EHEST
Component of ESSI
European Helicopter Safety Team

EHEST SAFETY MANAGEMENT TOOLKIT

MARIA

(My Assessment of Risks for Incidents and Accidents)

Guidance Manual

2nd Edition, 01 August 2016

Courtesy: Elicampiglio
Photo: Michele Calovi

European Helicopter Safety Team

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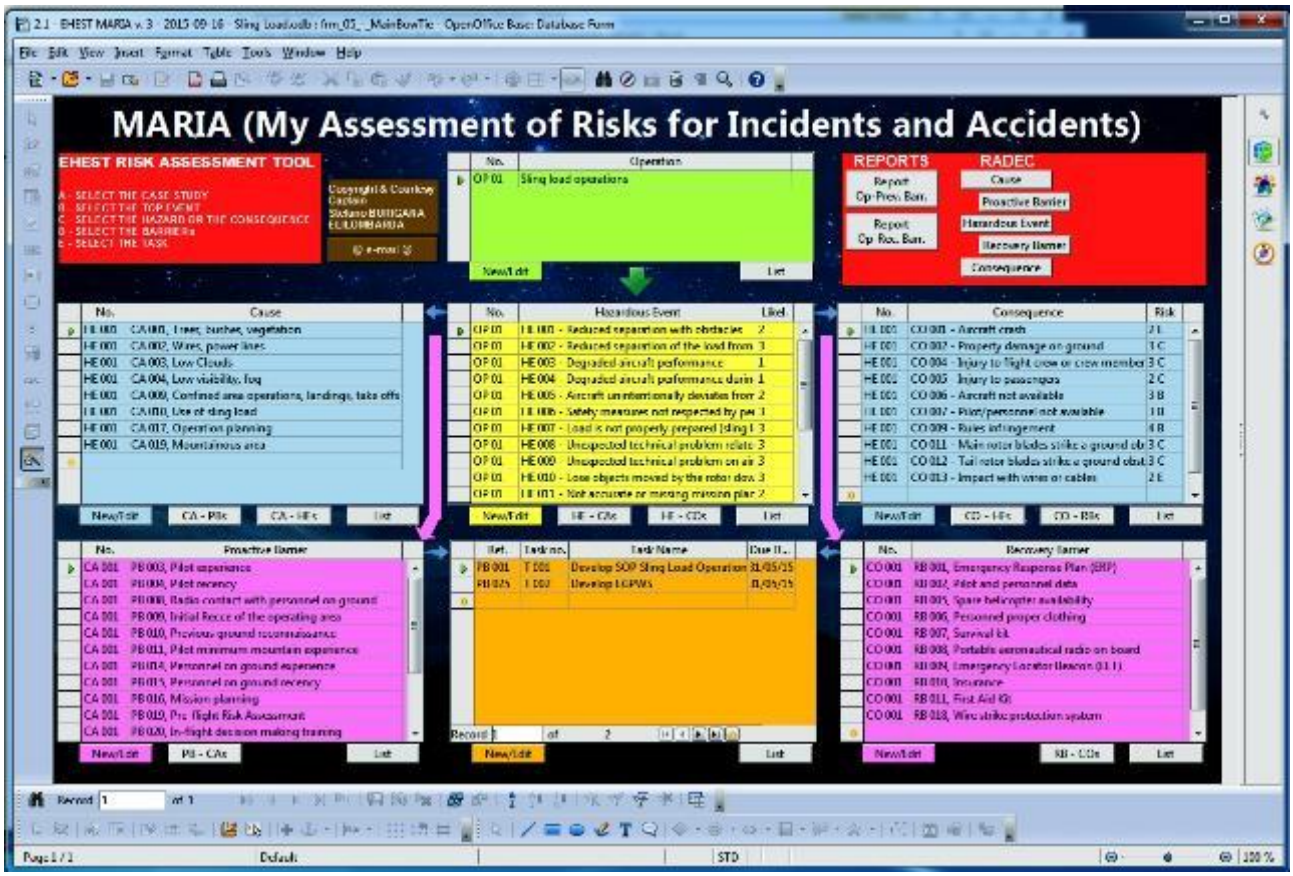
Guidance Manual



Edition 2

01 August 2016

ABOUT THE MANUAL

This manual will walk you through the installation of the OpenOffice suite and the usage of the EHEST "MARIA" tool.

The tool has been developed by Capt. Stefano BURIGANA, Elilombarda Safety Manager and revised by the EHEST Specialist Team Ops. & SMS. The tool has been released by EHEST to assist operators to develop their own Company risk assessments better.

The tool is open source, e.g. it can be used, copied, distributed and changed. The only requirements are that:

- **The tool cannot be sold or used for remuneration.**
- **If the tool is changed, the changes must be made available to the community.**

The information (risk evaluations) contained inside the tool must be considered as examples. Every operator MUST make its own analysis and risk evaluation, since those can significantly differ between different operators or operations.

NOTE: Downloading the MARIA file, the computer could save the file as "read only", preventing the insertion of data and the use of the database.

If necessary, right-click on the file (before opening it), select "Properties" and uncheck the "Read only" box.

Please report your comments and suggestions to:

ehest@easa.europa.eu

In case of "technical" questions about the MARIA tool, please report also to:

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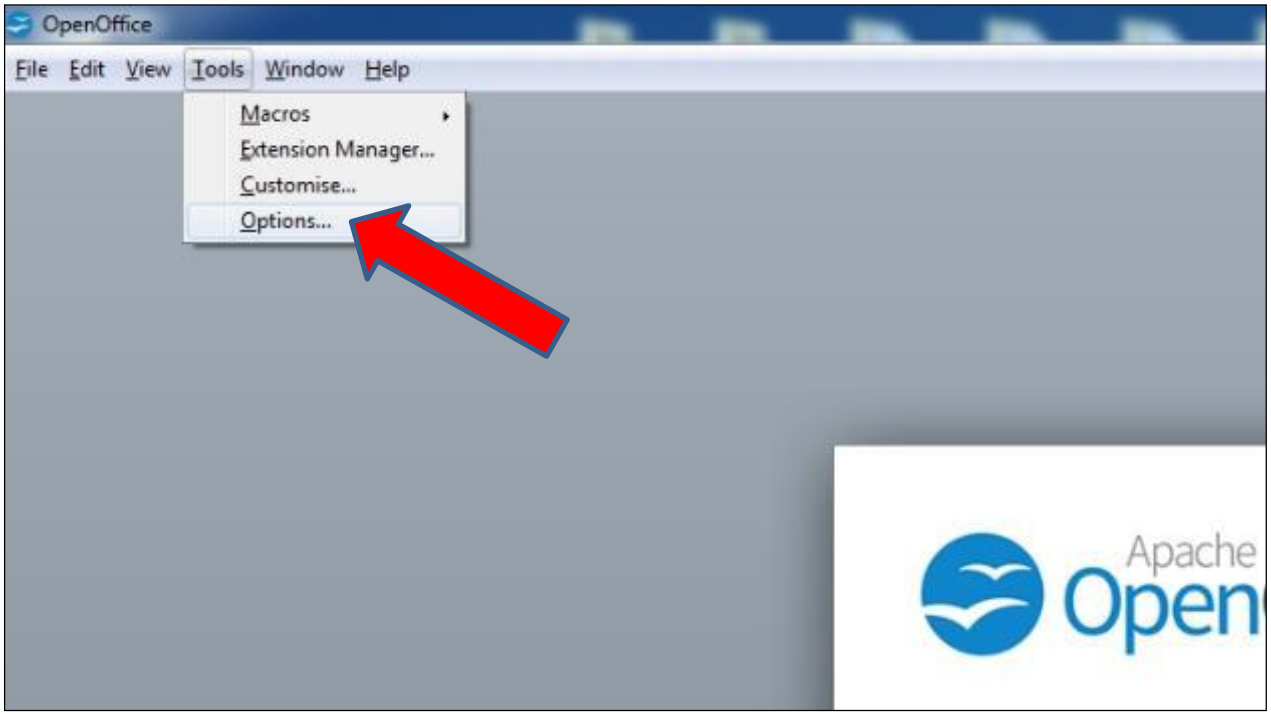
1) HOW TO INSTALL THE EHEST "MARIA"

MARIA is based on OpenOffice, an open source cost-free office suite that can be downloaded and installed by everybody. The idea was to create a tool that could be used with everyday computer programs but, since not every Microsoft Office suite has the Access database in it, EHEST opted for a world-recognized free program such as OpenOffice for the development of MARIA.

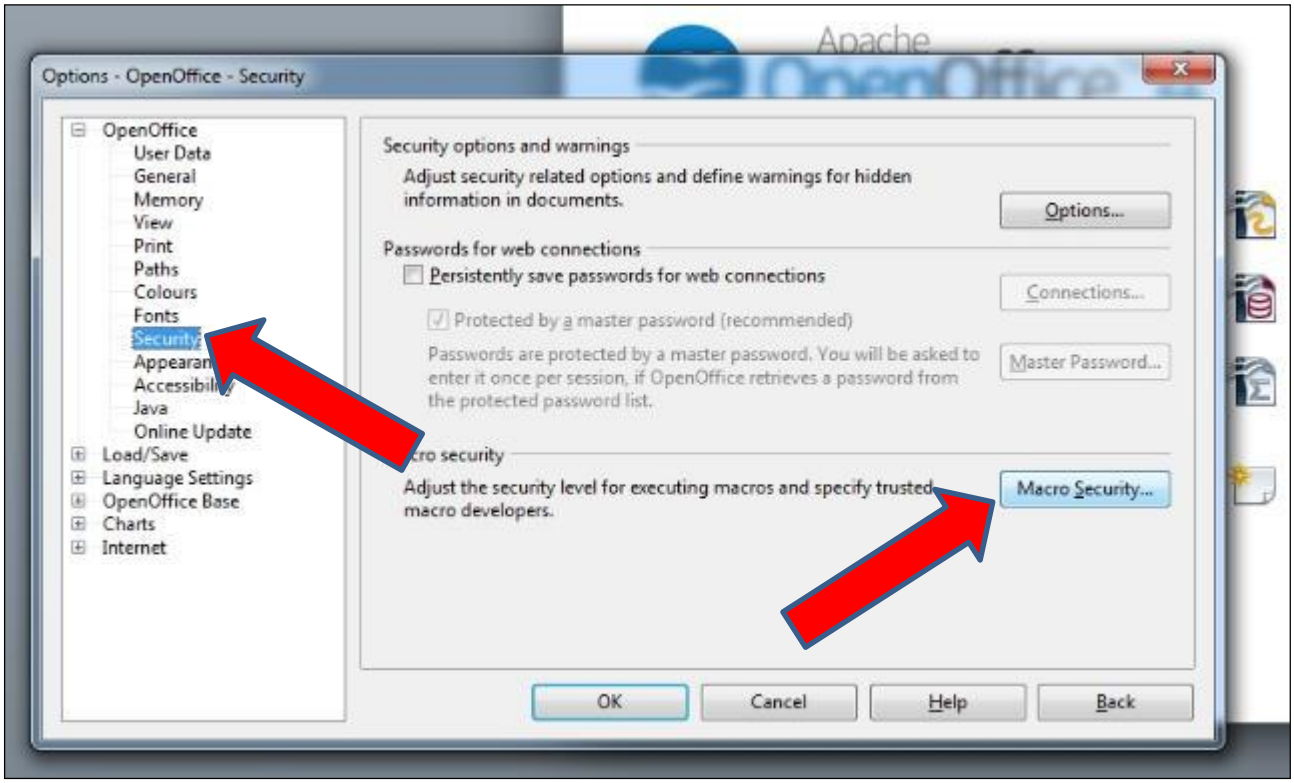
NOTE: There are different free Office suites available, e.g. NeoOffice, LibreOffice, OpenOffice. Be sure to use the Apache OpenOffice.

These are the steps for installing and setting up the OpenOffice suite to be used with MARIA.

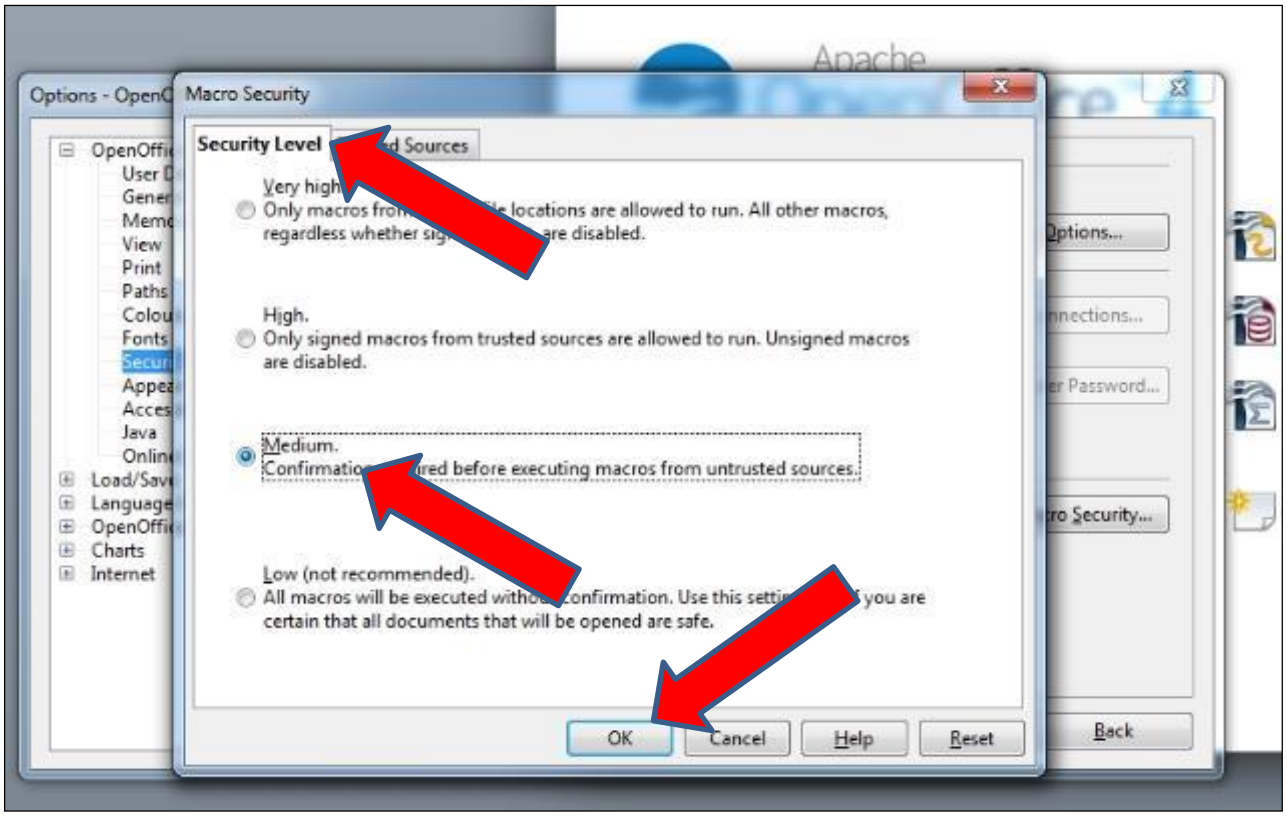
1) Download OpenOffice from http://www.openoffice.org/download/index.html
2) Install the OpenOffice suite
3) Enable macros:
   - Select Tools, Options



