iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** VII **Month of publication:** July 2021

DOI: https://doi.org/10.22214/ijraset.2021.36578

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VII July 2021- Available at www.ijraset.com

Modelling and Analysis of On-Site Emergency Plan of a Major Accident Hazard in a LPG Bottling Plant

Rishabh Shokeen[1], Dr. Aditya Tiwary[2]
[1]PG Scholar,[2] Associate Professor, IPS Academy Institute of Engineering & Science, Indore, India

Abstract: As an organization there is a range of responsibilities and legislation that require you to have a plan to ensure the safety of employees, customers and stakeholders who may be on site when an emergency occurs. Equally important is the ability of facility to react quickly to an emergency, saving time and money in restoring normal business. A well thought out, coordinated response helps prevent personal injury, property damage, and lessen the resulting hazard. When an organization plans on how it will respond to an emergency threatening its operations, it is more likely to survive the incident. During a large-scale disaster, local response agencies may be overwhelmed and unable to immediately respond to the organization site. The modelling and analysis of threats in a plant is not just for post hazard analysis, it includes all the working procedures when a hazard occurs.
Keywords: Stakeholders, Modelling, Analysis, Hazards, Organization

I. INTRODUCTION

Liquefied Petroleum Gas refers to a mix of gaseous hydrocarbons compounds, mainly propane and butane mixed in the ratio 55%-45%. The highly inflammable gas (LPG) is an odourless and colourless substance. LPG is made during natural gas processing and oil refining. LPG is separated from unprocessed natural gas using refrigeration process. LPG bottling plant is the place where the LPG gas is brought from outside by tankers mounted on a vehicle or a dedicated pipeline. In the LPG bottling plant, there is no manufacturing taking place. The very first step in the bottling plant that takes place start from the washing of empty cylinders which is kept on a roller belt and passed thorough high-pressure water and if any found faulty then sent to repair shed. The next step in this process of filling of LPG cylinder in the LPG bottling plant is of filling of washed cylinders with LPG by filling machine. Here in the filling shed filling takes place at two stages one is in cylinders and the other in tank lorries with the help of connecting hose pipes.

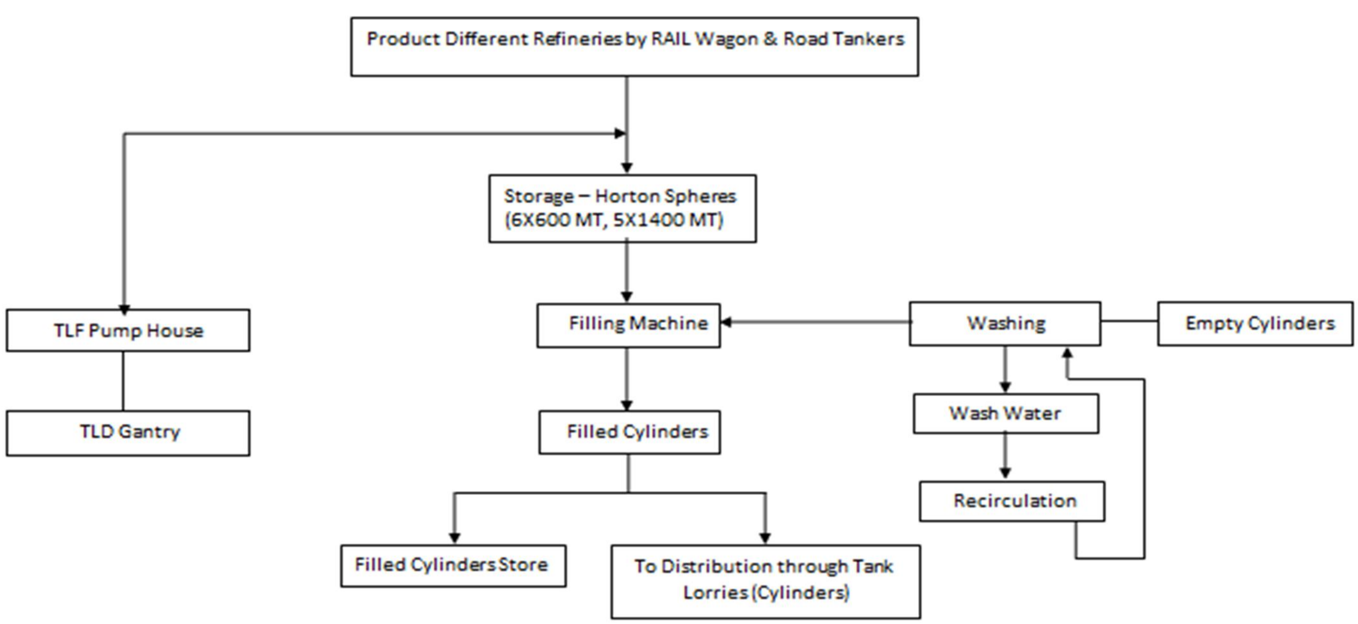


Fig. 1 LPG Bottling Plant

II. HAZARD AND THEIR CONSEQUENCES

LPG vessel full of liquid will generate 14.6kg/cm^2 pressure per degree Celsius rise in temperature. If LPG vessel is subjected to above condition, then there are possibilities that a hazard can occur. Further hazardous area identified were the tank truck loading/ unloading shed, Horton sphere, LPG pump/compressor shed, testing, and repairing shed, cylinder filling, unloading shed, cylinder repair shed.

