Risk Matrix Vol 1

Proper safety measures can make positive contributions toward increased production and reduced operating expenses. Risk Assessment is an effective means of identifying process safety risks and determining the most cost effective means to reduce risks. Some organizations perform quantitative risk assessment and some uses qualitative risk assessment tool such as risk ranking.

Following Process safety management services are offered to industries considering the kind of risks that exists in the plant operations:

- Hazard and operability (Hazop Studies)
- Failure Tree Analysis (FTA)
- Event Tree Analysis (ETA)
- Primary Hazard Analysis (PHA) using Dow index
- Risk Assessment (With Risk Ranking technique)

Risk Ranking is a common methodology for making risk based decisions without conducting quantitative risk analysis. Which ever risk ranking system is used, it has two key advantages over using other PSM methodologies:

- It differentiates relative risks to facilitate decision-making.
- And improves the consistency and basis of decision.

Companies are recommended to adopt a standard, defensible ranking system to allow for decision making, based on company's defined safety goals. The basic for risk ranking is the Risk Matrix that has consequence / severity and frequency axis. The product of consequence / severity and frequency provides a measure of risk. Risk Matrix is a methodology that can help you identify, prioritize and manage key risks on your program Risk Matrices can create liability issues and give a false sense of security, if not designed properly. An effective risk ranking matrix should have the following features:

- Be simple to use and understand
- Not require extensive knowledge of quantitative risk analysis to use.
- Have clear guidance to applicability
- Have consistent likelihood ranges that cover the full spectrum of potential scenarios.
- Have detailed descriptions of the consequences of concern for each consequences range.
- Have clearly defined tolerable and intolerable risk level.
- Show how a scenarios that are at an intolerable risk level can be mitigated to a tolerance level on the matrix
- Provide clear guidance on what action is necessary to mitigate scenarios with intolerable risk levels

The combination of a consequence / severity and likelihood range gives us an estimate of risk or a risk ranking.
Although there are many risk matrices that have been developed and published, the development and the application of risk matrices present their own challenges. Construction of a Risk Matrix starts by first establishing how the matrix is intended to be used .Some typical uses for risk ranking are Process Hazards analyses, facility siting studies and safety audits. A key initial decision that has to be made is to define the risk acceptability or tolerability criteria for the organization using the matrix. Another key aspect of the risk matrix design is having the capability to evaluate the effectiveness of risk mitigation measures. The next step is to define the consequence and the likelihood ranges.

First determine what are consequences of interest, these can include

1. Personnel safety
2. Public safety
3. Environmental impact
4. Property damage / business interruptions
5. Corporate image
6. Legal implications

The final step in developing the risk matrix is to translate the tolerability criteria onto matrix. The following example of matrix published in CCPS (Centre for Chemical Plant Safety) Guidelines for Hazard Evaluation Procedures, Second Edition is shown in Table 1

Table 1: Example of risk matrix

Consequence / **Frequency**	**1**	**2**	**3**	**4**
4	**IV**	**II**	**I**	**I**
3	**IV**	**III**	**II**	**I**
2	**IV**	**IV**	**III**	**II**
1	**IV**	**IV**	**IV**	**III**

Table 2 provides a description of the risk ranking categories used in table 1. For risk ranked I or II there is a time specified for the implementation of mitigation measures. Also in table 2, the risk rank III is defined as "Acceptable with controls". This is somewhat confusing as all scenarios are acceptable with the proper controls. So how do we avoid pitfalls and still have an effective risk ranking tool. One option is to avoid using quantitative frequencies and probabilities for the likelihood ranges and use layers of protection analysis (LOPA).

Table 2: Example of risk ranking categories

Risk Rank	**Category**	**Description**
I	Unacceptable	Should be mitigated with Engineering and /or administrative controls to risk rank III or less within a specified period such as 6 months.
II	Undesirable	Should be mitigated with Engineering and /or administrative controls to risk rank III or less within a specified period such as 12 months
III	Acceptable with controls	Should be verified that procedures or controls are in place.
IV	Acceptable	No mitigation required.

