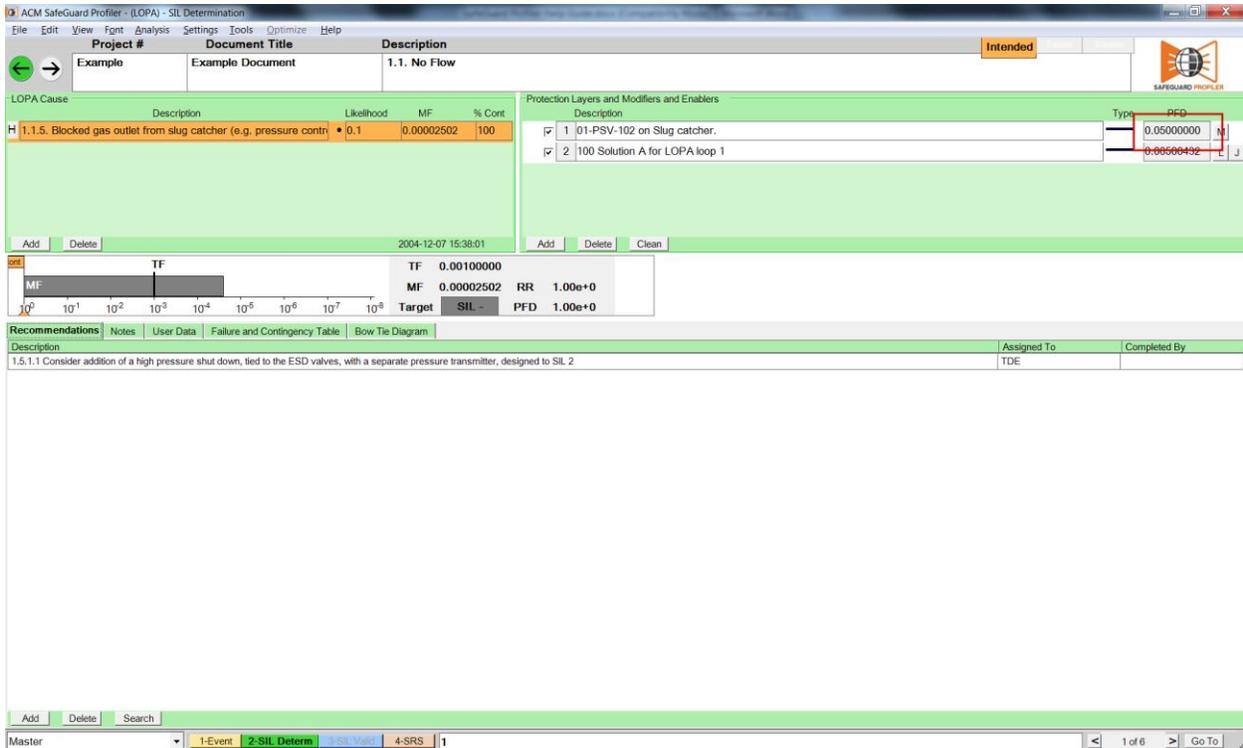


1. SIL Determination Using LOPA Scenario Analysis

1.1. The SIL Determination Page

Click “2-SIL Determ” at the bottom of the page to view the SIL Determination page.