Table I
Possible Consequences In Various Hazards

	Area Of Hazard/Type Tank Truck Loading/Unloading Shed	Consequences
1.	Rupture of connecting hoses	Uncontrolled release of liquid which can form an inflammable mixture in the atmosphere leading 10 flash fires or ignition.
2.	Pressure built up in tank trucks	Opening of safety relief valve resulting in release of LPG vapor to the atmosphere at a steady rate until pressure is reduced to 90% of set pressure
3.	Ignition of flammable fuel-air mixture	Fire in tank lorries
4.	Failure of tank trucks vessel resulting inquasi-instantaneous release	Vapor-cloud explosion
5.	Failure of vessels resulting in instantaneous release of liquid/vapormixture which ignition	BLEVE Fire Ball
6.	Horton Spheres: Structural failure of pressure vessel resulting in an instantaneous release of liquid vapor mixture which ignites	BLEVE Fire Ball
7.	LPG Pump and Compressor Shed: Ignition of flammable fuel/air mixture due to leakage	Fire
8.	Cylinder filling/Storage and loading/unloading shed: Ignition of flammable mixture of fuel/air due to leakage	Fire
9.	Explosive release of LPG from cylinder due to sudden impact of very high external forces	Explosion
10.	Ignition of flammable fuel/air mixture	Fire
11.	Ignition of flammable fuel/air mixture due to improper earthing	Fire
12.	Ignition of flammable fuel/air mixture due to flaring	Fire
13.	Rupture of hydraulic hoses at the time of hydrostatic testing of cylinders	Injury to working personal

A. Possible Cause and Methods of Preventing Hazard

1) Rupture of hose could be due to wear and tear/ poor quality of material used. Hose burst can be prevented by regular inspection of hoses for wear and tear. Periodically all hoses should be pressure tested as per OISD norms.
2) Sources of accidental ignition can be sparks due to friction caused by metal-to-metal rubbing and due to accumulation of static charge. Sparks can be prevented by using non- ferrous metals for hose coupling and proper earthing and bonding of tankers. Earthing oftank Lorries Bay and continuity of earthing should also been sure by making periodical checks.
3) Pressure vessel failure may be highly remote because they are mandatory tested hydraulically once in 5 years apart from ultrasonic thickness testing, magnetic testing for cracks etc.
4) Leakage of LPG through pump/valves can be avoided by regular maintenance to prevent the presence of any flammable air/fuel mixture in ambience.

All sources of ignition in the filing shed are avoided by the following means:

a) Proper earthing of equipment
b) Regular checking of electrical equipment
c) Regular maintenance of filling guns
d) No electric maintenance jobs will be allowed during operation hours unless ensured that area is gas free. For this, permit must be issued by Safety Officer and approved by Chief Plant Manager
e) Only brass/Teflon hammers to be used.
f) No inflammable materials like cotton wastes, oil cloth etc. should be allowed to accumulate in this area.
g) Cylinders are handled carefully and ensured that there is no horizontal stacking, rolling and impact on them.

5) Failure of cylinders in normal operation is also remote because all cylinders are visually inspected for dent, digs and corrosion as per OISD guidelines and are rejected by failing these guidelines. Hydraulic testing of all cylinders to be carried out once in 7 years for the first time and subsequent tests after every 5 years and the cylinders which failed in the test to be rejected immediately.

B. Specific hazard

Once there is an LPG fire, one must be careful and cautious about two specific likely developments-UVCE and BLEVE. Both the phenomena are violent explosion which may result in considerable damage to person and property.

1) *BLEVE:* Boiling Liquid Expanding Vapour Explosion (acronym BLEVE) is essentially a major container failure into two or more pieces, with the fragments or ruptured portion hurled off in different directions like missiles accompanied by blast/explosion.

BLEVE can take place with any liquid under the following conditions:

a) The liquid is superheated, i.e., temperature will rise above the normal boiling point by itself.
b) Sudden lowering of pressure occurs inside the container due to crack, thermal weakening, sudden uncontrolled opening of the relief valve etc.
c) Pressure and temperature conditions are suitable for ‘spontaneous nucleation' with which extremely rapid FLASH type evaporation will occur.

2) *Unconfined Vapour Cloud Explosion (UVCE):* Unconfined Vapour Cloud Explosion (acronym UVCE) is essentially an explosion which takes place after release of large amount of flammable gas into the atmosphere, which finds a source of ignition. LPG vapour being heavier than air settles down on the ground and if the leakage continuous from the source and vapour does not disperse due to wind then it forms a thick layer of LPG vapour, which is often termed as vapour cloud. There may be two types of explosions when this vapour cloud comes in contract with the ignition source-depending upon the quality of the vapour cloud. If the vapour cloud is just like a vapour 'pancake' i.e., there is not much premixing or entrained air for the lower levels of the vapour cloud, the cloud will ignite and burn as a deflagration. Such deflagration can cause a lot of damage by radiation and may cause secondary fires at some distance. Such explosions are called UVCEs and are the most common cause of Industrial Accidents.

III. SAFETY AND FIREFIGHTING ORGANIZATION

Safety and firefighting organization is the group of people responsible for controlling any hazard or fire that are occurs on site and it's the only committee which decides the working procedures that deal with maintain safety environment in a plant or facility. The head of this organization or committee is safety head or safety and firefighting coordinator. Safety committee is constituted in such a way that working staff of different categories should come and share their ideas regarding improvement of safety inside the plant. Committee also discusses new safety procedure to be adopted to improve upon old procedures and its members are changed at regular intervals. Safety committee meets once in three months and management safety committee meets monthly, in the plant. Committee discuss shortcoming and safety improvement of the plant.

