M/S MEGHMANI FINECHEM LTD.

Risk Assessment Report for Expansion of Chlor-Alkali Plant and Manufacturing of New Agro-Intermediates and Synthetic Organic Products at Plot No.: CH-1/CH-2, GIDC Industrial Estate, Dahej II, Taluka: Vagra, District: Bharuch, State: Gujarat.

JULY, 2017




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Environment for Development

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QUALITY CONTROL							
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1.1 RISK ASSESSMENT

The risk assessment process is intended to identify existing and probable hazards in all operations and work environment, to quantify the hazards and to access the risk levels of those hazards in order to prioritize those that need an immediate attention.

1.1.1 Scope & Methodology

Scope of the risk assessment covers the storage of all chemicals involved in proposed facilities. Methodology of Risk Assessment and Hazard Identification is detailed in ***Annexure 1.***

1.1.2 Hazard Identification

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

Hazardous chemical properties of raw materials and finished goods are shown in ***Table 1-1***.

Table 1-1: Chemicals Properties of raw Materials and Finished Goods

S. No.	Name of Raw Material	State	Boiling Point (°C)	Flash Point (°C)	Hazard Involved	LEL-UEL (%)	TLV ppm	LD50mg/kg LC50mg/m^3	Specific Gravity (water-1)	Vapor Density (air-1)	Odour Threshold (ppm)	IDLH (ppm)
Raw Materials												
1	Glycerin (95%)	Liquid	290	160	Combustible at high temp.	Lower - 0.9	NA	ORAL (LD50): Acute: 12600 mg/kg [Rat]. MIST(LC50): Acute: >570 mg/m 1 hours [Rat].	1.2636	3.17	NA	NA
2	Benzene	Liquid	80.1	-11.1	Toxic	1.2 - 7.8	2.5	ORAL (LD50): Acute: 930 mg/kg [Rat]. VAPOR (LC50): Acute: 10000 ppm 7 hours [Rat].	0.8787	2.8	4.68	500
3	Chlorine gas	Gas	100	NA	Toxic	NA	0.5	NA	1	0.62	NA	10
4	Hydrogen gas	Gas	-253	NA	Extremely Flammable	4.0 - 76.0	NA	Simple asphyxiant	NA	0.07	NA	NA
5	Hydrogen Chloride (HCl)	Liquid	50.5	NA	Non flammable	NA	5	LC50: Acute: 4701 ppm 0.5 hours [Rat].	1.19	1.267	0.25 - 10.0	50
6	Calcium Hydroxide	Solid	NA	NA	Non flammable	NA	NA	ORAL (LD50): Acute: 7340 mg/kg [Rat.].	2.24	NA	NA	NA
7	Toluene	Liquid	111	6	Flammable	1.1 - 7.1	190 mg/ m^3	ORAL (LD50): Acute: 636 mg/kg [Rat]. DERMAL (LD50): Acute: 14100 mg/kg [Rabbit].	0.8636	3.1	1.6	500
8	Liquid Caustic Soda (50%)	Liquid	1388	NA	Corrosive	NA	2	NA	2.13	NA	NA	6.11
9	Methyl Isobutyl Ketone	Liquid	117.5	14	Flammable and Toxic	1.4 - 7.5	NA	ORAL (LD50): Acute: 2671 mg/kg[Mouse]. 2080 mg/kg [Rat]. VAPOR (LC50): Acute: 8000 ppm 4 hour(s) [Rat].	0.802	3.45	0.1	500
10	Dimethyl	Liquid	138.5	30	Flammable	1.0 -	100	Acute: 4300 mg/kg [Rat].	0.864	3.7	1	900

S. No.	Name of Raw Material	State	Boiling Point (°C)	Flash Point (°C)	Hazard Involved	LEL-UEL (%)	TLV ppm	LD50mg/kg LC50mg/m^3	Specific Gravity (water-1)	Vapor Density (air-1)	Odour Threshold (ppm)	IDLH (ppm)
	Benzene					7.0		2119 mg/kg [Mouse]. DERMAL (LD50): Acute: >1700 mg/kg [Rabbit].				
11	Acetic Anhydride	Liquid	139	54	Flammable	2.7 - 10.3	5	ORAL (LD50): Acute: 0.5 to 5 g/kg (rat)	1.08	3.5	NA	200
12	Acetic Acid	Liquid	118.1	40	Toxic &Flammable	4.0 - 19.9	10	ORAL (LD50): Acute: 3310 mg/kg [Rat]. VAPOR (LC50): Acute: 5620 ppm 1 hours [Mouse].	1.049	2.07	0.48	50
13	Ferric Chloride	Liquid	316	NA	Non flammable	NA	NA	ORAL (LD50): Acute: 900 mg/kg [Rat]. 1278 mg/kg [Mouse].	2.9	5.61	NA	NA
14	Pyridine	Liquid	115	20	Flammable	1.8 - 12.40	5	ORAL (LD50): Acute: 891 mg/kg [Rat]. VAPOR (LC50): Acute: 28500 mg/m 1 hours [Rat].	0.9827	0.982	NA	1000
15	Di Chloro Acetic Acid /Mother Liquor (ML)	Liquid	194	110	Corrosive	NA	NA	ORAL (LD50): Acute: 2820 mg/kg [Rat]. DERMAL (LD50): Acute: 510 mg/kg [Rabbit].	1.5634	4.45	0.2	NA
16	Salt	Solid	1413	NA	Corrosive	NA	NA	ORAL (LD50): Acute: 3000 mg/kg [Rat.]. DUST (LC50): Acute: >42000 mg/m 1 hours [Rat].	2.165	NA	NA	NA
17	Sulphuric Acid	Liquid	270	NA	Toxic	NA	1	ORAL (LD50): Acute: 2140 mg/kg [Rat.]. VAPOR (LC50): Acute: 510 mg/m 2 hours [Rat].	1.84	3.4	NA	3.75

S. No.	Name of Raw Material	State	Boiling Point (°C)	Flash Point (°C)	Hazard Involved	LEL-UEL (%)	TLV ppm	LD50mg/kg LC50mg/m^3	Specific Gravity (water-1)	Vapor Density (air-1)	Odour Threshold (ppm)	IDLH (ppm)
18	Methanol	Liquid	64.5	12	Toxic	6 - 36.5	250	ORAL (LD50): Acute: 5628 mg/kg [Rat]. VAPOR (LC50): Acute: 64000 ppm	0.7915	1.11	100	200
19	Chlorine	Gas	100	NA	Toxic	NA	0.5	NA	1	0.62	NA	10
Products												
1	Dichloro Benzene (Ortho/Meta/ Para)	Liquid	180	67	Toxic	2.2 - 9.2	10	ORAL (LD50): Acute: 500 mg/kg [Rat]. 500 mg/kg [Rabbit].	1.3059	5.07	2	150
3	3,4-Xylidine OR	Solid	216	97	Combustible at high temp.	1.3 - 6.10	NA	ORAL (LD50): Acute: 840 mg/kg [Rat]. 707 mg/kg [Mouse].	0.984	NA	NA	NA
5	Chloro Benzene and /OR	Liquid	132	29	Flammable	1.3 - 9.6	10	LD50 = 0.5 to 5 g/kg (rat, rabbit)	1.11	3.9	NA	1000
6	Mono Chloro Acetic Acid and/OR	Liquid	189.3	126	Combustible at high temp.	lower 8.0	NA	ORAL (LD50): Acute: 55 mg/kg [Rat]. VAPOR (LC50): Acute: 254.6 ppm 4 hour(s) [Rat].	1.4043	NA	NA	NA
7	Tri Chloro Acetyl Chloride	Liquid	118	100	Non flammable	NA	NA	NA	1.62	6.3	NA	NA
8	Epichlorohydrin	Liquid	117	32	Toxic and Flammable	3.8 - 21.0	2	NA	1.183	NA	NA	75
14	Caustic Soda (100%)	Liquid	1388	NA	Corrosive	NA	2	NA	2.13	NA	NA	6.11
15	Chlorine Gas	Gas	100	NA	Toxic	NA	0.5	NA	1	0.62	NA	10