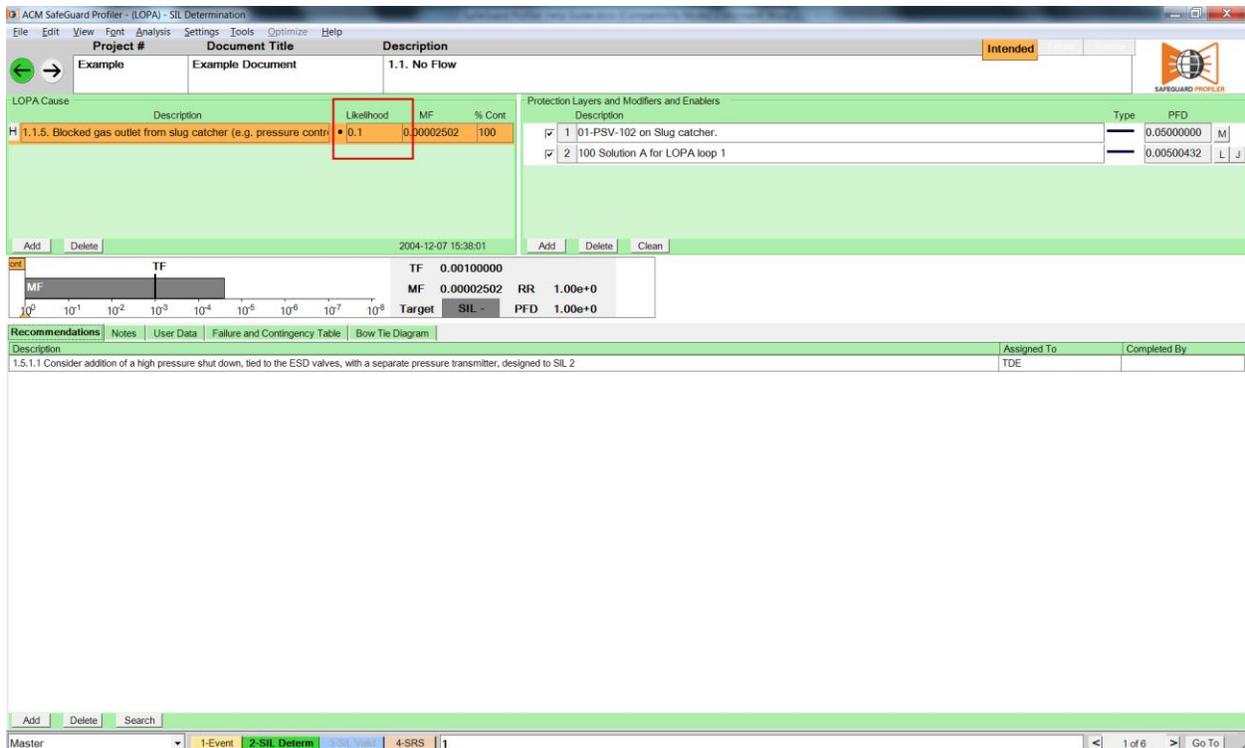


Confirm that all the relevant causes and safeguards from the HAZOP have been used in the creation of the loop.

Review the imported HAZOP to identify consequences that meet an agreed set of criteria for undergoing LOPA. Add new LOPA loops until the project contains a full set of scenarios for detailed analysis.

1.2. LOPA Causes: Likelihood

On the SIL Determination page, edit the likelihood values for the initiating events.



In the context of SafeGuard Profiler™, “likelihood” refers to “event frequency”. (IEC 61511 erroneously uses the terms “likelihood” and “frequency” synonymously.)

Likelihood ratings are usually available in the Risk Matrix document that the company or analyst chooses to guide the HAZOPs and LOPA studies. It is considered good practice for the first pass at the analysis to use conservative values.

1.3. Protection Layers: Probability of Failure on Demand (PFD)

1.3.1. Database Normalization Concept

SafeGuard Profiler™ utilizes a normalized relational database. Normalized tables are suitable for general-purpose querying, as data is organized to minimize redundancy.

Ensure that PFD values created during the LOPA sessions are unique. This means that protection layer PFD values must be uniquely matched to the protection layer description at all times.

1.3.2. Probability of Failure on Demand (PFD)

To assign a PFD value to a protection layer, click the “M” button beside the protection layer description. This will open the the “LOPA Protection Layer Edit” window.