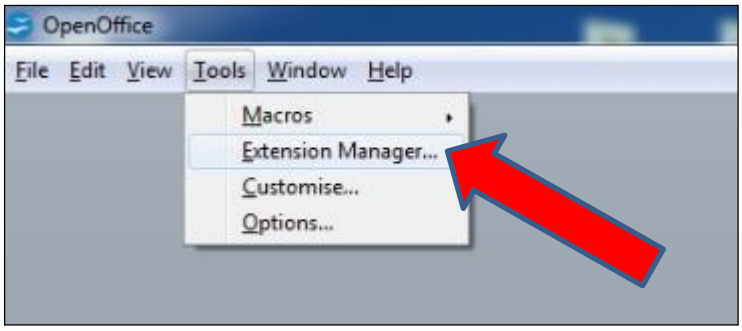
   - Select Security, Macro Security…



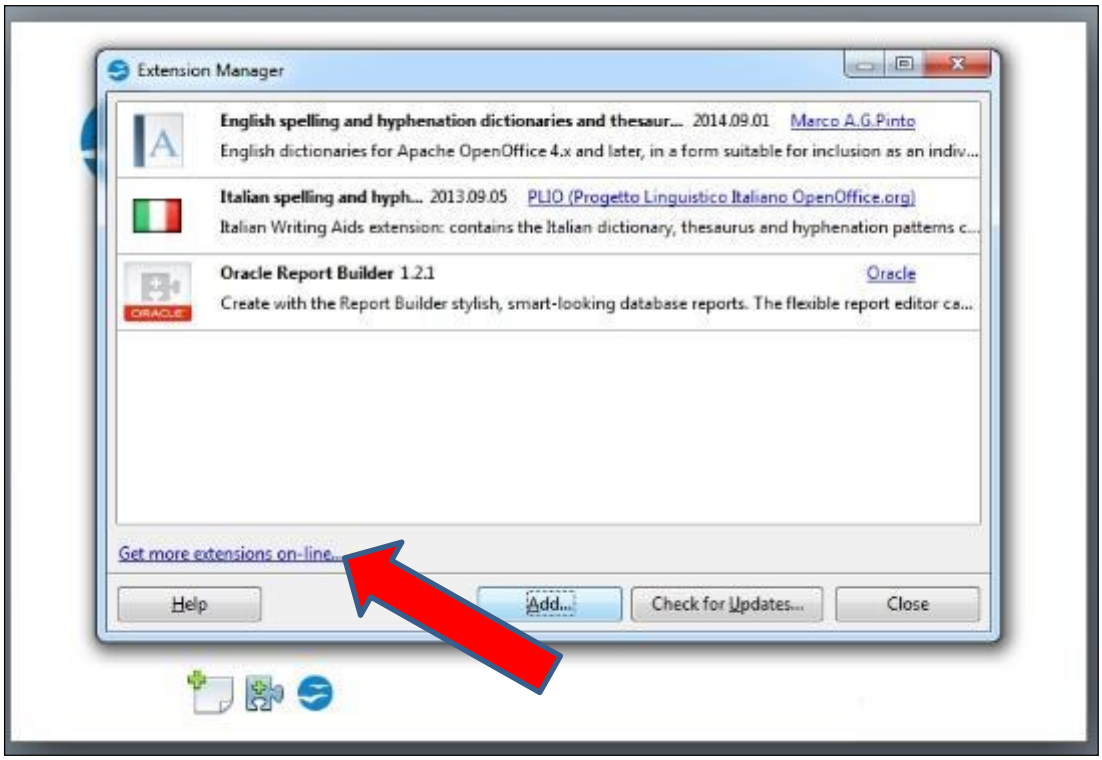
- Select Security Level tab, Medium (suggested), OK.



4) Install the Oracle Report Builder. This extension is used to produce the reports:
   - Select Tools, Extension Manager

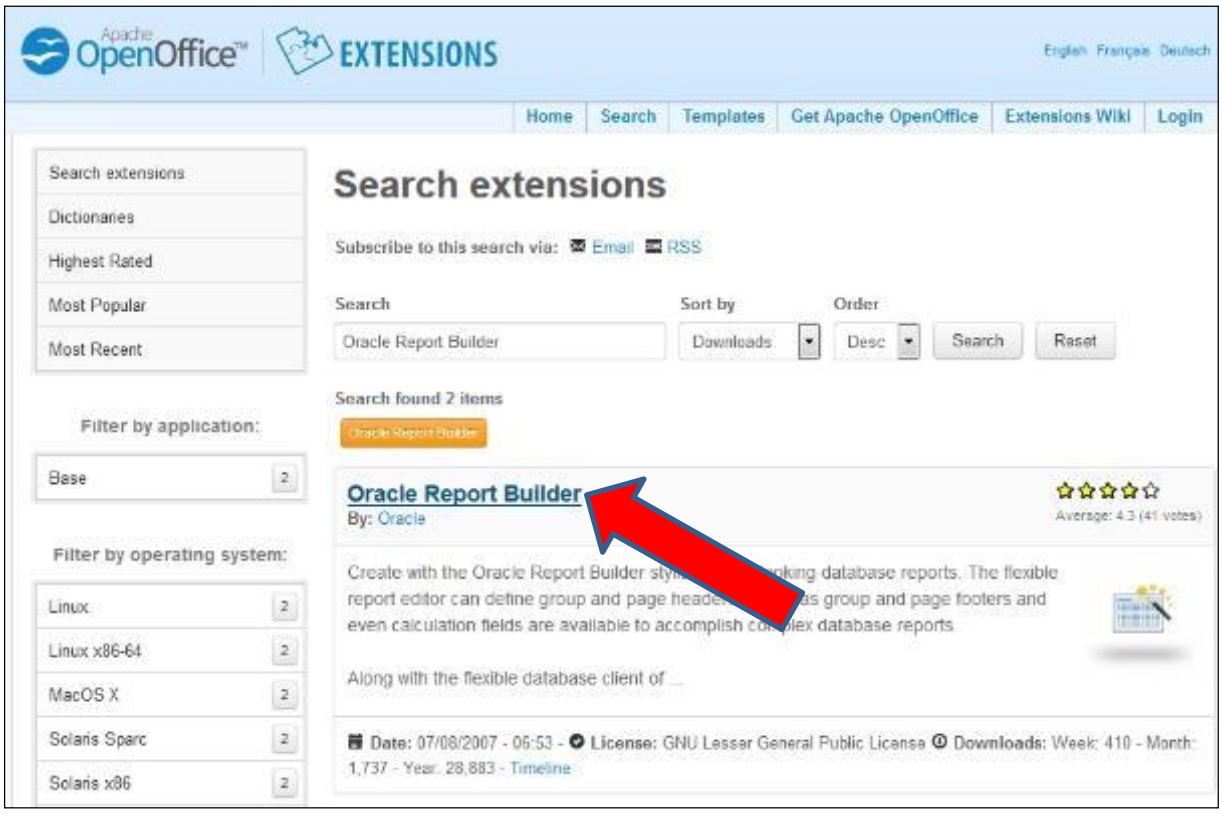


   - Select Get more extensions on-line (you must have an internet connection)

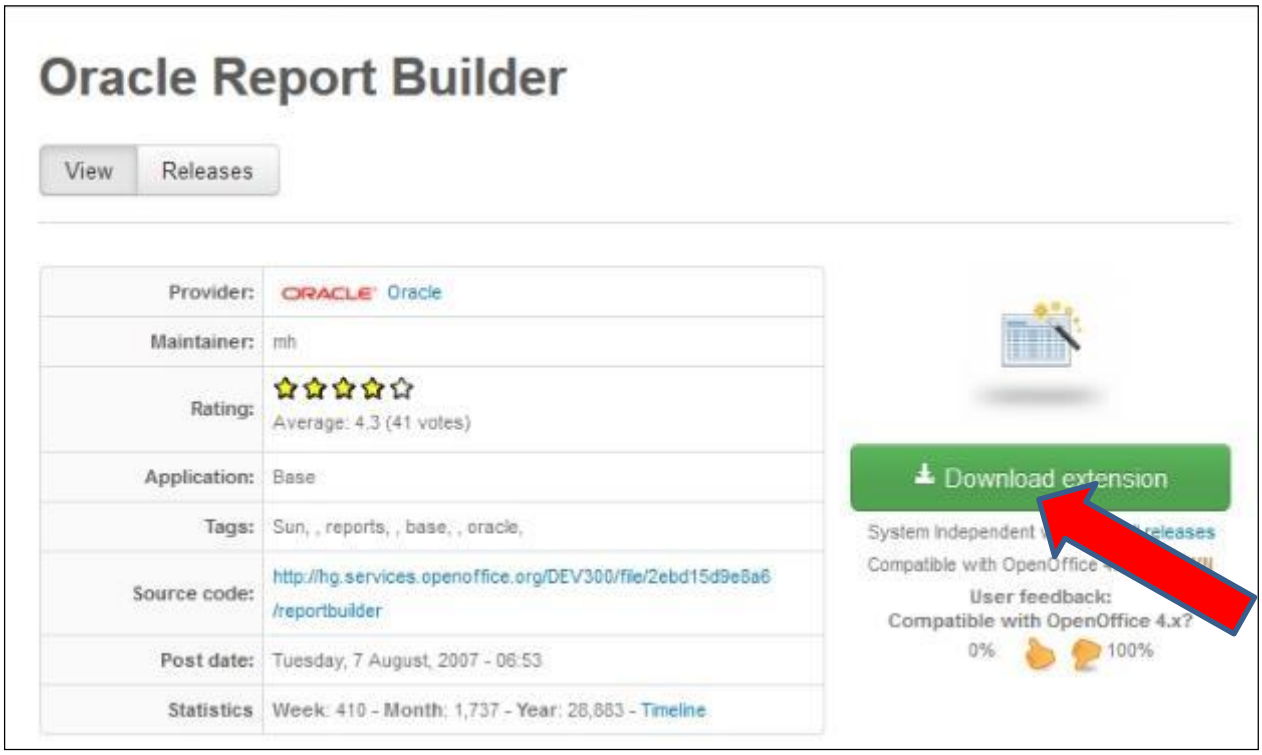


   - Write "Oracle Report Builder" in the search window and press Search

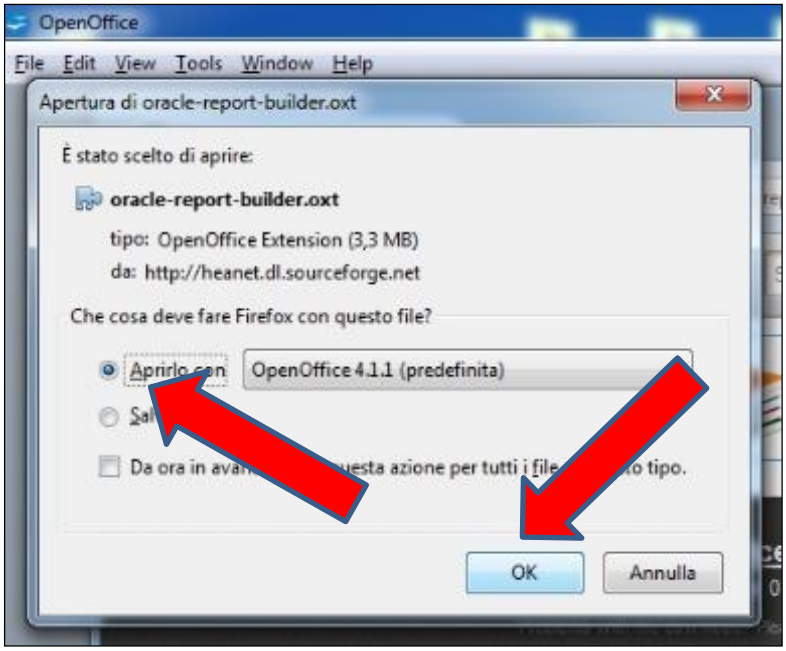
- Select the extension Oracle Report Builder



- Select Download Extension



- Select the extension Open with and OK



2) ABOUT TERMINOLOGY

MARIA uses a variation of the Bowtie methodology to manage the risk analysis, but efforts have been made in order to maintain consistency with the European Regulation terminology and concepts. This means that some terms were adapted to best represent the concepts or to reduce confusion with other available methodologies.

MARIA is not a BowTie method, but it takes some of the BowTie concepts.

Please refer to the UK CAA website for an explanation of BowTie

(http://www.caa.co.uk/default.aspx?catid=2786&pagetype=90).

With reference to the BowTie diagram above, these are the main differences:

Hazard is perhaps the most used word in aeronautical safety, but several different concepts are used with this word:

BOWTIE METHODOLOGY – Hazard is a situation, operation, event that is part of the normal life, but that has the potential of harming the safety. For example, weather is something we are used to living with: clouds, wind, rain, temperature are normal elements we cope with every day. These are all HAZARDS, but they can be harmful in case of low clouds, strong or gusty winds, heavy rain or icing conditions. In the latter case the hazards became THREATS and could be contributing factors for an unwanted situation (top event)

EUROPEAN REGULATION – The Regulation does not make such differentiation, but consider the HAZARD as a general event or situation that already is outside normal situation or that is already a contributing factor to a possible incident or accident. Cf. "ORO.GEN.200 - Management system – (a) (3)":

> the identification of aviation safety hazards entailed by the activities of the operator, their evaluation and the management of associated risks, including taking actions to mitigate the risk and verify their effectiveness;

In MARIA tool, both HAZARDS and THREATS (as for Bowtie meaning) are called CAUSES, and for simplicity they can be listed together.

The more general meaning of HAZARD used by the EU Regulation, in the Bowtie methodology is the central part of the graphic and is called TOP EVENT. As said before, these are situations or events that can be seen as an unwanted state, i.e. something happened that is already outside

the normal situation and, if not treated accordingly, can develop into an incident or accident. An example can be the inadvertent entry into IMC, altitude infringement or wrong radio frequency selection.

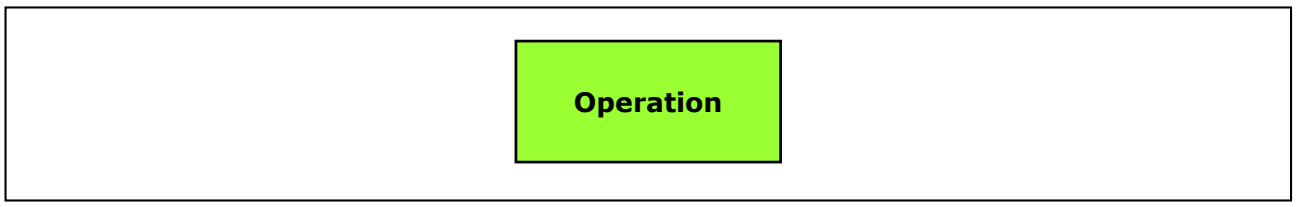
In MARIA tool, these are called HAZARDOUS EVENTS as they are close to the concept used by Bowtie methodology, but they can be easily understood as HAZARDS as for EU Regulation.

Consequences, Proactive and Recovery Barriers maintain the same meaning as for Bowtie terminology.