S. No.	Name of Raw Material	State	Boiling Point (°C)	Flash Point (°C)	Hazard Involved	LEL-UEL (%)	TLV ppm	LD50mg/kg LC50mg/m^3	Specific Gravity (water-1)	Vapor Density (air-1)	Odour Threshold (ppm)	IDLH (ppm)
16	Hydrogen Gas	Gas	-253	NA	Extremely Flammable	4.0 - 76.0	NA	Simple asphyxiant	NA	0.07	NA	NA
17	Sulphuric Acid	Liquid	270	NA	Toxic	NA	1	ORAL (LD50): Acute: 2140 mg/kg [Rat.]. VAPOR (LC50): Acute: 510 mg/m 2 hours [Rat].	1.84	3.4	NA	3.75
18	Sodium Hypochlorite	Liquid	40	NA	Non Flammable	NA	NA	ORAL (LD50): Acute: 5800 mg/kg [Mouse]. 8910 mg/kg [Rat].	1.07 - 1.093	0.62	NA	NA
19	Hydrochloric Acid	Liquid	108.58	NA	Toxic	NA	5	GAS (LC50): Acute: 4701 ppm 0.5 hours [Rat].	1.1 - 1.19	1.267	0.25 10.0	50
21	Chloromethane											
i	C2(Methylene Chloride)	Liquid	39.75	NA	Combustible at high temp.	12.0 - 19.0	50	ORAL (LD50): Acute: 1600 mg/kg [Rat].	1.3266	2.93	214	2300
ii	C3 (Chloroform)	Liquid	61	NA	Toxic	NA	10	ORAL (LD50): Acute: 695 mg/kg [Rat]. VAPOR (LC50): Acute: 47702 mg/m 4 hours [Rat].	1.484	4.36	85	500
iii	C4 (Carbon Tetrachloride	Liquid	76.54	NA	Toxic	NA	5	ORAL (LD50): Acute: 2350 mg/kg [Rat]. VAPOR (LC50): Acute: 8000 ppm 4 hour(s) [Rat].	1.594	5.3	50	200

1.1.3 Selection of Maximum Credible Loss Scenarios (MCLs')

Following important points should 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 (MSDS) of the chemicals those are selected for simulation are presented in ***Table 1-2***.

Table 1-2: Chemicals Selected for Simulation

S. No.	Raw Material	State	Flash Point (°C)	IDLH (ppm)	Hazard	UEL%	LEL%
1	Benzene	Liquid	-11.11	500	Flammable	8	1.2
2	Iso Propyl Alcohol	Liquid	11.6	2000	Flammable	12	2
3	Methanol	Liquid	11.11	6000	Flammable	36	6
4	Pyridine	Liquid	20	1000	Flammable	12.4	1.8
5	Toluene	Liquid	6	500	Flammable	7.1	1.1
6	Chlorine	Gas	N/A	10	Poisonous, Corrosive	-	-
7	Hydrogen	Gas			Highly Flammable	4	76

On the basis of the information provided in the above table 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 1-3***.

Table 1-3: Storage Condition and Scenarios Selected for Simulation

S. No.	Storage Tanks of	Hazard Involved	Capacity	Operating Condition		Types of Failure Possible	Consequences Studied
				Temp (°C)	Pressure (bar)		
1	Benzene	Flammable	50 KL	Atm.	Atm.	10 mm Leak 25 mm Leak Catastrophic Rupture	Jet Fire, Late Pool Fire, Toxic Release
2	Iso Propyl Alcohol	Flammable	10 KL	Atm.	Atm.	10 mm Leak 25 mm Leak Catastrophic Rupture	Jet Fire, Late Pool Fire
3	Methanol	Flammable	300 KL	Atm.	Atm.	10 mm Leak 25 mm Leak Catastrophic Rupture	Jet Fire, Late Pool Fire
4	Pyridine	Flammable	10 KL	Atm.	Atm.	10 mm Leak 25 mm Leak Catastrophic Rupture	Jet Fire, Late Pool Fire
5	Toluene	Flammable	10 KL	Atm.	Atm.	10 mm Leak 25 mm Leak	Jet Fire, Late Pool Fire

S. No.	Storage Tanks of	Hazard Involved	Capacity	Operating Condition		Types of Failure Possible	Consequences Studied
				Temp (°C)	Pressure (bar)		
						Catastrophic Rupture	
6	Chlorine	Flammable	120 KL	-7	10 bar	1 mm Leak	Toxic release
						5 mm Leak	
7	Chlorine (Through Pipeline)	Poisonous, Corrosive	70	-7	10 bar	1 mm Leak	Toxic release
						5 mm Leak	
8	Hydrogen (Through Pipeline)	Highly Flammable	3.6	Atm.	Atm.	10 mm Leak	Jet Fire & Late Ignition
						20 mm Leak	Jet Fire & Late Ignition

1.1.4 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.

Benzene

Radiation Level & effect distance due to the release of Benzene are presented in ***Table 1-4***, the overpressure effect distance are presented in ***Table 1-5***, the flash fire effect distance are presented in ***Table 1-6*** & the toxic effect distance due to release of Benzene are presented in ***Table 1-7***.

Table 1-4: Radiation Level & Effect Distance due to Release of Benzene

Chemical (Storage Tank)	Failure Scenario	Consequence	Weather Condition	Effective Distance in meter to Radiation Level		
				4 kW/m²	12.5 kW/m²	37.5 kW/m²
Benzene	10 mm leak	Jet fire	3.0/B	5	4	NR
			3.0/E	5	4	NR
			4.0/D	5	4	NR
		Late pool fire	3.0/B	26	17	5
			3.0/E	26	17	5
			4.0/D	27	17	6
	25 mm leak	Jet fire	3.0/B	12	10	8
			3.0/E	12	10	8
			4.0/D	12	9	8
		Late pool fire	3.0/B	26	17	5
			3.0/E	26	17	5
			4.0/D	27	17	6
	Catastrophic Rupture	Late pool fire	3.0/B	26	17	5
			3.0/E	26	17	5
			4.0/D	27	17	6

Table 1-5: Overpressure Effect Distance due to Release of Benzene

Chemical (Storage Tank)	Failure Scenario	Consequence	Met Data	Overpressure Distances in Meters		
				0.02	0.21	1.00
Benzene	25 mm leak	Late Ignition	3.0/B	17	11	11
			3.0/E	19	12	11
			4.0/D	16	11	10
	Catastrophic rupture	Late Ignition	3.0/B	88	37	33
			3.0/E	91	34	31
			4.0/D	93	39	34

Table 1-6: Flash Fire Effect Distance due to Release of Benzene

Chemical (Storage Tank)	Failure Scenario	Consequence	Met Data	Effective Distance in meter	
				0.5 LFL	LFL
Benzene	10 mm leak	Flash Fire	3.0/B	6	3
			3.0/E	10	4
			4.0/D	6	3
	25 mm leak	Flash Fire	3.0/B	15	6
			3.0/E	17	8
			4.0/D	15	5
	Catastrophic Rupture	Flash Fire	3.0/B	35	24
			3.0/E	32	23
			4.0/D	38	26

Table 1-7: Toxic Effect Distance due to Release of Benzene

Chemical (Storage Tank)	Failure Scenario	Met Data	Effective Distance in meter to Toxic Level			
			EPRG 1 (50 ppm)	EPRG 2 (150 ppm)	EPRG 3 (1000 ppm)	IDLH (500 ppm)
Benzene	10 mm leak	3.0/B	51	31	14	21
		3.0/E	154	81	23	48
		4.0/D	86	48	14	29
	25 mm leak	3.0/B	80	53	31	40
		3.0/E	212	109	36	65
		4.0/D	129	74	32	49
	Catastrophic Rupture	3.0/B	63	42	15	30
		3.0/E	200	97	24	54
		4.0/D	106	56	17	36

The contours for effect distance generated for the release of Benzene are presented in ***Figure 1-1*** to ***Figure 1-8***.

Figure 1-1: Late Pool Fire Effect - Benzene (10 mm Leak – 4.0/D)

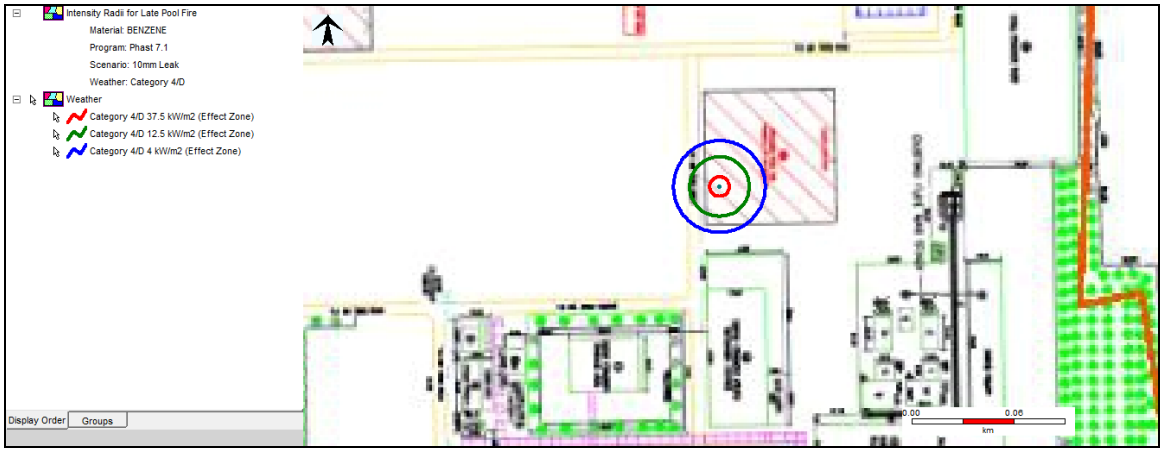


Figure 1-2: Toxic Risk Effect - Benzene (10 mm Leak – 3.0/E)