In the action plan of safety committee, the committee list out various jobs to be done to improve safety and decides the tentative date of completion, review previous committee meeting minutes, and discuss about the incomplete jobs, Record suggestions of the members and discuss their implementation, discuss implementation of new safe operating procedures inside the plant.

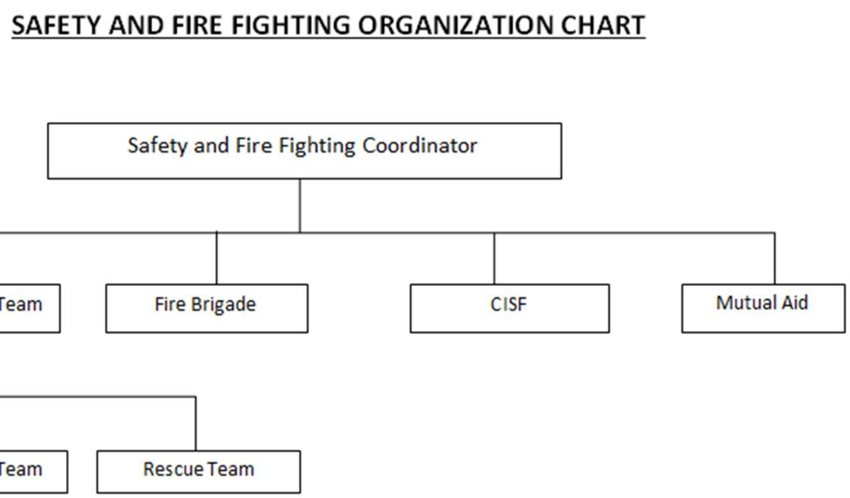


Fig. 2 Safety and Firefighting Organization Chart

A. Duties Of Fire In Chief

1) Complete control of firefighting job.
2) Order for external help, if necessary.
3) Rescue and evacuation job.
4) Co-ordination with firefighting, rescue, and auxiliary team.
5) Order for green signal after normalcy.

B. Duties Of Alternate Fire In Chief

1) Follow order from fire in chief.
2) Co-ordination with firefighting, rescue, and auxiliary team
3) Report black to fire in chief
4) After green signal make up job

C. Fire Fighting Order

1) The person who sees the fire first shouts fire-fire-fire.
2) Blow nearest hand siren.
3) Person at gate then blows electric siren.
4) Then the team members start job as per instruction of fire organization chart.
5) The shift in-charge becomes the fire chief till the location in-charge or alternate.
6) Location in-charge (in the absence of location in-charge) reaches the site.

Table II
MSDS (Material Safety and Data Sheet)

1	Chemical Identity		
	Chemical Name	:	Liquefied Petroleum Gas
	Chemical Classification	:	Fuel
	Synonym	:	LPG, Bottle Gas
	Trade Name	:	Indane
	Formula	:	Straight Chain C-3 andC-4 Saturated Hydrogen carbon mixture (CH^3-CH^2-CH^3, CH^2-CH^3)
	C.A.S. No	:	68746-85-7
	U.N. No	:	1075
	Hazchem No.		2 WE
	Hazardous Waste ID No.	:	5
	Shipping Name	:	Petroleum Gas, Liquified
	Code/Label	:	223/Class2, Flammable Gas
	Ingredients CAS No.	:	Butane 106-97-8
			Propane 74-98-6
2	Physical And Chemical Data		
	Boiling range/Point	:	-42 to 2 C
	Physical State	:	Gas at 15 C and 1 atm
	Appearances	:	Colour less
	Melting/Freezing Point	:	-47 C
	Vapor Pressure	:	120 PSL at 35 C
	Odour	:	Mild Sweet
	Vapor Density (Air = 1)	:	1.6 to 2.0
	Specific Gravity (Water = 1)	:	0.5 to 0.58
	Solubility in water (30)	:	Immiscible, Liquid Floats and Boils in Water
	Others	:	N.A.
	pH	:	N.A.
3	Fire And Explosion Hazard Data		
	Flammability	:	Yes/Flammable
	LEL%	:	1.5%
	UEL%	:	9.5%
	Flash Point	:	-104 to 60 C
	Auto Ignition Term	:	320-405
	TDG Flammability	:	Class 2, Flammable Gas
	Explosion Sensitivity to StaticElectricity	:	High
	Hazardous Combustion	:	Toxic gases and vapor as CO may be product released in a fire involving LPG

4	Reactive Data		
	Chemical Stability	:	Chemically Stable
	Incompatibility With	:	Strong Oxidising Material
	Other Material	:	None
	Reactivity	:	LPG attacks some forms of plastics, rubber, and coating. Heat contribution to the instability contact with strong oxidizing agents may cause fire and Explosions.
	Hazardous Reaction	:	Toxic gases and vapor e.g., CO may be released products in fires involving LPG.
5	Health Hazard Data		
	Routes of Entry	:	LPG can affect the body if it inhaled, or it comes in contact with the eyes and skin.
	Effects of Explosion/Symptoms	:	LPG is gaseous form acts as a simple asphyxiate and a central nervous system depressant. Over exposure to LPG can cause light headache and drowsiness, great exposure may also cause unconsciousness and death. Contact with liquid may also cause cold burns and Irritations.
	Emergency Treatment	:	In the event of an emergency institute first aid procedures and send for first aid or medical assistance.
	TLV (ACGIH) TWA	:	1000ppm 1800mg/m^3
	STEL	:	None
	Permissible Exposure Limit	:	1000ppm
	Odour Threshold	:	Propane is the main constituent of LPG odour threshold of propane is 5000 to20000 ppm.
	LD50	:	
	Propane	:	None
	Butane	:	None
	LC50	:	
	Propane	:	N.A.
	Butane	:	658 gm/m^3/4H
	NFPA Hazard Signals		
	Health	:	1
	Flammability	:	4
	Reactivity	:	0
	Special	:	N.A.