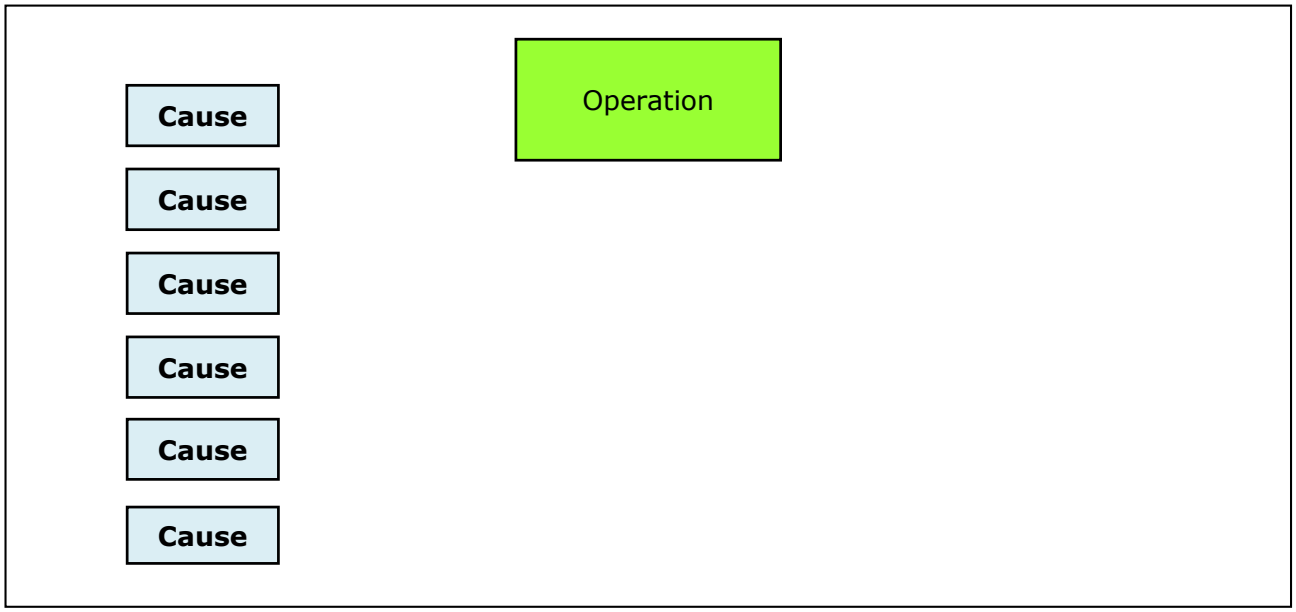
3) "MARIA" RISK ASSESSMENT METHODOLOGY

Following is a description of the MARIA risk assessment methodology.

First an **Operation** is created. An Operation is the risk assessment, the safety occurrence, the management of change, and so on, that we want to analyse in order to split it in more simple/basic contributing factors/causes.



The situation, or operation, we are studying is "inserted" or it "lives" inside a specific environment made of "Causes" which can either be Hazards or Threats.



Hazards are not necessarily "bad things": they are situations, environments, operations that we normally do or live with, but that can lead to an unwanted situation. As an example meteorological situations, or even a thunderstorm, is a Hazard: it exists and we live with it. It does not necessarily give any danger, yet… unless I fly under or within the thunderstorm, that is something I do not want to do (= Hazardous Event). If I end up under or within a thunderstorm, I can have damage to the aircraft, lightning strikes, even loss of control and crash on ground. These are all "Consequences" (see ahead) that are potentially catastrophic results from a non-regular situation (Hazardous Event).

Threats describe events that may cause an unsafe state if not managed with preventive controls. They are generally called "Contributing Factors", and are not unwanted situations (Hazardous Events) yet, but they can turn (alone or in combination) into a Hazardous Event if a barrier will not stop the sequence of events.

Consider the Hazardous Event and ask the question 'why' or 'how' could this occur?

In the thunderstorm example we can have:

HAZARDS (they are all normal elements we work with):

- Thunderstorm
- Night operations
- Marginal VFR

THREATS (contributing factors)

- The pilot heads toward the thunderstorm
- The aircraft was released with the weather radar not operative and under MEL
- Thunderstorms were not forecast

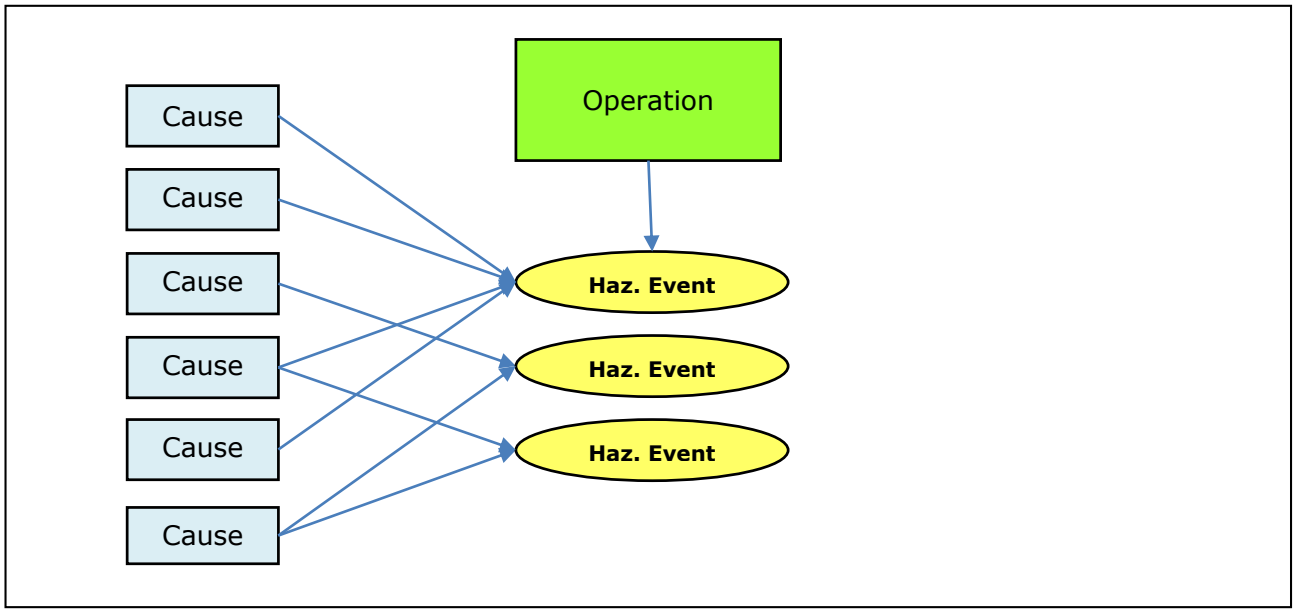
All the above are considered as "CAUSES".

"Causes" could end up in some unwanted events called **Hazardous Events.** These are events/occurrences/situation that are outside the normal management of a flight or maintenance: something happened which is not wanted, it puts the personnel or the aircraft in an unwanted situation, and it can be a precursor to a much worse incident or accident.

A single Cause can end up in more than a Hazardous Event. For example, flying close to a CB I can possibly end up with:

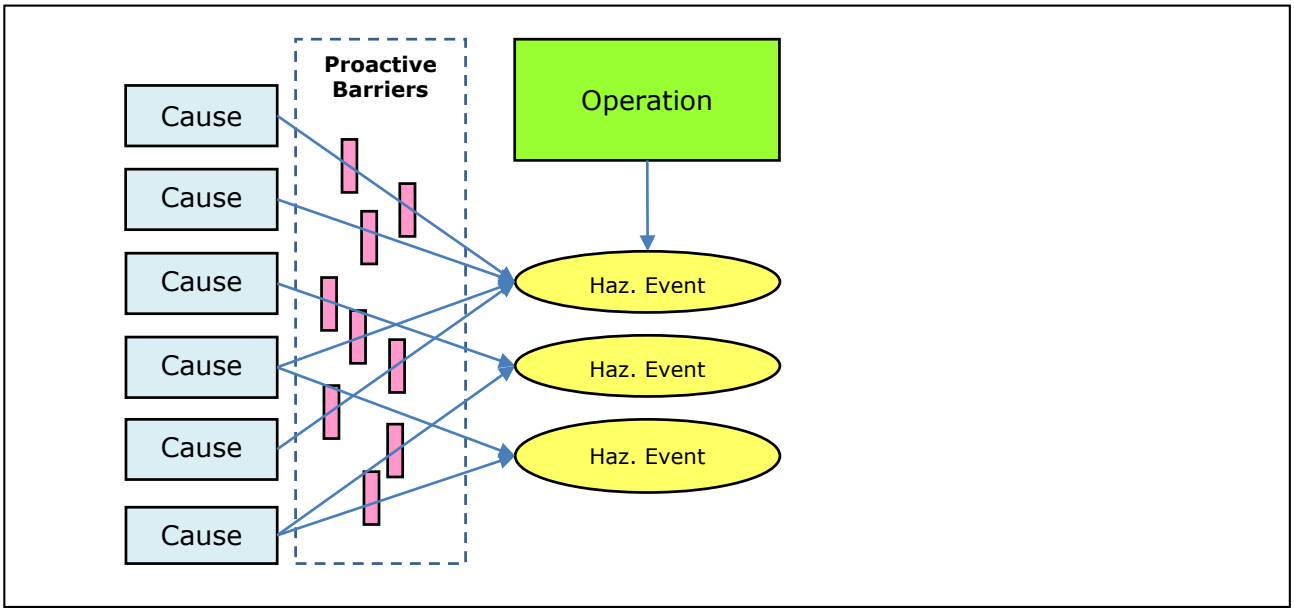
- flying in severe turbulence; or
- inadvertent IMC; or
- icing conditions; and so on.

These situations are outside the normal flight conditions I want to maintain, but they are not detrimental, yet. I am in an unwanted state or situation, but I can still recover from the situation provided I apply some recovery actions or "Barriers".

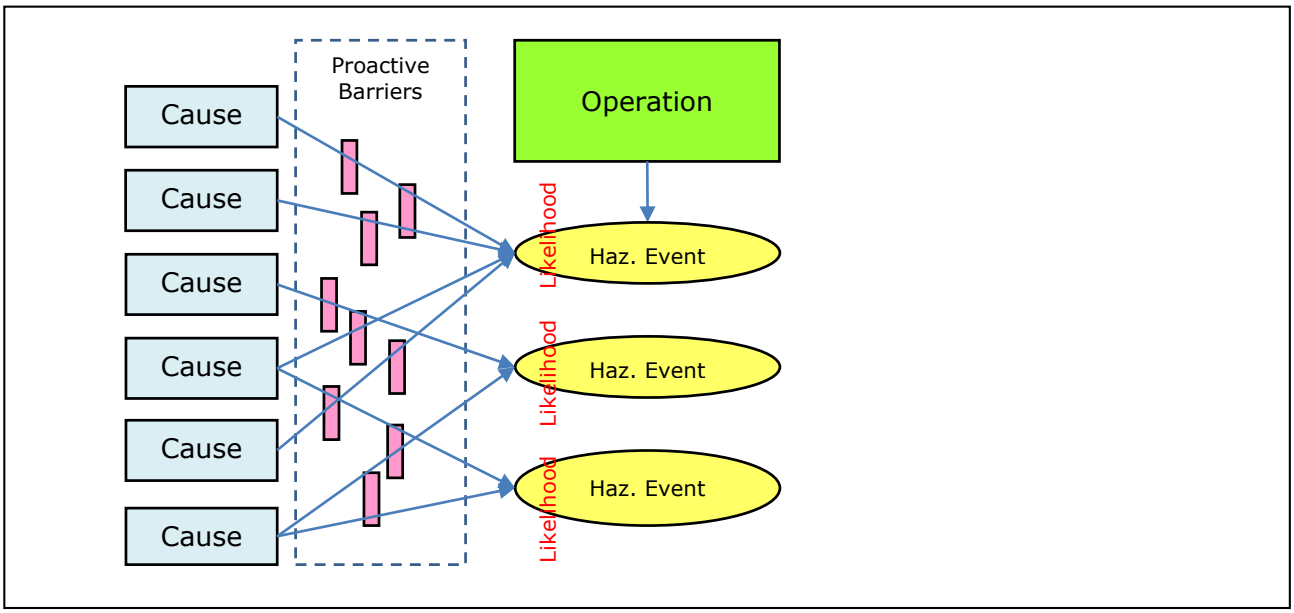


We generally have, or will strive to have, several methods for avoiding, intercepting, blocking events before they change from a normal and wanted situation to a dangerous, abnormal or unwanted situation (Hazardous Event). To do that, we use procedures, back-up systems, double controls, technology, and so on. All these are called **Proactive Barriers**.

Every Cause has its own list of related safety controls, called "Proactive Controls", that are put there to try to avoid, or put a "barrier", to a normal situation that can turn into an undesirable situation (Hazardous Event).



We can list all the things that will help us to maintain the control of the situation (Barriers). After that, we can evaluate the **Likelihood** (probability) that a particular Hazardous Event would happen and an unwanted state or situation would arise.



Together with the development and improvement of safety Barriers, the evaluation of the Likelihood of a Hazardous Event and the evaluation of the Risk level of a Consequence are the most important part of a safety analysis.

The Risk is assessed by the use of a **Risk Matrix**.

A Risk Matrix is an evaluation table, or graphic, where we choose in one side the possibility (Likelihood) that the "bad thing" (Hazardous Event or Consequence) would happen and in the other side the gravity (Severity) of the Consequences of the "bad thing" if it finally happens.

RISK MATRIX

Risk Likelihood	Risk Severity: Negligible (A)	Minor (B)	Major (C)	Hazardous (D)	Catastrophic (E)
Likely to occur many times. Has already occurred in the Company (> 3 times/year - indicative). Has occurred frequently in the history of the aviation industry. — Frequent (5)	5 A	5 B	5 C	5 D	5 E
Likely to occur sometimes. Has already occurred in the Company (< 3 times/year - indicative). Has occurred infrequently in the history of the aviation industry. — Occasional (4)	4 A	4 B	4 C	4 D	4 E
Unlikely to occur, but possible. Has already occurred in the Company at least once. Has seldom occurred in the history of the aviation industry. — Remote (3)	3 A	3 B	3 C	3 D	3 E
Very unlikely to occur. Not known to have occurred in the Company but already occurred at least once in the history of the aviation industry. — Improbable (2)	2 A	2 B	2 C	2 D	2 E
Almost inconceivable that the event will occur. It has never occurred in the history of the aviation industry. — Extremely Improbable (1)	1 A	1 B	1 C	1 D	1 E
Personnel	Superficial or no injuries	Light injuries	Serious injuries	Fatality	Multiple fatalities
Environment	Negligible or no effects	Little impact	Noteworthy local effects	Effects difficult to repair	Massive effects (pollution, destruction, etc.)
Material values & assets	Negligible impact	Financial loss with little impact. Damage < 50K€	Substantial financial loss. Damage < 250K€	Severe financial loss, long term eff. Damage < 1 M€	Catastrophic financial loss. Damage > 1 M€
Reputation	Light or no impact	Limited impact	Considerable impact	National impact	International impact

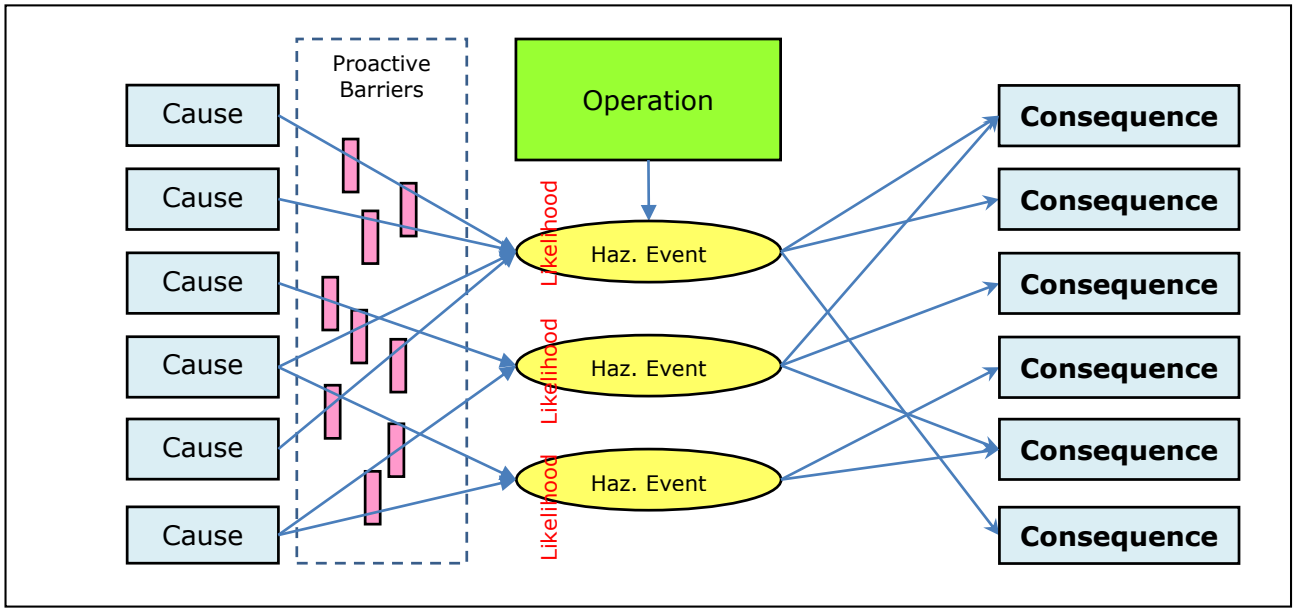
Unacceptable Risk Level	Unacceptable under the existing circumstances
Tolerable Risk Level	Acceptable based on risk mitigation. It may require management decision
Acceptable Risk Level	Acceptable

Risk Matrix should be of "quantitative" type, that means a matrix were the likelihood is a real statistic of similar events happened per amount of time/flight hours/cycles. In real life, this is not realistic for small or even medium size operators who would never fly the minimum statistic basic flight hours (10.000 or even 100.000) during the whole Company lifetime.

