**Safety practice**

**Tips for effective risk scenario identification**

Adam M Musthafa, Indonesia

**Summary**

A major hazard facility’s capability to carry out its “risk treatment” (e.g., implementation of Process Hazard Analysis/PHA recommendation) is typically significantly lower than its capacity to conduct “risk discovery”. This is the reason why the risk ranking of each identified scenario becomes an important step in Process Hazard Analysis (PHA - like HAZID, HAZOP, or LOPA). With the risk rank, an organisation can focus its resource on higher risk items before moving on to resolve lower risk ones. It is common for a major hazard facility to screen its PHA result for its top risks scenarios. Such practice allows the organisation to focus on the higher risks and bring them to the attention of senior management who are accountable to manage and reduce the risk to tolerable/acceptable risk. This paper outlines some tips for an organisation to identify its top risks from existing PHA.

**Keywords:** Risk scenario identification

**Top risk vs major accident hazard (MAH)**

A major accident hazard (MAH) is a hazard that causes a major accident event (MAE). A major accident event is a hazardous event that results in one or more fatalities or severe injuries or extensive damage to structure, installation or plant at large scale, severe and/or persistent impact on the environment. In some operating companies, this is represented by a scenario that resulted in the highest consequence level in their risk matrix. Others have frequency-consequence pairing definitions on the risk matrix that are defined as “top risk” scenarios.

While major accident hazards are normally identified as part of compliance with a regulatory requirement, top risks are voluntarily identified as part of day-to-day operations. Typically, it has a wider definition than major accident hazard and the list has used a tool to prioritise focus and resources. The top risks should include scenarios identified as major accident hazard, but may not be limited to the MAH. Regardless of how the operating company defines their top risks, their understanding of what scenario falls into this category and what control and mitigation they currently have are critical. Thus, many companies screen their PHA and risk assessment reports to have a list of the top 10 or 20 risks. The intention is to make them “visible” and understood by all personnel within the organisation. Everyone then can play their role in ensuring that these major events are prevented from happening.

**How are top risk scenarios identified?**

In some organisations, risk assessments and PHA conducted on an integrated database screening for top risk scenarios is just a matter of filtering an array of scenario data according to the predefined criteria. In others, an engineer or task force of competent personnel will screen through PHA and risk assessment reports for these scenarios by looking at its risk level (or consequence level). After the potential risks are screened, the list is then discussed with the technical authority and appropriate management to be further refined and formally approved as the organisation’s top risks. Figure 1 illustrates how this process is done. The scenario is to be screened from all types of Process Hazard Analysis and Risk Assessment.

Process Hazard Analysis (PHA) reports like HAZOP is the main source of the scenario. Some organisation’s also screen their scenarios from safety studies and formal safety assessment (FSA), like Escape, Evacuation, and Rescue Analysis (EEA), Fire and Explosion Risk Assessment (FERA), Emergency System Survivability Analysis (ESSA), Non-Hydrocarbon Hazard Analysis (NHHA). Others include risk from offsite risk assessments including housing and logistic risk assessments.

While process and process safety studies will mainly identify major accident hazards (with high or very high severity levels), other risk assessments like task, logistic, marine, housing, and health risk assessment will help the organisation identify the top risks outside MAH. For example, occupational safety risks or non-process hazards such as the risk of falling during periodic rope access work to inspect and repair flare tip on a 60m flare stack or forest fire impacting on oil and gas plant operation (a not uncommon phenomenon in South East Asia) may not be identified as a MAH. However, for some operators in Indonesia, these are among their top risks.

While the task is not a complicated one, without proper planning and procedure this process may lead to either an unnecessarily high number of top risk scenarios or missing out on important scenarios in your top risks register. The following

**Figure 1 – Top risk scenario screening**

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tips will help to systematically identify the top risks scenario in a worksite.

**Tip #1 — Have a clear definition for screening**

The most important reference in conducting top risk scenario identification is the criteria of top risks itself. In one top risk scenario identification workshop that we observed in Indonesia, the list was updated more than three times even before reaching technical authority and management desks. This was because the task force did not have clear and firm criteria on what constitutes a top risks scenario. The criteria were modified several times during and after the workshop, wasting valuable resources on reworks that should have been avoided by having clear and approved criteria for the top risk scenario from the start.

There are at least three approaches on how to define a top risk scenario. Figure 2 shows the difference between these approaches by using a 5 x 5 risk matrix. The first is consequence-based (normally used for major accident hazard identification). All scenarios with major or higher consequence levels (e.g. fatality and multiple fatality) are considered to be top risks. The advantage of this approach is that the definition is simple and mostly captures process safety risks. Occupational safety risk area usually falls on a lower consequence level and thus is automatically screened out (if they are to be managed separately from process safety risks).