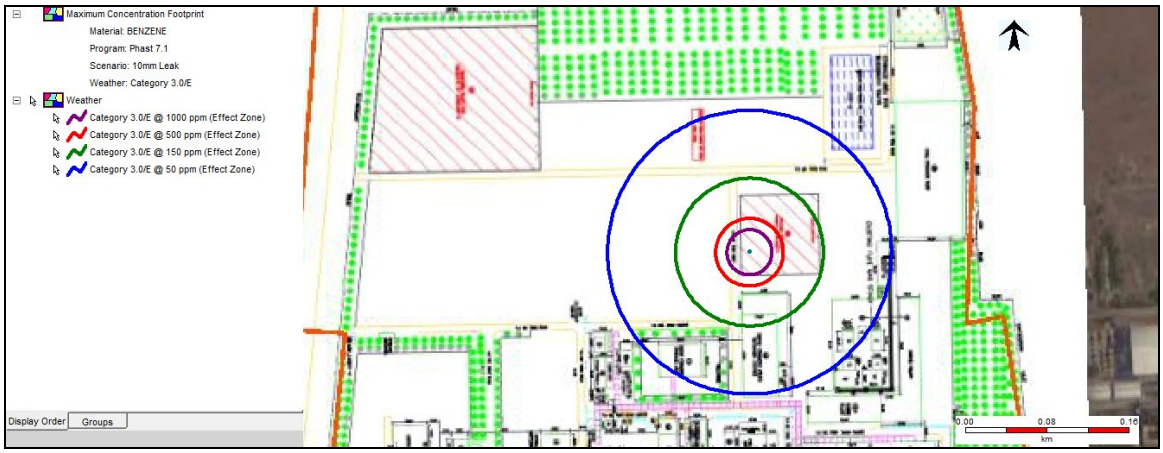


Figure 1-3: Late Pool Fire Effect - Benzene (25 mm Leak – 4.0/D)

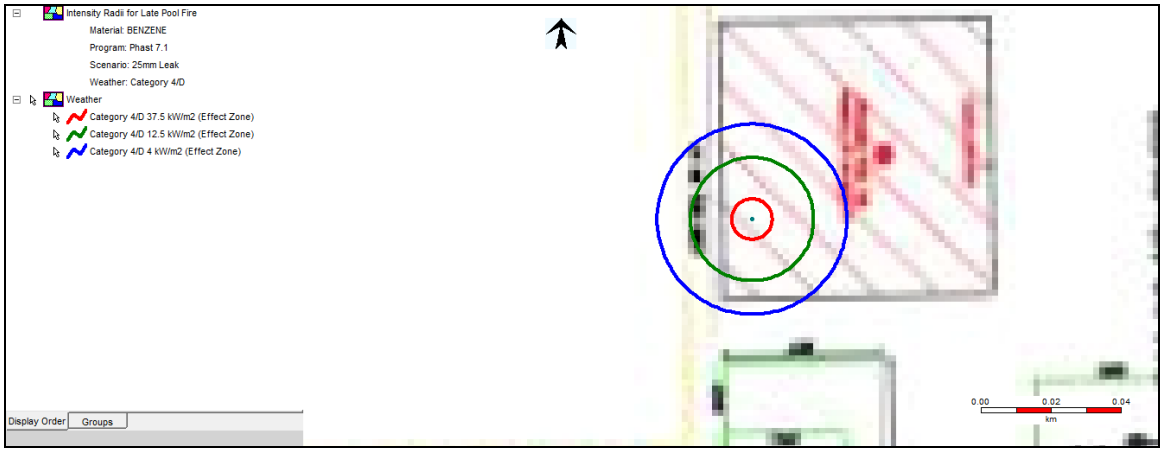


Figure 1-4: Toxic Risk Effect - Benzene (25 mm Leak – 3.0/E)

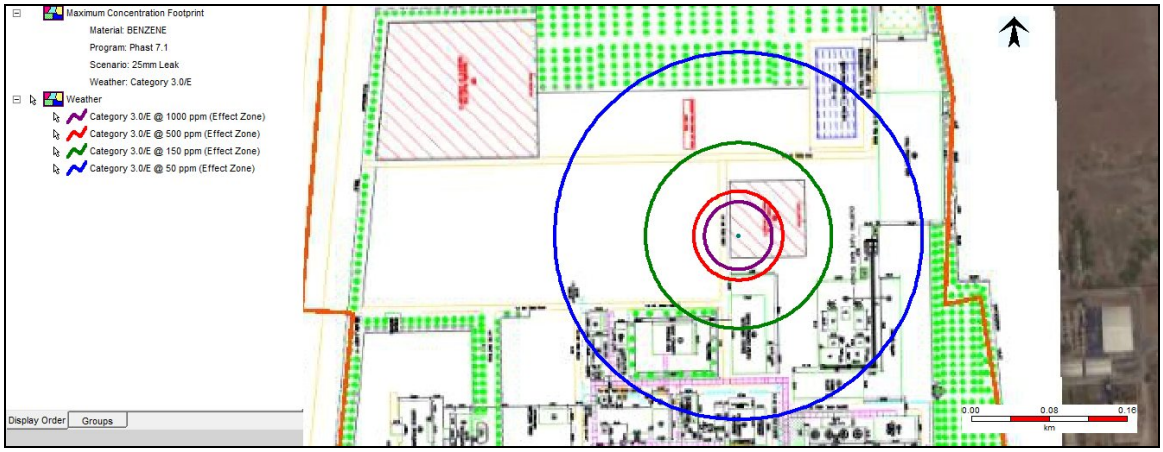


Figure 1-5: Late Pool Fire Effect - Benzene (Catastrophic Rupture – 4.0/D)

Figure 1-6: Toxic Risk Effect - Benzene (Catastrophic Rupture – 3.0/E)

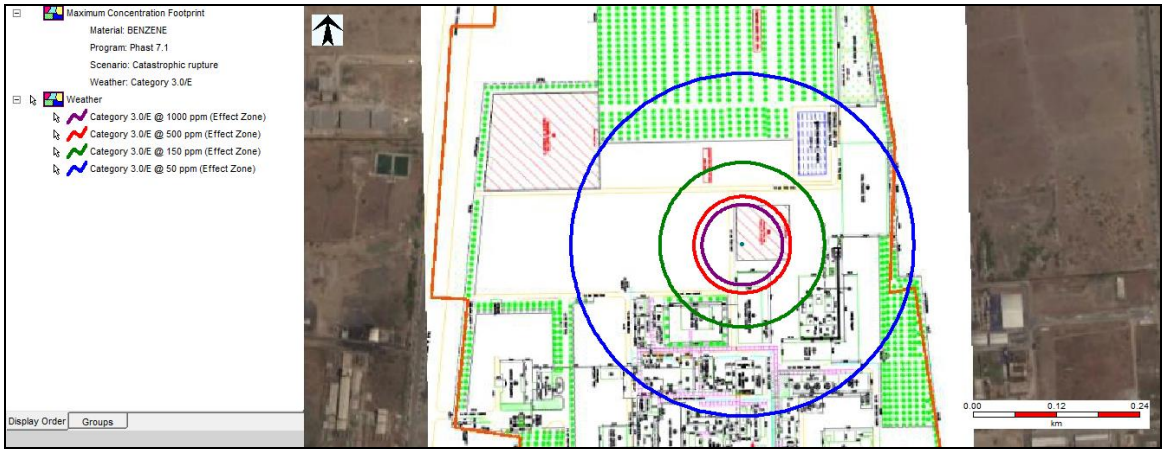
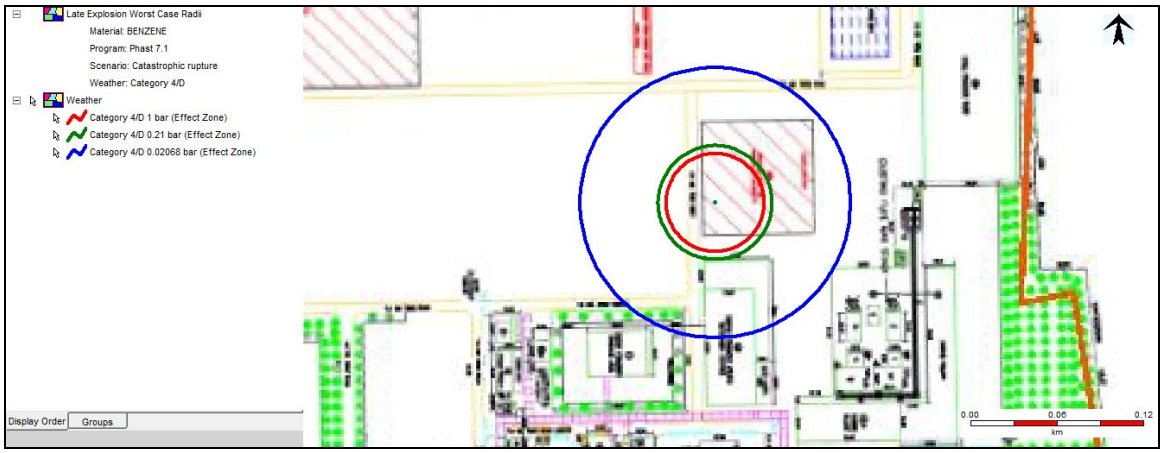


Figure 1-7: Flash Fire Risk Effect - Benzene (Catastrophic Rupture – 4.0/D)

Figure 1-8: Late Explosion Effect - Benzene (Catastrophic Rupture – 4.0/D)



Iso Propyl Alcohol

Radiation Level & effect distance due to the release of Iso Propyl Alcohol are presented in ***Table 1-8*** & the Flash Fire effect distance are presented in ***Table 1-9***.

