BowTieXP

LOPA Plugin manual

For LOPA plugin v1.4.0 and higher

(11-Aug-2016)

Please note that this documentation is preliminary and subject to change without notice. The latest version of this document can be obtained via CGE (e-mail support@cgerisk.com) or via a BowTieXP Value Added Reseller.

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Table of Contents

1
Installation & Activation

This chapter describes how the LOPA plugin is installed and activated for BowTieXP version 8.2 or higher. Please see the Appendix on how to install and activate the LOPA plugin for older versions of BowTieXP.

1.1. Plugin installation

BowTieXP has support for plugins. Plugins are small pieces of computer code which extend BowTieXP with custom functionality, allowing CGE to add customer functionality (as long as it falls within the possibilities offered by the plugin architecture / interface.

This manual describes our LOPA plugin, which extends BowTieXP with on-the-fly LOPA calculations on the bowties.

Plugins are delivered in files with a ".btpp" extension (short for BowTieXP Plugin Package).

To install a plugin we take the following steps:

- Download the plugin package from our web site.
- Double click the btpp file. This will install the plugin. You will get a confirmation window like this:

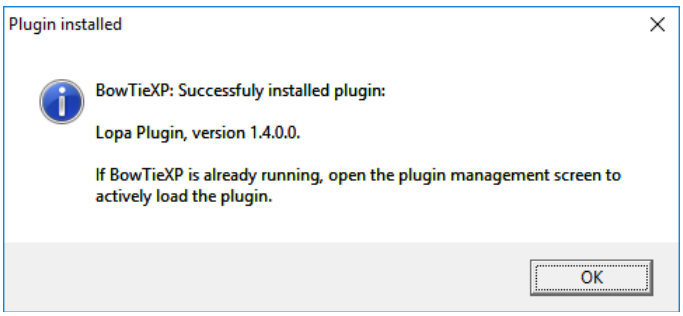


Figure 1: Plugin installation confirmation

- You can check if everything went ok by going to Help → Manage Plugins:

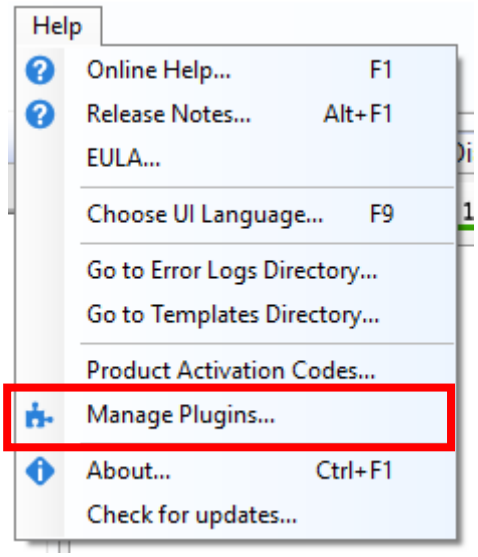


Figure 2: Manage Plugins

1.2. Plugin activation

Some plugins require an activation code, just like BowTieXP. The process is the same, except that you can have multiple activation codes for multiple plugins. Please note that plugins have the same host and site ids as BowTieXP. Make sure to send it along when you request your plugin activation code.

To add a new plugin activation code:

1. Navigate in the menu bar to Help → Manage Plugins.
2. The Lopa plugin still needs to be activated with an activation key. To do this, I can select the plugin and click 'Add an activation code'. This will give a popup where a valid activation key can be entered.

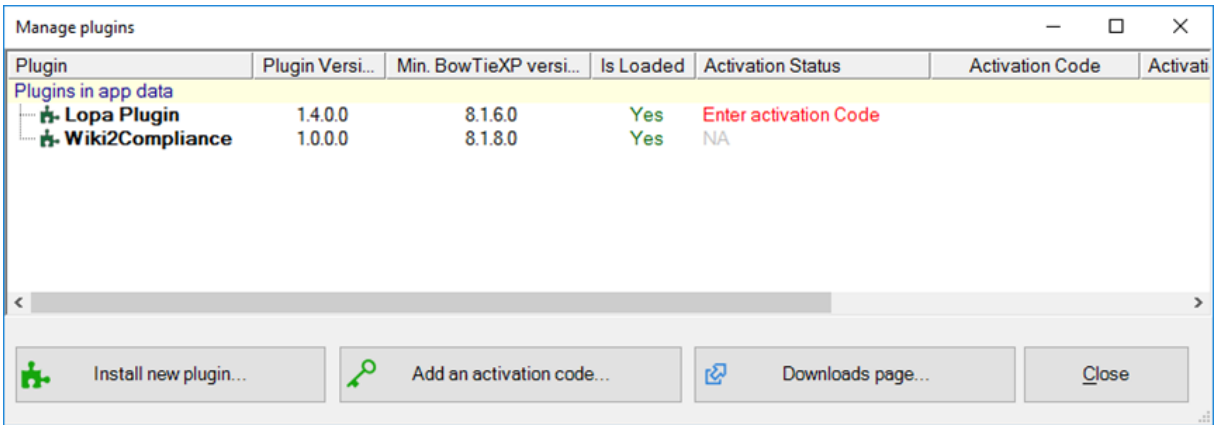


Figure 3: Plugin requiring activation

3. Once the activation key is added, it will be displayed in a dropdown. Right clicking a key will allow you to delete it if necessary.

