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Qra Results Used To Review Escape Evacuation And Rescue (Eer) Arrangements

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Abstract

The abstract summarizes use of QRA results to develop the Escape, Evacuation and Rescue Arrangement in gas processing facility. The Gas processing facilities are considered as major accident hazard industry and the legal system compels the operator to conduct various HSE studies in order to demonstrate the risk in operating the plan as ALARP.
This research paper detailing the approach to use the QRA results to verify the existing EER arrangements are not impacted by any of the major scenarios and to establish the safe EER arrangement in case needed.

Keywords: *Consequence, Frequency, EERA, Assembly point, refuges, and Assessment.*

1. Introduction

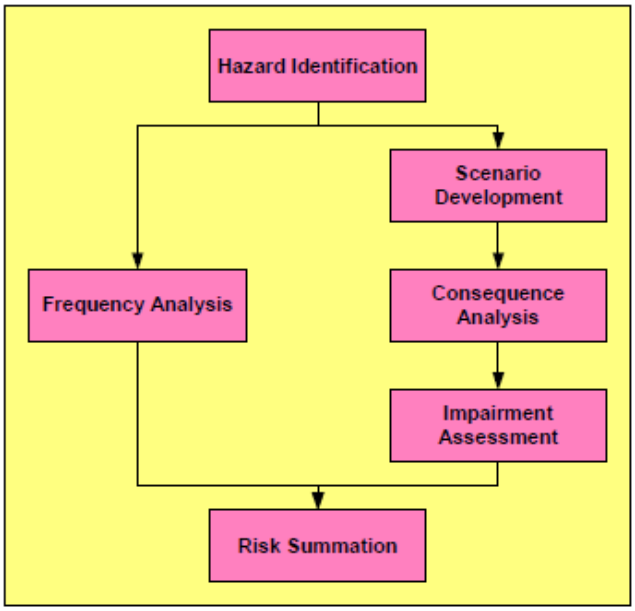
Qualitative Risk Assessment is common approach in the Gas processing plants to determine the risk associated in operating the plant. The operation of the gas processing plants includes drawing high sour gases from well under higher pressure, transporting them through pipelines to the receiving facility. In gas processing plant the Sulphur has extracted out from the process fluids using absorption technology and during this time the concentration may reach more than 69 to 80% (remember H_2S TLV-TWA is 5 ppm and STEL is 10PPM) which for more than the IDLH value of H_2S.
In terms of designing the plant designer usually consider high reliable materials and equipment, but the most common issues are the leaks happening in flanges and pump/compressor seals and exposure of toxic gas during plant maintenance and shut down periods.
Therefore, reviewing the EER arrangements putting a high priority and proactive approach before operate the gas plants.

2. Purpose of Qualitative Risk Assessment

The main purpose of oil and gas operators are conducting the QRA is for;

- Identify and quantify hazards and risks related to the transport, use and storage of hazardous materials;
- Determine hazards/risks due to possible accident scenarios which will lead to fire, explosion or toxic release;
- Recommend measures to be incorporated in the design and operation of the plant to keep hazards/risks to as low a level as practical;
- Facilitate the development of emergency response plans to deal with all possible accident scenarios.

As the QRA purpose is clearly stating in their last actions is to develop emergency response plans. In addition to that as proactive approach the QRA results will be used to verify your EER arrangements are in safe position and if needed re-align the EER arrangements based on the QRA results.



Technical Approach
The QRA provides enormous results based on the number of equipment, flange joints and piping lengths. Recent years many proprietary softwares are available in the

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market (e.g. DNV's PHAST, SHELL Sheperd and etc). these softwares provides results in terms of consequence distances for various leak size and frequency of leaks from world wide data bases.

In order to consider the results, initial approach is to first setting up the base line assumptions that are required and those are;

1. What are the credible major accident scenarios to be considered?
2. What are the hole size to be counted for Emergency response?
3. What frequency of major accident events are to be taken into the account?

The above can be answered on case by case basis, some one considers all leaks to be considered to be evaluated and scenario to be developed, but in this paper author consider 25mm leak is credible size due to the frequency of the leaks are also considerably high compared to a 100 mm or rupture case.

The credible scenarios needs to be considered for the gas processing plant are;

- Flammable gas dispersion
- Toxic gas dispersion
- Jet fire
- Explosion

The Major Accident Event frequency 1 event in 10000 years i.e 10^{-4}.

And the assessment of the EER arrangements are based on the below human vulnerability values for various events.

Exposure	Level	Effect
Heat radiation due to fire (flash fire/pool fire/jet fire/fire ball/BLEVE)	6.0 KW/m$^{2(note1)}$	Impairment of escape routes and for human pain within approximately 10 seconds; rapid escape only is possible.
Flammable vapor cloud	0.5 LFL[1]	Flash fire which can impact the personnel within the engulfed region
Explosion over pressure	0.15 bar	Level considered capable for impairing outdoor muster points
Hydrogen Sulphide	100 ppm (IDLH)[2] 10 ppm	Escape is possible within 30 minutes without any escape –impairing symptoms or irreversible health effects. STEL - Alarm level escape

1. OGP, Human valunerability creteria
2. IDLH- Immediate Danager to Life or Health

The above human vulnerability creterias are used to assess EER arrangement against the QRA consequence distnaces. In addition to that the toxic effects are measured using probit values. The fatality rate from toxic impact of H2S is calculated using the probit.

