3.46 Risk Assessment

Risk assessment gives a better picture of various scenarios of the plant as this also includes the consequences along with the probability of occurrence of the incidents. It is also helpful in prioritizing the risk from higher to the lower. Focus can be directed toward the events with higher risk envisaged. Risk assessment includes details about severity of the accident, probability of occurrence of the accident, and its frequency.

3.46.1 Identify and Implement Hazard Controls

Hazard control measures that already exist in the plant are identified. Additional safety measures are recommended for if the assessed risk is unacceptable or if the risk is not within the permissible limits.

3.46.2 Communicate

Information about the risk ande safety measures needs to be communicated among the workers as they have the highest potential of risk that arise from foreseen hazards. Proper training needs to be imparted about the nature of hazards, their probability of occurrence, cost implications, possible controls to mitigate the consequences and their responsibilities in risk management.

3.56 Risk Assessment and Management

Risk is based on probability of occurrence and the severity of accidents. It depends on the hazards present in the industry. Hazard is a physical or a chemical condition that has the potential to cause damage to people and environment. Hazards lead to risks. Risk can be assessed either quantitatively or qualitatively. Risk can be quantitatively defined by the product of probability of occurrence of event and its severity. But the calculation of risk is very difficult and if the probability of event is known it is not necessary that the severity has to be known and vice versa. There are many factors that add to this complexity as safety, cost, schedule, technical, and geo-physical conditions. Most of the decisions include one or more of these to be considered. An important part of risk management is deciding which types of risk to assess and how they should be compared to take decisions.

3.57 Probabilistic Risk Assessment

Probabilistic Risk Assessment (PRA) is a quantitative procedure to measure technical risks. This procedure includes identifying hazards and their initiating events, identifying mitigating safety measures, tracing possible chains of events, quantifying all individual probabilities, and severities to calculate risk. The probabilistic risk analysis is done through reliability analysis. Reliability is preventing the system from failure; therefore it is related to risk. When the system becomes complex, it is very difficult to account for various combinations of failures. Therefore, methods like fault tree and event tree are developed to facilitate such analysis.

3.50 Risk Picture: Definitions and Characteristics

According to the international standards, risk is defined as a combination of probability of events and their consequences. Risk is therefore a product of probability of occurrence of an undesirable event (realization of hazard) and the corresponding consequence. For a series of events that are responsible for risk, it can be expressed as a sum of the product of their probability of occurrence and consequences. This is given by:

$$R = \sum_i (p_i \cdot C_i) \tag{3.63}$$

where, p is the probability of accidents, C is the consequence of accidents. In general, in offshore industries, probability of occurrence of hazardous events is very low, but consequences are very high as they result in catastrophic accidents; this amounts to a high risk picture in offshore industries. This also necessitates to understand the fact that risk is more toward the loss and not toward the precaution of occurrence. It means that the financial component of risk, which leads to high economic loss is of major concern in offshore industries. While risk can be classified as personnel, environmental, and asset risk, personnel risk can be further subdivided into fatality risk and impairment risk. Asset risk can be subdivided into material damage risk and production delay risk.

3.43 Risk Acceptance Criteria

The risk acceptance criterion is important to compare the calculated risk of the plant with that of the acceptable limits. Different countries follow different acceptance criteria for the process industries. A brief summary of these risk criteria are shown in Table 3.8.

Table 3.8 Risk criteria in various countries (IS15656:2006)

Authority and application	Maximum tolerable risk (per year)	Negligible risk (per year)
VROM, The Netherlands (new)	1E–6	1E–8
VROM, The Netherlands (existing)	1E–5	1E–8
HSE, UK (existing hazardous industry)	1E–4	1E–6
HSE, UK (nuclear power station)	1E–5	1E–6

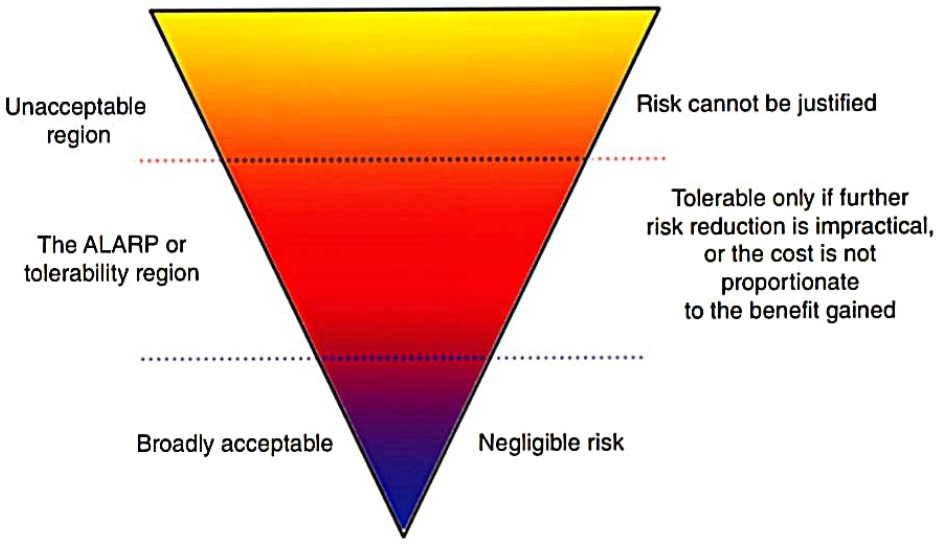

Figure 3.30 ALARP triangle

The risk acceptance criteria as per HSE, UK (for existing hazardous industry) can be expressed in form of ALARP (As Low As Reasonably Practical) triangle shown in Figure 3.30. From the figure it can be seen that the negligible risk or minimum acceptance criteria of risk is 1E-6 per year. Below this line the risk is broadly acceptable and risk is considered to be negligible. The maximum acceptable risk is 1E-4 per year. Above this risk, the risk is intolerable or unacceptable. In between is the ALARP region, in which the risk is tolerable only if further risk reduction is impractical, or the cost is not proportionate to the benefit gained.

3.37 Quantified Risk Assessment

Risk analysis can be defined as systematic identification and description of risk to personnel, environment, and equipments. Quantified Risk Assessment (QRA) therefore has to be focused on identification of applicable hazards and description of applicable risks to personnel, environment, and assets. The analytical elements of risk assessment include identifying the relevant hazards and to assess the risks arising from them. These also include identification of initiating events, causes, and consequences.

3.38 Hazard Identification (HAZID)

The identification of initiating events are generally called as HAZID. A broad review of possible hazards and sources of accidents are done initially. Critical hazards are then classified for the subsequent level of analyses. Some of the hazard identification tools employed in the industries are checklists, accident and failure statistics, HAZOP, comparison with detailed studies, and experience from previous similar projects, concepts, systems, equipment, and operations.

3.44 Hazard Assessment

Hazard assessment is carried out to prevent the work-related injury or illness to the workers. Assessing hazards deal with a careful insight of situations that could go wrong for the workers and assets in the plant. Hazard assessment is done through a series of questions that consists of what if the system fails, what if the safety valve is not working, etc.

(a) When?
Hazard assessment is done in the plant when a new work process is introduced or if there is any change in the work process or operation. Before the addition or installation of new critical equipments or the segment of the plant that has unhealthy working conditions, it is mandatory to carry out hazard assessment.

(b) How?
The hazard assessment is done through the procedures explained in the following section. All types of work and their related activities need to be identified and listed. While hazard assessment starts from this step, identifying hazardous activities among a list of operations being carried out in a process plant needs sound backing of experience.

3.45 Identify Hazards

Identifying hazards for each of the work-related activities is carried out by four methods: physical inspection, task or job hazard analysis, process analysis, and incident investigation findings.

3.45.1 Prioritizing Hazards

The high hazardous work activities that are identified need to be also prioritized. This includes preparation of incident reports, listing the severity of the incidents, data collection based on the discussion with the personnel on board, details that are borrowed from the material data sheet, data based on the incident's statistics and reports and safety audits.

Incident reports
In this section, work activities that are resulted in near-miss incidents are reported and documented.

3.48 Fatality Risk Assessment

Fatality risk assessment is one of the important elements of a quantified risk assessment. It involves a lot of uncertainties due to insufficient data available for the analysis. Therefore modeling fatalities is very complex. Ratio of fatalities to injuries in the exploration and production is about 1:1400 during the past 10 years. It is much clear that the injury statistics are more than fatalities and therefore focus has to be on reducing the injuries, which in turn will reduce the fatalities. If the fatality risk is assessed and focus on risk-reducing measures, then probably the risk of having injuries also can be reduced significantly.

3.48.1 Statistical Analysis

Statistical analysis of fatality risk is used when there exists sufficient database of accidents. Uncertainties are less extensive in a statistical analysis. Therefore, calculation of fatality risk, based on statistical analysis is often used for occupational hazards.

3.48.2 Phenomena-Based Analysis

This type of analysis includes chain of events such as cause of fire, fire loads, responses, and effects on personnel from fire loads. This approach describes the behavior of persons during a major accident. These analyses include various steps that a person has to go through in order to save his or her life in a

major accident. One of the main disadvantages of this type of analysis is that there are uncertainties involved in each step, which may lead to higher level of uncertainty in the whole analysis.

3.48.3 Averaging of FAR Values

FAR values are averaged over separate groups considered in the plant. Groups are categorized according to the departments in the plant, such as office, process, production, drilling, etc. FAR varies from one section to another, which implies that the personnel working in different sections will have different FAR levels.

Risk management is not merely a professional specialty; it's a basic human instinct. Every day, we all naturally evaluate and aim to minimize the danger to ourselves and others in a wide range of situations: crossing the street, purchasing a home, opening an email from an unfamiliar source. While risk professionals are well familiar with the core principles of risk management — risk identification, risk analysis, risk control, risk financing and claims management — they are certainly not the only ones to rely on them in their daily thinking and decision-making.