IV. PREVENTIVE MEASURE

Personal protective equipment:

A. Works should be provided with and enforced to use impervious clothing, gloves, face shields and other appropriate clothing necessary to prevent the skin contact with LPG or from contact with vessels containing LPG.
B. Splash-proof safety goggles should be used where LPG may contact the eyes.
C. Bulk storage in spheres in open air and well-ventilated place with proper separation.
D. The ground beneath and adjacent should be plain and concrete.
E. Avoid weeds, long grass, shrubs entries etc.
F. The ground may be sloped to prevent accumulation in case of spillage.
G. For large storage, catchments area filled with gravels away from the tank may be provided.
H. Storage should be away from other flammable materials and liquid oxygen.
I. Cylinder storage area should be kept away from bulk storage area.
J. Excess flow valve may be providing in the outlet line.
K. Fittings and mechanical integrity of the vessels and piping and fire precautions should be controlled as per HSE code "storage of LPG at fixed installation's (G) 34 London HMSO (1981).

Table III
Emergency and first aid measures

Fire	:	Dangerous when exposed to heat or flame. Keep containers cool by spraying with water if exposed to fire.
Exposure	:	If liquid LPG gets into eyes flush the eyes immediately with large amounts of water, lifting the lower and upper lids. Do not use hot water for eye flushing, take medical attention.
Skin Exposure	:	If liquid LPG gets on the skin immediately flush the contaminated skin with water. If liquid LPG soaks through the clothing change the clothing immediately and flush the skin with water. Do not use hot water. If irritation persists after washing, get medical attention.
Breathing	:	If a person breath in large amounts of LPG, move the person to fresh air at once. If breathing has stopped, perform artificial respiration keep the affected person warm and at rest; get medical attention as soon as possible.
Spillage	:	Steps to be taken: Shut off leaks if without risk. Prevent liquid entering sewage, basement,and work pits, vapor may create explosive atmosphere. Warn everybody-explosion hazard, evacuate if necessary.
Waste Disposal Method	:	Keep leaked liquid with sand or earth and dispose off by burning at a safe location or in a suitable combustion chamber.

V. HAZARD ANALYSIS AND RISK ASSESMENT

Hazard analysis and risk analysis plays a crucial role in risk management. Hazard analysis includes identification of all possible hazards potentially created by improper operations, products, process or application. Risk assessment is the next step after the collection of potential hazard. Risk in this context is the probability and severity of the hazard becoming reality.

A. Hazard Analysis

In hazard analysis we are using aloha 5.4.7 for knowing the area that will be affected when a hazard occurs in a facility premises. In this we are taking some of the hazardous conditions like a BLEVE hazard, the flow of air, direction of air. These all conditions considered in the hazard analysis are imaginary but correlates with the data of the site

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VII July 2021- Available at www.ijraset.com

1) ALOHA-1

Site Data:
Location: GHEVRA, INDIA
Building Air Exchanges Per Hour: 0.48 (unsheltered single storied)
Time: April 8, 2021, 1935 hours ST (using computer's clock)

Chemical Data:
Chemical Name: BUTANE
CAS Number: 106-97-8
Molecular Weight: 58.12 g/mol
AEGL-1 (60 min): 5500 ppm
AEGL-2 (60 min): 17000 ppm
AEGL-3 (60 min): 53000 ppm
LEL: 16000 ppm UEL: 84000 ppm
Ambient Boiling Point: 29.8°E
Vapor Pressure at Ambient Temperature: greater than 1 atm
Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

Atmospheric Data: (Manual Input of Data)
Wind: 7 miles/hour from NNW at 10 meters
Ground Roughness: urban or forest Cloud Cover: 7 tenths
Air Temperature: 86° F
Stability Class: D
No Inversion Height
Relative Humidity: 25%

Source Strength:
Leak from hole in spherical tank
Flammable chemical escaping from tank (not burning)
Tank Diameter: 14 meters
Tank Volume: 1,437 cubic meters
Tank contains liquid
Internal Temperature: 86° F
Chemical Mass in Tank: 600000 kilograms
Tank is 74% full
Circular Opening Diameter: 1 inches
Opening is 3 meters from tank bottom
Release Duration: ALOHA limited the duration to 1 hour
Max Average Sustained Release Rate: 646 pounds/min
(averaged over a minute or more)
Total Amount Released: 38,700 pounds
Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

Threat Zone:
Threat Modelled: Flammable Area of Vapor Cloud
Model Run: Heavy Gas
Red: 63 yards (9600 ppm = 60% LEL = Flame Pockets)
Yellow: 170 yards (1600 ppm = 10% LEL)

