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# Journey Towards Risk Based Process Safety

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## Abstract

Over the years, there have been many technological advancements in the industry and a huge growth in terms of operating capabilities. Being among the fastest growing organisations, managing enterprise wide risk effectively is a very crucial success factor. It is also recognized that identification and assessment of process safety risks is the cornerstone to sustain growth and to ensure worker and public safety.

In the area of process safety, there are well-defined and established risk analysis techniques ranging from very simple to quite rigorous ones depending on criticality and complexity of application. However selection and application of appropriate technique is understood by a small section of workforce and often left to mere judgement of analysts. Hence they are often mistaken for mere theory and may not be thought of as realistic. It is onerous task upon risk analysts to translate these analyses in such a way that these are projected in an effective way that connects these results with the impact to the business outcomes.

For Reliance, starting with Hazop studies, moving on to elaborate Process Hazard Analysis, LOPA and QRA has been a gradual journey. While traditional methodologies are applied throughout, there is a certain level of customisation done as per organizational needs. All such efforts are aimed at continuous improvement in the way risks are identified and also improve the quality of analysis.

Group wide requirements and supporting ground rules have been defined to effectively utilize these methodologies in a consistent manner across various locations. Customisation also means applying more rigour in the analyses with less subjectivity, pre-defining criteria for choosing scope for quantitative analyses or the way risks are estimated. These ground rules were developed for both qualitative and quantitative techniques like What-if/ Hazop, Consequence analysis, LOPA, MAR/ QRA. However these ground rules are aligned to current group strategy and can potentially undergo review in future and any required changes made.

The paper discusses the evolution process in the area of Risk Assessment, challenges faced in realizing the actual benefits out of the assessments and how certain alterations in assessment methodology have helped in continual improvement of process safety and risk management.

**Introduction:**

A very general perception is – 'what is generally accepted in the industry is good for all and should work for us'. There are always unique ways that each organisation needs to adopt to suit its requirements and Reliance has always endeavored to break the stereotype and manage operations and safety effectively.

Initial stages of process safety implementation generated organisation wide drive to evaluate potential undesirable consequences due to loss of containment events across the group in a big way. Systematic Baseline Process Hazard Analysis was conducted across facilities with internal cross disciplinary teams. More rigorous techniques like Layers of Protection Analysis (LOPA) and Quantitative Risk Analysis (QRA) for units with high impact potential and were applied for select units based on management decision.

As a result, there was a spurt of significant number of risks emerging from the analyses, resulting in many recommendations to reduce risks. Majority of such analyses were based on consequences, which were excessively conservative. Recommendations were often design changes or major investments to upgrade technology. In view of various operating facilities, ranging from newly commissioned units to those at the end of asset lifecycle, the same model could not deliver desired results.

However such efforts yielded enormous cultural and behavioural change among workforce through enhanced awareness on process safety, also positively impacting the company image.

As the process gained further maturity, it was realised that it is required to apply judicious risk management principles that can result in effective resource management for risk reduction and that process safety does not mean indiscriminate investments.

The initial phase of identifying risks was followed by actions for risk reduction and focus on barrier management. Effective application of all the process safety elements with focus on risk started showing overall improvement in the leading and the lagging indicators.

**Adapting traditional qualitative methods to Organisational needs:**

Hazard identification and risk assessment techniques like Hazop, what-if help determine the risk events that warrant risk reduction measures on priority. They also help provide a level of assurance to the management on the facility design and operations. These techniques often rely on team brainstorming and provide indicative results as perceived during the discussions.

Hazop technique is applied for new facilities or where major modifications to existing facilities is made. For operating facilities during the cyclic reviews, what-if is applied as a brainstorming technique to allow team to think through risk events ranging from credible to worst case type failures. While both Hazop and what-if carry advantages and limitations in their basic design, Reliance has attempted to adopt features of both these techniques to derive the best out of two.

