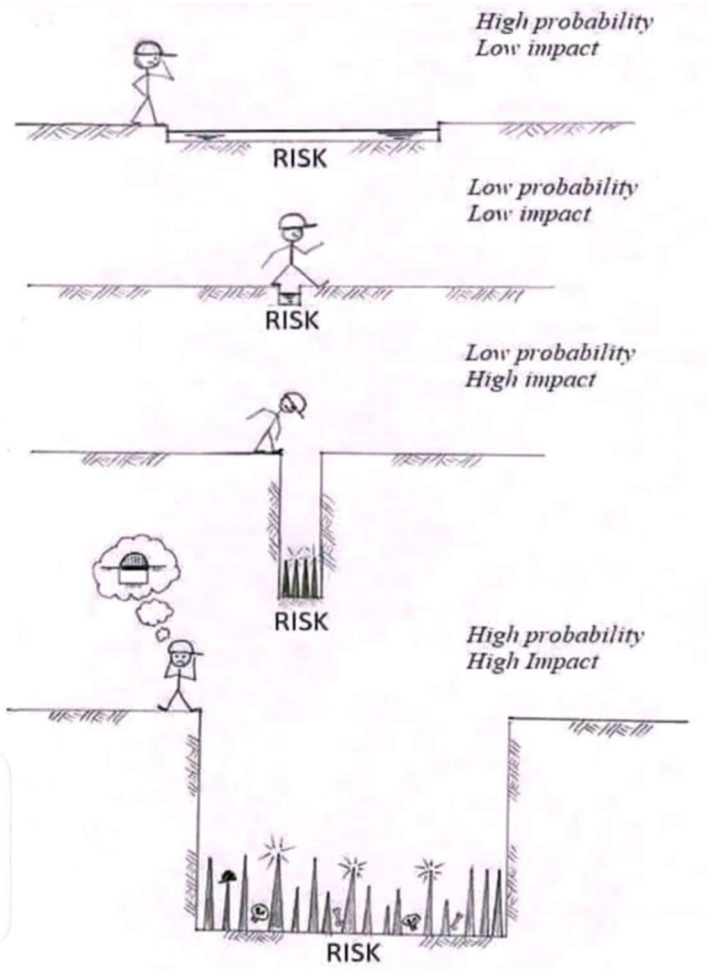
Risk Matrix



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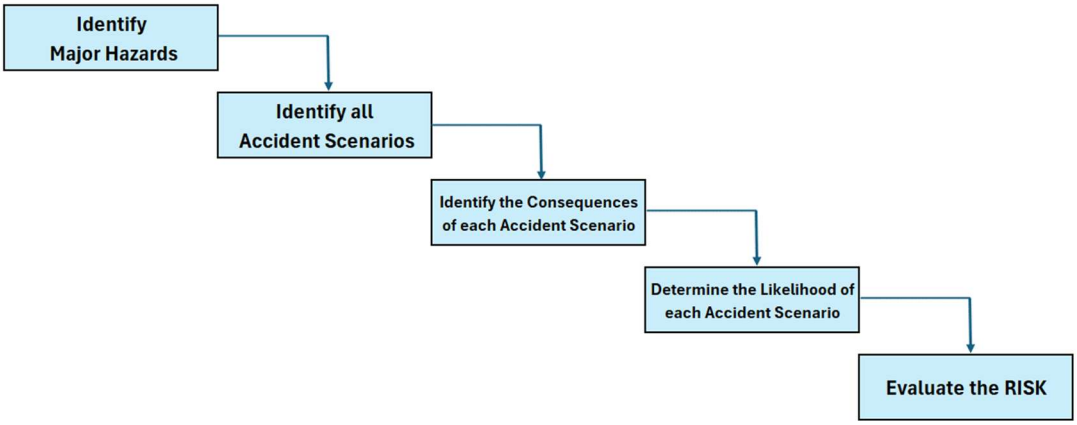
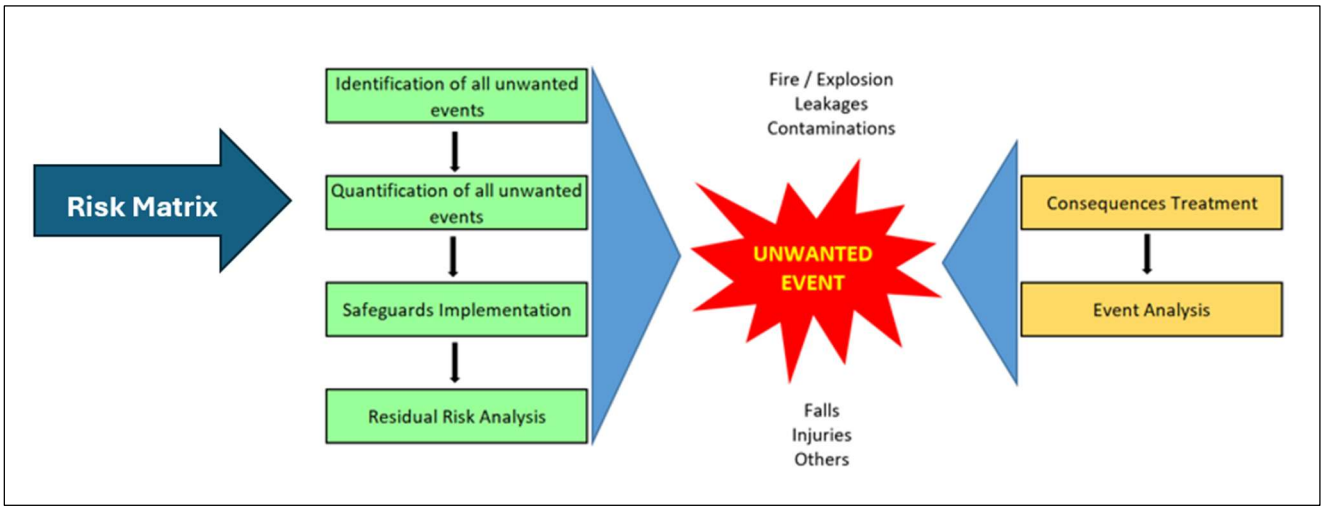
1. THE RISK MATRIX