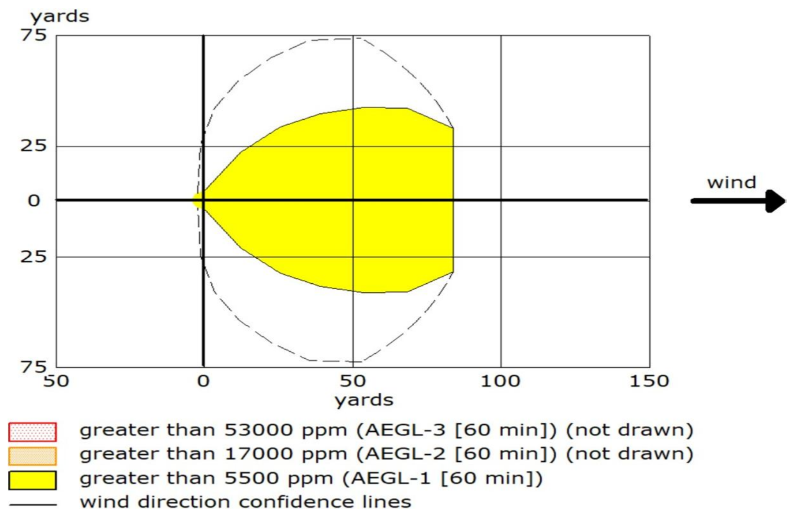


Fig. 3 Aloha-1 Graph

2) ALOHA-2

Site Data:
Location: GHEVRA, INDIA
Building Air Exchange Per Hour: 0.19 (unsheltered single storied)
Time: May 13, 2001, 2251 hours ST (using computer's clock)

Chemical Data:
Chemical Name: PROPANE
CAS Number: 74-98-6 Molecular Weight: 44.10 g/mol
AEGL-1(60 min): 5500 ppm AEGL-2(60 min): 17000 ppm AEGL-3(60 min): 33000 ppm
IDLH: 2100 ppm LEL: 21000 ppm UEL: 95000 ppm
Ambient Boiling Point: -44.8 °F
Vapor Pressure at Ambient Temperature: greater than 1 atm
Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

Atmospheric Data: (Manual Input of Data)
Wind: 7 miles/hour from nnw at 10 meters
Ground Roughness: urban or forest Cloud Cover: 7 tenths
Air Temperature: 86 °F Stability Class: D
No Inversion Height Relative Humidity: 25%

Source Strength:
Leak from hole in spherical tank
Flammable chemical escaping from tank (not burning)
Tank Diameter: 14 meters Tank Volume: 1,437 cubic meters
Tank contains liquid Internal Temperature: 86 °F
Chemical Mass in Tank: 528,532 Kilograms
Tank is 75% full
Circular Opening Diameter: 1 inch
Opening is 4.48 meters from tank bottom
Release Duration: ALOHA limited the duration to 1 hour
Max Average Sustained Release Rate: 1,270 pounds/min (averaged over a minute or more)
Total Amount Released: 76,251 pounds
Note: The chemical escaped as a mixture of gas and aerosol (two phase flow)

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VII July 2021- Available at www.ijraset.com

Threat Zone:
Model Run: Heavy Gas
Red: 51 yards --- (33000 ppm = AEGL-3 [60 min])
Note: Threat zone was not drawn because effects of near-field patchiness
Make dispersion predictions less reliable for short distances.
Orange: 75 yards --- (17000 ppm = AEGL-2 [60 min])
Yellow: 144 yards --- (5500 ppm = AEGL-1 [60 min])

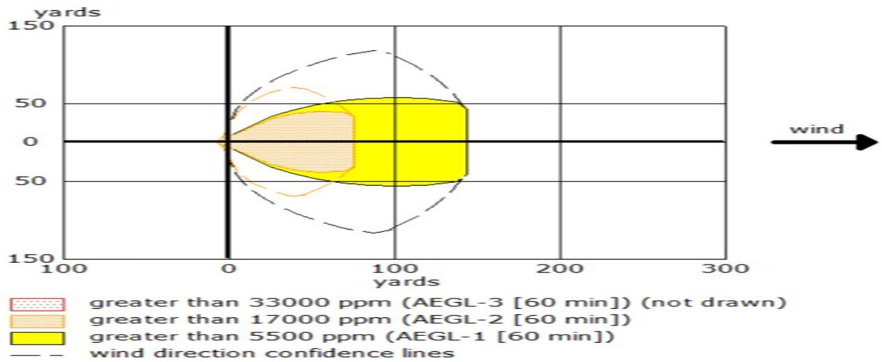


Fig. 4 Aloha-2 Graph

B. Risk Assessment (HAZOP and HAZID)

HAZOP and HAZID are risk analysis and assessment tools used in the workplace. HAZOP which stands for hazard and operability study is used to identify abnormalities in the working environment and pinpoint the root causes of abnormalities. It deals with comprehensive and complex workplace operations, which, if malfunctions were to occur, could lead to significant injury or loss of life.

HAZID stands for hazard identification. It is more of general risk analysis tool design to alert management to threats and hazards as early in the process as possible. The classification is made on the basis of probability and consequences. A HAZID study provides a qualitative analysis of a worksite in order to determine its worker safety risk level. Considering the points named as nodes where there is probability of a hazard to occur. HAZOP is generally based on pre assessment and post analysis study of hazard; in the table listed below we have mentioned all the causes, consequences and safeguards to deal with a real time situation or hazard, when it occurs. Similarly, in HAZID we have used a risk matrix table to show the probability of occurrence of hazard and its severity on manpower and different operations taking place in lpg bottling plant.