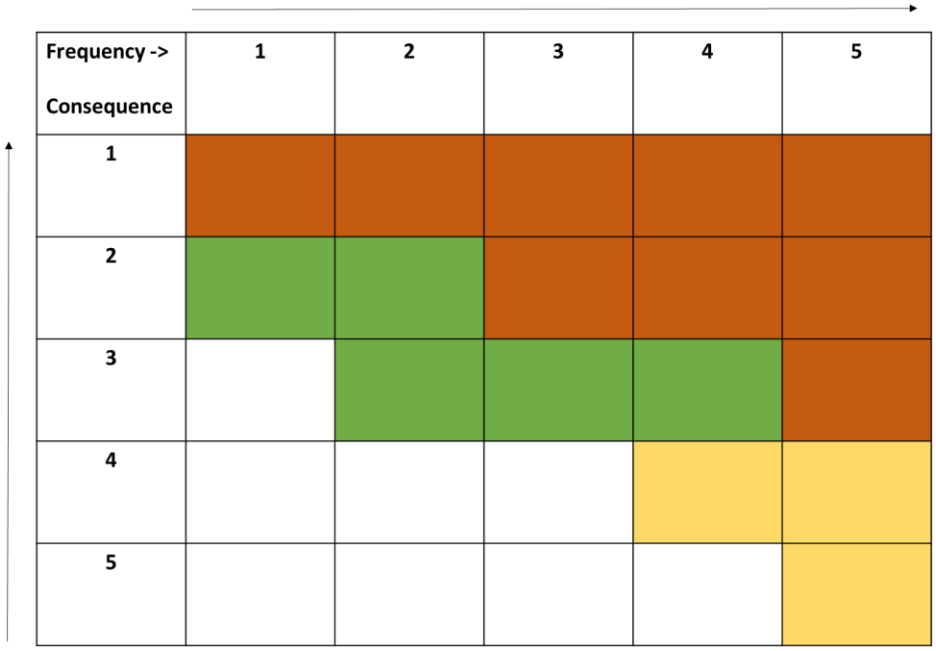
What-if methodology is strengthened with a structural approach through aspects such as the following:

- Apply ‘process deviations’
- Use ‘equipment specific checklists and loss of containment checklists’
- Review ‘What-if’ for transient operations - start-up and shut-down
- Review ‘What-if’ for other scenarios related to typical industry and unit specific aspects such as Instrumentation, Chemical Hazards, Equipment Integrity, rupture/leak, Relief, etc.

Above approach helps apply rigour in the way complex processes are analysed for risks and prompts analysis teams not to miss out on key aspects.

Risk events thus identified are subject to risk ranking for prioritisation through Risk Matrix defined for the organisation. This is used consistently in the analysis as a single lens to view all types of operational risks after a clear understanding was provided from top to bottom layers of organisation. Interpretation tables are designed to estimate consequences to People, Environment, Assets and Reputation.

**Figure-1 Risk Matrix (sample)**




While the qualitative techniques are strengthened to bring out the right risk events, the management observed there were inconsistencies and occasional fallacies in the analysis due to the subjectivity and heavy dependency on team judgement.

**Consequence based approach:**

First step towards rationalisation of the estimates was to quantify consequences through modeling in software tool based on globally accepted assumptions. These results helped in gaining better confidence in the estimates to help determine risk reduction actions.

Consequence based decisions brought a big shift in the way risks are viewed and gave an insight to those worst events that normally cannot be imagined even by an experienced team.

However an unexpected outcome of this approach is an increase in the number of proposals for risk reduction and there were signs of being over conservative creeping in. Typical recommendations were to install additional detectors in existing units, inclusion of redundant instrumentation in design and many other design changes. Further questions arose about the limit to such changes and how the residual risk is projected after they are implemented. It was realized that management has such a huge number of actions to approve, many of them required for high hazard operations. There are also potential disadvantages to adding more hardware to the unit.

Examples of such situations are: A facility that operated for 30 years, handling hazardous material with standard safety practices in place was subject to a what-if analysis and subsequently consequence analysis. The results showed up levels of concern that prompted that analysis team to recommend major metallurgy and instrumentation changes. Decisions on this unit were prioritised and consequences determined the actions. Soon after the changes were made with heavy investments, the business operations became quite unviable and were discontinued.

Another small facility with very small amounts of hazardous material was analysed through PHA, which indicated that there are many high severity risk events in the unit. There was a QRA study performed to confirm these results. Results did not indicate the same level of risk, ruling out the apprehensions generated based on PHA results.

These cases prompted that an overly conservative consequence based approach could be, at times, detrimental to the overall business objectives. An in-depth analysis of the business value obtained from the facility versus risks involved should have been a prudent approach in the first case. In the second case, appropriately QRA technique was applied to avoid over estimates and re-engineering.

**Getting the risk estimates right:**

The approach taken for various methodologies applied in risk assessments is depicted in Figure-2 below. As per traditional qualitative methodologies, only net risk estimates were made during Hazard evaluation based on existing barriers. There was a need identified to upgrade this philosophy to enable representing the significance of controls/ barriers in a better manner.

In addition to net risk estimates, requirements have been laid out that each risk event is subjected to analysis that estimates failure of all existing barriers depicting the ‘inherent or worst credible risk’ to provide further visibility on the worst potential of the risk event. The inherent risk always reminds management and the asset facing personnel of the significance of effectively managing those risks which otherwise can be bad for the organisation.

Assessment of inherent risk for each scenario is performed on qualitative basis, estimates made initially based on review of incident history and team judgement. Such qualitative estimates are further refined in quantitative risk analysis (QRA) for high severity risks.