A good program of Safety Management starts with the identification of all risks involved in a certain area/process. If the identification process is carried out in a thoroughly way, it is expected that the company will have a long list of identified unwanted events.

Then, a second step comes into play, which is the quantification of the identified risks, so that mitigating actions can be prioritized.

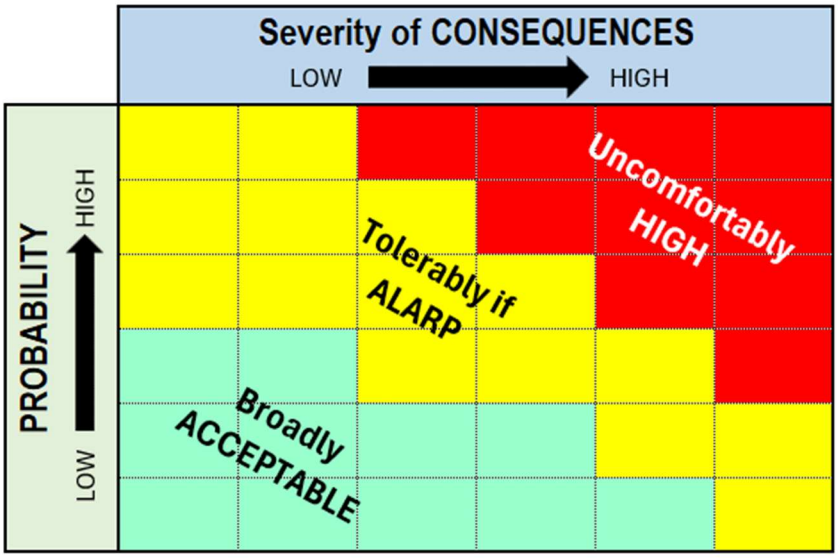


The Risk Matrix can be used as part of the plant Risk Management Program (RMP) to quantify the unwanted events, as show below:



For the purpose of making an initial assessment, **Risk Matrices** provide a convenient way of summarizing risk estimates and tolerability criteria.

A matrix, as illustrated below, typically comprises a rectangle divided into several boxes, with each box representing a different underlying risk level.



The analysis takes into consideration the probability and the severity of each undesired event and analyse where the result fits into the matrix. For each box there is a semi-quantitative description together with indicative values.

It is important to realize that the term “semi-quantitative estimates” does not imply that there is never any need to undertake rigorous estimation of the likelihood and consequence of specific events. In some cases, the outcome of an event may be obvious. For example:

- An ignition of 1 drum of flammable material located in a room specifically designed to recognized standards to contain the effects of the fire and potential explosion ➔ in this case, the assumption that a potentially fatal injury would be limited to the room occupants is reasonable and detailed modelling of the effects might not be required.
- If the event involves higher quantities of flammable materials that could potentially harm persons remote or adjacent to an operation, it may require detailed assessment. Detailed assessment is also required in cases where an ignition could potentially propagate within a building. Where prevention of propagation is dependent on control measures working on demand, e.g. drencher systems, an estimate should be made for the numbers of casualties that would result should these controls fail.

2. CONSEQUENCES & PROBABILITIES

The estimation of the Consequences and the Probability of an undesired event can be very subjective, depending on the experience of the team involved in the analysis and the quality of the information gathered prior to the analysis.