The second approach is risk-based. All likelihood and consequence pairs that fall into “higher or extreme” risks are considered top risks. This approach requires more effort for screening as the screener needs to look into both likelihood and consequence when doing their job. The advantage of this approach is that it is consistent with the risk definition that considers both likelihood and consequence. The disadvantage is for most process safety risks that have multiple layers of protection, risks that are already controlled to the likelihood level of “unlikely” or “rare” will be unintentionally screened out. These risks may be major accident hazard scenarios (as some high severity risks are excluded). This can be mitigated by requiring all previously identified major accident hazard scenarios to be included in the top risks register.

The last approach is a mix of both consequence-based and risk-based. This approach combines the first two approaches’ strengths. However, we may end up with a higher number of top risk scenarios with this approach. In this method, higher probability events with lower severity are included in the top risks on top of the typical major accident hazard risks. Some may ask the question, why don’t we just focus on the Major Accident Hazards?

The answer is management needs and discretion. Normally MAH is regulated and acute focus is automatically given to these scenarios. However, there are some other lower severity scenarios (outside the definition of MAH) that may have a significant impact on operations or historically have a higher probability of happening that management wants to include them as their top priority risk to mitigate. In one of the operations, forest fires occurred several times outside the fence of a gas treatment plant. While fire escalation to the plant area is prevented by a safe distance of process equipment from the plant, its impact on operations is significant. Lack of visibility and smoke inhalation may impair human performance and prevent crew changes.

On another plant, diesel transfer for power generation becomes a top risk as spills and leaks during transfer had occurred more than once in the last five years. The remote operations coupled with a lack of available competent contractors caused these normally lower risks to become top risk (considering diesel is combustible, and not flammable). While the risk of spilled diesel catching fire is remote, repeated diesel leaks and spills caught the management’s attention and prompted them to monitor and control this operation more closely by including them in the top risk register.

**Tips #2 — Start from existing but revalidated PHA studies**

Top risk scenarios should be identified from existing risk assessment and PHA studies as methodology commonly used in PHA like HAZOP and HAZID allows structured identification of hazards/risks. However, one should ensure that the PHA being referred to when conducting top risk scenario identification is up to date. Any inaccuracies and mistakes...
from the existing PHA will be carried over to the top risk scenario identification. Using obsolete PHA reports will lead to major integrity issues or defects in the scenario list.

Equipment may have been modified, operating conditions changed, or collective organisation competency on a task improved or reduced. This may render the identified top risks, including major accident hazard scenarios, invalid. Instead of jumping into top risk and major accident hazard scenario identification, it is more prudent to spend the resource to ensure all process safety information, risk assessments, and process hazard analysis are up-to-date first.

Tip #3 — Conduct quality control to ensure the list focuses only on top risks

Even when we have a clear and approved top risk criteria, we should still conduct quality control on the screened list. As we screen the top risk scenario from existing PHA and risk assessment reports, the quality of the list to a certain level depends on the quality of the report being screened.

In one experience, an engineer made a list of top risk scenarios where 90% of the top risk scenarios involved an operational error of valves that are not normally operated (e.g., locked closed drain valves to closed drain where liquid levels are normally controlled by a separate control valve). Not only were these scenarios not high-risk scenarios (competent operators will not operate something that is not needed to be operated), but they were also not valid PHA scenarios based on the company’s PHA practices.

Not-normally operated and locked closed valves in a continuous plant (non-batch) are normally operated only in special operations (e.g., start-up and shutdown) which are supported by a special permit and SOP. There is no need for the operator to even go near the valve in normal operation (no other valve is required to be operated). The risks thus should be managed not through PHA but rather through task or job risk assessment.

We still need to conduct “data/scenario cleaning” on the screened scenario. Not all PHA scenarios are valid, some may have errors. Some scenarios may be developed based on incorrect or obsolete information. Some PHA reports may have a gap in quality and integrity. Take a hard look at the initial screening result to ensure that only truly “top” risk scenarios are registered/screened.

Tip #4 — Follow up with risk communication and treatment

The last tip is arguably one of the most important steps of top risk scenario identification. It is to follow up the risk scenario identification with risk communication and risk treatment. Having a list of the top 10 or 20 risk scenarios will not help an organisation manage their risk better if the risks are not communicated to the workers and any recommendations are not appropriately followed up.

One method of top risk scenario communication that is now gaining a lot of interest is the use of bowtie diagrams. Bowtie helps communicate complex risk scenarios with a simple diagram. The bowtie should not be overly complicated if it is to be effective, and some training may need to be provided to the frontline team on how to read these diagrams before being rolled out and posted in a strategically located place.

Conclusion

Top risk scenario identification is now quite a common practice in major hazard facilities. Organisations screen their PHA results for major accident hazard scenarios and other higher risks scenarios to allow them to focus on these higher risks and bring them to the attention of senior management who are accountable to manage and reduce the risk to tolerable/acceptable risk. While it is not a complex task, the process requires proper procedure and planning.

Among many best practices, ensuring that the team has clear screening criteria, ensuring that only updated PHA and risk assessment reports are used, having a process to do a quality check of the initial screening product, and following up with risk communication and treatment is key to a successful top risk scenario identification.

References