7 ADDITIONAL STUDIES

7.1 Public Consultation

Not Applicable as the proposed project is in Notified Industrial Area.

7.2 Risk Assessment

7.2.1 Background

Key issues in Risk Assessment (RA) of the expansion of Synthetic Organic chemical based processing unit (M/s Jay Chemical Industries Limited, Unit-3) i.e. Category 5(f)B of the Schedule to the EIA Notification dated Sept. 14, 2006 (amended till date), for proposed manufacturing activities are discussed in this chapter. The risk assessment process is intended to identify probable hazards in the work environment and all operations, to quantify the hazards and to assess the risk levels of those hazards in order to prioritize those that need an immediate attention.

In the unlikely event that an abnormal consequence has occurred, the disaster management kicks in. This includes prescribing the procedures pertaining to a number of issues such as communication, encounter, rescue, rehabilitation and further steps to prevent recurrence of such consequence in future. These issues are addressed in the disaster management plan.

Both, the RA and DMP are living documents and need to be updated whenever there are changes in operations, equipment or procedures.

7.2.2 Key definition

The terminologies used in this Risk Assessment (RA) study are defined below.

Consequence: Magnitude or size of the damage or loss. In terms of health and safety, it is the degree of harm that could be caused to the people exposed to hazard, the potential severity of injuries or ill health, and/or the number of people who could be potentially affected. Consequence of hazard need not only be in terms of human safety criteria, but could also be in terms of a financial loss due to production and incurred costs due to repairs/replacement, environmental impacts as well as public outrage.

Disaster: A catastrophic consequence of a major emergency/accident that leads to not only extensive damage to life and property, but also disrupts all normal human activity for a significant period of time and requires a major national and/or international effort for rescue and rehabilitation of those affected.

Emergency: A situation of process deviation that, if uncontrolled, may lead to a major accident/disaster with potential short term and/or long term risk damage consequence to life and property in and/or around the workplace.

Emergency Response Planning Guidelines1 (EPRG1): The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour (without a respirator) without experiencing other than mild transient adverse health effects or without perceiving a clearly defined objectionable odour.

Emergency Response Planning Guidelines2 (ERPG2): The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.

Emergency Response Planning Guidelines3 (ERPG3): The maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.

Hazard: Source of potential harm, injury or loss to man and machines.

Immediately Dangerous to life and health (IDLH): It represents the maximum concentration of a chemical from which, in the event of respiratory failure, one could escape within 30 minutes without a respirator and without experiencing any escape/impairing (e.g. severe irritation) or irreversible health effects.

Lethal Concentration Low (LCLo): It is the lowest concentration of a material in air, other than LC50, which has been reported to cause death in human or animals.

Risk: Combination of the likelihood of a specific unwanted event and the potential consequences, if it occurs.

Risk Assessment: A process that involves estimation and measurement of risk to determine priorities and to enable identification of appropriate level of risk treatment (used also to describe the overall process of risk management).

Risk Control: Implementation of strategies to prevent, control and minimize hazards.

Risk Management: Overall description of the steps taken to manage risk, by identifying hazards and implementing controls in the workplace.

Risk Rating: The category, level, or risk assigned following risk assessment (e.g. High, Medium, or Low).

Threshold Limit Value (TLV): it is the permitted level of exposure for a given period on a weighted average basis (usually 8 hrs for 5 days in a week)

Short Time Exposure Limit (STEL): it is the permitted short-term exposure limit usually for a 15 minutes exposure.

Toxic Concentration Low (TCLo): It is the lowest concentration of a material in air, to which humans or animals have been exposed for any given period of time that has produced a toxic effect in humans or produced carcinogenic, neoplastigenic or tetratogenic effect in humans or animals

7.2.3 Methodology for Risk Assessment

The methodology includes,

3. Hazard identification,
4. Selection of potential loss scenarios,
5. Simulation of release source model on DNV's PHAST 7.1,
6. Plotting the damage contour on site map

7.2.4 Hazard Identification

The project description, and other project related data provided by the client have been comprehensively reviewed to identify the hazardous operations. Also the information on the hazardous properties (MSDS) of all the chemicals handled at the site has been reviewed to identify the hazards associated with the same.

This involves storage of some of the raw material at the site which can lead to uncontrolled release of hazardous material causing hazard. On the basis of this, the important hazards that can lead to accident in the proposed project are described in ***Table 7-1***.

Table 7-1: Important Hazardous Events

Type of Event	Explanation
BLEVE	Boiling Liquid Evaporating Vapor Explosion; may happen due to catastrophic failure of refrigerated or pressurized gases or liquids stored above their boiling points, followed by early ignition of the same, typically leading to a fire ball
Deflagration	Is the same as detonation but with reaction occurring at less than sonic velocity and initiation of the reaction at lower energy levels

Type of Event	Explanation
Detonation	A propagating chemical reaction of a substance in which the reaction front advances in the unreacted substance at or greater than sonic velocity in the unreacted material
Explosion	A release of large amount of energy that form a blast wave
Fire	Fire
Fireball	The burning of a flammable gas cloud on being immediately ignited at the edge before forming a flammable/explosive mixture.
Flash Fire	A flammable gas release gets ignited at the farthest edge resulting in flash-back fire
Jet Fire	A jet fire occurs when flammable gas releases from the pipeline (or hole) and the released gas ignites immediately. Damage distance depends on the operating pressure and the diameter of the hole or opening flow rate.
Pool Fire	Pool fire is a turbulent diffusion fire burning above a horizontal pool of vaporizing hydrocarbon fuel, where the fuel has zero or low initial momentum
Spill Release	'Loss of containment'. Release of fluid or gas to the surroundings from unit's own equipment / tanks causing (potential) pollution and / or risk of explosion and / or fire
Structural Damage	Breakage or fatigue failures (mostly failures caused by weather but not necessarily) of structural support and direct structural failures
Vapor Cloud Explosion	Explosion resulting from vapor clouds formed from flashing liquids or non-flashing liquids and gases

Hazard and Damage Assessment

Toxic, flammable and explosive substances released from sources of storage as a result of failures or catastrophes, can cause losses in the surrounding area in the form of:

- Toxic gas dispersion, resulting in toxic levels in ambient air,
- Fires, fireballs, and flash back fires, resulting in a heat wave (radiation), or
- Explosions (Vapours Cloud Explosions) resulting in blast waves (overpressure).

Consequences of Fire/Heat Wave

The effect of thermal radiation on people is mainly a function of intensity of radiation and exposure time. The effect is expressed in term of the probability of death and different degree of burn. The consequence effects studied to assess the impact of the events on the receptors are provided in ***Table 7-2*** .

Table 7-2: Damage due to Radiation Intensity

Radiation (kW/m^2)	Damage to Equipment	Damage to People
4.0	-	Causes pain if duration is longer than 20 sec. But blistering is unlikely.
12.5	Minimum energy to ignite wood with a flame; melts plastic tubing.	1% lethality in one minute. First degree burns in 10 sec.
37.5	Severe damage to plant	100% lethality in 1 min. 50% lethality in 20 sec. 1% lethality in 10 sec.

Consequences of Overpressure

The effects of the shock wave vary depending on the characteristics of the material, the quantity involved and the degree of confinement of the vapour cloud. The peak pressures in an explosion therefore vary between a slight over-pressure and a few hundred kilopascals (kPa). Whereas dwelling are demolished and windows and doors broken at overpressures as low as 0.03- 0.1 bar. Direct injury to people occurs at greater pressures. The pressure of the shock wave decreases rapidly with the increase in distance from the source of the explosion. The overpressure damage is shown in ***Table 7-3***.

Table 7-3: Overpressure Damage

Overpressure (bar)	Damage
0.02068	Limited minor structural damage

Overpressure (bar)	Damage
0.068 to 0.136	Corrugated asbestos shattered; corrugated steel or aluminium panels, fastenings fail, followed by buckling, wood panels (standard housing) fastenings fail, panels blown in
0.204 to 0.272	Frameless, self -framing steel panel building demolished; rupture of oil storage tanks

Source: CCPS Consequence Analysis of Chemical Release

Consequences of Toxic Release

The effect of exposure to toxic substance depends upon the duration of exposure and the concentration of the toxic substance.

Short-term exposures to high concentration give Acute Effects while long term exposures to low concentrations result in Chronic Effects.

Only acute effects are considered under hazard analysis, since they are likely credible scenarios. These effects are:

- Irritation (respiratory system, skin, eyes)
- Narcosis (nervous system)
- Asphyxiation (oxygen deficiency)
- System damage (blood organs)

7.2.5 Selection of Maximum Credible Loss Scenarios (MCLs')

Following important points have been be considered for the selection of release scenarios.

- Flammability and the flash point of the material
- Phase of material i.e. liquid or gas
- Threshold quantity of the chemicals as prescribed in MSHIC Rule
- Operating temperature and pressure of the material
- Total inventory of the material

On the basis of study of chemical properties whose IDLH value is less than 500 ppm and flash point is <60 (MSDS) are selected for simulation are presented in ***Table 7-4***.