CONSEQUENCE OF HAZARD				ANNUAL FREQUENCY				
				A	B	C	D	E
Severity	People (P)	Assets (A)	Environment (E)	< 0.00001	0.0001 – 0.00001	0.001 – 0.0001	0.01 – 0.001	> 0.01
0	No injury	No damage	No effect	L	L	L	L	L
1	Slight injury	Slight damage	Slight effect	L	L	L	L	M
2	Minor injury	Minor damage	Minor effect	L	L	L	M	M
3	Major injury	Localised damage	Localised effect	L	L	M	M	H
4	Single Fatality	Major damage	Major effect	L	M	M	H	H
5	Multiple Fatalities	Extensive damage	Extensive effect	M	M	H	H	H

Fig. 5 Risk Matrix

TABLE IV
HAZOP Study

<table>
<tr><td>Project:</td><td colspan="2">HAZOP Study for LPG Bottling Plant</td><td>Session Date:</td><td colspan="2">21 May 2021</td></tr>
<tr><td>Section Description:</td><td colspan="5">LPG Receipt from Tanker, Tanker decanting Shed, LPG Compressors, LPG Horton Sphere and Bullets</td></tr>
<tr><td>Design Intention:</td><td colspan="5">To receive and store LPG Horton Sphere and Bullets</td></tr>
<tr><td>Ref. No.</td><td>Parameter</td><td>Guideword</td><td>Cause</td><td>Consequence</td><td>Safeguards</td></tr>
<tr><td>N1.01</td><td>Flow</td><td>More</td><td>1. ROV-501/201/203/205/213 stuck open</td><td>Possible over pressurization of the Horton Sphere/Bullet, leading to rupture causing fire/explosion.</td><td>1.SOP based operation.
2. Level Transmitters provided (both H/S and bullets).
3. High Level Alarm provided on both H/S and bullets.
4. Gas detection system
5. Manned Operation
6. ESDs on manual intervention
7. Sprinklers based on Quartzoid Bulb (triggers at 79°C)
8. Firefighting System</td></tr>
<tr><td></td><td></td><td></td><td>2. Changeover from one storage vessel to another failure</td><td>Process upset.

Possible over pressurization of the Horton Sphere/Bullet, leading to rupture

causing fire/explosion.</td><td>1. SOP based operation
2. Manned operation
3. Level Transmitters provided (both H/S and bullets).
4. High Level Alarm provided on both H/S and bullets.

5. Gas detection system
6. ESDs on manual intervention
7. Sprinklers based on Quartzoid Bulb (triggers at 79°C)
8. Firefighting System</td></tr>
<tr><td>N1.02</td><td></td><td>Less/No</td><td>1. Empty LPG Tanker</td><td>Process upset loss of inventory to bullet/ Horton Sphere.</td><td>1. Manned Operation
2. SOP
3. Local pressure</td></tr>
<tr><td></td><td></td><td></td><td>2. Compressor Trips</td><td>Process upset, operational delays</td><td>1. High discharge pressure trip provided
2. PAVs provided in this system
3. SRV provided
4. Manned Operation
5. Inspection and Maintenance
6. SOPs and Dos & DON'T'S</td></tr>
</table>

			3. ROV-501/201/203/205/213 falls close	Possible over pressurization upstream, leading to fire/explosion	1. PAVs provided. 2. Manned operation. 3. Inspection and Maintenance.
			4. Leakage/Rupture	Loss of inventory, possible fire/explosion	1. Excess Flow Check valves 2. Gas detection system. 3. Manned operation. 4. ESD on Manual Intervention. 5. Firefighting system. 6. Inter Horton Sphere to Bullet and LPG transfer.
N1.03		Reverse	NFH as NRVs provided		
N1.04		Other	Water present in Indane LPG Tanker	Process Upset, no safety hazard	1. Sampling at TLD Bay by Roto gauge 2. Manned operation. 3. SOP based operation 4. Inspection 5. Water draining of Bullets/ Horton Sphere before filling operation.
N1.05	Pressure	High	1. High Ambient Temperature	No Safety Hazard as system designed for maximum ambient temperature.	
			2. External Fire	Possible overheating may result in over pressurization of the system. Possible damage to piping/equipment, safety hazard.	1. Gas detection system 2. SRVs on H/S and LPG Bullets. 3. PAVs provided in the entire system 4. Sprinklers based on Quartzoid Bulb (triggers at 79°C) 5. Sprinklers System provided to produce cooling effects. 6. Firefighting System. 7. DMP
N1.06		Low	Low Ambient Temperature	No Safety Hazard as system designed for minimum ambient temperature.	