LOPA Protection Layer Edit

LOP Type

- Preventive
- Mitigative
- Enabler
- Modifier
- Unassigned

PFD

Manual You may enter values such as 0.1 or 2e-1

Select a Loop to link to

	Value
1	1.1. No Flow (LOPA) <100>
100	Solution A for LOPA loop 1 (Risk Graph or SIF) <1>
101	CDN-DWGSCHM-030 (Risk Graph or SIF)
103	CDN-DWGSCHM-031 (Risk Graph or SIF)
104	(LOPA)
105	Loss of containment, potential for vapour cloud, explosion (need to be confirm

Cancel OK

Select "Manual" and set the PFD value (e.g. "0.05").

Click OK.

ACM SafeGuard Profiler - (LOPA) - SIL Determination

File Edit View Fgnt Analysis Settings Tools Optimize Help

Project # Document Title Description Intended

Example Example Document 1.1. No Flow

LOPA Cause Description Likelihood MF % Cont

H	1.1.5. Blocked gas outlet from slug catcher (e.g. pressure contr)	0.1	0.00002502	100
---	-------------------------------------------------------------------	-----	------------	-----

Protection Layers and Modifiers and Enablers

Type	Description	PF
<input checked="" type="checkbox"/>	1 01-PSV-102 on Slug catcher.	0.05000000
<input checked="" type="checkbox"/>	2 100 Solution A for LOPA loop 1	0.00000432

Add Delete 2004-12-07 15:38:01 Add Delete Clean

TF 0.00100000
MF 0.00002502 RR 1.00e+0
Target SIL - PFD 1.00e+0

Recommendations Notes User Data Failure and Contingency Table Bow Tie Diagram

Description	Assigned To	Completed By
1.5.1.1 Consider addition of a high pressure shut down, tied to the ESD valves, with a separate pressure transmitter, designed to SIL 2	TDE	

Add Delete Search

Master 1-Event 2-SIL Determ 3-PSV-102 4-SRS 1 1 of 6 Go To

As with the LOPA Cause likelihood values, it is considered good practice to assign conservative order-of-magnitude values to the PFD values for the protection layers.

2. Analyzing Alternate LOPA Scenarios

2.1. The Alternate Scenario Concept

SafeGuard Profiler™ lets you examine alternate scenarios that could stem from a set of causes leading to a particular consequence.

Alternate scenarios are often used to examine the effects of implementing recommendations, either from the original HAZOP or from the LOPA process itself.

The following diagram shows another loop from the example file, where the tolerable frequency was not met and where a recommendation was made to further mitigate the problem.

ACM SafeGuard Profiler - (LOPA) - SIL Determination

File Edit View Fgnt Analysis Settings Tools Optimize Help

Project # Example Document Title Description Loss of containment, potential for vapour cloud, explosion (need to be confirmed with dispurion study). Intended

LOPA Cause

Description	Likelihood	MF	% Cont
H Manual valve left open on inlet line.	0.0002	0.00020000	100

Protection Layers and Modifiers and Enablers

Description	Type	PFD
None identified.	10	1.00000000 M

Add Delete Clean

2004-12-07 15:38:01

SIL

MF 0.00020000 TF 0.00000100

RR 2.00e+2

Target SIL 2 PFD 5.00e-3

Recommendations

Description	Assigned To	Completed By
Confirm with previous dispersion study if a VCE is possible. Consider use of gas detection (to be reviewed under fire & gas global review).		

