ANNEXURE-30

RISK ASSESSMENT

AND

DISASTER MANAGEMENT PLAN

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RISK ASSESSMENT AND DISASTER MANAGEMENT PLAN

1.1 RISK ASSESSMENT

Accident can occur in every industry in spite of efforts to prevent them. Frequently they give rise to suffering and damage, the extent of which is, in part, determined by the potential for loss, surrounding the event. Many parts of petrochemical industries have high potential for loss and there have been cases, where loss, measured in both human and monetary terms, has been severe. It is equally true to say that there have been other cases where, because of effective action taken at the time, the full potential loss has been largely avoided. Effective action, in these cases, has been possible due to the existence of pre-planned and practiced procedures for handling major emergencies utilizing the combined resources of the industrial concern and outside services.

Section 41-B(4) of the Factories Act, 1948 requires that every occupier of a hazardous factor shall draw up and onsite emergency plan and detailed disaster control measures for the factory and make known to the workers and the general public in the vicinity, the safety measures required to be taken in the event of an emergency taking place.

1.2 CONSEQUENCE ANALYSIS

Hazardous substance, on release can cause damage on a large scale. The extent of the damage is dependent upon the nature of the release and the physical state of the material. In the present report the consequences for both flammable and toxic hazards are considered and the damages caused due to such releases are assessed with recourse to Multi Criteria Analysis (MCA). Flammable substances on release may cause jet fire & less likely unconfined vapour cloud explosion causing possible damage to the surrounding area. The extent of damage depends upon the nature of the release. The release of flammable materials and subsequent ignition results in heat radiation, pressure wave or vapour cloud depending upon the flammability and its physical state. It is important to visualize the consequence of the release of such substances and the damage caused to the surrounding areas.

Similarly the accidental release of toxic substances would lead to dispersion of gas cloud in the prevailing wind direction. An insight into physical effects resulting from the release of hazardous substances can be had by means of various models. Vulnerability models can also be used to translate the physical effects occurring in terms of injuries and damage to exposed population and buildings. **Table1-1** depicts the input data required for consequence analysis.

Table 1 Data for Consequence Analysis

Parameter	Case
Temperature	30-35 ^oC
Atmospheric Stability	C & D class
Relative Humidity	50 %
Wind Speed	3 - 5 m/s

Stability class C shows the slightly unstable conditions of the climate. Generally in the daytime, strong solar radiation i.e. More Sun & High Wind causes high turbulence in the climate. And in the nighttime, stable condition i.e. with moderate cloud exists which is nothing but a calm environmental condition. As per risk point of view, out of these two conditions one is extreme calm and one is extreme worst. Dispersion point of view, both can highly affect the extent of vulnerability of probable incident. The average speeds at these two conditions are assumed to be 3 m/s.

1.2.1 Factors influencing the use of Physical Effect Models

In order to calculate the physical effects of the accidental release of hazardous substance, following steps must be carried out in succession

- Determining the form in which the hazardous substance occurs e.g. gas, gas condensed to liquid or as a liquid in equilibrium with vapour
- Determination of the way in which the release takes place; for example intermittent or a continuous release
- Determination of the outflow volume (as a function of time) of the gas, vapour or liquid
- Dispersion of the released gas or vapour which has formed into the atmosphere.
- In case of flammable substances, the heat radiation is also calculated for the following situations:
- Torch or jet fires, if a jetted release is ignited
- In the event of an explosion of a gas cloud, the peak overpressure resulting from the explosion is calculated and the damage contours are plotted.
- In evaluating the dispersion of releases, Pasquill-Giffard atmospheric stability classes (A to F) and relevant ranges of wind speeds are used and as shown in below **Table.2**

Table 2 Pasquill – Giffard Atmospheric Stability

Sr. No.	Stability Class	Weather Conditions
1	A	Very unstable - sunny, light wind

2	A/B	Unstable - as with A only less sunny or more windy
3	B	Unstable - as with A/B only less sunny or more windy
4	B/C	Moderately unstable – moderate sunny and moderate wind
5	C	Moderately unstable – very windy / sunny or overcast / light wind
6	C/D	Moderate unstable – moderate sun and high wind
7	D	Neutral – little sun and high wind or overcast / windy night
8	E	Moderately stable – less overcast and less windy night
9	F	Stable – night with moderate clouds and light / moderate wind
10	G	Very stable – possibly fog

- The model is based on a point source. In practice, however, a point source will never exist; for example, a surface sources in the case of pools. To enable the source dimensions to be included in the calculation in the dispersion models in spite of this, an imaginary (virtual) point source is assumed, which is put back in such a way that the cloud area calculated according to the model has the source dimensions at the site of the actual source. In calculations based on a continuous source, the duration of the source is also included in the calculation. Some conditions for this calculation model are as follows:
- There must be some wind at the site
- The model applies only to open terrain; allowance is made, however, for the roughness of the terrain. The influence of trees, houses, etc. on the dispersion can be determined by means of the roughness length.

1.3 RISK ASSOCIATED TO STORAGE & PROCESS

1.3.1 Heat Load and Shock Waves

If a flammable gas or liquid is released, damage resulting from heat radiation or explosion may occur on ignition. The models used in this study for the effects in the event of immediate ignition (torch and pool fire) and the ignition of a gas cloud will be discussed in succession. Suitable software models are used (ALOHA) to calculate the heat radiation or peak overpressure as a function of the distance from the torch, the ignited pool or gas cloud. The physical significance of the various heat loads are depicted in **Table 3**.

Table 3 Damage Criteria for Heat Load, kW/m3

Exposure Time	t=10 seconds		t=30 seconds	
	with protection	without protection	with protection	without protection
1 % lethal injury	21.2	12.5	9.3	7.3
First degree burns	8.5	6.9	4.0	3.7

1.3.2 Gas/vapour Cloud Dispersion

The gas/Vapor cloud will disperse into the atmosphere following an accident and if the gas has a higher density than air; it will tend to spread in a radial direction because of gravity. This results in a gas/vapour cloud of particular diameter at a particular height. As a result of this, in contrast to a neutral gas, the gas released may spread against the wind direction.

1.3.3 Injuries Caused by Intoxication

In the event of people being exposed to toxic gases, the relationship between the damage and the toxic dose is established by a probit function, in the following form

$Pr = a + b \ln (Cnt)$

Where,

a = constant depending on the type of injury and toxic substance

b = constant depending on toxic substance

c = concentration of toxic substance in mg/m3

t = exposure time in minutes

n = constant depending on toxic substance

1.3.4 Preventive and Protective Measures

Basic preventive and protective features below should be provided regardless of the type of operation or the magnitude of the Fire and Explosion Index. When these protective features are not provided, the existing hazard exposure may be greater than the radius of exposure computed through F&E Index.

- Adequate water supplies for fire protection. The amount/quantity of the water requirement is based on rate of firewater required for the worst possible fire and the time duration for which the fire will last
- Structural design of vessels, piping, structural steel, etc.
- Overpressure relief devices
- Corrosion resistance and / or allowances
- Segregation of reactive materials in process lines and equipment
- Electrical equipment grounding
- Safe location of auxiliary electrical gear (transformers, breakers, etc.)
- Normal protection against utility loss (alternate electrical feeder, spare instrument, air compressor, etc.)
- Compliance with various applicable codes (ASME, ASTM, ANSI, Building Codes, Fire Codes, etc.)
- Fail-safe instrumentation
- Access to area for emergency vehicles and exits for personal evacuation
- Drainage to handle probable spills safely plus fire fighting water hose nozzle sprinkler and / or chemicals
- Insulation of hot surfaces that heat to within 80% of the auto-ignition temperature of any flammable in the area
- Adherence to the National Electrical Code. The Code should be followed except where variances have been requested/approved.
- Hazard area analysis followed by appropriate intrinsically safe electrical equipment wherever required
- Limitation of glass devices and expansion joints in flammable or hazardous service. Such devices are not permitted unless absolutely essential. Where used, they must be registered and approved by the production manager and installed in accordance with appropriate standards and specifications
- Building & equipment layout. Separation of high-hazard area must be recognized especially as it relates to born property damage & interruption of business. Provision of accessible battery limits block valves.
- Cooling tower loss prevention and protection.
- Protection of fired equipment against accidental explosion and resultant fire.

- Process control rooms shall be isolated by firewalls from process control laboratories and/or electrical switchgear transformers.

1.3.5 Burning Torch (flare)

If a release of a gas is ignited then a stable, diffusion torch or jet fire may be produced. This study uses a model with which the length of torch and the thermal load for the surrounding area can be calculated. For the flammable gas, in this model, an ellipse is assumed for the shape of a torch. The volume of the (torch) flare in this model is related to the outflow. Humidity in air has a relatively high heat-absorbing capacity.

Table 4 Damage Caused at Various Heat Loads

Heat Load (kW/m^2)	Type of Damage
37.5	Sufficient to cause damage to process equipment
25.0	Minimum energy required to ignite wood on infinitely long exposure (nonpiloted)
16.5	1% lethality, if exposed for 10 seconds
12.5	Minimum energy required for piloted ignition of wood, melting plastic tubing
6.9	First degree burns if exposed for 10 seconds
4.5	Sufficient to cause injury to personnel if unable to escape within 20 seconds; however, blistering of skin (1st degree burns) is likely
1.6	Will cause no discomfort on long exposures

In order to calculate the thermal load, the center of the flare is regarded as a point source. This center is taken as being half a flare-length from the point of outflow.

1.3.6 Vapour cloud explosion (VCE)

The vapor cloud explosion begins with a release of a large quantity of flammable vaporizing liquid or gas from a storage tank, transport vessel or pipeline producing a dangerous overpressure. These explosions follow a well-determined pattern. There are basically four features, which must be present for an effective vapour cloud explosion to occur with an effective blast. These are

- First, the release material must be flammable and at a suitable condition of temperature and pressure which depends on the chemical. The materials, which come under this category, range from liquefied gases under Pressure (e.g. Propylene); ordinary flammable liquids (e.g. cyclohexane, naphtha) to non liquefied flammable gases (e.g. ethylene, acetylene)

- Second, before the ignition, a cloud of sufficient size must have been formed. Normally ignition delays of few minutes are considered the most probable for generating the vapour cloud explosions
- Third, a sufficient amount of the cloud must be within the flammable range of the material to cause extensive over pressure.
- Fourth, the flame speed determines the blast effects of the vapour cloud explosions, which can vary greatly The flammable content of a gas cloud is calculated by three-dimensional integration of the concentration profiles, which fall within the flammable limits. If the gas cloud ignites, two situations can occur, namely non-explosive combustion (flash fire) and explosive combustion (flash fire + explosion).

The significance of the peak over pressure 8, 3.5, 1 psi is depicted in **Table 5** and the damage caused at various peak overpressures are depicted in **Table 6**

Table 5 Damage criteria for pressure Wave

Peak over Pressure(psi)	**Type of Damage**
Greater than 8	Destruction of buildings
Greater than 3.5	Serious injury likely
Greater than 1	Shatters glass

Table 6 Damage Produced by Blast

Pressure (Kpa)	**Pressure (psig)**	**Damage**
0.138	0.02	Annoying nose (137dB), if of low frequency (10-15 Hz)
0.207	0.03	Occasional breaking of large glass windows already under strain
0.276	0.04	Loud noise (143 dB). Sonic boom glass failure
0.69	0.1	Breakage of windows, small, under strain
1.035	0.15	Typical Pressure for glass failure
2.07	0.3	"Safe distance" (probability 0.95 no serious damage beyond this value) Missile limit Some damage to house ceilings; 10% window glass broken
2.76	0.4	Limited minor structural damage
3.45-6.9	0.5-1.0	Large and small windows usually shattered; occasional damage to window frames

4.83	0.7	Minor damage to house structures
6.9	1.0	Partial demolition of houses, made uninhabitable
6.9-13.8	1-2	Corrugated asbestos shattered Corrugated steel or aluminum panels, fastenings fail, followed by buckling Wood panels (standard housing) fastenings fail, panels blown in.
8.97	1.3	Steel frame of clad building slightly distorted
13.8	2	Partial collapse of walls and roofs of houses
13.8-20.7	2-3	Concrete or cinder block walls, not reinforced shattered
15.87	2.3	Lower limit of serious structural damage
17.25	2.5	50% destruction of brickwork of house
20.7	3	Heavy machines (3000 lb) in industrial building suffered little damage Steel frame building distorted and pulled away from foundations
20.7-27.6	3-4	Frameless, self-framing steel panel building demolished Rupture of oil storage tanks
27.6	4	Cladding of light industrial buildings ruptured
34.5	5	Wooden utilities poles (telegraph, etc.) snapped Tall hydraulic press (40000 lb) in building slightly damaged
34.5-48.3	5-7	Nearly complete destruction of houses
48.3	7.1	Loaded train wagons overturned
48.3-55.2	7-8	Brick panels, 8-12 in thick, not reinforced, fail by shearing or flexure
62.1	9	Loaded train box-cars completely demolished
69.0	10	Probable total destruction buildings Heavy (7000 lb) machine tools moved and badly damaged Very heavy (12000 lb) machine tools survived
2070	300	Limit of crater lip

1.3.7 Flash Fire

A flash fire is the non-explosive combustion of a vapour cloud resulting from a release of flammable material into the open air, which after mixing with air, ignites. A flash fire results from the ignition of a released flammable cloud in which there is essentially no increase in combustion rate. The ignition source could be electric spark, a hot surface, and friction between moving parts of a machine or an open fire.

Part of the reason for flash fires is that, flammable fuels have a vapour temperature, which is less than the ambient Temperature. Hence, as a result of a spill, they are dispersed initially by the negative buoyancy of cold vapors and subsequently by the atmospheric turbulence. After the release and dispersion of the flammable fuel the resulting vapour cloud is ignited and when the fuel vapour is not mixed with sufficient air prior to ignition, it results in diffusion fire burning. Therefore the rate at which the fuel vapour and air are mixed together during combustion determines the rate of burning in the flash fire.

The main dangers of flash fires are radiation and direct flame contact. The size of the flammable cloud determines the area of possible direct flame contact effects. Radiation effects on a target depend on several factors including its distance from the flames, flame height, flame emissive power, local atmospheric transitivity and cloud size.

1.3.8 BLEVE

BLEVE stands for Boiling Liquid Expanding Vapor Explosion. BLEVE is a follow-up effect, which occurs if the vapour side of a pipeline is heated by a torch of a pool fire. Due to the heating, the vapour pressure will rise and the material of the pipeline wall will weaken. At a given moment the weakened pipeline wall will no longer be able to withstand the increased vapour pressure and it will burst open. As a result of the expansion and flash-off a pressure wave occurs. In the case of flammable liquid are:

- A fireball: There are models with which the radius of the fireball and the thermal load can be calculated
- Pressure wave effects resulting from the expansion of the vapour and the flash-off
- Rupture of the pipeline, resulting in the formation of numerous fragments of the line. These fragments can be hurled over at fairly greater distances by the energy released.

TPL has developed the Risk Matrix with detailed Risk criteria for rating the risks accordingly and to mitigate the risk to the As Low As Reasonably Practicable (ALARP) level /an acceptable risk level.

- Hazard and Operability (HAZOP) /What-if for Process modification and new products
- Hazard Identification and Risk Assessment for all activities, products and services
- Chemical Hazard Assessment /(PrHA) Preliminary Process Hazard Analysis which is carried out for exposure, fire and reactivity hazards
- Job Safety Analysis for task assessment of process activities
- PPE Hazard Assessment and PPE mapping
- Management of Change /Change control reviews for all modifications.