Table 7-4: Chemicals selected for Simulation

Sr. No.	Raw Materials	Physical State	Means of Storage	Capacity of storage Means	No. of Storage Means	Total Capacity	Pressure	Temperature	Dyke Height (m)	Dyke Area (m^2)
Existing										
1	Ethylene Oxide	Gas	Tank Farm	7.5 MT	1	7.5 MT	3.5 Kg (By Nitrogen)	10^oC (Chilling System)	2	50
Proposed										
1	Acetic acid	Liquid	Tank	10 MT	1	10 MT	Atm	Amb	2	10
2	Ammonia	Gas	Cylinder	50 KG	10	500 KG	Atm	Amb	2	5
3	Ethylene Di Amine	Liquid	Barrel	200 Liter	10	02 MT	Atm	Amb	2	10
4	Liq. Bromine	Liquid	Glass Bottle	500 Liter	1	0.5 KL	Atm	Amb	2	1
5	Methanol	Liquid	Tank Farm	20 KL	1	20 KL	Atm	Amb	2	20
6	Formic acid	Liquid	Carboy	50 Kg	20	01 MT	Atm	Amb	2	1

On the basis of the information provided in ***Table 7-4,*** and as discussed over failures sceneries given in publications like World Bank Technical Paper 55 and TNO Purple Book and the experience of the consultant, MCLs' which may take place are presented in ***Table 7-5.***

Table 7-5: Scenarios Selected for Simulation

S. No.	Storage Tanks of	Hazard involved	Types of Failure Possible		Consequences Studied
			Credible Scenarios	Worst Case Scenarios	
1	Ethylene Oxide	Flammable	10 mm Leak, 25 mm Leak	Catastrophic Rupture	Jet Fire & Late Pool Fire, late ignition
2	Acetic acid	Flammable & Toxic	5 mm Leak, 10 mm Leak	Catastrophic Rupture	Jet Fire & Late Pool Fire, late ignition & Maximum Concentration effect
3	Ammonia	Toxic	5 mm Leak, 10 mm Leak	Catastrophic Rupture	Maximum Concentration effect
4	Ethylene Di Amine	Flammable	10 mm Leak, 25 mm Leak	Catastrophic Rupture	Jet Fire & Late Pool Fire, late ignition
5	Liq. Bromine	Toxic	1 mm Leak, 5 mm Leak	Catastrophic Rupture	Maximum Concentration effect
6	Methanol	Flammable	10 mm Leak, 25 mm Leak	Catastrophic Rupture	Jet Fire & Late Pool Fire, late ignition
7	Formic acid	Flammable & Toxic	1 mm Leak, 5 mm Leak	Catastrophic Rupture	Jet Fire & Late Pool Fire, late ignition & Maximum Concentration effect

Failure Rates

A leak or rupture of a tank, release some or all of its content, can be caused by brittle failure of the tank wall, welds or connected pipework due to use of inadequate materials, combined with loading such as wind, earthquake or impact. Failure rates for selected MCLS' are provided in ***Table 7-6.***

Table 7-6: Failure Frequency for Storage Tanks

Categories	Catastrophic Rupture Frequency (per tank per year)	Leak Frequency (per year)
Refrigerated Storage Tank (Single Wall)	2.3×10^{-5}	1.0×10^{-5}
Refrigerated Storage Tank (Double Walled)	2.5×10^{-8}	1.0×10^{-5} (for primary containment)
Atmospheric Storage Tank	3.0×10^{-6}	2.8×10^{-3}
Pressure Vessels	4.7×10^{-7}	1.2×10^{-5} (for Hole Size 3 to 10 mm)
		7.1×10^{-6} (for Hole Size 10 to 50 mm)

Reference: International Association of Oil & Gas Producers (OGP); Report No. 434-3, March 2010

Also, the risk assessment is considered using certain internationally recognized yardsticks for measuring risk. These first need to be explained, and this is done as ***Table 7-7***.

Table 7-7: Broadly Accepted Frequency

Annual Fatality risk level per year	Conclusion
10^{-3}	Unacceptable to everyone. Immediate action shall be taken to reduce the hazards
10^{-4}	Willing to spend public money to control hazards, such as traffic signs, fire departments etc
10^{-5}	People still recognize. Safety slogans have precautionary rings. Such as never swim alone, never point a gun
10^{-6}	Not of great concern to everyone. People are aware of these hazards but feel that they cannot happen to them. Such as Lightning Never Strikes twice an Act of God.

7.2.6 Simulation of Release and Development of Contours

As the MCLS' were developed for the selected set of chemicals, the next step is to carry out the consequence analysis. The consequence analysis results along with their contours are presented in the following sections.

Ethylene Oxide

Radiation level and effect distance are presented in ***Table 7-8*** & Overpressure effect distances are presented in ***Table 7-9.***

Table 7-8: Radiation Level and Effect Distance

Chemical (Storage Tank)	Failure Scenario	Consequence	Met Data	Effective Distance in meter to Radiation Level		
				4 kW/m2	12.5 kW/m2	37.5 kW/m2
Ethylene Oxide (7.5 MT)	10 mm leak	Jet fire	2.0/A	27.2	22.2	NR
			3.0/E	25.6	20.6	16.9
			4.0/D	24.4	19.5	15.9
		Late Pool Fire	2.0/A	27.0	16.7	6.5
			3.0/E	27.7	17.7	7.0
			4.0/D	28.0	18.3	7.3
	25 mm leak	Jet fire	2.0/A	52.8	42.8	34.8
			3.0/E	49.8	39.9	32.7
			4.0/D	47.8	38.0	31.2
		Late Pool Fire	2.0/A	27.0	16.7	6.5
			3.0/E	27.7	17.7	7.0

Chemical (Storage Tank)	Failure Scenario	Consequence	Met Data	Effective Distance in meter to Radiation Level		
				4 kW/m2	12.5 kW/m2	37.5 kW/m2
			4.0/D	28.0	18.3	7.3
	Catastrophic Rupture	Late Pool Fire	2.0/A	27.0	16.7	6.5
			3.0/E	27.7	17.7	7.0
			4.0/D	28.0	18.3	7.3

Table 7-9: Overpressure Effect Distance

Chemical (Storage Tank)	Failure Scenario	Consequence	Met Data	Overpressure Distances in Meters		
				0.02	0.21	1.00
Ethylene Oxide (7.5 MT)	10 mm leak	Late Ignition	2.0/A	39	24	21
			3.0/E	38	24	21
			4.0/D	25	13	11
	25 mm leak	Late Ignition	2.0/A	56	35	32
			3.0/E	57	35	32
			4.0/D	45	25	22
	Catastrophic rupture	Late Ignition	2.0/A	248	97	81
			3.0/E	264	98	81
			4.0/D	266	98	87

The contours for effect distance generated are presented in ***Figure 7-1 to Figure 7-3***.

Figure 7-1:Jet Fire effect Consequence Contour due to 25 mm hole leak at Weather Condition 2.0/A

Figure 7-2: Late Pool Fire effect Consequence Contour due to Catastrophic Rupture at Weather Condition 4.0/D

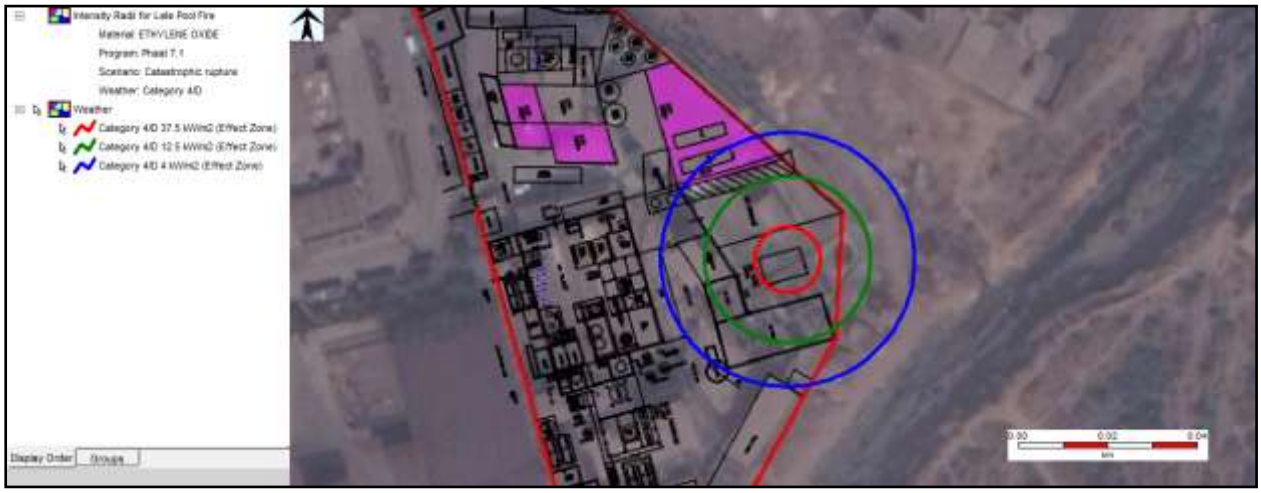


Figure 7-3:Overpressure effect Consequence Contour due to 25 mm hole leak at Weather Condition 3.0/E

Acetic Acid

Radiation level and effect distance are presented in ***Table 7-10*** & Toxic effect distances are presented in ***Table 7-11***.

Table 7-10: Radiation Level and Effect Distance

Chemical (Storage Tank)	Failure Scenario	Consequence	Met Data	Effective Distance in meter to Radiation Level		
				4 kW/m2	12.5 kW/m2	37.5 kW/m2
Acetic Acid (10 MT)	5 mm Leak	Jet fire	2.0/A	NR	NR	NR
			3.0/E	NR	NR	NR
			4.0/D	NR	NR	NR
		Late Pool Fire	2.0/A	5.6	2.8	NR
			3.0/E	5.8	2.8	NR
			4.0/D	5.9	2.8	NR
	10 mm leak	Jet fire	2.0/A	NR	NR	NR
			3.0/E	NR	NR	NR
			4.0/D	NR	NR	NR
		Late Pool Fire	2.0/A	5.6	2.8	NR
			3.0/E	5.8	2.8	NR

Chemical (Storage Tank)	Failure Scenario	Consequence	Met Data	Effective Distance in meter to Radiation Level		
				4 kW/m2	12.5 kW/m2	37.5 kW/m2
			4.0/D	5.9	2.8	NR
	Catastrophic Rupture	Late Pool Fire	2.0/A	5.6	2.8	NR
			3.0/E	5.8	2.8	NR
			4.0/D	5.9	2.8	NR

Table 7-11: Toxic Effect Distance

Chemical (Storage Tank)	Failure Scenario	Met Data	Effective Distance in meter to Toxic Level			
			EPRG 1 (1 ppm)	EPRG 2 (6 ppm)	EPRG 3 (73 ppm)	IDLH (50 ppm)
Acetic Acid (10 MT)	5 mm leak	2.0/A	80.8	36.5	17.1	19.2
		3.0/E	300.9	103.4	22.1	25.8
		4.0/D	162.5	58.1	11.1	14.4
	10 mm leak	2.0/A	109.0	54.7	29.6	33.1
		3.0/E	388.5	138.9	38.0	43.8
		4.0/D	207.6	76.1	19.8	22.7
	Catastrophic Rupture	2.0/A	133.3	73.1	31.8	37.8
		3.0/E	530.1	246.6	69.5	99.4
		4.0/D	420.9	194.7	58.8	82.8

The contours for effect distance generated are presented in ***Figure 7-4 & Figure 7-5***.