Master 1-Event 2-SIL Determ 3-SRS 4-SRS 105 6 of 6 Go To

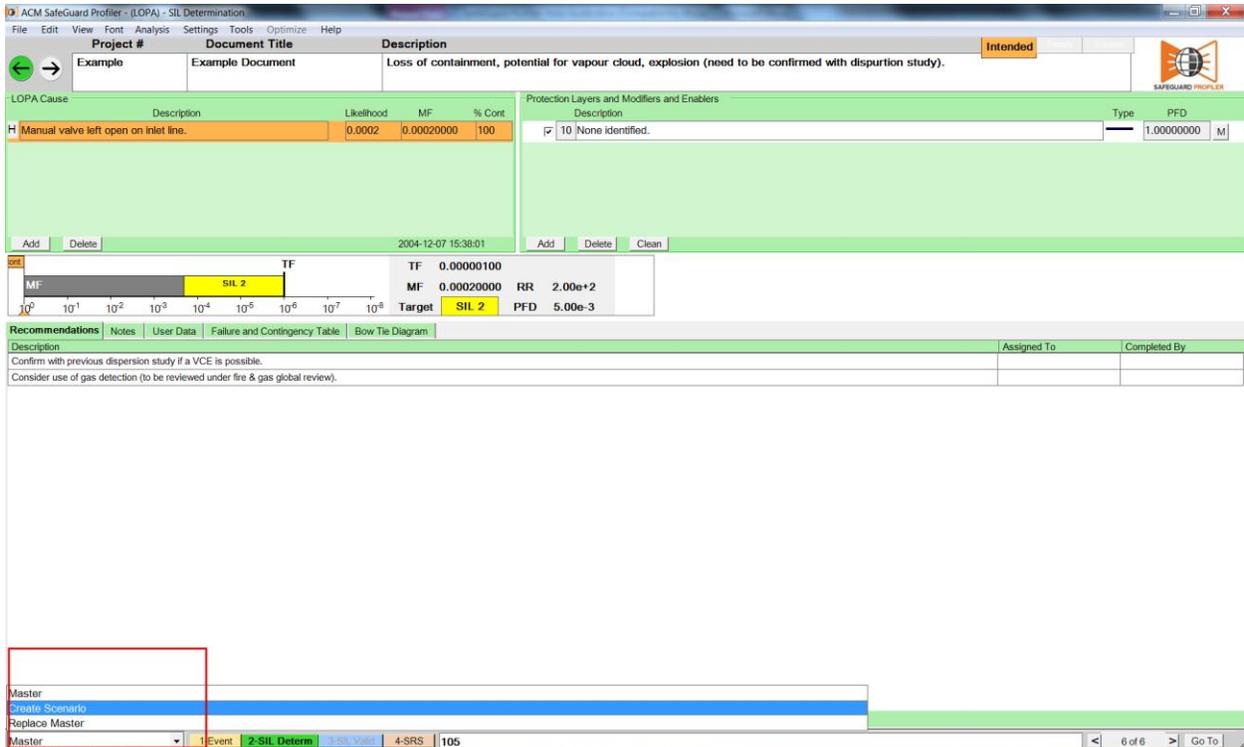
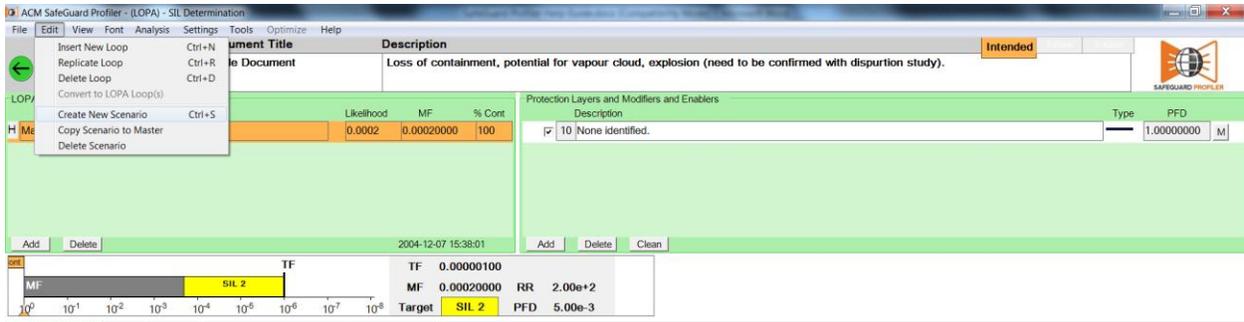
2.2. Creating Alternate Scenarios

To create an alternate scenario, either:

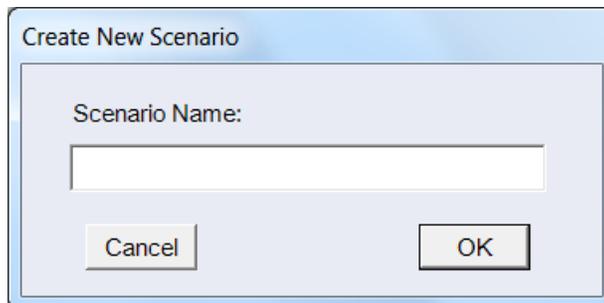
Select Edit > Create New Scenario from the top menu.