1.4 RISK ASSESSMENT STUDY USING ALOHA

With the help of the atmospheric data and the specifications of the storage tank for storing Propylene, Chlorine, risk assessment for the storage and explosion of the chemicals inside the plant was modeled using the software ALOHA. ALOHA (Aerial Locations of Hazardous Atmospheres) is a program designed to model chemical releases for emergency responders and planners. It can estimate how a toxic cloud might disperse after a chemical release and also features several fires and explosions scenarios.

ALOHA displays its estimate as a threat zone, which is an area where a hazard (such as toxicity, flammability, thermal radiation, or damaging overpressure) has exceeded a user-specified Level of Concern (LOC).ALOHA allow you to model many release scenarios: toxic gas clouds, BLEVEs (Boiling Liquid Expanding Vapor Explosions), jet fires, vapor cloud explosions, and pool fires. Depending on the release scenario, ALOHA evaluates the corresponding type of hazard. The Material Safety Data Sheets (MSDS) of all raw materials and finished products used in the project are attached as **Annexure-15.** The results for the storage of Propylene, Propylene Oxide, Chlorine and Dichloro Propane are given along with the corresponding preventive and mitigation measures are added in accordance to the hazards that are bound to happen.

Table 7 Hazardous Chemicals Stored

S. No	Name of chemicals	No. of Storage Tanks	Licensed quantity/proposed storage (Kg)	Remarks
1	Propylene	2	346000	Licence obtained from PESO (Annexure-16)
2	Propylene oxide	2	232000	-
3	Chlorine	NA(Pipe line)	70000/day	Licence obtained from PESO (Annexure-16)
4	Chlorinated Organics	2	220000	-

1.4.1 Propylene Oxide

Physical Hazard Information:

Propylene oxide is extremely volatile. When released to soil, it will quickly evaporate into the atmosphere. Once in the atmosphere, propylene oxide is photo chemically degraded by hydroxyl radicals.

Propylene oxide is stable under recommended storage conditions. Propylene oxide liquid and vapor are extremely flammable. Vapors may travel long distances and are heavier than air. Vapor may cause flash fire or explosion. Vapor concentrations between 1.6 percent and 42 percent in air can explode if an ignition source is present. Avoid exposure to an open flame or heat source. Aqueous mixtures with propylene oxide concentrations are as low as 0.75% may be flammable. Elevated temperatures can cause hazardous polymerization. Avoid temperatures above 50°C.

Health Exposure Information:

Contact with Propylene Oxide may cause severe irritation with corneal injury, which may result in permanent impairment of vision, even blindness. Chemical burns may occur. Contact with vapor may cause irritation experienced as mild discomfort and redness. Prolonged contact with the skin is not likely to cause significant irritation unless the product is confined under clothing or gloves. Aqueous solutions may cause more severe effects, including burns. Prolonged or widespread contact may result in absorption of potentially harmful amounts.

Inhalation studies in animals suggest that lifetime exposure to high levels of propylene oxide may cause cancer. It is classified as “B2 - probable human carcinogen” by the U.S. Environmental Protection Agency (EPA). The International Agency for Research on Cancer (IARC) classifies propylene oxide as Group 2B “possibly carcinogenic to humans” based on the same data.

TPL has a clear and concise Onsite emergency plan to mitigate any emergencies that arise in handling the chemicals stored inside the plant which will be discussed in detail.

Some of the safety and operational measures to be followed in case of an emergency in handling the Propylene Oxide are as follows:

- Industrial spills or releases are infrequent and generally contained. If a large spill does occur, dike the area to contain the spill.
- In case of a fire, deny any unnecessary entry into the area and consider the use of unmanned hose holders. Use water spray of fog, carbon-dioxide or dry-chemical extinguishers, or foam to fight the fire.
- Vapors are heavier than air and may travel a long distance and accumulate in low-lying areas. The public should be warned of downwind vapor explosion hazards.
- An inert gas atmosphere or pad is required over propylene oxide during transfer or storage to prevent air from entering the system and forming explosive mixtures. The more common inert gases, such as nitrogen and methane, are recommended for this purpose.

- Keep fire water out of waterways and sewers to minimize the potential for environmental damage. Follow emergency procedures carefully.
- Sprinklers are provided around the storage bullets.
- Sensors are connected to the storage bullets.
- The entire storage area of chemicals is fenced and provided with security. Entry is restricted to 50 mts from storage area. The area around the storage will be free of ignition sources and other hazards.
- Fire hydrant systems are provided through out the storage area to avoid fire explosion.

Table 8 Atmospheric data (Manual Input)

S.No	Parameters	Case
1.	Wind	3 meters/second from SE at 10 meters
2.	Ground Roughness	urban
3.	Cloud Cover	0 tenths
4.	Air Temperature	35° C
5.	Stability Class	B/C
6.	Relative Humidity	50%

Table 9 Source Strength

S.No	Parameters	Case
1	Tank Type	Cylindrical (Horizontal)
2	Chemical Type	Flammable Escaping From Tank(Not Burning)
3	Tank Diameter	3.75 m
4	Tank Length	15.147 m
5	Tank Volume	167 Cubic Meters (Storage capacity 145 Cubic Meters)
6	Internal Temperature	35^{0}c
7	Chemical Mass In Tank	95,020 kg
8	Position Of The Leak	0 m From The Tank Bottom
8	Circular Opening Diameter	1 Inch
9	Total Amount Released	6,511 kg
10	Max Average Sustained Release Rate	110 Kilograms/Min
11	Capacity Of Tank	70 % Full
12	State Of Chemical Inside The Tank	Liquid

THREAT ZONE:

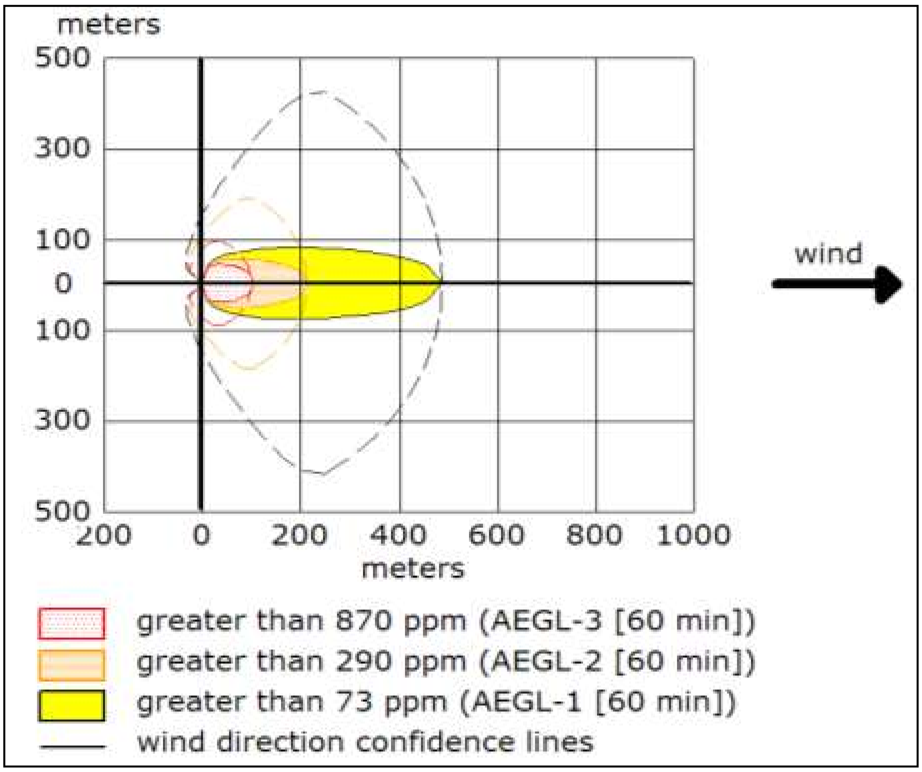
Threat Modeled: Toxic area of vapour cloud

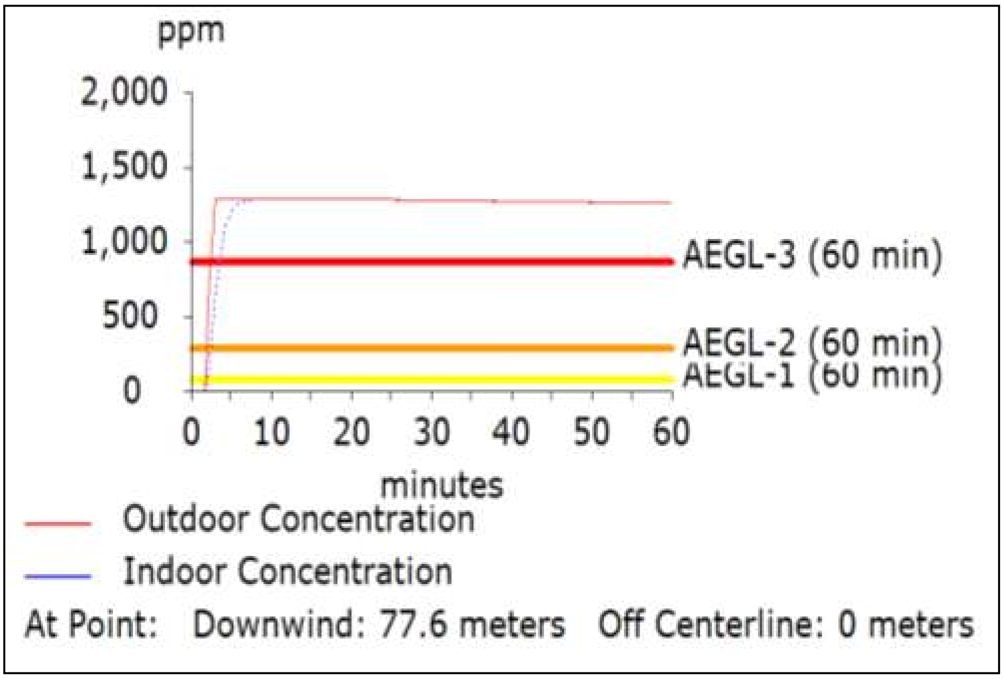
Model Run: Heavy Gas

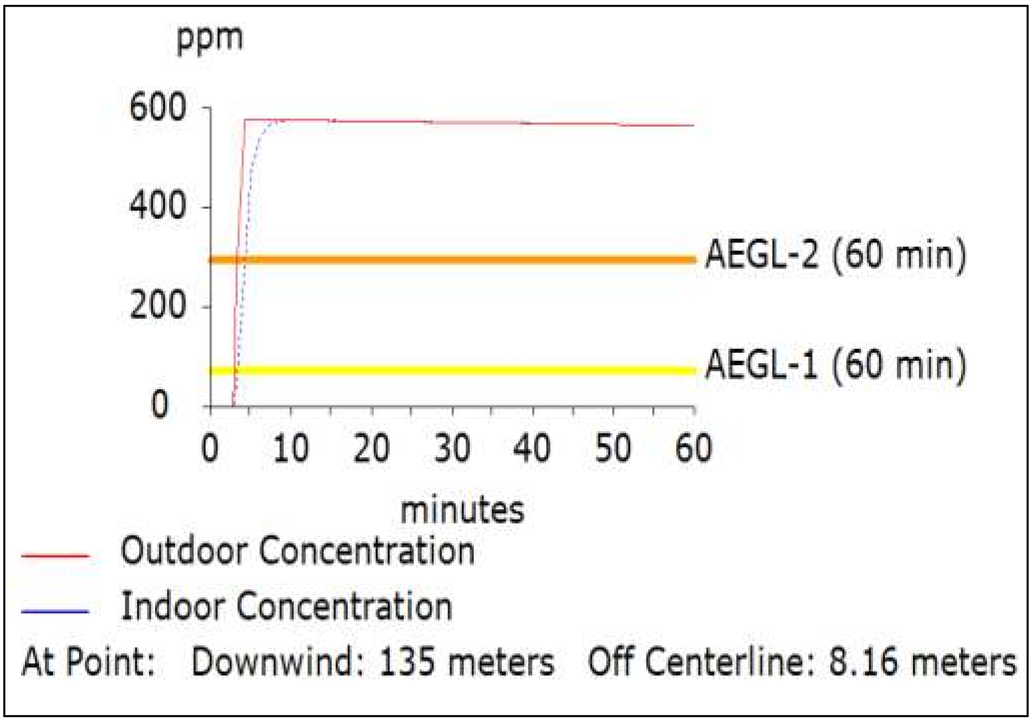
Red : 101 meters --- (870 ppm = AEGL-3 [60 min])

Orange: 214 meters --- (290 ppm = AEGL-2 [60 min])

Yellow: 490 meters --- (73 ppm = AEGL-1 [60 min])







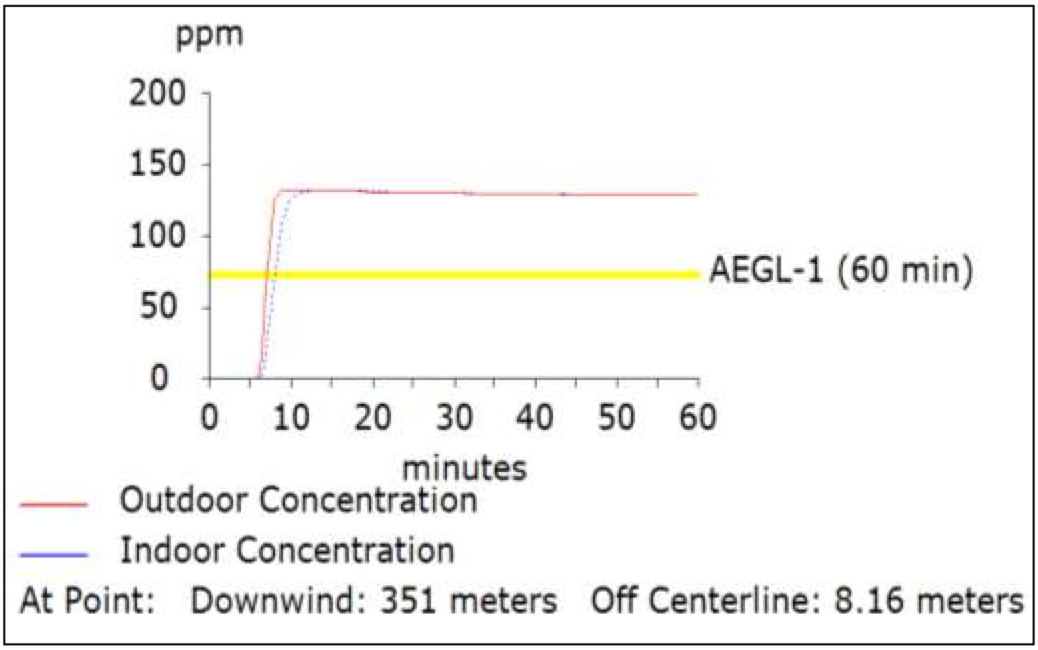


Figure 1 Toxic area of vapour cloud for Propylene Oxide

Figure 2 Google Image of Threat Zone- Toxic area Vapor cloud for Propylene Oxide

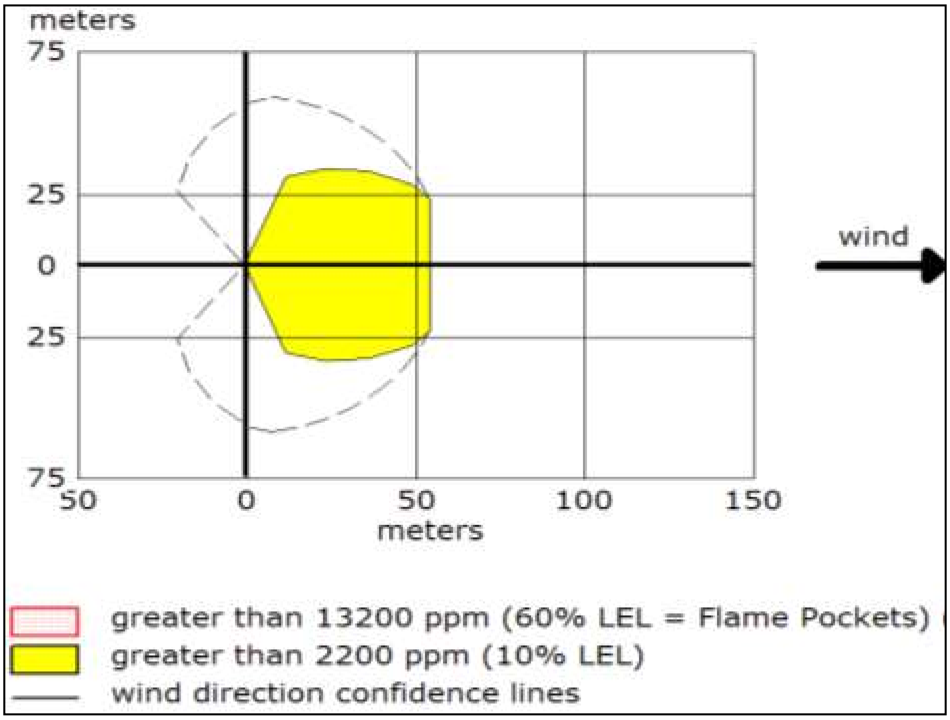
THREAT ZONE:

