FEATURE

A Taste of Quantitative Risk Assessment

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QUANTITATIVE Risk Assessment (QRA) is a technique to quantify the risk to personnel within and without an asset or facility. For Malaysian upstream oil & gas activities, facilities are remotely located without adjoining third party assets. So QRA tends to focus on the risk to personnel present at the facilities. An example of the objective of such a work is to:

1. Provide a numerical estimate of the Individual Risk per Annum (IRPA) for the various personnel categories at the facilities
2. Provide a numerical estimate of the combined Potential Loss of Life (PLL) per year on the respective facilities
3. Identify and rank the key risk contributors to personnel working on these facilities
4. Evaluate the acceptability of these risk levels against the agreed risk tolerability criteria
5. Recommend, if applicable, practical and effective measures to further tolerate the risk within As Low as Reasonably Practicable (ALARP) levels.

METHODOLOGY

Figure 1 illustrates the classical structure of a risk assessment. It is a very flexible structure and has been used to guide the application of risk assessment to many different hazardous activities. With minor changes to the wording, the structure can be used for qualitative risk assessment as well as for QRA.

The first stage is system definition, defining the installation or the activity where risks are to be analysed. The scope of work for the QRA should define the boundaries for the study, identifying which activities are included and which are excluded and which phases of the installation's life are to be addressed.

Next, hazard identification consists of a qualitative review of possible accidents that may occur, based on previous accident experience or judgement where necessary. There are several formal techniques for this which are useful in their own way to give a qualitative appreciation of the range and magnitude of hazards and to indicate appropriate mitigation measures, which may be described as hazard assessment. In a QRA, hazard identification uses similar techniques, but has a more precise purpose – selecting a list of possible failure cases that are suitable for quantitative modelling.

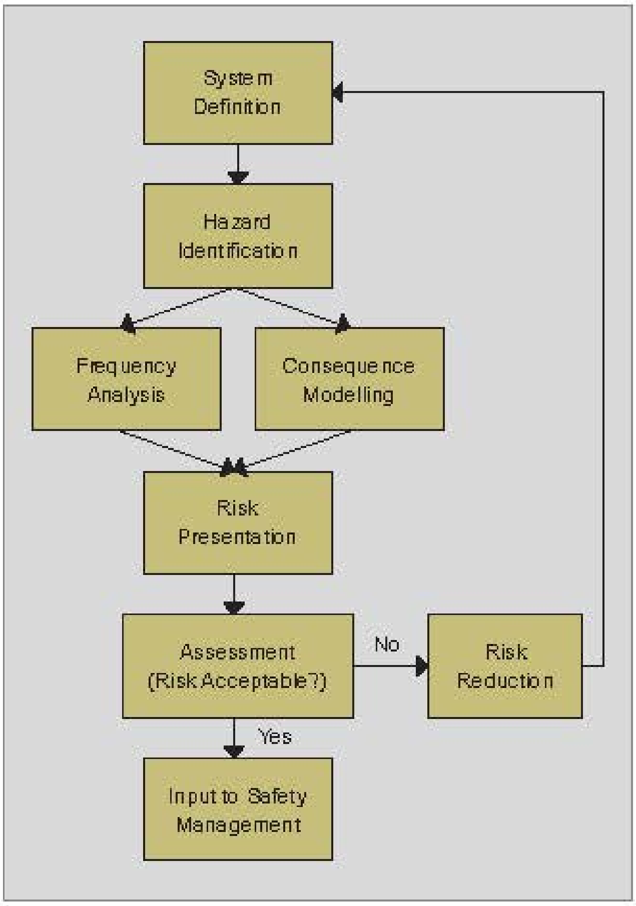


Figure 1

Once the hazards have been identified, frequency analysis estimates how likely it is for the accidents to occur. The frequencies are usually obtained from analysis of previous accident experience, or by some form of theoretical modelling.

In parallel with the frequency analysis, consequence modelling evaluates the resulting effects if the accidents occur, and their impact on personnel, equipment and structures, the environment or business. Estimation of the consequences of each possible event often requires some form of computer modelling, but may be based on accident experience or judgements if appropriate.

