An Introduction to Risk Management

by Ir. Razmahwata bin Mohd. Razalli

RISK management is an issue that affects all aspects of life. There is a general idea of what risk entails, what activities and assets are 'risky', and a desire to achieve acceptable levels of risk. In the engineering sphere, the definition of risk is a little more precise, so that comparisons of risk against a common scale are possible, and quantitative assessments may be made. This allows for the comparison of the various risks that are present as well as to determine the efforts required to reduce risks to acceptable levels.

The chemical process industry (CPI), particularly the oil and gas industry, has experienced several unfortunate major events, which have contributed to a negative image of the CPI in terms of the level of risk. One such event was the 6 July 1988 Piper Alpha incident, which resulted in 167 deaths and 10% loss in the North Sea oil and gas production. It is the worst offshore oil disaster in terms of lives lost, and had a major impact on the safety standards of the offshore petroleum industry.

Another incident was the Exxon Valdez oil spill on 24 March 1989 where between 260,000 and 750,000 barrels (41,000m^3 to 119,000m^3) of crude oil was spilt. A more recent accident was the Deepwater Horizon oil spill, also known as the Gulf of Mexico oil spill or the BP oil spill. It is the largest accidental marine oil spill in the history of the petroleum industry.

RISK

Risk can be defined as the 'combination of the frequency of occurrences of harm, and the severity of that harm'. Another way of defining it is as the 'product of the probability or likelihood of a hazard resulting in an adverse event, times the severity of the event'. Based on these definitions, there is an interaction between the severity of an event and the likelihood of the occurrence of the event. 'Low' and 'high risk' are considered a qualitative assessment of a risk. A low risk scenario may involve a very severe outcome (*e.g.* multiple fatalities, significant environmental impact), but a very low frequency of occurrence.

Various tools are used to depict risk and assist in the risk management decision-making process. Among the common methods is the use of a risk matrix. Severity of harm is shown on one axis, and likelihood of the harm's occurrence is depicted on the other. The matrix can be coloured to indicate the different risk levels of high, medium and low (see Figure 1).

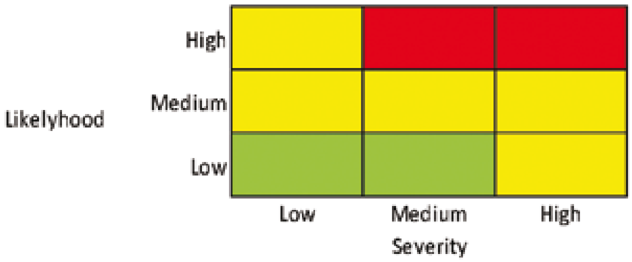

Figure 1: A sample of a risk assessment matrix

A sample data used to define risk is shown in Figure 2. In this case, the frequency (fatalities per 10,000 vehicles) and the severity (fatality) are used to determine whether the activity meets the definition of acceptable risk (*i.e.* a maximum number of fatalities per 10,000). Note that the graph does not define what is an acceptable risk, *i.e.* what number of fatalities is acceptable.

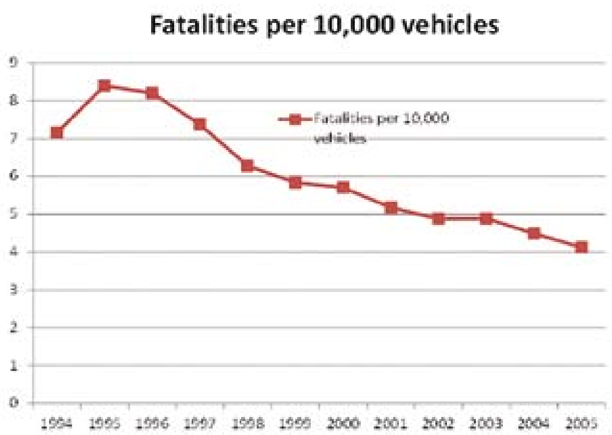

Figure 2: Road fatalities per 10,000 vehicles

(Source: Overview of Current Road Safety Situation in Malaysia, En. Mohd. Nizam bin Mustafa, Highway Planning Unit, Road Safety Section, Ministry of Works)

The definition of risk is related to the definition of safety, which is 'freedom from unacceptable risk'. Unacceptable risk is defined by the project stakeholders, either encompassed in a definitive statement (cost to reduce the occurrence of a fatality is set at a maximum limit) or a quantitative comparison (risks must be lower than a certain level of tolerance).