Threat Modeled: Flammable Area of Vapor Cloud

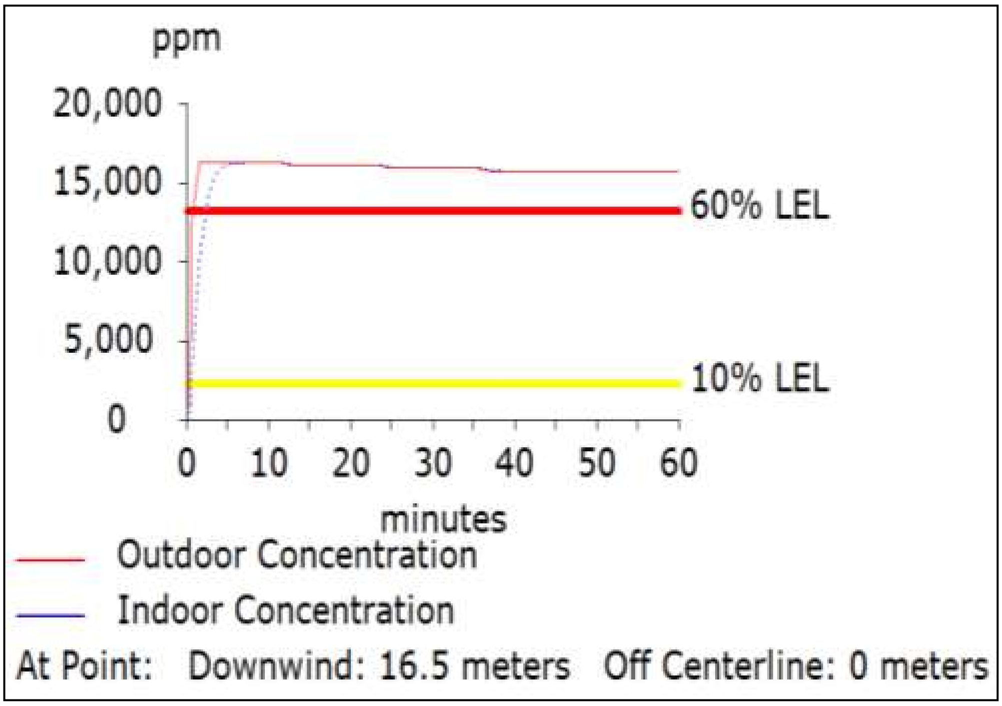
Red : 19 meters --- (13200 ppm = 60% LEL = Flame Pockets)

Note: Threat zone was not drawn because effects of near-field patchiness make dispersion predictions less reliable for short distances.

Yellow: 54 meters --- (2200 ppm = 10% LEL)



Note: Red (60%LEL) Threat zone was not drawn because effects of near-field patchiness make dispersion predictions less reliable for short distances.



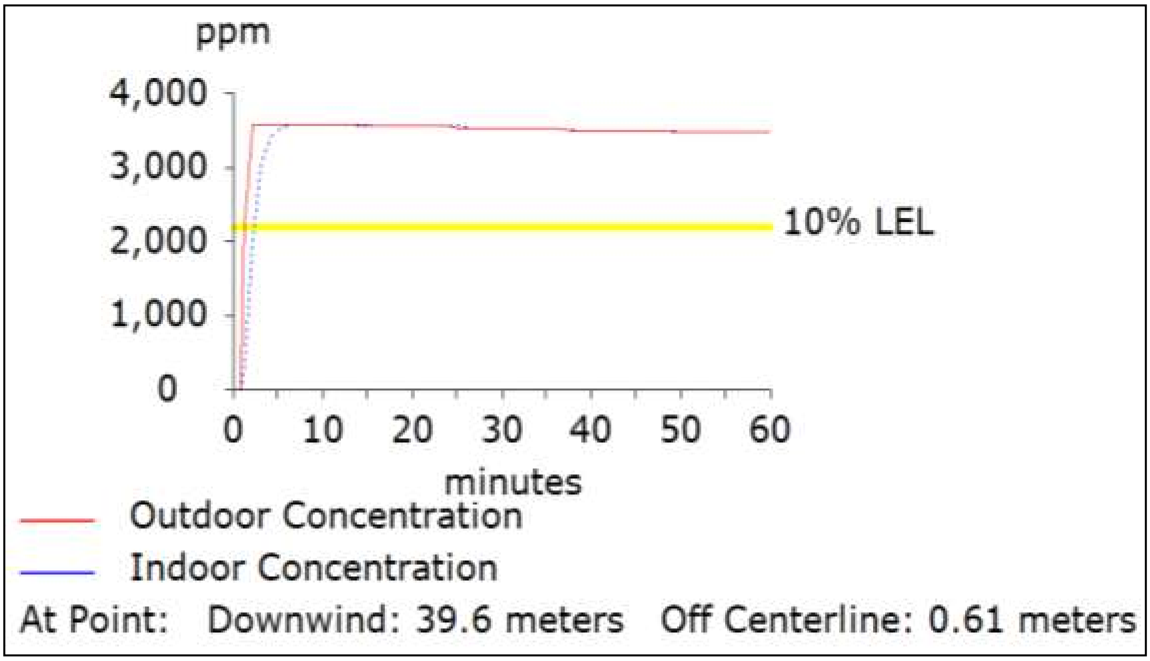


Figure 3 Flammable Area of Vapor Cloud for Propylene Oxide

Figure 4GoogleImage- Flammable Area of Vapour Cloud for Propylene Oxide

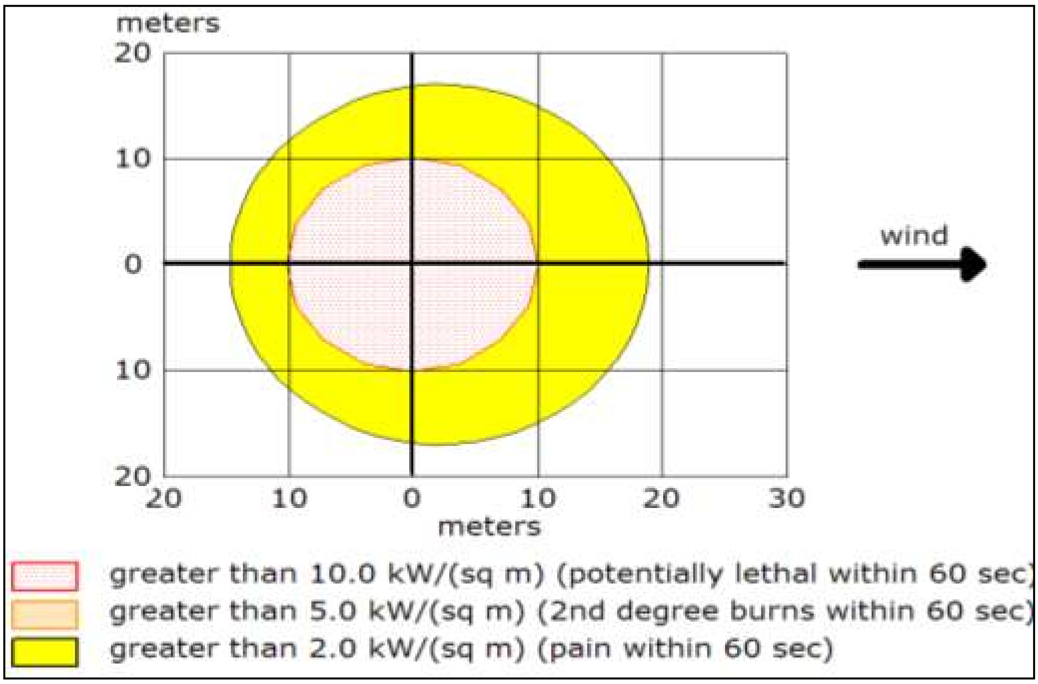
THREAT ZONE:

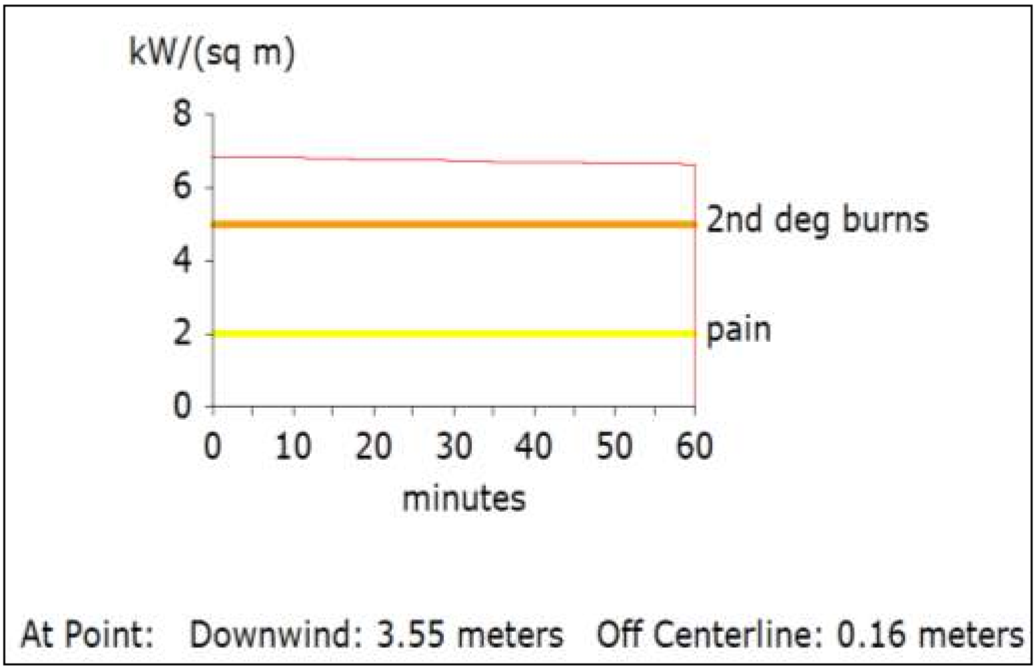
Threat Modeled: Thermal radiation from jet fire

Red : 10 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)

Orange: 10 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

Yellow: 19 meters --- (2.0 kW/(sq m) = pain within 60 sec)





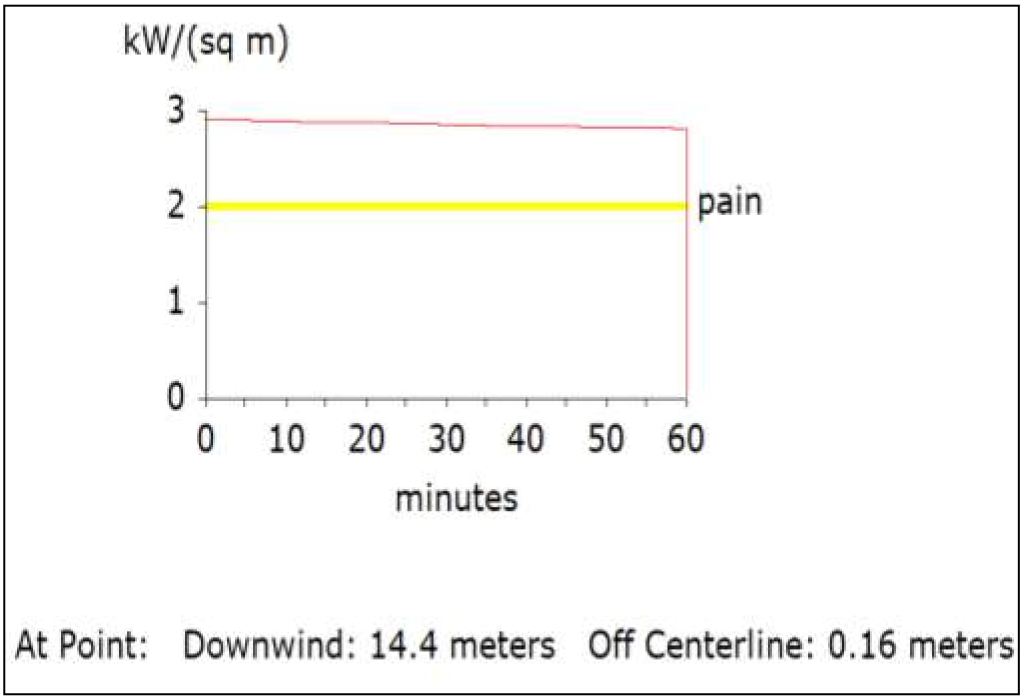


Figure 5 Chemical Escaped from the Tank and Burned as a Jet Fire for Propylene Oxide

BLEVE:

Along with the above mentioned physical properties of Propylene Oxide used at the start, Boiling Liquid Expanding Vapour Explosion (BLEVE) can be assessed by giving the internal pressure at failure as 370 psi. And the corresponding results are given below:

Percentage of tank mass in fireball: 100%

Fireball Diameter: 265 meters

Burn Duration: 16 seconds.