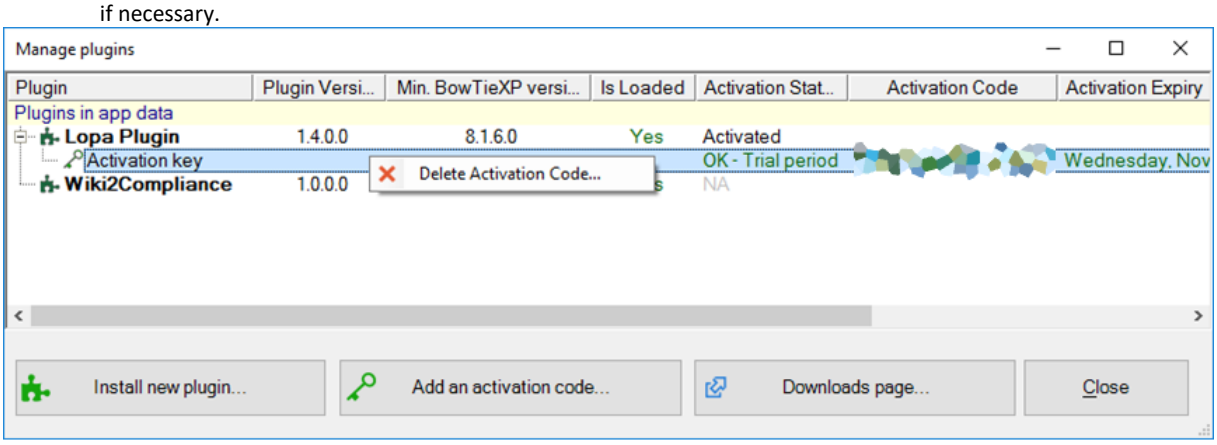


Figure 4: Managing plugin activation keys

4. A restart of the software might be required before the plugin can be used.

1.2.1. Plugin activation for group locked codes

If you are doing a group locked activation, and want to deploy codes by means of a dat file, you can do the same for plugins. Please request your plugin activation code in a dat file from us, and we'll supply one. This dat file will be picked up when placed next to the bowtie.exe executable, just like for regular activation codes. The name of this dat file must match the "pluginactivation*.dat" pattern.

2
Getting started

2.1. Enable LOPA plugin

For the LOPA plugin to work on your file, some user data keys and diagram display profiles will need to be created, if not yet present. This needs to be done once for each file you want the LOPA plugin to work on. To do so:

1. Double click a threat, barrier or consequence.
2. Go to the new tab called “Lopa”.
3. Click on “Enable Lopa on this file”.

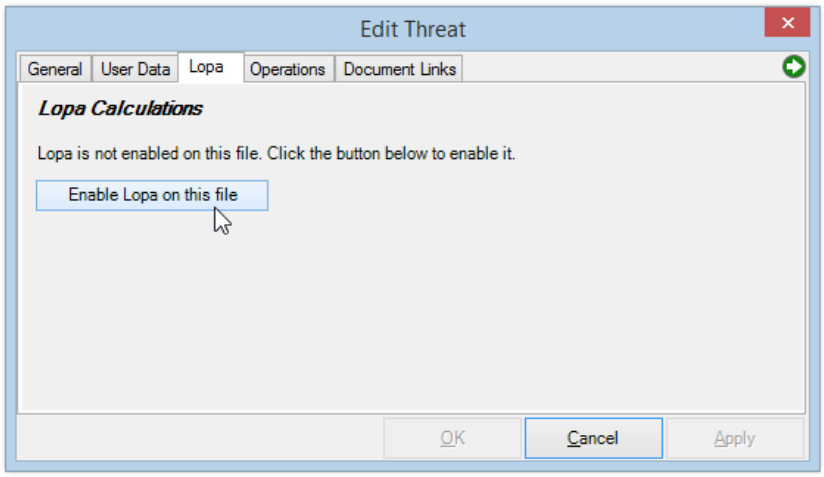


Figure 5 - Enable LOPA plugin

2.2. Fields to fill in

Within the LOPA plugin, certain fields are mandatory and others are optional. The plugin will only calculate the top event and consequence frequencies when all the mandatory fields are filled in with a correct notation. The mandatory fields are indicated in the manual by the following sign: .

1. Fill in acceptance frequencies on the top event and consequences. You can use 1E-6 type notations or 0.0001 type notations.

Note #1: Please use a dot as decimal separator and not a comma.