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RISK MANAGEMENT

Risk management is the identification, assessment and prioritisation of, followed by the coordination and economical application of resources to minimise, monitor and control the probability and/or impact of the occurrence of harm. Therefore, risk management focuses on the risks inherent in an activity or an asset, and takes appropriate countermeasures so that the risk becomes acceptable.

Risk management should be implemented in a logical manner. Humans have a tendency to perceive recent occurrences as having a higher risk now than before the accident occurred. Those responsible for risk management should be aware that even though there is a requirement to take action in response to an accident, a proper analysis (cost-benefit screening for instance), needs to be conducted to ensure the extensiveness of the response is tempered in light of the benefits obtained, and the desired risk reduction is achieved without implementing excessive measures.

Risk management should not be taken in isolation. It should be an integral part of the design philosophy. In the oil and gas industry, it is engrained in the engineer's methodology to manage risks as part of the engineering process. At the design stage, documents such as the API RP 14C (Recommended Practice for Analysis, Design, Installation and Testing of Basic Surface Safety Systems for Offshore Production Platforms) and API 521 (Pressure-relieving and Depressuring Systems) are referred to. These documents will provide guidance as to what measures should be in place to achieve the minimum acceptable levels of risk.

In addressing safety issues, the consequences of risks are typically broken down into various categories, for example, safety, environmental impact, public relations, commercial and financial. Each consequence is evaluated according to the appropriate category. Each category may have a different weighting, which subsequently determines the suitable response to address the risk. For example, every risk consequence identified in the environmental impact category will have to be reduced, whereas risks in the commercial category will only be addressed if their risk ranking is categorised as 'medium' or 'high'.

Milestones and deliverables should be included in the project to address risk management. One example would be the production of a safety philosophy document at the start of the engineering phase, defining the approach that will be taken for risk mitigation. The document provides guidance when a hardware approach to risk management is applicable, and it will recommend procedural methods in a case where a hardware implementation would be economically unreasonable. Another document that may be considered is the Safety Memorandum and Process Safety Flow Scheme (PFSF). This document is used as a record for specific safety concerns related to instrumentation and devices. Formal safety reviews may be conducted at appropriate stages of the design, thus facilitating a forum for discussion.

Engineering addresses risk management by either eliminating the cause or mitigating the severity of the risk. Elimination attempts to reduce the frequency of harmful occurrences to zero. One such method can be encapsulated in the title of a paper written by Trevor Kletz 'What you don't have, can't leak'. For example, if a design can be improved such that a required hazardous substance, such as a reaction intermediate product, does not have to be present in significant quantities, then risks associated with that product can be reduced if not eliminated. It is worth noting that this idea has been introduced following the Flixborough disaster on 1 June 1974.

Another application of the 'elimination' strategy is that if the storage of materials is required, eliminate the risk of accident by isolating the storage site far away from people. This principal could have been applied to the 19 November 1894 San Juanico disaster, where the town was allowed to be built around a liquid petroleum gas (LPG) terminal.

Mitigating a risk involves reducing the severity of harm. In most cases, mitigation methods favourably reduce the occurrence of that harm as well. One example would be the installation of isolation systems that could limit the magnitude of a chemical release if the process was breached, causing a leak or a rupture. The isolation systems would assist in limiting the inventory accessible to the breach point, preventing a larger amount of substance to be spilled, or in the case of hydrocarbons, decreasing the probability for the substance to reach an ignition source and escalating the leak into a fire scenario.

Another example would be the application of a firewater or fire fighting system to reduce the severity of a fire. A properly designed system would provide cooling facilities for unit operations that were on fire to prevent further mechanical failure, as well as prevent the escalation of the event by cooling adjacent units that may be damaged or ignited due to the ongoing event.

CONCLUSION

Risk management in engineering is an integral part of the process, to deliver a product that does not expose workers, the environment and the public at large to unacceptable risks. An understanding and appreciation of risks needs to be incorporated into the engineering exercise. A good balance between capital expenditure against benefits gained from risk reduction is required, to allow for an optimum return on investment. ■

ERRATA

The Editorial Board would like to apologise to the author, Ir. Lee Boon Chong, for publishing the wrong version of the forum "Talk on Project Learning for Sustainable Innovativeness and Competitive Advantage" in the May issue of the Bulletin.