Figure 7-4: Maximum Concentration effect Consequence Contour due to 10 mm hole leak at Weather Condition 3.0/E

Figure 7-5: Maximum Concentration effect Consequence Contour due to Catastrophic Rupture at Weather Condition 3.0/E

Ammonia

Toxic effect distances are presented in ***Table 7-12.***

Table 7-12: Toxic Effect Distance

Chemical (Storage Tank)	Failure Scenario	Met Data	Effective Distance in meter to Toxic Level			
			EPRG 1 (25 ppm)	EPRG 2 (150 ppm)	EPRG 3 (750 ppm)	IDLH (300 ppm)
Ammonia (50 kg)	5 mm leak	2.0/A	54.4	21.9	10.5	18.3
		3.0/E	212.8	76.7	27.8	62.8
		4.0/D	119.3	44.1	15.5	35.9
	10 mm leak	2.0/A	54.3	24.5	11.5	21.9
		3.0/E	219.8	79.9	29.4	65.7
		4.0/D	115.9	43.1	15.2	35.1
	Catastrophic Rupture	2.0/A	53.1	28.3	20.1	26.7
		3.0/E	220.9	80.9	30.3	67.1
		4.0/D	118.7	46.6	22.0	38.5

The contours for effect distance generated are presented in ***Figure 7-6 to Figure 7-7***.

Figure 7-6: Toxic Consequence Contour due to 10 mm hole leak at Weather Condition 3.0/E

Figure 7-7: Toxic Consequence Contour due to Catastrophic Rupture at Weather Condition 3.0/E

Ethylene Diamine

Radiation level and effect distance are presented in ***Table 7-13***, & Overpressure effect distances are presented in ***Table 7-14.***

Table 7-13: Radiation Level and Effect Distance

Chemical (Storage Tank)	Failure Scenario	Consequence	Met Data	Effective Distance in meter to Radiation Level		
				4 kW/m2	12.5 kW/m2	37.5 kW/m2
Ethylene Diamine (200 Liter)	10 mm leak	Jet fire	2.0/A	16.9	13.7	NR
			3.0/E	15.8	12.7	NR
			4.0/D	14.9	12.0	10.3
		Late Pool Fire	2.0/A	9.7	6.0	2.8
			3.0/E	10.0	6.5	2.8
			4.0/D	10.2	6.7	2.8
	25 mm leak	Jet fire	2.0/A	35.0	28.3	NR
			3.0/E	32.7	26.3	51.4
			4.0/D	31.2	25.0	50.6
		Late Pool Fire	2.0/A	9.7	6.0	2.8
			3.0/E	10.0	6.4	2.8
			4.0/D	10.2	6.7	2.8
	Catastrophic Rupture	Late Pool Fire	2.0/A	-	-	-
			3.0/E	-	-	-
			4.0/D	-	-	-

Table 7-14: Overpressure Effect Distance

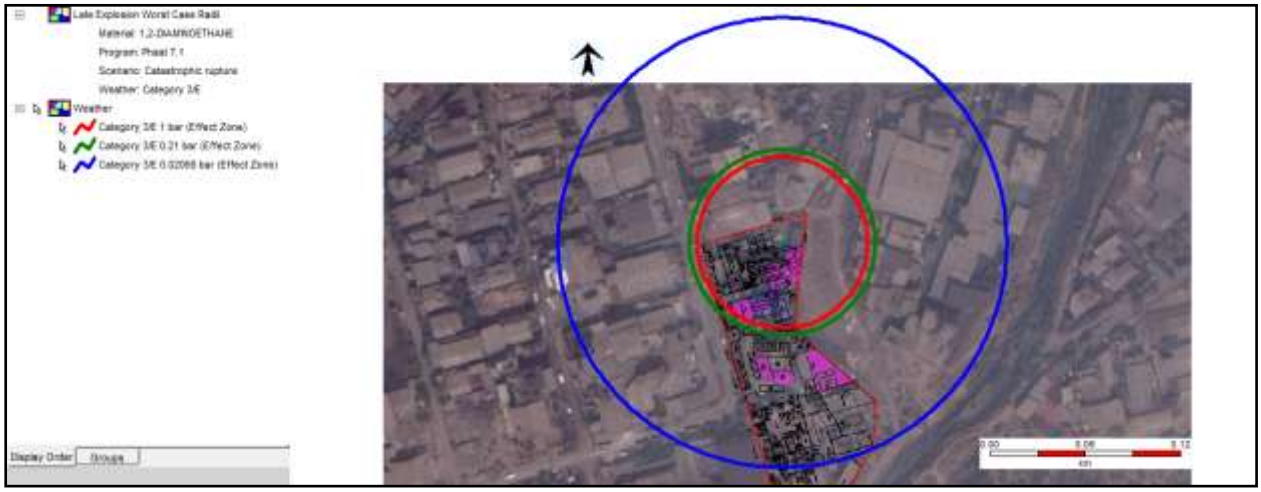
Chemical (Storage Tank)	Failure Scenario	Consequence	Met Data	Overpressure Distances in Meters		
				0.02	0.21	1.00
Ethylene Diamine (200 Liter)	Catastrophic rupture	Late Ignition	2.0/A	135	43	35
			3.0/E	140	58	53
			4.0/D	139	53	51

The contours for effect distance generated are presented in ***Figure 7-8 to Figure 7-10***.

Figure 7-8: Jet Fire effect Consequence Contour due to 25 mm hole leak at Weather Condition 2/A

Figure 7-9: Late Pool Fire effect Consequence Contour due to 25 mm leak at Weather Condition 4.0/D

Figure 7-10: Overpressure effect Consequence Contour due to Catastrophic Rupture at Weather Condition 3.0/E



Liq. Bromine

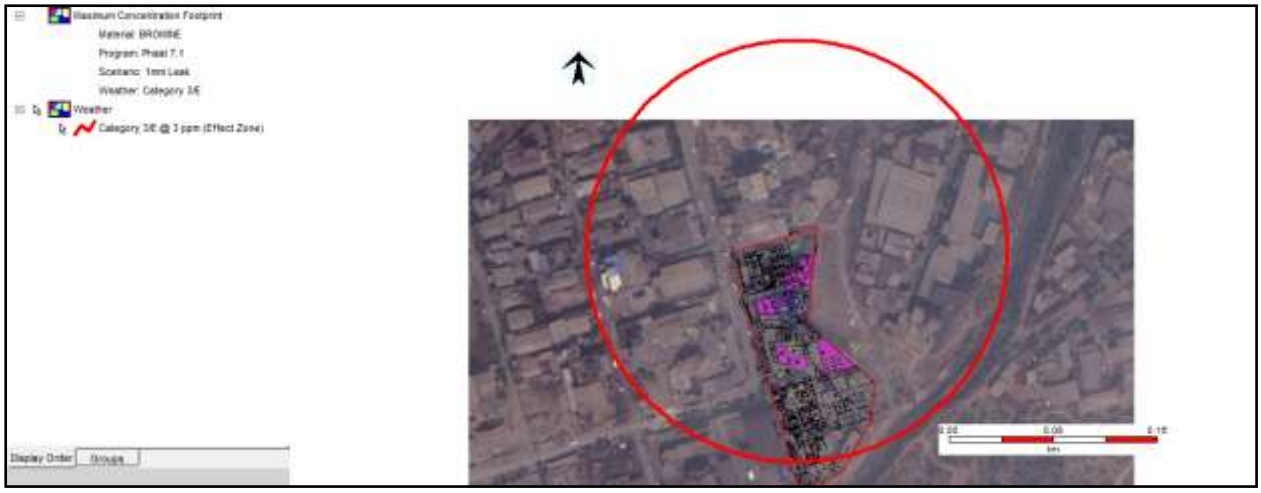
Toxic effect distances are presented in ***Table 7-15***.

Table 7-15: Toxic Effect Distance

Chemical (Storage Tank)	Failure Scenario	Met Data	Effective Distance in meter to Toxic Level			
			EPRG 1 (0.1 ppm)	EPRG 2 (0.5 ppm)	EPRG 3 (5 ppm)	IDLH (3 ppm)
Bromine (500 Liter)	1 mm leak	2.0/A	188.7	83.4	24.9	39.1
		3.0/E	902.4	381.1	105.5	171.7
		4.0/D	495.1	203.3	57.4	90.7
	5 mm leak	2.0/A	333.9	148.9	46.1	71.4
		3.0/E	1672.7	697.8	495.1	315.8
		4.0/D	877.8	364.2	100.3	162.7
	Catastrophic Rupture	2.0/A	343.2	163.2	65.5	88.4
		3.0/E	1670.8	694.7	206.3	328.6
		4.0/D	952.8	433.3	123.3	196.5

The contours for effect distance generated are presented in ***Figure 7-11***.

Figure 7-11:Toxic Consequence Contour due to 1 mm hole leak at Weather Condition 3.0/E



Methanol

Radiation level and effect distance are presented in ***Table 7-16***, & Overpressure effect distances are presented in ***Table 7-17***.

Table 7-16: Radiation Level and Effect Distance

Chemical (Storage Tank)	Failure Scenario	Consequence	Met Data	Effective Distance in meter to Radiation Level		
				4 kW/m2	12.5 kW/m2	37.5 kW/m2
Methanol (20 KL)	10 mm leak	Jet fire	2.0/A	9.9	NR	NR
			3.0/E	9.2	NR	NR
			4.0/D	8.6	NR	NR
		Late Pool Fire	2.0/A	8.4	4.4	NR
			3.0/E	8.5	4.7	NR
			4.0/D	8.6	5.0	NR
	25 mm leak	Jet fire	2.0/A	18.2	NR	NR
			3.0/E	16.9	NR	NR
			4.0/D	16.1	13.2	NR
		Late Pool Fire	2.0/A	8.4	4.4	NR

Chemical (Storage Tank)	Failure Scenario	Consequence	Met Data	Effective Distance in meter to Radiation Level		
				4 kW/m2	12.5 kW/m2	37.5 kW/m2
			3.0/E	8.5	4.7	NR
			4.0/D	8.6	5.0	NR
	Catastrophic Rupture	Late Pool Fire	2.0/A	8.4	4.4	NR
			3.0/E	8.5	4.7	NR
			4.0/D	8.6	5.0	NR

Table 7-17: Overpressure Effect Distance

Chemical (Storage Tank)	Failure Scenario	Consequence	Met Data	Overpressure Distances in Meters		
				0.02	0.21	1.00
Methanol (20 KL)	Catastrophic rupture	Late Ignition	2.0/A	19	12	11
			3.0/E	19	12	11
			4.0/D	29	14	12

The contours for effect distance generated are presented in ***Figure 7-12 & Figure 7-13***.