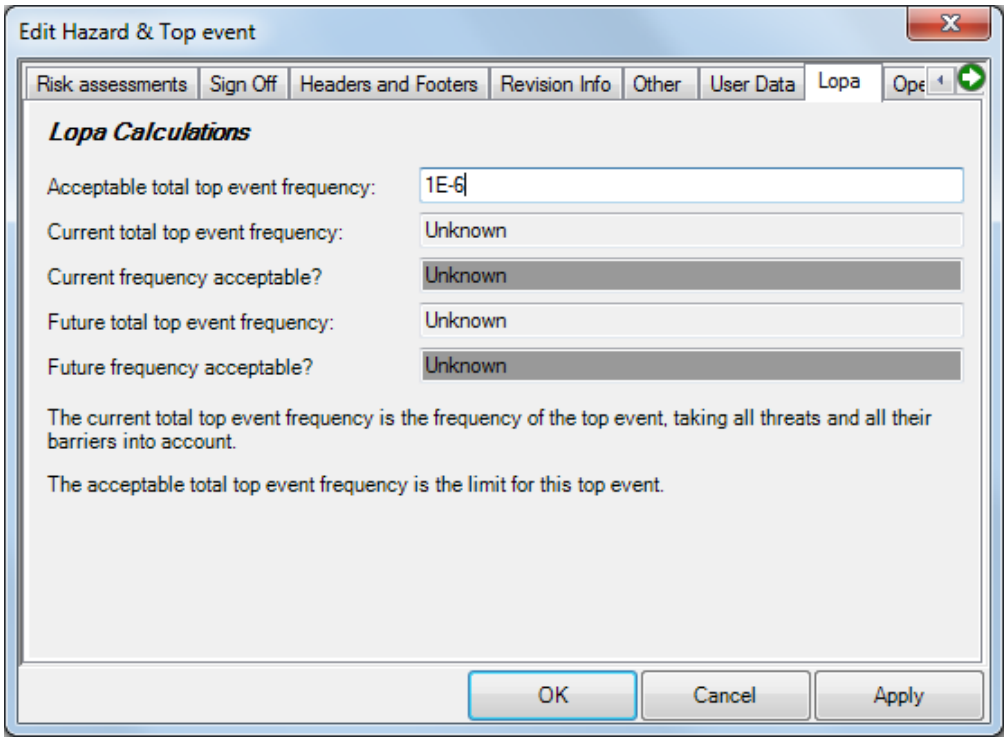


Figure 6 - Setting acceptable top event frequency

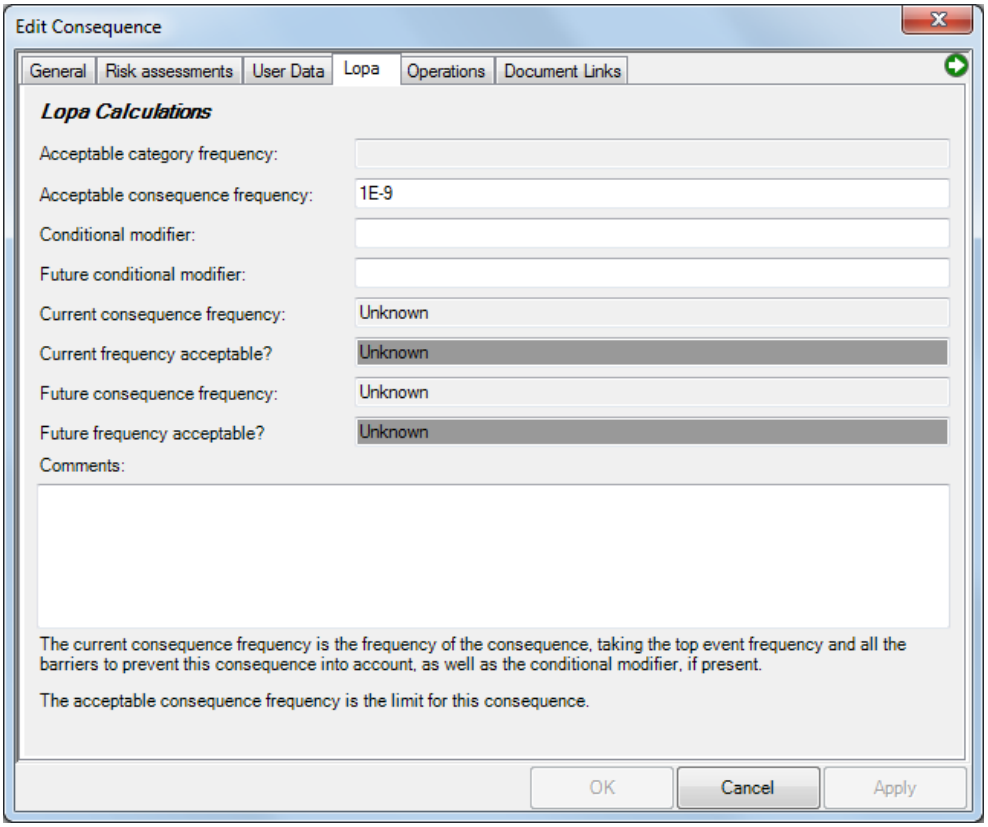


Figure 7 - Setting acceptable consequence frequency

2. It is possible to add a probability to the consequence in the 'Conditional modifier' field. Conditional modifiers within the LOPA method allow you to take factors like luck into account to estimate the probability that an event will actually lead to damage or harm. Common conditional modifiers are probability of occupancy, ignition and fatality. The comments box of the consequence can be used to describe the basis for the conditional modifier.

It is also possible to fill in the expected conditional modifier in the future if it differs from the current value.

3. Fill in initiating event frequency on the threats. Optionally fill in the expected initiating event frequency in future if different from the current initiating event frequency.

