



Preventing Catastrophic Incidents in Chemical Process Industries with Help of Process Hazard Analysis-Experiment on Hydrogen Manufacturing Unit of Petroleum Refinery

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Abstract: The chemical process industry is subject to various federal and local regulations and requirements that are challenging to meet and resource intensive. Time and human factors often lead to a "Check Box" mentality where requirements are fully complied with "On Paper" with little or no emphases on quality of compliance. Occupational Safety and Health Administration's (OSHA) Process Safety Management (PSM) requirements are often exposed to this "check box" mentality, especially the Process Hazard Analysis (PHA) element which is the engine that drives and affects the whole PSM program. Poor implementation of PHA affects mechanical integrity, operating procedures, training, and emergency response; and is considered a root cause of most major incidents. Unfortunately, poor quality PHAs are widespread, hard to identify and can be more dangerous than conducting no PHA at all since it may provide a false sense of safety. Unfortunately, existing literature as well as recognized and generally accepted good engineering practices (RAGAGEP) do not provide sufficient guidelines for assessing PHA quality. The guidelines proposed in this thesis help in properly auditing PHA studies by identifying traps and bad practices that most companies fall into when performing PHAs. Hydrogen is widely produced and used in the process industries with growing use in the public domain. While the former area of focus would obviously necessitate process safety considerations, the latter involves activities such as transportation in which occupational safety issues for individuals are paramount. The current research addresses this issue by identifying several areas of application in the hydrogen economy for three key process safety concepts: (i) inherently safer design, (ii) safety management systems, and (iii) the use of case studies. This study thus illustrates, by means of referenced examples, the transferable nature of key process safety concepts to various features of the emerging hydrogen economy. The primary thesis of this work is the notion that inherently safety design principles, Process Hazard Analysis Techniques, safety management systems, and lessons learned from case histories have broader implications for safety than would be apparent by restricting their use solely to the process industries.

Keywords: Preventing Catastrophic Incidents

I. INTRODUCTION

Most accidents occur because we do not know how to prevent them but because we do not use the information that is available. The recommendations made after an accident are forgotten when the people involved have left the plant; the procedures they introduced are allowed to lapse, the equipment they installed is no longer used, and the accident happens again. It is vital to assess the process and the risks involved properly to prevent incidents occurring in any Process facility. A Process Hazard Analysis (PHA) is one of the most important elements of the Process Safety Management (PSM) Program. A PHA is an organized and systematic effort to identify and analyze the significance of potential hazards associated with the processing or handling of highly hazardous chemicals. The PHA analyzes the potential causes and consequences of fires, explosions and releases of toxic chemicals; and the equipment, instrumentation, human actions and other factors which might affect the process. The PSM Rule allows the use of several PHA methods. Most accidents do not occur because we do not know how to prevent them but because we do not use the information that is available. The recommendations made

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after an accident are forgotten when the people involved have left the plant; the procedures they introduced are allowed to lapse, the equipment they installed is no longer used, and the accident happens again. It is vital to assess the process and the risks involved properly to prevent incidents occurring in any Process facility. The Process Hazard Analysis (PHA) is a systematic approach for identifying, evaluating, and controlling the hazards of processes involving highly hazardous chemicals. It focuses on equipment, instrumentation, utilities, human actions, and external factors that might impact the process.

The organization must be performing an initial Process Hazard Analysis (hazard evaluation) on all processes covered by this standard. The process hazard analysis methodology selected must be appropriate to the complexity of the process and must identify, evaluate, and control the hazards involved in the process.



II. LITERATURE REVIEW

As a result of this constant conflict between safety and short-term financial goals, most literature available contains guidelines backed up by existing regulations. The issue is that most regulations are reactive, governmental, and/or legislative responses to major incidents or catastrophes. Thus, these regulations are not always comprehensive. Moderate or minor incidents do not always trigger a new regulation to control the risk, even if it had the potential to have much higher consequences. Another reason why regulations may not always be comprehensive is that creating a regulation requires enormous resources to ensure proper monitoring and enforcement, especially when a regulation applies to a whole country with small and big businesses. So, it may not always be practical to create a regulation. Therefore, the majority of PHA auditing knowhow exists in the form of company internal processes/procedures, or is embedded into the minds of experienced employees who do not always have the time to document or publish their knowledge. In addition, due to the qualitative nature of most of the available risk assessment techniques, PHAs prove to be often elusive and difficult to audit. Expansive than the natural expansive soil in its original state, before addition of the chemical stabilizers (Hunter 1988). Hence, in soils containing soluble sulfates, physical stabilization techniques may be more appropriate than chemical stabilization methods. A good example of risk assessment auditing guidelines resource which is based on existing regulations is the Guidelines for Auditing PSM Systems developed by the Center for Chemical Process Safety (CCPS). In this study contains guidelines on auditing Hazard Identification and Risk Analysis studies, mostly includes guidelines based on federal regulations such as OSHA and EPA regulations for PSM and RMP, respectively. Their developed guidelines do also incorporate state regulations such as New Jersey, California, and Delaware as well. However, they are not comprehensive enough and they do not focus on quality of implementation of PHA. They do give guidelines for auditing the overall performance of the PHA element implementation. For example, this resource does not adequately address the experience

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validation requirements of PHA team members and other sources of variance such as the inaccurate assessment of risk.

III. HAZARD EVALUATION

There are also requirements within legislation such as in the MSIHC Rules, PNGRB Rules, etc. requiring those companies handling hazardous materials to have in place an adequate Safety Management System (SMS) and to fulfil specified obligations. These requirements range from the preparation of Major Accident Prevention Policies to submission of detailed safety reports to a competent authority. IS 15656 (2006) Code of Practice gives detailed guidance on Hazard Identification and Risk Analysis for use in the Indian Industry. The OSHA regulation 29CFR 1910.119, for Process Safety Management in the USA mentions PHA as an integral element of such systems, advocating systematic techniques for the identification of hazards.

- Study 1: Concept Stage Hazard Review
- Study 2: FEED/Project Definition
- Study 3: Detailed Design Hazard Study
- Study 4: Construction Design Verification
- Study 5: Pre-Commissioning Safety Review
- Study 6: Project Closeout / Post Start-up Safety Review.

IV. SELECTION OF TECHNIQUES

A successful hazard evaluation program requires tangible management support; sufficient, technically competent people (some of whom must be trained to use the hazard evaluation techniques); adequate, up-to-date information and drawings; and selection of the techniques (matched to the complexity and hazard of the process). Fortunately, a variety of flexible hazard evaluation techniques exist. Below is a simple listing of generally accepted techniques:

4.1 Qualitative Techniques

- Preliminary Hazard Analysis (PreHA)
- Checklist
- What-If Analysis
- What-If/Checklist Analysis
- 2 Guide Word Analysis
- Hazard and Operability (HAZOP) Analysis
- Failure Modes and Effects Analysis (FMEA)

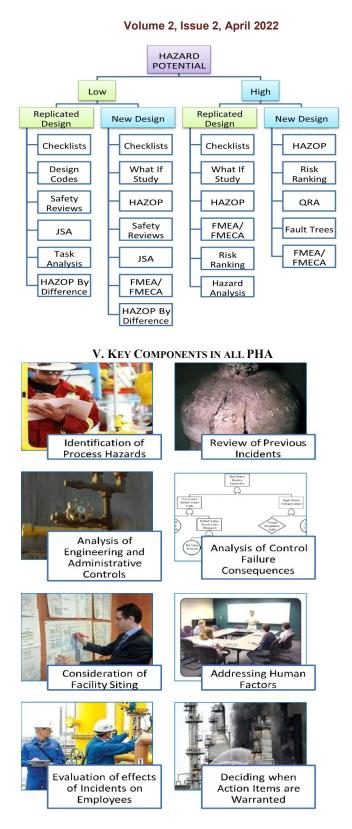
4.2 Quantitative Techniques

- Layer of Protection Analysis (LOPA)
- Dow Fire and Explosion Index (F&EI)
- Dow Chemical Exposure Index (CEI)
- Fault Tree Analysis (FTA)
- Event Tree Analysis (ETA)
- Human Reliability Analysis (HRA)

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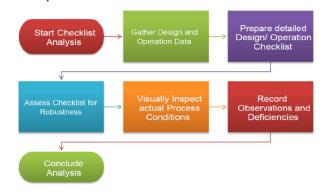


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5.1 PHA Methods

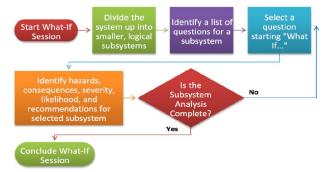
A. Checklist Analysis

A checklist analysis is used to verify the status of a system. The checklist analysis method is versatile, easy to use and can be applied at any stage in the life of a process.



B. What-If Analysis

The purpose of a what-if analysis is to identify hazards, hazardous situations, or specific accident events that could produce an undesirable consequence. This analysis comprises experienced personnel brainstorming a series of questions, which begin with "What if...?". Each question represents a potential failure in the facility or mis-operation of the facility



C. HAZOP Studies

HAZOP Study is a technique used to identify the potential hazards and operational problems critical to the plant design/ operational integrity, and assess the risks posed.

A Establishing requirement HAZOP Coordinator (Process Engineer)	Selection of HAZOP Leader Team Formation Scheduling HAZOP Study	Finalizing HAZOP Scope with Leader Gather updated information - P&IDs, etc.	Node segregation - Listing and Color Markup of Nodes Fill Checklist of HAZOP Study Pre- requisites (Refer Annexure-3)	HAZOP Study
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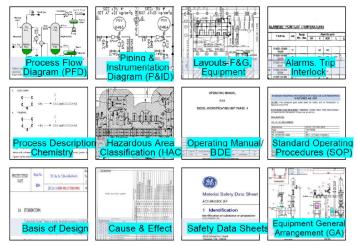
The basic concept behind HAZOP studies is that processes work well when operating under design conditions. When deviations from the process design conditions occur, operability problems and accidents can occur. A HAZOP Analysis addresses hazards and proble ms affecting operability. The HAZOP study method uses guidewords to ask questions about any potential deviation to the mode of operation, evaluating the related Causes and Consequences.



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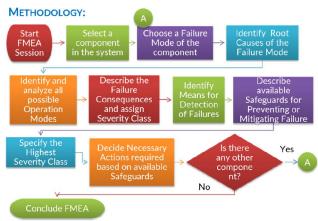


Essential documentation Required for HAZOP



D. Failure Modes and Effects Analysis (FMEA)

FMEA is a technique used to identify hazards/ ways in which a component/ system can fail to perform their design intention. A FMEA is used to examine each potential failure mode of a process to determine the effects of the failure on the system. A failure mode may be identified as a loss of function, a premature function, an out-of-tolerance condition, or a physical characteristic, such as a leak, observed during inspection. The effect of a failure mode is determined by the system's response to the failure



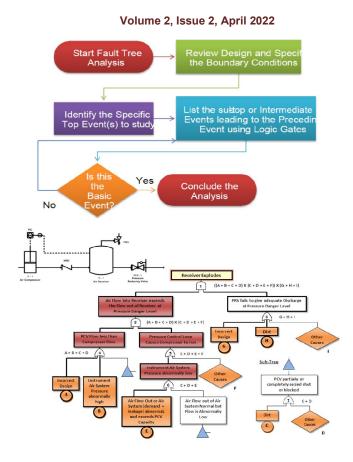
E. Fault Tree Analysis (FTA)

An FTA is a graphical, top-down analysis that starts with a hazardous event and works backwards to identify the causes of the preceding event. A Fault Tree is a visual logical model which is used to describe how a specific unwanted event (Top Event) in a system may be caused by the effects of a single failure or a combination of failures.

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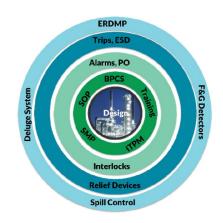
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F. Layer of protection analysis (LOPA)

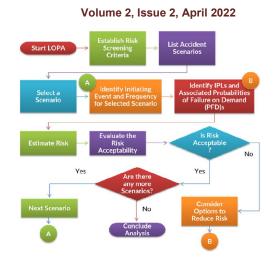
It is a simplified Risk Assessment Method. It provides a method for evaluating the risk of hazard scenarios and comparing it with the risk tolerance criteria to decide if existing safeguards are adequate, and whether additional safeguards are needed. The Protection Layers can be either Preventive or Mitigating. Preventive Layers act by avoiding an occurrence of the scenario, and include:

- Inherently safer design features;
- Active Physical Protection Devices, such as Relief Valves;
- Basic Process Control System; and
- Safety Instrumented Functions (SIF)

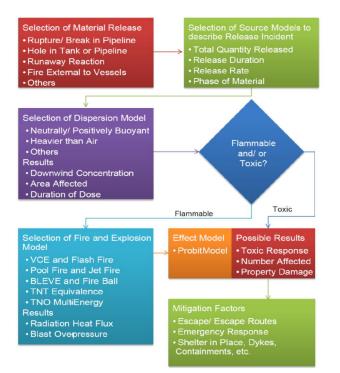




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G. Consequence Analysis



H. Risk Criteria

Authority and Application	Maximum Tolerable Risk (per year)	Negligible Risk (per year)
VROM, The Netherlands (New plant)	1.0E-6	1.0E-8
VROM, The Netherlands (Existing)	1.0E-5	1.0E-8
HSE, UK (Existing hazardous plants)	1.0E-4	1.0E-6
HSE, UK (New Nuclear Plants)	1.0E-5	1.0E-6
HSE, UK (Substance transport)	1.0E-4	1.0E-6
HSE, UK (New housing near plants)	3 x 1.0E-6	3 x 1.0E-7
Hong Kong (New Plants)	1.0E-5	Not used

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VI. SOFTWARE METHODOLOGY

The proposed software tool consists of two separate parts with shared classes and databases. The first part is used for the actual simulation of the analyzed system. In this software module, the connection of our tool with the software methodology is established and when the simulation case is open and active, individual streams and operation units are checked for the possibility of performing a HAZOP study.

Advanced Software for Consequence Analysis

- Estimate the consequences of a release of a toxic or flammable material
- Model releases from; catastrophic ruptures, leaks, line ruptures, relief valves and rupture disks
- Models include; Multi-component mixtures, aerosol and pool formation, Jet & pool fires, BLEVE & vapor cloud explosion, toxic effects

6.1 Availability of Software

- DNV PHAST/PHAST
- SHELL FRED/ SHEPHERD
- PHA PRO (HAZID/HAZOP/ENVID)
- Exsilentia (IPF/SIL)
- Detect 3D
- PIPENET
- FLARE SIM
- FLARE NET
- MAROS
- HYSYS/UNISIM

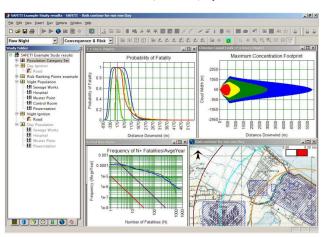
6.2 What will it enable you to do?

- Use Multi Energy, Baker Strehlow Tang and BLEVE Blast models
- Define Regions of congestion/confinement
- Calculate location specific Overpressure
- Exceedance Frequency
- Define Building Types library
- Each Building type has specific vulnerability to overpressure, radiation and toxic effects
- Place buildings and insert Population of different categories within those buildings
- Define Areas and report risk by population category and/or area
- Assess Escalation frequency
- Calculate individual and societal risk using;
- Phast Consequence modelling
- Population density
- Ignition sources
- Accident frequency rates
- Wind rose data
- Output includes;
- FN Curves, Tabular Risk Ranking,
- Risk Contours



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VII. EXPERIMENT

Process Hazard Analysis study for Hydrogen Manufacturing Unit by using QRA Technique Based on the QRA study for the Hydrogen Manufacturing Unit (HMU)

7.1 Objectives

- Quantify the level of individual fatality risks associated with the HMU unit.
- Demonstrate that the level of risks is in compliance with the UK HSE guidelines

7.2 Major Risk contributors LPG as feed

Large leak from the pipeline connecting to the vessel 22% Medium leak from the pipeline connecting to the vessel 13%

7.3 Major Risk contributors Naphtha as feed

Large leak from the pipeline connecting to the vessel 13% Medium leak from the pipeline connecting to the vessel 10%

7.4 Major Risk contributors Natural Gas as feed

Large leak from the Reactor 10 % Medium leak from the Reactor 7%

7.5 Major Risk contributor's RF Gas as feed

Large leak from the reactor 10%

VIII. SCOPE OF STUDY

Verify the individual and societal risk levels in accordance with UK HSE criteria

Tabulation of the consequences in terms of:

Distances to radiation levels, Lower Flammability Limit (LFL) and explosion overpressure for different weather classes according to specific criteria classes

8.1 Basic of Hydrogen

Hydrogen is the first element in the periodic table, with chemical symbol H. It consists of one proton (a core unit of positive charge) and one electron (negative charge). It has atomic number 1 and atomic weight of 1.00794.u, being the lightest element on the periodic table



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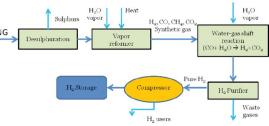


A. Hydrogen Applications

- Chemical Industry
- Automobile
- Laboratories
- Alternative Fuels etc.

B. Hydrogen Manufacturing process in Petroleum Refinery

- Feed Preparation
- Hydrogenation And Desulphurization
- Adiabatic Pre-Reforming
- Tubular Steam Reforming
- Heat Exchange Reforming (Hter)
- Shift Conversion
- Hydrogen Product Purification By Psa
- Steam Production By Waste Heat Recovery
- Process Condensate Stripping



C. Letter Code of Equipment Identification

- F: Fired Heaters
- BC: Air Heaters
- B: Steam Super Heaters
- BR: Waste Heat Boiler
- CA: Stack
- C: Towers
- R: Reactors
- E: Heat Exchanger Equipment (Including process gas boiler)
- EA: Air Coolers
- V: Process Vessels, Tanks and Accumulators

8.2 QRA Methodology

In a QRA, hazard identification uses similar techniques, but has a more precise purpose – defining the boundaries of a study in terms of materials to be modelled, release conditions to be modelled, impact criteria to be used, and identifying and selecting a list of failure cases that will fully capture the hazard potential of the facilities to be studied. Failure cases are usually derived by breaking the process system down into a larger number of sub- systems, where failure of any component

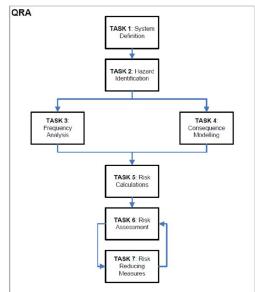
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in the sub-system would cause similar consequences. In pipeline case, this can be performed by breaking the line into sections depending on availability of isolation valves along the line.