Table 1-8: Radiation Level & Effect Distance due to Release of Iso Propyl Alcohol

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
Iso Propyl Alcohol	10 mm leak	Jet fire	3.0/B	2	NR	NR
			3.0/E	2	NR	NR
			4.0/D	2	NR	NR
		Late pool fire	3.0/B	13	8	3
			3.0/E	13	8	3
			4.0/D	13	9	3
	25 mm leak	Jet fire	3.0/B	6	5	NR
			3.0/E	6	5	NR
			4.0/D	6	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
		Late pool fire	3.0/B	13	8	3
			3.0/E	13	8	3
			4.0/D	13	9	3
	Catastrophic Rupture	Late pool fire	3.0/B	13	8	3
			3.0/E	13	8	3
			4.0/D	13	9	3

Table 1-9: Flash Fire Effect Distance due to Release of Iso Propyl Alcohol

Chemical (Storage Tank)	Failure Scenario	Consequence	Met Data	Effective Distance in meter	
				0.5 LFL	LFL
Iso Propyl Alcohol	10 mm leak	Flash Fire	3.0/B	2	2
			3.0/E	2	2
			4.0/D	2	2
	25 mm leak	Flash Fire	3.0/B	2	2
			3.0/E	2	2
			4.0/D	2	2
	Catastrophic Rupture	Flash Fire	3.0/B	10	6
			3.0/E	17	9
			4.0/D	19	10

The Contours for effect distance generated for the release of Iso Propyl Alcohol are presented in ***Figure 1-9 - Figure 1-12***.

Figure 1-9: Late Pool Fire Risk Effect - Iso Propyl Alcohol (10 mm Leak – 4.0/D)

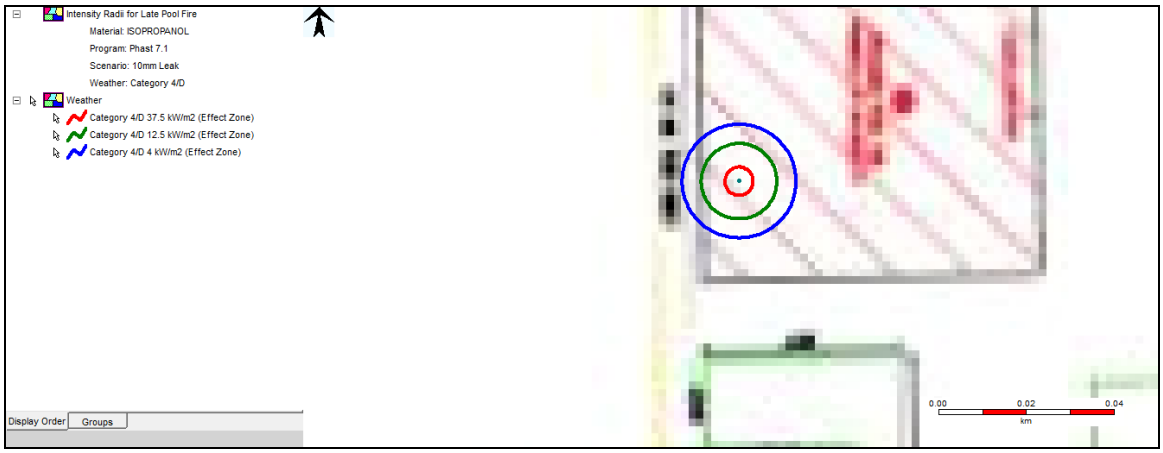


Figure 1-10: Late Pool Fire Effect - Iso Propyl Alcohol (25 mm – 4.0/D)

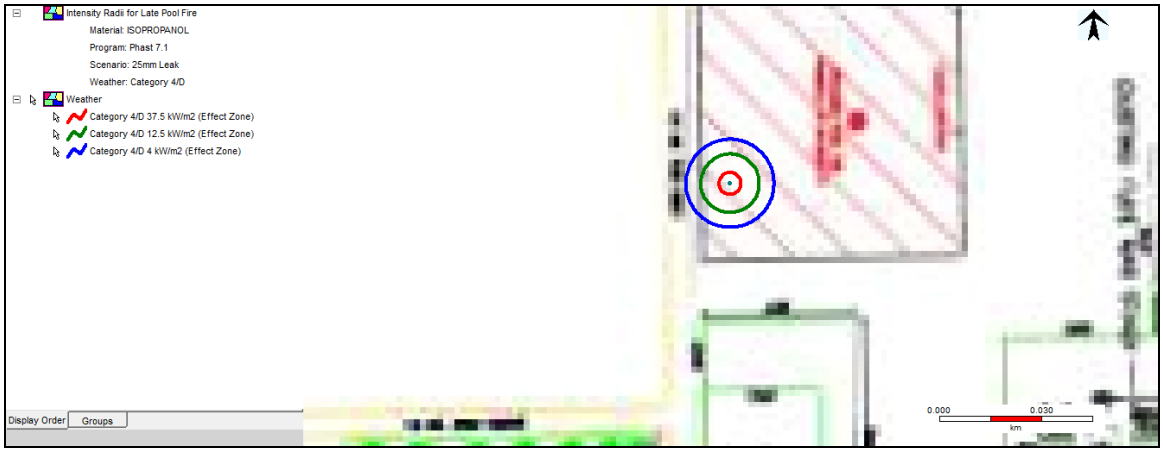


Figure 1-11: Late Pool Fire Effect -Iso Propyl Alcohol (Catastrophic Rupture – 4.0/D)

Figure 1-12: Flash Fire Risk Effect - Iso Propyl Alcohol (Catastrophic Rupture – 4.0/D)

Methanol

Radiation Level & effect distance due to the release of Methanol are presented in ***Table 1-10,*** & the Flash Fire effect distance are presented in ***Table 1-11*** & Late Explosion effect are presented in ***Table 1-12***.

Table 1-10: Radiation Level & Effect Distance due to Release of Methanol

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	10 mm leak	Jet fire	3.0/B	8	NR	NR
			3.0/E	8	NR	NR
			4.0/D	8	NR	NR
		Late pool fire	3.0/B	27	18	NR
			3.0/E	27	18	NR
			4.0/D	27	19	NR
	25 mm leak	Jet fire	3.0/B	18	NR	NR
			3.0/E	18	NR	NR
			4.0/D	17	14	NR
		Late pool fire	3.0/B	29	19	NR
			3.0/E	29	20	NR
			4.0/D	29	20	NR
	Catastrophic Rupture	Late pool fire	3.0/B	29	19	NR
			3.0/E	29	19	NR
			4.0/D	29	20	NR

Table 1-11: Flash Fire Effect Distance due to Release of Methanol

Chemical (Storage Tank)	Failure Scenario	Consequence	Met Data	Effective Distance in meter	
				0.5 LFL	LFL
Methanol	10 mm leak	Flash Fire	3.0/B	6	3
			3.0/E	10	4
			4.0/D	5	3
	25 mm leak	Flash Fire	3.0/B	8	4
			3.0/E	10	4
			4.0/D	8	4
	Catastrophic Rupture	Flash Fire	3.0/B	25	10
			3.0/E	37	10
			4.0/D	29	10

Table 1-12: Late Explosion Effect Distance due to Release of Methanol

Chemical (Storage Tank)	Failure Scenario	Consequence	Met Data	Overpressure Distances in Meters		
				0.02	0.21	1.00
Methanol	Catastrophic rupture	Late Ignition	3.0/B	83	25	16
			3.0/E	80	24	16
			4.0/D	81	24	16

The Contours for effect distance generated for the release of Methanol are presented in ***Figure 1-13 - Figure 1-17***.

