

Hazard Identification, Risk Assessment and Control at Gas Inlet Area of Onshore Terminal

Yeshaswee Bijalwan¹ Dr. Nehal A Siddique²

^{1,2}Department of Health Safety & Environment

^{1,2}College of Engineering, University of Petroleum and Energy Studies, Dehradun, India

Abstract—'Risk' is the product of the probability that a specified undesired event will occur and the severity of the consequences of the event. To determine the 'risk' of a specific 'hazardous event' taking place therefore requires information on the likelihood of the event taking place and the severity of the adverse consequences that could be expected to follow from it. Risk is a term which combines the chance that a specified undesired event will occur and the severity of the consequences of the event. To determine the risk associated with a specific 'hazardous event', information is therefore required on the chance of the event taking place and the severity of the consequences that might be expected to follow from it. Risk is sometimes also defined as the product of probability and the severity of consequences. The Risk Assessment Matrix (RAM) is a tool designed to enable a consistent approach to qualitative risk assessment. It also establishes a common terminology to support communication about Risk throughout the Petroleum –E&P. To achieve this, the RAM shall be interpreted and used in accordance with certain fundamental principles: RAM assessment refers only to the analysis of specific risks to determine how to categorize them in RAM terms. A RAM assessment does not generate a decision about the action that should be taken in respect of any Risk or any financial or asset management issues. Consequently, a RAM assessment will always be only one step in a wider process of identification, control, mitigation or communication of Risk (HEMP-Hazards and Effects Management Process).

Key words: Gas Inlet Area of Onshore Terminal, Hazard Identification

I. INTRODUCTION

Hazard Identification and Risk Analysis (HIRA) is a collective term that encompasses all activities involved in identifying hazards and evaluating risk at facilities, throughout their life cycle, to make certain that risks to employees, the public, or the environment are consistently controlled within the organization's risk tolerance. These studies typically address three main risk questions to a level of detail commensurate with analysis objectives, life cycle stage, available information, and resources.

The three main risk questions are:

- Hazard – What can go wrong?
- Consequences – How bad could it be?
- Likelihood – How often might it happen?

When answering these questions, the objective is to perform only the level of analysis necessary to reach a decision, because insufficient analysis may lead to poor decisions and excessive analysis wastes resources.

A. Definitions

- Hazard – Potential to Cause Harm.
- Risk - Consequence X Likelihood.

It is likelihood of happening of an event, within a specified period, which triggers a hazard to release its consequences.

- Likelihood -Chance that an event will happen, expressed as number of times per year based on experience (i.e. frequency) (on a scale A to E)
- Consequence -Impact on People, Assets, Environment and Reputation if an event happens)
- Severity – Level of consequence (on a scale 0-5)

B. Scope and Application

This procedure describes the RAM and the assessment process. It illustrates the application of the RAM in a range of HSE management processes with a number of examples and FAQs.

The RAM is also applied in business strategy to assess and prioritize business risks. It is used in the asset integrity field where a number of derivative forms of the standard RAM have been developed. Non-HSE applications such as these are outside the scope of this procedure.

C. Methods

The RAM is a (6 X 5) matrix that is used for qualitative assessments of Risk and for prioritization of activities and resources. It is based on the concept of applying experience of events or incidents in the past to predict risks in the future.

- The vertical axis represents increasing Consequences (Severity levels 0 to 5) in terms of harm to people, damage to assets, effect on the environment and impact on reputation (PAER categories).
- The horizontal axis represents increasing likelihood (levels A to E) of the Consequence under consideration.
- Boxes in the matrix represent levels of Risk, increasing from top left to bottom right corners of the matrix.
- The matrix is divided into blue, yellow and red areas to illustrate the increasing level of Risk.

Severity	CONSEQUENCES				INCREASING LIKELIHOOD				
	People	Assets	Environment	Reputation	A	B	C	D	E
					Never heard of in the Industry	Heard of in the Industry	Has happened in the Organisation or more than once per year in the Industry	Has happened at the Location or more than once per year in the Organisation	Has happened more than once per year at the Location
0	No injury or health effect	No damage	No effect	No impact	Blue	Blue	Blue	Blue	Blue
1	Slight injury or health effect	Slight damage	Slight effect	Slight impact	Blue	Blue	Blue	Blue	Blue
2	Minor injury or health effect	Minor damage	Minor effect	Minor impact	Blue	Blue	Blue	Yellow	Yellow
3	Major injury or health effect	Moderate damage	Moderate effect	Moderate impact	Blue	Blue	Yellow	Yellow	Red
4	PTD or up to 3 fatalities	Major damage	Major effect	Major impact	Blue	Yellow	Yellow	Red	Red
5	More than 3 fatalities	Massive damage	Massive effect	Massive impact	Yellow	Yellow	Red	Red	Red

D. Risk Assessment Matrix

The meaning of blue, yellow and red is described in the sections on the specific applications of the RAM. In general the blue, yellow and red areas are labelled Low, Medium and High to illustrate increasing level of Risk.