THREAT ZONE: Thermal radiation from fireball

Red: 458 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)

Orange: 652 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

Yellow: 1.0 kilometers --- (2.0 kW/(sq m) = pain within 60 sec)

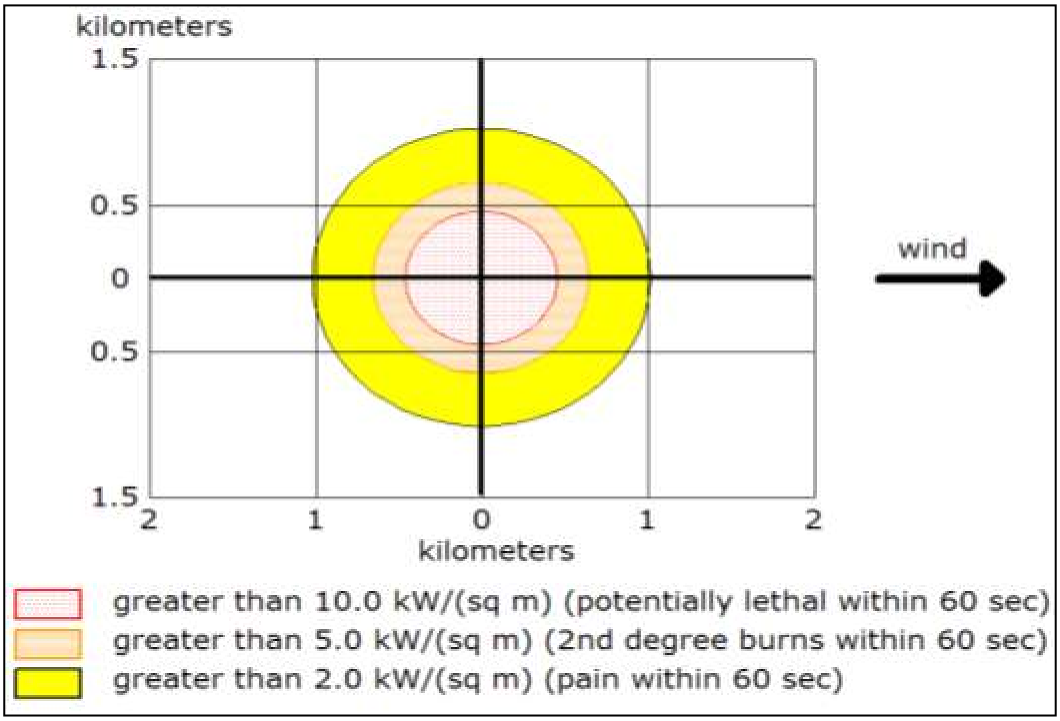


Figure 6 Thermal Radiation From Fireball for Propylene Oxide

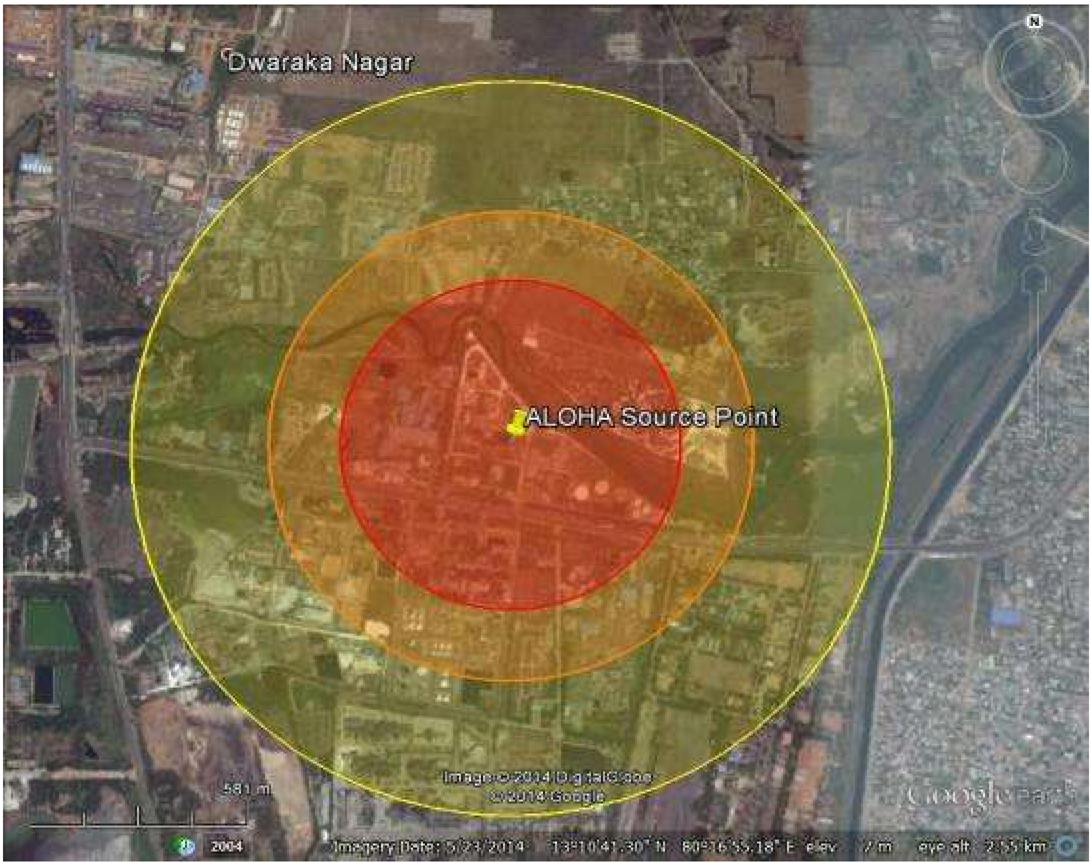


Figure 7 Google Image- Thermal radiation from Fire Ball

1.4.2 Propylene

Table 10 Source Strength

Tank Type	**Horizontal Cylindrical Tank**
Chemical Type	Flammable Chemical Escaping From Tank (Not Burning)
Tank Diameter	4.064m
Tank Length	22.4m
Tank Volume	346 m^3
State Of The Chemical	Liquid
Internal Temperature	-20^0c
Chemical Mass In Tank	101,786 Kilograms
Tank Capacity	70 % Full
Circular Opening Diameter	1inch
Position Of The Leak	0 Meters From Tank Bottom
Release Duration	Aloha Limited The Duration To 1 Hour
Max Average Sustained Release Rate (Averaged Over A Minute Or More)	682 kilograms/min
Total Amount Released	40,222 Kilograms

THREAT ZONE

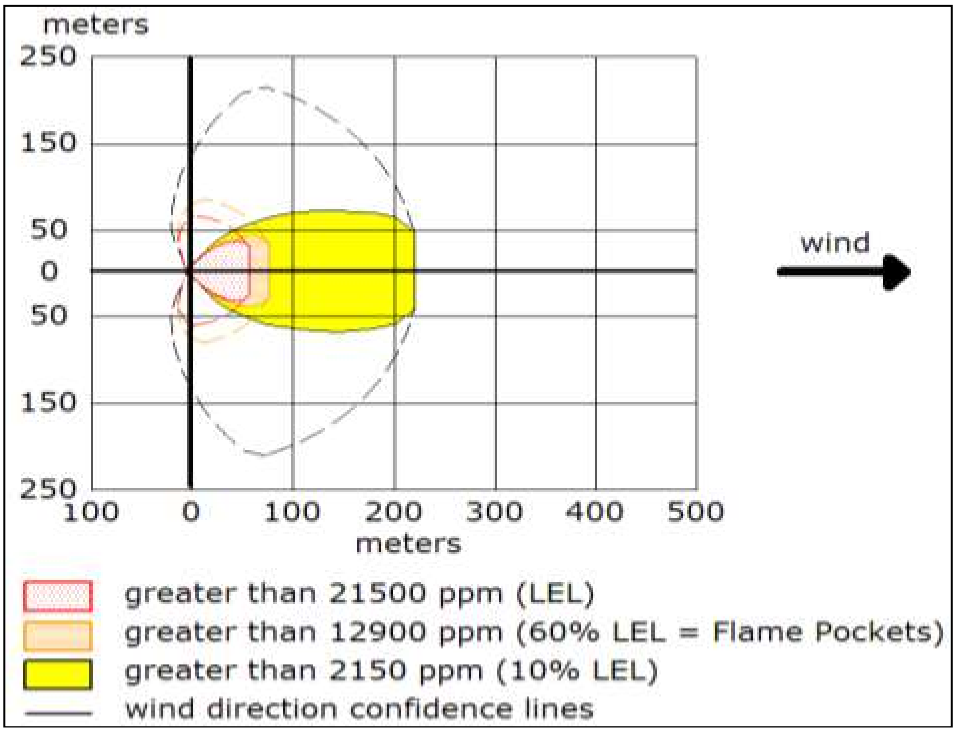
Threat Modeled: Flammable Area of Vapor Cloud

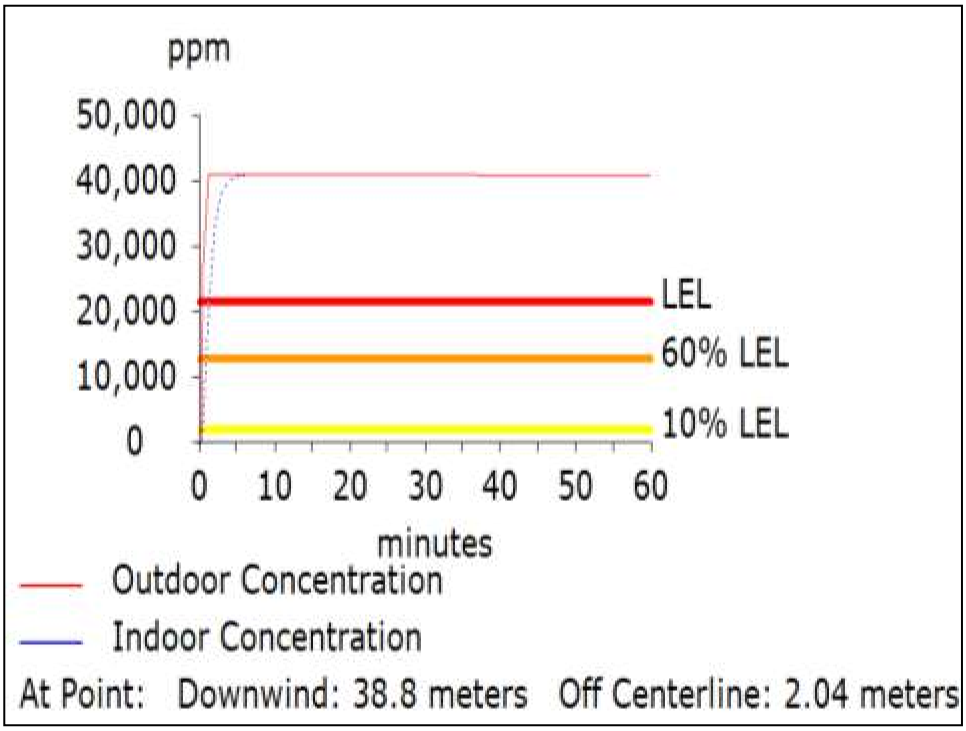
Model Run: Heavy Gas

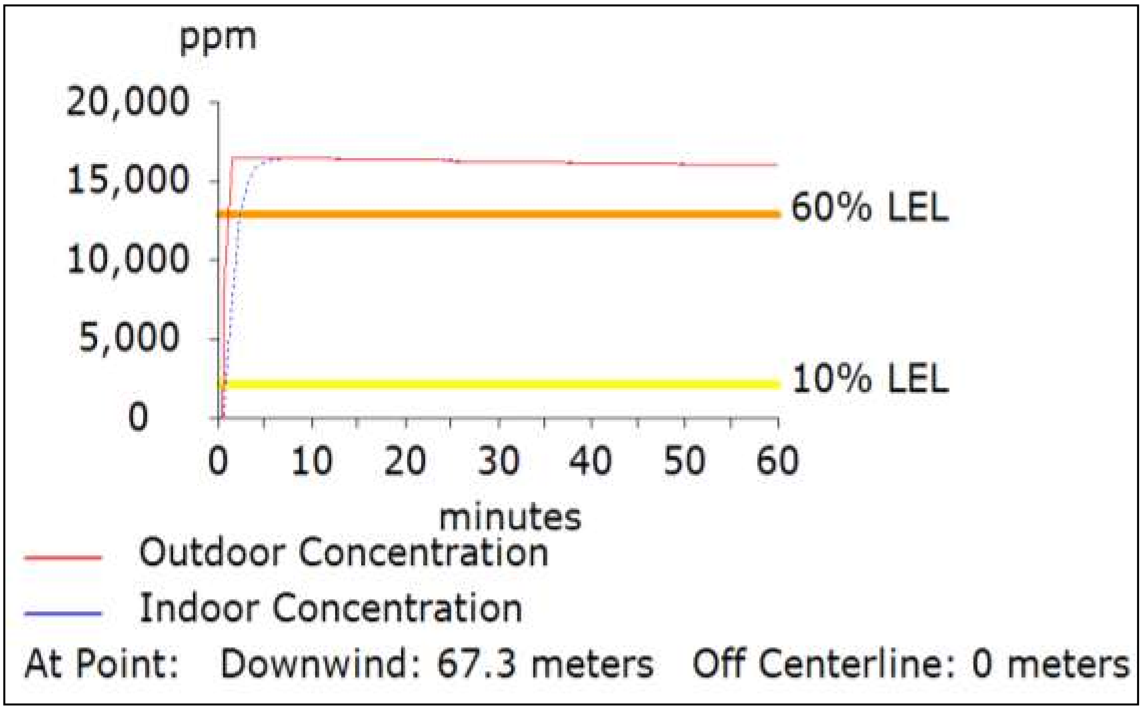
Red : 57 meters --- (21500 ppm = LEL)

Orange: 77 meters --- (12900 ppm = 60% LEL = Flame Pockets)

Yellow: 221 meters --- (2150 ppm = 10% LEL)


meters
250
150
50
0
50
150
250
100
0
100
200
300
400
500
meters
wind
greater than 21500 ppm (LEL)
greater than 12900 ppm (60% LEL = Flame Pockets)
greater than 2150 ppm (10% LEL)
wind direction confidence lines


ppm
50,000
40,000
30,000
20,000
10,000
0
0
10
20
30
40
50
60
minutes
LEL
60% LEL
10% LEL
Outdoor Concentration
Indoor Concentration
At Point: Downwind: 38.8 meters Off Centerline: 2.04 meters



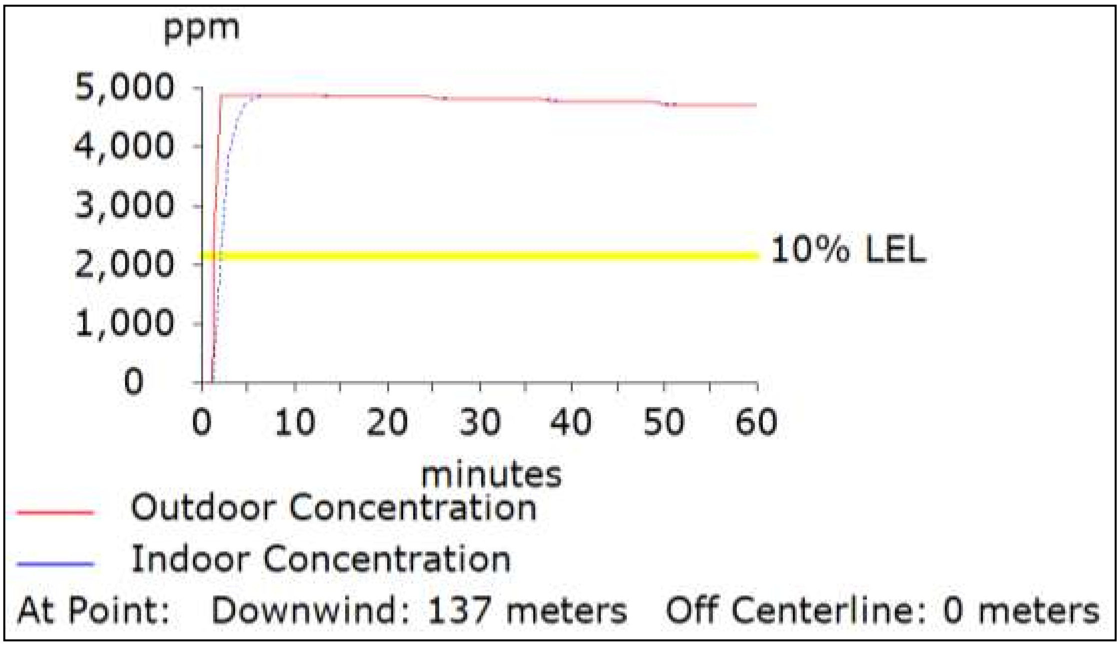


Figure 8 Heavy Gas Flammable Area of Vapor Cloud for Propylene

THREAT ZONE

Threat Modeled: Overpressure (blast force) from vapor cloud explosion

Type of Ignition: Ignited by spark or flame

Level of Congestion: Congested

Model Run: Heavy Gas

Red : LOC was never exceeded --- (8.0 psi = destruction of buildings)