Figure 7-12:Jet Fire Effect Consequence Contour due to 25 mm hole leak at Weather Condition 2.0/A

Figure 7-13: Overpressure effect Consequence Contour due to Catastrophic Rupture at Weather Condition 4.0/D

Formic Acid

Radiation level and overpressure effect distance are presented in ***Table 7-18***, Overpressure distances are presented in ***Table 7-19*** & Toxic effect distances are presented in ***Table 7-20***.

Table 7-18: Radiation Level and Effect Distance

Chemical (Storage Tank)	Failure Scenario	Consequence	Met Data	Effective Distance in meter to Radiation Level		
				4 kW/m2	12.5 kW/m2	37.5 kW/m2
Formic Acid (50 kg)	1 mm leak	Jet fire	2.0/A	NR	NR	NR
			3.0/E	NR	NR	NR
			4.0/D	NR	NR	NR
		Late Pool Fire	2.0/A	NR	NR	NR
			3.0/E	NR	NR	NR
			4.0/D	NR	NR	NR
	5 mm leak	Jet fire	2.0/A	NR	NR	NR
			3.0/E	NR	NR	NR
			4.0/D	NR	NR	NR
		Late Pool Fire	2.0/A	NR	NR	NR
			3.0/E	NR	NR	NR
			4.0/D	NR	NR	NR
	Catastrophic Rupture	Late Pool Fire	2.0/A	-	-	-
			3.0/E	-	-	-
			4.0/D	-	-	-

Table 7-19: Overpressure Effect Distance

Chemical (Storage Tank)	Failure Scenario	Consequence	Met Data	Overpressure Distances in Meters		
				0.02	0.21	1.00
Formic Acid (50 kg)	Catastrophic rupture	Late Ignition	2.0/A	41	16	12
			3.0/E	43	17	13
			4.0/D	42	16	13

Table 7-20: Toxic Effect Distance

Chemical (Storage Tank)	Failure Scenario	Met Data	Effective Distance in meter to Toxic Level			
			EPRG 1	EPRG 2	EPRG 3	IDLH (30 ppm)
Formic Acid (50 kg)	1 mm leak	2.0/A	-	-	-	6.5
		3.0/E	-	-	-	20.2
		4.0/D	-	-	-	NH
	5 mm leak	2.0/A	-	-	-	34.6
		3.0/E	-	-	-	123.0
		4.0/D	-	-	-	68.5
	Catastrophic Rupture	2.0/A	-	-	-	343.6
		3.0/E	-	-	-	1921.2
		4.0/D	-	-	-	1258.7

The contours for effect distance generated are presented in ***Figure 7-14 & Figure 7-15***.

Figure 7-14: Toxic Consequence Contour due to 5 mm leak at Weather Condition 3.0/E

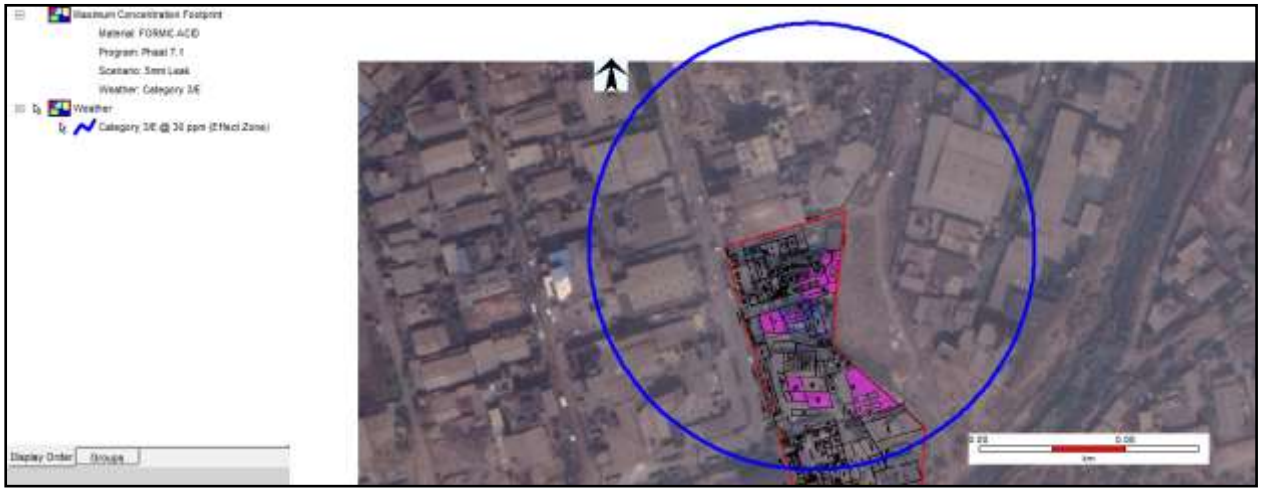


Figure 7-15: Toxic Consequence Contour due to Catastrophic Rupture at Weather Condition 3.0/E

7.2.7 Compilation of results

Based on the above study, the maximum distance affected due to Radiation level, Overpressure effect and Toxic Dispersion effect is given in ***Table 7-21***.

Table 7-21: Maximum Effective Distances

Chemical	Scenario	Effect Distance in Meters				
		At Radiation level 4 Kw/m^2	At Radiation level 37.5 Kw/m^2	At Overpressure 0.02 bar	At Overpressure 1 bar	At Toxic Level
Ethylene Oxide	Normal Condition (25 mm Leak)	52.8 @ 2/A	34.8 @ 2/A	57 @ 3/E	32 @ 2/A	-
	Worst case (Catastrophic Rupture)	28 @ 4/D	7.3 @ 4/D	266 @ 4/D	87 @ 4/D	-
Acetic Acid	Normal Condition (10 mm Leak)	5.9 @ 4/D	NR	-	-	43.8 @ 3/E
	Worst case (Catastrophic Rupture)	NR	NR	-	-	99.4 @ 3/E
Ammonia	Normal Condition (10 mm Leak)	-	-	-	-	65.7 @ 3/E
	Worst case (Catastrophic Rupture)	-	-	-	-	67.1 @ 3/E
Ethylene Diamine	Normal Condition (25 mm Leak)	35 @ 2/A	51.4 @ 3/E	-	-	-
	Worst case (Catastrophic Rupture)	-	-	140 @ 3/E	53 @ 3/E	-
Liquid Bromine	Normal Condition (5 mm Leak)	-	-	-	-	315.8 @ 3/E
	Worst case (Catastrophic Rupture)	-	-	-	-	328.6 @ 3/E
Methanol	Normal Condition (25 mm Leak)	18.2 @ 2/A	NR	-	-	-
	Worst case (Catastrophic Rupture)	8.6 @ 4/D	NR	29 @ 4/D	12 @ 4/D	-
Formic Acid	Normal Condition (5 mm Leak)	NR	NR	-	-	123 @ 3/E
	Worst case (Catastrophic Rupture)	NR	NR	43 @ 3/E	13 @ 3/E	1921.2 @ 3/E

7.3 Safety Measures

7.3.1 Treatment and Control

After examining the high priority risks, a prime consideration is given to the potential to reduce or eliminate the risk by using the hierarchy of controls. This assists in establishing methods to reduce risk. The desirability of control plans (with reducing effectiveness) is as follows;

- Elimination: Take step to eliminate the hazard completely,
- Substitution: Replace with less hazardous material, substance or process,
- Separation: Isolate hazard from person by guarding, space,
- Administrative: Adjusting the time or conditions of risk exposures,
- Training: Increasing awareness, improving skills and making tasks less hazardous to persons involved,
- Personal protective equipment: Use appropriately designed and properly fitted PPE.

Control measures can reduce either the likelihood or consequence of the event or both. Depending on the level of reduction of the hazard, there could still be a residual risk that needs to be monitored so that a secondary prevention process can be initiated when trigger points are reached.

The control measures and action will be adopted by Jay Chemical Industries Limited, Unit-3 to minimize the risk present in the facility for the hazardous event are summarized in ***Table 7-22***.

Table 7-22: Event Consequences, Treatment and Control

Hazardous Event	Possible Consequences	Treatment and Control
Loss of containment Rupture / leak in storage tanks	Fire, explosion and toxic hazards	Gas detectors, Dyke wall provision, Level indicator, Earthing, flame arrestor & visual observation, Ready availability of fire extinguishers and fire hydrant system

7.3.2 Control Measures for Hazardous Raw Materials

- Isolated storage
- Firefighting facility with Fire extinguishers and Sand buckets. Hydrant and Sprinkler provided at E.O. Storage area.
- Integrity of storage tanks checked by engineers.
- Flameproof fittings at Ethylene oxide
- Earthing Arrangements
- MSDS available for emergency handling
- Required PPEs available for emergency including SCBA
- Lightening arrester provided
- Safety instructions boards displayed
- Bund wall provided surrounding some storage tank
- Flame arrester provided in tanks vent pipe
- Chemical handle in closed system.
- Pipe, joints etc. checked by engineer
- Barrier provided which prevents tanker striking
- Employees are trained to handle with care
- Employees trained to use SCBA
- Employees trained to evacuate with wet cloth on nose

7.3.3 Precaution during Storage, process and handling of chemicals

- All chemicals are stored in a segregated and approved area.

- Were all PPEs like safety gloves, goggles, helmet, safety shoes, nose mask
- Maintain eye washer, body shower and quick-drench facilities in work are.
- Do not enter storage areas and confined spaces unless adequately ventilated.
- Eating, drinking and smoking should be prohibited in areas where material is handled, stored and processed.
- Workers should wash hands and face before eating and drinking.
- For leak, spills or other emergency, use full chemical-resistant suit should beworn only by trained and authorized persons.

7.3.4 Precautions to be taken during Transportation

Following are some precautions that will be taken during the loading and unloading of material in plant premises

- Ensuring all labels remains intact on containers and packaging
- Wear antistatic hand gloves / antistatic safety shoe in shop floor
- Wear safety goggles in all cases where the eyes may be exposed to dust, flying particles, or splashes of liquids.
- Wear respirator when exposed to harmful aerosols, dusts, gases or vapors.
- Restrict vehicle speed in factory premises up to 15 KMPH
- Before the tanker enters the industry premises, the tanker is to be inspected for authorized entry and safe & sound condition of the tanker, its contents and that of the prime mover. Flammable material carrying tankers entering plant are to be fitted with spark arresters on their exhaust.
- Static charge neutralizing
- The quality of the chemical in the tanker should be ascertained before unloading to avoid contamination of chemical already at storage.
- Coupling used for connecting hose to tanker must be leak proof.
- For flammable chemicals, the tanker and the hose are to be properly earthed before starting unloading operation.
- Unloading should be done under personal supervision of responsible staff authorized by the management.
- Provision of sample quantity of water / neutralizing medium to take care of leakage / spillage must be made. Inert gas hose stations must be available at unloading point.
- Fire alarm and firefighting facility commensurate with the chemical should be provided at the unloading point.