TABLE V
HAZID Study

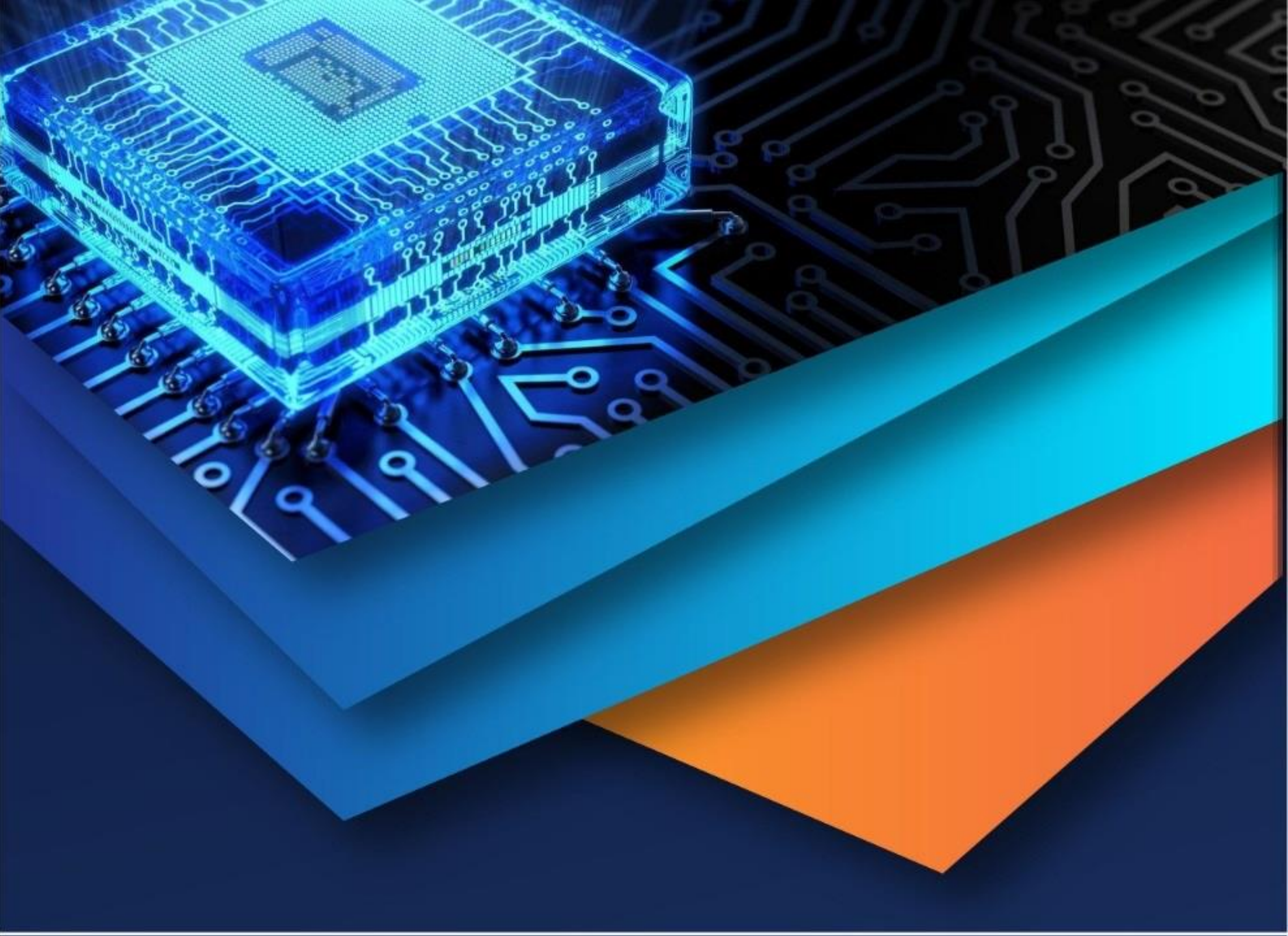
Project:	HAZID Study for IOCL LPG Bottling Plant		Session Date:	21 May 2021		
Session:	LPG Bottling Plant					
GUIDEWORD	CAUSES	MAJOR EFFECTS	PREVENTIVE & MITIGATION MEASURES	FREQ	CONS	RISK
1. Unignited HC Release	1.1 Overfilling of LPG cylinder.	Operator may be exposed to HC vapours.	1. Gross weighing method for cylinder filling. 2. Continuous monitoring of filling operation. 3. Gas detection system. 4. Vapor extraction Unit 5. ESD on manual intervention. 6. PPEs 7. DMP	B	2	L
	1.2 Leakage/ rupture	Loss of containment, possible operator exposure to HC vapours.	1. Excess Flow Check Valves provided. 2. PAVs/SRVs provided in the entire system. 3. Gas detection system. 4. ESD on manual intervention 5. inspection & maintenance 6. Provision for inter Horton sphere and bullet LPG transfer.	D	2	M
	1.3 Uncontrolled drainage from H/S	Possible operator exposure to HC vapours	1. Excess Flow Check Valves provided 2. Gate valve and quick shut of valve 3. SOPs 4. Gas Detection system 5. ESDs on manual intervention. 6. Drainage is strictly manned. 7. Inspection & maintenance 8. PPEs 9. DMPC	C	4	M
2. Ignited HC Release	2.1 Overfilling of LPG Cylinder	Possible fire/explosion, safety hazard	1. Gross Weighting method for cylinder filling 2. Continuous monitoring of filling operation. 3. Gas detection system. 4. ESD on manual intervention. 5. Fire detectors and Firefighting system. 6. Sprinklers based on Quartzoid Bulb (triggers at 79°C) 7. PPEs 8. DMP	B	4	M
	2.2 Leakage/Rupture	Fire/Explosion, Safety hazard	1. Excess flow Check valves provided 2. Gas detection system. 3. ESD on manual intervention. 4. Inspection & maintenance. 5. Provision for inter Horton Sphere and bullet LPG transfer. 6. Fire detectors and Firefighting	B	4	M