In order to make the process less subjective, the tables presented in this document brings some values that can be used as a guide to perform the analysis. Note that the number presented are the ones commonly found in pertinent literature and also used by many companies – however, they can substantially vary from company to company, depending on their experience with some particular event.

2.1 – CONSEQUENCE: For each undesired event, all possible consequences must be evaluated regarding:

- Impact on health and safety
- Impact on the environment
- Impact on the corporate image
- Interruption of services to customers
- Impact on the business
- Impact on the quality
- Damages to the installations

The following table brings a proposal for the estimations of potential consequences:

Consequence	NOTABLE	SIGNIFICANT	VERY SIGNIFICANT	SERIOUS	VERY SERIOUS	CATASTROPHIC
Safety & Health	01 case of minor injury	01 case of medical treatment OR restriction to work	01 case of Lost Workday (LWC) OR multiple medical treatments	01 permanent disablement OR multiple cases of Lost Workday (LWC)	01 fatality	Multiple fatalities
Environment	Insignificant pollution, contained inside the site	Small pollution, contained inside the site	Evident pollution, local concern	Local significant pollution	Large local pollution	Extremely severe pollution
Corporate Image	Small impact. 01 complaint	Local impact. 10 complaints	Local news. 100 complaints	Regional news coverage	National news coverage	National headlights. Severe damage to corporate image.
Interruption of Services to Customers	Small stock problem OR small defect on product.	Small temporary loss of production	Short interruption on supply to important customers.	Medium time interruption on supply to important customers.	Long interruption on supply to important customers AND/OR loss of production for long time.	Permanent loss of production AND/OR loss of important customers.
Impact on Business (1)	< USD 5k	> USD 5 k	> USD 50 k	> USD 200 k	> USD 1 M	> USD 50 M
Quality	Insignificant defect or nonconformities	Significant defect or nonconformities	Very Significant defect or nonconformities	Serious defect or nonconformities	Very Serious defect or nonconformities	Multiple defects or multiple very serious nonconformities.
Damage to Installations	Small damage to installations. Loss of production < 1 day	Significant damage to installations. Loss of production < 1 week	Very significant damage to installations. Loss of production < 1 month	Serious damage to installations. Loss of production < 6 months	Very serious damage to installations. Loss of production < 1 year	Catastrophic damage to installations. Loss of production > 1 year

(1) The amount (USD) that defines the impact on business may vary from company to company.

2.2 – PROBABILITY: The probability of occurrence of a certain event is based on similar events found in the literature or within the experience of the company. There are many variations of probability values that can be used by companies – the table below brings the most common ones:

LIKELIHOOD	DESCRIPTION	Events per Year
Almost certain	Likely to occur, many times a year.	> 1
Very likely	Likely to occur at least once in a 10 year period OR it is known to have occurred in the plant sometime in the past.	10^{-1} to 1
Possible	Have already occurred in the plant at least once in the past.	10^{-2} a 10^{-1}
Unlikely	Never occurred in the plant but have occurred in similar external installations.	10^{-4} a 10^{-2}
Very Unlikely	Never occurred in the plant but have occurred somewhere else in the world in installations not related to the local business.	10^{-6} a 10^{-4}
Extremely Unlikely	Might theoretically occur, but there are no known events in the world.	< 10^{-6}

2.3 – THE RISK MATRIX: Once both the consequences and probabilities of an undesired event is known, the Risk Matrix can then be used to estimate the severity of the event.

Consequences ➡ / Probability ⬇	NOTABLE	SIGNIFICANT	VERY SIGNIFICANT	SERIOUS	VERY SERIOUS	CATASTROPHIC
Almost Certain	**2**	**2**	**1**	**1**	**1**	**1**
Very Likely	**3**	**2**	**2**	**1**	**1**	**1**
Likely	**3**	**3**	**2**	**2**	**1**	**1**
Unlikely	**4**	**4**	**3**	**3**	**2**	**1**
Very Unlikely	**4**	**4**	**4**	**4**	**3**	**2**
Extremely Unlikely	**4**	**4**	**4**	**4**	**4**	**3**

The Matrix shows 4 categories of risk, as follows:

Risk Category 1: UNACCEPTABLE. Work must not begin or must be stopped immediately until the risk has been reduced or eliminated.

Risk Category 2: TOLERABLE. Work may continue or begin only if it is no longer possible to introduce additional controls to reduce or eliminate the risk (ALARP concept – As Low As Possible).

Risk Category 3: ACCEPTABLE. The work can continue or begin, periodically checking the possibility of further reduction or elimination of the risk (ALARP concept – As Low As Possible).

Risk Category 4: TRIVIAL. Work can continue or start normally.

OBS: Some companies use to further subdivide the Risk Category 1 to allow an additional distinction between the severity of the high consequence events.

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