7.3.5 Information about Ammonia Hazards and precaution to be taken in case of Gas Leakage.

Ammonia is a colourless gas with characteristic pungent smell. It is lighter than air (Vapour Density 0.6), soluble in water and flammable. It is toxic and corrosive.

Toxicity

- Rapid evaporation of the liquid may cause frostbite. The substance is corrosive to the eyes, skin and respiratory tract. Exposure could cause asphyxiation due to swelling in the throat. Inhalation may cause lung oedema, but only after initial corrosive effects on eyes and/or airways have become manifest.
- Repeated or chronic inhalation of the vapour may cause chronic inflammation of the upper respiratory tract. Lungs may be affected by repeated or prolongated exposure. This may result in chronic obstructive pulmonary disorders (COPD).
- TLV is 25 PPM, STEL : 35 PPM

Symptoms

Inhalation is Burning sensation. Cough, Laboured breathing, Shortness of breath, Sore throat. Symptoms of Skin are Redness, Pain, and Blisters. Skin Burns on contact with liquid frostbite. Symptoms of eyes are Redness, Pain, and Severe on contact with liquid frostbite.

First Aid

- Inhalation Move patient to Fresh air. Rest. Half-upright position. Administration of oxygen may be needed. Refer immediately for medical attention.
- Eye Exposure Rinse with plenty of water for several minutes (remove contact lenses if easily possible). Refer immediately for medical attention.
- Dermal Exposure Rinse skin with plenty of water or shower for at least 15 minutes. ON FROSTBITE: rinse with plenty of water, do NOT remove clothes. Refer immediately for medical attention.

Reactivity

Mixtures with mercury, silver and gold oxides are shock-sensitive. The substance is a strong base. It reacts violently with acid and is corrosive. Reacts violently with strong oxidants, halogens and many other substances. Attacks copper, aluminium, zinc and their alloys. Dissolves in water evolving heat. The substance reacts with most organic and inorganic compounds, causing fire and explosion hazard.

Fire or Explosion

- Ammonia Gas explosive limit vol% in air is 15-33.6.
- Cylinders exposed to fire may vent and release toxic and/or corrosive gas through pressure relief devices.
- Containers may explode when heated.
- Ruptured cylinders may rocket. Keep cylinder cool by spraying of water.

Spill or Leak

- The Gas is lighter than air.
- Fully encapsulating, vapor protective clothing should be worn for spills and leaks with no fire.
- Do not touch or walk through spilled material.
- Stop leak if you can do it without risk.
- Use fine water spray to reduce vapors or divert vapor cloud drift. Avoid allowing water runoff to contact spilled material.
- Do not direct water at spill or source of leak.
- Prevent entry into waterways, sewers, basements or confined areas.
- Isolate area until gas has dispersed.
- Ventilate the area.

Emergency Evacuation

- On indication of gas leakage, cover nose and mouth with wet cloth and move away quickly to safe location.
- Women and children should come out from house, keeping piece of wet cloth on face.
- On getting information about any gas leakage, use available mode of transport to move away quickly from the place.
- Life is more precious than property. Immediately move away from the places, as and when you get information about any emergency.
- Set the cattle free. They will reach to safe place on their own.
- To avoid hazard of fire during gas leakage, put out any type of open flames. Do not light up lighters or match sticks.
- In case of such incident, give shelter to old and disabled persons inside house, keeping all windows and doors closed. Keep radio 'ON' for any announcements.
- Do not leave the safe place where you have assembled without instructions from authorized person.

7.3.6 Information about Ethylene oxide Hazards and Precaution to be taken in case of Gas Leakage.

Ethylene oxide is colourless and flammable Gas at 250C and liquid at 00C. The gas has characteristic of sweat odor of ether, noticeable when its concentration in air exceed 500 ppm. Ethylene oxide is readily soluble in water and many other organic solvent. The Gas is heavier than air and travel along the ground. (Vapour Density 1.5) Distant ignite possible.

Toxicity

- Toxic if inhaled
- May cause genetic defects
- May cause cancer
- Eye, Skin and Respiratory irritation occurs due to exposure.
- TLV is 1 PPM, OEL: 1.8 mg/m3.

Symptoms

The vapour is irritating to the eyes, skin and respiratory tract. Water solutions may cause skin blisters. Rapid evaporation of the liquid may cause frostbite. Cough, Drowsiness, Headache, Nausea, Sore throat, Vomiting, Weakness, Frostbite, Redness, Pain, Blurred vision, Redness, Pain. Repeated or prolonged contact may cause skin sensitization. Repeated or prolonged inhalation may cause asthma. The substance may have effects on the nervous system. This substance is carcinogenic to humans. May causes heritable genetic damage to human germ cells.

First Aid

- Inhalation Move patient to fresh air. Rest. Refer for medical attention.
- Eye Exposure First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then refer for medical attention.
- Dermal Exposure Wash exposed area extremely thoroughly with soap and water.

Reactivity

The substance may polymerize due to heating, under the influence of acids, bases, metal chlorides and metal oxides. This generates fire or explosion hazard. Decompose above 560°C in the absence of air. This generates fire and explosion hazard. React violently with many compounds.

Fire or Explosion

- Ethylene oxide explosive limits, vol% in air: 3-100
- Extremely flammable. Gas/air mixtures are explosive. Risk of fire and explosion as a result of decomposition when heated.
- NO open flames, NO sparks and NO smoking. Closed system, ventilation, explosion-proof electrical equipment and lighting. Use non-sparking hand tools.
- Shut off supply; if not possible and no risk to surroundings, let the fire burn itself out. In other cases extinguish with powder, alcohol resistant foam, water spray, carbon dioxide. In case of fire: keep Tank cool by spraying with water. Combat fire from a sheltered position.

Spill or Leak

- Vapours from liquid are initially heavier than air and spread along ground.
- Fully encapsulating, vapour protective clothing and SCBA set should be worn for spills and leaks with no fire.
- Do not touch or walk through spilled material.
- Keep adequate level of water in the dyke of ethylene storage tanks in order to avoid vaporization of liquid Ethylene oxide.

- Stop leak if you can do it without risk.

Emergency Evacuation

- On indication of gas leakage, cover nose and mouth with wet cloth and move away quickly to safe location.
- Women and children should come out from house, keeping piece of wet cloth on face.
- On getting information about any gas leakage, use available mode of transport to move away quickly from the place.
- Life is more precious than property. Immediately move away from the places, as and when you get information about any emergency.
- Set the cattle free. They will reach to safe place on their own.
- To avoid hazard of fire during gas leakage, put out any type of open flames. Do not light up lighters or match sticks.
- In case of such incident, give shelter to old and disabled persons inside house, keeping all windows and doors closed. Keep radio 'ON' for any announcements.
- Do not leave the safe place where you have assembled without instructions from authorized person.
- Information about Phosphorous Tri Chloride Hazards and Precaution to be taken in case of Spillage.
- Phosphorous tri chloride is COLOURLESS OR YELLOW FUMING LIQUID WITH PUNGENT odour.
- The vapour is heavier than air and spread along ground. (Vapour Density 4.75)

Toxicity

- TLV: 0.2 ppm as TWA; 0.5 ppm as STEL.
- The substance is corrosive to the eyes, skin and respiratory tract. Inhalation of the vapour may cause lung oedema. Exposure above the OEL could cause death. The effects may be delayed.

Symptoms

Inhalation of vapour resulting Sore throat, Cough, Burning sensation, Nausea, Vomiting Shortness of breath, Laboured breathing, Skin exposure may result Pain, Redness, Blisters, Skin burns, Exposure of eye may resulting Pain, Redness, Watering of the eyes, Severe deep burns, Loss of vision, Ingestion may resulting Burning sensation, Abdominal pain, Shock or collapse.

First Aid

- Inhalation Fresh air, Rest. Half-upright position. Artificial respiration may be needed. Refer for medical attention.
- Eye Exposure First rinse with plenty of water for several minutes (remove contact lenses if easily possible)
- Dermal Exposure Remove contaminated clothes. Rinse skin with plenty of water or shower.
- Ingestion Rinse mouth. Do not induce vomiting. Refer for medical attention.

Reactivity

Decomposes on heating. This produces toxic and corrosive fumes including hydrogen chloride and phosphorus oxides. Reacts with oxidants. Reacts violently with water. This produces heat and decomposition products including hydrochloric acid and phosphoric acid. This generates fire and explosion hazard. Reacts violently with alcohols, phenols and bases. Attacks metals and many other materials.

Spill or Leak

- Vapours from liquid are initially heavier than air and spread along ground.
- Fully encapsulating, vapour protective clothing and SCBA set should be worn for spills and leaks with no fire.
- Do not touch or walk through spilled material.

- Stop leak if you can do it without risk.
- Evacuate danger area! Consult an expert! Ventilation. Collect leaking and spilled liquid in sealable containers as far as possible. Absorb remaining liquid in dry sand or inert absorbent. Then store and dispose of according to local regulations. Personal protection: chemical protection suit including self- contained breathing apparatus.
- Information about Thionyl chloride Hazards and Precaution to be taken in case of Spillage.
- Thionyl chloride is colourless-to-yellow or reddish fuming liquid with pungent odour.
- The vapour is heavier than air and spread along ground. (Vapour Density - 4.1)

Toxicity

TLV: 0.2 ppm as STEL.

The substance is very corrosive to the eyes, skin and respiratory tract. Corrosive on ingestion Inhalation of the vapour may cause lung oedema. The substance may cause effects on the lungs. This may result in inflammation and blockage of the airways. Exposure far above the OEL could cause death. The effects may be delayed.

Symptoms

Inhalation of vapour resulting Sore throat. Cough. Burning sensation. Shortness of breath. Laboured breathing. Skin exposure may result Pain. Redness. Skin burns. Exposure of eye may resulting Pain.

Redness. Severe deep burns. Ingestion may resulting Burning sensation. Abdominal pain. Shock or collapse.

First Aid

- Inhalation Fresh air, Rest. Half-upright position. Artificial respiration may be needed. Refer for medical attention.
- Eye Exposure First rinse with plenty of water for several minutes (remove contact lenses if easily possible)
- Dermal Exposure Remove contaminated clothes. Rinse skin with plenty of water or shower.
- Ingestion Rinse mouth. Do not induce vomiting. Refer for medical attention.