- QRA Approach
- Hazard Identification
- Consequence Modelling/PHAST Software

8.3 Frequency Analysis

A. Failure Case Scenarios

Following scenarios have been identified for the HMU from the PFD stream no., pressure, temperature is taken from the mass and energy balance sheet, elevation of all the equipment is measured from the Plot plan of HMU. The mass inventory is taken as the sum of static inventory and dynamic inventory. Dynamic inventory is calculated by multiplying flow rate (taken from mass & energy balance sheet) with isolation time which is considered as 15min

S.No.	Case Description	Associated Equipment	Stream number	Pressure (barg)	Temperature (deg C)	Phase	Inventory (m3)
1	LPG from BL to V-101	Interconnecting P/L, V-101	2005	9	40	Liquid	310.110
2	Naphtha from BL to V-102	Interconnecting P/L, V-102	2004	3	40	Liquid	243.011
3	Ng from BL to E-101A/S	Interconnecting P/L, E-101A/S	2010	36.5	40	Gas	15017.235
4	RFG from BL to E-101A/S	Interconnecting P/L	2000	36.5	40	Gas	14381.298
5	LPG from V-101 to E-101A/S	Interconnecting P/L, P-101A/S	2060	36.5	40	Liquid	19.64
6	Naphtha from V-102 to E-101A/S	Interconnecting P/L, P-102A/S	2060	36.5	40	Liquid	5436.574
S.No.	Case Description	Associated Equipment	Stream number	Pressure (barg)	Temperature (deg C)	Phase	Inventory (m3)
7	Interconnecting p/l from E-101A/S to R-101	Interconnecting P/L,			1000	2	
	to K-101	R-101, E-102A/S	2060	35.5	380	Gas	5643.420
8	Interconnecting p/l from R-101 to R-103	R-101, E-102A/S Interconnecting P/L, R-102, R-103,E-104	2060 2100	35.5 30.1	380 490	Gas Gas	5643.420 49260.695
8	Interconnecting p/l from R-101 to	Interconnecting P/L,					
	Interconnecting p ⁴ from R-101 to R-103 Interconnecting p ⁴ from R-103 to	Interconnecting P/L, R-102, R-103,E-104 Interconnecting P/L,	2100	30.1	490	Gas	49260.695
9	Interconnecting p ⁴ from R-101 to R-103 Interconnecting p ⁴ from R-103 to R-104 Interconnecting p ⁴ from R-104 to	Interconnecting P/L, R-102, R-103,E-104 Interconnecting P/L, R-104 Interconnecting P/L,	2100	30.1	490	Gas	49260.695 13238.489
9	Interconnecting p/I from R-101 to R-103 Interconnecting p/I from R-103 to R-104 Interconnecting p/I from R-104 to R-105 Interconnecting p/I from R-105 to	Interconnecting P/L, R-102, R-103,E-104 Interconnecting P/L, R-104 Interconnecting P/L, R-105,E-105,E-106 Interconnecting P/L, E-107,E-108,EA-101,	2100 2150 2207	30.1 29.4 23.1	490 421 210	Gas Gas Gas	49260.695 13238.489 80980.544

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B. Continuous Releases

If ignited immediately, a continuous release will form a jet fire. If ignition is delayed, a flammable cloud would be formed and drifted with the wind. In such situation, if the cloud is ignited (after some delays), a flash fire or Vapour Cloud Explosion (VCE) may result, depending upon the degree of congestion within area and energy strength of the ignition source.

C. Instantaneous Releases

An instantaneous release would result from catastrophic rupture of a storage vessel (such as the storage cylinders, the trailers etc.) or reactors. If ignition is immediate, a fireball may be formed depending on the nature of the material. If ignition occurs after some delay similar to continuous release, a flash fire or VCE may be the consequence.

List of Failure Cases

				Hole s	izes (mm	1)
S.No.	Case Description	Associated Equipment	Small	Medium	Large	Full bore rupture
1	LPG from BL to V-101	Interconnecting P/L, V-101	5	25	101.6	-
2	Naphtha from BL to V-102	Interconnecting P/L, V-102	5	25	100	203.2
3	Ng from BL to E-101A/S	Interconnecting P/L, E-101A/S	5	25	101.6	
4	RFG from BL to E-101A/S	Interconnecting P/L	5	25	101.6	-
5	LPG from V-101 to E- 101A/S	Interconnecting P/L, P-101A/S	5	25	101.6	-
6	Naphtha from V-102 to E-101A/S	Interconnecting P/L, P-102A/S	5	25	101.6	-
7	Interconnecting p/l from E- 101A/S to R-101	Interconnecting P/L, R-101, E-102A/S	5	25	100	150
8	Interconnecting p/l from R- 101 to R-103	Interconnecting P/L, R-102, R-103,E-104	5	25	100	150
9	Interconnecting p/l from R- 103 to R-104	Interconnecting P/L, R-104	5	25	100	150
10	Interconnecting p/l from R- 104 to R-105	Interconnecting P/L, R-105, E-105, E-106	5	25	100	150
11	Interconnecting p/l from R- 105 to V-104	Interconnecting P/L, E-107, E-108,EA-101, E-109, V-104	5	25	100	150
12	Interconnecting p/l from V- 104 to PSA unit	Interconnecting P/L	5	25	100	150
13	Interconnecting p/l from PSA Unit to product H2 to BL	Interconnecting P/L	5	25	100	304.8

Release Duration

Release duration of 3600 seconds is chosen for this study. This includes the time to detect, isolate and the subsequent blow down (if possible) of the node from which leak occurs. After the leak is detected and the section is isolated it is understood that no more inventory is entering the section.

Frequency Discussion

Estimation of the likelihood of occurrence of each of the failure cases modelled has been done based on historical failure frequencies of process equipment. The historical failure data are based on an extensive research on several failure frequency databases worldwide. The most reputable, comprehensive and appropriate data are selected for each of the equipment failure frequency for associated piping has been taken from Leak software, failure frequency for process vessels, columns, heat-exchangers, pumps and filters.

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8.4 Consequence Analysis

A. Consequence Assessment

For each defined failure case for the Hydrogen Manufacturing Unit, the consequence modelling is carried out to determine the potential effects of releases, the results of which are discussed in terms of hazard distances. The corresponding consequences in terms of flammable and explosive effects are modelled and analyzed by using PHAST RISK software version 6.54. The flammable consequences that may potentially arise from failure of an equipments or lines are:

- Pool Fire
- Jet fires;
- Flash fires;
- Fireball; and/or
- Explosions.

Pool Fire

The consequence analysis is performed using DNV proprietary software PHAST. PHAST is a consequence and impact assessment module integrated within DNV risk calculation software PHAST Risk. The following descriptions are based on the different hazard types modeled, which are jet fires, flash fires, vapor cloud explosions, pool fires. a Pool fire is represented by the thermal radiation envelope. Three levels of radiation are presented in this report, i.e.:

- 4 kW/m2; this level is sufficient to cause personnel if unable to reach cover within 20s; however, blistering of the skin (second degree burn) is likely; 0: lethality.
- 12.5 kW/m2; this level will cause extreme pain within 20 seconds and movement to a safer place is instinctive. This level indicates around 6% fatality for 20 seconds exposure.
- 37.5 kW/m2; this level of radiation is assumed to give 100% fatality.

Jet Fire

A jet fire may result from ignition of a high-pressure leakage of gas from process plants or storage tanks. Jet fires are characterized by a high momentum jet flame that is highly turbulent. The flame is lifted above the exit opening from which the gas is discharged generally at high pressure. This distance appears because the combustion process can only take place when the flow velocity is reduced sufficiently to allow stable combustion.

The extent of the consequence of a Jet fire is represented by the thermal radiation envelope. Three levels of radiation are presented in this report, i.e.:

- 4 kW/m2; this level is sufficient to cause personnel if unable to reach cover within 20s; however, blistering of the skin (second degree burn) is likely; 0: lethality,
- 12.5 kW/m2; this level will cause extreme pain within 20 seconds and movement to a safer place is instinctive. This level indicates around 6% fatality for 20 seconds exposure.
- 37.5 kW/m2; this level of radiation is assumed to give 100% fatality.

Flash Fire

A flash fire is the non-explosive combustion of a flammable vapour cloud resulting from a release of volatile material into the open air, which, after mixing with air, ignites. The flame initially propagates slowly, often 10m/s or less, and in the Shell Maplin, Sands experiments often was unable to overcome the wind speed to flash back to the source. However, where congestion or confinement exist, flame speeds can accelerate to hundreds of m/s and overpressure effects will result.particularly for materials that have high boiling points. Flash calculations were conducted to consider the vaporization of light components in the streams, especially for high pressure or high temperature process conditions. Flashed vapor and light component releases will behave as jets, with jet fire and vapor cloud impacts modelled in the same way as for gas releases

Vapour Cloud Explosion (VCE)

Due to the large volume of flammable materials and highly flammable material with higher proportion of the more volatile components, there is significant potential for Vapour Cloud Explosion Events (VCE) in case any ignition source is not Copyright to IJARSCT DOI: 10.48175/568 636 www.ijarsct.co.in



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available immediately. Maximum flammable fuel volume for prediction of explosionoverpressure effects estimated to be considerable based on flow rate, isolation time (15 mins), time for vaporization and probability of VCE scenario.

Toxic Consequences

In the event of a release of toxic material (eg.H2S or NH3) not being ignited, the concentration of material in the cloud is progressively reduced by dilution with air until the concentration is well below any toxic effects. Such Unignited releases do not directly affect the plant, but cloud affect people enveloped by the cloud. Distances to 3% fatality level, the IDLH concentration and the exposure limit have been calculated using the dispersion models.

Flammable Consequence Results for LPG



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				Release Rate &				uence Dist	ance(m)																	
S.No	Node	Description	Accident Scenario	Duration	Event	Impact criteria	D 11m/s	B 3m/s	F 3m/																	
		E-108, EA-101,				4Kw/m2	NR	NR	NR																	
- 1		E-109, V-104			Flash fire	LFL (51974.6 ppm)	6.98	9.22	10.10																	
			Medium	1.344kg/s & 3,600s	Jet fire	37.5Kw/m2	NR	NR	NR																	
					Jet nre	4Kw/m2	18.55	16.92	16.98																	
					Flash fire	LFL (51974.6 ppm)	57.53	56.30	60.84																	
			Large	21.50kg/s & 3,600s	Jet fire	37.5Kw/m2	57.82	29.81	30.68																	
					Jet nre	4Kw/m2	71.49	64.67	64.75																	
					Flash fire	LFL (51974.6 ppm)	90.79	85.14	90.96																	
			Catastrophic Rupture		Jet fire	37.5Kw/m2	78.81	46.44	45.80																	
					Jet mre	4Kw/m2	99.06	91.35	91.06																	
					Flash fire	LFL (51974.6 ppm)	1.79	2.18	2.27																	
			Small	0.054kg/s & 3,600s	Jet fire	37.5Kw/m2	NR	NR	NR																	
					Jet nire	4Kw/m2	NR	NR	NR																	
					Flash fire	LFL (51974.6 ppm)	7.12	9.38	10.27																	
			Medium	1.344kg/s & 3,600s	Jet fire	37.5Kw/m2	NR	NR	NR																	
8	from V-104 to PSA D/T	Interconnecting			Jet nire	4Kw/m2	18.70	17.06	17.11																	
8	from V-104 to PSA	Interconnecting P/L		P/L			Flash fire	LFL (51974.6 ppm)	60.39	58.13	63.13															
							Large	21.89kg/s & 3,600s	Jet fire	37.5Kw/m2	58.17	58.17	30.06													
					Jet nre	4Kw/m2	71.93	65.17	65.05																	
- 1					Flash fire	LFL (51974.6 ppm)	97.68	17.06 17.11 58.13 63.13 58.17 30.06 65.17 65.09 90.75 97.15 46.77 46.13																		
																				Catastrophic Rupture		Jet fire	37.5Kw/m2	79.24	46.77	46.13
					Jet nire	4Kw/m2	99.64	91.93	91.63																	
9	Interconnecting p/l	Interconnecting			Flash fire	LFL (40000 ppm)	3.41	4.63	5.06																	
	from PSA Unit to		Small	0.0212kg/s & 3,600s	Jet fire	37.5Kw/m2	NR	NR	NR																	
	product H2 to BL				Jet nre	4Kw/m2	NR	NR	NR																	
			Medium	0.531kg/s & 3,600s	Flash fire	LFL (40000 ppm)	20.28	19.26	21.03																	
				24	Jet fire	37.5Kw/m2	NR	NR	NR																	
					_																					
S.No				Release Rate &				uence Dist	ance(m)																	
S.No	Node	Description	Accident Scenario	Duration	Event	Impact criteria	D 11m/s	B 3m/s	F 3m/																	
						4Kw/m2	19.74	20.66	20.71																	
					Flash fire	LFL (40000 ppm)	62.25	54.60	62.96																	
			Large	8.49kg/s & 3,600s	Jet fire	37.5Kw/m2	61.23	42.47	42.50																	
					Jet fire	4Kw/m2	70.98	74.10	73.84																	
					Flash fire	LFL (40000 ppm)	131.43	113.11	128.6																	
			Catastrophic Rupture			37.5Kw/m2	156.46	111.18	111.0																	
- 1		1			Jet fire	4Kw/m2	195.96	203.72	202.1																	
			canasa opine raipine		Jet fire																					