Orange: 66 meters --- (3.5 psi = serious injury likely)

Yellow: 116 meters --- (1.0 psi = shatters glass)

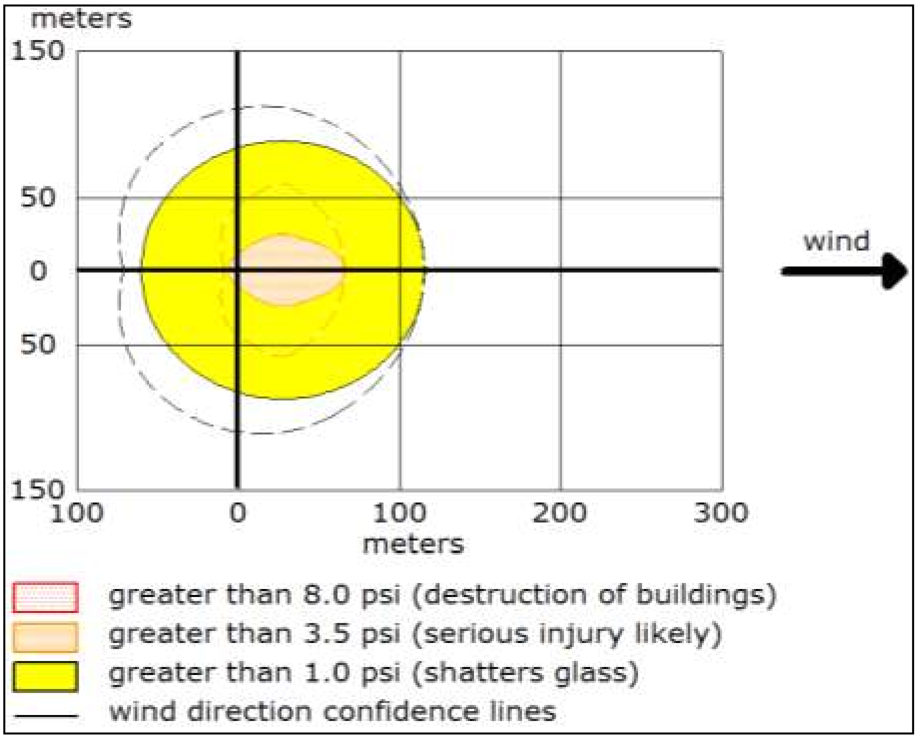


Figure 9 Overpressure (blast force) from vapor cloud explosion for Propylene

BLEVE

Along with the above mentioned physical properties of Propylene Oxide used to define the source strength, Boiling Liquid Expanding Vapour Explosion (BLEVE) can be assessed by giving the internal pressure at failure as 370 psi. And the corresponding results are given below:

Percentage of tank mass in fireball: 100%

Fire ball diameter: 271 meters

Burn duration is 16 seconds

THREAT ZONE

Threat Modeled: Thermal radiation from fireball

Red : 574 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)]

Orange: 811 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

Yellow: 1.3 kilometers --- (2.0 kW/(sq m) = pain within 60 sec)

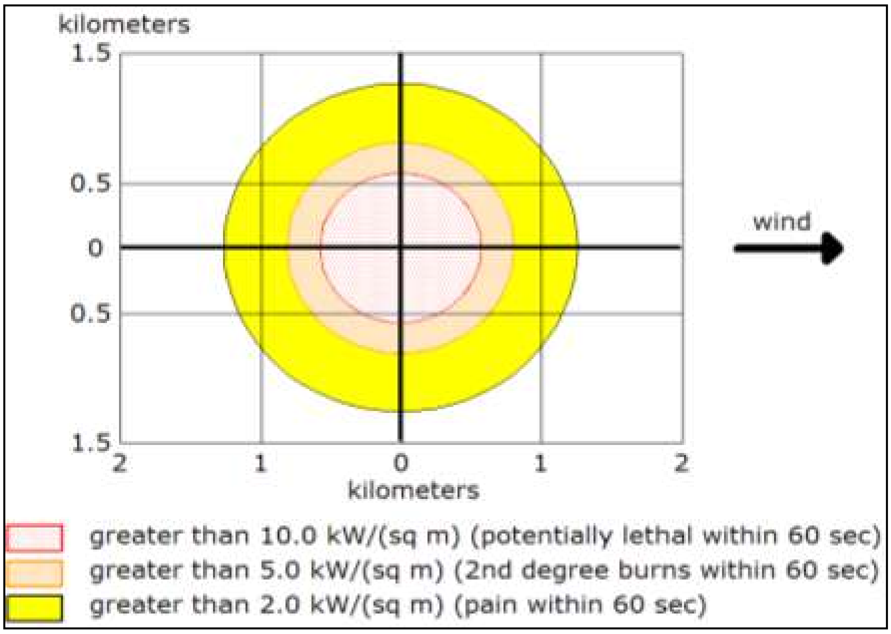


Figure 10 Thermal radiation from fireball for Propylene

Some of the safety measures and observations for Propylene storage are given below:

- Sprinklers are provided around the storage bullets.
- Sensors are connected to the storage bullets.
- The entire storage area of chemicals is fenced and provided with security. Entry is restricted to 50 mts from storage area. The area around the storage will be free of ignition sources and other hazards.
- Fire hydrant systems are provided through out the storage area to avoid fire explosion.

1,2-Dichloropropane (Chlorinated Organics)

Table 11 Source Strength

S.No	Parameters	Case
1	Tank Type	Cylindrical Type (Vertical)
2	Chemical Type	Flammable Chemical escapes From Tank
3	Tank Diameter	5m
4	Tank Length	6m
5	Tank Volume	100 Cubic Meters
6	State Of Chemical Inside	Liquid
7	Internal Temperature	40^0c
8	Chemical Mass In Tank	93,795Kilograms

9	Tank Capacity	70 %Full
10	Circular Opening Diameter	1 Inches
12	Release Duration	Aloha Limited The Duration To 1 Hour
13	Max average Release Rate	20.1 Kilograms/Min
14	Total Amount released	807 kilograms
15	Diameter Of Puddle Spread	14 m
16	Ground Type	concrete

THREAT ZONE

(Toxic area of vapour cloud)

Threat Modeled: Flammable chemical escaping from tank (not burning) The chemical escaped as a liquid and formed an evaporating puddle.

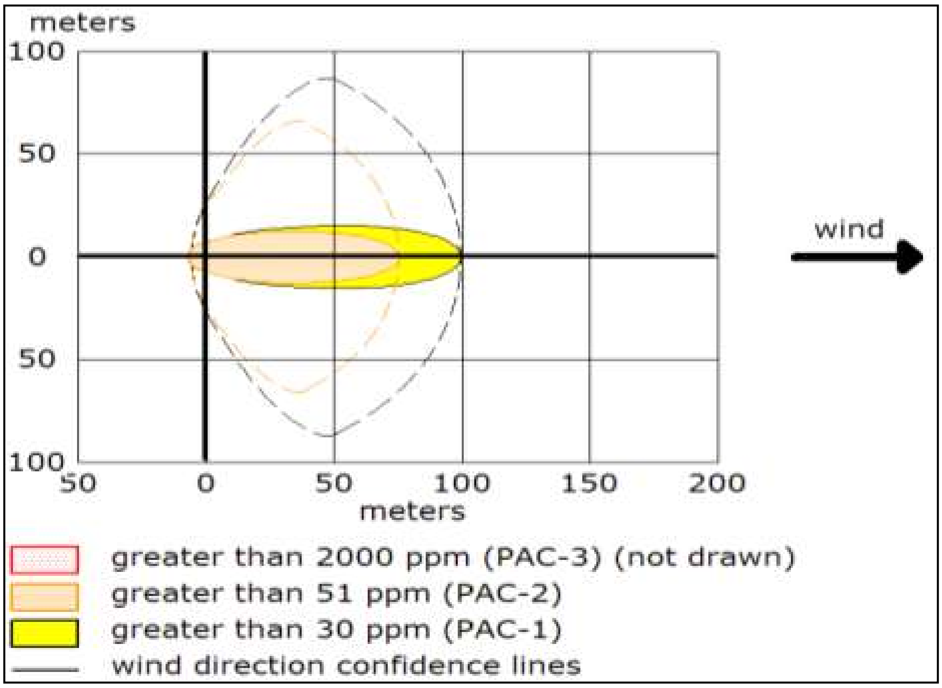
The puddle spread to a diameter of 14.0 meters.

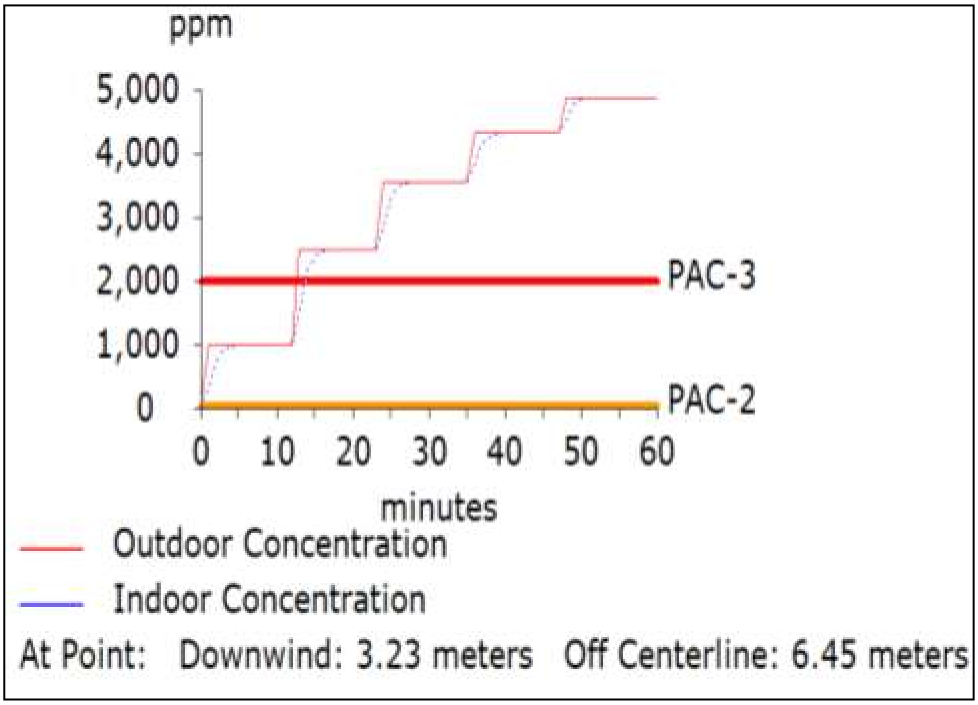
Red : less than 10 meters (10.9 yards) --- (2000 ppm = PAC-3)

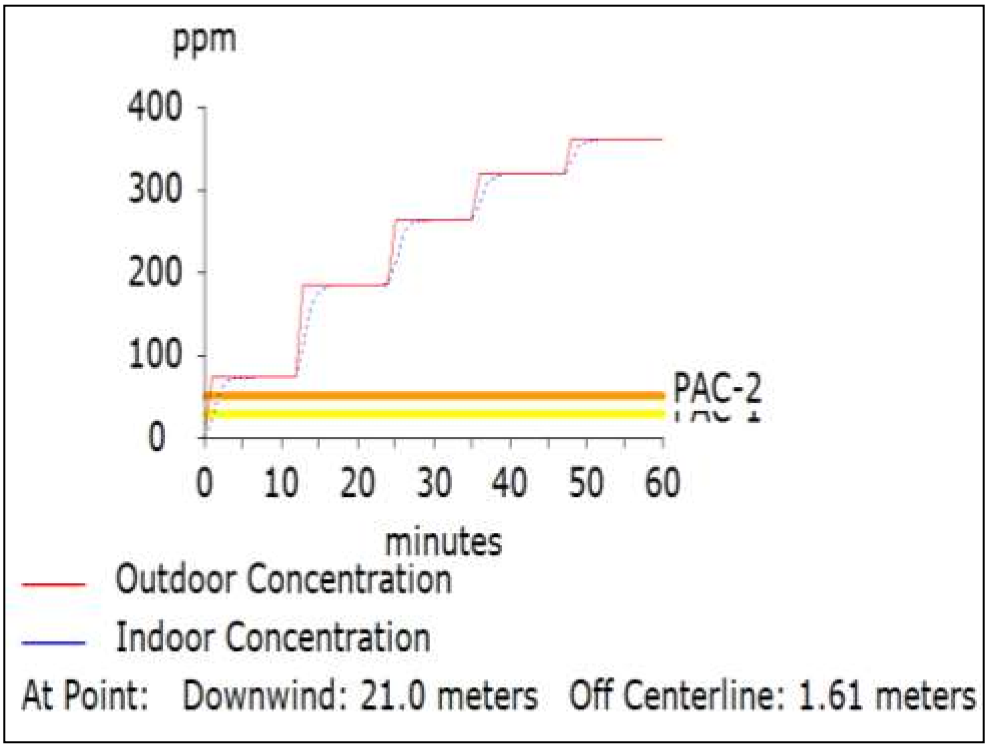
Note: Threat zone was not drawn because effects of near-field patchiness make dispersion predictions less reliable for short distances

Orange: 76 meters --- (51 ppm = PAC-2)

Yellow: 100 meters --- (30 ppm = PAC-1)




ppm
5,000
4,000
3,000
2,000
1,000
0
PAC-3
PAC-2
0
10
20
30
40
50
60
minutes
Outdoor Concentration
Indoor Concentration
At Point: Downwind: 3.23 meters Off Centerline: 6.45 meters


ppm
400
300
200
100
0
PAC-2
0
10
20
30
40
50
60
minutes
Outdoor Concentration
Indoor Concentration
At Point: Downwind: 21.0 meters Off Centerline: 1.61 meters

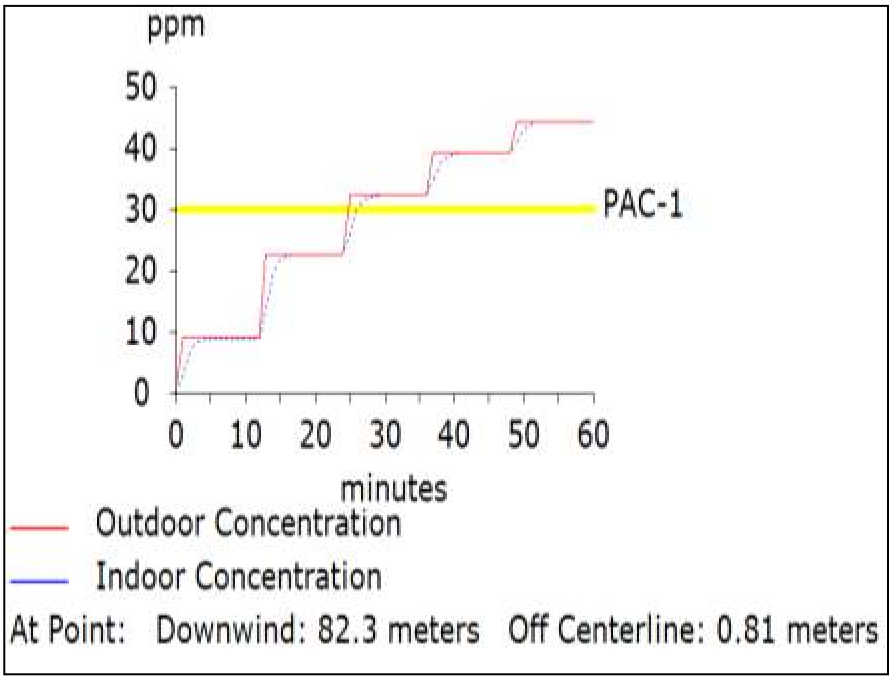


Figure 11 Flammable Chemical Escaping from Tank (not burning) for Dichloropropane