For this reason, we work with "qualitative" reference when it comes to evaluate the likelihood part of the risk matrix. Just sit down and think if a similar event has ever happened in the Company, in similar Companies, or in the aeronautical world (as far as you know). In the worst situation (no information at all) just think how often could that event happen in your company and make an evaluation based on your judgment. This could not be a scientific approach, but it is surely better than having no likelihood ideas at all. After all: who better than you knows your job? You will probably make a good estimation of likelihood based on your knowledge and experience of similar situations.

Hazardous Events are assessed only for the Likelihood that this event could happen, while Consequences are assessed also by the possible severity of the consequences. This is because in the Hazardous Event nothing detrimental happened yet, but we only have an unwanted situation that we want to recover from.

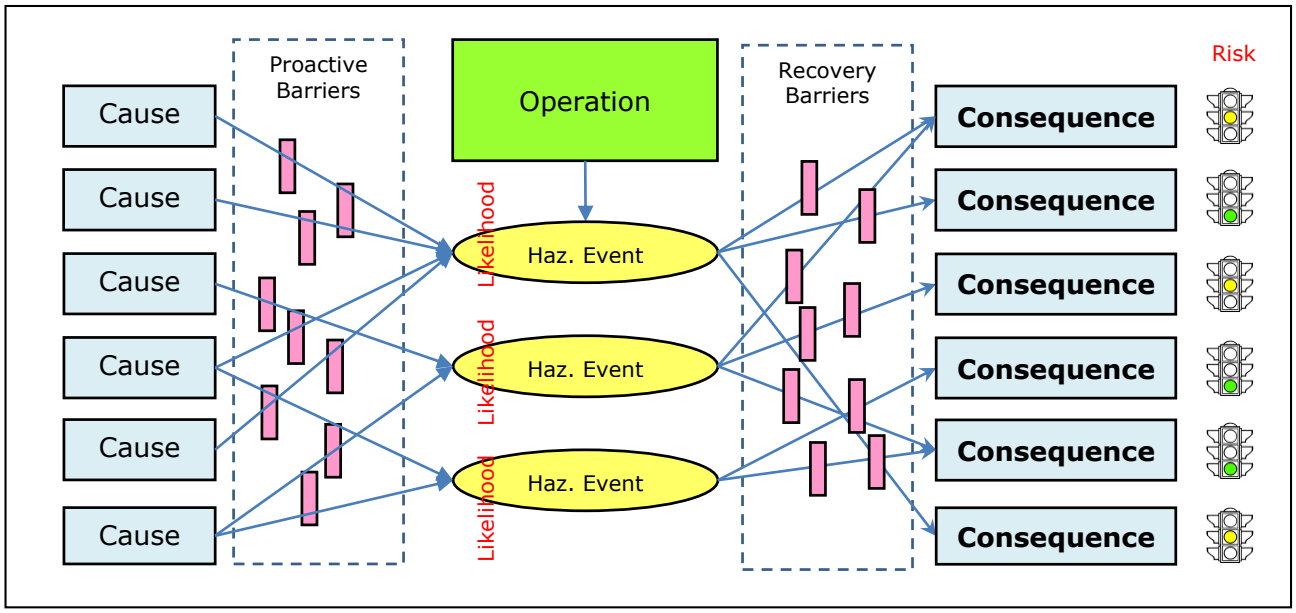
As said before, the Hazardous Event is only an occurrence or situation that could lead to an accident. Therefore, the next step is to identify and link all the **Consequences** that could be triggered by the Hazardous Events. This is the right side of the tool.



Consequences describe the possible incidents or accidents that may potentially result from the Hazardous Event if the event is not managed with recovery controls.

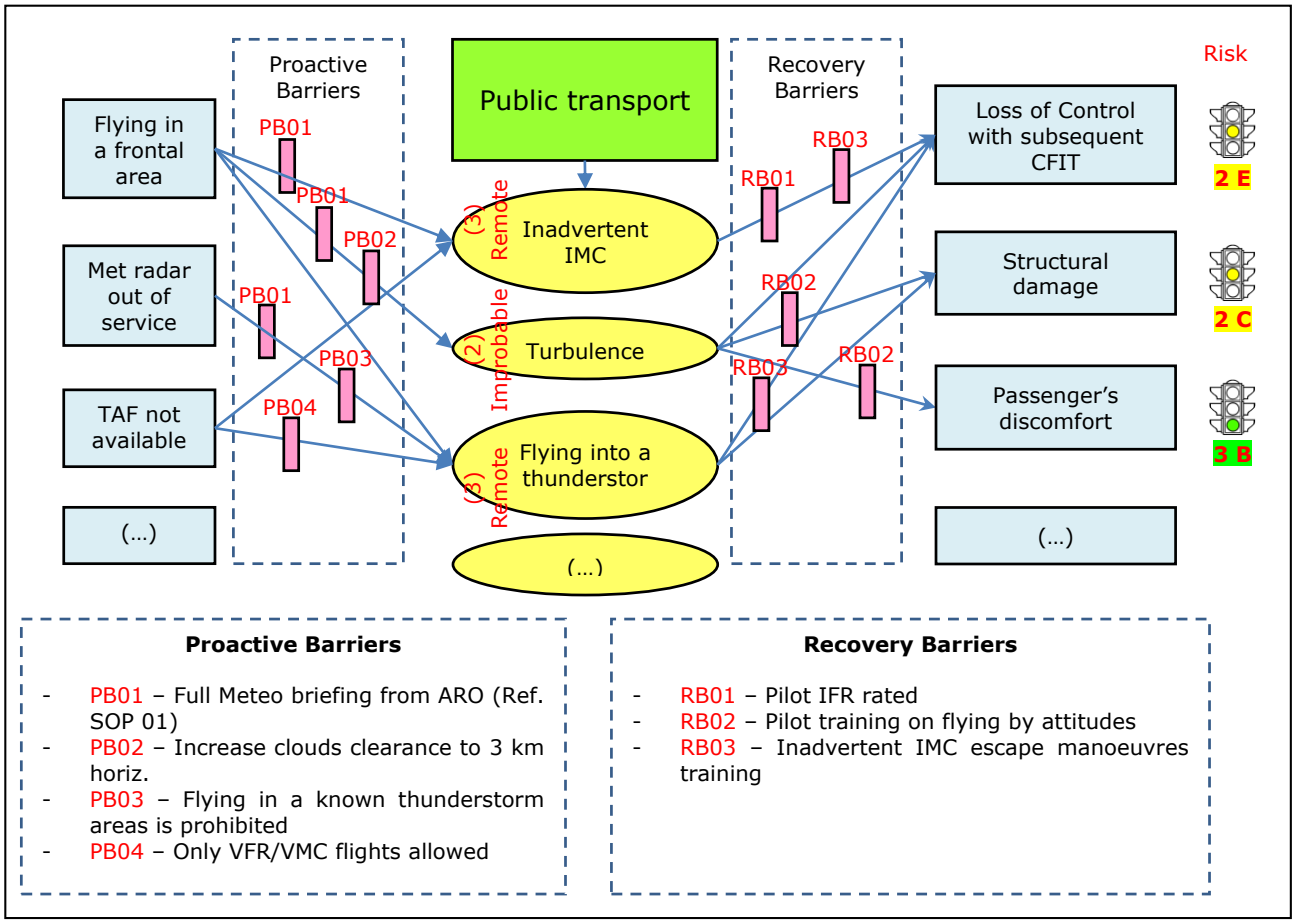
In our flying close to a CB example, the inadvertent IMC Hazardous Event could lead to a loss of control with possible CFIT if the pilot do not do something to recover from the inadvertent IMC (Recovery Barriers).

As well as the Proactive Barriers, we can have several measures in place to reduce the possibility that a Hazardous Event turns into a Consequence. These are called **Recovery Barriers**.



In the practical world, mitigations could be either the measures that block the chain of events from an abnormal situation (Hazardous Event) to the possible Consequence (reducing the Risk Likelihood), or the measures in place to reduce the deleterious outcome of an accident (reducing the Risk Severity).

The following example is how the thunderstorm could be analysed and rated.



4) WHY AN EHEST RISK ASSESSMENT TOOL?

Handling a complete methodology to make an in depth risk assessment and analysis could became very complicated, because there are many connections between the elements (in a technical database terminology: several "many-to-many relations") that makes the use of a classical "tabular list" very unhandy. Just to clarify:

- An operator will have several Operations (i.e. risk assessments on its operations, changes, occurrences, etc.).
- Each Operation has several Hazardous Events. Each Hazardous Event can be linked to more than one Operation. **(many-to-many relations)**
- Each Hazardous Event could be triggered by several Causes. Each Cause can be the starting point of several Hazardous Events. **(many-to-many relations)**

- Each Hazardous Event can be prevented by several Proactive Barriers. Those Barriers are used to limit the Likelihood that a Hazardous Events happens. **(many-to-many relations)**
- Hazardous Events can lead to some Consequences. More than one Consequence could be the result of several Hazardous Events. **(many-to-many relations)**
- I could stop the event chain from a Hazardous Event to Consequences or reduce the magnitude of the Consequence through the implementation of some Recovery Barriers. Those Recovery Barriers can be used to reduce the potential negative effects of many Hazardous Events. **(many-to-many relations)**

Now, try to keep in mind all these connections when developing your own 'Bowtie' on plain paper!... Impossible even for easy studies.

To help the safety analysts (e.g. Post Holders, Managers, Safety Managers) to take into consideration all the dangerous situations and the controlling elements related to their operations, EHEST developed the MARIA tool.

5) HOW TO USE THE EHEST "MARIA" TOOL

NOTE:

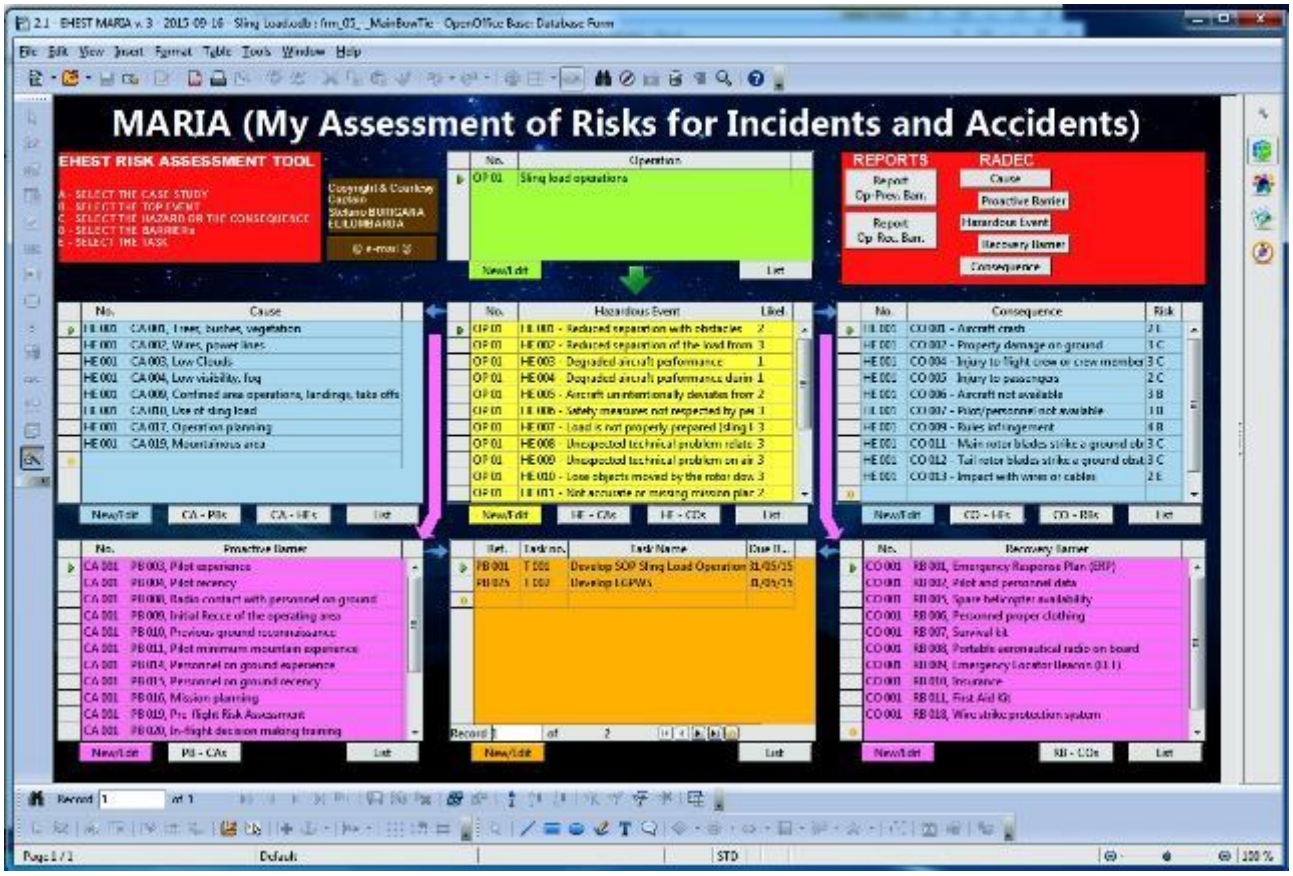
The OpenOffice Base program, as many other programs, could crash erasing important data or a whole day's work.

I strongly suggest to periodically save your work, i.e. every ten minutes of work or after an important entry.

