GRIF | Risk module

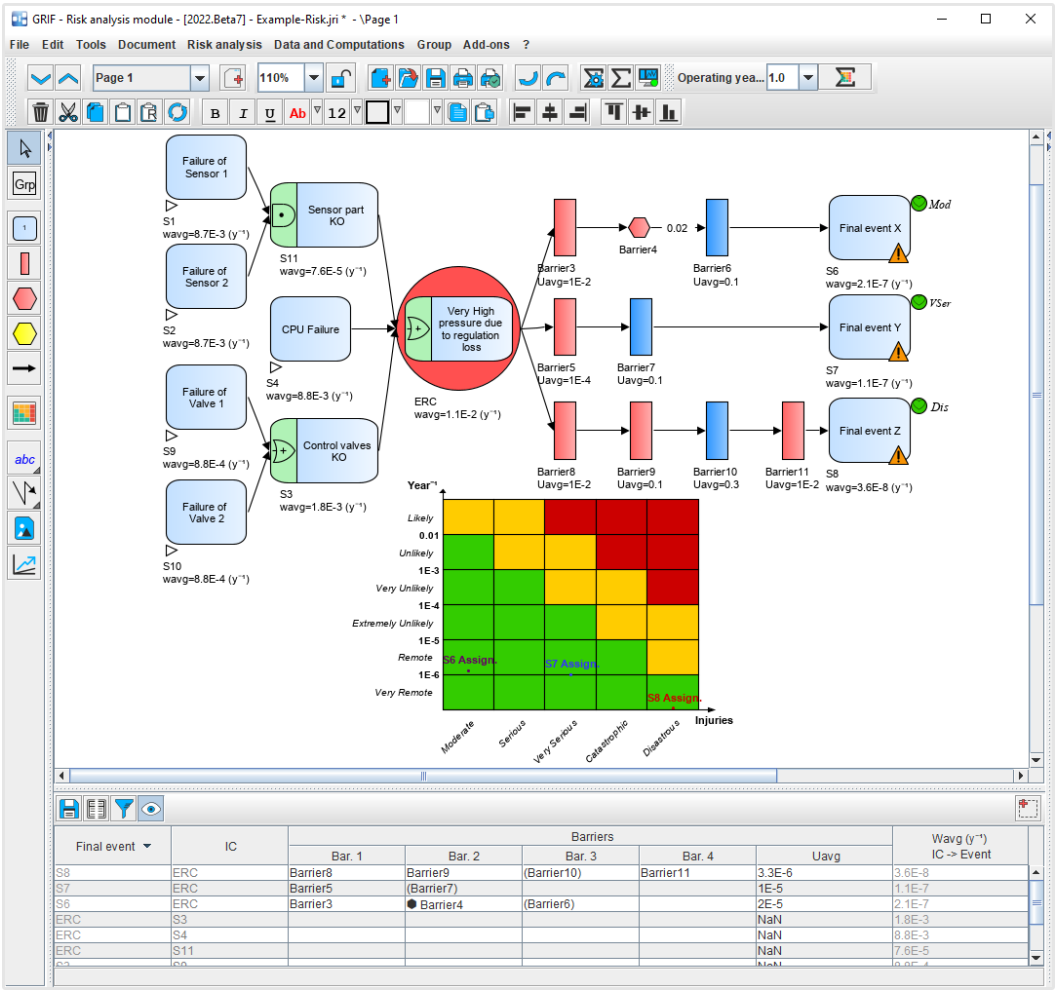
Technical sheet

To assess and reduce risks using the Bow-tie method and LOPA

GRIF (GRaphical Interface for reliability Forecasting), a technology of TotalEnergies since the 80s, includes 3 packages and 12 modules allowing the user to choose the most appropriate modelling technique for the resolution of the studied system. Risk module is one of the seven modules belonging to Boolean package.

Risk serves to model layers of protection or Safety Instrumented Systems using either the bow-tie method or a LOPA (Layer Of Protection Analysis) table. In addition to its user-friendly graphical interface, this module is based on **ALBIZIA**, the BDD (Binary Decision Diagram) computation engine developed by TotalEnergies, that has the capacity to run **accurate probabilistic calculations** and to **supply much of the information** required for risk studies.