BLEVE

Along with the above mentioned physical properties of 1,2-dichloropropane used to define the source strength, Boiling Liquid Expanding Vapour Explosion (BLEVE) can be assessed by giving the internal pressure at failure as 350psia. And the corresponding results are given below:

Percentage of tank mass in fireball: 100%

Fire ball diameter: 264 meters

Burn duration is 16 minutes

THREAT ZONE

Threat Modeled: Thermal radiation from fireball

Red : 307 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)

Orange: 452 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

Yellow: 719 meters --- (2.0 kW/(sq m) = pain within 60 sec)

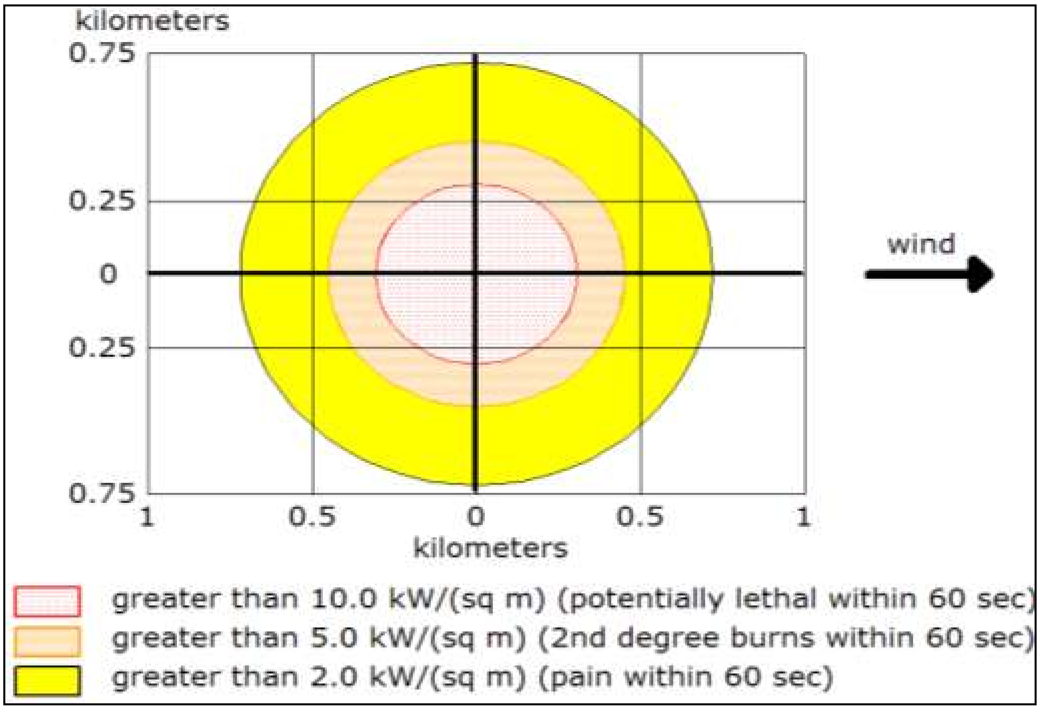


Figure 12 Thermal radiation from Fireball for Dichloropropane

After the risk assessment of the chemicals that are stored and used in the plant being done using ALOHA, some of the salient observations, recommendations and safety measures for the same is discussed below:

- 1,2-Dichloropropoane is not compatible with aluminium, oxidizing agents such as perchlorates, peroxides, nitrates, chlorine, strong acids such as hydrochloric, sulfuric, nitric, strong bases such as sodium hydroxide, potassium hydroxide and metals like potassium, sodium, magnesium, Zinc.
- Use only non-sparkling tools and equipments, especially when opening and closing containers of 1,2-Dichloropropoane.
- Sprinklers are installed throughout the premises.
- Sensors are connected to the storage bullets.
- The entire storage area of chemicals is fenced and provided with security. Entry is restricted to 50 mts from storage area. The area around the storage will be free of ignition sources and other hazards.
- Fire hydrant systems are provided through out the storage area to avoid fire explosion.

1.4.3 Chlorine

Table 12 Source Strength

S.No	Parameters	Case
1.	Chemical Type	Non-Flammable Gas Is Escaping From Pipe
2.	Pipe Diameter	4inches
3.	Pipe Length	1800meters
4.	Pipe Roughness	Smooth
5.	Hole Area	12.6sq In
6.	Pipe Press	4839 Atm
7.	Pipe Temperature	35^0c
8.	Max Average Sustained Release Rate	83.4 Kilograms/Min
9.	Total Amount Released	3959kg

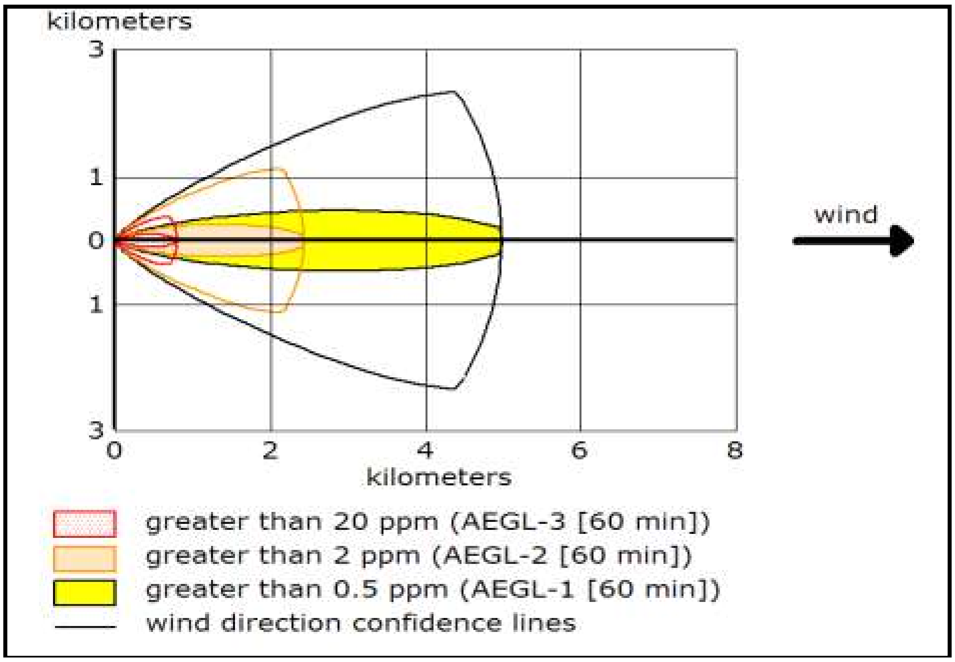
THREAT ZONE:

Model Run: Heavy Gas (Non-flammable gas is escaping from pipe)

Red : 802 meters (20 ppm = AEGL-3 [60 min])

Orange: 2.4 kilometers (2 ppm = AEGL-2 [60 min])

Yellow: 5.0 kilometers (0.5 ppm = AEGL-1 [60 min]



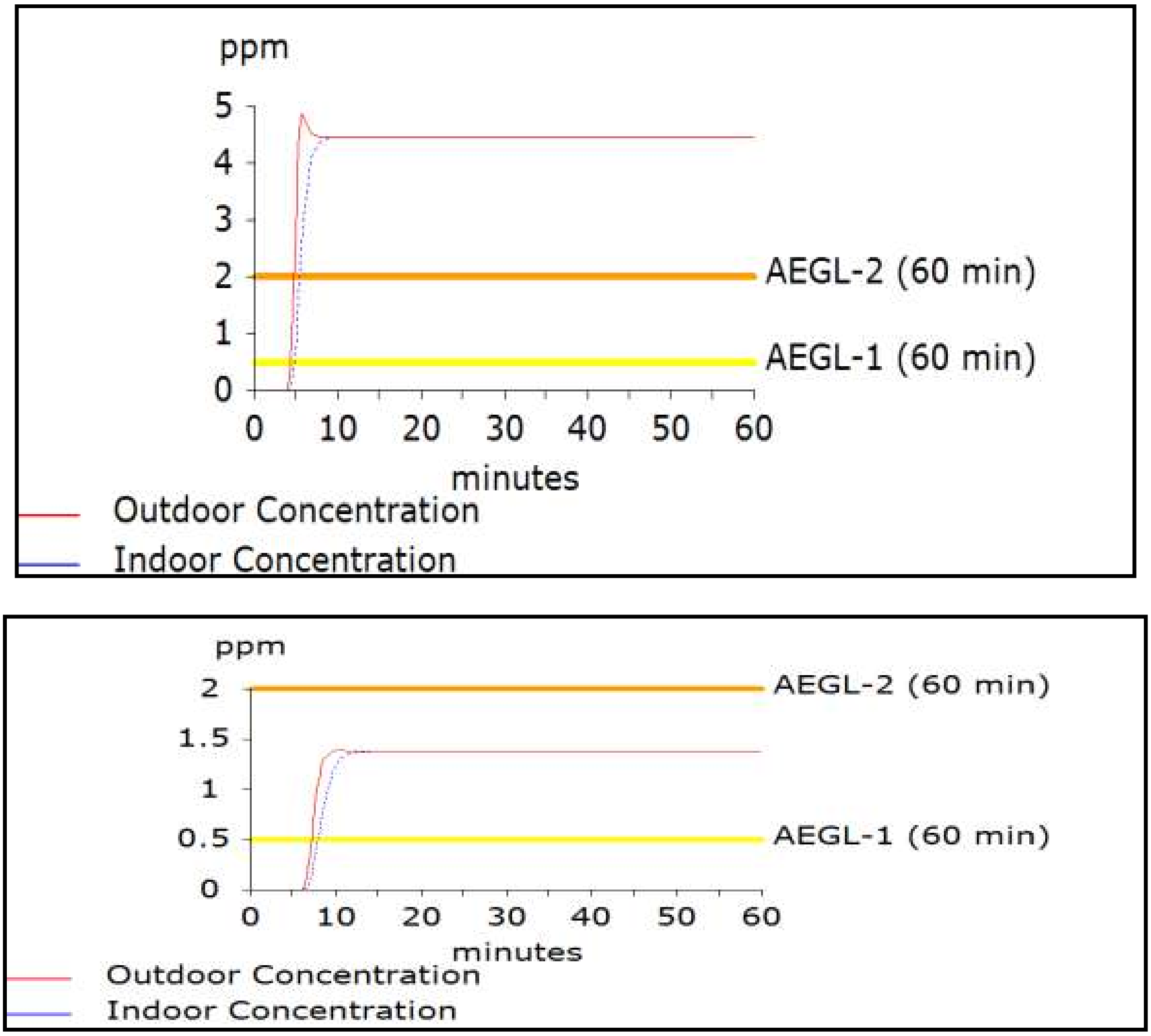


Figure 13 Threat Zone for Non flammable Gas Escaping from Pipeline for Chlorine

After the risk assessment of the chemicals that are stored and used in the plant being done using ALOHA, some of the salient observations, recommendations and safety measures for the same is discussed below.

- The pipelines for chlorine transportation are well designed and laid/routed along the periphery of the LAB plant, far away from the Main plant, at 1meter elevation.
- Both the chlorine pipelines have provision to isolate at either ends Viz manual isolation valves at HCD & automatic shut off valves at ECH plant. Also a waste Air De-chlorination connection is available at HCD for safety releasing the locked up chlorine in the pipelines, should a necessity arise.
- No electrical power cables are running along the chlorine pipes throughout the course. However, only signal cables such as telephone/ computer cables, fire alarm call point cables, smoke detector and chlorine sensor cables are housed together in a metallic conduit routed through the culvert.
- The societal risk is in the lower part of ALARP region to the broadly acceptable level.

- With the current maintenance practices and testing, major chlorine toxic gas release appears to be a remote possibility.

1.5 MAINTENANCE SYSTEM AND SAFETY DEVICES

- Scheduled and effective maintenance of instruments and safety devices are observed and regular inspection of line is carried out and external corrosion prevention is implemented, to prevent failures which resulting in release of toxic vapours.
- It is observed that an effective maintenance schedule, control and safety devices are in place. The lines are periodically painted to prevent corrosion. Further regular inspection is carried out every six months to ascertain the healthiness of the chlorine pipelines. A survey of the supports provided for the chlorine lines reveal that they are designed as per standard engineering practices and are adequate for the service.
- The unit has detailed procedure for safety releasing the chlorine line for any maintenance work including Hot Work and for bringing back the pipelines into service after maintenance.

1.5.1 Safety Management System (SMS)

The unit has a well documented safety management system (SMS) covering a number of elements. The unit has a well laid inspection programme. It has Cl2 gas detectors suitably located. By effective implementation of the prevalent system, to a very large extent, failures could be prevented.

1.5.2 Specific Recommendations

It is recommended that additionally, remote operated shut-off valves may be provided at suitable locations to cut off chlorine, in case of emergency. This would reduce the quantity of chlorine released from the lines in case of chlorine leak.

1.5.3 Chlorine Detectors

Chlorine detectors have been installed in the culvert area, in addition to others provided in the plant. Same are being periodically tested. Upkeep of the same has to be ensured.

Upon assessment of the possible major accident scenarios, likelihood of such a scenario & the consequences, it is concluded that in accordance with the ‘Risk tolerability criteria’ specified UK Health & Safety Executive (UK-HSE), both the individual risk and the societal risk are found to be in the lower part of the ALARP (As Low As Reasonably Practicable) region to the broadly acceptable level.

1.5.4 Pipe Line System

The mitigation and safety measures for the piping system present in the plant are given below:

- Failure of pipe work generally results from:
- Impact
- Fire (resulting in a direction between steel and chlorine)
- Severe internal or external corrosion.
- The lines should be safe from impacts and separated from pipelines carrying corrosive or flammable materials. It is observed that both the chlorine lines are well laid and routed such that they do not meet any possible impact loads.
- Chlorine reacts with steel at temperature above 2500C. Hence no hot patch works to be carried out on the leaky chlorine pipelines. Similarly mixing of chlorine with gas or oil should never be allowed as it can lead to exothermic reaction and fire. We find that the unit has well laid procedures to address the same and to carry out the maintenance safely.
- Severe internal or external corrosions in chlorine pipelines can happen due to moisture entry inside the chlorine gas or any accelerated external corrosion arising out of improper painting, badly maintained supports and improper insulation. Proximity to the coast may also contribute to external corrosion. It is observed that the unit is maintaining periodic painting of pipelines & periodic inspection of supports and installation to overcome the same.