Flammable Consequence Results for Naphtha

S.No	Node	Description	Accident Scenario	Release Rate &	Event	Terror and and territor		uence Dist	fance(m)
5.No	Node	Description	Accident Scenario	Duration	Event	Impact criteria	D 11m/s	B3m/s	F 3m/s
					Flash fire	LFL (10055.5 ppm)	4.54	5.84	8.10
					7.00	37.5Kw/m2	8.15	9.80	9.80
			Small	0.276kg/s & 3600s	Jet fire	4Kw/m2	13.95	15.87	15.81
						37.5Kw/m2	NR	14.10	11.54
					Pool fire	4Kw/m2	NR	27.19	28.39
					Flash fire	LFL (10055.5 ppm)	44.91	64.07	68.93
						37.5Kw/m2	35.34	41.81	41.67
			Medium	6.891kg/s & 3600s	Jet fire	4Kw/m2	60.56	68.29	67.85
			Wiedram	0.891Kg/s & 50005		37.5Kw/m2	NR	NR	NR
					Pool fire	4Kw/m2	84.71	82.44	80.56
					Flash fire	LFL (10055.5 ppm)	111.95	174.10	207.9
1	Naphtha from BL to V-102				Flashine				
		P/L, V-102			Jet fire	37.5Kw/m2	99.96	109.16	108.58
			Large	110.25kg/s & 1476.63s	1.00000000	4Kw/m2	171.83	181.58	179.83
					Pool fire	37.5Kw/m2	NR	NR	NR
		Interconnecting P/L, V-102 Interconnecting P/L,P-102A/S, E-101A/S				4Kw/m2	260.29	228.39	223.20
					Explosion	0.3bar	NH	235	281
					Flash fire	LFL (10055.5 ppm)	162.61	247.88	310.87
					Jet fire	37.5Kw/m2	141.36	163.18	160.33
			Constantin Destant		Jet me	4Kw/m2	241.13	273.41	267.5
			Catastrophie Rupture		Pool fire	37.5Kw/m2	NR	NR	NR
					Pool fire	4Kw/m2	317.95	266.44	262.3
					Explosion	0.3bar	NH	315	358
	Naphtha from V-102 to E-	Interconnecting			Flash fire	LFL (10050.8 ppm)	6.64	9.61	11.63
2	101A/S		Small	0.877kg/s & 3,600s	Jet fire	37.5Kw/m2	12.37	14.51	14.57
		E-101A/S				4Kw/m2	21.66	23.39	23.39
			Medium	21.933kg/s & 3,600s	Flash fire	LFL (10050.8 ppm)	\$4.66	113.54	132.4
			Weddall	21.955kg/s & 5,000s	rasame	LFL (10050.8 ppm)	\$4.00	TIPLOT	10404
_			Median		Pasarare	LFL (10050.8 ppm)			
No	Node	Description	Accident Scenario	Release Rate & Duration	Event	Impact criteria	Consequ D	nence Dist B 3m/s	
.No	Node	Description		Release Rate &	Event	Impact criteria	Consequ D 11m/s	uence Dist B 3m/s	ance(m) F 3m/s
.No	Node	Description		Release Rate &		Impact criteria 37.5Kw/m2	Consequ D 11m/s 52.94	nence Dist B 3m/s 61.86	ance(m) F 3m/s 61.86
.No	Node	Description		Release Rate &	Event Jet fire	Impact criteria 37.5Kw/m2 4Kw/m2	Consequ D 11m/s 52.94 93.58	nence Dist B 3m/s 61.86 101.52	ance(m) F 3m/s 61.86 100.77
No	Node	Description		Release Rate &	Event	Impact criteria 37.5Kw/m2 4Kw/m2 LFL (10060.8 ppm)	Consequence D 11m/s 52.94 93.58 362.08	B 3m/s 61.86 101.52 524.25	ance(m) F 3m/ 61.86 100.77 559.94
No	Node	Description		Release Rate &	Event Jet fire	Impact criteria 37.5Kw/m2 4Kw/m2 LFL (10060.8 ppm) 37.5Kw/m2	Consequ D 11m/s 52.94 93.58 362.08 169.17	nence Dist B 3m/s 61.86 101.52 524.25 206.21	ance(m) F 3m/ 61.86 100.77 559.94 205.23
No	Node	Description	Accident Scenario	Releaxe Rate & Duration	Event Jet fire Flash fire	Impact criteria 37.5Kw/m2 4Kw/m2 LFL (10060.8 ppm) 37.5Kw/m2 4Kw/m2	Consequ D 11m/s 52.94 93.58 362.08 169.17 291.53	B 3m/s 61.86 101.52 524.25 206.21 338.41	ance(m) F 3m/ 61.86 100.77 559.94 205.23 335.03
No	Node	Description		Release Rate &	Event Jet fire Flash fire	Impact criteria 37.5Kw/m2 4Kw/m2 LFL (10060.8 ppm) 37.5Kw/m2 4Kw/m2 37.5Kw/m2	Consequence D 11m/s 52.94 93.58 362.08 169.17 291.53 NR	B 3m/s 61.86 101.52 524.25 206.21 338.41 82.41	ance(m F 3m/ 61.86 100.77 559.94 205.23 335.03 79.92
No	Node	Description	Accident Scenario	Releaxe Rate & Duration	Event Jet fire Flash fire Jet fire Pool fire	Impact criteria 37.5Kw/m2 4Kw/m2 LFL (10060.8 ppm) 37.5Kw/m2 4Kw/m2 37.5Kw/m2 4Kw/m2	Consequence D 11m/s 52.94 93.58 362.08 169.17 291.53 NR NR NR	B 3m/s 61.86 101.52 524.25 206.21 338.41 82.41 90.17	ance(m F 3m/ 61.86 100.77 559.94 205.23 335.03 79.92 89.43
No	Node	Description	Accident Scenario	Releaxe Rate & Duration	Event Jet fire Flash fire Jet fire Pool fire Explosion	Impact criteria 37.5Kw/m2 4Kw/m2 1.FL (10050.8 ppm) 37.5Kw/m2 4Kw/m2 37.5Kw/m2 0.3bar	Conseq D 11m/s 52.94 93.58 362.08 169.17 291.53 NR NR NR 440	B 3m/s 61.86 101.52 524.25 206.21 338.41 82.41 90.17 636	ance(m) F 3m/s 61.86 100.77 559.94 205.23 335.03 79.92 89.43 672
No	Node	Description	Accident Scenario	Release Rate & Duration 362.36kg/s & 3,600s	Event Jet fire Flash fire Jet fire Pool fire	Impact criteria 37.5Kw/m2 4Kw/m2 LFL (10060.8 ppm) 37.5Kw/m2 4Kw/m2 37.5Kw/m2 4Kw/m2	Consequence D 11m/s 52.94 93.58 362.08 169.17 291.53 NR NR NR 440 6.58	B 3m/s 61.86 101.52 524.25 206.21 338.41 82.41 90.17	ance(m) F 3m/s 61.86 100.77 559.94 205.23 335.03 79.92 89.43
No	Node	Description	Accident Scenario	Releaxe Rate & Duration	Event Jet fire Flash fire Jet fire Pool fire Explosion Flash fire	Impact criteria 37.5Kw/m2 4Kw/m2 1.FL (10050.8 ppm) 37.5Kw/m2 4Kw/m2 37.5Kw/m2 0.3bar	Conseq D 11m/s 52.94 93.58 362.08 169.17 291.53 NR NR NR 440	B 3m/s 61.86 101.52 524.25 206.21 338.41 82.41 90.17 636	ance(m) F 3m/ 61.86 100.77 559.94 205.23 335.03 79.92 89.43 672 11.52
No	Node	Description	Accident Scenario	Release Rate & Duration 362.36kg/s & 3,600s	Event Jet fire Flash fire Jet fire Pool fire Explosion	Impact criteria 37.5Kw/m2 4Kw/m2 LFL (10060.8 ppm) 37.5Kw/m2 4Kw/m2 37.5Kw/m2 4Kw/m2 0.3bar LFL (10060.8 ppm)	Consequence D 11m/s 52.94 93.58 362.08 169.17 291.53 NR NR NR 440 6.58	uence Dist B 3m/s 61.86 101.52 524.25 206.21 338.41 82.41 90.17 636 9.39	ance(m) F 3m/s 61.86 100.77 559.94 205.23 335.03 79.92 89.43 672
No	Node	Description	Accident Scenario	Release Rate & Duration 362.36kg/s & 3,600s	Event Jet fire Flash fire Jet fire Pool fire Explosion Flash fire	Impact criteria 37.5Kw/m2 4Kw/m2 LFL (10060.8 ppm) 37.5Kw/m2 4Kw/m2 0.3bar LFL (10060.8 ppm) 37.5Kw/m2 4Kw/m2 4Kw/m2	Consequ D 11m/s 52.94 93.58 362.08 169.17 291.53 NR NR NR 440 6.58 12.28	nence Dist B 3m/s 61.86 101.52 524.25 206.21 338.41 82.41 90.17 636 9.39 14.41	ance(m F 3m ⁴ 61.86 100.77 559.94 205.22 335.03 79.92 89.43 672 11.52 14.38 23.11
No	Note	Description	Accident Scenario	Release Rate & Duration 362.36kg/s & 3,600s	Event Jet fire · Flash fire · Jet fire · Explosion Flash fire · Flash fire · Flash fire	Impact criteria 37.5Kw/m2 4Kw/m2 LFL (1000.6 spm) 37.5Kw/m2 4Kw/m2 0.3bar LFL (10060.8 ppm) 37.5Kw/m2	Consequ D 11m/s 52.94 93.58 362.08 169.157 291.53 NR NR NR 440 6.58 12.28 21.50	uence Dist B 3m/s 61.86 101.52 524.25 206.21 338.41 82.41 90.17 636 9.39 14.41 23.23	ance(m F 3m ⁴ 61.86 100.77 559.94 205.22 335.03 79.92 89.43 672 11.52 14.38 23.11
No	Node	Description	Accident Scenario	Release Rate & Duration 362.36kg/s & 3,600s 0.862kg/s & 3,600s	Event Jet fire Flash fire Jet fire Pool fire Explosion Flash fire Jet fire	Impact criteria 37.5Kw/m2 4Kw/m2 1EL (1000:0.5 ppm) 37.5Kw/m2 4Kw/m2 37.5Kw/m2 4Kw/m2 0.3bar LFL (1000:0.5 ppm) 37.5Kw/m2 4Kw/m2 1EL (1000:0.5 ppm) 37.5Kw/m2	Consequ D 11m/s 52.94 93.58 362.08 169.17 291.53 NR NR 440 6.58 12.28 21.50 83.85 52.62	uence Dist B 3m/s 61.86 101.52 524.25 206.21 338.41 90.17 636 9.39 14.41 23.23 112.67 61.43	ance(m F 3m ² 61.86 100.77 559.94 205.23 335.03 79.92 89.43 672 11.52 14.38 23.11 130.54 61.21
No	Node	Description	Accident Scenario	Release Rate & Duration 362.36kg/s & 3,600s 0.862kg/s & 3,600s	Event Jet fire Flash fire Jet fire Explosion Flash fire Jet fire Flash fire Jet fire Jet fire	Impact criteria 37.5 Kewim2 4 Kwim2 LFL (1006:0.5 ppm) 37.5 Kwim2 4 Kwim2 4 Kwim2 12 L(1006:0.5 ppm) 37.5 Kwim2 4 Kwim2 12 L(1006:0.5 ppm) 37.5 Kwim2 4 K	Consequ D 11m/s 52.94 93.58 362.08 169.17 291.53 NR NR 440 6.58 12.28 21.50 83.85 52.62 93.01	uence Dist B 3m/s 61.86 101.52 524.25 206.21 338.41 82.41 90.17 636 9.39 14.41 23.23 112.67 61.43 100.81	ance(m F 3m ² 61.86 100.77 559.94 205.23 335.03 79.92 89.43 672 11.52 14.38 23.11 130.54 61.21 100.07
No	Node	Description	Accident Scenario	Release Rate & Duration 362.36kg/s & 3,600s 0.862kg/s & 3,600s	Event Jet fire Flash fire Jet fire Explosion Flash fire Jet fire Jet fire Jet fire Ish fire Jet fire	Impact criteria 37.5Kw/m2 4Kw/m2 1LTL (10060.5 ppm) 37.5Kw/m2 4Kw/m2 37.5Kw/m2 4Kw/m2 LFL (10060.5 ppm) 37.5Kw/m2 4Kw/m2 LFL (10060.5 ppm) 37.5Kw/m2 4Kw/m2 1LFL (10060.5 ppm) 37.5Kw/m2 4Kw/m	Consequ D 11m/s 52.94 93.58 362.08 169.17 291.53 NR NR 440 6.58 12.28 21.50 83.85 52.62 93.01 352.31	uence Dist B 3m/s 61.86 101.52 524.52 206.21 338.41 82.41 90.17 636 9.39 14.41 23.23 112.67 61.43 100.81 100.81 511.72	ance(m F 3m/ 61.86 100.77 559.96 205.23 335.03 79.92 89.43 672 11.52 14.38 23.11 130.55 61.21 100.07 552.20
		Description	Accident Scenario	Rolesce Rate & Duration 362.30kgs & 3.600s 0.862kg/s & 3.600s 21.55kg/s & 3.600s	Event Jet fire Flash fire Jet fire Explosion Flash fire Jet fire Flash fire Jet fire	Impast criteria 37.5 Kswim2 4Kwim2 LFL (10060.8 ppm) 37.5 Kswim2 4Kwim2 4Kwim2 4Kwim2 4Kwim2 4Kwim2 12TL (10060.8 ppm) 37.5 Kswim2 LFL (10060.8 ppm) 37.5 Kswim2 4Kwim2	Consequ D J1m/s 52.94 93.58 362.08 169.17 291.53 NR NR 440 6.58 12.28 21.50 83.85 52.62 93.01 352.31 165.90	Bence Dist B 3m/s 61.86 101.52 524.25 206.21 338.41 82.41 99.17 636 9.39 14.41 23.23 112.67 61.43 100.81 511.72 202.27	ance(m F 3m/ 61.86 100.77 559.96 205.23 335.03 79.92 89.43 672 11.52 14.38 23.11 130.54 61.21 100.07 552.20 201.32
	Interconnecting p71 from E-	Interconnecting P/L, R-101,	Accident Scenario	Release Rate & Duration 362.36kg/s & 3,600s 0.862kg/s & 3,600s	Event Jet fire Flash fire Jet fire Explosion Flash fire Jet fire Jet fire Flash fire Jet fire Flash fire Jet fire	Impact criteria 37.5Kw/m2 4Kw/m2 37.5Kw/m2 37.5Kw/m2 37.5Kw/m2 38.5Kw/m2 4Kw/m2 LFL (10060.8 ppm) 37.5Kw/m2 4Kw/m2 LFL (10060.8 ppm) 37.5Kw/m2 4Kw/m2 4Kw/m2 4Kw/m2 4Kw/m2	Conseq D 11m/s 52.94 93.58 362.08 362.08 169.17 291.53 NR NR NR 440 6.58 12.28 21.50 6.58 12.28 21.50 52.62 93.01 352.31 165.90 286.06	Bence Dist B 3m/s 61.86 101.52 524.25 206.21 338.41 82.41 90.17 636 9.39 14.41 23.23 112.67 61.43 100.81 511.72 202.27 332.22	ance(m) F 3m ⁶ 61.86 100.77 559.94 205.22 335.03 79.92 89.43 672 11.52 14.38 23.11 130.54 61.21 100.55 552.22 201.32 328.91
		Interconnecting	Accident Scenario Large Small Medium	Rolesce Rate & Duration 362.30kgs & 3.600s 0.862kg/s & 3.600s 21.55kg/s & 3.600s	Event Jet fire Flash fire Jet fire Explosion Flash fire Jet fire Jet fire Jet fire Ish fire Jet fire	Impact criteria 37.5 Kw/m2 4 Kw/m2 4 Kw/m2 37.5 Kw/m2 37.5 Kw/m2 37.5 Kw/m2 37.5 Kw/m2 4 Kw/m2 1 LFL (1006.3 ppm) 37.5 Kw/m2 4 Kw/m2 1 LFL (1006.3 ppm) 37.5 Kw/m2 4 Kw/m2 37.5 Kw/m2 4 Kw/m2 37.5 Kw/m2 4 Kw/m2	Consequence D 11m/s 52.94 93.58 362.08 169.17 291.53 NR NR 440 6.58 12.28 21.50 83.85 52.62 93.01 352.31 165.90 286.06 NR	Bence Dist B 3m/s 61.86 101.52 206.21 338.41 92.41 90.17 636 9.39 14.41 23.23 112.67 61.43 112.67 61.43 112.67 20.21 332.22 20.227 332.22 110.27	ance(m) F 3m ² 61.86 100.77 559.94 205.23 335.03 79.92 89.43 672 11.52 14.38 23.11 130.54 61.21 100.07 552.26 201.23 328.91 74.22
	Interconnecting p71 from E-	Interconnecting P/L, R-101,	Accident Scenario Large Small Medium	Rolesce Rate & Duration 362.30kgs & 3.600s 0.862kg/s & 3.600s 21.55kg/s & 3.600s	Event Jet fire Flash fire Jet fire Explosion Flash fire Jet fire Plash fire Jet fire	Impact criteria 37.5Kw/m2 4Kw/m2 37.5Kw/m2 37.5Kw/m2 37.5Kw/m2 37.5Kw/m2 4Kw/m2 1LFL (1006:0.5 ppm) 37.5Kw/m2 4Kw/m2 1LFL (1006:0.5 ppm) 37.5Kw/m2 4Kw/m2 37.5Kw/m2 4Kw/m2 4Kw/m2 4Kw/m2 4Kw/m2	Consequence D 11m/s 52.94 93.58 362.08 169.17 291.53 NR 440 6.58 12.28 21.50 83.85 52.62 93.01 352.31 165.90 286.06 NR NR	Rence Dist B 3m/s 61.86 101.52 206.21 338.41 90.17 636 9.39 14.41 23.23 112.67 61.43 100.81 511.72 202.27 332.22 110.27 96.52	ance(m) F 3m/ 61.866 100.77 559.96 205.22 335.025 89.433 672 11.52 23.111.52 14.388 672 11.52 23.111.52 130.55 61.211 100.07 552.22 201.32 328.913 328.91
	Interconnecting p71 from E-	Interconnecting P/L, R-101,	Accident Scenario Large Small Medium	Rolesce Rate & Duration 362.30kgs & 3.600s 0.862kg/s & 3.600s 21.55kg/s & 3.600s	Event Jet fire Flash fire Jet fire Explosion Flash fire Jet fire Jet fire Flash fire Jet fire Flash fire Det fire Flash fire Flash fire Det fire Flash fire Flash fire Flash fire Det fire Flash fire	Impact criteria 37.5Kw/m2 4Kw/m2 4Kw/m2 37.5Kw/m2 37.5Kw/m2 47.5Kw	Consequ D 11m/s 52.94 93.58 362.08 169.17 291.53 NR NR 440 6.58 12.28 21.50 83.85 52.62 93.01 352.31 165.90 286.06 NR NR NR 427.74	Bence Dist B 3m/s 61.86 101.52 224.25 206.21 338.41 90.17 63.66 9.39 14.41 23.23 112.67 61.43 100.81 511.72 202.27 332.22 110.27 96.52 61.484	ance(m) F 3m/ 61.866 100.77 559.94 205.22 335.02 79.922 89.433 672 205.22 335.02 79.922 89.433 672 205.25 205.25 205.
	Interconnecting p71 from E-	Interconnecting P/L, R-101,	Accident Scenario Large Small Medium	Releve Rete & Duration 362.30kgs & 3.600s 0.862kg/s & 3.600s 21.55kg/s & 3.600s	Event Jet fire Flash fire Jet fire Explosion Flash fire Jet fire Plash fire Jet fire	Impact criteria 37 5Kw/m2 4Kw/m2 4Kw/m2 37.5Kw/m2 47.5Kw/m2	Consequence D 11m/s 52.94 93.58 169.17 291.53 NR 440 6.58 21.50 83.85 52.62 93.01 352.31 165.90 286.06 NR NR NR NR 427.74 427.74	tence Dist B 3m/s 61.86 101.52 524.25 206.21 338.41 \$2.41 \$2.41 \$2.41 \$2.41 \$2.41 \$2.41 \$2.41 \$2.42 \$38.41 \$2.42 \$12.67 61.43 100.81 \$11.72 202.27 332.22 \$100.81 \$11.72 \$2.65 \$100.85 \$100.85 \$100.81 \$11.267 \$100.81 \$11.267 \$11.277 \$12.2777 \$12.2777 \$12.277777777777777777777777777777	ance(m) F 3m/ 61.86 100.77 559.94 205.22 335.01 79.92 89.43 67.2 11.552 23.111 130.55 61.211 130.552 2201.32 328.91 74.222 89.800 669.84 97.252 201.321 328.91 74.222 89.800 669.84 72.985 72.985 72.985 72.985 72.985 74.222
	Interconnecting p71 from E-	Interconnecting P/L, R-101,	Accident Scenario Large Small Medium	Releve Rete & Duration 362.30kgs & 3.600s 0.862kg/s & 3.600s 21.55kg/s & 3.600s	Event Jet fire Flash fire Jet fire Explosion Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Pool fire Explosion Flash fire	Impact criteria 37. 5 (Kw/m2 45Kw/m2	Consequ D 11m/s 52.94 93.58 362.08 169.17 291.53 NR NR 440 440 458 12.28 21.50 83.85 52.62 93.01 352.31 165.90 286.06 NR NR NR 427.74 528.62 93.01 352.352.352.352.352.352.352.352.352.352.	Rence Dist B 3m/s 61.86 101.52 524.25 206.21 338.41 82.41 90.17 636 9.39 14.41 23.23 112.67 61.43 100.81 511.72 202.27 332.22 110.27 96.52 614.84 777.44 282.43	ance(m) F 3m ² 61.86 100.77 559.94 205.23 335.03 79.92 205.23 335.03 79.92 205.23 335.03 79.92 21.152 1.1
	Interconnecting p71 from E-	Interconnecting P/L, R-101,	Accident Scenario Large Small Medium Large Large	Releve Rete & Duration 362.30kgs & 3.600s 0.862kg/s & 3.600s 21.55kg/s & 3.600s	Event Jet fire Flash fire Jet fire Explosion Flash fire Jet fire Jet fire Flash fire Jet fire Flash fire Det fire Flash fire Flash fire Det fire Flash fire Flash fire Flash fire Det fire Flash fire	Impact criteria 37. 5f5w/m2 4f5w/m2 17. (1000:05.ppm) 37. 5f5w/m2 4f5w/m2 4f5w/m2 4f5w/m2 4f5w/m2 4f5w/m2 17. (1000:05.ppm) 37. 5f5w/m2 4f5w/m2	Consequence D 11m/s 52.94 33.58 362.08 169.17 291.53 291.53 291.53 NR NR 440 6.58 12.28 21.50 23.10 352.31 165.90 236.06 NR NR NR NR NR NR NR 427.74 528.67 231.36 395.62	Rence Dist B 3m/s 61.86 61.86 61.86 524.25 206.21 82.41 82.41 90.17 636 9.39 14.41 23.23 112.67 61.43 112.67 61.43 112.72 202.27 96.52 110.27 96.52 110.27 96.52 112.84 777.44 282.43 460.28 160.85 161.85 161.85 161.85 161.85 161.85 161.85 161.85 161.85 161.85 161.85 161.85 161.85 161.85 161.85 161.85 161.85 161.85 161.85 161.85 163.85 177.85 163.85 16	antce(m) F 3m/ 61.86 5 559.54 205.23 335.03 79.92 205.23 335.03 79.92 205.23 335.03 79.92 205.23 335.03 79.92 201.152 21.152 23.11 130.54 61.21 100.077 552.26 23.11 130.54 61.21 100.07 79.92 23.11 130.54 61.21 100.077 79.92 23.11 130.54 61.22 100.077 79.92 23.11 130.54 61.22 100.077 79.92 23.11 130.54 61.22 100.077 79.92 23.11 130.54 61.22 23.11 130.54 61.22 23.11 130.54 61.22 23.11 130.54 61.22 23.11 130.54 61.22 23.11 130.54 61.22 23.11 130.54 61.22 23.12 23.22 23
. No	Interconnecting p71 from E-	Interconnecting P/L, R-101,	Accident Scenario Large Small Medium	Releve Rete & Duration 362.30kgs & 3.600s 0.862kg/s & 3.600s 21.55kg/s & 3.600s	Event Jet fire Flash fire Jet fire Pool fire Explosion Flash fire Jet fire Flash fire Flash fire Flash fire Flash fire Flash fire Jet fire Flash fire Let fire Flash fire Flash fire Let fire Flash fi	Impact criteria 37. 5 (Kw/m2 45Kw/m2	Consequ D 11m/s 52.94 93.58 362.08 169.17 291.53 NR NR 440 440 458 12.28 21.50 83.85 52.62 93.01 352.31 165.90 286.06 NR NR NR 427.74 528.62 93.01 352.352.352.352.352.352.352.352.352.352.	Rence Dist B 3m/s 61.86 101.52 524.25 206.21 338.41 82.41 90.17 636 9.39 14.41 23.23 112.67 61.43 100.81 511.72 202.27 332.22 110.27 96.52 614.84 777.44 282.43	ance(m) F 3m ² 61.86 559.94 205.23 335.03 559.94 205.23 335.03 79.92 205.23 335.03 79.92 205.23 335.03 79.92 205.23 135.03 672 23.11 159.24 61.21 109.07 552.26 61.21 109.07 552.26 61.22 11.52 201.32 328.91 74.22 201.32 328.91 74.22 201.32 328.91 74.22 669.84 729.87
	Interconnecting p71 from E-	Interconnecting P/L, R-101,	Accident Scenario Large Small Medium Large Large	Releve Rete & Duration 362.30kgs & 3.600s 0.862kg/s & 3.600s 21.55kg/s & 3.600s	Event Jet fire Flash fire Jet fire Explosion Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Pool fire Explosion Flash fire	Impact criteria 37. 5f5w/m2 4f5w/m2 17. (1000:05.ppm) 37. 5f5w/m2 4f5w/m2 4f5w/m2 4f5w/m2 4f5w/m2 4f5w/m2 17. (1000:05.ppm) 37. 5f5w/m2 4f5w/m2	Consequence D 11m/s 52.94 33.58 362.08 169.17 291.53 291.53 291.53 NR NR 440 6.58 12.28 21.50 23.10 352.31 165.90 236.06 NR NR NR NR NR NR NR 427.74 528.67 231.36 395.62	Rence Dist B 3m/s 61.86 61.86 61.86 524.25 206.21 82.41 82.41 90.17 636 9.39 14.41 23.23 112.67 61.43 112.67 61.43 112.72 202.27 96.52 110.27 96.52 110.27 96.52 112.84 777.44 282.43 460.28 160.85 161.85 161.85 161.85 161.85 161.85 161.85 161.85 161.85 161.85 161.85 161.85 161.85 161.85 161.85 161.85 161.85 161.85 161.85 161.85 163.85 177.85 163.85 16	antce(m) F 3m/ 61.86 5 559.54 205.23 335.03 79.92 205.23 335.03 79.92 205.23 335.03 79.92 205.23 335.03 79.92 201.152 21.152 23.11 130.54 61.21 100.077 552.26 23.11 130.54 61.21 100.07 79.92 23.11 130.54 61.21 100.077 79.92 23.11 130.54 61.22 100.077 79.92 23.11 130.54 61.22 100.077 79.92 23.11 130.54 61.22 100.077 79.92 23.11 130.54 61.22 23.11 130.54 61.22 23.11 130.54 61.22 23.11 130.54 61.22 23.11 130.54 61.22 23.11 130.54 61.22 23.11 130.54 61.22 23.12 23.22 23
	Interconnecting p71 from E-	Interconnecting P/L, R-101,	Accident Scenario Large Small Medium Large Large	Releve Rete & Duration 362.30kgs & 3.600s 0.862kg/s & 3.600s 21.55kg/s & 3.600s	Event Jet fire Flash fire Jet fire Pool fire Explosion Flash fire Jet fire Flash fire Flash fire Flash fire Flash fire Flash fire Jet fire Flash fire Let fire Flash fire Flash fire Let fire Flash fi	Impact criteria 37 55 (Weinko 17 55 (Weinko 17 (10000 Jpn) 17 155 (Weinko 17 155 (Weinko	Consequence D 11m/s 52.94 93.58 362.08 169.17 201.53 NR NR NR 440 6.58 12.18 83.85 52.62 21.50 83.85 52.62 21.50 83.85 83.85 83.62 NR NR NR NR NR 440 440 440 440 440 440 440 440 440 44	Bands B 3m/s 61.86 101.52 524.25 206.21 338.41 82.41 90.17 636 9.39 114.41 23.23 112.67 61.43 100.81 511.72 202.27 332.22 110.27 96.52 614.84 777.44 282.43 460.28 NR	ance(m) F 3m/ 61.8665(m) 559.94 205.22 335.02 79.92 205.22 335.02 79.92 205.22 335.02 79.92 205.22 23.11 130.54 61.22 21.13 23.11 130.54 61.22 201.32 328.91 78.22 201.32 328.91 78.22 201.32 328.95 22.20 3