E. Conducting a Risk Assessment

In order to make the Risk Assessment technique work effectively, it is necessary to look into the following:

- Define objective and scope
- Prepare for the risk assessment
- Carry out the risk assessment
- Record the results
- Follow up

1) Step1: Define Objectives and Scope of Assessment

It is essential that the objectives and scope are clearly understood by all concerned and documented and agreed before the start of the study. The definition should include, but not necessarily be limited to the following:

- Steps of works to be carried out
- Extent to which effects on and by adjacent work should be considered
- Study program including action reply and final reporting dates
- Links with other risk assessment being conducted on adjacent or related plants

2) Step 2: Identify Hazards in the Tasks/Activity/Incident

The starting point for a RAM assessment is an understanding of the Hazard in its context (activity, location etc.), or an understanding of the particular incident being considered.

Once the activity chart or process mapping has been developed and broken down, and then each task should be reviewed for the hazards in them.

There are many techniques that are well established to identify the hazards in the tasks. Some of them are as below

- “What if “technique “
- Brainstorming
- Checklist etc.

What if technique originates from the question; what could go wrong? Or what if.Should occur? It is

an exercise that visualizes every kind of failure and upsets that could happen during the task. This step requires in depth knowledge of the job as well as hazards involved in carrying out the same. This involves assuming that each part of the equipment or step of the procedure fails, in turn.

Brainstorming is done using a small group of people who are knowledgeable of the tasks. The group contributes ideas for hazards that could be present in the tasks. A Checklist is supposed to provide some procedure line to identify various hazards. Following points are to be considered during checklist preparation.

Hazards from Process:

- Pressure
- Thermal relief
- Trapped energy
- Fire
- Ejecting material
- Flammable substance
- Hot / Cold substances
- Flammable material
- Corrosive substances
- Powder or dust
- Fumes
- Asphyxiate
- Toxic material

Hazards from the location:

- Confined space
- Falling object
- Working at height
- Uneven or slippery surfaces
- Sharp edges
- Protruding objects
- Insufficient illumination
- Noise
- Radioactive sources
- Electrical machineries

Hazards from the work/tools used:

- Electrical shock
- Heavy loads
- Moving / rotating machineries
- Projectiles / particles
- Vibration
- Being caught between moving part
- Use of uncertified / untested tools

Hazards from people:

- Inadequate and improper knowledge Lack of skills
Lack of experience Poor communication Wrong assumptions
Doing action in the wrong sequence

While considering the hazards it is also to be kept in mind that who or which group at large might be harmed, including the external community.

A more detailed Hazard identification checklist can also be used for complicated jobs; also there may be more hazards specific to certain jobs and to a particular workplace, which also needs to be evaluated.

IS 17776: 2000 "Hazards and Effects Hierarchy" gives the comprehensive list of hazards (more than 400) encountered during E&P activities. This document shall be the basis to prepare detailed Hazard identification checklist for complicated jobs. Appendix-III gives the list of hazards customized on the basis of IS 17776:2000.

3) STEP 3: Identify Potential Consequences

Identify the consequences that could develop from a release of the Hazard under the prevailing conditions. Ask the question: 'What could happen if the controls don't work or they fail?'

For example, the operation of a pump in crude oil service involves the potential for a release of crude oil in the event of a pump seal failure. Some of the consequences that could result are:

- Leak of crude oil into the drain system and then into the sea.
- Ignition of the crude oil resulting in a small fire around the pump.
- Inadequate firefighting and escalation of the fire to the point where other process equipment fails and a major fire and explosion occurs.

4) Step 4: Estimate the Severity of each potential Consequence

For each of the identified consequences assess the Severity (0 - 5) in the four Consequence categories - people, assets, environment and reputation (PAER). Bottom up (Higher to lower severity.) approach shall be adapted while selecting the suitable severity class in RAM.

In the crude oil pump example above, for the consequence in which crude oil leaks from the pump seal and flows through the drain system into the sea, there could be impacts in 3 Consequence categories - asset, environment and reputation.

5) Step 5: Estimate the Likelihood

For each of the potential consequences make an estimate of the Likelihood of the Consequence in terms of the Likelihood levels A to E. Start the process of selecting the likelihood from right to left side of the RAM.