Risk



Final event	IC	Barriers					Wavg (y⁻¹) IC -> Event
		Bar. 1	Bar. 2	Bar. 3	Bar. 4	Uavg	
S8	ERC	Barrier8	Barrier9	(Barrier10)	Barrier11	3.3E-6	3.6E-8
S7	ERC	Barrier5	(Barrier7)			1E-5	1.1E-7
S6	ERC	Barrier3	Barrier4	(Barrier6)		2E-5	2.1E-7
ERC	S3					NaN	1.8E-3
ERC	S4					NaN	8.8E-3
ERC	S11					NaN	7.6E-5

Modelling and computations:

Entering **bow-tie diagrams** is very simple and based on an **intuitive graphical user interface**. The different elements can be entered rapidly, i.e. the initial events for which users specify the frequency of occurrence, the final events and their criticality, and the barriers for which the failure is defined based on the **many laws available**.

The lower section is used to enter a **LOPA** in the form of a **table**. In this case, a scenario is created by entering the unwanted event (existing or new), the initial cause and the different barriers included in the protection measures. The bow-tie model is built and automatically formatted in the data entry zone.

GRIF

GRaphical Interface for reliability Forecasting

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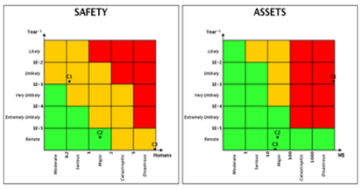
Hardware requirement: Intel Core i3 or faster, 4 GB of free RAM, 1 GB of free space, no internet connection needed. **Software requirements**: Windows 10 or Linux or MacOS X with Java 11. **Licenses**: standalone with USB dongle or Floating licenses with Sentinel server. Installable, laptop.

ALBIZIA, developed by TotalEnergies, provides many results for analytical computations:

- **The instantaneous and average frequencies for all scenarios**.
- **The demand frequency of barrier**.
- **The PFD (probability of failure on demand) and PFH (average failure frequency) of barrier**, which have been specified in detail (periodic test, SIL loop, etc.).
- **The Risk Reduction Factor** required to remain within an acceptable risk zone.
- **The importance factor (including Barlow Proschan)** to identify the barriers to be improved.

Specificities and strengths:



- **Multiple risks :** Several risk matrices can be defined, such as Safety, Assets or Environment risk matrices. For each matrix, a criticality level is defined: moderate, serious, major, etc. The criticality thresholds and frequency limits can be configured. For each scenario, a risk is recorded on each matrix. A scenario can be qualified as catastrophic in terms of Human risks but moderate if it is considered in terms of financial risks and vice versa.

- **Models:** do you run regular studies that contain the same safety barriers and the same risk matrices? GRIF Risk enables you to create models with a certain number of pre-configured barriers and risk matrices.

- **A posteriori average:** many software applications multiply the average frequency of the initial event $w_{avg}(EI)$ by the average failure probability for each barrier $PFD_{Avg}(Barrier_i)$ to calculate the frequency of a scenario.

  - The following formula is imprecise and non-conservative:

$$F_{avg} = w_{avg}(EI) * \prod_{i=0}^{nbBar} PFD_{Avg}(Barrier_i)$$

  - The Risk module calculates an average over [0,T] of frequency w for a Boolean formula:

$$F_{avg} = \frac{1}{T}\int_{o}^{T} w\left(EI \;\&\; \prod_{i=0}^{nbBar} Barrier_i\right)$$

This approach, combined with the use of BDD is at the cutting-edge in terms of scenario frequency calculations.

Risk is suitable with all modules of GRIF Boolean package:

- **Bow-tie diagrams created in Risk can interact with any model of GRIF Boolean package:** Fault Trees, Reliability Block Diagrams, SIS, etc. A barrier or initial event can therefore be detailed and the dependencies between barriers, which may share certain components, can be factored in.
- **Rather than a simple Risk Reduction Factor for barriers, a Safety Instrumented Function from the SIL module can be added to the bow-tie model using the Bool module.** This approach ensures that the loop achieves the required PFD/PFH and confirms that the new frequency for each scenario is in an acceptable zone.
- Moreover, **the Safety Requirement Specification system will help users to comply with IEC61508 or any other standard** when the ability to define requirements is a key feature.

Using data and results:

- Input data summarized in tables making it easier to check the quality of an entry.
- Possibility of automating calculations (batch runs) and drawing variations for sensitivity analysis.
- Results are stored in the document and can be exported in a variety of formats (csv, XML, Excel, etc.).
- Results can be viewed as line graphs, pie charts or histograms.
- Vectorial printing in PDF format generates high-quality pictures but the files are small enough to be sent by e-mail even if the document contains hundreds of pages.
- External files (PDF certificates, system pictures, ...) can be included in the document and be part of the full report.
- Interaction with the operating system: possibility of copying/pasting to or from word processing software, spreadsheets, or presentation tools.

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Trial version available on
grif.totalenergies.com