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S.No	Node	Description	Accident Scenario	Release Rate & Duration	Event	Impact criteria	D 11m/s	B 3m/s	F 3m/s
	to R-103	P/L, R-102,			Flash fire	LFL (53531.9 ppm)	5.13	5.91	6.30
		R-103, E-104	Medium	1.469kg/s & 3,600s	Jet fire	37.5Kw/m2	NR	NR	NR
						4Kw/m2	19.31	18.61	18.68
					Flash fire	LFL (53531.9 ppm)	31.39	33.66	35.10
			Large	23.51kg/s & 563.07s	Jet fire	37.5Kw/m2	58.85	45.72	45.46
						4Kw/m2	76.88	73.34	73.22
					Flash fire	LFL (53531.9 ppm)	51.31	50.35	54.14
			Catastrophic Rupture		Jet fire	37.5Kw/m2	82.85	63.56	63.19
						4Kw/m2	108.06	104.99	104.59
			Small	0.0603kg/s & 3,600s	Flash fire	LFL (53531.9 ppm)	1.24	1.36	1.40
			14.5		Flash fire	LFL (53531.9 ppm)	5.28	6.13	6.53
			Medium	1.508kg/s & 3,600s	Jet fire	37.5Kw/m2	NR	NR	NR
		Interconnecting				4Kw/m2	19.61	18.88	18.95
5	Interconnecting p/l from R-103 to R-104	P/L,		24.121 / 6.2.000	Flash fire	LFL (53531.9 ppm)	33.47 59.51	35.12	36.27
	10 10-104	R-104	Large	24.13kg/s & 3,600s	Jet fire	37.5Kw/m2 4Kw/m2	77.80	46.26 74.26	46.01
					21.1.0				
			Catastrophic Rupture		Flash fire	LFL (53531.9 ppm) 37.5Kw/m2	54.43 56.19	53.43 64.25	56.60 63.87
			Catastrophic Rupture		Jet fire	37.5Kw/m2			
	1. D. D. 104			0.04/71 / 0.3 (00		4Kw/m2	65.28	106.26	105.84
ō	Interconnecting p/l from R-104 to R-105	P/L, R-105,	Small	0.0467kg/s & 3,600s	Flash fire	LFL (51365.3 ppm)	1.62	2.03	2.15
	to R-105	E-105, E-106			Flash fire	LFL (51365.3 ppm)	6.52	8.73	9.60
		2-100, 2-100	Medium	1.167kg/s & 3,600s		37.5Kw/m2	NR	NR	NR
			A COLUMN	1.10/162/3 00 3,0003	Jet fire	4Kw/m2	17.79	16.50	16.56
					Flash fire	LFL (51365.3 ppm)	50.09	49.39	52.66
			Large	18.68kg/s &3,600s		37.5Kw/m2	55.64	34.23	33.15
			Large		Jet fire	4Kw/m2	69.53	64.10	64.02
						4RW/III2	09.55	04.10	04.02
								701	
S.No	Node	Description	Accident Scenario	Release Rate &	Event	Impact criteria	D	uence Dis	tance(n
5110	LIQUE	Description	Accident Scenario	Duration	Lveat	impacteriteria	11m/s	B 3m/s	F 3m
					Flash fire	LFL (51365.3 ppm)	75.34	71.90	74.7
			0		Flash fire	LFL (51505.5 ppm)	75.75	50.75	49.5
			Catastrophic Rupture		Jet fire	37.5Kw/m2			
						4Kw/m2	96.73	90.93	90.6
			Small	0.054kg/s & 3,600s	Flash fire	LFL (51974.6 ppm)	1.75	2.14	2.24
					Flash fire	LFL (51974.6 ppm)	6.98	9.22	10.1
			Medium	1.344kg/s & 3,600s		37.5Kw/m2	NR	NR	NR
		Interconnecting			Jet fire	4Kw/m2	18.55	16.92	16.9
	Interconnecting p/l from R-	P/L, E-107,	-		Flash fire	LFL (51974.6 ppm)	57.53	5630	60.8
7	105 to V-104	E-108.EA-101.		21 401 / 0.2 402	Tiasa me	37.5Kw/m2	57.82	29.81	30.6
	103 10 1-104	E-109,V-104	Large	21.50kg/s & 3,600s	Jet fire				
		L-109, v-104				4Kw/m2	71.49	64.67	64.7
					Flash fire	LFL (51974.6 ppm)	90.79	\$5.14	90.9
			Catastrophic Rupture		Jet fire	37.5Kw/m2	78.81	46.44	45.8
					Jet me	4Kw/m2	99.06	91.35	91.0
					Flash fire	LFL (51974.6 ppm)	1.79	2.18	2.27
			Small	0.054kg/s & 3,600s		37.5Kw/m2	NR	NR	NR
					Jet fire	4Kw/m2	NR	NR	NR
					71.1.0				
					Flash fire	LFL (51974.6 ppm)	7.12	9.38	10.2
			Medium	1.344kg/s & 3,600s	Jet fire	37.5Kw/m2	NR	NR	NR
8	Interconnecting p/l from V-104	Interconnecting				4Kw/m2	18.70	17.06	17.1
0	to PSA unit	P/L			Flash fire	LFL (51974.6 ppm)	60.39	58.13	63.1
			Large	21.89kg/s & 3,600s		37.5Kw/m2	58.17	58.17	30.0
					Jet fire	4Kw/m2	71.93	65.17	65.0
					Flash fire		97.68	90.75	97.1
			Catastraphia Durt		a rear till c		79.24	46.77	
			Catastrophic Rupture		Jet fire	37.5Kw/m2			46.1
					1000000000	4Kw/m2	99.64	91.93	91.6
9	Interconnecting p/l from PSA	Interconnecting	Small	0.0212kg/s & 3,600s	Flash fire	LFL (40000 ppm)	3.41	4.63	5.00
	Unit to product H2 to BL	P/L			Jet fire	37.5Kw/m2	NR	NR	NR
				Release Rate &				quence Di	stance()
No	Node	Description	Accident Scenario	Duration	Event	Impact criteria	D	B Jm/s	F 3u
							11m/s		
						4Kw/m2	NR	NR	N
				to be the second second	Flash fire	LFL (40000 ppm)	20.28	19.26	21.0
			Medium	0.531kg/s & 3,600s	Jet fire	37.5Kw/m2	NR	NR	NF
					Jet fire	4Kw/m2	19.74	20.65	20.1
			-		Flash fire	LFL (40000 ppm)	62.25	54.60	62.9
			Large	8.49kg/s & 3.600s		37.5Kw/m2	61.23	42.47	42.5
					Jet fire	4Kw/m2	70.98	74.10	73.8
					Flash fire	4KW/m2 LFL (40000 ppm)	131.43		128
					1 1abli life	Li L (40000 ppm)		115.11	
			Catastrophis Day						
			Catastrophic Rupture		Jet fire	37.5Kw/m2 4Kw/m2	156.46		202

Flammable Consequence Results for Natural gas

				Release Rate &			Conseq	uence Dist	ance(m)	
S.No	Node	Description	Accident Scenario	Duration	Event	Impact criteria	D 11m/s	B 3m/s	F 3m/s	
			Small	0.113kg/s & 3600s	Flash fire	LFL (44000 ppm)	2.39	2.72	2.92	
					Flash fire	LFL (44000 ppm)	10.50	13.62	14.90	
			Medium	2.82kg/s & 3600s	Jet fire	37.5Kw/m2	23.03	19.34	29.39	
					Jet nre	4Kw/m2	29.90	29.58	29.64	
	NG from BL to E-101A/S	Interconnecting			Flash fire	LFL (44000 ppm)	95.62	87.93	96.99	
1	NG from BL to E-101A/S	P/L, E-101A/S		Large	46.66kg/s & 3600s	Jet fire	37.5Kw/m2	53.17	67.61	67.66
					Jet fire	4Kw/m2	76.73	115.68	115.10	
					Flash fire	LFL (44000 ppm)	210.51	182.36	201.74	
			Catastrophic Rupture		Jet fire	37.5Kw/m2	142.35	118.96	118.61	
					Jet me	4Kw/m2	200.10	216.50	214.55	
			Small	0.0696kg/s & 3,600s	Flash fire	LFL (43534.9 ppm)	1.75	2.11	2.04	
					Flash fire	LFL (43534.9 ppm)	7.24	9.10	9.91	
			Medium	1.74kg/s & 3,600s	Jet fire	37.5Kw/m2	17.62	14.83	14.80	
					Jet fire	4Kw/m2	23.10	22.93	22.99	
2	Interconnecting p/l from E-	P/L, R-101,	P/L, R-101,			Flash fire	LFL (43534.9 ppm)	50.13	50.08	52.38
-	101A/S to R-101				E-102A/S	Large	27.83kg/s & 3,600s	Jet fire	37.5Kw/m2	68.77
		L-IVANO			Jet nre	4Kw/m2	91.07	91.59	91.26	
					Flash fire	LFL (43534.9 ppm)	74.35	70.96	73.59	
			Catastrophic Rupture		Jet fire	37.5Kw/m2	94.50	76.14	76.15	
					Jet fire	4Kw/m2	127.99	132.25	131.48	
3	Interconnecting p/l from R-101	Interconnecting	Small	0.0532kg/s & 3,600s	Flash fire	LFL (43737.8 ppm)	1.41	1.68	1.76	
	to R-103	P/L, R-102,			Flash fire	LFL (43737.8 ppm)	5.78	7.43	8.10	
		R-103, E-104	Medium	1.33kg/s & 3,600s	Jet fire	37.5Kw/m2	13.43	12.12	11.80	
					Jet fire	4Kw/m2	19.94	19.89	19.95	
			Large	21.29kg/s & 3,600s	Flash fire	LFL (43737.8 ppm)	39.62	40.73	42.46	
					Jet fire	37.5Kw/m2	61.59	49.15	49.21	