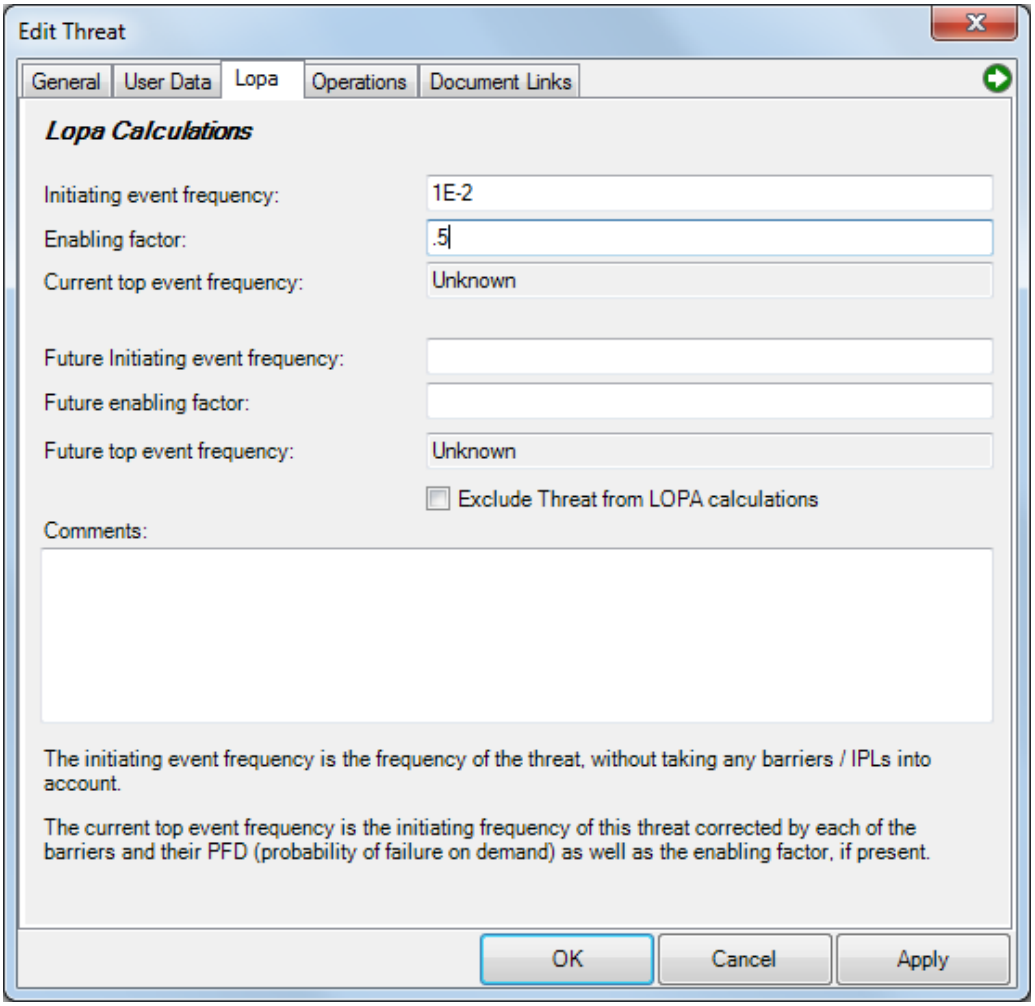


Figure 8 - Event frequency on threat

4. It is possible to add a probability to the threat in the 'Enabling factor' field. An Enabling Factor is something that cannot directly cause the next event, but has to be present in order for the scenario to proceed. For example: when the threat is 'Strong winds' and the top event 'Fall of scaffold', the enabling factor is 'Presence of personnel on scaffold'. The initiating frequency is then the probability of strong winds and the enabling factor is the probability of presence of personnel on scaffold. These numbers will be multiplied by the software.

Note: The Enabling Factor is by default '1' (100%) in the bowtie, indicating that the threat can cause the top event on its own.

5. Fill in the probability of failure on demand (PFD) values of IPL's on all the barriers. The current PFD field shows the calculated current level of protection.

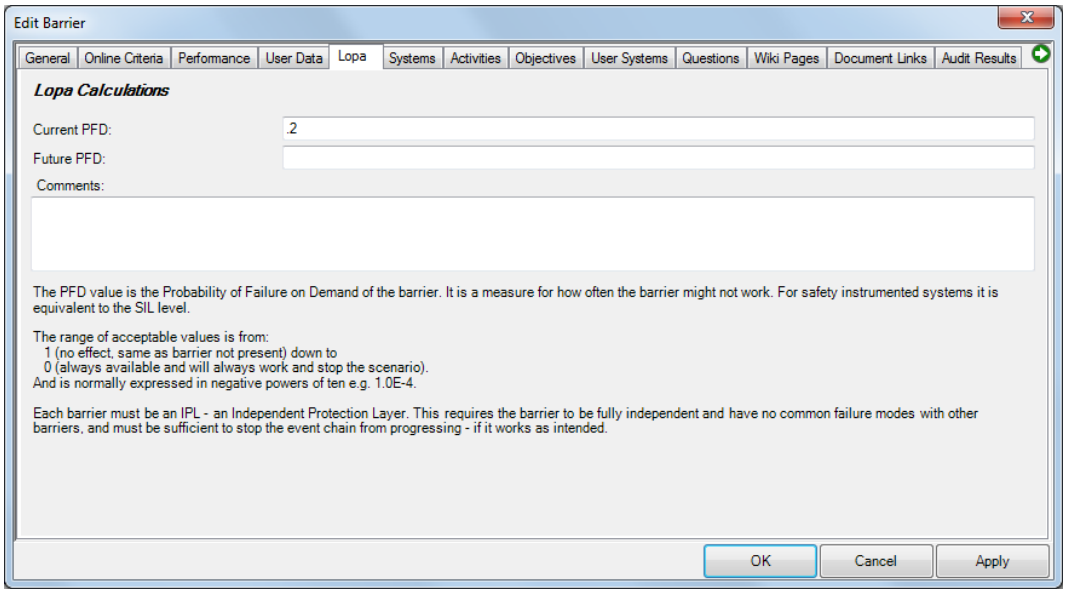


Figure 9 - Setting the PFD for a barrier

6. If all mandatory fields have been filled in, the plugin will now:
    a. Multiply each threat's Initial event frequency with the enabling factor (if present) and with all PFD's from the barriers on that line to get a residual event frequency for each threat. Below example illustrates this:
    1E-2 * .5 * .2 = .001

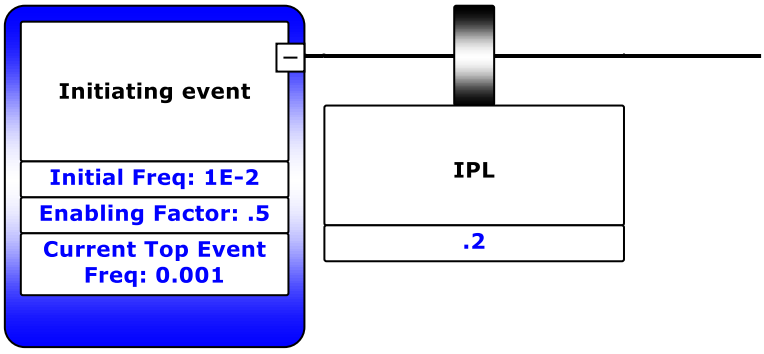
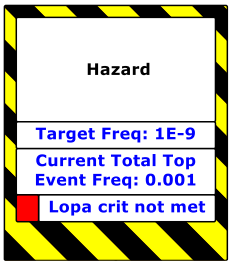


Figure 10 – Calculation of the Current Top Event frequency per threat

    b. The current top event frequency for each threat/initiating event will be summed to get the Total current top event frequency, visualised on the hazard-top event pair. That frequency is compared against the acceptable top event frequency, and the plugin will tell you if the acceptance criteria is either met or not.