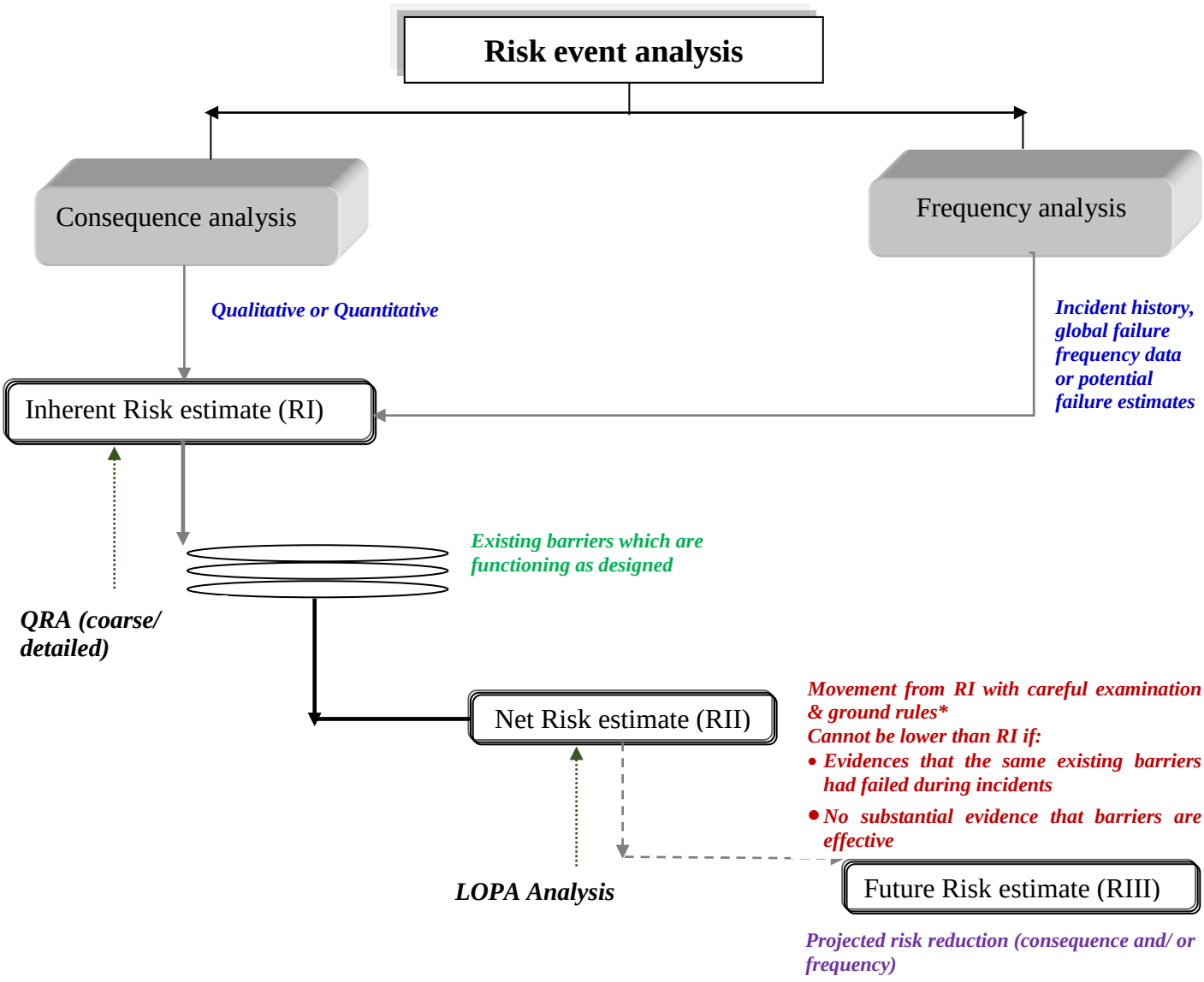
While performing the inherent risk estimates, guidance is provided for teams to adopt a conservative approach in not crediting such factors those are not designed protect against a

particular risk event, e.g., favourable meteorological conditions, population patterns in the area at the time of incident, non-ignition of flammable vapours and successful emergency response actions including evacuation. This is especially valid while considering incident occurrence frequency, i.e., those occurred in the facility lifetime or in the organisation.

This means that an incident where the flammable cloud did not ignite due to prevalent conditions at the time of the incident should be analysed estimating 'what worse could happen if the same cloud had ignited'. Any unusual response actions taken during the incident, which are not planned for, should also not be assumed will happen in future during the likelihood estimates.

The approach mentioned above relies heavily on maintaining a good incident database for review by the analysis teams. This exercise otherwise may still be ineffective if left for mere judgement.