For professionals who practice formal risk management processes based on these tried-and-true principles, a periodic review can be both reinforcing and refreshing. It's also valuable for lay people to learn about the principles of risk management so they can gain a deeper understanding of why they and their organizations make the choices they do. Using an everyday example is a great way to educate people on risk management principles, so they can then apply these guidelines to real-world operational issues and situations.

#1: Risk identification

This first principle is just what it sounds like: What risks are presented to me, my organization, my customers, etc., in the scenario in front of me?

As an example, think about riding in or driving a car. You might identify the risk of having an accident due to poor maintenance of the car, failure to keep gas in the tank, speeding, or driving under the influence. Another identified risk may be the possibility of damaging property — either the car itself or someone's property. There is also a risk of financial loss if proper liability insurance is not in place or if the driver gets a speeding ticket, and so forth.

#2: Risk analysis

This stage involves gathering data and considering the meaning of the data points over a span of time. An analysis of the identified risks begs one to ask: How often could this adverse event happen (frequency)? And if it does happen, what's the worst way it could turn out (severity)?

In our car scenario, the worst that could happen is loss of life. Additional analysis may determine that the risk of being in an auto accident is low because the driver is never on the highway or only drives in good weather during daylight, on roads with speed limits of 30 miles per hour or less, in a well-maintained car, etc. The analysis part of the risk management process should take you through several what-if scenarios and help you arrive at the potential frequency and severity of an event.

#3: Risk control

Risk control offers opportunities to implement solutions that support risk avoidance, prevention and reduction. The risk avoidance technique in our car example would be not to own a car nor ride in a car. In reality, a minimal amount of risk still exists, as you could be hit by a car as a pedestrian or injured while using mass transit, but in certain scenarios, risk can be avoided completely.

Risk prevention aims to reduce the frequency or likelihood of the event or loss. This might mean preventing car breakdowns by following maintenance and inspection schedules, keeping air in the tires and gas in the tank, and following all driving laws.

#4: Risk financing

This fourth principle focuses on the economics of risk. Risk financing is a way to cover any financial losses that the implemented risk control techniques did not prevent from happening. In our example, even with all the proper maintenance on the car, safe driving, etc., an accident can still occur. By having appropriate auto insurance, funds are generated by the insurance company to pay for the loss — in this case, damage to the car.

#5: Claims management

Whereas risk financing is about managing the financial impact, claims are about managing the harm done. When a loss occurs, a claim may be filed to recover damages. In the car example, a claim may be filed with the insurance company of the driver at fault to recover for the damage that occurred. If the driver at fault was not insured, a different course of action may be necessary to hold the driver personally responsible for the damage.

5 Basic Methods for Risk Management

Avoidance

Retention

Sharing

Transferring

Loss Prevention and Reduction

Investopedia

1. Avoidance

Avoidance is a method for mitigating risk by not participating in activities that may incur injury, sickness, or death. Smoking cigarettes is an example of one such activity because avoiding it may lessen both health and financial risks.

According to the American Lung Association, smoking is the leading cause of preventable death in the U.S. and claims more than 480,000 lives per year.[1] Additionally, the U.S. Centers for Disease Control and Prevention notes that smoking is the No. 1 risk factor for getting lung cancer, and the risk only increases the longer that people smoke.[2]

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2. Retention

Retention is the acknowledgment and acceptance of a risk as a given. Usually, this accepted risk is a cost to help offset larger risks down the road, such as opting to select a lower premium health insurance plan that carries a higher deductible rate. The initial risk is the cost of having to pay more out-of-pocket medical expenses if health issues arise. If the issue becomes more serious or life-threatening, then health insurance benefits are available to cover most of the costs beyond the deductible. If the individual has no serious health issues warranting any additional medical expenses for the year, then they avoid the out-of-pocket payments, mitigating the larger risk altogether.

3. Sharing

Sharing risk is often implemented through employer-based benefits that allow the company to pay a portion of insurance premiums with the employee. In essence, this shares the risk with the company and all employees participating in the insurance benefits. The understanding is that with more participants sharing the risks, the costs of premiums should shrink proportionately. Individuals may find it in their best interest to participate in sharing the risk by choosing employer health care and life insurance plans when possible.

4. Transferring

The use of health insurance is an example of transferring risk because the financial risks associated with health care are transferred from the individual to the insurer. Insurance companies assume the financial risk in exchange for a fee known as a premium and a documented contract between the insurer and individual. The contract states all the stipulations and conditions that must be met and maintained for the insurer to take on the financial responsibility of covering the risk.

5. Loss Prevention and Reduction

This method of risk management attempts to minimize the loss, rather than completely eliminate it. While accepting the risk, it stays focused on keeping the loss contained and preventing it from spreading. An example of this in health insurance is preventative care.

Health insurers encourage preventative care visits, often free of co-pays, where members can receive annual checkups and physical examinations. Insurers understand that spotting potential health issues early on and administering preventative care can help minimize medical costs in the long run. Many health plans also provide discounts to gyms and health clubs as another means of prevention and reduction in order to keep members active and healthy.