Note: summing up the frequencies of multiple threats is done by default by the plugin. It is possible to exclude a threat from the LOPA calculation, by double-clicking a threat and checking the box "Exclude Threat from LOPA calculations".

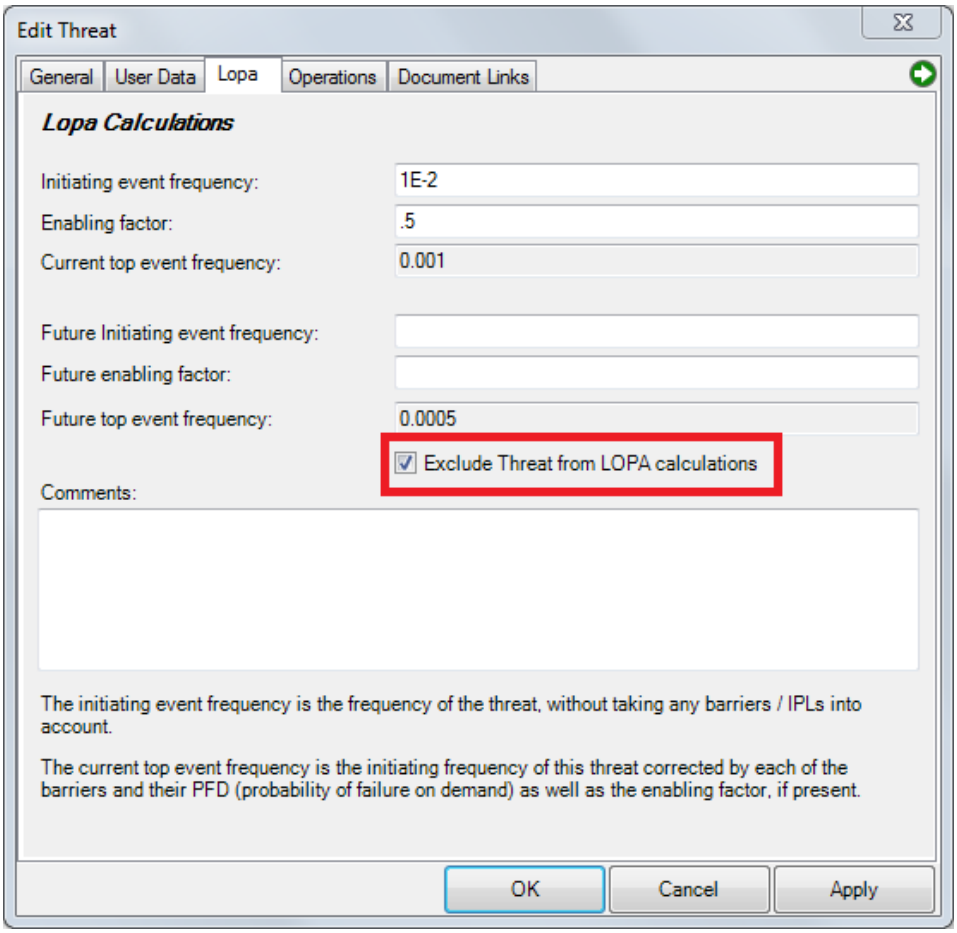


Figure 11 - Excluding a Threat from LOPA calculations

c. Each consequence frequency is calculated by starting with the current total top event frequency, and multiplying it with the barrier PFD's on a consequence line, and finally with the conditional modifier, if present. (For consequence frequencies calculated per scenario, see section 4.2 Classic LOPA reports.)
d. The calculated frequency of the consequence will be compared to the acceptable consequence frequency and the plugin will tell you whether the acceptance criteria is met or not.
e. The same is done for the future situation, using all the future values instead of the current values. This results in an acceptance criteria either being met or not in the future.

Note #1: When determining if acceptance criteria are met, a small error is allowed to compensate for floating-point rounding errors. The actual frequency is allowed to be larger than the acceptable frequency by a margin of **acceptable frequency × 10^-5**.

Note #2: Escalation factors and escalation factor barriers are not included in the LOPA calculation.

2.2.1. Future fields

The current frequency/enabling factor/conditional modifier/IPL fields show the calculated current level of protection. The future frequency/enabling factor/conditional modifier/IPL field allow you to compare the current frequencies to a predicted frequency given an expected or hypothesized change. The future fields are optional.

Note: A barrier we plan to implement would get a current PFD of 1, and the future PFD will be the expected probability of failure. A PFD of 1 means no contribution / reduction.

Note: If only a future PFD is used and no other future related fields, the future consequence frequencies will be calculated using the current initiating event and current top event frequency. When the future initiating event frequency is used, all the future associated fields will be used for the future consequence frequency calculation.

2.3. LOPA display profiles

The LOPA plugin adds two display profiles to the file when it's enabled. The normal "Lopa" profile shows just the current situation, whereas the "Lopa – Future" profile shows both the current and future situations. These profiles can be edited in the same manner as any other display profile within BowTieXP.