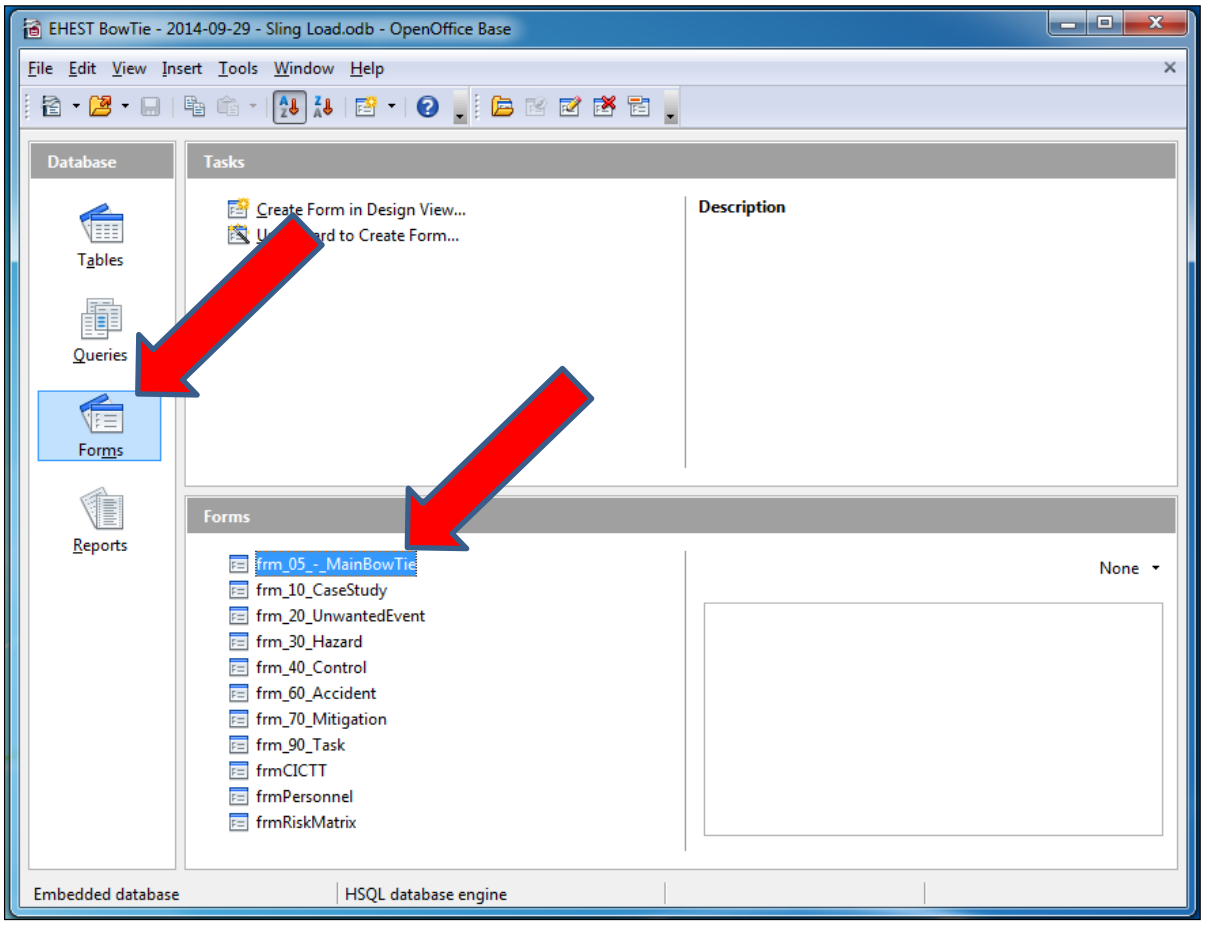
Moreover, because it happened that after a crash the file could not be opened anymore or behaved strangely, I strongly suggest to back up your working file periodically or after important entries.

Open the database double-clicking on the MARIA file.

Wait until the main page opens. It could take a while (up to 1 minute).



If the main page does not open automatically, select "Forms" from the left-side column and then double-click on "frm_05_-_MainBowTie" on the bottom-right window.


EHEST BowTie - 2014-09-29 - Sling Load.odb - OpenOffice Base
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Database
Tables
Queries
Forms
Reports
Tasks
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Description
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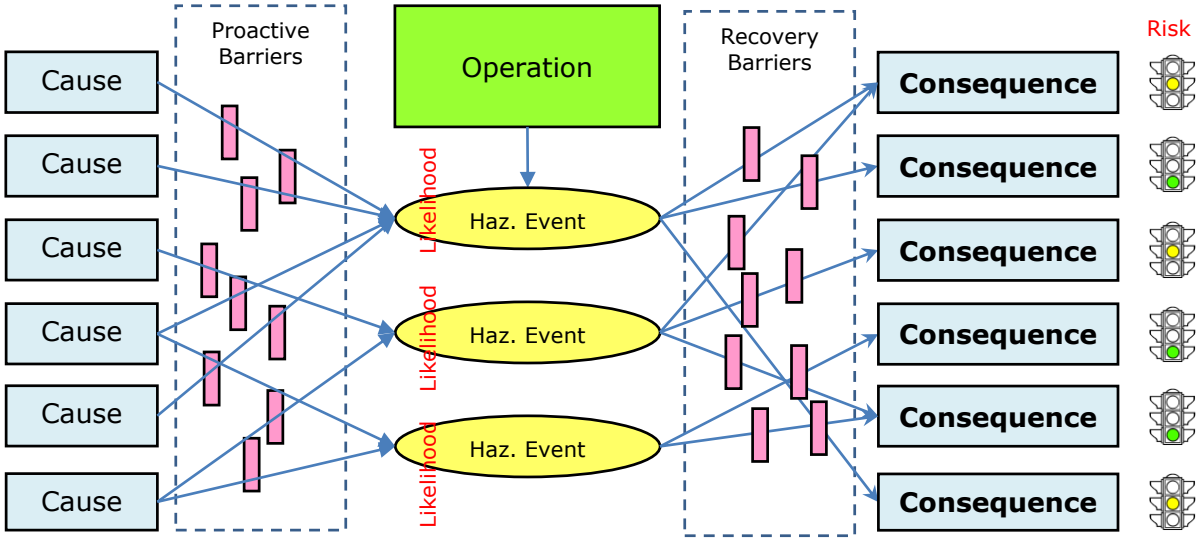
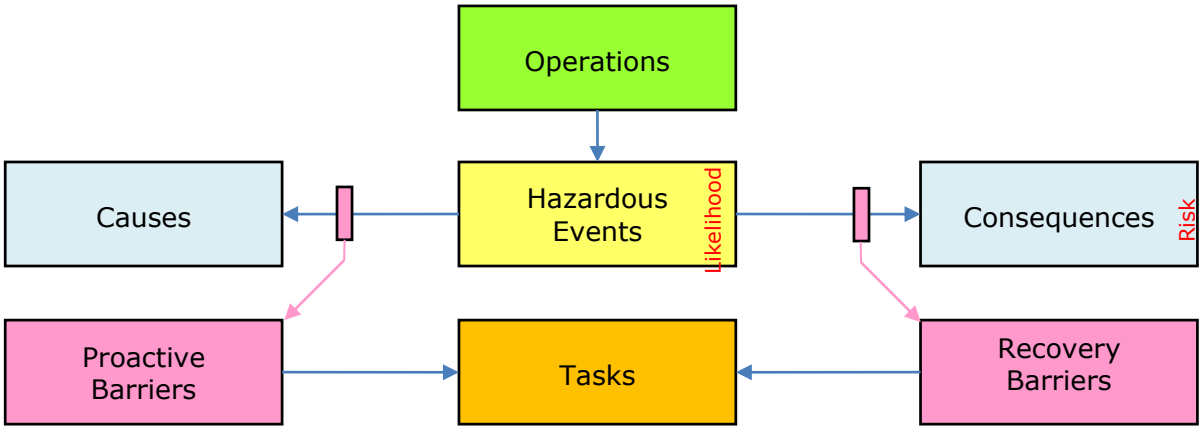
frm_10_CaseStudy
frm_20_UnwantedEvent
frm_30_Hazard
frm_40_Control
frm_60_Accident
frm_70_Mitigation
frm_90_Task
frmCICTT
frmPersonnel
frmRiskMatrix
None
Embedded database
HSQL database engine

Here you can find the tool structure, as explained before, and how it is showed on the main form:

TOOL STRUCTURE

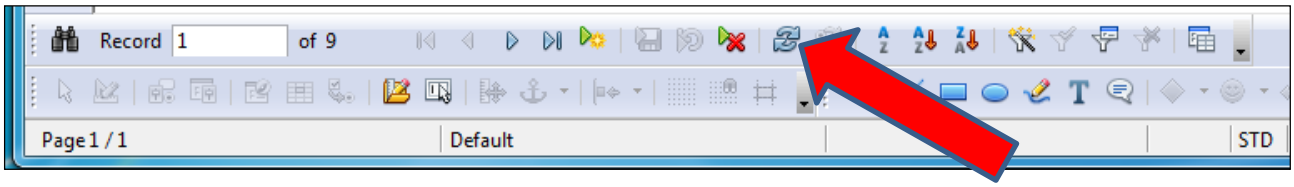


MAIN FORM REPRESENTATION



You can enter information (Operation, Hazardous Event, Cause, Proactive Barrier, Consequence, Recovery Barrier, Task) in the order you want. The important thing is then to link every piece of information together.

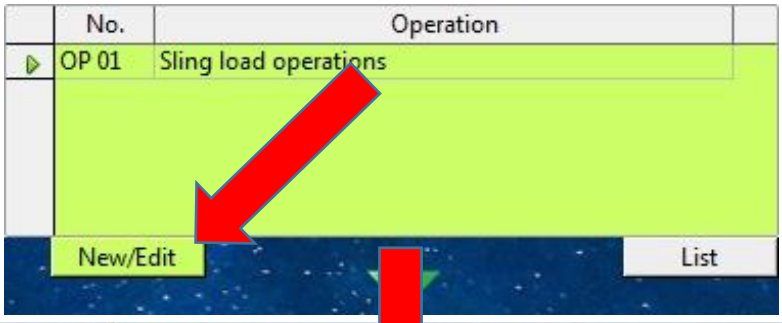
NOTE: in order to be able to see the variations to the database after an entry, use the "Refresh" button on the lower part of the database window, or close and re-open the form.

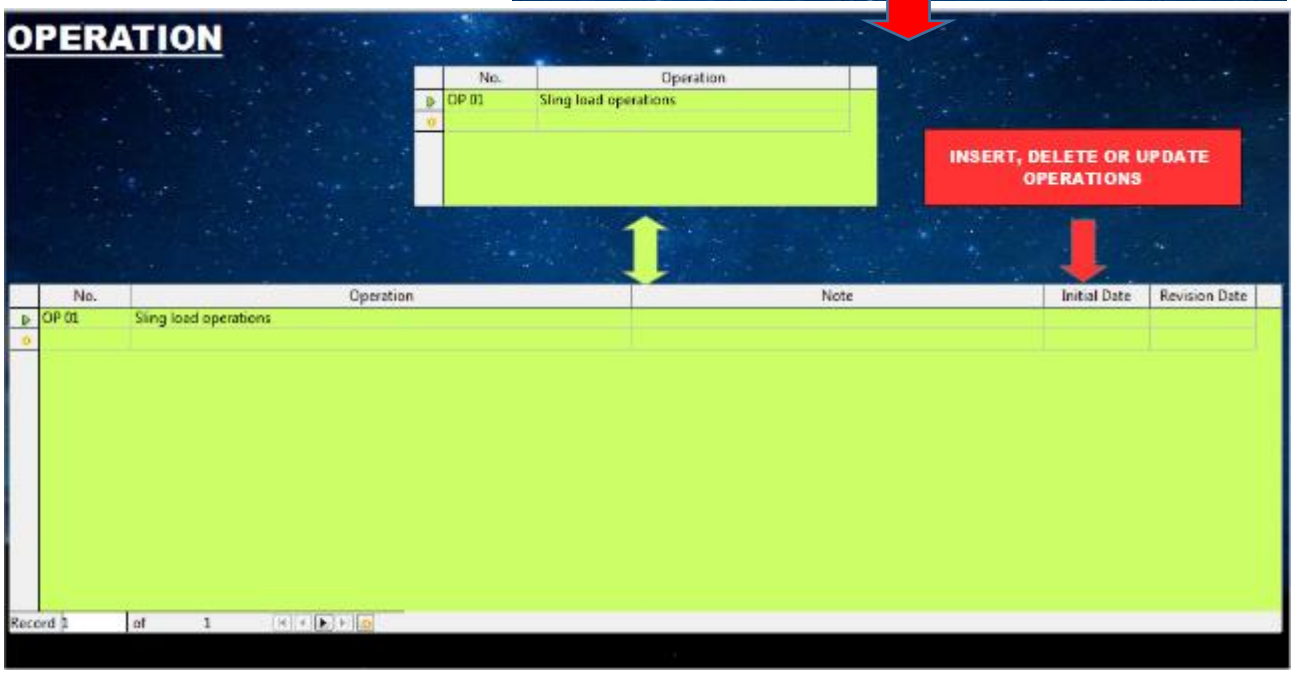


OPERATION

You start a safety study, or Operation (risk assessment, management of change, occurrence analysis, etc.), by defining the Operation number and its definition.

Press "New/Edit" to enter the Operation window.





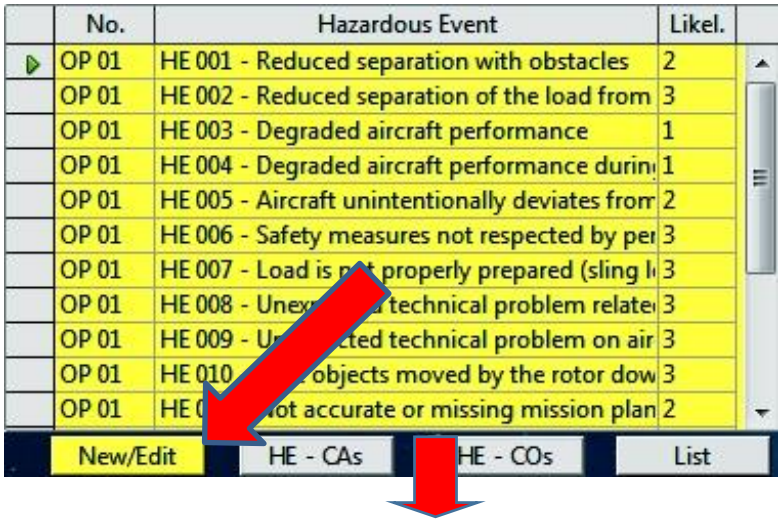
The table at the top briefly lists all the Operations already inserted. You can enter or edit the Operations in the table below.