Use the hot keys Ctrl + S

Use the scenario dropdown menu at the bottom left of the application window.



In the “Create New Scenario” dialog, enter a scenario name and click OK. For this example, type “Recommendation”.



This is a simple duplicate of the original master scenario except that the name “Recommendation” appears in the scenario dropdown box. Any changes made to this alternate scenario will not affect the Master scenario.

To examine the effect of implementing the recommendation, go to the “Protection Layer” section and click “Add”.

ACM SafeGuard Profiler - (LOPA) - SIL Determination

File Edit View Fgnt Analysis Settings Tools Optimize Help

Project # Document Title Description Intended

Example Document Example Document Loss of containment, potential for vapour cloud, explosion (need to be confirmed with dispurion study).

LOPA Cause

Description	Likelihood	MF	% Cont
H Manual valve left open on inlet line.	0.0002	0.00020000	100

Protection Layers and Modifiers and Enablers

Description	Type	PFD
10 None identified.		1.00000000

Add Delete Clean

2004-12-07 15:38:01

TF 0.00000100 MF 0.00020000 RR 2.00e+2 Target SIL 2 PFD 5.00e-3

Recommendations Notes User Data Failure and Contingency Table Bow Tie Diagram

Description	Assigned To	Completed By
Confirm with previous dispersion study if a VCE is possible.		
Consider use of gas detection (to be reviewed under fire & gas global review).		

Add Delete Search

Recommendation 1-Event 2-SIL Determ 3-... 4-SRS 105

6 of 6 Go To

In the Add LOPA Protection Layer window, you may choose between:

- selecting an existing protection layer, used elsewhere in the project; or
- creating a new protection layer.

ACH 511 Add LOPA Protection Layer

LOPA Protection Layer

Project: *Example*

Layer of Protection: Filter By

ID	Type	Description	LOP Ty...	PFD
1	-	01-PSV-102 on Slug catcher.	-	0.05000000
2	-	100 Solution A for LOPA loop 1	-	0.00500432
6	-	HHFA Supply	-	0.10000000
3	-	HHLA	-	0.10000000
4	-	High Flow Alarm (from plant)	-	0.10000000
7	-	LLPA Supply	-	0.50000000
9	-	Low Flow Alarm (from shipper)	-	0.10000000
10	-	None identified.	-	1.00000000
8	-	Operating Procedures	-	0.10000000
5	-	Shipping Alarm	-	0.10000000

Create New LOPA Protection Layer

Preventive 
 Mitigative 
 Enabler 
 Modifier 
 Unassigne 

(Note the Description must be unique.)

Description: Gas detector

For a new protection layer, enter a unique description to identify it and click OK.

The screenshot shows the ACM SafeGuard Profiler software interface. The main window displays the following information:

- Project #:** Example
- Document Title:** Example Document
- Description:** Loss of containment, potential for vapour cloud, explosion (need to be confirmed with dispersion study).
- Intended:** (Status)

LOPA Cause Table:

LOPA Cause	Description	Likelihood	MF	% Cont
H	Manual valve left open on inlet line.	0.0002	0.00020000	100

Protection Layers and Modifiers and Enablers Table:

Description	Type	PFD
<input checked="" type="checkbox"/> 10 None identified.	1	1.00000000 M
<input checked="" type="checkbox"/> 11 Gas detector	1	M

Summary Statistics:

TF	0.00000100	RR	2.00e+2
MF	0.00020000	Target	SIL 2
Target	SIL 2	PFD	5.00e-3

Recommendations:

Description	Assigned To	Completed By
Confirm with previous dispersion study if a VCE is possible.		
Consider use of gas detection (to be reviewed under fire & gas global review).		

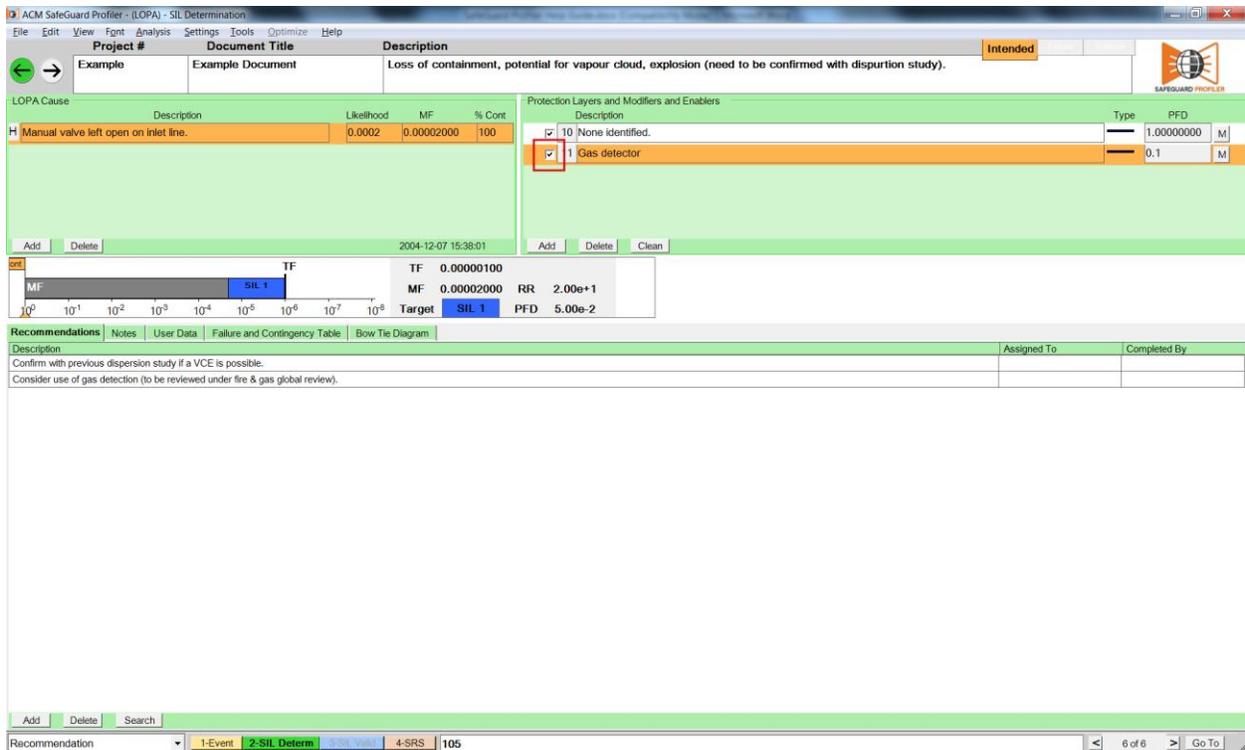
The interface also includes a risk matrix plot showing SIL 2 levels and a bottom navigation bar with tabs for 1-Event, 2-SIL Determ, 3-Global, and 4-SRS.

This new protection layer is determined to be effective for mitigating all three initiating events. Following conservative practice, its PFD is assigned a manual value of 0.1.

To change the protection layer's PFD value, click the "M" button to the right of the PFD field. This will launch the "LOPA Protection Layer Edit" window.

Apply the protection layer to all the LOPA causes:

1. Click to highlight each cause in the LOPA Cause list; and
2. In the "Protection Layer" list, ensure the checkbox for the new protection layer is checked.



The results show that the mitigated frequency is now very close to the tolerable frequency. More in-depth analysis of initiating event likelihoods and PFDs for protection layers could show that the tolerable frequency is actually met.