropriate license and family privileges. For more information, refer to the Sites section of the documentation.

Field	Data Type	Description	Behavior and Usage
Lower Bound	Numeric	The lower boundary value for the Safety Integrity Level.	You can enter a value manually.
Mode of Operation	Character	Indicates whether the record defines the SIL value for a safety system operating on low demand mode or on continuous mode.	You can enter a value manually.
Safety Integrity Level	Numeric	The SIL value for which the boundary values are defined in the record.	You can enter a value manually.
Upper Bound	Numeric	The upper boundary value for the Safety Integrity Level.	You can enter a value manually.

Passive IPL Records

Passive IPL records store information about the probability of failure of various types of passive IPLs. This topic provides an alphabetical list and description of the fields that exist for the Passive IPL family. The information in the table reflects the baseline state and behavior of these fields.

Important: The records in this family can be modified only by users who belong to the Security Groups MI SIS Administrator or MI HA Administrator.

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.

Field	Data Type	Description	Behavior and Usage
Default Value	Numeric	Indicates the default probability that the Passive IPL will fail to mitigate the risk.	You can enter a value manually.
Lower Range	Numeric	Indicates the lower range for the probability that the Passive IPL will fail to mitigate the risk.	You can enter a value manually.

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Field	Data Type	Description	Behavior and Usage
Passive IPL ID	Character	Identifies the type of Passive IPL.	This field appears a list that is populated by the MI_PASSIVE_IPL System Code Table.
Upper Range	Numeric	Indicates the upper range for the probability that the Passive IPL will fail to mitigate the risk.	You can enter a value manually.

Catalog Items

Queries Folder

The Catalog folder `\\Public\Meridium\Modules\LOPA\Queries` contains the following items.

Query Name	Behavior and Usage
LOPA Approved Query	Returns the list of LOPA that are in the Complete state. This query populates the **Approved** section on the **LOPA Overview** page with the list of LOPA that is retrieved.
LOPA Under Review Query	Returns the list of LOPA that are not in the Complete state. This query populates the **Under Review** section of the **LOPA Overview** page with the list of LOPA that is retrieved.
ALL LOPA Query	Returns the list of LOPA associated with a specific Site. This query is used to display a list of LOPA that you can link to a Hazards Analysis Consequence.
Consequence Modifier LOPA Query	Returns the list of Conditional Modifiers that are associated with a LOPA.
Safeguard LOPA Query	Returns the list of Safeguards that are associated with a LOPA.
LOPA Page Filter Query	Returns the list of LOPA that are associated with the Equipment or Functional Location that you choose.
LOPA_ASSET_CONTEXT_APPROVED	Returns the list of LOPA that are in the Complete state and are associated with the Equipment or Functional Location that you choose.
LOPA_ASSET_CONTEXT_UNDER_REVIEW	Returns the list of LOPA that are not in the Complete state and are associated with the Equipment or Functional Location that you choose.
IPL Checklist Admin Query	Returns the list of IPL criteria that have been configured in the LOPA Application Settings. This query is used to display the criteria in the **IPL Checklist** workspace in LOPA Application Settings.

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Query Name	Behavior and Usage
Active IPL Query	Returns the list of Active IPL records. This query is used to display the Active IPL ID and the Default Value fields in the **Active IPL** workspace in LOPA Application Settings.
Consequence Adjustment Probabilities Query	Returns the list of Consequence Adjustment Probabilities records. This query is used to display the Modifier ID and the Default Value fields in the **Consequence Adjustment Probabilities** workspace in LOPA Application Settings.
Human IPL Query	Returns the list of Human IPL records. This query is used to display the Human IPL ID and the Default Value fields in the **Human IPL** workspace in LOPA Application Settings.
Initiating Event type query	Returns the list of Initiating Events. This query is used to display the Initiating Event ID, Default Value, Lower Boundary, and Upper Boundary fields in the **Initiating Events** workspace in LOPA Application Settings.
Passive IPL Query	Returns the list of the Passive IPL records. This query is used to display the Passive IPL ID and the Default Value fields in the **Passive IPL** workspace in LOPA Application Settings.

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