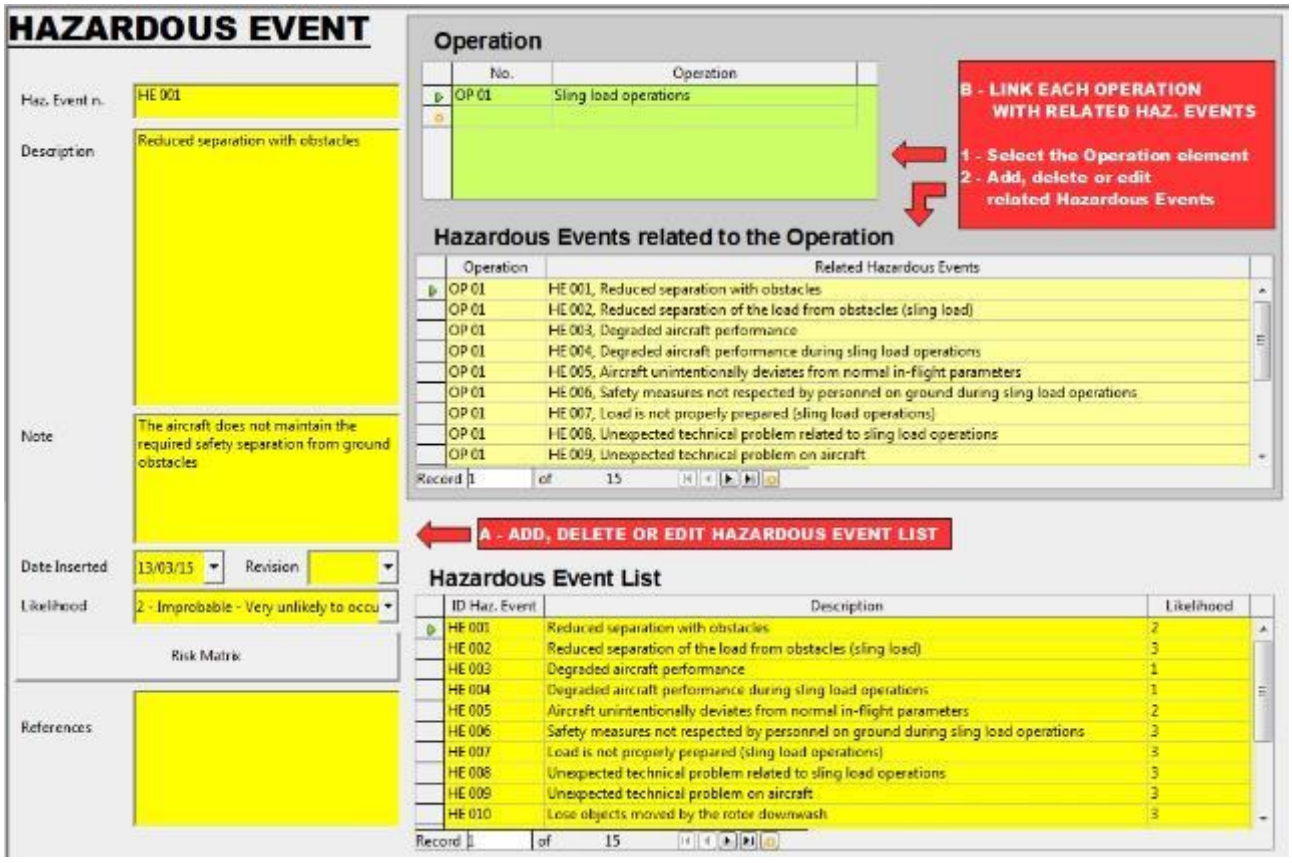
To close the window just click on the "X" on the upper-right of the window.

HAZARDOUS EVENT

In this window you find all the Hazardous Events linked to the selected Operation. If you select a different Operation you will see its related Hazardous Event list.

To write a new Hazardous Event or to edit the existing ones, press "New/Edit" button and the following window will show up

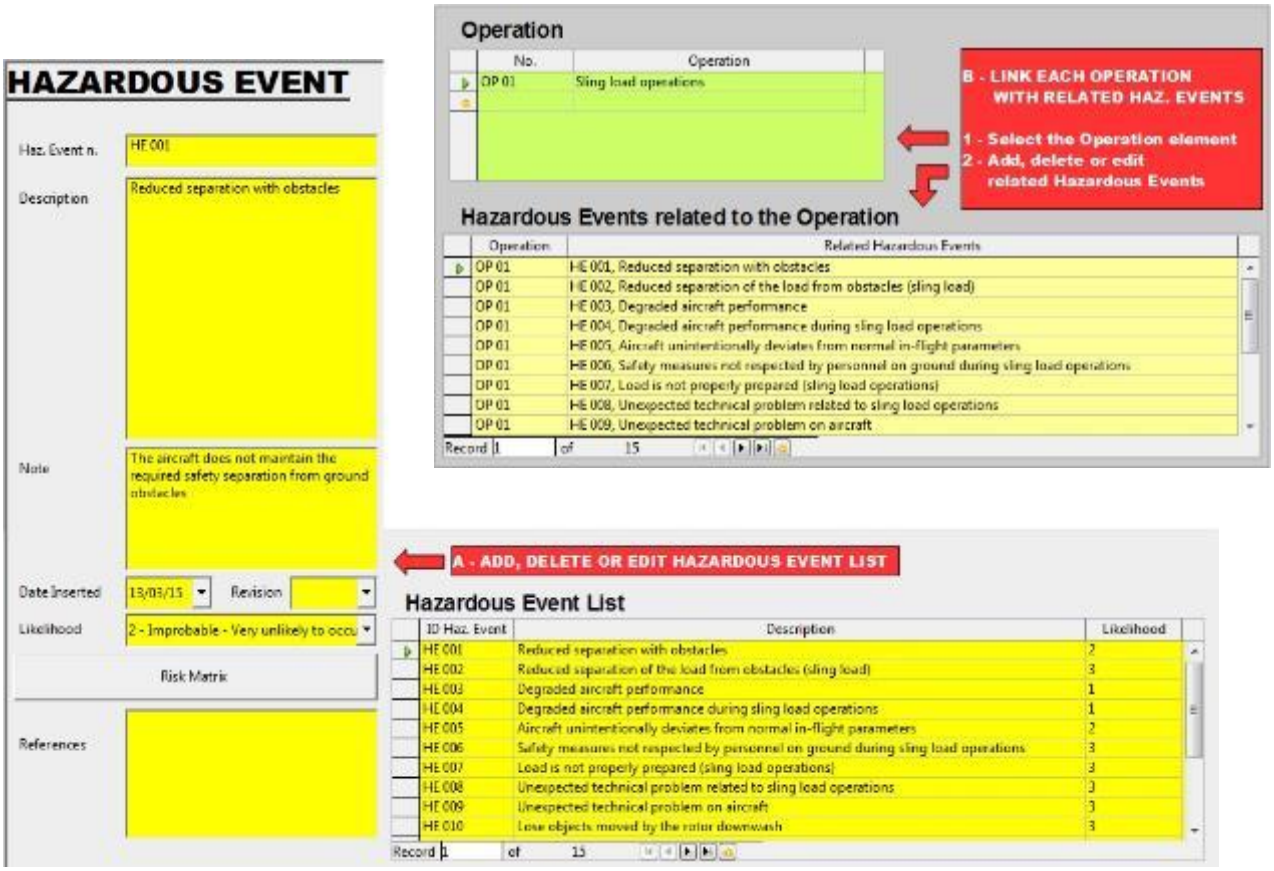




This window is split in two sections:

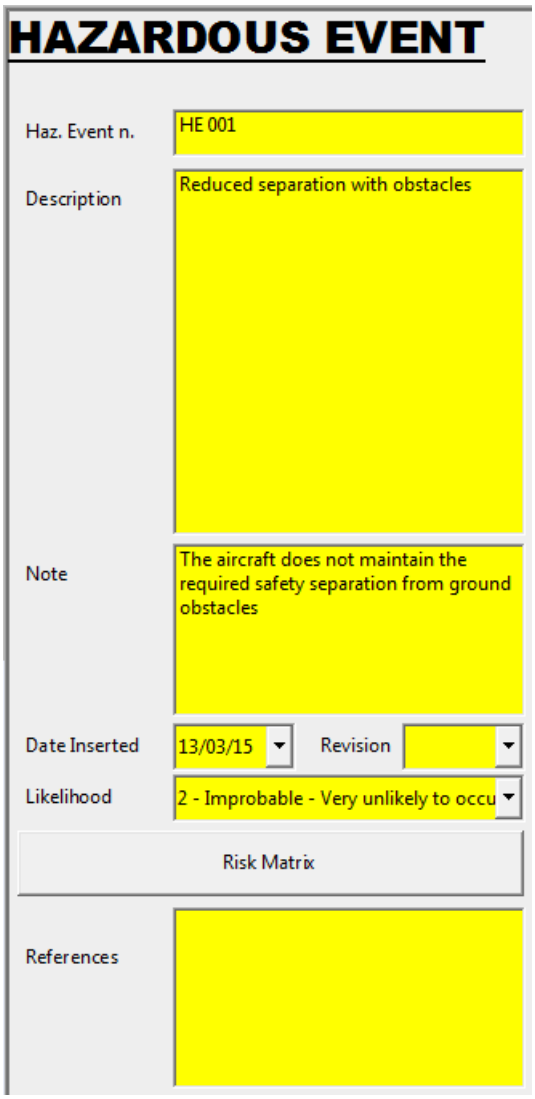
a complete list of all the inserted Hazardous Events…

… and a place where to link the Operation with the related Hazardous Events.



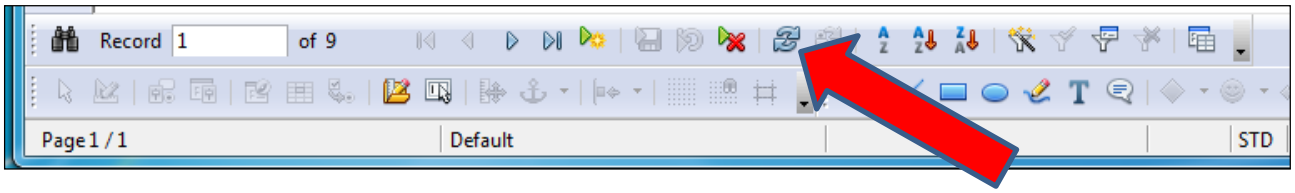
You can insert a new Hazardous Event clicking on the "new record" symbol just under the Hazardous Event list.

Then just fill up the left-hand, yellow-coloured section.

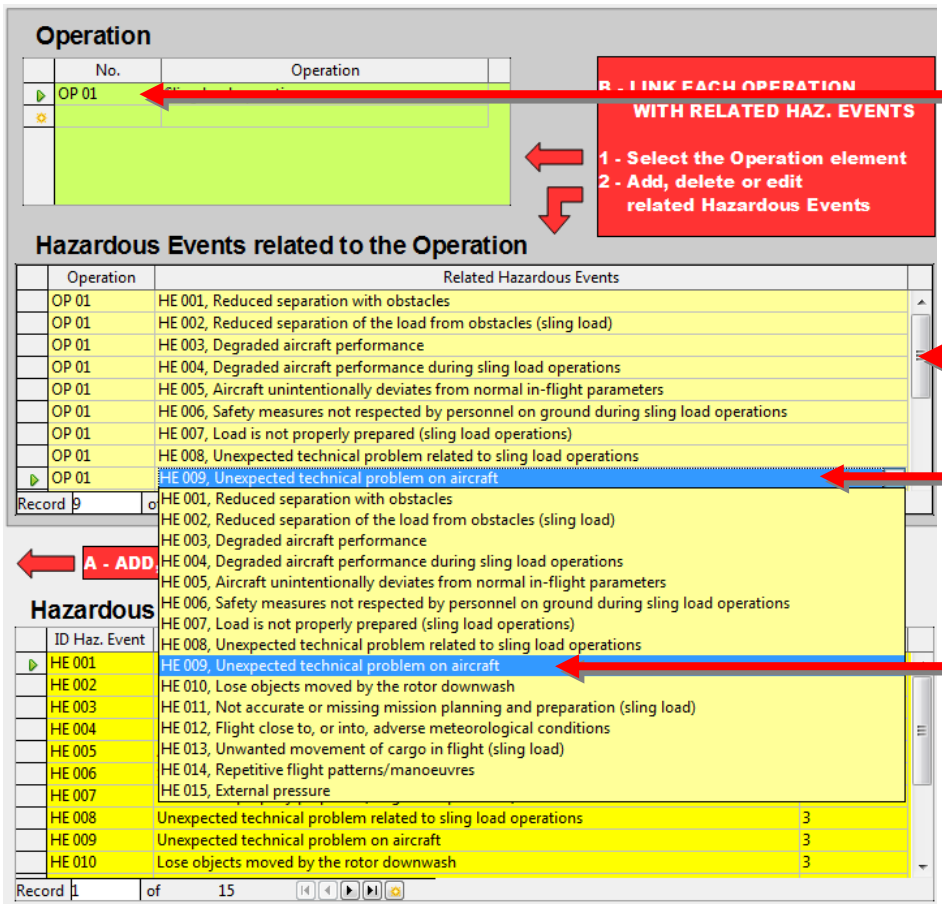


←	Hazardous Event reference Number (must be unique)
←	Give a name to the Hazardous Event
←	Explain the Hazardous Event.
←	Insertion and revision dates
←	Rate the Likelihood
←	Show up the Risk Matrix for reference
←	List the references

NOTE: in order to be able to see the variations to the database use the "Refresh" button on the lower part of the database window, or close and re-open the form.



To link the Hazardous Events to the related Operation:



Select the Operation you are working on
Scroll to the end of the available Hazardous Event list and select the empty record
Click on the drop down menu
Select the new Hazardous Event to link it to the active Operation. **NOTE: you cannot choose the same Hazardous Event twice**

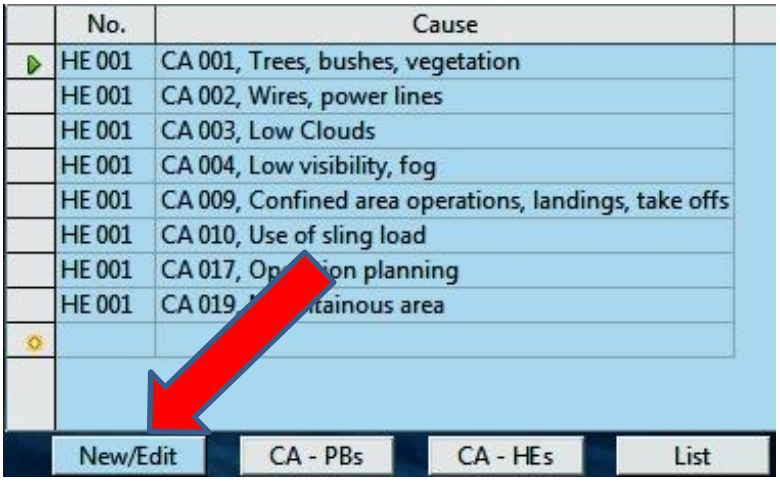
NOTE: Each Hazardous Event must have at least one linked Cause and one linked Consequence entry in order to have a correct list output. Likewise, each Cause and each Consequence entry must have at least one linked barrier.

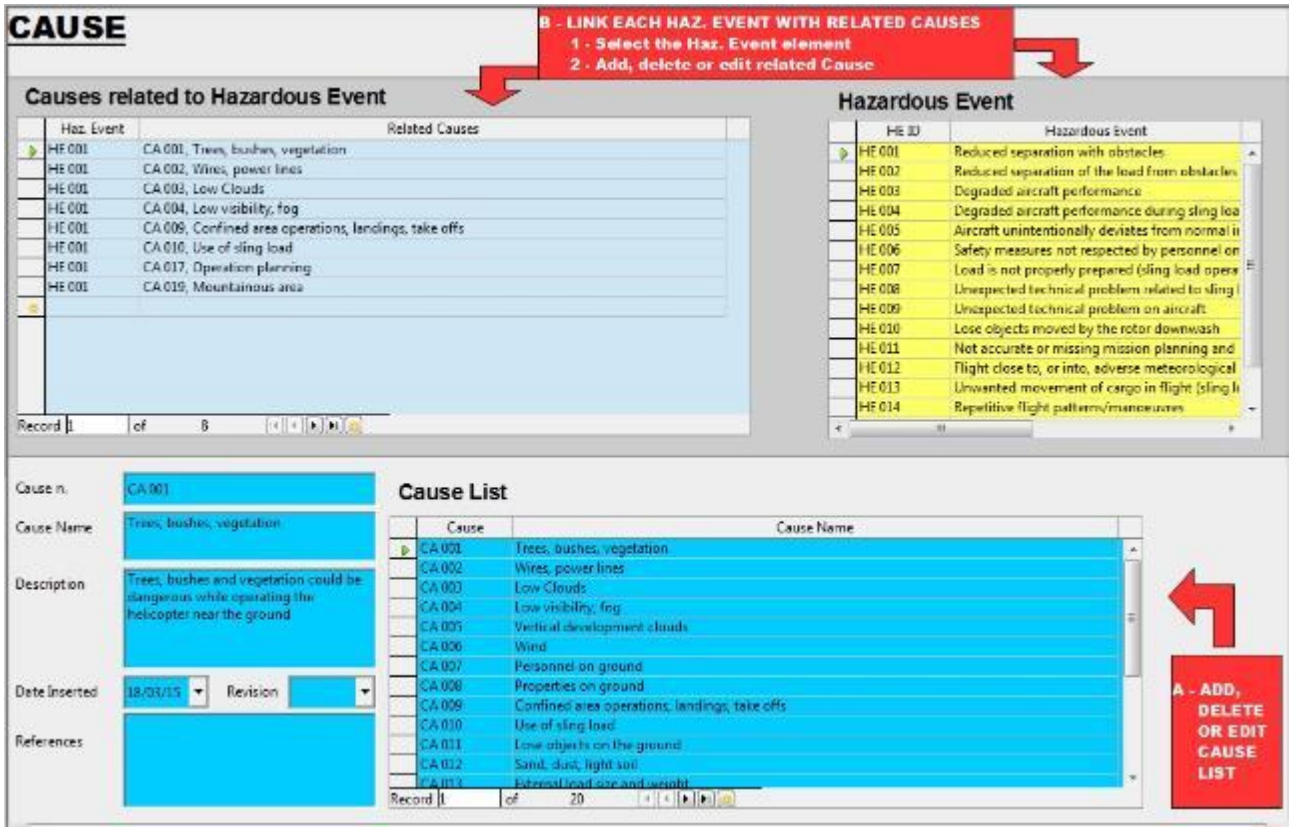
It is suggested to create a Cause, Consequence and Barriers entry, like "00 – No Entry" to be used in case of no operative entry.

CAUSE

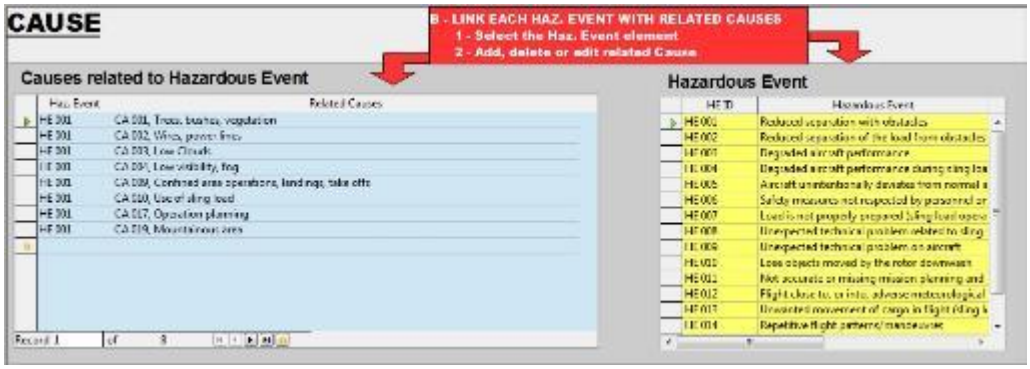
In this window you find all the Causes linked to the selected Hazardous Event. If you select a different Hazardous Event you will see its related Cause list.

To write a new Cause or to edit the existing ones, press "New/Edit" button and it will show the following window.



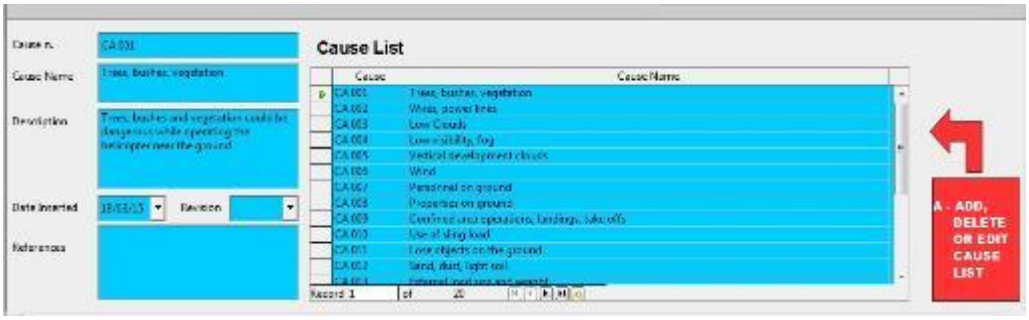


Once again, this window is split into two sections: the list of Causes linked to the selected Hazardous Event, and the list of all the inserted Causes. In this section you can edit the Causes or create new one.



Linked Causes to Hazardous Events

List of Causes

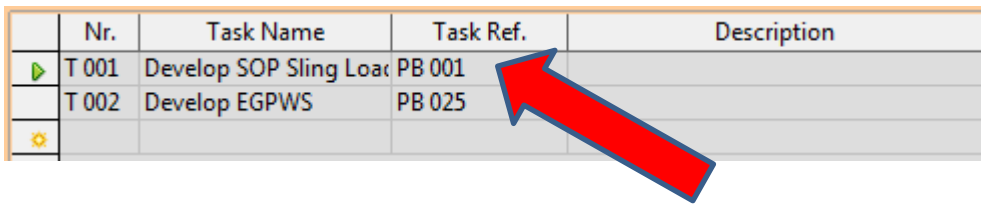


The procedure is similar to that explained in the HAZARDOUS EVENT paragraph just above.

CONSEQUENCES – PROACTIVE/RECOVERY BARRIER – TASK

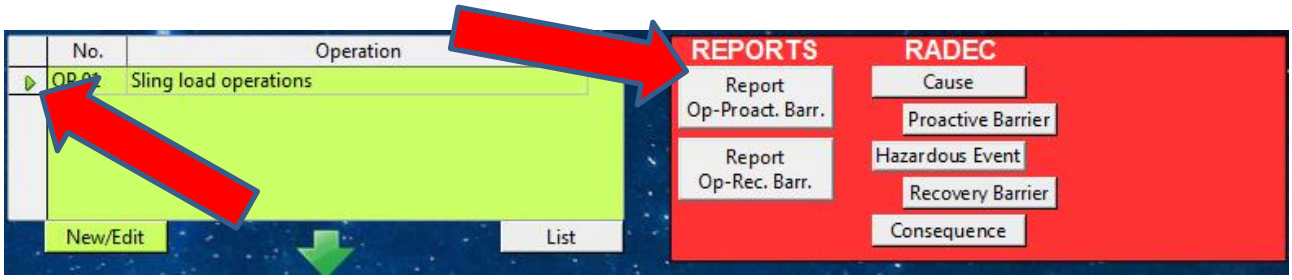
The other parts of the tool work in a similar way to the Hazardous Event and Cause sections explained before.

Tasks are not automatically linked to the Proactive or Recovery Barriers, but you must manually insert the reference number in the Task. Ref. cell.



REPORTS

You can create general reports based on the selected Operation. The reports will give you all the Hazardous Events, and the linked Causes, Proactive Barriers, Consequences and Recovery Barriers in a tabular form.



Just click the related button to open a new spreadsheet window with all the elements in a cascade.

"**Report CS-Proact. Barr.**" button creates a list of all related elements of the selected Operation:

Operation

Hazardous Event

Cause

Proactive Barrier

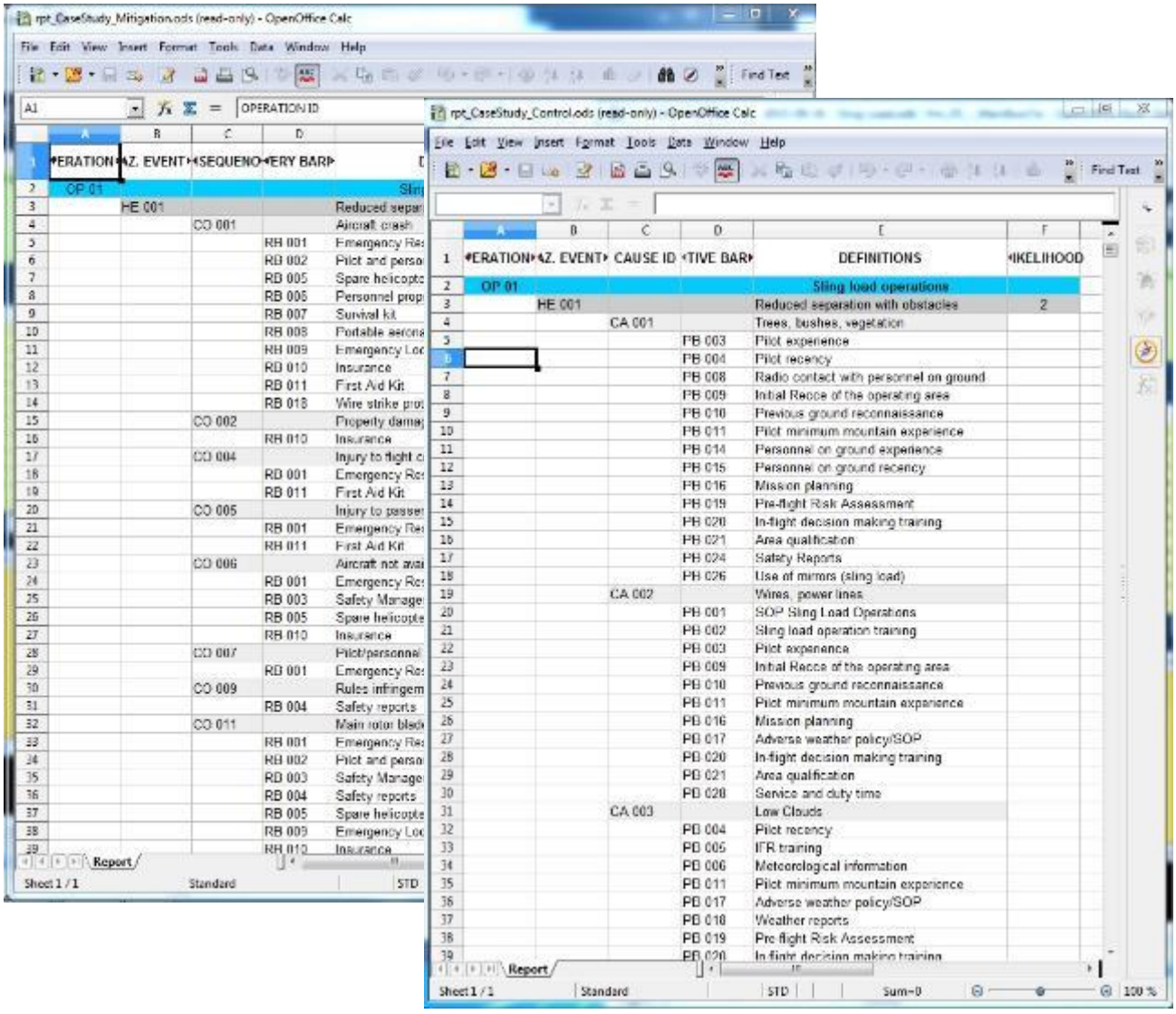
"**Report CS-Rec. Barr.**" button creates a list of all related elements of the selected Operation:

Operation

Hazardous Event

Consequence

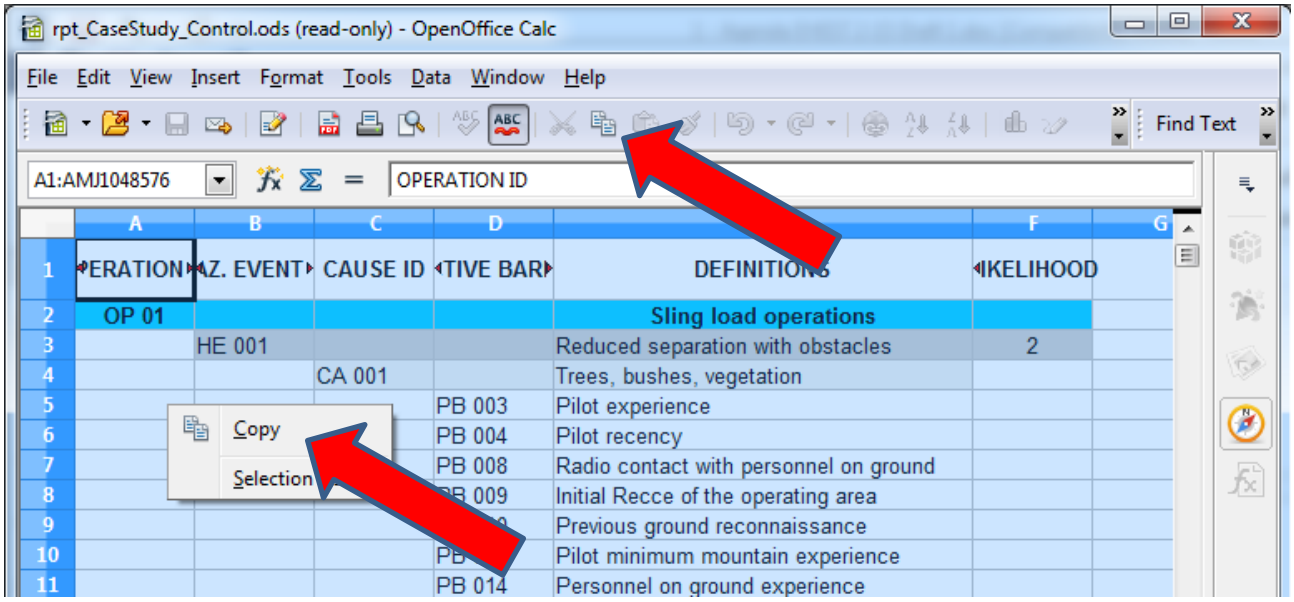
Recovery Barrier



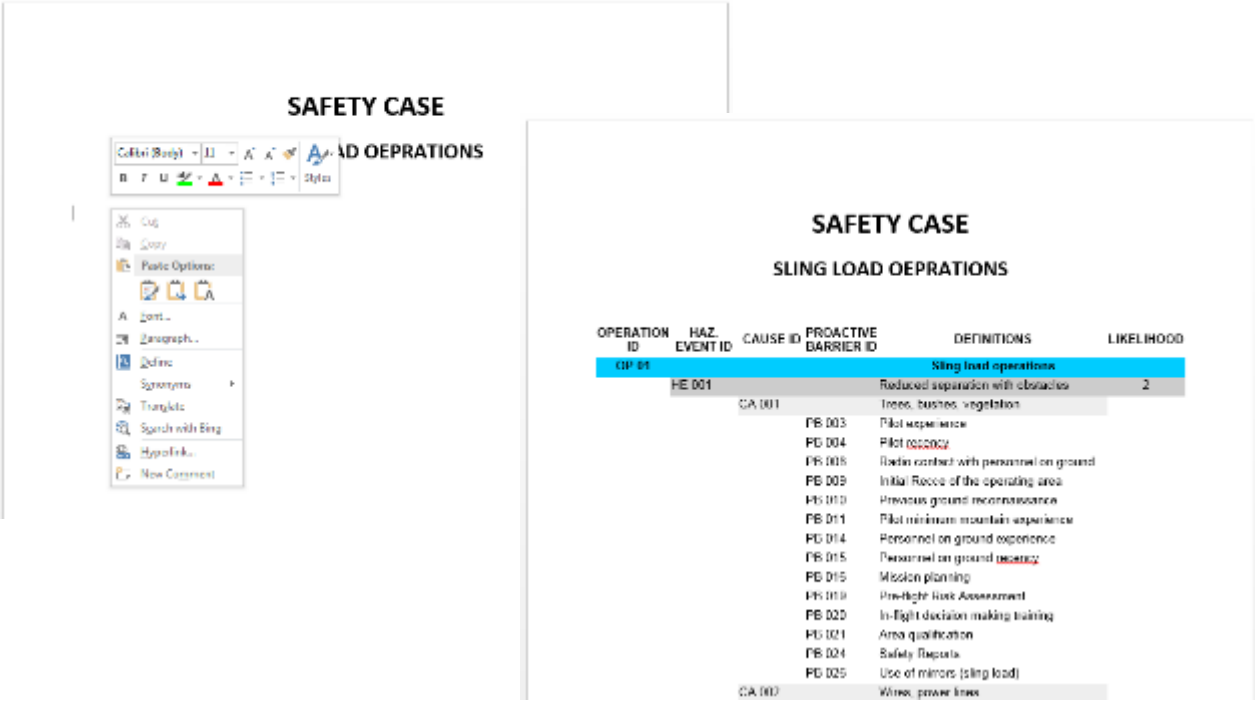
NOTE: Due to the various "many-to-many" links inside the database, the reports could take quite a long time to show up (1 minute or even more).