**Figure-2 Typical methodology for risk estimates**



**Net risk estimates and decreasing subjectivity:**

Combining the qualitative analyses with the quantified consequence estimates gave a reasonable level of confidence in the results. However there was still scope of improvement in the frequency estimates. There have been a few articles published in forums like the 'Global Congress on Process Safety' that mention how HAZIDs and HAZOPs are integrated with LOPA principles.

On similar lines, Reliance has devised an internal calibration scale that directionally guides the teams on applying credits for barriers. This is helpful because application of LOPA technique for all the scenarios is also not feasible considering the number of scenarios to be analysed. Hierarchy of controls as the basis, a qualitative rule set for taking credits on likelihood was developed.

For e.g., an alarm with operator action will enable movement by only one level on the scale where there is a common event like a minor leak from primary seal of a pump. Further credits to the scale can only be taken upon higher safeguards, say addition of an emergency shutdown system.

The scale does not allow likelihood estimates to be able to determine that 'a scenario has a very remote possibility to occur (say scale 1 or 2 in the table below)' unless there are inherently safer mechanisms included in the design. Examples include design like the pipe-in-pipe, eliminating potential failure points in the process like the stagnant zones prone to corrosion, rapid deinventorying through gravity, etc.

**Figure-3 Frequency estimate table (Representative sample)**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Scale to estimate **worst credible risk** | | | | |
| Event not occurred in industry/ Remote possibility | Event has occurred in industry | Event occurred in organisation | Occurred at the facility under study | Frequent occurrence at the location |
| Scale to make movements to estimate **net risk** | | | | |
| Inherently Safer Principles applied | Highly reliable controls (passive + mechanical protective device and / or active | Active controls (SIF) and/or mechanical protective device | Human intervention based on process monitoring<br>Or<br>BPCS or | Administrative controls only |

| | | | | |
|---|---|---|---|---|
| | devices with high SIL rating) | | DCS interlock | |
| Note : When making net likelihood estimates, move boxes to the left only if the controls mentioned in the left scale exist; Else position remains | | | | |

However based on a common criteria set for the organisation, scenarios with high severity potential are analysed through LOPA technique which is less subjective and more reliable. Risk estimates analysed through LOPA are re-mapped into the Risk Matrix and results from PHA corrected, as required.

Above principles are also applied for future risk estimates made for proposed risk reduction measures. Under some cases, these future estimates are performed quantitatively. This projection of future risk helps in taking decisions on risk reduction measures by the management.

The journey towards customizing risk assessment techniques has been gradual, and the upgradation of risk assessment methodology based on findings from internal processes for quality assurance. Hence such incremental changes to the process should be tailor-made for each organisation as per the requirements.

**Application of risk estimates in overall process safety:**

The risk assessment studies performed on units have a larger impact on the overall operations the unit when applied across other key processes that can be linked to various elements of process safety, e.g., Asset Criticality & Mechanical integrity, Management of Change (MoC), Auditing & Assurance.

Journey towards Risk Based Process Safety requires close integration between each of these elements and all of them aligned to the identified risks.

Reliance has invested a lot of efforts in integration of all the key processes like critical equipment identification & integrity management, incident management, MoC with the Risk process. All these processes rely on the risk assessments as the basis to determine criticality and enforce focused actions on high risk items.

**Risk and Process Safety Competency – a critical factor in the journey:**

It is well understood across industry that each change management requires a major shift in the thought process in the organisation across various levels. Training the risk analysis teams at facility level is the first step which typically consumes the maximum efforts. Principles mentioned above not only require understanding of traditional Hazard identification methods but also the concepts of LOPA and QRA. These are rigorous techniques and usually there are only a few resources who are trained in applying them. This has been an area of challenge to continually improve process safety competency across the facilities. To make model simpler for asset facing personnel, customisation of the rule set using the Risk Matrix in combination with the LOPA principles proved beneficial.

The next level was to get the leadership appreciate the enhanced understanding of barriers in risk management and the need for shift in the application of the risk assessment tools. A significant contributing factor in managing the program effectively is that the key decision makers understand the assumptions and principles. There are ongoing efforts in facilitating Competency development programs for leadership and the analysis teams to bridge any gaps in knowing and applying the requirements.

Process safety subcommittees at each facility help in steering these efforts to engage wider group of stakeholders and helps in achieving effective communication. Continuous upgradation of in-house competency is achieved by partnering with external groups with process safety expertise, active participation in global forums, getting personnel training on focused areas through external expert groups, etc.

**Give time!**

Through the journey in the shift from one set of requirements to another, it has been an experience that the changes take time to be realised at ground level. A critical factor is to 'Give Time' for any changes to get absorbed and matured. It is clearly evident across the industry that any number of changes made to the documents do not yield results, unless a systematic and steady headway is made in the translating them to actions. Risk Assessment can be a better tool in managing & prioritising operating risks but does not compensate for basic principles and best practices of operations to achieve safe and reliable operations.