The Likelihood level should be judged from past experience, by asking the question: 'How often in the past has a hazard release resulted in a Consequence similar to the one that we are considering?' The approach is one of applying history to predict the future.

The estimate of Likelihood should be based on the Likelihood of the particular Consequence under consideration, not on the Likelihood of the Hazard being realized or incident occurring.

In the example above an estimate should be made of the likelihood of the crude oil pump seal leak

resulting in oil into the sea, not the likelihood that the pump seal will leak.

The reliability of the Likelihood estimate, and therefore of the RAM assessment, depends to a large extent on the availability of data on previous incidents and on the knowledge and experience of the assessors. It is therefore important to maintain databases of previous incidents and make them available to everyone who will be making RAM assessments.

The hazard release scenario or the incident under consideration will often not be identical to the previous incidents that are being used to predict likelihood. Also, detailed information on previous incidents outside the Organization, or even outside the Location, may not be readily available in some companies. Therefore, a combination of available information and judgment from experience has to be applied to make a best estimate of the Likelihood level A to E.

6) STEP 6: Estimate the risk rating

For each potential Consequence determine the risk rating for each of the applicable PAER categories in terms of the product of the Consequence Severity and the Likelihood. The risk ratings (up to 4 for each potential Consequence) can be plotted on the matrix to provide a visual representation of the risk profile of the hazard release scenario under consideration.

Risk ratings derived in this way reflect the controls that have typically been applied in the Location or Organization over the period for which previous incidents were used to estimate Likelihood. There is normally insufficient data on these previous incidents to allow the Likelihood estimates, and therefore the RAM ratings, to be re-estimated for the situation with additional controls in place. It is therefore recommended not to use the RAM to assess the effect of additional controls on the level of Risk. The residual risk after applying additional controls should be judged against the applicable Tolerability Criteria.

7) STEP 7: Application of the Risk Assessment

Risk assessment is an important step in a number of processes used in the Group. Each of these processes is governed by its own detailed protocols, which specify how the RAM is to be used in that context. This section outlines some of these processes, and describes how the RAM fits into them. It also indicates where to find detailed guidance on these processes. It is essential to consult the detailed guidance and not to rely on the following descriptions.

F. Hazard Control

1) Elimination

Getting rid of a hazardous job, tool, process, machine or substances perhaps the best way of protecting workers. For example, a salvage firm might decide to stop buying and cutting up scrapped bulk fuel tanks due to explosion hazard.

2) Substitution

Sometimes doing the same work in a less hazardous way is possible. For example, a hazardous chemical can be

replaced with a less hazardous one. Controls must protect workers from any new hazards that are created.

3) *Isolation*

Isolate big machines in another place.

4) *Engineering control*

- Redesign
- Isolation
- Automation
- Barriers
- Absorption
- Dilution

5) *Administrative controls*

- Safe work procedures
- Supervision and

- Job rotations
- Housekeeping, repair and maintenance programs
- Hygiene must

6) *Personal protective equipment (PPE)*

Personal protective equipment (PPE) and clothing is used when other controls measures are not feasible and where additional protection is needed. Workers must be trained to use and maintain equipment properly. The employer and workers must understand the limitations of the personal protective equipment. The employer is expected to require workers to use their equipment whenever it is needed. Care must be taken to ensure that equipment is working properly. Otherwise, PPE may endanger a workers health by providing an illusion of protection.

Hazard Identification , Risk Assesment & Control (HIRAC)									
Section/Department/Work:		Pressure Reduction System			Date		1/8/2015 to 31/8/2015		
Activity:		Operations							
Sr No.	Description of Task/ Activity	Hazards	Consequence	Risk Assessment				Risk Level H/ML	Control Measures
				P	A	E	R		
Chemical Hazards									
1	Gas flow from CRP to PRS station	Corrosion	Corroded pipe may leak natural gas which can lead to Fire.	5 B	5 B	3 C	2 C	Medium	1)Low Temperature Carbon Steel Used 2)Periodic Maintenance 3)corosion monitoring 4)Inspection-thickness survey.
Physical Hazards									
2	Working at Height	Fall from height	Personal Injury	4 C	2 C	0 A	1 B	Medium	1)Fall Protection requirements Safety Harness must be used when working at height $\geq 2m$ 2)Certified work platform provided for all work at height activities. 3)Lowering / Rising materials by rope and hand line. 4)Good House Keeping maintained at elevated. 5)Training provided for persons working at height. 6)Tool box Talk conducted before execution of work 7)Enclosed below perimeter with warning barricades. 8)Spaad sheets are provided to avoid falling tools through the gaps. 9)Safety harness is inspected and certified by competent person certified by factories.