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	Nøde			Release Rate &				uence Dist	anec(m
S.No	Nøde	Description	Accident Scenario	Duration	Event	Impact criteria	D 11m/s	B 3m/s	F 3m
						4Kw/m2	81.02	80.99	\$0.74
					Flash fire	LFL (43737.8 ppm)	59.55	57.63	60.2
			Catastrophic Rupture			37.5Kw/m2	57.78	68.41	68.4
					Jet fire	4Kw/m2	79.81	117.27	116.6
			Small	0.054kg/s & 3,600s	Flash fire	LFL (45562.1 ppm)	1.52	1.80	1.85
			.9118011	0.004489300 0,0003	Flash fire	LFL (45562.1 ppm)	6.09	8.06	8.75
			Medium	1.34kg/s & 3,600s	110501100	37.5Kw/m2	NR	NR	NR
			Incolom		Jet fire	4Kw/m2	19.94	19.63	19.7
					Flash fire	4KW/m2 LFL (45562.1 ppm)	44.40	44.29	46.0
4	Interconnecting p/l from R-103 to R-104	P/L, R-104			Finsh fire				
	10 10-104	F/L, K=104	Large	21.48kg/s & 3,600s	Jet fire	37.5Kw/m2	61.45	48.55	48.6
						4Kw/m2	79.94	78.95	78.7
			127 C 127 C 127 C		Flash fire	LFL (45562.1 ppm)	65.21	62.43	64.5
			Catastrophic Rupture		Jet fire	37.5Kw/m2	84.84	67.34	67.3
						4Kw/m2	112.58	113.84	113.3
			Small	0.0428kg/s & 3,600s	Flash fire	LFL (48485 ppm)	1.87	2.33	2.45
				1.07kg/s & 3,600s	Flash fire	LFL (48485 ppm)	7.29	10.37	11.5
			Medium	1.0/148/5 02 5,0005	Jet fire	37.5Kw/m2	NR	NR	NR
					Jerme	4Kw/m2	17.91	16.69	16.7
5	Interconnecting p/l from R-104	P/L, R-105.			Flash fire	LFL (48485 ppm)	53.67	52.87	54.4
2	to R-105	E-105, E-106	Large	17.14kg/s & 3,600s		37.5Kw/m2	55.13	38.05	37.2
		E=105, E=106			Jet fire	4Kw/m2	69.63	65.10	65.0
					Flash fire	LFL (48485 ppm)	78.03	72.69	75.7
			Catastrophic Rupture			37.5Kw/m2	76.78	54.09	53.3
					Jet fire	4Kw/m2	96.70	92.58	92.2
б	Interconnecting p/l from R-	Interconnecting	Small	0.054kg/s & 3,600s	Flash fire	LFL (49492.6 ppm)	1.98	2.39	2.45
0	105 to V-104	P/L, E-107,	Medium	1.26kg/s & 3.600s	Flash fire	LFL (49492.6 ppm)	7.68	10.67	11.8
		E-108,EA-101,	Predicin	1.2042 7 00 5,000 5	Jet fire	37.5Kw/m2	NR	NR	NR
		,			Jet tire	37.3Kw/m2	NR	NR	INR
e ac	1.000.02.0	198. 000000	100 901 Pc2 1100	Release Rate &	1440 1 2	AL 1 2 30 101		uence Dis	tance(t
5.No	Node	Description	Accident Scenario	Duration	Event	Impact criteria	D	B 3m/s	F 3m
		E-109,V-104				111 / 2	11m/s	17.22	17.2
		E-109, V-104				4Kw/m2	18.74		
					Flash fire	LFL (49492.6 ppm)	63.76	61.56	65.6
			Large	20.17kg/s & 3,600s	Jet fire	37.5Kw/m2	57.73	34.42 66.09	33.3
						4Kw/m2	71.91		
					Flash fire	LFL (49492.6 ppm)	96.21	\$9.10	93.5
			Catastrophic Rupture		Jet fire	37.5Kw/m2	78.23	51.22	
			Catastrophic Rupture		Jet fire	37.5Kw/m2 4Kw/m2	78.23 99.57	51.22 93.51	
			Catastrophic Rupture Small	0.054kg/s & 3,600s	Jet fire Flash fire				93.1
					Flash fire	4Kw/m2 LFL (49414.7 ppm)	99.57	93.51	93.1
			Small	0.054kg/s & 3,600s	Flash fire Flash fire	4Kw/m2 LFL (49414.7 ppm) LFL (49414.7 ppm)	99.57 2.03 7.86	93.51 2.43 10.93	93.1 2.5 12.1
_					Flash fire	4Kw/m2 LFL (49414.7 ppm) LFL (49414.7 ppm) 37.5Kw/m2	99.57 2.03 7.86 NR	93.51 2.43 10.93 NR	93.1 2.5 12.1 NF
,	Interconnecting p/l from V-104	Interconnecting	Small		Flash fire Flash fire Jet fire	4Kw/m2 LFL (49414.7 ppm) LFL (49414.7 ppm) 37.5Kw/m2 4Kw/m2	99.57 2.03 7.86 NR 18.89	93.51 2.43 10.93 NR 17.36	93.1 2.5 12.1 NF 17.4
7	Interconnecting p/l from V-104 to PSA unit	Interconnecting P/L	Small Medium	1.26kg/s & 3,600s	Flash fire Flash fire Jet fire Flash fire	4Kw/m2 LFL (49414.7 ppm) LFL (49414.7 ppm) 37.5Kw/m2 4Kw/m2 LFL (49414.7 ppm)	99.57 2.03 7.86 NR 18.89 67.15	93.51 2.43 10.93 NR 17.36 64.13	93.1 2.5 12.1 NR 17.4 68.8
7			Small		Flash fire Flash fire Jet fire	4Kw/m2 LFL (49414.7 ppm) 1.FL (49414.7 ppm) 37.5Kw/m2 4.Kw/m2 1.FL (49414.7 ppm) 37.5Kw/m2	99.57 2.03 7.86 NR 18.89 67.15 37.16	93.51 2.43 10.93 NR 17.36 64.13 34.78	93.1 2.5 12.1 NF 17.4 68.8 33.7
7			Small Medium	1.26kg/s & 3,600s	Flash fire Flash fire Jet fire Flash fire Jet fire	4Kw/m2 LFL (49414.7 ppm) 1.FL (49414.7 ppm) 37.5Kw/m2 4.Kw/m2 1.FL (49414.7 ppm) 37.5Kw/m2 4.Kw/m2	99.57 2.03 7.86 NR 18.89 67.15 37.16 72.35	93.51 2.43 10.93 NR 17.36 64.13 34.78 66.53	93.1 2.5 12.1 NF 17.4 68.9 33.1 66.4
7			Small Medium Large	1.26kg/s & 3,600s	Flash fire Flash fire Jet fire Flash fire Jet fire Flash fire	4Kw/m2 LFL (49414.7 ppm) 1.FL (49414.7 ppm) 37.5Kw/m2 4.Kw/m2 1.FL (49414.7 ppm) 37.5Kw/m2 4.Kw/m2 1.FL (49414.7 ppm)	99.57 2.03 7.86 NR 18.89 67.15 37.16 72.35 102.66	93.51 2.43 10.93 NR 17.36 64.13 34.78 66.53 93.36	93.1 2.5: 12.1 NR 17.4 68.8 33.7 66.4 98.5
7			Small Medium	1.26kg/s & 3,600s	Flash fire Flash fire Jet fire Flash fire Jet fire	4Kw/m2 LFL (49414.7 ppm) 1.FL (49414.7 ppm) 37.5Kw/m2 1.FL (49414.7 ppm) 37.5Kw/m2 4.Kw/m2 1.FL (49414.7 ppm) 37.5Kw/m2 37.5Kw/m2	99.57 2.03 7.86 NR 18.89 67.15 37.16 72.35 102.66 78.61	93.51 2.43 10.93 NR 17.36 64.13 34.78 66.53 93.36 51.66	93.1 2.5 12.1 NF 17.4 68.8 33.7 66.4 98.5 50.5
	to PSA unit	Ρ/L	Small Medium Large	1.26kg/s & 3,600s	Flash fire Flash fire Jet fire Jet fire Jet fire Flash fire Jet fire	4Kw/m2 LFL (49414.7 ppm) LFL (49414.7 ppm) 37.5Kw/m2 LFL (49414.7 ppm) 37.5Kw/m2 LFL (49414.7 ppm) 37.5Kw/m2 LFL (49414.7 ppm) 37.5Kw/m2	99.57 2.03 7.86 NR 18.89 67.15 37.16 72.35 102.66 78.61 100.13	93.51 2.43 10.93 NR 17.36 64.13 34.78 66.53 93.36 51.66 94.13	93.1 2.5: 12.1 NR 17.4 68.8 33.7 66.4 98.5 50.5 93.8
7	to PSA unit Interconnecting p1 from PSA		Small Medium Large Catastrophic Rupture	1.26kg/s & 3,600s 20.41kg/s & 3,600s	Flash fire Flash fire Jet fire Jet fire Jet fire Flash fire Jet fire Flash fire	4Kw/m2 LFL (49414.7 ppm) 1FL (49414.7 ppm) 37.5Kw/m2 4Kw/m2 1FL (49414.7 ppm) 37.5Kw/m2 1FL (49414.7 ppm) 37.5Kw/m2 1FL (49000 ppm) 1FL (40000 ppm)	99.57 2.03 7.86 NR 18.89 67.15 37.16 72.35 102.66 78.61 100.13 3.41	93.51 2.43 10.93 NR 17.36 64.13 34.78 66.53 93.36 51.66 94.13 4.63	93.1 2.5: 12.1 NR 17.4 68.8 33.7 66.4 98.5 50.5 93.8 5.0
	to PSA unit	P/L Interconnecting	Small Medium Large	1.26kg/s & 3,600s	Flash fire Flash fire Jet fire Jet fire Jet fire Flash fire Jet fire	4Kw/m2 LFL (49414.7 ppm) LFL (49414.7 ppm) 37.5Kw/m2 4Kw/m2 LFL (49414.7 ppm) 37.5Kw/m2 4Kw/m2 LFL (49414.7 ppm) 37.5Kw/m2 1EFL (4000 ppm) 37.5Kw/m2	99.57 2.03 7.86 NR 18.89 67.15 37.16 72.35 102.65 102.61 100.13 3.41 NR	93.51 2.43 10.93 NR 17.36 64.13 34.78 66.53 93.36 51.66 94.13 4.63 NR	93.1 2.5 12.1 NF 17.4 68.5 33.7 66.4 98.9 50.5 93.8 5.0 NF
	to PSA unit Interconnecting p1 from PSA	P/L Interconnecting	Small Medium Large Catastrophic Rupture	1.26kg/s & 3,600s 20.41kg/s & 3,600s	Flash fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire	4Kw/m2 LFL (49414.7 ppm) 37.5Kw/m2 4Kw/m2 LFL (49414.7 ppm) 37.5Kw/m2 4Kw/m2 LFL (49414.7 ppm) 37.5Kw/m2 LFL (49414.7 ppm) 37.5Kw/m2 LFL (40000 ppm) 37.5Kw/m2 4Kw/m2	99.57 2.03 7.86 NR 18.89 67.15 37.16 72.35 102.65 102.66 100.13 3.41 NR NR	93.51 2.43 10.93 NR 17.36 64.13 34.78 66.53 93.36 51.66 94.13 4.63 NR NR	93.1 2.5 12.1 NF 17.4 68.8 33.7 66.4 98.5 50.9 93.8 5.0 NF NF
	to PSA unit Interconnecting p1 from PSA	P/L Interconnecting	Small Medium Large Catastrophic Rupture Small	1.26kg/s & 3,600s 20.41kg/s & 3,600s 0.0212kg/s & 3,600s	Flash fire Flash fire Jet fire Flash fire Jet fire Flash fire Flash fire Jet fire Flash fire Flash fire	4Kw/m2 LFL (49414.7 ppm) 37.5Kw/m2 4Kw/m2 LFL (49414.7 ppm) 37.5Kw/m2 4Kw/m2 LFL (49414.7 ppm) 37.5Kw/m2 4Kw/m2 LFL (40000 ppm) 37.5Kw/m2 4Kw/m2 LFL (40000 ppm)	99.57 2.03 7.86 NR 18.89 67.15 37.16 72.35 102.66 78.61 100.13 3.41 NR NR NR NR 20.28	93.51 2.43 10.93 NR 17.36 64.13 34.78 66.53 93.36 51.66 94.13 4.63 NR NR 19.26	93.1 2.5 12.1 NF 17.4 68.5 33.7 66.4 98.5 50.5 93.8 5.0 NF NF 21.0
	to PSA unit Interconnecting p1 from PSA	P/L Interconnecting	Small Medium Large Catastrophic Rupture	1.26kg/s & 3,600s 20.41kg/s & 3,600s	Flash fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire	4Kwm2 LFL (49414.7 ppm) LFL (49414.7 ppm) 37.5Kwim2 4Kwim2 LFL (49414.7 ppm) 37.5Kwim2 LFL (49414.7 ppm) 37.5Kwim2 LFL (49414.7 ppm) 37.5Kwim2 LFL (40000 ppm) 37.5Kwim2	99.57 2.03 7.86 NR 18.89 67.15 37.16 72.35 102.66 78.61 100.13 3.41 NR NR 20.28 NR	93.51 2.43 10.93 NR 17.36 64.13 34.78 66.53 93.36 51.66 94.13 4.63 NR NR NR NR NR NR NR NR NR	93.1 2.5 12.1 NF 17.4 68.5 33.7 66.4 98.5 50.5 93.8 5.0 NF 21.0 NF
	to PSA unit Interconnecting p1 from PSA	P/L Interconnecting	Small Medium Large Catastrophic Rupture Small	1.26kg/s & 3,600s 20.41kg/s & 3,600s 0.0212kg/s & 3,600s	Flash fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire	4Kwm2 LFL (4414.7 ppm) 1FL (4414.7 ppm) 37.5Kwim2 4Kwim2 LFL (4414.7 ppm) 37.5Kwim2 4Kwim2 LFL (44014.7 ppm) 37.5Kwim2 4Kwim2 LFL (40000 ppm) 37.5Kwim2 4Kwim2 4Kwim2	99.57 2.03 7.86 NR 18.89 67.15 37.16 72.35 102.66 78.61 100.13 3.41 NR NR 20.28 NR 19.74	93.51 2.43 10.93 NR 17.36 64.13 34.78 66.53 93.36 51.66 94.13 4.63 NR NR 19.26 NR 19.26	93.1 2.5 12.1 NF 17.4 68.6 33.7 66.4 98.5 50.5 93.8 5.0 93.8 5.0 NF NF 21.0 NF 20.7
	to PSA unit Interconnecting p1 from PSA	P/L Interconnecting	Small Medium Catistrophic Rupture Small Medium	1.26kg/s & 3,600s 20.41kg/s & 3,600s 0.0212kg/s & 3,600s 0.531kg/s & 3,600s	Flash fire Flash fire Jet fire Flash fire Jet fire Flash fire Flash fire Jet fire Flash fire Flash fire Flash fire	4Kw/m2 LJF. (4444.7 ppm) 12F. (4441.47 ppm) 137.5Kw/m2 LJF. (4441.47 ppm) 137.5Kw/m2 LJF. (4401.47 ppm) 137.5Kw/m2 LJF. (44000 ppm) 137.5Kw/m2 LJF. (40000 ppm) 137.5Kw/m2 LJF. (40000 ppm) 137.5Kw/m2 LJF. (40000 ppm)	99.57 2.03 7.86 NR 18.89 67.15 37.16 72.35 102.66 78.61 100.13 3.41 NR NR 20.28 NR 19.74 62.25	93.51 2.43 10.93 NR 17.36 64.13 34.78 66.53 93.36 51.66 94.13 4.63 NR NR NR 19.26 NR 20.66 54.60	93.1 2.5 12.1 NR 17.4 68.8 33.7 66.4 98.5 50.5 93.8 5.0 NR NR 21.0 NR 21.0 NR 21.0 NR 21.0 NR
	to PSA unit Interconnecting p1 from PSA	P/L Interconnecting	Small Medium Large Catastrophic Rupture Small	1.26kg/s & 3,600s 20.41kg/s & 3,600s 0.0212kg/s & 3,600s	Flash fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire	4Kwm2 LFL (4414.7 ppm) 1FL (4414.7 ppm) 37.5Kwim2 4Kwim2 LFL (4414.7 ppm) 37.5Kwim2 4Kwim2 LFL (44014.7 ppm) 37.5Kwim2 4Kwim2 LFL (40000 ppm) 37.5Kwim2 4Kwim2 4Kwim2	99.57 2.03 7.86 NR 18.89 67.15 37.16 72.35 102.66 78.61 100.13 3.41 NR NR 20.28 NR 19.74	93.51 2.43 10.93 NR 17.36 64.13 34.78 66.53 93.36 51.66 94.13 4.63 NR NR 19.26 NR 19.26	93.1 2.5 12.1 NF 17.4 68.8 33.5 50.5 93.8 50.5 93.8 50.0 NF 21.0 NF 21.0 NF 21.0 21.0 20.5 20.5 20.5 20.5 20.5 20.5 20.5 20
	to PSA unit Interconnecting p1 from PSA	P/L Interconnecting	Small Medium Catistrophic Rupture Small Medium	1.26kg/s & 3,600s 20.41kg/s & 3,600s 0.0212kg/s & 3,600s 0.531kg/s & 3,600s	Flash fire Flash fire Jet fire Flash fire Jet fire Flash fire Flash fire Jet fire Flash fire Flash fire Flash fire	4Kwim2 LFL (4944.47 ppm) LFL (4444.7 ppm) 17.5Kwim2 LFL (4444.7 ppm) 7.5Kwim2 4Kwim2 LFL (4444.7 ppm) 17.5Kwim2 4Kwim2 LFL (4444.7 ppm) 17.5Kwim2 4Kwim2 LFL (4000 ppm) 17.5Kwim2 4Kwim2 LFL (40000 ppm) 17.5Kwim2 4Kwim2 LFL (40000 ppm) 17.5Kwim2 LFL (40000 ppm) 17.5Kwim2	99.57 2.03 7.86 NR 18.89 67.15 37.16 72.35 102.66 78.61 100.13 3.41 NR NR 20.28 NR 19.74 62.25 61.23	93.51 2.43 10.93 NR 17.36 64.13 34.78 66.53 93.36 51.66 94.13 4.63 NR NR NR NR NR 19.20 NR 20.66 54.60 42.47	93.1 2.5 12.1 NR 17.4 68.8 33.7 66.4 98.5 50.5 93.8 5.0 NR 21.0 NR 21.0 NR 21.0 NR 21.0 NR 21.0 20.7 62.9
8	to PSA unit Interconnecting pT from PSA Unit to product H2 to BL	P/L Interconnecting	Small Medium Catistrophic Rupture Small Medium	1.26kg/s & 3,609s 20.41kg/s & 3,600s 0.0212kg/s & 3,600s 0.531kg/s & 3,600s 8.49kg/s & 3,600s	Flash fire Flash fire Jet fire Flash fire Jet fire Flash fire Flash fire Jet fire Flash fire Flash fire Flash fire	4Kwim2 LFL (4944.47 ppm) LFL (4444.7 ppm) 17.5Kwim2 LFL (4444.7 ppm) 7.5Kwim2 4Kwim2 LFL (4444.7 ppm) 17.5Kwim2 4Kwim2 LFL (4444.7 ppm) 17.5Kwim2 4Kwim2 LFL (4000 ppm) 17.5Kwim2 4Kwim2 LFL (40000 ppm) 17.5Kwim2 4Kwim2 LFL (40000 ppm) 17.5Kwim2 LFL (40000 ppm) 17.5Kwim2	99.57 2.03 7.86 NR 18.80 67.15 37.16 72.35 102.66 78.61 100.13 3.41 NR NR NR 20.28 NR 19.74 62.25 61.23 70.98	93.51 2.43 10.93 NR 17.36 64.13 34.78 66.53 93.36 51.66 94.13 4.63 NR NR NR NR NR 19.20 NR 20.66 54.60 42.47	93.1 2.5 12.1 NR 17.4 68.8 33.7 66.4 98.5 50.5 93.8 5.0 NR NR 21.0 NR R 21.0 NR R 21.0 NR R 21.7 2 73.8
	to PSA unit Interconnecting pT from PSA Unit to product H2 to BL	P/L Interconnecting	Small Medium Catistrophic Rupture Small Medium	1.20kg/s & 3,600s 20.41kg/s & 3,600s 0.0212kg/s & 3,600s 0.531kg/s & 3,600s 8.40kg/s & 3,600s R.40kg/s & 3,600s	Flash fire Flash fire Jet fire Flash fire Jet fire Flash fire Flash fire Jet fire Flash fire Flash fire Flash fire	4Kwim2 LFL (4944.47 ppm) LFL (4444.7 ppm) 17,5Kwim2 LFL (4444.7 ppm) 75,5Kwim2 4Kwim2 LFL (4444.7 ppm) 17,5Kwim2 LFL (4444.7 ppm) 17,5Kwim2 LFL (4444.7 ppm) 17,5Kwim2 LFL (40000 ppm) 17,5Kwim2	99.57 2.03 7.86 NR 18.80 67.15 37.16 72.35 102.66 78.61 100.13 3.41 NR NR 20.28 NR 19.74 62.25 61.23 70.98 Conseq D	93.51 2.43 10.93 NR 17.36 64.13 34.78 66.53 93.36 51.66 94.13 4.63 NR NR NR NR 19.20 NR NR 20.66 54.60 42.47 74.10	93.1 2.5 12.1 NR 17.4 68.8 33.7 7.4 66.4 98.5 50.5 50.5 50.5 50.5 50.5 50.5 93.8 50.0 NR 21.0 NR 22.0 73.8
8	to PSA unit Interconnecting pT from PSA Unit to product H2 to BL	P/L Interconnecting P/L	Small Medium Large Catastrophic Rupture Small Medium Large	1.26kg/s & 3,609s 20.41kg/s & 3,600s 0.0212kg/s & 3,600s 0.531kg/s & 3,600s 8.49kg/s & 3,600s	Flash fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Etash fire	4K N/m2 LFL (494147 ppm) 37 5Kw/m2 LFL (494147 ppm) 77 5Kw/m2 LFL (494147 ppm) 77 5Kw/m2 LFL (494147 ppm) 77 5Kw/m2 LFL (49000 ppm) 78 5Kw/m2 LFL (40000 ppm) 74 Kw/m2 LFL (40000 ppm) 73 5Kw/m2 LFL (49000 ppm) 74 5Kw/m2 LFL (49000 ppm) 75 5Kw/m2 LFL (4900 ppm) 75 5Kw/m	99.57 2.03 7.86 NR 18.80 67.15 37.16 72.35 102.66 78.61 100.13 3.41 NR NR NR NR NR NR NR 19.74 62.25 61.23 70.98 Conseq D 111m/s	93.51 2.43 10.93 NR 17.36 64.13 34.78 66.53 93.36 51.66 94.13 4.63 NR 19.26 NR 19.26 NR 20.66 54.60 VR 24.7 74.10	93.1 2.5 12.1 NR 17.4 68.8 33.7 66.4 98.5 50.5 50.5 50.0 83.8 93.8 50.0 NR 21.0 21.0 21.0 21.0 21.0 21.0 21.0 21.0
8	to PSA unit Interconnecting pT from PSA Unit to product H2 to BL	P/L Interconnecting P/L	Accident Scenario	1.20kg/s & 3,600s 20.41kg/s & 3,600s 0.0212kg/s & 3,600s 0.531kg/s & 3,600s 8.40kg/s & 3,600s R.40kg/s & 3,600s	Flash fire Flash fire Jet fire Flash fire Jet fire Flash fire Flash fire Jet fire Flash fire Jet fire Jet fire Jet fire	4K Nvm2 LFL (4414.7 ppm) JFL (4414.7 ppm) J7.5Kw/m2 4K.Nvm2 LFL (4414.7 ppm) J7.5Kw/m2 LFL (4414.7 ppm) J7.5Kw/m2 4K.Nvm2 LFL (40000 ppm) J7.5Kw/m2 4K.Nvm2 LFL (40000 ppm) J7.5Kw/m2 4K.Nvm2 LFL (40000 ppm)	99.57 2.03 7.86 NR 18.80 67.15 37.16 72.35 102.66 78.61 100.13 3.41 NR NR 20.28 NR 19.74 62.25 61.23 70.98 Conseq D 11m/s 131.43	93.51 2.43 10.93 NR 17.36 64.13 34.78 93.36 51.66 94.13 4.63 NR 19.26 NR 19.26 NR 19.26 NR 19.26 S4.60 42.47 74.10 Rence Dist B3m/s 113.11	93.1 2.5 12.1 NR 17.4 68.8 33.7 66.4 98.5 50.5 50.5 93.8 50.0 NR 21.0 21.0 NR 21.0 21.0 73.8 500 NR NR NR 21.0 73.8 73.8 73.8 73.8
8	to PSA unit Interconnecting pT from PSA Unit to product H2 to BL	P/L Interconnecting P/L	Small Medium Large Catastrophic Rupture Small Medium Large	1.20kg/s & 3,600s 20.41kg/s & 3,600s 0.0212kg/s & 3,600s 0.531kg/s & 3,600s 8.40kg/s & 3,600s R.40kg/s & 3,600s	Flash fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Etash fire	4K N/m2 LFL (494147 ppm) 37 5Kw/m2 LFL (494147 ppm) 77 5Kw/m2 LFL (494147 ppm) 77 5Kw/m2 LFL (494147 ppm) 77 5Kw/m2 LFL (49000 ppm) 78 5Kw/m2 LFL (40000 ppm) 74 Kw/m2 LFL (40000 ppm) 73 5Kw/m2 LFL (49000 ppm) 74 5Kw/m2 LFL (49000 ppm) 75 5Kw/m2 LFL (4900 ppm) 75 5Kw/m	99.57 2.03 7.86 NR 18.80 67.15 37.16 72.35 102.66 78.61 100.13 3.41 NR NR NR NR NR NR NR 19.74 62.25 61.23 70.98 Conseq D 111m/s	93.51 2.43 10.93 NR 17.36 64.13 34.78 66.53 93.36 51.66 94.13 4.63 NR 19.26 NR 19.26 NR 20.66 54.60 VR 24.7 74.10	93.1 2.5 12.1 NR 17.4 68.8 33.7 66.4 98.5 50.5 50.5 50.0 83.8 93.8 50.0 NR 21.0 21.0 21.0 21.0 21.0 21.0 21.0 21.0