Pr = - 10.87 + 1.0 LN(C1.9 * t)

Where:

Pr: Probit number

C: H2S concentration in ppm t: exposure duration in minutes

Sample Assessment

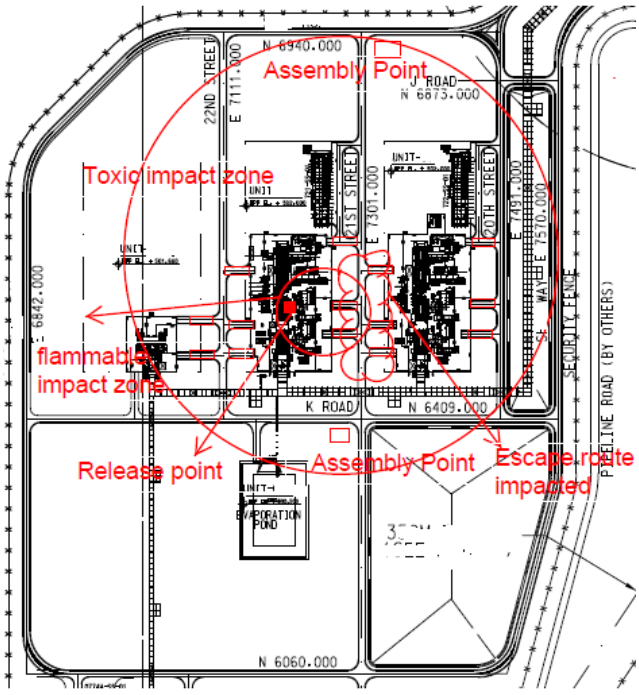
Below table depicts the consequence distances derived from QRA for 25mm leak and rupture case.

Location 1

EER arrangement	Hole size (mm)	Jet fire 6 kw/m^2	Flash fire .5 LFL	Explosion	Toxic H_2S 1% fatality
Assembly point	25	40 mtr	41 mtr	Not credible	955 mtr
	Rupture	261 mtr	536 mtr	356 mtr	6300 mtr

Using the results in a plot plan of a particular plant to review the existing EER arrangements e.g. Assembly point, Escape Routes, Refuges etc.

The results are plotted in an example plant layout as shown below.



By plotting the results on the layout plans for two different leaks for all the consequences, one can decide which escape way is not impaired and existing assembly points are safe are do we need to relocate?, finally an EER

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assessment table cane be developed for different scenarios as below;

Assembly Points– Summary of Impairment Assessment Results

Assembly Point	Hole Size (mm)	Jet Fire	FF	Explosion	Toxics
		6.3 kW/m²	50% LFL	(0.15 bar)	H_2S (10ppm)
North East	25			N.A*	
	Rupture				
South East	25			N.A*	
	Rupture				
No assembly point provided					

Legend:

	No Impairment
	Impairment due to worst case credible release – 25 mm hole size
	Impairment due to worst case catastrophic release – 150 mm hole size

With same approach one can assess the all other EER facilities and arrangement in plant facilities. With this kind of exercise and assessment for all the plant areas, final result can be production of an updated version of EER layout plans. Based on the new EER layouts, the Facility response plan has to be updated.

Results

By reviewing the consequence results and plotting on the layouts, it is evident that existing assembly point is affected on rupture sized leaks not on the 25mm leaks, but on 25mm leak the assembly point gets impacted on the toxic gas leak. Therefore this method provides a confirmation of the EER arrangements are in safe location by seeing it visually, in addition to that any Organization can develop their escape routes and by considering the wind direction.

The review of the EER arrangements includes provision of safety equipment e.g. cartridge masks and escape sets, in this study the requirement could be use of escape breathing apparatus to be worn by the personnel to escape from the location to assembly point.

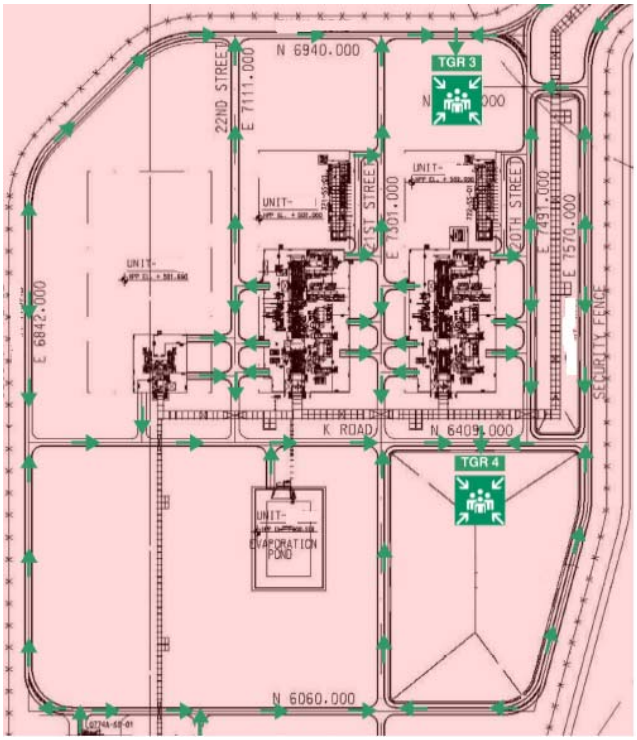
The assembly point seems to be open type, due to the toxic dispersion effect this Assembly point could be not useable during the toxic release case, therefore it needs to be closed type or moved to safer place e.g. toxic gas refuges (explosion protected, breathing air provision for "n" number of people).

In the event decision to be made to move the assembly point, the personnel walking distance needs to be considered (e.g. walking speed 1m/s for the plain surface and 0.8 m/s for stair case and structures).

After all the analysis has been done, Organization could be able to develop their Escape way routes as new layouts.

7. Conclusions

It is essential to consider QRA results for assessing EER arrangements in hydro carbon processing facility where the number of major accident events existence is high and develop scenarios for preparing Emergency response plans.



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