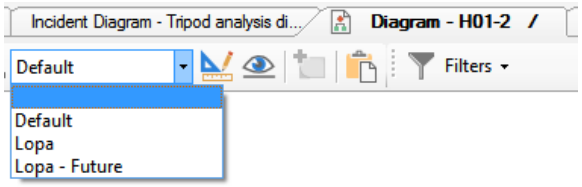


Figure 12 - LOPA display profiles

3

Consequence category acceptance criteria

You can also use consequence categories to standardise acceptance criteria for different kinds of consequences. This is done like this:

1. Go to BowTie Lookup tables > Consequence categories and right click > New Consequence Category.

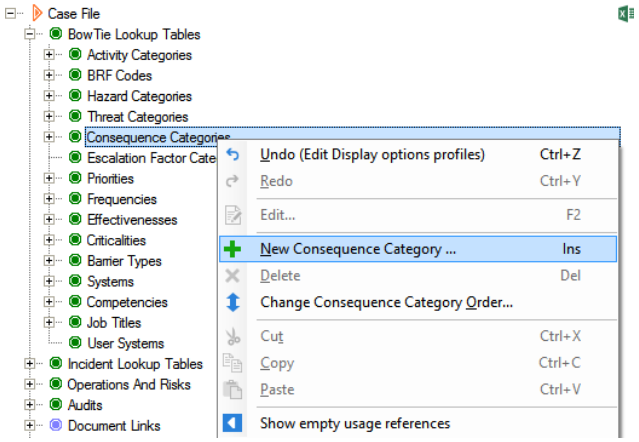


Figure 13 - Adding a consequence category in the treeview

2. In the LOPA tab, you can put in an acceptable consequence frequency.

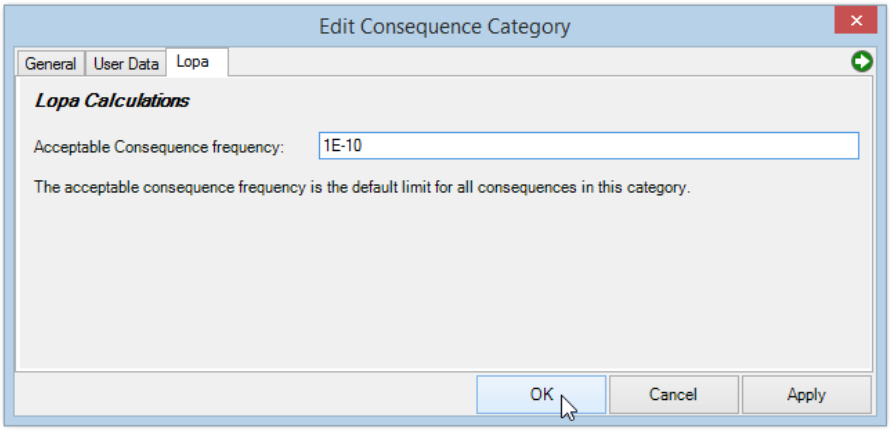


Figure 14 - Adding an acceptable frequency on a consequence category

3. Now you can choose a category on a consequence:

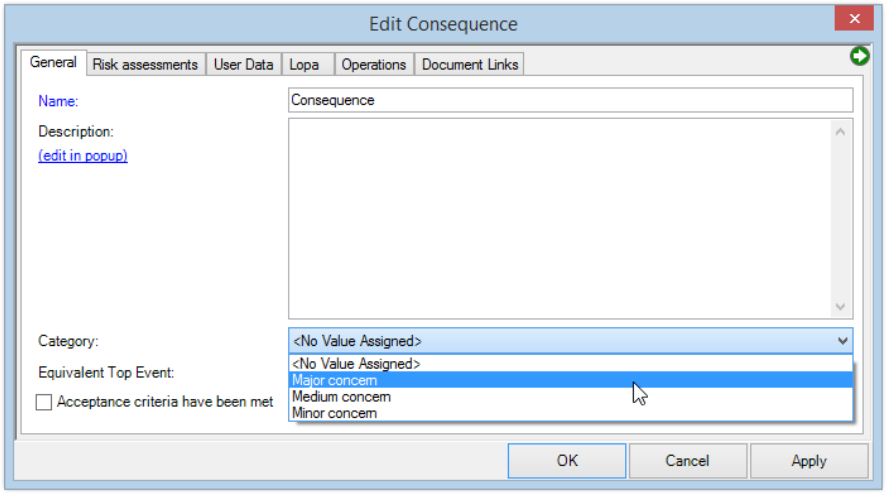


Figure 15 - Assigning a consequence category to a consequence

4. The LOPA tab on the consequence will show the acceptable category frequency, which comes from the consequence category.