Flammable Consequence Results for RF Gas

				Release Rate &			Conseq	uence Dis	iance(m)								
S.No	Node	Description	Accident Scenario	Duration	Event	Impact criteria	D 11m/s	B3m/s	F 3m/s								
			Small	0.1124kg/s & 3600s	Flash fire	LFL (33243.2 ppm)	2.81	3.66	3.86								
					Flash fire	LFL (33243.2 ppm)	14.87	18.87	20.91								
			Medium	2.81kg/s & 3600s	Jet fire	37.5Kw/m2	22.92	7.23	19.42								
					Jet life	4Kw/m2	29.83	29.60	29.66								
		Interconnecting P/L,E-101A/S			Flash fire	LFL (33243.2 ppm)	136.57	115.62	125.04								
1	RFG from BL to E-101A/S			Large	46.41kg/s & 3,600s	Jet fire	37.5Kw/m2	om) 136.57 115.62 125 84.30 67.70 67.	67.78								
					Jet fire	4Kw/m2	113.50	116.17	115.58								
					Flash fire	LFL (33243.2 ppm)	272.04	224.62	249.99								
			Catastrophic Rupture		Jet fire	37.5Kw/m2	142.59	119.24	118.96								
			Catastroprac Rupture			4Kw/m2	200.99	217.65	215.68								
					Explosion	0.3bar	NH	NH	294.33								
			Small	0.0704kg/s & 3,600s	Flash fire	LFL (33243.2 ppm)	2.13	2.50	2.65								
		Interconnecting P/L, R-101, E-102A/S			Flash fire	LFL (33243.2 ppm)	8.83	11.94	13.25								
			P/L, R-101,	P/L, R-101,	Medium	1.76kg/s & 3,600s	Jet fire	37.5Kw/m2	17.73	15.03	15.03						
					Interneting			Interneties			Jet fire	4Kw/m2	23.19	23.11	23.11		
2	Interconnecting p/l from E-						Flash fire	LFL (33243.2 ppm)	60.45	57.49	59.91						
4	101A/S to R-101					Large	28.14kg/s & 3,600s	Jet fire	37.5Kw/m2	69.10	55.16	55.37					
						E-102A/S	E-102A/S	E-102A/S	E-102A/S	E-102A/S	E-102A/S	E-102A/S	E-102A/S	E-102A/S			Jet fire
					Flash fire	LFL (33243.2 ppm)	84.91	79.12	83.29								
			Catastrophic Rupture		Jet fire	37.5Kw/m2	95.01	76.72	76.73								
					Jet fire	4Kw/m2	129.11	133.70	132.90								
3	Interconnecting p/l from R-101	Interconnecting	Small	0.0552kg/s & 3,600s	Flash fire	LFL (33243.2 ppm)	1.86	2.08	2.23								
	to R-103	P/L, R-102,			Flash fire	LFL (33243.2 ppm)	7.15	9.79	11.03								
		R-103, E-104	Medium	1.38kg/s & 3,600s	Jet fire	37.5Kw/m2	14.81	12.80	12.67								
		10100, 2 101					Jet fire	4Kw/m2	20.30	20.30	20.36						
			Large	22.09kg/s & 3,600s	Flash fire	LFL (33243.2 ppm)	48.75	47.65	50.04								