Figure 1-13: Late Pool Fire Effect - Methanol (10 mm Leak – 4.0/D)

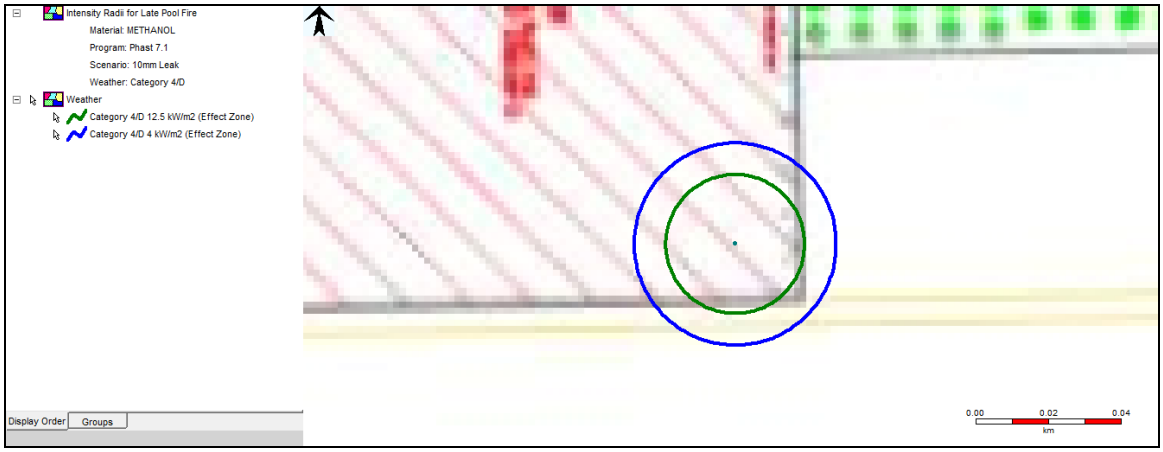


Figure 1-14: Late Pool Fire Effect - Methanol (25 mm Leak – 4.0/D)

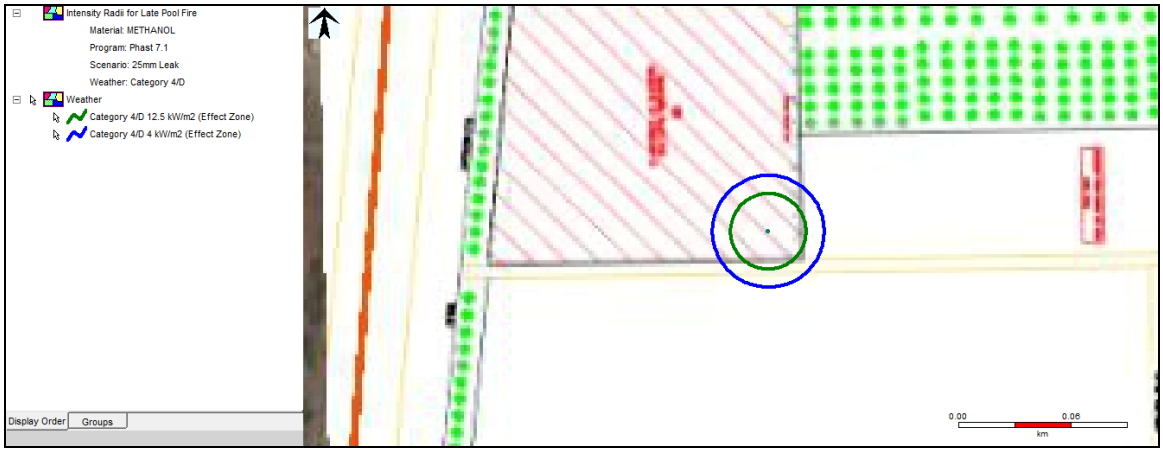


Figure 1-15: Late Pool Fire Effect - Methanol (Catastrophic Rupture – 4.0/D)

Figure 1-16: Flash Fire Effect - Methanol (Catastrophic Rupture – 3.0/E)

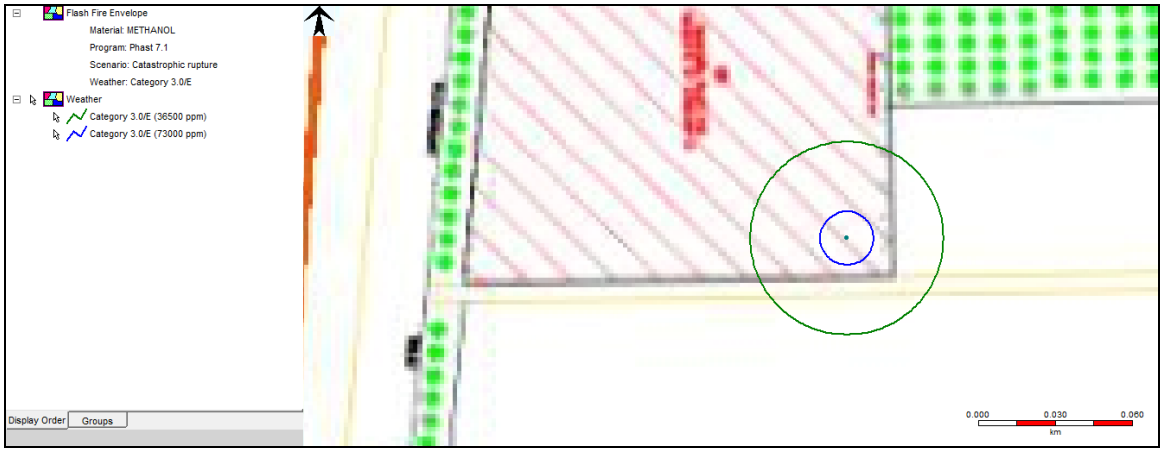
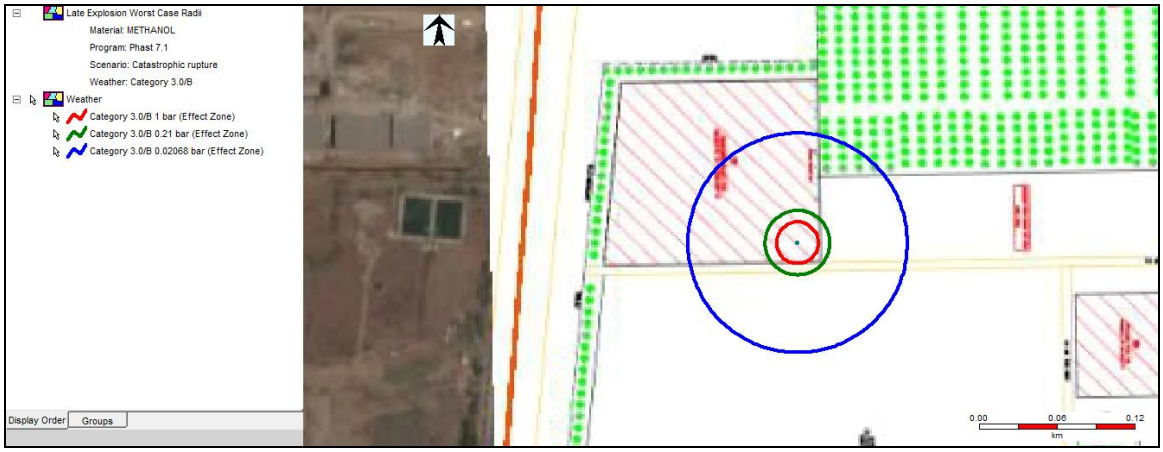


Figure 1-17: Late Explosion Effect - Methanol (Catastrophic Rupture – 3.0/B)



Pyridine

Radiation Level & effect distance due to the release of Pyridine are presented in ***Table 1-13,*** & the Flash Fire effect distance are presented in ***Table 1-14***.

Table 1-13: Radiation Level & Effect Distance due to Release of Pyridine

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
Pyridine	10 mm leak	Jet fire	3.0/B	NR	NR	NR
			3.0/E	NR	NR	NR
			4.0/D	NR	NR	NR
		Late pool fire	3.0/B	15	10	4
			3.0/E	15	10	4
			4.0/D	15	10	4
	25 mm leak	Jet fire	3.0/B	4	3	NR
			3.0/E	4	3	NR
			4.0/D	4	3	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
		Late pool fire	3.0/B	15	10	4
			3.0/E	15	10	4
			4.0/D	15	10	4
	Catastrophic Rupture	Late pool fire	3.0/B	15	10	4
			3.0/E	15	10	4
			4.0/D	15	10	4

Table 1-14: Flash Fire Effect Distance due to Release of Pyridine

Chemical (Storage Tank)	Failure Scenario	Consequence	Met Data	Effective Distance in meter	
				0.5 LFL	LFL
Pyridine	10 mm leak	Flash Fire	3.0/B	2	2
			3.0/E	2	2
			4.0/D	2	2
	25 mm leak	Flash Fire	3.0/B	2	2
			3.0/E	2	2
			4.0/D	2	2
	Catastrophic Rupture	Flash Fire	3.0/B	6	4
			3.0/E	10	4
			4.0/D	9	4

The Contours for effect distance generated for the release of Pyridine are presented in ***Figure 1-18- Figure 1-20***.