Reactivity

Decomposes above 140°C. This produces toxic and corrosive fumes. Reacts violently with water. This produces toxic fumes of sulphur dioxide and hydrogen chloride. Reacts with many substances such as combustible substances, amines, bases and metals. This generates fire and explosion hazard.

Spill or Leak

- Vapours from liquid is initially heavier than air and spread along ground.
- Fully encapsulating, vapour protective clothing and SCBA set should be worn for spills and leaks with no fire.
- Do not touch or walk through spilled material.
- Stop leak if you can do it without risk.
- Evacuate danger area! Consult an expert! Ventilation. Collect leaking and spilled liquid in sealable containers as far as possible. Absorb remaining liquid in dry sand or inert absorbent. Then store and dispose of according to local regulations. Personal protection: chemical protection suit including self- contained breathing apparatus

7.4 Disaster Management Plan

7.4.1 Objectives

- To define and to assess emergencies, including risk and environmental impact assessment.
- To prevent the emergency turning into a disaster.
- To safeguard employees and people in vicinity.

- To minimize damage to property or/and the environment.
- To inform employees, the general public and the authority about the hazards/risks assessed, safe guards provided, residual risk if any and the role to be played by them in the event of emergency.
- To inform authorities and mutual-aid centre to come for help.
- Effective rescue and treatment of casualties.
- To identify and list any dead injury.
- To inform and help relatives.
- To secure the safe rehabilitation of affected areas and to restore normalcy.
- To provide authoritative information to the news media.
- To preserve records, equipment etc. and to organize investigation into the cause of the emergency and preventive measures to stop its reoccurrence.
- To ensure safety of the workers before personnel re-enter and resume work.
- To work out a plan with all provisions to handle emergencies and to provide for emergency preparedness and the periodical rehearsal of the plan

On-Site Emergency Plan

An accident takes place in a factory and its effects are confined to the factory premises involving only the people working in the factory.

Off-Site Emergency Plan

If an accident takes place in a factory and its effects are felt outside the factory premises, the situation thus generated is called an off-site emergency

7.4.2 Roles and Responsibilities

Site Main Controller (SMC)

- To take decisions for declaring Onsite emergency after assessing magnitude of occurrence.
- Declaring Offsite Emergency in consultation with District authorities if emergency is likely to affect the peoples of outside the company.
- Ensure all designated persons function their defined duty.
- Inform District Authorities like District collector, police, Director-Industrial safety & health.
- Nominate a person to give information to the media, public, and members of families of the affected.
- Take the help of outside experts, if necessary.
- Remain in touch with the Incident Controller and keep the public informed about the status of emergency.
- Advise to cutoff or restart utility services if required.
- Give the all clear signal after the emergency has come under complete control.

Incident Controller and Dy. Incident Controller

- Assess the situation & initiate mitigating measures for controlling emergency with help of Key personnel & Essential persons
- To advise SMC for declare emergency.
- Direct rescue and firefighting operations.
- Call outside fire brigade or other agency through ECC if required & provide them required help.
- Direct to shut down and evacuation of plant and areas likely to be affected by the emergency.
- Secure the safety of personnel, Search for casualty.
- Be in touch with the site main controller and keep informed of developments.
- Preserve evidences for necessary accident inquiry.
- After controlling emergency, inform Site main controller for ALL CLEAR SIREN

- Preserve evidence of accident for investigation purpose.
- Carry out investigation and suggest corrective measures to stop reoccurrence.

Key Personnel

To implement the decisions & orders given by SMC & IC e.g.

- Casualty search, first aid, medical treatment, Shutdown plants, emergency engineering work, Evacuate personnel, Arrange for supplies of equipment, utility, (water, power etc.), carry out atmospheric tests with utilizing essential persons.
- To help outside agencies.

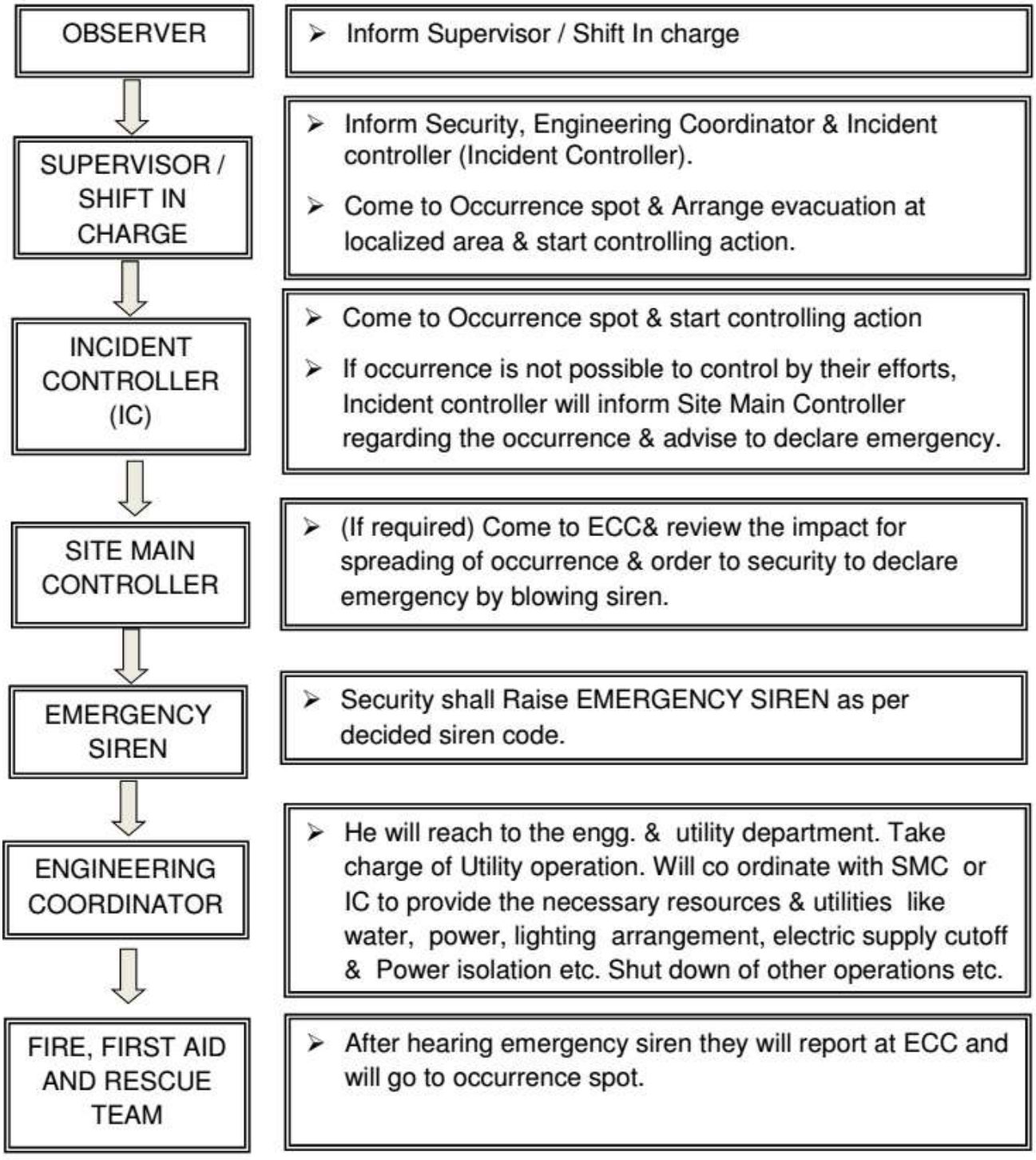
Fire\Rescue & First aid team

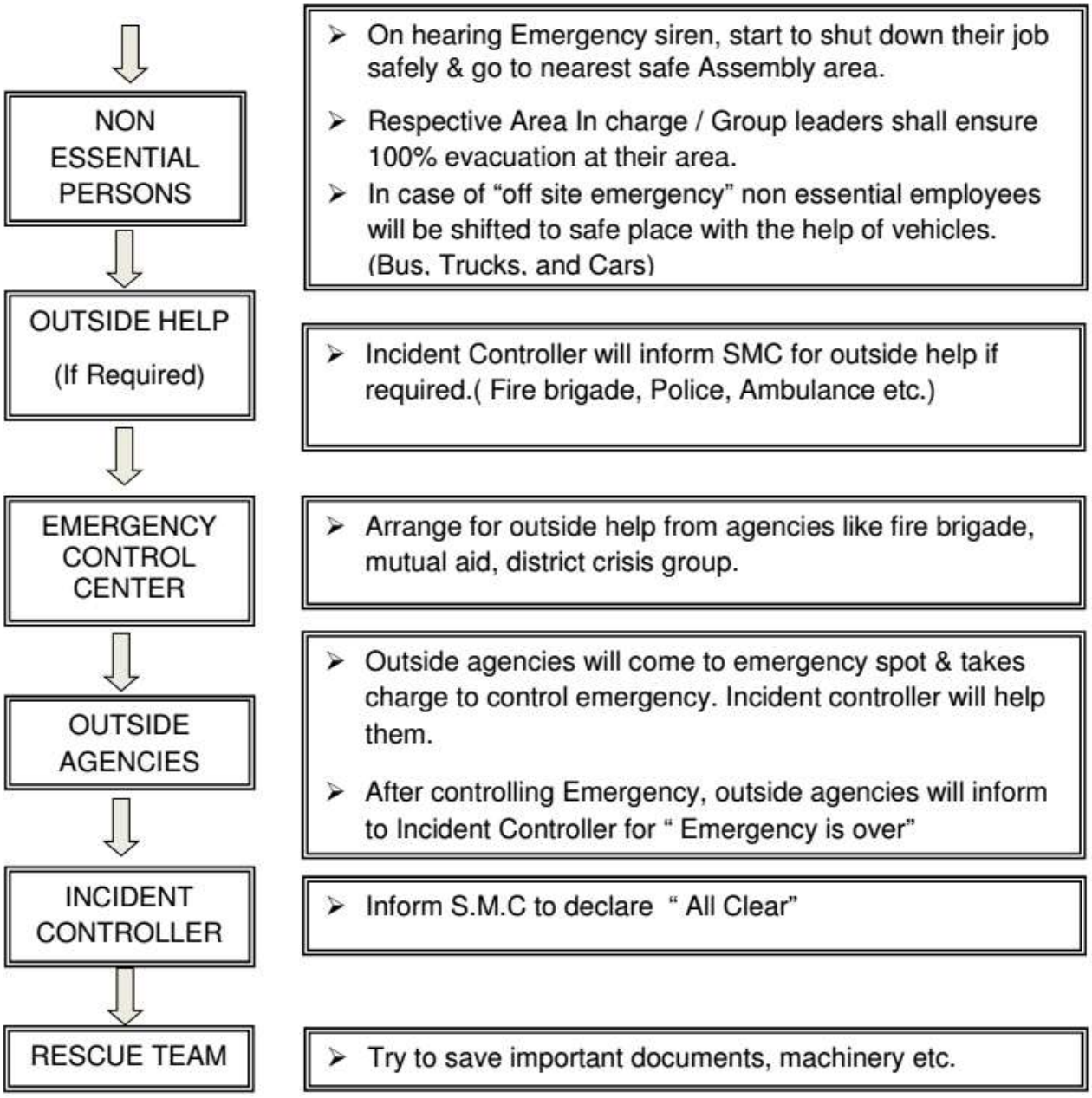
- Go to occurrence spot on getting information of occurrence after reporting to SMC.
- Remain with incident controller assist him for controlling emergency.
- Conduct Firefighting as well as rescue operation at occurrence spot in consultation with incident controller.
- Hand over the casualties to HR coordinator for first aid as well as medical treatment.
- Get any kind of help from Incident controller & ECC for conducting firefighting & rescue operation

Engineering Coordinator

- He will reach to the engineering & utility department. Take charge of Utility operation. He will coordinate with SMC or IC to provide the necessary resources & utilities like water, power, lighting arrangement, electric supply cut-off & power isolation etc. Shut down of other operations etc.