A visual inspection of the pipeline and its surroundings, at least once in a month, should be carried out. Particular attention should be taken to following aspects:

- Points of deterioration of the thermal insulation.
- Circumstances arising in the vicinity of the pipeline which could present a risk to it e.g. crane activity.
- Periodic inspection and testing of the piping system is required at the internal between which should never exceed 4-5 years. It should take into account the following aspects:
- Thickness testing of the pipe walls in specific areas as specified at the time of construction (ultrasonic).
- As a general rule, all accessories should be replaced in a systematic manner before there is any risk of them becoming defective.

It is observed that the unit has the following practices:

- Visual inspection of the pipelines in the culvert once a month.

- Checking of smoke detectors & chlorine sensors in the culvert once a week.
- Thickness measurement of chlorine pipelines every six months.
- The employees are well educated and trained to work safely and to use the personal protective equipment and other safeguards provided. The unit organizes periodic refresher training for its employees to enhance their safety awareness and emergency preparedness.
- Respiratory protection system is available in the form of self-contained breathing apparatus giving the required supply for 30-40 minutes with audible alarm when the pressure falls below a stipulated figure.
- The unit has adequate number of self contained breathing apparatus kept at strategic locations, well maintained and all plant employees are trained to use the same.

1.6 EHS – Special Studies

Perceiving the need for the understanding and mitigation of the potential risks inherent in the design and operation of all processes, with the help of internal and external technically competent professionals, TPL has conducted several process safety studies /Hazard evaluation studies as given below.

Credible potential emergency scenarios were identified, studied and counter measures were arrived at.

- Hazardous Area Classification Studies
- Consequence Analysis of Process Hazards
- Onsite Emergency Plan

1.6.1 Other Process Safety Measures in Practices

- Systems exist to ensure that all production and storage areas and containment vessels have the necessary design safeguards, such as fire detection and prevention systems, spill containment barriers, ignition source prevention, inert blanketing, etc.
- Systems exist to ensure that all materials are stored or housed in suitable containers according to inherent hazard characteristics and that all materials are properly and clearly identified.
- Programs exist to ensure the proper segregation and separate storage and handling of incompatible materials at all times
- Containment vessels, reactors and other process equipment are equipped with proper safety devices, such as pressure relief valves, flame arrestors, static discharge systems, etc.
- Instrumentation, detectors and other process safety sensing equipment are properly placed, maintained, calibrated and distributed so as to perform as intended in monitoring operations.

1.6.2 On Site Emergency Preparedness& Response Plan

Organizations have a responsibility to provide support to individuals who are in crisis due to loss of life, natural disasters, or other traumatic events. In emergency situations, a pre-planned and organized approach is most effective in reducing psychological and social difficulties. The formation of a trained Emergency Response Team will increase the probability of preserving life, maintaining order under adverse conditions and returning the situation to a normal environment.

Emergency – as specified under this plan refers to occurrences of one or more of the following events:

a. Fire by release of flammable liquid / vapour.
b. Release of toxic vapour.
c. Release of toxic liquid
d. Natural Calamities

1.6.2.1 Fire By Release Of Flammable Liquid / Vapour :

The bulk of materials stored and processed inside the plant are hydrocarbons. Fire hazard is main emergency, which could be envisaged. Fire is not likely to endanger the neighborhood. All the pumps have standby so that a defective system can be isolated and transferred to a safe storage. The recovered mixtures of hydrocarbon from the various drains are burnt in the heaters as fuel. In case of fire due to inflammable materials / hydro carbons, the plant has sufficient fire fighting system to combat fire.

- At TPL, layout for storage of hydrocarbon in the Tank farm has been done according to the statutory requirement of Explosives department with prescribed safety distances between tanks and other installations.
- All tanks storing hydrocarbons whose flash point is below 32°C have been provided with automatic water sprinkler system.
- These tanks have also been provided with nitrogen blanketing to prevent release of hydrocarbon vapors to atmosphere and dilute the flammable mixtures to render them non-flammable.
- TPL has sufficient number of manual call points located throughout the plant with their main panels located at Fire station. A repeater panel of Fire alarm system is located in Main control room itself.
- Fire alarm panel is connected to four sirens to alert all employees and Fire Station in case of emergencies

.

The following are the locations of siren.

- Main Control Room roof top
- Captive Power Plant roof top
- Boiler House
- Near ETP
- Hand operated manual siren at the north entrance of MCR

The following are the locations of windsock

- Top of the Administration Building
- Top of Main Control Room
- Top of Dehydrochlorination column
- Top of Light tower at the west of Lime godown
- Top of Light tower at the east of FO tank farm

TPL has a well laid individual Fire Water pumping system. Some of the salient features of the system are as follows:

1. The fire pumping system of TPL is well fitted with Jockey pumps, Main motor driven pumps and Diesel engine driven pumps.
2. Fire hydrant header runs throughout the plant, with sufficient number of hydrants and monitors as per the Tariff Advisory Committee (TAC) requirements.
3. Fire water reservoirs total capacity is 2386m^3 and can be used for about 6 hours of continuous fire fighting.
4. In case of emergencies, there is a provision to draw water from the raw water reservoirs which will help fire fighting for another 10 hours.

As per TAC's requirement, sufficient number of portable extinguishers of various capacities comprising of Dry Chemical Powder (DCP), Carbon dioxide (CO2) are provided in all areas of the plant for Fire fighting. Apart from it, fire hose cabinets and central hose stations containing fire hoses, branches etc., are also located at strategic points in the plant.

- TPL has its own 2 No. of Fire Tenders each having water, foam and DCP. TPL has two foam cum water monitors mounted on trailers, two foam nursers placed on wheels and three foam cum water monitor on trolley that have been strategically located in LAB and ECH Plants.

- TPL has adequate stock of foam to fight any major fires and sufficient spare extinguishers of all types are stocked. Sufficient numbers of aluminized heat protection suits are available.
- Apart from the above, sufficient numbers of Self Contained Breathing Apparatus (SCBA), total protection suits, face masks, chemical filters, for various gases, gas detection equipments etc. are also available. At TPL, there is a fullfledged Occupational Health Centre functions round the clock with one Ambulance affiliated to Sugam hospital. In case of emergency, patients are referred to Apollo Hospital.
- TPL's Safety department is headed by a well experienced Deputy Manager- Safety and assisted by Safety Executive who work in General shifts. The Fire crew consists of 18 well trained Firemen who work round the clock in shifts.
- TPL has a 10 T, 30 T and 100 T crane parked in the crane parking area in road E of LAB plant.
- TPL has its own DGs which can take care of the entire plant load during TNEB power failures.

1.6.2.2 Release of Toxic Gases:

Chlorine used in the plant can give rise to an emergency in case of leak. The material is not flammable but highly corrosive to human tissue. The gas is heavy, light yellowish highly irritating and moves with wind on the ground. Chlorine is used as one of the raw materials for PO production. Chlorine is not stored in the plant but obtained directly from the Heavy Chemical Division (HCD) plant through pipelines running along the peripheral compound of LAB plant and through the Manali Express Highway culvert. The worst case of emergency scenario in TPL would be when the Chlorine from Chlorine pipeline is released to atmospheres. The chances of occurrence of such an event is remote due to the inbuilt safety systems incorporated in the design of Storage vessel and the regular inspection checks being carried out on the system.

The following are the safety precautions taken:

- The plant is designed as per the safe codes and controlled by microprocessor operated digital control system with sufficient redundancy to provide a more reliable protection system.
- All operating staffs are trained on safe operation and shutdown of plant and safety procedures.
- Chlorine sensors have been installed at chlorine handling areas at the HCD plant, highway culvert and at the Existing plant. This will give immediate alarm in case of identifying any chlorine leak facilitating immediate response.
- Chlorine handling pipelines are provided with flanges only at the HCD plant end and at the existing plant end thereby minimizing the risk of leak on en route.

- In case of accidental chlorine release, it can be immediately routed to HCD plant's chlorine scrubber (Waste Air Dechlorination) system for neutralizing, using 18% sodium hydroxide (NaOH) solution. WAD stack is also provided with a chlorine sensor to monitor the effectiveness of the neutralizing system.
- Protective gears are available to immediately attend to any failure of equipments without loss of human life and also time.
- Periodic thickness survey is being conducted on pipes to monitor the corrosion rate.
- The above features make the system sound in preventing release of chlorine to the atmosphere.

1.7 Emergency Management Philosophy, Policies & Principles

Emergency Response Philosophy of TPL is to provide "reasonable assurance that adequate protective measures can and will be taken in the event of an incident or emergency". This document sets forth emergency planning standards and defines the responsibilities of the organizations involved in emergency response. Some of the main features of the emergency philosophy includes:

- Requires high quality in the design and operation of the facilities to reduce the likelihood of malfunctions.
- Recognizes that equipment can fail and operators can make errors, therefore requiring safety systems to reduce the chances that malfunctions will lead to accidents.
- Recognizes that, in spite of these precautions, accidents may happen, therefore requiring containment structures and other safety features to prevent escalation and
- Has in place organizations capable of responding to incident's and emergency situations that may occur involving any of the TPL facilities or supporting operations, to preserve life.

The added feature of emergency planning philosophy provides that, even in the unlikely event of an incident or release to the environment, there is reasonable assurance that actions can be taken to preserve life, injury to people damage to plant or the environment.

It is TPL's Emergency Management policy to operate without injuries, illnesses, or incidents. TPL will act according to following principles:

- Act with caring, compassion and concern
- Protect life, health & safety, the environment and the community
- Act morally and ethically
- Minimize property and economic damage
- Maximize restoration of normal activities

TPL has an extensive and a well-structured Emergency Plan along with the responsibilities assigned to the employees working inside the plant. The salient features of the emergency plan for the proposed plant are as follows:

1.7.1 Objectives of the Emergency Management Plan

- To safeguard the life of personnel working in the plant and neighborhood.
- To prevent cascading of the plant emergencies endangering neighborhood.
- To avoid confusion/panic and to attend the emergency with a clear cut line of action.
- Preservation of information, records etc. which will help in the investigation.
- Providing relevant information to and securing the assistance of district authorities, communication media and other authorities, as being included in Manali group industries emergency plan.

1.7.2 Basis of Plan

- The prime element of the plan is to get key personnel of necessary disciplines who have knowledge and background to assess the situation and give direction as per the objectives, as quickly as possible.
- The plan realizes the need for certain basic information to assess the emergency situation, mobilize relief etc.
- Initiation of procedure for major emergency will be done by Chief Emergency Coordinator (CEC) of the concerned plant who shall take all decisions necessary for immediate control of emergency, including shutting down of the section or plant as and when required.
- In case the emergency situation calls for outside assistance, either through existing mutual aid plan with other industries or otherwise shall be coordinated by Chief Emergency Coordinator of LAB plant.

1.7.3 Escape Routes

Since TPL is an in-housed plant, entire area is exposed to the atmosphere. For the above reason, heat radiation & smoke due to major fire/toxic vapour release to the atmosphere will not accumulate. Moreover, it will travel favorably in wind direction. Chances of human contact with vapour or heat radiation is very less, as the workers can always escape through the alternate route. The number of main entry/exit points for the factory is two. All the escape routes are broad straight and they are interconnected so as to have a direction change. The approach roads inside the factory are always kept free from obstructions and poor visibility. To identify the roads, name boards have been displayed in each road. All the escape routes ultimately lead to the emergency Assembly Point.

1.7.4 Assembly Points

On hearing the emergency siren, all the employees of TPL not assigned with any specific work as per emergency procedure manual will rush to the assembly point. The assembly point is located near Gate – 6 close to Existing Plant control room and the alternate assembly point is located near ECH drum filling point. The same assembly points are used for the PO plant.

For contract workers, the assembly point is located near ECH control room across the road in ECH plant. The alternate assembly point is located near ECH drum filling point across the road in ECH plant.

An Instruction board in Tamil has been installed near ECH main Gate describing the emergency actions that are to be observed by contract workmen in case of an emergency. In case of an emergency, TPL employees are connected with the emergency and all contract employees have to assemble at their respective assembly / alternate assembly point based on the wind direction. Manpower accounting is done in these assembly points by manpower accounting and search team.

- Assembly point for TPL employees is – West of ECH plant Main Control Room building.
- Alternate assembly point for TPL employees is – East of ECH drum filling point across the road.
- Assembly point for contract employees is – West of ECH plant Main Control Room building across the road.
- Alternate assembly point for contract employees is – South of ECH drum filling point across the road.

1.7.5 Emergency Control Room

At present, Main Control Room of the respective plant is used as Emergency Control Room. In the emergency control room, important safety equipment, personnel protective equipment, data regarding plant safety, fire fighting, shutdown procedure, list of important telephone numbers are available. Paging system, P&T phone, hotline with Fire Station and ECH control room & intercom with CPCL are also available for communication and requesting assistance during emergency. The information available is updated then and there.

The Emergency Control Centre in fire station is the alternate emergency control room. This building can withstand 15 psi of external pressure. It has the fire alarm panel of both LAB and ECH plants, wireless system, direct P&T phone and hot line with Main Control rooms, CPCL, PAPL control rooms.

1.7.5.1 Emergency Control Room for ECH Plant

- Emergency control room – ECH Plant Main Control Room.
- Alternate emergency control room – Emergency Control Centre (ECC) at Fire station in LAB plant.

1.7.6 Emergency Alarm

Emergency fire alarm manual call points have been installed at various locations in ECH plant and the same will be used for the proposed PO plant. In actuating a fire alarm manual call point, the exact place of emergency will be indicated in the Fire alarm panel of the concerned plant in the Emergency Control Centre and in the repeater panel installed in the respective plant's control room. On actuation of a fire alarm call point, the fire siren(s) automatically gets triggered and gives wailing sound alerting concerned emergency personnel to rush to the emergency spot without any delay. The system also enables the Fire crew to reach the emergency spot immediately. Once the emergency is over, continuous siren is sounded for 2 minutes for the return of employees and contract workmen to their workplace. During emergency all work permits stand cancelled and are to be renewed after all clear siren.

1.7.7 Sequence of Action

Any person noticing an emergency situation will give information to Fire Station / Main Control Room using any one of the following emergency communication facility :-

- Operate/ break emergency alarm manual call point glass.
- Paging call stations available at various locations of the Plant to Main Control Room
- Intercom system to call Fire Station or Main Control room of respective plant
- The caller and the persons nearby will fight the emergency till the emergency task force arrives.

1.7.8 Location, Storage and Quantities of Raw Materials Stored in the Facility

The chemicals used and stored in the facility are characterized according to the reactive group the chemical belongs to. The chemicals are stored in a segregated manner such as no compatibility issues arise. The Classification of chemicals are as follows:

Table 13 Classification of chemicals according to its functions

Reactive Group	Chemicals In The Plant
Combustible and Flammable	Furnace Oil, Propylene Oxide
Inorganic	Lime

Halogenated organics	Dichloro Propane
Hydrocarbons	Propylene
Oxidizing Agent	Chlorine

Table 14 Raw materials and its storage

S. No	Name of raw materials	No. of Storage Tanks	Storage capacity MT	Storage Container
1	Propylene	2 Bullets	346	Cylindrical tanks
2	Chlorine	NA	NA	Pipeline
3	Furnace Oil	1	394.4	Day tank/Pipeline
4	Lime	NA	300	Storage Godown

Table 15 Chemical & Physical properties of chemicals

Chemical Name	**C.A.S NO.**	**B.P (°C)**	**Vapour density**	**S.G.**	**TLV ppm**	**STEL ppm**	**Flash Point (°C)**	**LEL (%)**	**UEL (%)**	**A.I (°C)**	**Hazard**
Propylene	115-07-1	-47.7	1.5	0.609@-47^{0}c	NA	Asphyxiant	-107.5	2.4	10.1	460	Flammable (Liquefied)
1,2-Dichloropropane	78-87-5	96.8	3.5	1.58@20^{0}c	75	110	21.1	3.4	14.5	557.2	Flammable liquid
Lime	471-34-1	N/A	N/A	2.7-2.9	10	N/A	N/A	N/A	N/A	N/A	N/A (Dust Explosion is a possibility)
Furnace oil	68476-30-2	184-339	Not pertinent	0.94-0.95@20^{0}c	100	Not listed	60-90	1.3	7.5	254	Combustible liquid
Chlorine	7782-50-5	-34	2.49	1.47 @0^{0}c	1	3	N/A	N/A	N/A	N/A	Non flammable
Propylene oxide	75-56-9	34.23	2	0.833 @ 20^{0}C	2		-37	2.3	38.5	465	Flammable(carcinogen)

1.7.9 Response Planning

The scope of this emergency response plan is to detail the various preventive measures and operational actions that need to be undertaken by the company to contain any hazmat leaks, spill and control or extinguish any fire in the event of a emergency situations that occur within the plant area so to prevent and reduce injury to personnel and minimize property damage and loss.