Figure 1-18: Late Pool Fire Effect - Pyridine (10 mm Leak – 4.0/D)

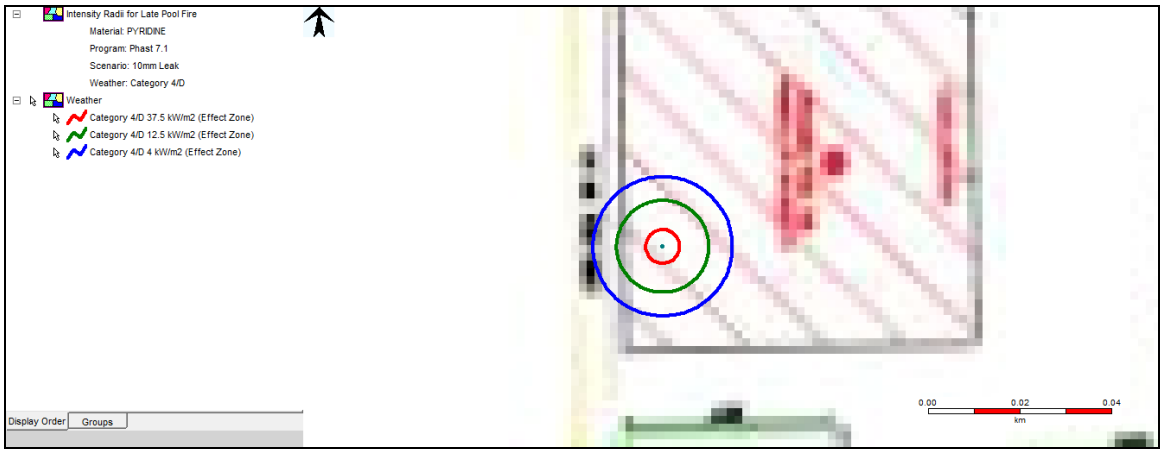


Figure 1-19: Late Pool Fire Effect - Pyridine (25 mm Leak – 4.0/D)

Figure 1-20: Late Pool Fire Effect - Pyridine (Catastrophic Rupture – 4.0/D)

Toluene

Radiation Level & effect distance due to the release of Toluene are presented in ***Table 1-15,*** & the Flash Fire effect distance are presented in ***Table 1-16*** & Late Explosion effect are presented in ***Table 1-17***.

Table 1-15: Radiation Level & Effect Distance due to Release of Toluene

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
Toluene	10 mm leak	Jet fire	3.0/B	2	NR	NR
			3.0/E	2	NR	NR
			4.0/D	2	NR	NR
		Late pool fire	3.0/B	20	13	5
			3.0/E	20	13	5
			4.0/D	20	13	5
	25 mm leak	Jet fire	3.0/B	5	4	NR
			3.0/E	5	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
			4.0/D	5	4	NR
		Late pool fire	3.0/B	20	13	5
			3.0/E	20	13	5
			4.0/D	20	13	5
	Catastrophic Rupture	Fireball Ellipse	3.0/B	20	13	5
			3.0/E	20	13	5
			4.0/D	20	13	5

Table 1-16: Flash Fire Effect Distance due to Release of Toluene

Chemical (Storage Tank)	Failure Scenario	Consequence	Met Data	Effective Distance in meter	
				0.5 LFL	LFL
Toluene	10 mm leak	Flash Fire	3.0/B	2	2
			3.0/E	2	2
			4.0/D	2	2
	25 mm leak	Flash Fire	3.0/B	2	2
			3.0/E	3	2
			4.0/D	2	2
	Catastrophic Rupture	Flash Fire	3.0/B	15	10
			3.0/E	16	9
			4.0/D	18	11

The Contours for effect distance generated for the release of Toluene are presented in ***Figure 1-21 - Figure 1-24***.

Figure 1-21: Late Pool Fire Effect - Toluene (10 mm Leak – 4.0/D)

Figure 1-22: Late Pool Fire Effect - Toluene (25 mm Leak – 4.0/D)

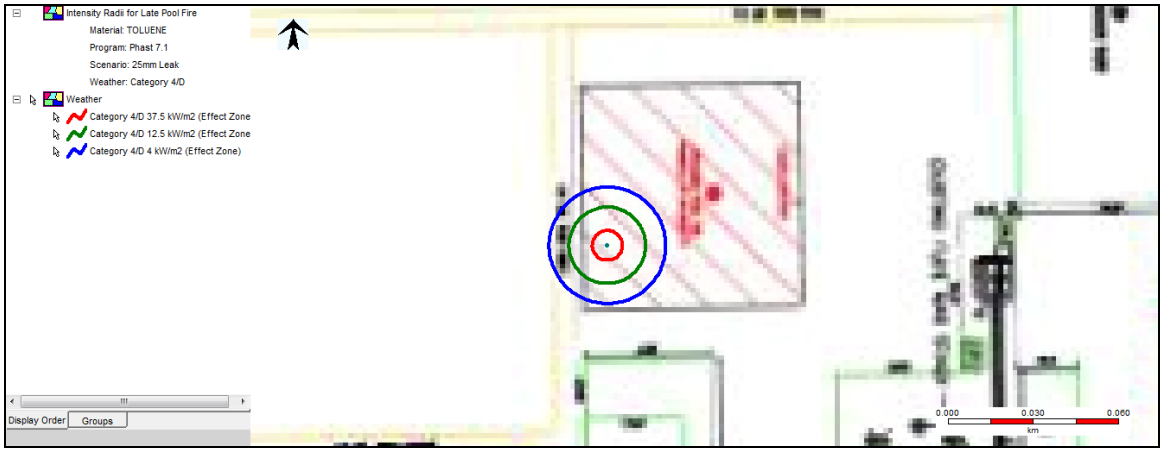
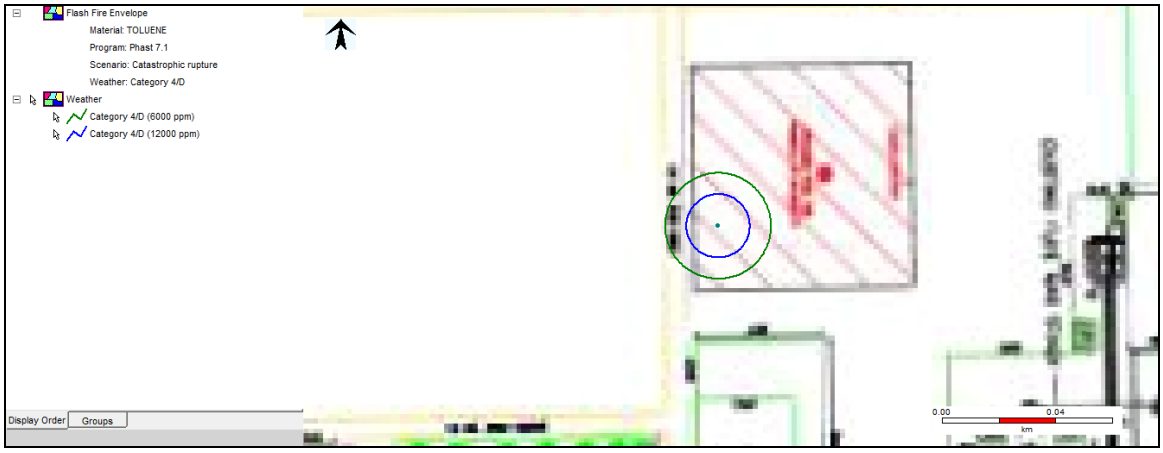


Figure 1-23: Late Pool Fire Effect - Toluene (Catastrophic Rupture – 4.0/D)

Figure 1-24: Flash Fire Effect - Toluene (Catastrophic Rupture – 4.0/D)



Chlorine

Toxic effect distance due to the release of Chlorine are presented in ***Table 1-17***.

Table 1-17: Toxic Effect Distance due to Release of Chlorine from Tank

Chemical (Storage Tank)	Failure Scenario	Met Data	Effective Distance in meter to Toxic Level			
			EPRG 1 (1 ppm)	EPRG 2 (3 ppm)	EPRG 3 (20 ppm)	IDLH (10 ppm)
Chlorine tank (120 kl)	1 mm leak	3.0/B	203	111	41	68
		3.0/E	776	424	136	244
		4.0/D	402	216	71	124
	5 mm leak	3.0/B	1,290	727	281	449
		3.0/E	5,195	2,688	873	1,531
		4.0/D	2,716	1,457	506	856

The Contours for effect distance generated for the release of Chlorine are presented in ***Figure 1-25 & Figure 1-26***.