Figure 7-16: Onsite Site Emergency Organogram





7.4.3 Outside Organizations if involved in assisting On Site emergency

Type of Accident (Emergency)

An industrial emergency is referred to a situation arising from a sudden failure of an Industrial Plant, which may have detrimental effects on Life, Property or the Environment. This can be further classified into two broad categories.

On site Emergency

Consisting of those situations affecting a plant of the industrial facility can be managed by reasonably available resources of the industrial facility itself. However outside help may require

Offsite Emergency

Consisting of more serious situations affecting general plant of the industrial facility, even spreading outside and requiring neighbouring industry, Local crisis group or District level resources to manage emergency situation.
The major one as defined in above will necessitate the mutual aid scheme / Outside Organizations into the action, including Government Hospital, Fire brigade etc., under Disaster Control Plan.

Sr. No.	Type of Possible accidents or events	Area / Material Affected
1	Toxic vapor release	Whole plant & Outside area.
2	Spillage	Whole plant
3	Fire & Explosion	Whole plant

Details of Neighbouring/Outside Organization-Mutual Aid Tie-up

Our unit and Mayur Chemicals, Bodal Chemical, GIDC Vatva. Dist. Ahmedabad are mutually agreed to provide support during emergency. The units are very near to our site.

The name of the contact person, contact numbers & facility is as mentioned bellow;

Sr. No.	Name of Company	Contact Person	Contact Number	Facility to be provide
1	**Mayur Chemicals** GIDC Vatva, Ahmedabad	Bharatbhai	9925019812	• Vehicles • Fire Extinguishers • Stretcher • Trained Manpower • First aid kit • Personal Protective Equipment • S.C.B.A Set
2	**Bodal Chemical** GIDC Vatva, Ahmedabad	Chiragbhai	9726162699	

Details of Local Authorities -Mitigating Emergency

No.	Name of Company	Contact Number
01	District Collector -Ahmedabad	079 27561970 to 77
02	Commissioner of Rescue & Relief - Ahmedabad	1070
03	Mamlatdar - Vatva, Ahmedabad	079 25711122
04	DISH (Office) - Ahmedabad	079 25502346 /47/64/49
05	Police station - Vatva	079 25830004 / 24
06	Fire Fighter Odhav	079 22875434
07	Vatva Industries Association Hospital	079 40049522 500/501/502/503/504
08	ESIC Hospital - Vatva	079 25833409
09	GPCB R.O. Head	079 27556634 /31/32
10	Torrent Power Vatva GIDC	079 22551912

7.4.4 Types of Accident & System Elements

Type Of Accident	System Elements	Hazard	Safety Relevant Component
Fire, Explosion	• Compressor (Press.5 kg/cm^2) • Boiler (Press. - 4.5 kg/cm^2, Temperature -220°C) • Electrical Transformer- 1000 KVA • D.G -250 KVA	Bursting of Compressor, Boiler & Fire in Transformer Resulting building collapse and fatality	• Handling by trained person. • Earth pits are checked periodically for their sensitivity. • Well ventilated all areas. • Fire fighting facility with fire extinguishers and Sand buckets. • Stability of building inspected by competent person as per norms. • Lightening arrestor provided in the Unit. • Earthling provided to all machines and structure. • Compressor inspected by competent person. • Boiler testing by competent agency. • B.D Value checked for transformer oil.

Type Of Accident	System Elements	Hazard	Safety Relevant Component
			• Double earthling provided to D.G and Transformers. • Flameproof electrical fittings at E.O. handling area. • Pressure gauge, Safety valve and PRV installed as per requirement.

7.4.5 Emergency Control Centre:

The emergency control centre is the place from where the emergency handle is directed and coordinated. The Site main Controller, Officer and the persons helping them will perform their role from this centre.

The Emergency Control Centre is located in Security office. The emergency control centre is equipped with adequate resources to receive and transmit the information and directions from and to the incident controller and outside. The facilities available in the control centre are detailed as under:

- One intercom and one telephone with STD facility to be provided exclusively for transmitting the message.
- A copy of "On Site Emergency Plan" showing following details:
  - Plans showing Factory entrance and road systems.
  - Plan showing Hazardous material storage.
  - List of key personnel, addresses and telephone numbers.
- First Aid Box- 01.
- Material Safety Data Sheets for all chemicals stored on site.
- Note pad, pens, pencils and other stationery.
- Role of employees.
- Items of personal protective equipment includes gumboots, dust mask, cartridge mask, SCBA set, safety belts etc.
- List showing Important Telephone numbers
- List showing name and contact number of first aider and fire fighter.

7.4.6 Measures taken to Avoid Stress and Strain

Name of the Items	Hazard	Preventive steps taken
Failure of pressure gauge, stop valve, PRV, safety valve	Bursting of vessel	Periodical calibration
Failure of machine structure.	Collapse & leakage of materials	Regular painting for corrosion protection. Regular checking by operator & supervisor
Failure of bearings	Generation of Heat	Care taken by engineering Maintenance
Failure of gasket joints, pipes.	Leakage of solvents & material	Checking during preventive maintenance
Building structure failure	Leakage of solvents & fire/explosion	Stability of building checked by competent person periodically
Bursting of compressors	Blast resulting Building damage	Safety valve, pressure gauge, power cut off system provided. Whole vessel checked by competent person every six monthly.

7.4.7 Details regarding communication facilities available

A. Emergency communication system.

Siren system:

Siren (Range 2.0 K.M.) provided in plant premises and siren switch provided at Security cabin.

Table 7-23: Siren Codes

Emergency Siren Code		
Fire/Explosion	10 Second ON 10 Second OFF	Three Times
Toxic Release	10 Second ON 10 Second OFF	Four Times
All Clear	Continuous	One Minutes

Other Communication Systems:

- Fax
- Mobile phone

Assembly Point:

Assembly point is defined near Security Gate -1 and Security Gate -2 marked with proper signboard for identification.

7.4.8 Details of fire - fighting and other facilities

a. Portable Installations:

Different types & sizes of fire extinguishers are installed at various locations inside the plant. In addition to the portable extinguishers, hand appliances like fire sand bucket are also installed.

Table 7-24: Quantities of fire extinguishers & hand appliances

Sr. No.	Fire Extinguishers	Capacity	Qty.
1	ABC Type	1 kg	2
2	ABC Type	5kg	4
4	ABC Type	10kg	8
5	DCP Type	5kg	9
	DCP Type	10kg	2
6	CO2 Type	4.5 kg	3
7	CO2 Type	3kg	4
8	CO2 Type	9kg	5
9	Foam Type	50 Liter	3
10	Sand Bucket	1 x 4	

Table 7-25: Safety Shower details

Sr. No.	Location	Qty.
1	Safety Shower at Plant	02

Table 7-26: Details of First Aid Boxes

Sr. No.	Location	Qty.
1	First Aid Box	03

Fixed installation:

Fire water storage -Fire water reservoir of 100 KL Capacity exclusively for use as fire water.

List of personnel protective equipment (respiratory &non-respiratory)

Table 7-27: Details of PPEs

Sr. No.	PPEs	Quentity in Nos.
1	Helmet	80
2	Safety Goggles	50
3	Dust Mask	500

4	Ear Plug	50
5	Safety Shoes	60
6	Hand Gloves	300
7	Safety Belt	03
8	Safety Net	01
	Robe Ladder	01

Details of first aid and hospital services available and its adequacy

The unit is small. First Aid box available at security gate. Details are as follows.

Table 7-28: Details of First Aider and Hospital Services

Sr. No.	Type of Facility	Units
1.	**Manpower:**	
	First Aider	About 14
2.	**Medicines :**	
	Life Saving drugs set: with medicines as per Gujarat Factory Rules	01 Boxes
3.	Emergency Vehicle	01
4.	Vatva Industries Association Hospital	10 Beds
5.	ESIC Hospital - Vatva, Bapunagar	More than 50 Beds.

7.4.9 Details of Antidotes

Details of antodotes are given in ***Table 7-29***.

Table 7-29: Details of Antidotes

Sr. No.	Name of Antidote	Description	Quantity	Details
1	Methylene Blue	Used to treat Cyanosis and methemoglobinemia	10 Nos. ampoules	Injection USP 10ml x 10 ampoules

7.5 Safety measures to be taken for general Public living in the vicinity

These industries and the people living nearby form the "general public", who are unaware of the identification of hazards and associated risks within our premises. However, they shall be protected in any incident which could spread outside our premises. In this context only, an OFF SITE EMERGENCY RESPONSE PLAN is drawn. This OFF SITE EMERGENCY RESPONSE PLAN is framed with all statutory authorities, who swing into action, when a disaster happens.

7.5.1 Off-Site Emergency Plan

Need of the Site Emergency Plan

Depending upon the wind direction and velocity, the effects of accident in factory may spread to outside its premises. To avoid major disaster it is essential to seek guidance/assistance of statutory authorities, police and health department. The movement of traffic may have to be restricted.