The lists are an OpenOffice spreadsheet document that can be copied-pasted to any OpenOffice document or other commercial word processors and spreadsheets (e.g. Microsoft Word or Excel).

Select all the required cells and then select "Copy" (icon, or right click on the selection, or Ctrl-C key combination).

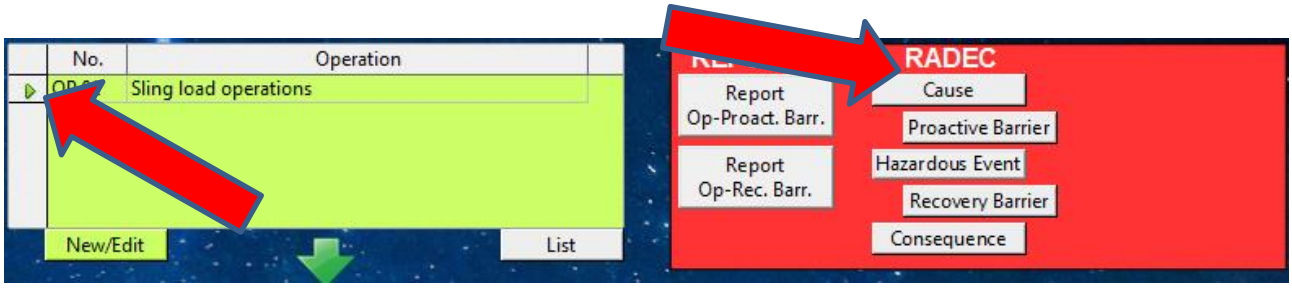


Open your new word processor or spreadsheet document, point the position you want to insert the table and select "Paste" (icon, or right click on the selection, or Ctrl-V key combination).



EHEST RADEC FORM

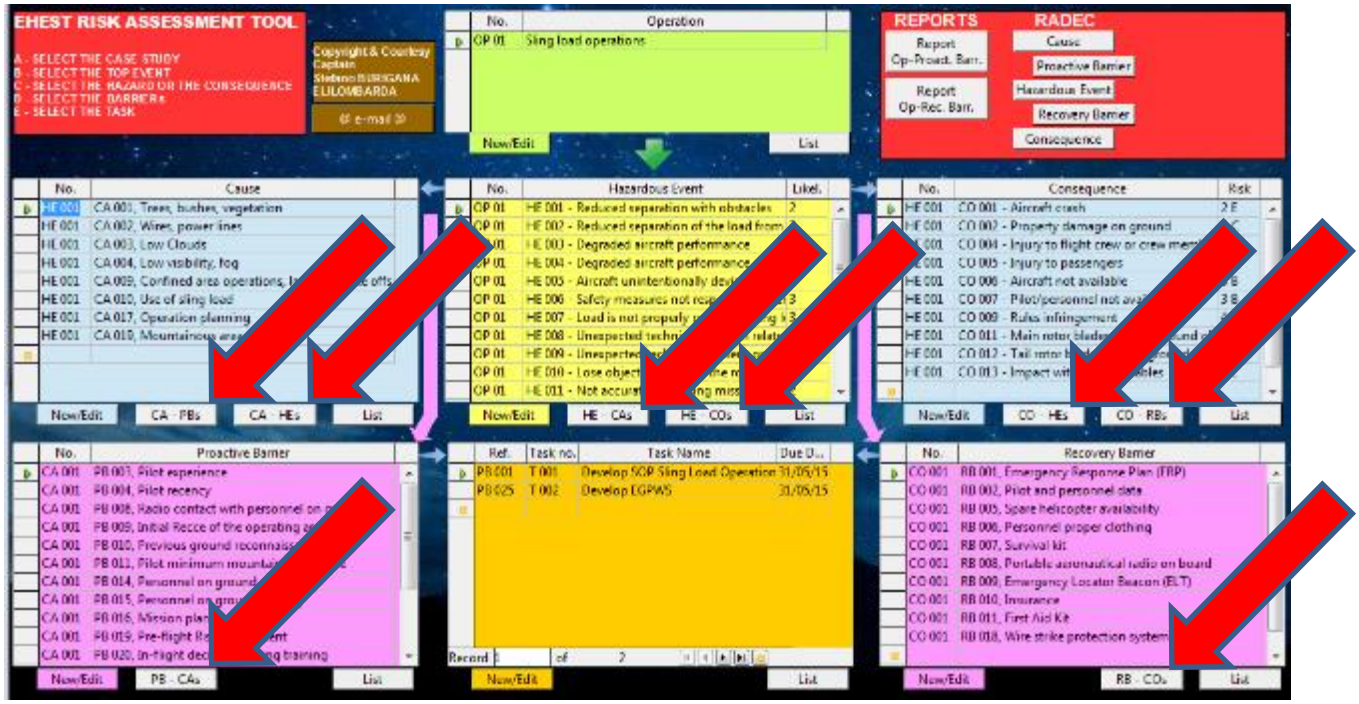
It is possible to select all the elements related to the selected Operation by clicking on the RADEC buttons.



These buttons provide a list of the Cause, Hazardous Events, Proactive Barriers, Consequences and Recovery Barriers you can use on your own documents or in the EHEST RADEC form (ref. EHEST SMS Manual non-complex operators). Just select the items and copy-paste on your documents.

SPECIFIC REPORTS

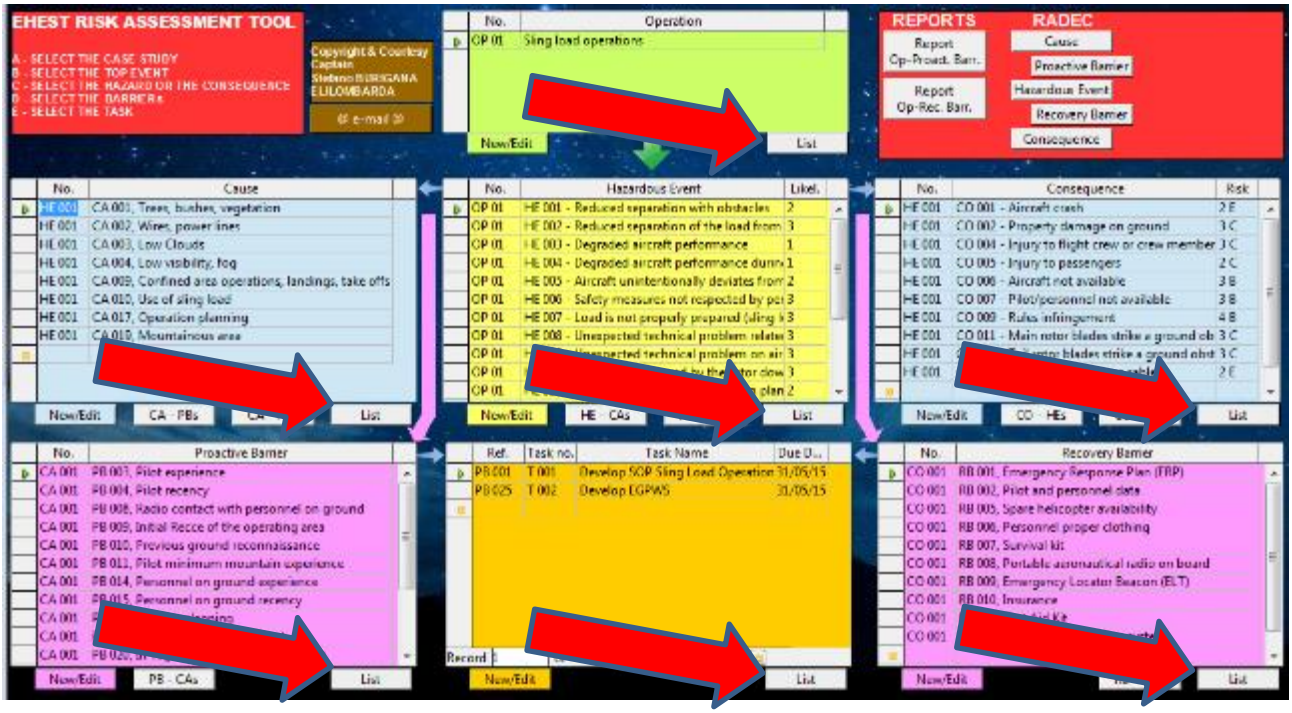
There are several reports available related to specific relations between the risk assessment elements.



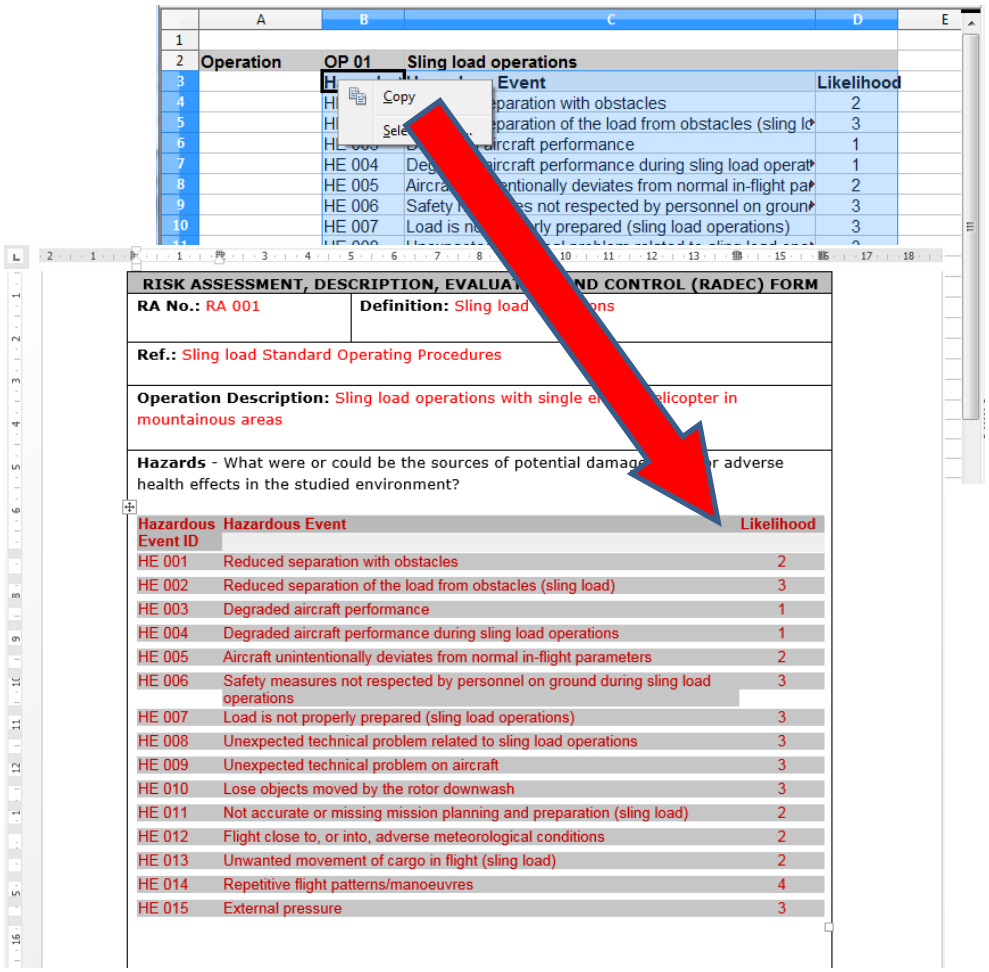
HE – CAs	Reports all the **Causes** related to the selected **Hazardous Event**
HE – COs	Reports all the **Consequences** related to the selected **Hazardous Event**
CA - HEs	Reports all the **Hazardous Events** related to the selected **Cause**
CA – PBs	Reports all the **Proactive Barriers** related to the selected **Cause**
PB – CAs	Reports all the **Causes** related to the selected **Proactive Barrier**
CO – HEs	Reports all the **Hazardous Events** related to the selected **Consequence**
CO – RBs	Reports all the **Recovery Barriers** related to the selected **Consequence**
RB - COs	Reports all the **Consequences** related to the selected **Recovery Barrier**

LISTS

To have a list of <u>all</u> the inserted Operations, Hazardous Events, Causes, etc., select the "List" button underneath every table.



Use the reports output to copy-paste to your safety documents.



Operation	OP 01	Sling load operations	
		Event	Likelihood
	HE 001	Reduced separation with obstacles	2
	HE 002	Reduced separation of the load from obstacles (sling load)	3
	HE 003	Degraded aircraft performance	1
	HE 004	Degraded aircraft performance during sling load operations	1
	HE 005	Aircraft unintentionally deviates from normal in-flight parameters	2
	HE 006	Safety measures not respected by personnel on ground during sling load operations	3
	HE 007	Load is not properly prepared (sling load operations)	3

RISK ASSESSMENT, DESCRIPTION, EVALUATION AND CONTROL (RADEC) FORM

RA No.: RA 001 **Definition:** Sling load operations

Ref.: Sling load Standard Operating Procedures

Operation Description: Sling load operations with single engine helicopter in mountainous areas

Hazards - What were or could be the sources of potential damage or adverse health effects in the studied environment?

Hazardous Event ID	Hazardous Event	Likelihood
HE 001	Reduced separation with obstacles	2
HE 002	Reduced separation of the load from obstacles (sling load)	3
HE 003	Degraded aircraft performance	1
HE 004	Degraded aircraft performance during sling load operations	1
HE 005	Aircraft unintentionally deviates from normal in-flight parameters	2
HE 006	Safety measures not respected by personnel on ground during sling load operations	3
HE 007	Load is not properly prepared (sling load operations)	3
HE 008	Unexpected technical problem related to sling load operations	3
HE 009	Unexpected technical problem on aircraft	3
HE 010	Lose objects moved by the rotor downwash	3
HE 011	Not accurate or missing mission planning and preparation (sling load)	2
HE 012	Flight close to, or into, adverse meteorological conditions	2
HE 013	Unwanted movement of cargo in flight (sling load)	2
HE 014	Repetitive flight patterns/manoeuvres	4
HE 015	External pressure	3

6) SUPPORT EHEST

The EHEST Specialist Team Ops & SMS is making a big effort in order to develop and promote useful safety tools to the aeronautical world. Based on the practical final user experience, these tools can be improved.

Please support EHEST job by reporting your feedbacks and your suggestions to:

ehest@easa.europa.eu