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				Release Rate &				quence Dis	tamte(i
No	Node	Description	Accident Scenario	Duration	Event	Impact criteria	D 11m/s	B3m/s	F 3m
						37.5Kw/m2	62.49	49.98	50.1
					Jet fire	4Kw/m2	82.51	82.72	82.4
					Flash fire	LFL (33243.2 ppm)	69.34	65.36	69.
			Catastrophic Rupture			37.5Kw/m2	86.58	69.61	69.0
					Jet fire	4Kw/m2	116.80	119.86	119.
			Small	0.0524kg/s & 3,600s	Flash fire	LFL (46325.4 ppm)	1.56	1.84	1.9
			Jinau	0.0024429142 0,0001	Flash fire	LFL (46325.4 ppm)	6.23	8.15	8.9
			Medium	1.311kg/s & 3.600s		37.5Kw/m2	NR	NR	N
			Meanum	1.51 Ikg/s & 5,0005	Jet fire	4Kw/m2	19.63	19.17	19.
					71.1.0	LFL (46325.4 ppm)	44.56		
4	Interconnecting p/1 from R-103	Interconnecting			Flash fire			44.60	46.
	to R-104	P/L, R-104	Large	20.98kg/s & 3,600s	Jet fire	37.5Kw/m2	60.61	47.46	47.
						4Kw/m2	78.27	76.61	76.4
					Flash fire	LFL (46325.4 ppm)	65.39	62.53	64.
			Catastrophic Rupture	-	Jet fire	37.5Kw/m2	83.57	65.74	65.
					rettate	4Kw/m2	109.98	110.22	109.
			Small	0.0427kg/s & 3,600s	Flash fire	LFL (48574.1 ppm)	1.87	2.34	2.4
					Flash fire	LFL (48574.1 ppm)	7.30	10.40	11.3
			Medium	1.067kg/s & 3,600s		37.5Kw/m2	NR	NR	N
		-	meanin	1.007129.412 3,0004	Jet fire	4Kw/m2	17.87	16.63	16.
5	Interconnecting p/l from R-104	Interconnecting			Flash fire	LFL (48574.1 ppm)	53.68	52.86	54.
>	to R-105	P/L, R-105, E-105, E-106		17.08kg/s & 3.600s	r lasti fire		55.09	37.51	
		E-105, E-100	Large		Jet fire	37.5Kw/m2			36.
						4Kw/m2	69.43	64.79	64.
					Flash fire	LFL (48574.1 ppm)	77.96	72.95	75.
			Catastrophic Rupture		Jet fire	37.5Kw/m2	76.64	53.57	52.
						4Kw/m2	96.39	92.11	91.3
6	Interconnecting p/l from R-	Interconnecting	Small	0.045kg/s & 3,600s	Flash fire	LFL (49592.3 ppm)	1.79	2.24	2.3
				Release Rate &			Consea	uence Dist	ance(n
S.No	Node	Description	Accident Scenario	Duration	Event	Impact criteria	D	B 3m/s	F 3m
	105 to V-104	P/L E-107.			Flash fire	LFL (49592.3 ppm)	11m/s 7.01	9.61	10.6
	10310 9-104	E-108,	24.5	1 1001 / 0.0 (00	Plash fire		NR		
			Medium	1.128kg/s & 3,600s	1.0	37.5Kw/m2		NR	NR
		E4-101			Jet fire	111 1 0		1610	
		EA-101, E-109,V-104			S	4Kw/m2	17.59	16.17	16.2
		EA-101, E-109,V-104		10.02 (0.3.00	Flash fire	LFL (49592.3 ppm)	17.59 55.11	53.90	16.2 57.1
		EA-101, E-109,V-104	Large	18.06kg/s & 3,600s	S	LFL (49592.3 ppm) 37.5Kw/m2	17.59 55.11 55.24	53.90 31.68	16.2. 57.10 31.6
		EA-101, E-109,V-104	Large	18.06kg/s & 3,600s	Flash fire Jet fire	LFL (49592.3 ppm) 37.5Kw/m2 4Kw/m2	17.59 55.11 55.24 68.50	53.90 31.68 62.68	16.2 57.1 31.6 62.6
		EA-101, E-109,V-104		18.06kg/s & 3,600s	Flash fire	LFL (49592.3 ppm) 37.5Kw/m2 4Kw/m2 LFL (49592.3 ppm)	17.59 55.11 55.24 68.50 81.98	53.90 31.68 62.68 76.77	16.2 57.1 31.6 62.6 80.5
		EA-101, E-109,V-104	Large Catastrophic Rupture	18.06kg/s & 3,600s	Flash fire Jet fire	LFL (49592.3 ppm) 37.5Kw/m2 4Kw/m2 LFL (49592.3 ppm) 37.5Kw/m2	17.59 55.11 55.24 68.50 81.98 75.14	53.90 31.68 62.68 76.77 47.91	16.2 57.1 31.6 62.6 80.5 46.7
		EA-101, E-109,V-104	Catastrophic Rupture		Flash fire Jet fire Flash fire Jet fire	LFL (49592.3 ppm) 37.5Kw/m2 4Kw/m2 LFL (49592.3 ppm) 37.5Kw/m2 4Kw/m2	17.59 55.11 55.24 68.50 81.98 75.14 95.09	53.90 31.68 62.68 76.77 47.91 88.75	16.2 57.1 31.6 62.6 80.5 46.7 88.4
		EA-101, E-109,V-104		18.06kg/s & 3,600s	Flash fire Jet fire Flash fire Jet fire Flash fire	LFL (49592.3 ppm) 37.5Kw/m2 4Kw/m2 LFL (49592.3 ppm) 37.5Kw/m2 4Kw/m2 LFL (49503.1 ppm)	17.59 55.11 55.24 68.50 81.98 75.14 95.09 2.02	53.90 31.68 62.68 76.77 47.91 88.75 2.43	16.2 57.1 31.6 62.6 80.5 46.7 88.4 2.53
		EA-101, E-109,V-104	Catastrophic Rupture Small	0.0511kg/s & 3,600s	Flash fire Jet fire Flash fire Jet fire	LFL (49592.3 ppm) 37.5Kw/m2 4Kw/m2 LFL (49592.3 ppm) 37.5Kw/m2 4Kw/m2 LFL (49503.1 ppm) LFL (49503.1 ppm)	17.59 55.11 55.24 68.50 81.98 75.14 95.09 2.02 7.86	53.90 31.68 62.68 76.77 47.91 88.75 2.43 10.94	16.2 57.1 31.6 62.6 80.5 46.7 88.4 2.55 12.1
		EA-101, E-109,V-104	Catastrophic Rupture		Flash fire Jet fire Flash fire Jet fire Flash fire Flash fire	LFL (49592.3 ppm) 37.5Kw/m2 4Kw/m2 LFL (49592.3 ppm) 37.5Kw/m2 4Kw/m2 LFL (49503.1 ppm) LFL (49503.1 ppm) 37.5Kw/m2	17.59 55.11 55.24 68.50 81.98 75.14 95.09 2.02 7.86 NR	53.90 31.68 62.68 76.77 47.91 88.75 2.43 10.94 NR	16.2 57.1 31.6 62.6 80.5 46.7 88.4 2.5 12.1 NR
		EA-101, E-109,V-104	Catastrophic Rupture Small	0.0511kg/s & 3,600s	Flash fire Jet fire Flash fire Jet fire Flash fire Flash fire Jet fire	LFL (49592.3 ppm) 37.5Kw/m2 4Kw/m2 LFL (49592.3 ppm) 37.5Kw/m2 4Kw/m2 LFL (49503.1 ppm) LFL (49503.1 ppm) 37.5Kw/m2 4Kw/m2	17.59 55.11 55.24 68.50 81.98 75.14 95.09 2.02 7.86 NR 18.84	53.90 31.68 62.68 76.77 47.91 88.75 2.43 10.94 NR 17.28	16.2 57.1 31.6 62.6 80.5 46.7 88.4 2.5 12.1 NR 17.3
-	Interconnecting p1 from V-104	E-109,V-104	Catastrophic Rupture Small	0.0511kg/s & 3,600s	Flash fire Jet fire Flash fire Jet fire Flash fire Flash fire	LFL (49592.3 ppm) 37.5Kw/m2 4Kw/m2 LFL (49592.3 ppm) 37.5Kw/m2 4Kw/m2 LFL (49503.1 ppm) LFL (49503.1 ppm) 37.5Kw/m2	17.59 55.11 55.24 68.50 81.98 75.14 95.09 2.02 7.86 NR	53.90 31.68 62.68 76.77 47.91 88.75 2.43 10.94 NR	16.2 57.1 31.6 62.6 80.5 46.7 88.4 2.5 12.1 NR 17.3
7	Interconnecting p1 from V-104 to P5A unit	E-109,V-104	Catastrophic Rupture Small	0.0511kg/s & 3,600s	Flash fire Jet fire Flash fire Flash fire Flash fire Jet fire Jet fire Flash fire	LFL (49592.3 ppm) 37.5Kw/m2 4Kw/m2 LFL (49592.3 ppm) 37.5Kw/m2 LFL (49503.1 ppm) LFL (49503.1 ppm) LFL (49503.1 ppm) 37.5Kw/m2 LFL (49503.1 ppm) 37.5Kw/m2	17.59 55.11 55.24 68.50 81.98 75.14 95.09 2.02 7.86 NR 18.84 67.11 57.99	53.90 31.68 62.68 76.77 47.91 88.75 2.43 10.94 NR 17.28 64.09 34.06	16.2 57.1 31.6 62.6 80.5 46.7 88.4 2.53 12.1 NR 17.3 68.8 33.0
7	Interconnecting p1 from V-104 to PSA unit	E-109,V-104	Catastrophic Rupture Small Medium	0.051kg/s & 3,600s 1.27kg/s & 3,600s	Flash fire Jet fire Flash fire Jet fire Flash fire Flash fire Jet fire	LFL (49592.3 ppm) 37.5Kwim2 4Kwim2 LFL (49592.3 ppm) 37.5Kwim2 LFL (49593.1 ppm) LFL (49503.1 ppm) J.FL (49503.1 ppm) 37.5Kwim2 4Kwim2 LFL (49503.1 ppm) 37.5Kwim2 4Kwim2	17.59 55.11 55.24 68.50 81.98 75.14 95.09 2.02 7.86 NR 18.84 67.11	53.90 31.68 62.68 76.77 47.91 88.75 2.43 10.94 NR 17.28 64.09	16.2 57.1 31.6 62.6 80.5 46.7 88.4 2.53 12.1 NR 17.3 68.8 33.0
7	Interconnecting p1 from V-104 to P5A unit	E-109,V-104	Catastrophic Rupture Small Medium	0.051kg/s & 3,600s 1.27kg/s & 3,600s	Flash fire Jet fire Flash fire Flash fire Flash fire Jet fire Jet fire Flash fire	LFL (49592.3 ppm) 37.5Kw/m2 4Kw/m2 LFL (49592.3 ppm) 37.5Kw/m2 LFL (49503.1 ppm) LFL (49503.1 ppm) 37.5Kw/m2 4Kw/m2 LFL (49503.1 ppm) 37.5Kw/m2 4Kw/m2 LFL (49503.1 ppm) 37.5Kw/m2 4Kw/m2 LFL (49503.1 ppm)	17.59 55.11 55.24 68.50 81.98 75.14 95.09 2.02 7.86 NR 18.84 67.11 57.99 72.12 101.46	53.90 31.68 62.68 76.77 47.91 88.75 2.43 10.94 NR 17.28 64.09 34.06 66.17 93.25	16.2 57.1 31.6 62.6 80.5 46.7 88.4 2.5 3 12.1 NR 17.3 68.8 33.0 66.1 98.3
7	Intercentering p1 from V-104 to PSA unit	E-109,V-104	Catastrophic Rupture Small Medium	0.051kg/s & 3,600s 1.27kg/s & 3,600s	Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Flash fire	LFL (49592.3 ppm) 37.5Kwim2 4Kwim2 LFL (49592.3 ppm) 37.5Kwim2 LFL (49593.1 ppm) LFL (49503.1 ppm) J.FL (49503.1 ppm) 37.5Kwim2 4Kwim2 LFL (49503.1 ppm) 37.5Kwim2 4Kwim2	17.59 55.11 55.24 68.50 81.98 75.14 95.09 2.02 7.86 NR 18.84 67.11 57.99 72.12	53.90 31.68 62.68 76.77 47.91 88.75 2.43 10.94 NR 17.28 64.09 34.06 66.17	16.2 57.1 31.6 62.6 80.5 46.7 88.4 2.5 3 12.1 NR 17.3 68.8 33.0 66.1 98.3 49.6
7	Interconnecting p1 from V-104 to PSA unit	E-109,V-104	Catastrophic Rupture Small Medium Large	0.051kg/s & 3,600s 1.27kg/s & 3,600s	Flash fire Jet fire Flash fire Flash fire Flash fire Jet fire Flash firc Jet fire	LPL (49592.3 ppn) 37.5 Kw/m2 4 Kw/m2 1 LPL (49592.3 ppn) 37.5 Kw/m2 1 LPL (49503.1 ppn) 37.5 Kw/m2 1 Kw/m2	17.59 55.11 55.24 68.50 81.98 75.14 95.09 2.02 7.86 NR 18.84 67.11 57.99 72.12 101.46	53.90 31.68 62.68 76.77 47.91 88.75 2.43 10.94 NR 17.28 64.09 34.06 66.17 93.25	16.2 57.1 31.6 62.6 80.5 46.7 88.4 2.5 3 12.1 NR 17.3 68.8 33.0 66.1 98.3 49.6
7	to PSA unit	E-100,V-104	Catastrophic Rupture Small Medium Large	0.051kg/s & 3,600s 1.27kg/s & 3,600s	Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Flash fire	LFL (49592.3 ppm) 37.5Kw/m2 4Kw/m2 LFL (49592.3 ppm) 37.5Kw/m2 LFL (49503.1 ppm) 15FL (49503.1 ppm) 37.5Kw/m2 LFL (49503.1 ppm) 37.5Kw/m2 LFL (49503.1 ppm) 37.5Kw/m2 4Kw/m2 LFL (49503.1 ppm) 37.5Kw/m2	17.59 55.11 55.24 68.50 81.98 75.14 95.09 2.02 7.86 NR 18.84 67.11 57.99 72.12 101.46 78.54	53.90 31.68 62.68 76.77 47.91 88.75 2.43 10.94 NR 17.28 64.09 34.06 66.17 93.25 50.87	16.2 57.1 31.6 62.6 80.5 46.7 88.4 2.53 12.1 NR 17.3 68.8 33.0 66.1 98.3 49.6 93.2
	to PSA unit	E-109,V-104 Interconnecting P/L	Catastrophic Rupture Small Medium Large	0.051kg/s & 3,600s 1.27kg/s & 3,600s	Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Jet fire Flash fire Jet fire Flash fire Flash fire Jet fire Flash fire	LPL (49592.3 ppn) 37.5 Kw/m2 4 Kw/m2 1 LPL (49592.3 ppn) 37.5 Kw/m2 1 LPL (49503.1 ppn) 37.5 Kw/m2 1 Kw/m2	17.59 55.11 55.24 68.50 81.98 75.14 95.09 2.02 7.86 NR 18.84 67.11 57.99 72.12 101.46 78.54 99.78	53.90 31.68 62.68 76.77 47.91 88.75 2.43 10.94 NR 17.28 64.09 34.06 66.17 93.25 50.87 93.57	16.2 57.1 31.6 62.6 80.5 46.7. 88.4 46.7 2.5 3 12.1 17.3 68.8 33.0 66.1 98.3 49.6 93.2 5.0 6
	to PSA unit	E-100,V-104	Catastrophic Rupture Small Medium Large Catastrophic Rupture	0.051kg/s & 3,600s 1.27kg/s & 3,600s 20.04kg/s & 3,600s	Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Jet fire	LPL (4992.3 gpm) 37.5Kw/m2 4Kw/m2 LFL (49692.3 ppm) 37.5Kw/m2 4Kw/m2 LFL (49903.1 ppm) 12FL (49903.1 ppm) 37.5Kw/m2 4Kw/m2 LFL (49903.1 ppm) 37.5Kw/m2 4Kw/m2 12FL (49903.1 ppm) 37.5Kw/m2 4Kw/m2 12FL (49903.1 ppm) 37.5Kw/m2 4Kw/m	17.59 55.11 55.24 68.50 81.98 75.14 95.09 2.02 7.86 NR 18.84 67.11 57.99 72.12 101.46 78.54 99.78 3.41	53.90 31.68 62.68 76.77 47.91 88.75 2.43 10.94 NR 17.28 64.09 34.06 66.17 93.25 50.87 93.57 4.63	16.2 57.10 31.60 62.69 80.51 46.7 88.40 2.53 12.19 NR 17.3 68.8 33.0 66.11 98.3 49.6
	to PSA unit	E-100,V-104	Catastrophic Rupture Small Medium Large Catastrophic Rupture	0.051kg/s & 3,600s 1.27kg/s & 3,600s 20.04kg/s & 3,600s	Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Flash fire	LFL (49952.5 gpm) 37.555w/m2 4Kwim2 LFL (49602.3 ppm) 37.55w/m2 4Kwim2 LFL (49950.3 ppm) 17.555w/m2 37.555w/m2 4Kwim2 LFL (49950.1 ppm) 37.555w/m2 LFL (49000 ppm) 37.555w/m2	17.59 55.11 55.24 68.50 81.98 75.14 95.09 2.02 7.86 NR 18.84 67.11 57.99 72.12 101.46 78.54 99.78 3.41 NR	53.90 31.68 62.68 76.77 47.91 88.75 2.43 10.94 NR 17.28 64.09 34.06 66.17 93.25 50.87 93.57 4.63 NR	16.2 57.1 31.6 62.6 80.5 46.7 88.4 2.53 12.1 17.3 16.6 88.4 2.53 12.1 17.3 66.8 83.4 99.6 6.1 19.8 33.0 06.1 19.8 35.0 06.1 19
	to PSA unit	E-100,V-104	Catastrophic Rupture Small Medium Large Catastrophic Rupture	0.051kg/s & 3,600s 1.27kg/s & 3,600s 20.04kg/s & 3,600s	Flash fire Jet fire Flash fire Flash fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Flash fire	LFL (49992.3 ppm) 37.555/win2 47.555/win2 LFL (49902.3 ppm) LFL (49903.1 ppm) LFL (49903.1 ppm) LFL (49903.1 ppm) 37.556/win2 47.66/03.1 ppm) 37.556/win2 LFL (49903.1 ppm) 37.556/win2 LFL (49000 ppm) 37.556/win2 47.66/wi	17.59 55.11 55.24 68.50 81.98 75.14 95.09 2.02 7.86 NR 18.84 67.11 57.99 72.12 101.46 78.54 99.78 3.41 NR NR	53.90 31.68 62.68 76.77 47.91 88.75 2.43 10.94 NR 17.28 64.09 34.06 66.17 93.25 50.87 93.57 4.63 NR NR	16.2 57.1 31.6 62.6 80.5 46.7 88.4 2.53 12.1 17.3 16.6 88.4 2.53 12.1 17.3 66.8 83.4 99.6 6.1 19.8 33.0 06.1 19.8 35.0 06.1 19
	to PSA unit	E-100,V-104	Catastrophic Rapture Small Medium Large Catastrophic Rapture Small	0.051kg/s & 3.600s 1.27kg/s & 3.600s 20.04kg/s & 3.600s 0.0212kg/s & 3.600s	Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Jet fire Flash fire Jet fire Flash fire Jet fire Jet fire Jet fire	LFL (49952.5 ppm) 37.5558/win2 4Kwim2 LFL (49652.3 ppm) 37.556/wim2 4Kwim2 LFL (49563.1 ppm) 17.5558/min2 12.66953.1 ppm) 37.5558/min2 LFL (49963.1 ppm) 37.5558/min2 LFL (49600 ppm) 37.5568/min2 LFL (40000 ppm)	17.59 55.11 55.24 68.50 81.98 75.14 95.09 2.02 7.86 NR 18.84 67.11 57.99 72.12 101.46 78.54 99.78 3.41 NR 20.28	53.90 31.68 62.68 76.77 47.91 88.75 2.43 10.94 NR 17.28 64.09 34.06 66.17 93.25 50.87 4.63 NR NR NR NR NR NR NR	16.2 57.1 31.6 62.0 80.5 46.7. 88.4 2.53 12.1 NR 17.3 66.8 33.0 66.1 98.3 349.6 93.2 5.00 NR NR NR 21.0 NR
	to PSA unit	E-100,V-104	Catastrophic Rupture Small Medium Large Catastrophic Rupture Small Medium	0.0511kg/s & 3.600s 1.271kg/s & 3.600s 20.04kg/s & 3.600s 0.0212kg/s & 3.600s 0.0212kg/s & 3.600s	Flash fire Jet fire Flash fire Jet fire Flash fire Flash fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire	LPL (49992.5 ppm) 37.5 Kw/m2 4Kw/m2 LPL (49992.3 ppm) 37.5 Kw/m2 4Kw/m2 LPL (49903.1 ppm) 37.5 Kw/m2 LPL (49903.1 ppm) 37.5 Kw/m2 4Kw/m2 LPL (49903.1 ppm) 37.5 Kw/m2 Kw/m2 LPL (49000 ppm) 37.5 Kw/m2 4Kw/m2 4Kw/m2 4Kw/m2 4Kw/m2 4Kw/m2 4Kw/m2 4Kw/m2 4Kw/m2	17.59 55.11 55.24 68.50 81.98 75.14 95.09 2.02 7.86 NR 8.84 67.11 57.99 72.12 101.46 78.54 99.78 3.41 NR NR 20.28 NR NR 19.74	53.90 31.68 62.68 76.77 47.91 88.75 2.43 10.94 NR 17.28 64.09 34.06 66.17 93.25 93.25 93.57 4.63 NR NR NR 19.26 NR	16.2 57.1 31.6 62.6 80.5 46.7 2.5 3 12.1 NR 17.3 68.8 33.0 66.1 98.3 49.6 93.2 5.0 6 NR NR 21.0 NR 21.0 NR 21.0 NR
	to PSA unit	E-100,V-104	Catastrophic Rapture Small Medium Large Catastrophic Rapture Small	0.051kg/s & 3.600s 1.27kg/s & 3.600s 20.04kg/s & 3.600s 0.0212kg/s & 3.600s	Flash fire Jet fire Flash fire Flash fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Flash fire	LPL (49992.5 ppm) 37.55kwim2 45Kwim2 1PL (49902.3 ppm) 47.55kwim2 LPL (49903.1 ppm) LPL (49903.1 ppm) 37.55kwim2 45Kwim2 1RL (49903.1 ppm) 37.55kwim2 45Kwim2 LPL (49903.1 ppm) 37.55kwim2 45Kwim2 LPL (49000 ppm) 37.55kwim2 45Kwim2 LPL (40000 ppm) 37.55kwim2	17.59 55.11 55.24 68.50 81.98 75.14 95.09 2.02 7.86 NR 18.84 67.11 8.84 67.11 57.99 72.12 101.46 78.54 99.78 3.41 NR NR NR NR NR NR	53.90 31.68 62.68 76.77 47.91 88.75 2.43 10.94 NR 17.28 64.09 34.06 66.17 93.57 4.63 NR NR 19.26 NR 20.66	16.2: 57.14 31.69 80.51 88.44 2.53 12.19 NR 46.7: 33.00 66.18 98.34 98.34 98.34 98.32 5.06 61.11 98.32 5.06 NR NR 21.07 7 62.90 NR
	to PSA unit	E-100,V-104	Catastrophic Rupture Small Medium Large Catastrophic Rupture Small Medium	0.0511kg/s & 3.600s 1.271kg/s & 3.600s 20.04kg/s & 3.600s 0.0212kg/s & 3.600s 0.0212kg/s & 3.600s	Flash fire Jet fire Flash fire Flash fire Flash fire Flash fire Flash fire Flash fire Flash fire Flash fire Flash fire Jet fire Flash fire Flash fire	LPL (49992.5 ppm) 37.55kw/m2 48.kw/m2 LPL (49992.3 ppm) 37.55kw/m2 48.kw/m2 LPL (49903.1 ppm) 37.55kw/m2 48.kw/m2 LPL (49903.1 ppm) 37.55kw/m2 48.kw/m2 LPL (49000 ppm) 37.55kw/m2 48.kw/m2 LPL (49000 ppm) 37.55kw/m2 48.kw/m2 LPL (49000 ppm) 37.55kw/m2	17.59 55.11 55.24 68.50 81.98 75.14 95.09 2.02 7.86 NR 18.84 67.11 57.99 72.12 101.46 78.54 99.78 3.41 NR 20.28 NR NR 20.28 NR NR 20.25 61.23	53.90 31.68 62.68 76.77 47.91 88.75 2.43 10.94 NR 17.28 64.09 34.06 66.17 93.25 50.87 93.57 4.63 NR NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR	16.2: 57.10 31.60 80.51 46.7: 88.44 2.53 312.11 NR 17.33 68.8: 33.00 66.11 98.33 49.6 5.06 0.11 93.22 5.06 NR NR 21.0. NR 21.0. NR 21.0. NR 21.0 S.50 93.22 5.06 S.50 S.50 S.50 S.50 S.50 S.50 S.50 S.50
8	to PSA unit Interconnecting p/l from PSA Unit to produce H2 to BL	E-109,V-104	Catastrophie Rupture Small Medium Large Catastrophie Rupture Small Medium Large	0.051kgs & 3,600s 1.27kg/s & 3,600s 20.04kgs/s & 3,600s 0.0212kg/s & 3,600s 0.0212kg/s & 3,600s 0.531kg/s & 3,600s 8.49kg/s & 3,600s Release Rote &	Flash fire Jet fire Flash fire Jet fire Flash fire Flash fire Flash fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire	LPL (49992.5 ppm) 37.555/wim2 48.56/m2 17.455/wim2 18.(49592.3 ppm) 37.555/wim2 48.56/m2 48.56/m2 48.56/m2 47.555/wim2 18.(4990.3 ppm) 37.555/wim2 18.(4990.3 ppm) 37.555/wim2 18.56/m2	17.59 55.11 55.24 68.50 81.98 95.09 202 7.86 67.11 57.99 72.12 101.46 57.99 72.12 101.46 57.99 72.12 101.46 67.11 57.99 72.12 101.46 67.11 NR NR 10.74 62.25 61.23 Concequer	53.90 31.68 62.68 88.75 2.43 10.94 NR 17.28 64.09 34.06 66.17 93.25 50.87 93.25 50.87 93.25 93.57 4.63 NR 19.26 NR 19.26 NR 20.66 54.60 42.47	16.2: 57.14 31.64 62.64 80.55 46.7: 88.44 2.55 12.19 NR 17.3- 66.8: 33.00 66.11 98.33 49.6 93.22 5.066 NR 21.00.7 62.94 42.59 10.55 1
	to PSA unit Interconnecting p/l from PSA Unit to produce H2 to BL	E-100,V-104	Catastrophic Rupture Small Medium Large Catastrophic Rupture Small Medium	0.051kg/s & 3,600s 1.27kg/s & 3,600s 20.04kg/s & 3,600s 0.0212kg/s & 3,600s 0.0212kg/s & 3,600s 0.511kg/s & 3,600s 8.49kg/s & 3,600s	Flash fire Jet fire Flash fire Flash fire Flash fire Flash fire Flash fire Flash fire Flash fire Flash fire Flash fire Jet fire Flash fire Flash fire	LPL (49992.5 ppm) 37.55kw/m2 48.kw/m2 LPL (49992.3 ppm) 37.55kw/m2 48.kw/m2 LPL (49903.1 ppm) 37.55kw/m2 48.kw/m2 LPL (49903.1 ppm) 37.55kw/m2 48.kw/m2 LPL (49000 ppm) 37.55kw/m2 48.kw/m2 LPL (49000 ppm) 37.55kw/m2 48.kw/m2 LPL (49000 ppm) 37.55kw/m2	17.59 55.11 55.24 68.50 81.98 75.14 95.09 2.02 7.86 NR 18.84 67.11 57.99 72.12 101.46 78.54 99.78 3.41 NR 20.28 NR NR 20.28 NR NR 20.25 61.23	53.90 31.68 62.68 88.75 2.43 10.94 NR 17.28 64.09 34.06 66.17 93.25 50.87 93.25 50.87 93.25 93.57 4.63 NR 19.26 NR 19.26 NR 20.66 54.60 42.47	16.2: 57.14 31.64 62.64 80.55 46.7: 88.44 2.55 12.19 NR 17.3- 66.8: 33.00 66.11 98.33 49.6 93.22 5.066 NR 21.00.7 62.94 42.59 10.55 1
8	to PSA unit Interconnecting p/l from PSA Unit to produce H2 to BL	E-109,V-104	Catastrophie Rupture Small Medium Large Catastrophie Rupture Small Medium Large	0.051kgs & 3,600s 1.27kg/s & 3,600s 20.04kgs/s & 3,600s 0.0212kg/s & 3,600s 0.0212kg/s & 3,600s 0.531kg/s & 3,600s 8.49kg/s & 3,600s Release Rote &	Flash fire Jet fire Flash fire Jet fire Flash fire Flash fire Flash fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire	LPL (49992.5 ppm) 37.555/wim2 48.56/m2 17.455/wim2 18.(49592.3 ppm) 37.555/wim2 48.56/m2 48.56/m2 48.56/m2 47.555/wim2 18.(4990.3 ppm) 37.555/wim2 18.(4990.3 ppm) 37.555/wim2 18.56/m2	17.59 55.11 55.24 68.50 81.98 2.02 7.514 95.09 2.02 7.86 NR 18.84 90.78 57.99 72.12 101.46 67.11 57.99 72.12 101.46 78.54 NR NR NR NR NR NR NR NR NR NR NR NR NR	53.90 31.68 62.68 88.75 2.43 10.94 NR 17.28 64.09 34.06 66.17 93.25 50.87 93.25 50.87 93.25 93.57 4.63 NR 19.26 NR 19.26 NR 20.66 54.60 42.47	16.2: 57.1(31.6(62.6) 80.5(46.7, 88.4) 42.5(88.4) 12.1(NR 17.3: 66.1(98.3; 33.0(66.1(98.3; 49.6(17.3) 66.6(19.3) 12.1(NR 12.5(NR 12.5(NR 12.5(NR 12.5(NR 12.5(NR 12.5(NR 12.5(NR 12.5(NR 12.5(NR 15.5(NR)
8	to PSA unit Interconnecting p/l from PSA Unit to produce H2 to BL	E-109,V-104	Catastrophie Rupture Small Medium Large Catastrophie Rupture Small Medium Large	0.051kgs & 3,600s 1.27kg/s & 3,600s 20.04kgs/s & 3,600s 0.0212kg/s & 3,600s 0.0212kg/s & 3,600s 0.531kg/s & 3,600s 8.49kg/s & 3,600s Release Rote &	Flash fire Jet fire Flash fire Flash fire Flash fire Flash fire Flash fire Jet fire	LPL (6992-3 ppm) 37 Storing 2 37 Storing 2 37 Storing 2 37 Storing 2 37 Storing 2 37 Storing 2 47 (6990-1 ppm) 37 Storing 2 47 (690-1 ppm) 37 Storing 2 37 Storing 2 3	17.59 55.11 55.24 68.50 81.98 95.09 2 02 75.14 95.09 2 02 75.14 95.09 2 02 75.14 95.09 2 02 75.14 95.09 2 02 75.14 95.09 2 02 75.14 95.09 2 02 75.14 95.09 2 02 75.14 95.09 90.78 3.41 NR 20.22 5.341 NR 20.23 5.341 NR 20.23 5.341 NR 20.23 5.341 NR 20.23 5.342 NR 20.33 70.99 70.98 70.99 70.9	53.90 31.68 62.68 62.68 76.77 47.91 88.75 2.43 NR 10.94 NR 17.28 64.09 34.06 66.17 93.25 50.87 93.57 4.63 NR NR 19.26 50.87 NR NR 19.26 50.87 NR 19.25 50.87 NR NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 54.60 42.47 NR 19.26 54.60 42.47 NR 19.26 54.60 42.47 NR 19.26 54.60 42.47 NR 19.26 54.60 42.47 NR 19.26 54.60 42.47 19.26 54.60 42.47 19.26 54.60 42.47 19.26 54.60 42.47 19.26 54.60 42.47 19.26 54.60 42.47 19.26 54.60 42.47 19.26 54.60 42.47 19.26 54.60 42.47 19.26 54.60 42.47 19.26 54.60 42.47 19.26 54.60 42.47 19.26 54.60 42.47 19.26 54.60 42.47 19.26 19.26 54.60 42.47 19.26 19.26 19.27 19.26 19	16.2: 57.1(31.6(80.5) 46.7; 88.44 2.53 46.7; 88.44 2.53 3.0(66.1) 98.33 49.6(93.32) 5.066 NR 93.22 5.066 NR 20.7; 62.99 42.59 HE 20.7; 62.99 42.59 HE 20.7; 62.99 42.59 HE 20.7; 63.85 HE 20.7; 64.99 12.19
8	to PSA unit Interconnecting p/l from PSA Unit to produce H2 to BL	E-109,V-104	Catastrophic Rupture Small Medium Large Catastrophic Rupture Small Medium Large Accident Scenario	0.051kgs & 3,600s 1.27kg/s & 3,600s 20.04kgs/s & 3,600s 0.0212kg/s & 3,600s 0.0212kg/s & 3,600s 0.531kg/s & 3,600s 8.49kg/s & 3,600s Release Rote &	Flash fire Jet fire Flash fire Jet fire Flash fire Flash fire Flash fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire Jet fire Flash fire	LPL (1992-3 ppm) 37 Storia 2 486/m2 17 (1992-3 ppm) 37 Storia 2 17 (1992-3 ppm) 37 Storia 2 17 (1993-1 ppm) 17 (1993-1 ppm) 17 (1993-1 ppm) 37 Storia 2 486/m2 17 (1993-1 ppm) 37 Storia 2 37 Storia 2 486/m2 17 (1993-1 ppm) 37 Storia 2 37 Storia 2 486/m2 17 (1993-1 ppm) 37 Storia 2 37 Storia 2 37 Storia 2 37 Storia 2 486/m2 17 (1993-1 ppm) 37 Storia 2 37 Storia 2 486/m2 17 (1993-1 ppm) 37 Storia 2 486/m2 37 Storia 2 486/m2 37 Storia 2 486/m2 37 Storia 2 486/m2 37 Storia 2 486/m2 37 Storia 2 486/m2 48	17.59 55.11 55.24 68.50 81.98 81.98 75.14 95.09 72.12 101.46 77.854 99.78 99.78 54 99.78 54 99.78 54 99.78 54 99.78 54 99.78 54 99.78 54 99.78 54 99.78 54 99.78 54 99.78 54 99.78 54 99.78 54 99.78 54 99.78 54 99.78 54 99.78 54 99.78 54 99.78 54 99.78 99.78 54 99.78 99.78 54 99.78 54 99.78 54 99.78 54 99.78 54 99.78 54 99.78 54 99.78 54 99.78 54 99.78 54 99.78 54 99.78 54 97.79 97.70 78.54 97.70 97.70 78.54 97.70 97.70 78.54 97.70 97.70 78.54 97.70 97.70 77.54 97.70 97.70 77.54 97.70 97.70 97.70 77.54 97.70 97.70 77.54 97.70 97.70 77.54 97.70 97.70 77.54 97.70 97.70 77.70 9	53.90 31.68 62.68 76.77 2.43 88.75 2.43 10.94 17.28 64.09 34.06 66.17 93.25 66.17 93.25 93.57 74.63 93.57 NR NR NR NR NR NR NR NR NR 20.66 24.69 94.25 19.26	16.2: 57.1(1) 31.6(2) 80.5(1) 46.7: 88.4(1) 2.53 12.1(1) NR 17.3: 66.8: 33.0(0) 66.8: 33.0(0) 66.8: 33.0(0) 93.2: 5.06(6) 93.2: 5.06(6) NR NR 21.0(0) NR NR 21.0(0) NR NR 21.0(0) NR NR 21.0(0) NR NR 21.7(1) 73.85 12.8(0)
8	to PSA unit Interconnecting p/l from PSA Unit to produce H2 to BL	E-109,V-104	Catastrophie Rupture Small Medium Large Catastrophie Rupture Small Medium Large	0.051kgs & 3,600s 1.27kg/s & 3,600s 20.04kgs/s & 3,600s 0.0212kg/s & 3,600s 0.0212kg/s & 3,600s 0.531kg/s & 3,600s 8.49kg/s & 3,600s Release Rote &	Flash fire Jet fire Flash fire Flash fire Flash fire Flash fire Flash fire Jet fire	LPL (6992-3 ppm) 37 SKwin2 48/win2 17L (6992-2 ppm) 37 SKwin2 17L (6992-1 ppm) 37 SKwin2 17L (6990-1 ppm) 17L (6990-1 ppm) 37 SKwin2 48/win2 17L (6990 ppm) 37 SKwin2 48/win2 17L (6990 ppm) 37 SKwin2 17L (6990 ppm) 37 SKwin2 17L (6990 ppm) 37 SKwin2 17L (6990 ppm) 37 SKwin2 17L (6990 ppm) 37 SKwin2 18/ Kowin2 17L (6990 ppm) 37 SKwin2 17L (6990 ppm) 37 SKwin2 18/ Kowin2 17L (6990 ppm) 37 SKwin2 17L (6	17.59 55.11 55.24 68.50 81.98 95.09 2 02 75.14 95.09 2 02 75.14 95.09 2 02 75.14 95.09 2 02 75.14 95.09 2 02 75.14 95.09 2 02 75.14 95.09 2 02 75.14 95.09 2 02 75.14 95.09 90.78 3.41 NR 20.22 5.341 NR 20.23 5.341 NR 20.23 5.341 NR 20.23 5.341 NR 20.23 5.342 NR 20.33 70.99 70.98 70.99 70.9	53.90 31.68 62.68 62.68 76.77 47.91 88.75 2.43 NR 10.94 NR 17.28 64.09 34.06 66.17 93.25 50.87 93.57 4.63 NR NR 19.26 50.87 NR NR 19.26 50.87 NR 19.25 50.87 NR NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 50.87 NR 19.25 54.60 42.47 NR 19.26 54.60 42.47 NR 19.26 54.60 42.47 NR 19.26 54.60 42.47 NR 19.26 54.60 42.47 NR 19.26 54.60 42.47 19.26 54.60 42.47 19.26 54.60 42.47 19.26 54.60 42.47 19.26 54.60 42.47 19.26 54.60 42.47 19.26 54.60 42.47 19.26 54.60 42.47 19.26 54.60 42.47 19.26 54.60 42.47 19.26 54.60 42.47 19.26 54.60 42.47 19.26 54.60 42.47 19.26 54.60 42.47 19.26 19.26 54.60 42.47 19.26 19.26 19.27 19.26 19	16.2: 57.10 31.68 62.69 80.58 46.72 88.48 2.53 312.19 NR 17.34 66.82 33.02 66.18 98.34 49.65 93.22 5.06 NR NR 21.0 NR 21.0 NR 21.0 S.06 94.2.50 S.06 94.2.50 S.06 S.06 S.06 S.06 S.06 S.06 S.06 S.0