1.8 Emergency Procedures and Responsibilities of Various Teams

1.8.1 Team Line Up

In an event of occurrence of an emergency, the team lineup is as follows:-

- Emergency Task Force
- Plant Protection Team
- Communication Team
- Medical Team
- Security Team
- Manpower Accounting & Search Team
- Repair Team

The above teams shall function under Chief Emergency Coordinator of the concerned Plant.

Table 16 Composition For Various Emergency Teams

S.No	Team	Leader	Members
1	Emergency Task Force	Shift- In- Charge	Lead Fireman- 1 Mechanical Technician- 1 Production Technician- 1 Fireman- 1 MSS Operator -1
2	Plant Protection	Panel Engineers	Production Technician- 1 (Area Operator)
3	Communication	ETP Operator	NIL
4	Security	Security In – Charge	Security Guard- 2
5	Manpower Accounting & Search	Chemist-QA	Security Guard- 1

6	Medical	Chemist-QA	First Aid Attendant- 1 Ambulance Driver- 1
7	Repair Team	Mechanical Technician	Instrument Technician- 1

Depending upon the nature of emergency, the Chief Emergency Coordinator of the concerned plant is authorized to mobilize additional manpower or allot additional responsibilities to combat the emergency.

All Shift-In-Charges of respective departments will assign the team for each person reporting to him in the shift and inform the respective team leaders at the beginning of each shift.

The fire tender driver on hearing the siren, should note the emergency location from the fire alarm panel and immediately take the fire tender to the emergency spot.

Ambulance driver should take the ambulance and follow the fire tender to the emergency location and report to the Chief Emergency Coordinator.

1.8.2 Functional Responsibilities of Each Team

1.8.2.1 **Chief Emergency Coordinator-** The Chief Emergency Coordinator shall execute his functions with all his powers within his command, within his area of responsibilities. He will take complete control of the plant and coordinate for handling the emergency.

1.8.2.2 **Emergency Task Force**- This team will start combating the emergency directly under the leadership of Chief Emergency Coordinator of the concerned plant. The group leader for this team will be Shift- In- Charge of the concerned plant and will be assisted by all the team members for controlling the emergency.

1.8.2.3 **Plant Protection Team** - This team will ensure the safety of the remaining part of the plant. They will take instructions from the Chief Emergency Coordinator as to whether a plant shutdown has to be taken and execute the same. If required, they will request for additional labour force from assembly point.

1.8.2.4 **Communication Team** - This team takes direct instructions from the Chief Emergency Coordinator of the concerned plant and will communicate with the internal and external agencies to establish a true communication network operating from Main Control Room of Concerned plant.

1.8.2.5 **Medical Team** - During emergency, in the event of any person getting hurt, the Medical Team will render necessary First Aid assistance and arrange for providing medical facilities outside the premises, if required.

1.8.2.6 **Security Team** - This team will ensure that no unauthorized personnel enter the premises. All contract personnel will be conducted out of the plant and assembled at assembly / alternate assembly point (depending on wind direction) designated for contract employees. Emergency Zone will be cordoned off.

1.8.2.7 **Manpower Accounting and Search Team** - The objective of this team is to ensure that all personnel in the plant are accounted properly and locate / rescue missing persons. If required, this team will arrange for food, clothing with the Coordination of HR function.

1.8.2.8 **Repair Team** - This team will assist the Emergency Task Force and contain the emergency within the place of occurrence.

1.8.3 Detailed Responsibilities of Chief Emergency Coordinator

- On receipt of emergency call, the Shift-in-charge (Production)/ AVP of the concerned plant will take charge as Chief Emergency Coordinator, as per authorization.
- The Chief Emergency Coordinator will rush to the site emergency and take stock of the situation. He shall guide the Emergency Task Force for speedy control of the accident. On arrival of other Team members, he shall assign duties as required and return to Main Control Room, if necessary, for co-ordination in plant shutdown or any other action.
- He will arrange for emergency drawal of any material from Main stores in LAB plant through Repair Team Members.
- He will give definite and clear-cut line of action to all team leaders.

The priority of communication shall be as follows:

- He will call back the TPL fire tender, if it has gone out to attend emergency in the neighboring plant or Industry.

- If there are simultaneous emergency in different section of the plant, the CEC will decide the priority requirements of mobilizing additional fire tender and men based on the severity of the incident.
- In case, the incident is of ON-SITE EMERGENCY ONLY and additional external help is required, request for additional help from external agencies like CPCL / MPL / MFL (given priority wise), will be made by CEC of LAB plant only.
- CEC will ensure safety of the plant and its personnel in the plant. He will make an assessment of the emergency and decide on external assistance.
- Before declaring Off-site emergency, Chief Emergency Coordinator of the concerned plant should consult Chief of Site or Occupier for recommending an Off-site emergency. Upon obtaining concurrence, only the Chief Emergency Coordinator of the concerned plant shall inform Manali police Station over phone.
- The Shift-In-Charge of the unaffected plant will stand on alert and extend all help required for combating emergency in concerned plant.
- The Shift-In-Charges of both plants will have the details of (composition) emergency team members at the shift beginning.

1.8.4 Responsibilities of Leaders of Various Teams

1.8.4.1 Emergency Task Force

- The Shift-In Charge (Production) of concerned plant will be the leader of the Emergency Task Force. He will handle the emergency with the help of his team members.
- In shifts, Shift-In Charge (Production) of both plants will have composition details of emergency team members in the beginning of the shift at their respective Control Room.
- The Shift-In Charge (Production) of concerned plant will ensure that fire water pumps are immediately started in case of an outbreak of emergency.
- He will also ensure that the concerned area operator is stationed in the fire water pump house to maintain fire water header pressure. The operator shall not be moved from the pump house until the emergency is over.
- He will coordinate with the Repair Team leader and his team to attend to any repairs to contain the emergency, if required.
- He will take the help of Security Team to cordon off the area.

- He will ensure that the emergency does not escalate, but is contained and extinguished within the spot of occurrence.

1.8.4.2 Plant Protection Team

If emergency escalates, the leader of the plant protection team will take direction from the Chief Emergency Coordinator of the concerned plant and shutdown the plant safely. He will take instructions from the Chief Emergency Coordinator of the concerned plant and immediately mobilize his team to attend to protection of plant in all respects.

1.8.4.3 Communication Team

The Communication Team leader on hearing the emergency will report to Chief Emergency Coordinator of the concerned plant at the location of incident.

- He will receive detailed description of the emergency and also will take the list of persons to be communicated internally and externally.
- He will establish internal communication.

The following priority will be followed in passing information

- Deputy Manger (Safety)
- Production-in-charge
- GM (Operations)
- AGM (HRM)
- Whole Time Director (Operations)

The following is the order of communication to external agencies, if required.

- Neighbors with whom we have mutual aid scheme namely CPCL.
- He will refrain from communication with any other external agency.

1.8.4.4 Medical Team

- The leader on receiving/ noting the emergency information will mobilize his team. The First Aid attendant will remain in Occupational Health Centre in full readiness.
- The leader of the team will rush to site of accident and report to the Chief Emergency Coordinator of the concerned plant.

- The leader of the medical team will accompany the injured to Occupational Health Centre in the ambulance.
- Any injured person brought to the Occupational Health Centre will be attended by the first aid attendant. The First Aid Attendant will not move out of the Occupational Health Centre till the emergency is over and all clear siren is sounded. Under exceptional circumstances, the first aid attendant shall rush to the site of the emergency on receiving instructions from medical team leader. The team leader will keep continuous communication with the Chief Emergency Coordinator of the concerned plant and direct the injured to hospital for further treatment if required.
- In cases where hospital treatment is required, the leader of the medical team will arrange for transportation of victim and inform the concerned Hospital in advance and arrange for prompt treatment giving brief background of the accident.
- The leader of the medical team will list the names of all personnel to whom treatment has been given and those who have been directed to the hospital.
- He will mobilize additional transport with assistance from SIC (LAB Plant) to carry additional injured people, if required.

1.8.4.5 Security Team

- On hearing the Siren from any one of the plants, the security personnel will ensure that the main gates (gate no.2 & 3) of both LAB & ECH plants are kept opened and prevent the entry / movement of unauthorized personnel.
- The Team Leader will report at emergency site to take instructions from Chief Emergency Coordinator of concerned plant. He will arrange to provide security coverage at the main gate, plant gate, and site of occurrence of emergency and also at assembly points.
- The Security team leader will effectively cordon off the emergency area and will prevent unauthorized people entering the scene.
- Outside fire tenders or ambulances requisitions by the Chief Emergency Coordinator is to be permitted into the plant. Security guard at the entrance gate of the concerned plant will guide CPCL/MPL/MFL/ other outside fire tenders/ambulances to the emergency spot. Other Officers from state Government or neighboring industries should be courteously conducted to Administration Block at ECH plant and inform

the Chief Emergency Coordinator of the concerned plant or Senior Executive so that they can be taken care of.

- All tank Lorries inside the plant, where emergency is declared, should be sent to non-plant area. Tankers engaged in unloading in Tank farm area during the time of emergency, shall be sent out after disconnection of hoses by contract workmen engaged for such work.
- Provide number of contractor personnel available during emergency inside the affected plant to Manpower Accounting and search team leader.
- In case of fire or other emergencies in pipelines crossing Manali Express highway, the security team shall ensure the stoppage of vehicular traffic at safe distance on either sides and restore normalcy after containing the emergency and obtaining clearance from CEC of proposed Plant.
- A duty security guard from West main gate will report to fire station on hearing siren to take charge of the communication systems.
- The contract workmen engaged in unloading of flammable liquids in tank farm area, shall be directed to their respective assembly point only after they disconnect unloading hoses connected to tankers.
- With respect to chlorine leak in the proposed plant, one security guard shall carry out emergency actions in the administration building of the proposed site.

1.8.4.6 Manpower Accounting and Search Team

- The leader of the team, on hearing the emergency, will report to the Chief Emergency Coordinator of concerned plant at the site of emergency and take clear cut instruction.
- He will ensure that the list of all personnel who have entered the plant is made available immediately. Number of contract workmen to be collected, from Security Department.
- After consolidation of this, the team leader will ensure proper accounting of the personnel as soon as they report at the assembly point designated for TPL employees.
- In case, any person is reported missing in the affected plant, he will inform Chief Emergency Coordinator of concerned plant and start the searching operations with his team.

- In case the emergency is prolonged, the leader of Manpower Accounting & Search team shall arrange for food, refreshment, clothing and extra vehicles for all personnel in plant with the help of HR department.
- He will ensure that he and his team members wear the necessary protective gear while searching for the missing personnel.

1.8.4.7 Repair Team

- The team leader will take definite instructions from the Chief Emergency Coordinator of concerned plant and will immediately be available with the Emergency Task Force at the place of emergency to attend to repair work.
- He will mobilize his team with necessary tools and tackles to handle any repair work on an immediate basis.
- After 'G' shift hours, the repair team member will collect Main Stores key from East plant gate Security Guard & open the Main stores at LAB Plant, if directed by CEC of the concerned plant for emergency drawal of any material.

1.9 Communication and Follow up Activities

1.9.1 Emergency Procedure

When an emergency occurs in LAB or ECH plant, the person noticing the emergency should immediately actuate the nearby Fire Alarm Manual Call Point (FAMCP) or report to concerned Main Control Room by paging or report to fire station by telephone (Intercom number : "333").

If the FAMCP is actuated or the emergency message is reported by paging in an affected plant, the concerned panel Engineer shall take following actions:-

1. Inform the nature and location of emergency by paging.
2. Inform the unaffected plant's main control room about nature and location of emergency.
3. The panel engineer at unaffected plant's control room shall in turn announce the nature and location of emergency by paging requesting concerned emergency teams to rush to the spot of emergency.
4. On hearing the emergency announcement the fireman present in the unaffected plant should report fire station immediately.

If the emergency message is informed to fire station by telephone, the same shall be passed on to the concerned Main Control Room Panel Engineer by fireman. The panel engineer will inform the Shift-in-charge of the concerned plant and Control Room of the unaffected plant regarding the emergency. The panel Engineers of both ECH and LAB plants will announce on paging system, the location and nature of the emergency requesting concerned teams to rush to the emergency spot. The members of emergency teams shall stop the maintenance & other related activities immediately on hearing the announcement and rush to the spot of emergency. The operators shall stick to their spot of work unless directed by Panel engineers or Chief Emergency Coordinator. All others not associated with any emergency team should clear the emergency spot and rush to assembly / alternate assembly point, depending on wind direction.

Once the information reaches the concerned Chief Emergency Coordinator, he rushes to the spot. All team members except first aid attendant and security guard of Manpower Accounting and search team assemble at the spot of emergency to take over their duties under the control of the concerned Chief Emergency Coordinator.

The Chief Emergency Coordinator of the concerned plant will give necessary instructions to team leaders and co-ordinate for combating the emergency. If required, he shall co-ordinate with the panel engineers through Public Address System for safe shutdown/operation of plant, section, etc.

The communication Team Leader after getting instruction from Chief Emergency Coordinator at the spot of emergency will come to Main Control Room of the concerned plant for passing information to concerned persons as per instruction.

Chief Emergency Coordinator will decide on additional manpower requirements depending upon the requirement and availability.

1.9.2 Intimating Employees during Emergency (Chlorine Leak)

- Whenever fire siren is sounded, the duty security guard at Gate 3 (ECH main gate) will confirm with the leader of security team about the nature of emergency. The same will be performed for the proposed plant.
- If the emergency is due to Chlorine leak or release at the plant, the duty security guard will alert the employees of administration building about the chlorine leak/release by

pressing the emergency buzzer and will shut down the AC system of the administration building

- He will also ensure those windows and the main entry doors to administration building are kept closed. At this point of time, no one should move out of the building. This is only an alert message.
- The Security team leader will be in constant touch with SIC for emergency evacuation of admin building. Depending upon the wind direction, and amount of chlorine release, SIC will instruct Security Team leader and Panel Engineer, about evacuation of Admin Building. The Panel Engineer will actuate the 'Emergency Evacuation System', installed in the Admin Building which will start the Pre-Recorded message, "Emergency in the Factory. Please evacuate the office premises immediately". The security guards of gate 3 also will inform all employees to evacuate the admin building.
- Upon directed, the employees of admin building will assemble at the north of Fire Station (alternate assembly point of LAB plant).
- After all clear siren is sounded; all the employees will go back to admin building.

All the above existing onsite emergency facilities will be followed and performed for proposed PO manufacturing.