Figure 1-25: Toxic Risk Effect - Chlorine (1 mm Leak – 3.0/E)

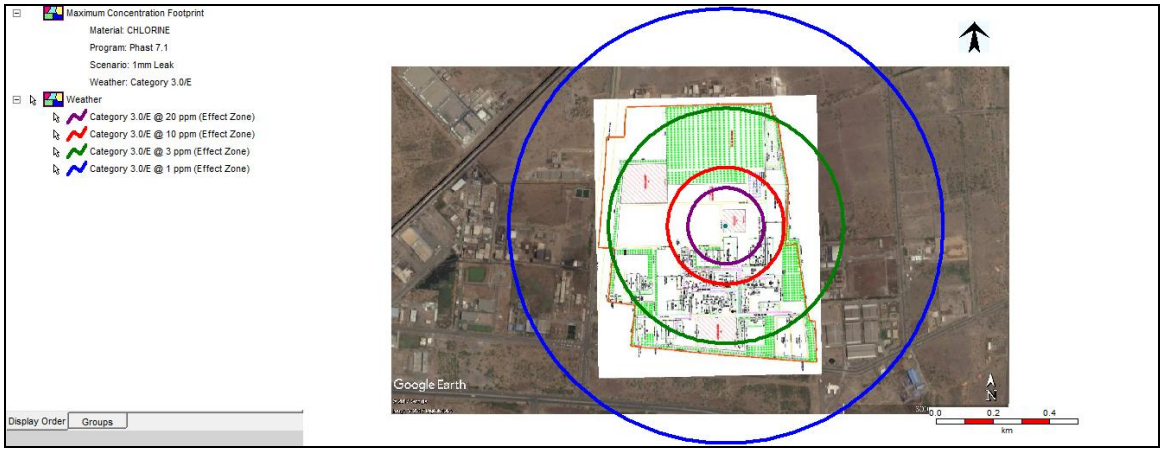
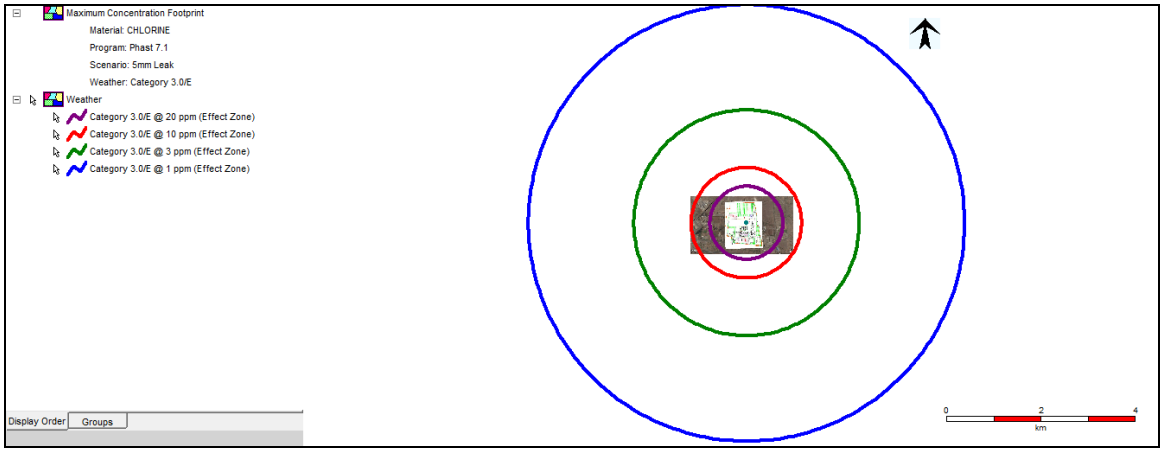


Figure 1-26: Toxic Risk Effect - Chlorine (5 mm Leak - 3.0/E)



Chlorine (Through Pipeline)

Toxic effect distance due to the release of Chlorine from pipeline is presented in ***Table 1-18***.

Table 1-18: Toxic Effect Distance due to Release of Chlorine from Pipeline

Chemical (Storage Tank)	Failure Scenario	Met Data	Effective Distance in meter to Toxic Level			
			EPRG 1 (1 ppm)	EPRG 2 (3 ppm)	EPRG 3 (20 ppm)	IDLH (10 ppm)
Chlorine pipeline (3.8 m^3/10 min)	1 mm leak	3.0/B	203	111	41	68
		3.0/E	776	424	136	244
		4.0/D	402	216	72	124
	5 mm leak	3.0/B	1,293	727	280	449
		3.0/E	5,207	2,685	866	1,525
		4.0/D	2,725	1,456	504	853

The Contours for effect distance generated for the release of Chlorine pipeline are presented in ***Figure 1-27 & Figure 1-28***.

Figure 1-27: Toxic Risk Effect - Chlorine Pipeline (1 mm Leak – 3.0/E)

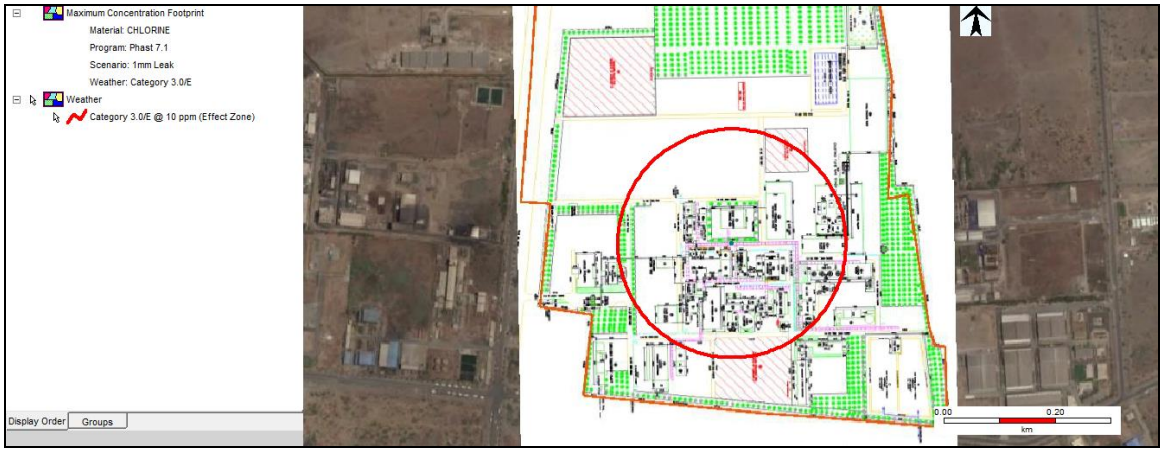
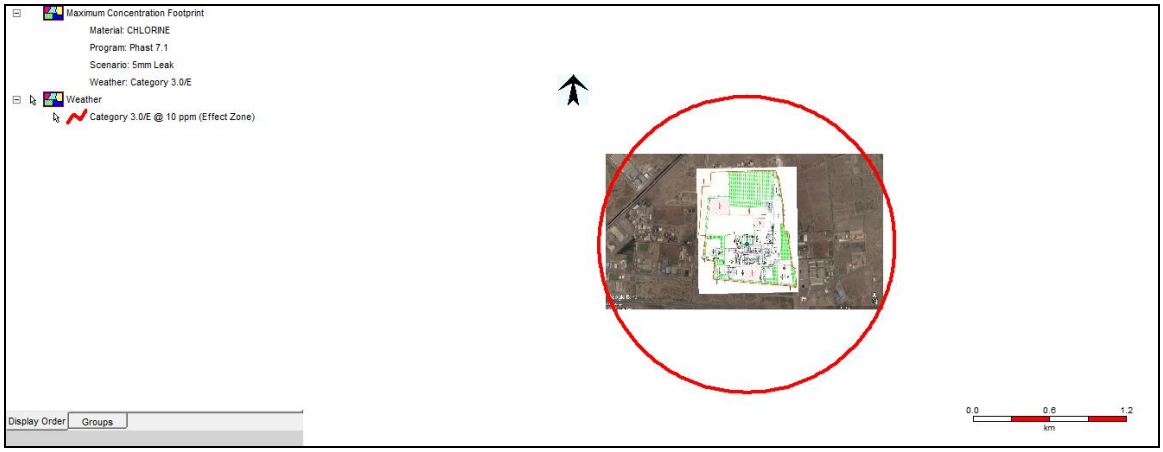


Figure 1-28: Toxic Risk Effect - Chlorine Pipeline (5 mm Leak – 3.0/E)



Hydrogen (Through Pipeline)

Radiation Level & effect distance due to the release of Hydrogen from pipeline are presented in ***Table 1-19,*** & the Flash Fire effect distance are presented in ***Table 1-20*** & Late Explosion effect are presented in ***Table 1-21*.**

Table 1-19: Radiation Level & Effect Distance due to Release of Hydrogen

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
Hydrogen Pipeline	10 mm leak	Jet fire	3.0/B	5	NR	NR
			3.0/E	5	NR	NR
			4.0/D	6	NR	NR
	20 mm leak	Jet fire	3.0/B	13	10	NR
			3.0/E	13	10	NR
			4.0/D	13	10	NR
		Fireball Ellipse	3.0/B	40	22	10
			3.0/E	40	22	10
			4.0/D	40	22	140

Table 1-20: Flash Fire Effect Distance due to Release of Hydrogen

Chemical (Storage Tank)	Failure Scenario	Consequence	Met Data	Effective Distance in meter	
				0.5 LFL	LFL
Hydrogen Pipeline	10 mm leak	Flash Fire	3.0/B	10	6
			3.0/E	10	7
			4.0/D	10	6
	20 mm leak	Flash Fire	3.0/B	18	12
			3.0/E	18	13
			4.0/D	19	13

Table 1-21: Late Explosion Effect Distance due to Release of Hydrogen

Chemical (Storage Tank)	Failure Scenario	Consequence	Met Data	Overpressure Distances in Meters		
				0.02	0.21	1.00
Hydrogen Pipeline	20 mm leak	Late Ignition	3.0/B	34	15	12
			3.0/E	36	15	12
			4.0/D	34	15	12

The Contours for effect distance generated for the release of Hydrogen from pipeline are presented in ***Figure 1-29 - Figure 1-31***.