Toxic Consequence Results for LPG

S.No	Node	Description	Accident Scenario	Release Rate & Duration	Event	Impact criteria	Consequence Distance(m)		
3.110							D 11m/s	B 3m/s	F 3m/
	Interconnecting p/l from R-103 to R-104	Interconnecting P/L,R-103, R-104	Small	0.0603kg/s & 3,600s	Toxicity	3% lethality	50	50	50
			Medium	1.508kg/s & 3,600s			100	100	75
1			Large	24.13kg/s & 3,600s			250	225	12
			Catastrophic Rupture				300	stance(v B 3m/s 50 100 225 225 225 225 225 225 225 225 225 2	125
		• • • • •	Small	0.0463kg/s & 3,600s			50	50	50
2	Interconnecting p/l from R-104 to R-105	Interconnecting P/L, R-105,	Medium	1.158kg/s & 3,600s	Toxicity	3% lethality	150		10
		E-105, E-106	Large	18.52kg/s & 3,600s			350	250	15
			Catastrophic Rupture				425	50 100 225 50 125 200 125 250 325 50 175 350 450 50 175	17
	Interconnecting p1 from R-105 to V-	Interconnecting	Small	0.054kg/s & 3,600s	-		50	50	5
		P/L, E-107,	Medium	1.344kg/s & 3,600s			200	175	15
3	104	E-108,	Large	21.50kg/s & 3,600s	Toxicity	3% lethality	500	350	30
5	104	EA-101, E-109,V-104	Catastrophic Rupture				650	450	35
	Interconnecting p/l from V-104 to PSA	Interconnecting	Small	0.054kg/s & 3,600s	-	and d. P.	50	50	5
4			Medium	1.344kg/s & 3,600s			200	175	15
4	unit	P/L	Large	21.89kg/s & 3,600s	- Toxicity	3% lethality	575	225 50 125 250 325 50 175 350 450 50	31
			Catastrophic Rupture				725	475	41



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Toxic Consequence Results for Naphtha

S.No	Node	Description	Accident Scenario	Release Rate & Duration	Event	Impact criteria	Consequence Distance(m)		
34140							D 11m/s	B 3m/s	F 3m/s
	Naphtha from V-102 to E-101A/S	Interconnecting P/L,P-102A/S, E-101A/S	Medium	21.94kg/s & 3,600s	Toxicity		125	125	200
1			Large	362.35kg/s & 3,600s		3% lethality	475	675	950
	Naphtha from BL to V-102		Small	0.276kg/s & 3600s	Toxicity		NR	NR	NR
2		Interconnecting	Medium	6.891kg/s & 3,600s			75	100	100
2	Napatha from BL to V-102	P/L, V-102	Large	110.25kg/s & 1,476.63s	Toxicity	3% lethality	125	150	175
			Catastrophic Rupture	-	1		150	tanec(tr B 3m/x 125 675 NR 100 150 150 100 225 250 255 125 255 125 255 125 255 125 325 325 175 350 B 30m/x 450 50 100 100 225 255 125 255 125 325 325 325 325 325 325 325 3	200
		Interconnecting P/L,R-104	Small	0.0603kg/s & 3,600s	Toxicity	3% lethality	50	50	50
			Medium	1.508kg/s & 3,600s			125	100	100
3	Interconnecting p/l from R-103 to R-104		Large	24.13kg/s & 3,600s			275	225	125
			Catastrophic Rupture				325	250	150
		Interconnecting P/L, R-105, E-105, E-106	Small	0.0467kg/s & 3,600s	- Toxicity	7 3% lethality 25 3% lethality 375 450	25	25	25
			Medium	1.167kg/s & 3,600s			150	125	100
4	Interconnecting p/l from R-104 to R-105		Large	18.68kg/s &3,600s			375	250	150
			Catastrophic Rupture		1		450	325	175
5	Interconnecting p/l from R-105 to V- 104	Interconnecting P/L, E-107, E-108,	Small	0.054kg/s & 3,600s	Toxicity	3% lethality	25	25	25
			Medium	1.344kg/s & 3,600s			200	175	150
			Large	21.50kg/s & 3,600s			500	350	300
S.No	Node		Accident Scenario	Release Rate &		Impact	Consequence Distance(m)		
2740	rvode	Description	Accident Scenario	Duration	Event	criteria	D 11m/s		F 3m/s
		EA-101, E-109, V-104	Catastrophic Rupture				650	450	350
	Interconnecting p/l from V-104 to PSA	Interconnecting	Small	0.054kg/s & 3,600s	Territolog	20/1-1-1-1-1	50	50	50
6			Medium	1.344kg/s & 3,600s			200	175	150
0	unit	P/L	Large	21.89kg/s & 3,600s	Toxicity	3% lethality	575	350 sequen tance(n B 3m/s 450 50 175	375
- 1			Catastrophic Rupture	-	1	1	725	475	425

Toxic Consequence Results for Natural gas

S.No	Node	Description	Accident Scenario	Release Rate & Duration	Event	Impact criteria	Consequence Distance(m)		
							D 11m/s	B 3m/s	F 3m/s
	Interconnecting p/l from R-103 to R-104	Interconnecting P/L,R-104	Small	0.054kg/s & 3,600s	- Toxicity	3% lethality	25	25	25
			Medium	1.34kg/s & 3,600s			125	100	75
1			Large	21.48kg/s & 3,600s			275	200	100
			Catastrophic Rupture				275	tance(n B 3m/s 25 100 200 25 25 100 250 325 25 150 325 400 50 150 355	125
			Small	0.0428kg/s & 3,600s		3% lethality	25	25	25
2	Interconnecting p/l from R-104 to R-105	Interconnecting P/L, R-105,	Medium	1.07kg/s & 3,600s	Toxicity		150	100	sce(m) F 3 F 3 Statistical State 5 25 30 75 30 100 30 125 5 25 30 100 30 125 5 25 30 100 30 125 5 25 30 125 5 25 30 275 0 50 125 50 125 50 125 50 125 50 125 250 10 125 10 125 10 300
2	Interconnecting p/1 from R-104 to R-105	E-105, E-106	Large	17.14kg/s & 3,600s	Toxicity		350	250	
			Catastrophic Rupture				425	B 3m/s 25 100 200 25 100 25 100 25 100 250 325 25 150 325 400 50 150 150	125
		1222 1.421	Small	0.054kg/s & 3,600s			25	25	25
		P/L E-107,	Medium	1.26kg/s & 3,600s			175	150	125
3	Interconnecting p/l from R-105 to V-104	E-108,EA-101,	Large	20.17kg/s & 3,600s	Toxicity	3% lethality	500	325	250
		E-109,V-104	Catastrophic Rupture				625 4	400	275
		ng p1 from V-104 to PSA Interconnecting Medium 1.26kg/s & 3,	0.051kg/s & 3,600s			50	50	50	
	Interconnecting p1 from V-104 to PSA unit		Medium	1.26kg/s & 3,600s	Toxicity	3% lethality	175	150	125
4			Large	20.41kg/s & 3,600s			525	350	300
			Catastrophic Rupture				650	425	325

Toxic Consequence Results for RF Gas

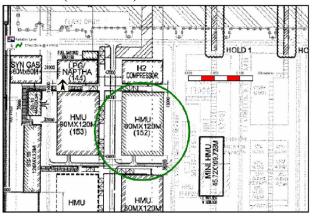
S.No	Node	Description	Accident Scenario	Release Rate & Duration	Event	Impact criteria	Consequence Distance(m)		
							D 11m/s	B 3m/s	F 3m/s
	Interconnecting p/ from R-103 to R-104	Interconnecting P/L,R-104	Small	0.0524kg/s & 3,600s	- Toxicity	3% lethality	50	50	50
1			Medium	1.311kg/s & 3,600s			125	100	100
	interconnecting printing Re103 to Re104		Large	20.98kg/s & 3,600s			275	200	100
			Catastrophic Rupture	-			275	175	125
			Small	0.0427kg/s & 3,600s	- Toxicity	3% lethality	50	50	50
2		Interconnecting	Medium	1.067kg/s & 3,600s			150	100	100
-	Interconnecting p/l from R-104 to R-105	P/L, R-105, E-105, E-106	Large	17.08kg/s &3,600s			325	225	150
			Catastrophic Rupture	-	1		400		150
		Interconnecting	Small	0.045kg/s & 3,600s		ty 3% lethality	50	50	50
		P/L, E-107,	Medium	1.128kg/s & 3,600s	Toxicity		150	125	ds 3m/s 0 50 0 100 0 100 0 100 5 125 0 50 0 100 5 125 0 50 5 150 5 125 5 125 5 175 0 200 0 50 5 150 5 150 0 50 5 150 0 300
3	Interconnecting p/l from R-105 to V-104	E-108, EA-101.	Large	18.06kg/s & 3,600s			375	275	175
		EA-101, E-109,V-104	Catastrophic Rupture				450	350	200
			Small	0.051kg/s & 3,600s		ity 3% lethality	50 50 50	50	
	Interconnecting p/l from V-104 to PSA unit	Interconnecting P/L	Medium	1.27kg/s & 3,600s	- Toxicity		200	175	150
4			Large	20.04kg/s & 3,600s			500	350	300
			Catastrophic Rupture	-			650	425	325



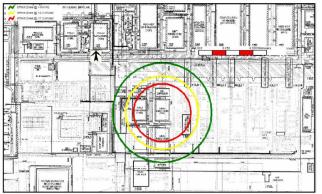
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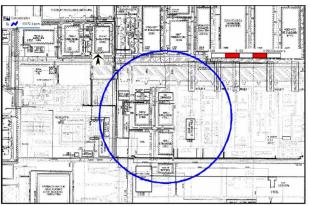
Pool fire - large leak from the E-101A/S (LPG as feed)



Jet fire - large leak from the E-101A/S (LPG as feed)



Flash fire - large leak from the E-101A/S



IX. PHA SCOPE COMPREHENSIVENESS

9.1 Non-Routine Mode of Operation

The biggest and most dangerous gap in PHA performance is the failure to include non-routine mode of operation. More than 80% of process facilities do not perform PHAs for non-routine mode of operation. Yet, a paper published by the Process Improvement Institute (PII) which reviewed 47 major process safety incidents occurring from 1987 to 2010 revealed that almost 70% of all moderate to major incidents occurred during non-routine mode of operation. This figure was even

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confirmed by a poll sent to over 50 of PII's clients. Discussing this issue with another safety consulting company, which leads PHAs on a regular basis, also confirmed that this is a major issue in most process facilities, despite the fact that performing PHAs for all modes of operation is an OSHA PSM requirement according to OSHA's 29 CFR 1910.119. What makes this issue even more dangerous, is that common PHA methodologies employed for continuous mode of operation only identifies 5-10% of the potential hazardous scenarios for non-routine mode of operation. This risk becomes even more evident when factoring the number of shutdown/startups performed by each facility each year, the fact that during startup/shutdown operations most safeguards proposed to reduce risk during continuous operation are bypassed, and that the reliance on operator actions is substantially increased greatly increasing human error and reducing reliability. This results in the increased probability of a major incident occurring by 30-50 times.

9.2 Facility Siting

Another common gap shared by many companies is also failing to include or consider facility siting (i.e., effect of potential explosions and toxic releases on nearby occupied buildings) in their PHA. Most facilities will do a good job in including all process nodes. However, they might fail to assess facility siting entirely. Addressing facility siting is a requirement in the USA and is driven by OSHA and EPA. Yet, some facilities perform this task separately without incorporating its findings in the facility's PHA studies. Auditors should verify incorporation of facility siting assessment findings in PHA recommendations. In addition, since facility siting assessment should be part of the PHA, auditors should ensure that facility siting studies are performed at least every 5 years and incorporated in PHA revalidations. This is extremely important not only because it reduces residual risk that went unidentified in previous PHAs, but also because building occupancy indices may change as well, which may result in significant change in the consequences and the level of risk assessed in the previous PHA studies. Auditors should also verify that temporary structures, such as portable buildings or trailers used during turnaround and inspection (T&I) for contractor occupancy, are only placed in safe zones defined in the facility siting assessment. During the BP Texas city incident, 15 contractors were fatally injured in trailers that were not placed in safe zones

9.3 Chemical Inventory

Chemicals stored in the process are not subject to being overlooked in a PHA study. However, chemicals used for maintenance usually are overlooked. Improper storage of flammable or toxic chemicals stored in warehouses and sheds can lead to major incidents. A well-known one is the incident that occurred in Tianjin, China 2015. The explosions which originated from chemicals stored in a storage warehouse had a power which exceeded 20 tons of TNT. So, depending on the quantity and nature of the stored chemicals, a facility might be completely wiped out. Had a quality PHA been performed on this chemical warehouse, the risk would have been greatly reduced.

Auditors should not only ensure that all chemical storage warehouses/buildings have been included in the PHA, but also maximum inventory reached for these chemicals should be verified through site verifications, inventory reports, and/or employee interviews. It is also vital to ensure that maximum chemical inventories are accounted for in PHA revalidations as well. A change in inventory may slip through existing gaps in the facility's MOC process, especially if the chemical inventory is managed by a different department which may not have an engineer or qualified person. This is often seen in big companies where material/chemical warehouses are managed independently. Furthermore, in general warehouses are often perceived as low risk and have poor PSM implementation monitoring.

9.4 Shared Processes

Special attention must be given to shared processes and connected boundaries between different units in a given facility. Performing PHAs on processes like utility lines and flare headers that are shared among several units in a facility can be neglected unintentionally. When ownership of process units is segregated and the responsibility of performing PHAs is assigned to several PHA teams, the teams might neglect performing PHAs on shared processes or miss sections as a result of differently defined boundaries between units. The auditor should verify first if references in PHA do in fact link to a performed PHA on the shared process. In addition, the auditor should verify that the boundaries of connecting process units are similarly defined and no section of the facility is overlooked.



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9.5 Inherently Safer Design (ISD)

Utilizing the ISD principals to reduce risk should be a critical step in any PHA study. Although it is most effective during conceptual design and front-end engineering design (FEED), it should also be applied to reduce consequence severity for high consequence hazardous scenarios identified during initial PHA studies. Although ISD can be applied at any time during the facility's lifecycle, it makes more sense practically and financially to apply them during the design stage of the process. By now, ISD awareness should not be an issue and auditors should pursue and verify implementation of ISD principals.

X. CONCLUSION AND FUTURE SCOPE

10.1 Conclusion

After completion of the study, I found that A process hazard analysis (PHA) or evaluation is an organized and systematic approach to identifying and analyzing the potential hazards associated with the processing or handling of highly hazardous chemicals. It evaluates and analyses possible causes and consequences of fires, explosions, releases, and spills of dangerous and flammable chemicals by focusing on equipment, utilities, human actions and external factors. Activities documenting and tracking implementation of corrective actions or safety improvements are not part of a PHA report. However, the PSM Rule requires a documented, integrated system for managing and monitoring action items. This system must assure that action items and recommendations are addressed and documented in a timely manner. OSHA UAS has also issued the guidelines for PSM compliance.

As implied throughout the thesis, it is critical that the audit team use guidelines similar to the ones proposed in this study as part of an overall PSM audit. Focusing on auditing the quality of the PHA element alone will unquestionably assist in identifying gaps in implementation and company policies/standards. However, solving these identified gaps will require looking at the bigger picture, which only can be attained from auditing the whole safety management system (SMS). Implementation deficiencies in process safety information, incident investigation, training, and mechanical integrity for example, will definitely have cascading effects on PHA implementation. In addition, implementation deficiencies in PHA quality will also have cascading effects on other PSM elements such as mechanical integrity, operating procedures, emergency planning and response. Therefore, it is highly recommended that users of these proposed guidelines incorporate them as part of an overall PSM audit. It is also highly recommended that users of these guidelines also use their findings to propose recommendations that focus on improving the SMS, eliminating the identified gaps, and updating the internal standards and procedures of the facility to ensure continuous improvement. It is most frustrating to find out that all the man-hours, money, and effort that went into performing the monumental task of auditing the whole SMS just to find that the audit report merely became a document hidden on a shelf collecting dust. Spending the time and money to perform this audit and use its findings to close the company's SMS gaps should be seen as an investment by the facility's executives. It will unquestionably save a lot of money and ensure business continuity on the long run.

10.2 Future Scope

The intent of this element is to define the requirements to conduct a Process Hazard Analysis (PHA) on each process covered by the PSM Program. This critical element identifies the process hazards, evaluates the consequences and defines appropriate control measures to eliminate or minimize the severity of the hazard.

The next step that follows developing these guidelines would be of course to test them in a pilot exercise at a chemical/hydrocarbon facility. Multiple pilots will help complete and refine these guidelines, and make them more practical to use. The natural step following those pilot exercises and improvement of guidelines is to use them to enhance the facility's internal standards and procedures in order to help close identified gaps, develop systems that assist in making the PHA element easier to audit and monitor with the goal of steering the facility for continuous improvement of PHA element implementation. To help assure that all hazards are identified and evaluated, PHA will be help to the following processes

- Oil & Gas Processing
- Rubber Processing
- Petrochemical
- Cement Processing
- Pharmaceutical
- Water Treatment Process Copyright to IJARSCT

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- Toxic or Pesticide Chemical Processing
- Hazardous Waste Treatment Process
- Textile Processing
- Other Chemicals and Process Industries

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