Required information will be given to the authority and consultation will be sought for remedial measures.

Purposes of the off-site emergency plan

To provide the local/district authorities, police, fire, brigade, doctors, surrounding industries and public the basic information of risk and environmental impact assessment and appraise them of the consequences and the protection/prevention measures and to seek their help to communicate with public in case of major emergency.

- To assist district authorities for preparing the off-site emergency plan for district or particular area and to organize rehearsals from time to time and initiate corrective actions on experience.
- Structure of the Off-Site Emergency Plan
- Available with concerned authorities.

Role of the Factory Management

- The site main controller will provide a copy of action plan to the statutory authorities in order to facilitate preparedness of district/area off-site emergency plan.
- Role of Emergency Co-ordination Office (ECO)
- He will be a senior police or fire officer co-ordination with site main controller. He will utilize emergency control center.

Role of Local Authority

Preparation of Off Site Plan lies with local authorities. An emergency-planning officer (EPO) works to obtain relevant information for preparing basis for the plan and ensures that all those organization involved in offsite emergency and to know their role and responsibilities.

Role of Fire Authorities

The fire authorities will take over the site responsibility from incident controller after arrival. They will be familiarized with site of flammable materials, water and foam applies points, firefighting equipment.

Role of the Police and Evacuation Authorities

- Senior Police Officer designed, as emergency co-ordination officer shall take over all control of an emergency. The duties include protection of life, property and control of traffic movement.
- Their functions include controlling standards, evacuating public and identifying dead and dealing with casualties and informing relatives of dead or injured.
- There may be separate authorities/agencies to carry out evacuation and transportation work.
- Evacuation depends upon the nature of accident, in case of fire only neighbouring localities shall be alerted. Whole areas have to be evacuated in case of toxic release.

Role of Health Authorities

After assessing the extent of effect caused to a person the health authorities will treat them.

Role of Mutual Aid Agencies

Our unit and Mayur Chemicals, Bodal Chemical GIDC Vatva, Ahmedabad are mutually agreed to provide support during emergency. The units are very near to our site.

Role of Factory Inspectorate

- In the event of an accident, the Factory Inspector will assist the District Emergency Authority for information and helping in getting Neighbouring Industries/mutual aid from surrounding factories.
- In the aftermath, Factory Inspector may wish to ensure that the affected areas are rehabilitated safely

7.6 Leak Detection and Repair Programme (LDAR)

Leak detection and repair programme (LDAR) is a work practice designed to quantify and control fugitive emissions from potential sources like pumps, open ended lines, sampling connections, valves, flanges etc. Leaking equipment is a major source of volatile organic compounds (VOC) and volatile hazardous air pollutants.

A component that is subjected to LDAR requirements shall be monitored at specified, regular intervals to determine any leakage. Any leaking component then shall be repaired or replaced within a specified time frame.

Procedure to be followed;

Identifying the components: All possible components that can leak shall be properly identified and tagged.

Leak definition: - Thresh hold leak definition shall be lower than what is prescribed in the regulations. Weekly visual inspections of pumps, valves shall be done for indications of liquids leaking.

Monitoring the components: As per the frequency the component shall be monitored for leak possibility using a portable detecting instrument.

Repairing the components: After a leak is detected, the component shall be modified or replaced to correct the leakage. The component shall be considered repaired only after it has been monitored and shows leakage below the thresh-hold limits.

Record keeping: All record of the above steps shall be maintained for future use.

M/s JCIL-3 has used effective techniques for the control of fugitive emissions like use of;

- Special packing in pumps and valves
- Closed loop sampling systems
- Closed lines for process fluid transfer

Air quality shall be regularly monitored and recorded and appropriate action shall be taken if the air quality is found to be deteriorating.

Table 7-30: LDAR protocol for VOC measurement

Sr.No.	Component	Frequency of monitoring	Repair schedule
1.	Valves/ Flanges	Quarterly	Repair will be started immediately after detection of leak.
2.	Pump seals	Quarterly	
3.	Compressor seals	Quarterly	
4.	Pressure relief devices	Quarterly	
5.	Pressure relief devices (after venting)	Within 24 hours	
6.	Heat Exchangers	Quarterly	
7.	Process drains	Annually	
8.	Components that are difficult to monitor	Annually	
9.	Pump seals with visible liquid dripping	Weekly	
10.	Any component with visible leaks	Weekly	
11.	Any component after repair/ replacement	Within a week	

7.7 Checklist of Do's and Don'ts of preventive maintenance, strengthening of HSE, manufacturing utility staff for safety related measures

Table 7-31: Do's & Don'ts of Preventive Maintenance

Do's	Don'ts
Do ensure all equipment is installed correctly and operating as intended.	Don't underestimate the inconvenience caused by equipment breakdown.
Do follow the manufacturer's instructions for the installation, operation, storage, cleaning and maintenance of equipment.	Don't be tempted to operate your equipment beyond its rated capacity. Don't push it to its limits or use it for purposes other than what it was designed for.
Do proper arrangement of the power fluctuation and surge protection of the equipment's.	Don't overload power points and electrical circuitry. E.g. 'piggybacking' of double adapters, power boards and extension leads.
Do schedule regular electrical testing of all equipment.	Don't wait for failure to occur - implement a preventative maintenance program now.

Do's	Don'ts
Schedule the thermal, hydro test, thickness testing of the equipment's.	Do not allow the person to work without getting the authorized work permit.
Develop the check list for the preventive maintenance of the equipment's.	Do not allow hot work like welding, cutting, drilling in the Flammable or chemical storage zone.
Do keep all equipment well ventilated to prevent it from overheating. Keep moisture away too.	Do not allow the person to do the maintenance work without availability of safety measures/PPE's.
Do keep 'pest control' programs up to date. Remember rats and mice are good climbers and can easily chew through wires, cabling and the like.	Do not allow the person to do the work in low oxygen zone. Area has to be check by oxygen analyzer before maintenance.
Do train staff in the safe use and maintenance of equipment, including the early warning signs of failure.	Do not allow to pump to work dry and without discharge.
Do encourage employees to report any problems with equipment immediately.	Do not allow the utilities to work beyond its rated capacity.
Do promote a safety culture to limit the chance of workplace accidents and injuries	Do not allow any maintenance work without ensuring that the main of the supply to the equipment is removed.
Establish 'Maintenance Schedule' for ensuring all major equipment is regularly checked and kept in good working order.	
Review and replace consumable items, such as belts and filters, according to the manufacturer's instructions.	
Keep an accurate log book of all maintenance activities.	
Replacement parts that can quickly become obsolete or difficult to source.	
The storage tanks/reactors are completely flushed by inert gas and tested by Oxygen analyzes before go for Preventive maintenance.	
The overall noise level in and around the plant area shall be kept well within the prescribed standards by providing noise control measures including acoustic insulation, hoods, silencers, enclosures vibration dampers etc. on all sources of noise generation.	
Use appropriate MOC of the Equipment's for the handling of Corrosive & toxic chemicals.	
Do regular cleaning & painting of the structural materials.	
Do schedule oiling & greasing of the gears, or rotating equipment's.	
Do ensure that the plug out of any electrical connection before doing maintenance of the Equipment's.	

Table 7-32: Do's & Don'ts list for HSE & Safety measures

Do's	Don'ts
Proper lifting tools & tackles or equipment's with adequate capacity.	Don't use the tools & tackles or equipment's above its designed lifting load capacity.
Authorized person & supervision should be for material handling	Do not allow person to move in the Drum loading & forklift movement area.
Knowledge of material handling & hazard related to the same.	Do not store the chemicals that are incompatible with other chemicals.
Do the separate arrangement for Hazardous & non-hazardous chemicals along with proper identifications.	Do not allow empty containers of hazardous chemicals to be used by others.
Use appropriate personal protective equipment like gloves, aprons, respirator, face shield etc. while handing the Hazardous chemicals	Do not dispose chemical without chemical treatment or neutralization.
Use safety showers, eye washer in case of splash of chemical into the eyes.	Do not use chemicals or solvent for cleaning hands & doing siphoning by mouth.
Provide proper ventilation at the chemical handling area to limit their concentration within prescribed level.	Do not spill the chemical & movement of loose lid filled drums.
Segregate toxic, flammable chemicals and keep them under control.	Do not leave flammable & hazardous material at the work area.

Do's	Don'ts
While lifting a load physically, keep the load as near as possible to the body with feet properly placed for body balance.	Do not hold the load with top & also do not exceed the lifting load more than 55 kg for men & 30 kg for women.
The waste Hazardous container, waste used cloths, carboys, bags should be disposed properly.	Do not store flammable & Hazardous chemical in open area.
Keep minimum inventory of flammable material.	Do not use instrument that are not intrinsically safe in the explosive area.
Keep the fire water tank always full & schedule cleaning of filters or strainer attached to the pumps.	Do not allow to take the water from Fire water tank for plant uses.
Schedule testing of fire hydrant hose, hose reel, hose clams.	Do not keep damaged hose pipe into the Hose boxes.
Do proper earthling of all the storage tanks, Reactors & electrical equipment's & panels to prevent the accumulation of Static charges.	Do not allow unloading & loading of flammable chemicals with proper earthling arrangement.
Check periodically operationally of the firefighting system & repair the abnormalities immediately.	Do not misuse fire-fighting equipment other than intended purpose.
Proper ventilation shall be provided in the work area.	Do not obstruct accessibility to the fire related equipment.
Do maintain the First aid boxes with necessary antidotes & bandages.	Do not keep the medicines which are of expiry dates.
Do follow the sign of No smoking, No Mobile & any another electronic item	Do not smoke in the No smoking zone.
Do your working area proper cleaning & dust free	Do not let the dust to make the layers on the instruments.
Provide proper free space for the movement of personnel & material.	Do not allow the dustbins to overflow.
Keep separate bins for paper, plastics, metals, glass & boi medical waste.	Do not disturb the safety equipment's form their mentioned place.
Do regular refilling of fire extinguishers.	Do not block emergency exit area, emergency switch & on/off switches of the equipment's.
Ensure exits are indicated / painted for use during emergency.	Do not generate extra waste.
Arrest all types of spills such as chemical, water, oil, air / gas, steam etc. and clean up the area immediately.	Do not leave a spillage unattended.
Know the location where emergency equipment such as first aid box, firefighting equipment, SCBA, Stretchers are kept.	Do not destroy the inspection tag provided with the fire equipment.
Regular health checkup of all the employee. And maintain the record for the same.	
Proper direction mentioned & location of Assembly point for the plant personal.	