When the frequencies and consequences of each modelled event have been estimated, they can be combined to form measures of overall risk. Various forms of risk presentation may be used. Risk to life is often expressed in two complementary forms:

- Individual risk or risk experienced by an individual. This has previously been identified as IRPA
- Group (societal) risk or risk experienced by a group of people who are exposed to the hazard. This has been previously identified as PLL

Up to this point, the process has been purely technical, and is known as risk analysis. The next stage is to introduce criteria, which are yardsticks to indicate whether the risks are acceptable, or to make some other judgement about their significance. This step begins to introduce non-technical issues of risk acceptability and decision-making, and the process is then known as risk assessment.

In order to make the risks acceptable, risk reduction measures may be necessary. The benefits from these measures can be evaluated by repeating the QRA with them in place, thus introducing an iterative loop into the process. The economic costs of the measures can be compared with the risk benefits using cost-benefit analysis.

The result of a QRA is some form of input to the design or on-going safety management of the installation, depending on the objectives of the study.

FREQUENCY ANALYSIS

The following section provides an outline of one step of the QRA process, the frequency of topside releases. In this case, the initiating event considered loss of containment of hydrocarbons due to a leak.

ISOLATABLE SECTION

Isolatable sections define a set of interconnected equipment, piping and ancillaries that can totally discharge its contents into the environment. The set or system is isolated from other parts of the process by Emergency Shutdown Valves (ESDV). The inventory within the section and the properties of the fluid can subsequently be used to estimate consequences of the leak such as jetfire, poolfire, flashfire, explosion and/or toxic release from that section.

PARTS COUNT

Leak of hazardous materials can take place through a hole of any size, from a small hole to a large leakage along a process line or within an isolatable section. It is most likely to occur at any joint and connection along the process line, such as flanges, valves, instrument or equipment. The number of parts or equipment within an isolatable section provides a basis to determine the leak frequency from that section. The consequences and the frequencies of leak will then provide an estimate of ignited (e.g. fire and explosion) and unignited (e.g. CO_2 release) risks to personnel.

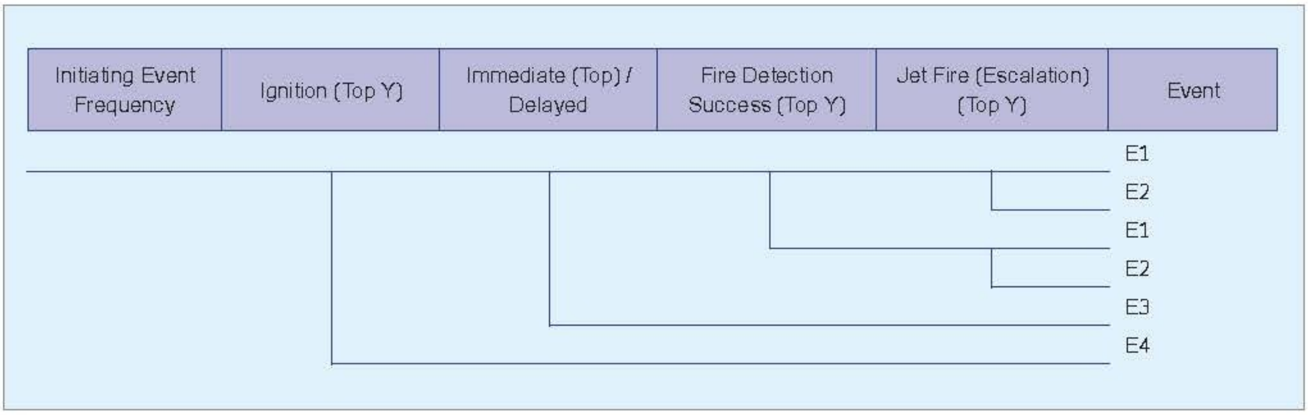
LEAK FREQUENCY DATA

Leak frequencies for defined nominal hole sizes (i.e. pinhole, small, medium and large) in each component type are identified from available databases, for example the UKHSE Hydrocarbon Release Database.

EVENT TREE

Event tree analysis is used to examine the development of an initiating event (in this case, a leak) into its possible outcomes. An example of a truncated event tree is as follows:

Table 1



The events may be classified as Jet Fire with Escalation (E1), Jet Fire Without Escalation (E2), Flash Fire (E3), No Ignition (E4). ■