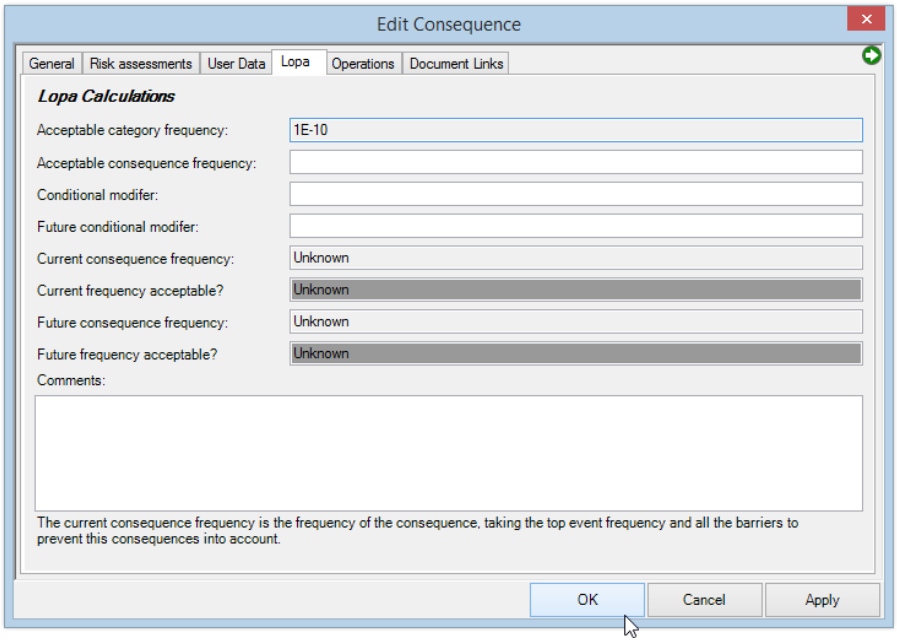


Figure 16 - Acceptable category frequency applied to consequence

5. This category frequency will be overridden if you manually put in an acceptable consequence frequency on the consequence.

4
Reports

There are a number of reports available for the LOPA plugin. Some reports follow the bowtie method calculations as in the diagram and others follow the classic LOPA approach. The difference is that the bowtie method calculates the frequency of the consequence given all the threats, while the classic LOPA calculates the frequency of a specific scenario line, thus the frequency of the consequence given one threat.

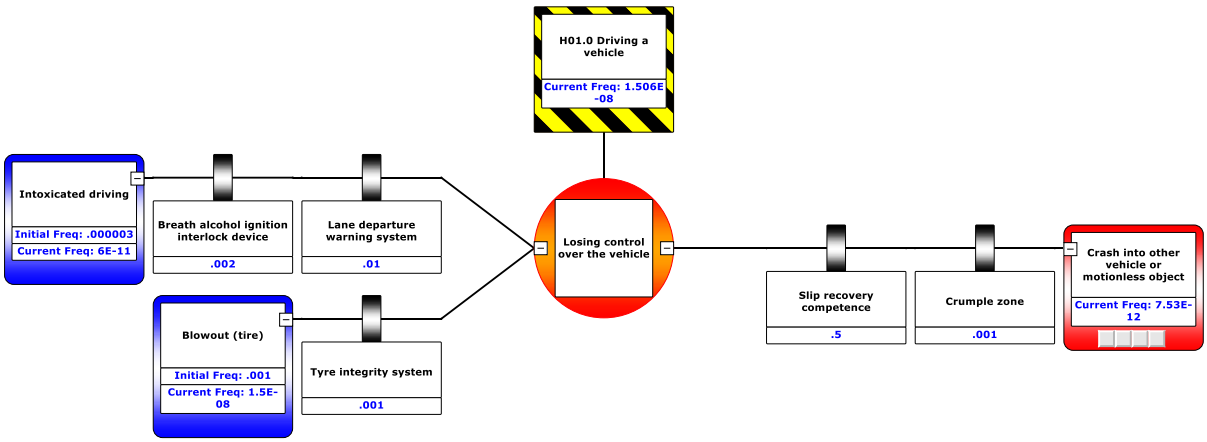


Figure 17 - Consequence frequency calculation via bowtie method

Consequence frequency of 'Crash into other vehicle or motionless object' =
(Residual event frequency of 'Intoxicated driving' + Residual event frequency of 'Blowout (tire)') * .5 * .001 = 7.53E-12

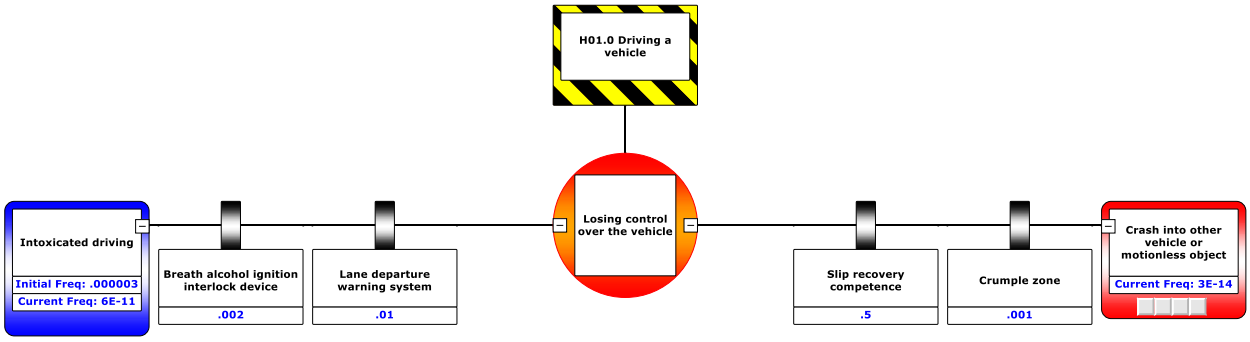


Figure 18 - Consequence frequency calculation via Classic LOPA: part 1

Consequence frequency of 'Crash into other vehicle or motionless object' caused by 'Intoxicated driving' =
Residual event frequency of 'Intoxicated driving' * .5 (PFD) * .001 (PFD) = 3E-14