VII. CONCLUSION AND FUTURE SCOPE

The future scope of this research work is to help the user develop a comprehensive plan to prevent or lessen the effect of a hazard and also safeguard the safety of workers working in the premises, by taking into considerations all the hazards and there consequences and deeply studying the use of equipment installed at the premises and the role of different key personnel present on site or off site responsible for fire and hazard safety

REFERENCES

[1] Nilambar Barilia,Vimal Chandra Srivastava and Indira Mishra-"theoretical and experimental studies on hazard analysis of lpg/lng release" reviews in chemical engineering - De Gruyter/2017-volume 33 issue 4
[2] Analysis of tank safety with propane-butane on lpg distribution station, polish journal of chemical technology volume 19 issue 4 2017-0074
[3] Nitin Roy,Hans J.posman "Pattern and trends in injuries due to consumer propane incidents" article view 330-ACS chemical health safety,2020.27.4,251-258
[4] lakshmi k.a and lakshmi,M.V.V.C(2016)"quattative risk assesment on hydrocarbons release",international journal of research in engineering and applies sciences 6(10),221-232
[5] singh M.s and saikon V(2014)"assesment of industrial hazard for offsite emergency planning and response"-a simulated study on environs of indane(lpg) bottling plant,keanean journal of science,3,43-52
[6] behesti M.H,dehgan S.F hajizadih,R.JAFRI and koohpaii.M (2018) modelling the consequences of explosion,fire and gas leakage in domestic cylinders containing LPG and mid health sci res,8,83-88
[7] PRAMOD kumar"fire disaster following lpg tanker explosion in kannur(kerala,India)":august 27,2012 , burns volume 39 issue 7,nov 2013,pages 1479-1487
[8] richard H MCKEE,Deborah Herron,Mark Soperstein "the toxicological properties of petroleum gases"-intenational journal toxicol jan-feb 2014-33(1suppl)285-515
[9] Tatsushigi Fukunaga,Hiditaka Yamamoto "lpg poisoning: report of two cases and review"-forensic science international volume 82,issue 3 25 oct 1996,page 193-200
[10] Haridass, Sundaram"Health and safety hazards management in oil and gas industry"- international journal of engineering and technical research v6(06) volume 6 issue 06,june 2017
[11] national disaster management authority (NDMA) guidelines on chemical (industrial) disaster management 2007
[12] on site emergency planning workbook,new south wales state emergency management committee.
[13] Crossthwaite, P. J., Fitzpatrick, R. D., and Hurst, N. W., (1985), Risk Assessment for the Siting of Developments near Liquefied Petroleum Gas Installations. IChemE Symposium Series, 110, 373-400.
[14] Sachan, S. S., and Premi, R., (2015), Hazard Identification and Risk Assessment in LPG Bottling Plant. International Journal of Science Technology & Engineering, 1(12), 19-22.
[15] Jimoh, M., (2018), Six die, several injured in Lagos gas plants' explosions. New Telegraph, Retrieved June 6, 2017, from https://newtelegraphonline.com/2018/01/six-die-several-injured-lagos-gas-plants-explosions/
[16] Drager, "Gas Dispersion", Drager Safety AG & Co. KGaA, Germany, www.draeger.com, access July 2017.
[17] IAEA, "External Human Induced Events In Site Evaluation For Nuclear Power Plants", IAEA NS- G-3.1, Vienna, 2002.
[18] June Mellawati, Siti AlimahSG "The Potential Hazards of Human Activity Around The Nuclear Plant Site: Case Study of Nuclear Plant Site at Puspiptek Serpong." S Conference Proceedings; Enhancing Quality of Life Through Human Well Being and Environmental Sustainability In Social Science. September 12-14, 2017, Bogor City, Indonesia. Bogor International Conference for Social Science. Djuanda University, Bogor. 2017.
[19] Siti Alimah, Dedy Priambodo, June Mellawati, "Analisis Potensi Bahaya Ledakan SPPBE di Sekitar Calon Tapak RDE.", Majalah Ilmiah Pengkajian Industri BPPT, Vol. 11 No. 1, April, 2017.
[20] L. Rosmayati,"Kajian Komposisi Hidrokarbon dan Sifat Fisika-Kimia LPG untuk Rumah Tangga, Lembaran Publikasi Minyak dan Gas Bumi", Lembaran Publikasi Minyak dan Gas, Vol. 46. No.2, Agustus, 2012.
[21] New Jersey Department of Health, "Righ to Know Hazardous Substance Fact Sheet Liquefied Petroleum Gas", May, 2010.
[22] M.S.B. Ishak, "Secermination of Explosion Parameter of LPG-Air Mixtures in The Closed Vessel", A Thesis Submitted in Fulfillment of the Requirements for The Awards of The Degree of Bachelor of Chemical Engineering (Gas Technology), University Malaysia Pahang, November, 2008.
[23] Ministry of ESDM, "Study of Gas Substitution with Other Energy in The Industrial Sector", Center of Data and Technology for Information of Energy and Mineral Resources, Ministry of Energy and Mineral Resources, 2013.
[24] Siddiqui, NA., "Study of Release of Hydrocarbon in The Atmosphere While LPG and Propane Tankers Loading and Its Occupational Health Effects", International Journal of Scientific & Technology Research Volume 1, Issue 11, December 2012.
[25] Sirdah, M.M, et.al., "Possible Health Effects of Liquefied Petroleum Gas on Workers at Filling and Distribution Stations of Gaza Governorates", Eastern Mediterranean Health Journal, March, 2013.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY