Risk Assessment Matrices – Fit For Purpose?

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Risk Assessment Matrices are a widely used tool in the process industries to assisted with risk based decision making. A commonly asked question is whether the Risk Assessment Matrix is "Fit For Purpose"?

This paper examines a number of factors related to the construction of, procedures for and use of Risk Assessment Matrices that can, if appropriately considered, improve the quality of an organisation's Risk Assessment Matrix and the consistency of its use.

This paper concludes that if an organisation considers these factors, it can develop a Risk Assessment Matrix that is "Fit For Purpose".

Introduction

The Risk Assessment Matrix is a tool that is widely used in the process industries to assist with risk based decision making. They are used in a number of situations, such as Management of Change, HAZOP, prioritising resource.

A question that is often asked is whether the Risk Assessment Matrix is "Fit for purpose"?

Like any tool the Risk Assessment Matrix is only effective if it is constructed appropriately, used correctly and in the correct scenarios.

In this paper, the Author discusses areas for consideration by which the use of the RAM can be made more effective. The following areas are covered:

- Constructing the RAM to improve usability and consistency
- Ensuring that Procedures give appropriate guidance on the use of the RAM for the different situations in which it is to be used.
- Providing training to staff on the effective use of the Risk Assessment Matrix

Constructing the Risk Assessment Matrix

For a Risk Assessment Matrix to be considered "Fit for purpose", it needs to be appropriately constructed, so that it fits the processes in which it is going to be used and reflects the organisation that is going to use it. The Risk Assessment Matrix should be constructed in such a way to promote consistency in its use.

Appropriate word models

Use of word models for both consequences and likelihood can aid the Risk Assessment Matrix user in selecting the most appropriate category. This can aid repeatability and hence consistency of application by different users. As an example, use of "heard of in industry" may provide less subjectivity than "unlikely".

To gain maximum benefit the word models need to be appropriate for the organisation using them. As an example, use of "happens multiple times per year at location" and "happens multiple times per year throughout organisation" is only appropriate where the "location" is part of a wider organisation with a number of "locations" within the organisation. Consideration of other "locations" within the organisation is of benefit as internal sharing of incidents may be more consistent than for external incidents.

While use of word models such as these can provide extra guidance when selecting the appropriate category and hence improve consistency of Risk Assessment Matrix use, they still require the users to have a reasonable amount of corporate memory (knowledge of incidents at the location and within the wider organisation) and industrial experience (knowledge of incidents in the wider industrial sector) to gain maximum benefit.

Where the location constructing a Risk Assessment Matrix is a greenfield site (i.e. that location is yet to be built and hence has no operating experience), further consideration is required for the word models. Some word models, for example, "heard of at the location" are not appropriate in this case.

Combining detailed word models (e.g. "heard of in industry"), simplified world models (e.g. "unlikely") and a frequency band (e.g. "once per 10,000 to 100,000 years"), may provide the most consistency, however, it does create the potential for conflict. The procedure detailing the use of the RAM should address what to do in such circumstance.

Granularity of Risk Assessment Matrices

We have experience of working with Risk Assessment Matrices that have a significant number of likelihood and frequency divisions, some times outside of the scope of the Risk Assessment being carried out. For example, multiple divisions of high severity consequences such as "1 to 10 offsite fatalities" and "greater than 10 offsite fatalities". Where the consequence of a

scenario is estimated to be offsite fatalities, it may be assumed that use Risk Assessment Matrix is not a proportionate risk assessment method for this scenario.

Where the Risk Assessment Matrix is to be used at a management level to assist with management of an organisations scenarios, this increased granularity may be warranted. However, where the Risk Assessment Matrix is to be used day to day for conducting risk assessments, the extra level of detail may make the Risk Assessment Matrix unwieldy and lead to confusion.

In addition to too much granularity posing problems, too little granularity may also be problematic. Where there is insufficient division between likelihood or consequences (boxes too big), it is possible for a number of scenarios with differing consequence and likelihood to be assigned the same Risk Assessment Matrix rating. Depending on how the Risk Assessment Matrix is being used, this could lead to a number of undesirable outcomes:

- Not possible to rank one risk against another
- Not possible to show risk reduction between mitigated and unmitigated scenarios – additional safeguards result in the same Risk Assessment Matrix
- Depending on the calibration of the Risk Assessment Matrix, possible to have risks that require further assessment and provision of further barriers, deemed as in the Tolerable if ALARP or broadly acceptable region.
- Forcing the user to pick a different likelihood or consequence than is realistic to force a scenario into the region on the Risk Assessment Matrix that the user needs in order to meet their aim (justifying further measures, showing that the risk is low etc.)

Ownership and calibration

Whatever word models and level of detail has been chosen for the Risk Assessment Matrix, it should be tailored to the requirements of the organisation that owns and uses it. This means that not only should they be calibrated so that, as a minimum, they comply with local legislative tolerability criteria (e.g., for the UK, the tolerability criteria contained within UK HSE's "Reducing Risk Protecting People", Chemical and Downstream Oil Industries Forum (CDOIF)'s "Environmental Risk Tolerability for COMAH Establishments") or relevant industry good practice (e.g. EN1473 "Installation and equipment for liquefied natural gas – Design of onshore installations"), but also to reflect the organisation's appetite for risk. For a given consequence, one organisation may deem a particular likelihood less tolerable, and therefore would be willing to commit more resource to mitigate against it, than another organisation.

Procedures and Training

For the Risk Assessment Matrix to be considered "Fit for purpose" and to be an effective decision making tool, it needs to be used in the most appropriate way for any given situation.

Its use also needs to be consistent. Different people have different experiences and knowledge, hence a risk assessment for the same scenario conducted by two different users may have a slightly different outcome. This variation can be minimised by ensuring all users consider at least follow a common procedure and the same assessment basis (which consequence should be chosen, should safeguards be included, etc.).

Procedures

To ensure consistency of use of the Risk Assessment Matrix within a wider process (e.g. Management of Change, HAZOP), use of the Risk Assessment Matrix should be included in a procedure. The procedure should include descriptions of the following things (discussed in more detail later in this paper):

- Defining the scenario – including guidance on whether it is more appropriate to consider the worst case consequence or the most likely consequence of a scenario.
- How and when safeguards should be incorporated into the assessment
- How the inputs and outputs for the risk assessment should be recorded

Paper Trail

However the Risk Assessment Matrix is to be used, it is critical that means are provided for consistently documenting the justification for the consequences and the likelihood chosen, and the resultant Risk Assessment Matrix rating for that scenario.

This is necessary so that in the future (e.g. during incident investigation) the rationale of the risk assessment can be interrogated.

Training

To ensure that the users of a procedure utilising the Risk Assessment Matrix are using it consistently Once a procedure has been created (or updated) for a process involving the Risk Assessment Matrix, it is important that adequate training and regular refreshers are given to the personnel expected to undertake the procedure.

Using the Risk Assessment Matrix

The following are important considerations when using the Risk Assessment Matrix. Guidance should be provided in the relevant procedures to ensure that items are considered in a consistent manner by the users.

Scenario Definition

One common issue with the use of Risk Assessment Matrices is a lack of clarity on the scenario that is being considered.

A contributor to this issue may be the orientation of the RAM, with likelihood along the x axis and consequence along the y axis. This has the potential to lead the user to select the likelihood of the scenario before the consequence is fully defined. It is not possible to determine the likelihood of a scenario before that scenario has been defined.

To remedy this issue, it is important to fully define the scenario that is being assessed and assign the consequence category before determining the likelihood. For example the appropriate likelihood may relate to initiating event, in the case where the unmitigated risk is being determined, or it may be the estimated likelihood of the ultimate consequences in the case where all available safeguards are being considered.

By not fully defining the scenario being assessed the likelihood may be inappropriate leading to an over or under estimate of the risk posed by the scenario.

Comparison of scenario with word models

When determining the likelihood category by comparison to the word model, e.g. “heard of in industry”, it is important to consider carefully what is being compared. For example do the two scenarios involve process materials with similar hazardous properties (flammability. toxicity), are the process conditions similar (operating temperature and pressure), does the equipment have similar failure modes.

It is also important to consider that the scenario that was “heard of in industry” will have had procedural controls, control barrier and mitigation systems in place, are these equivalent to the scenario being risk assessed.

Not focusing only on the worst case

While it is important to consider the worst-case consequence of a particular scenario, in most cases this will be the lowest frequency outcome. It is important to consider those lower severity consequences which may occur frequently and therefore present a higher risk, these higher frequency lesser severity events can often get missed.

Taking Credit for Safeguards

Depending on the situation in which the Risk Assessment Matrix is being used, it may be necessary to take into consideration the existing or proposed safeguards. The effect of the safeguard on the scenario should be considered, will the safeguard make the scenario less likely to happen or will it lessen the severity of the consequences if the scenario does happen, or reduce the potential for escalation.

Where the risk assessment being conducted is determining the unmitigated risk, it may still be appropriate to consider any inherent safety measures that are integral to the design, for example, appropriate design pressure and temperature, materials of construction that are suitable for the service they are under.

Finally, to maintain a degree of conservatism, it may be appropriate to exclude the use of conditional modifiers (e.g., probability of ignition, probability of explosion, vulnerability) when assessing the frequency of an events. These conditional modifiers could be included if a more detailed risk assessment is required.

Utilising the output appropriately

The Risk Assessment Matrix will provide the assessed scenario with a Risk Assessment Matrix rating. This may be in the form of coordinates representing the consequence and likelihood category, a colour (e.g. red, amber, green), or a number. In whatever form the result, it should be used to decide upon the next step in the process in which the Risk Assessment Matrix is being used.

It may be that the output means that no further actions is required (e.g. low risk), that further measures should be considered (e.g. where the Risk Assessment Matrix is being used as part of Management of Change), that a more detailed risk assessment is required (e.g. a scenario in a HAZOP requiring a LOPA analysis).

If the output from the Risk Assessment Matrix is not used correctly, then either the risk assessment that was completed was of limited benefit or it could lead to the inadequate management of risks.

Conclusion

While the use of Risk Assessment Matrices have a number of benefits, it is clear that there are a number of limitations which can adversely affect the results. It is the view of the Author that the effects of the limitations can be reduced by ensuring that the construction of Risk Assessment Matrices considers the following:

- Using appropriate word models for consequence and severity
- Using an appropriate level of granularity
- Appropriate ownership and calibration

Once the Risk Assessment Matrix has been constructed, the limitations can be further reduced by providing appropriate procedures which include the following:

- In what circumstances should the Risk Assessment be undertaken
- How the scenario should be defined
- In which situations should existing and proposed safeguards be included
- Appropriate use of the Risk assessment Matrix output

If Risk Assessment Matrices have been appropriately constructed and procedures are in place to guide the user in how to use it, Risk Assessment Matrices can be considered “Fit for purpose”.

References

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