Source: CCPS Guidelines for Hazard Evaluation Procedures, Second Edition

Table 3: Likelihood ranges based on the levels of protection.

Likelihood Ranges	**Quantitative Frequency criteria** **Typical Scenarios**
Level 4	Initiating event or failure Hose Leaks / Ruptures
Level 3	One level of protection Piping leaks
Level 2	Two Levels of protection Full bore failures of small lines or fittings
Level 1	Three levels of protection Tank / Process vessel failures

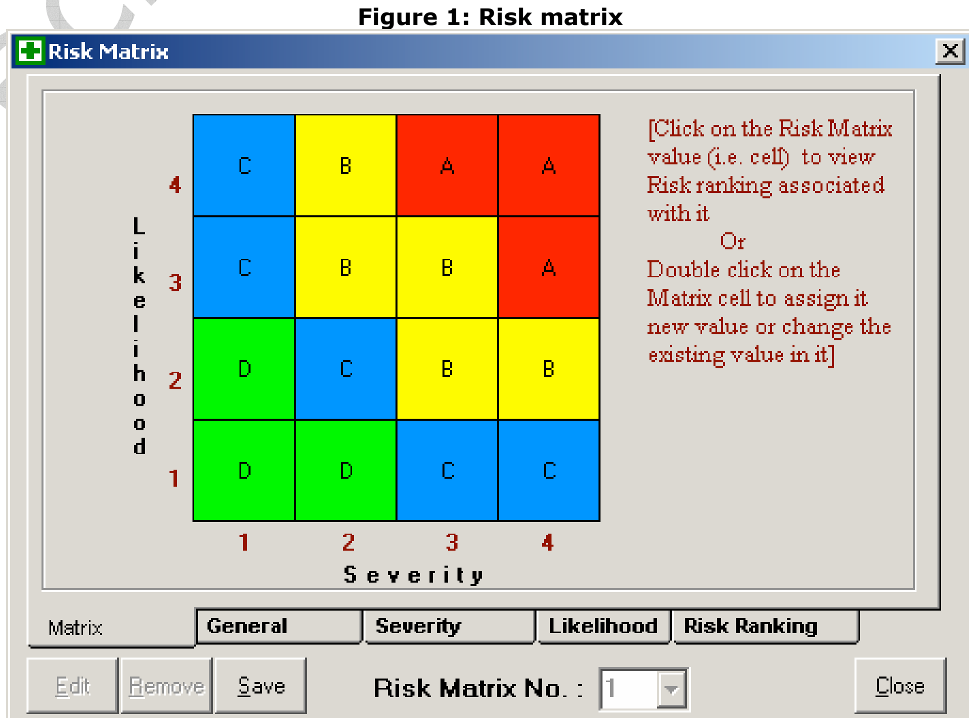
The above likelihood ranges can be used in conjunction with the typical consequences ranges shown in Table 4

Table 4: Typical consequence ranges criteria

Consequence Range	Quantitative safety consequence criteria
4	Onsite /Offsite: Potential for multiple life threatening injuries or fatalities
	Environmental: Uncontained release with potential for major environmental impact.
	Property: Plant damage value in excess of $100 million
3	Onsite / Offsite: Potential for single life threatening, injuries or fatalities
	Environmental: Uncontained release with potential for moderate environmental impact
	Property: Plant Damage value in the range of $10 - $100 Million
2	Onsite / Offsite: Potential for an injury requiring a physician's care
	Environmental: Uncontained release for potential for minor environmental impact.
	Property: Plant damage value in the range of $1 to $10 Million
1.	Onsite: Potential restricted to injuries requiring no more than first aid. Offsite: Odor or noise complaint.
	Environmental: Contained release with local impact.
	Property: Plant damage value in the range of $0.1 to $1 Million

The resulting risk matrix is shown in figure 1.

Figure 1: Risk matrix



Source: Risk matrix developed using Hazop Pro

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