3	Manual Handling & Lifting	Back Strains or injuries. Musculoskeletal pains.	Personal Injury	4 C	1 B	0 A	1 A	Medium	<p>1) Proper lifting techniques are observed. Ex: back straight, bend knees loads close to the body, firm grip.</p> <p>2) Buddy system on handling heavy loads.</p> <p>3) Proper lifting plans are adopted.</p> <p>4) Carrying heavy weight firmly without bending or twisting.</p> <p>5) Lifting tools, chain pulley blocks and D shackles are inspected, certified and colour coded each quarterly.</p>
4	Hot work includes welding, cutting & grinding	<p>1) Explosion due to presence of flammable vapours, materials or hydrocarbons.</p> <p>2) welding arc rays or flying grinding sparks.</p> <p>3) welding fumes.</p>	<p>1) Fire</p> <p>2) Personal Injury</p> <p>3) Occupational Health effects</p> <p>4) Eye strains or Eye injuries</p> <p>5) electrocution</p>	5 B	5 B	3 C	2 C	Medium	<p>1) Zero percent flammable vapours are ensured with the help of calibrated portable gas detectors.</p> <p>2) Combustible materials are removed from the area.</p> <p>3) Eye Protection Mask, Glasses or goggles, face shields are provided.</p> <p>4) Fire Blankets are provided properly & adequately to contain all sparks within the work area.</p> <p>5) All the gas cylinders are kept in vertical position and caps on the valves are used when not in use.</p> <p>6) All oxy-acetylene cylinders are fitted with approved regulators gauges & Flash back arrestors.</p> <p>7) Welding machines frames/body are properly grounded.</p>
		<p>4) Electricity</p> <p>5) Injury caused by grinding wheel.</p>	<p>6) Burns: 1st degree, 2nd degree or 3rd degree burns.</p> <p>7) Personal Injury</p>						<p>8) Oxy acetylene machines are kept away from welding and cutting operations.</p> <p>9) Only certified welders are performing welding job.</p> <p>10) Fire extinguishers are provided in the working booths.</p> <p>11) RPE's are provided and worn.</p> <p>13) Defective tools are eliminated.</p> <p>14) During grinding operation right disc is used for right job.</p> <p>15) Grinding disc comply with the rating standards of the grinder.</p> <p>16) Roof of the welding booths are hooked properly</p> <p>17) Hot Work permit</p>

ERGONOMICAL HAZARDS									
12	Workspace	Back Strains or injuries. Musculoskeletal pains.	Personal Injury	2 D	0 A	0 A	0 A	Medium	1)Job Rotation 2)Work space design
13	Physically Demanding Task	Back Strains or injuries. Musculoskeletal pains.	Personal Injury	2 D	0 A	0 A	0 A	Medium	1) <u>Torquing</u> machine for tightening of bolts
15	Long / Irregular working hours	Back Strains or injuries. Musculoskeletal pains.	Personal Injury	2 D	0 A	0 A	0 A	Medium	1)Job Rotation 2)Regular intervals between work hours
16	Poor <u>organisation</u> and job design	Back Strains or injuries. Musculoskeletal pains.	Personal Injury	3 C	3 C	0 A	2 C	Medium	1)Work space design
PRESSURE									
17		Gas under Pressure	Personal Injury due to projectile	2 C	0 A	0 A	0 A	Medium	1) Pressure Safety Valve is used 2) <u>Pressure</u> Control Valves are used 3) <u>Hydrotesting</u> 4) <u>Thickness</u> <u>Suvey</u> 5)DCS Monitoring. 6) <u>Caution</u> Boards. 7) Restricted Entry.
18		Liquid under Pressure	Cold Burns Spillage Pool Fire Fatality / Personal Injury	4 C	2 C	0 A	2 C	Medium	1) Pressure Safety Valve are used 2) Pressure Control Valves are used 3) <u>DCS</u> Monitoring 4) PPE (<u>cyrogenic</u> gloves) are used for cold burns 5) <u>Hydrotesting</u> . 6) Restricted entry. 7) Thickness survey. 8) <u>Caution</u> boards.

II. CONCLUSION

Hazard identification and risk assessment and control are ongoing processes. Make sure to undertake a risk assessment and control process at the proper time and place so as to control the workplace, making it safe for all who enter.

REFERENCES

- [1] "Orientation programs manual of onshore processing operations".
- [2] "Hazard effective registers".
- [3] Hazard Identification and Risk assessment sheets.
- [4] http://fbme.utm.my/wp-content/uploads/2014/01/ve_gl_hirarc.pdf
- [5] <http://group.ril.com>
- [6] Shell Risk Assessment Matrix