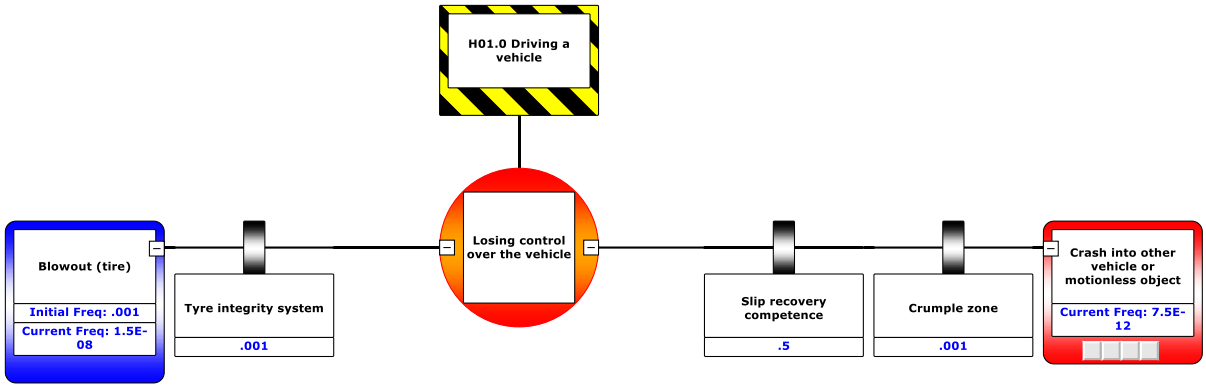


Figure 19 - Consequence frequency calculation via Classic LOPA: part 2

Consequence frequency of 'Crash into other vehicle or motionless object' caused by 'Intoxicated driving' = Residual event frequency of 'blowout (tire)' * .5 (PFD) * .001 (PFD) = 7.5E-12

4.1. Standard reports

The two reports 'BowTie Method Overall' and 'LOPA scenario overview and segments (BowTie method)' follow the calculation of the consequence frequency via the bowtie method. These reports include the top event frequency and the top event target frequency.

The report 'BowTie Method Overall' is an Excel report in which each bowtie is concisely described per Excel sheet. The report 'LOPA scenario overview and segments (BowTie method)' is a report in which parts of the bowtie are described separately. Each threat to top event is described and the top event to each consequence. The descriptions include a diagram depicting the part of the bowtie being described.

4.2. Classic LOPA reports

The three reports 'LOPA Classic Scenario Analysis', 'LOPA classic summary with related open Actions' and 'LOPA Riskassessment summary sheet, opens in XL' show the calculations per line (one threat to one consequence). Please be aware that if you use these reports, you should adjust the target frequency to be the frequency for a threat leading to the consequence and not for the occurrence of the consequence. For example if you state for a specific consequence that it may only occur at a frequency of .001, and you have two threats, you can pick a target frequency of .0005 for the first line and thereby also a target frequency of .0005 for the second line, so the total frequency of both lines is .001.

The Classic LOPA report only works when there are consequences in the bowtie diagram. If you have a bowtie which has a left side only, you can use the standard reports to get the classic LOPA approach, by looking at the current top event frequency of each threat.

Appendix

The appendix describes how the LOPA plugin can be installed for BowTieXP versions lower than version 8.2. Please see chapter 1 on how to install and activate the LOPA plugin for BowTieXP version 8.2 or higher.

Installation of the LOPA plugin with older versions of BowTieXP

1. Download BowTieXP here*:
   http://www.cgerisk.com/downloads/bowtiexp/index-all.php.
   * The LOPA report 'LOPA Riskassessment summary sheet, opens in XL' is only available in v7.0.11 or higher
2. Unzip bowtie.exe to a folder of your choice.
3. Download the LOPA plugin (lopa.dll) here:
   http://www.cgerisk.com/downloads/bowtiexp/index-plugins.php.
4. Login with the provided credentials.
5. Create a folder called "Plugins" next to the bowtie.exe file

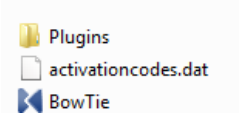


Figure 20 - Plugin installation

6. Put the lopa.dll file in this folder.
7. Run bowtie.exe

Activation of the LOPA plugin with older versions of BowTieXP

1. Navigate in the toolbar to Help -> Plugin Activation Codes.
2. Click on the green plus button to add a new plugin activation code.
3. Add the activation or trial code, and click OK.

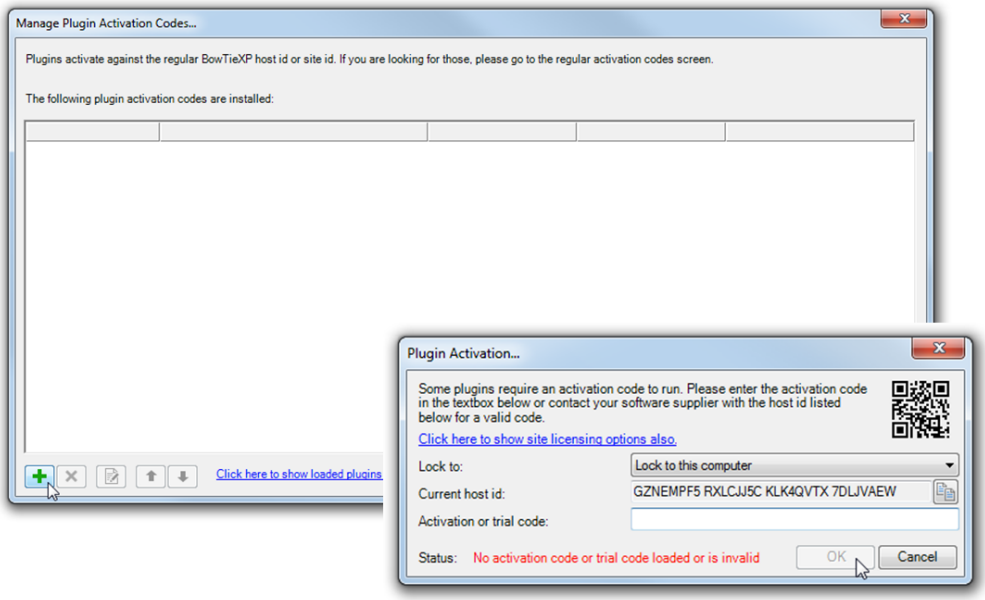


Figure 21 - Plugin activation