Figure 1-29: Fireball Ellipse Effect - Hydrogen Pipeline (20 mm Leak – 4.0/D)

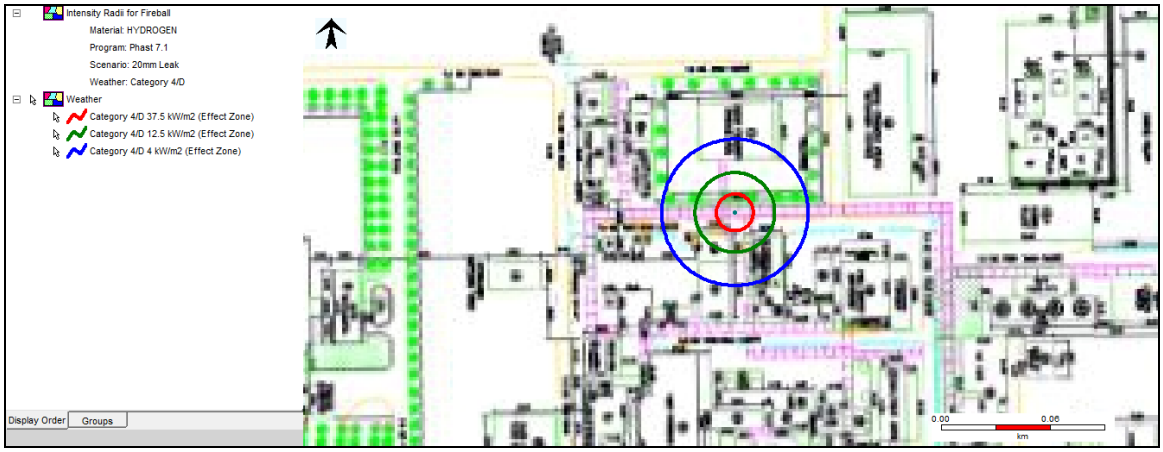


Figure 1-30: Flash Fire Effect - Hydrogen Pipeline (20 mm Leak – 4.0/D)

Figure 1-31: Late Explosion Effect - Hydrogen Pipeline (20 mm Leak – 4.0/D)

1.1.5 Disaster Management Plan

Emergency Organization

Introduction

In order to achieve above objectives the role of key personnel is clearly defined to avoid confusion and to meet the emergency effectively. The Site Controller and the Incident Controller are the personnel for effective control of an emergency. As per the emergency preparedness chart the success of control of an emergency situation depends upon their timely action. The action for these persons and Emergency do's and don'ts are given in this section.

Assembly Point

Assembly points will be earmarked during making of detailed Onsite Emergency Plan on Execution of the Project.

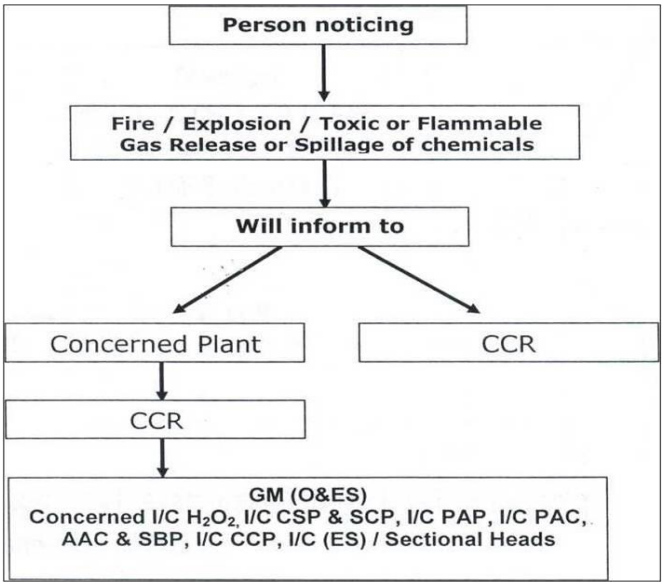
Emergency Control Centre

The Emergency Control Center (ECC) is the Place from where the emergency control operations to handle the emergency are directed and controlled. It will be attended by Site Main Controller, Key Personnel and Senior Officers of fire, Police, District Authorities and Emergency Services. The Center is equipped with telephone Communication facility to keep contact with incident controller and areas of works as well as outside.

Emergency Control Organization is identified as following.

- Site Controller,
- Incident Controller, EHS Coordinator, Security Personnel,
- Key Personnel,
- Central Control Room,
- Occupational Health Centre.

Figure 1-32: Emergency Control Organization Chart



Members of team will be evenly distributed in all the shifts and eight to ten members are available in the factory at any point of time to handle the emergency situation. Team members will be given refresher training from time to time.

Personal Protective Equipment (PPE) Facilities to be maintained in ECC

Breathing Sets

- Self-Contained Breathing Sets and spare cylinders will be available at different locations;
- Emergency Life Saving Apparatus (ELSA) will be available at plant. Breathing time is 10 minutes for each set.

Eye Wash and Safety Shower

At different locations in the factory Eye wash fountain and safety shower assemblies are installed.

Fire/ Fire Fighting Agents

- Water can be used when applied in the form of spray and to keep exposed material from being damaged by the fire. It can be used to sweep the flames off the surface of liquid.
- Water or foam may cause frothing when applied on flammable liquids having flash point above 100°C. Water sprays has to be applied carefully by causing the frothing to occur on the surface and this foaming action blankets and extinguishes the fire.
- Water may be used to blanket fire and accomplish extinguishing. It must be applied gently to the surface of the liquid.
- Water may be ineffective except when applied gently to the surface to blanket and extinguish the fire.
- Foam
- Alcohol Resistant Foam
- CO_2
- Dry Chemical Powder

First Aid/ Antidotes

- Wash affected areas/ eyes with copious amounts of water.
- Remove to fresh air/ administer Oxygen.
- Artificial respiration.
- Give copious drinks of water.
- Induce vomiting.
- Remove contaminated clothing.
- Antibiotics/ steroid eye drops.
- Administer portico steroid spray.
- Analgesic for pain, antibiotic for prevention of infection.

Fire Extinguisher

Fire extinguishers for emergency, located at strategic positions at each process plant, storage areas, security office etc. The same area will be easily accessible, marked properly and maintained regularly. Following Fire Extinguishers are provided;

Table 1-22: Details of Fire Extinguisher

S. No.	Type of Fire Extinguisher
1	Carbon Dioxide (CO_2)
2	Dry Chemical Powder (DCP)
3	Mechanical Foam (MF)

Fire Hydrant System

- Fire Hydrants
- Monitors

Hoses

- 15 m length
- 7.5 m length

Fire tender:

- Water tank
- Foam tank
- DCP type FE
- CO_2 type FE

Water Sprinkler System

- High velocity water sprinkler system
- Fire water Tank

First Aid

Well-equipped first aid boxes made available at different location at site. Appoint trained persons as first aiders and trained them regularly.

Key Persons of the Emergency Team and their Duties

During general shift, persons designated below will perform the assigned emergency responsibilities. In their absence, or during the shift, alternate persons designated will assume responsibilities.

Table 1-23: Details of Key Personnel of the Emergency Team and their Duties

S. N.	Abbreviated Form	Full Form	Who will act
1	SMC	Site Main Controller	Sr. M/DGM/GM(D)/ED(D) (Senior person available in premises) Sr. Officer of CCR till arrival of SMC
2	IC	Incident Controller	Shift In-charge / Dy. M / M (of concerned plant & area)
3	Key Personnel	--	All HODs / All Sectional Head / Senior most person available in respective dept.
4	CCR	Central Control Room	--
5	OHC	Occupational Health Centre	--
6	PPE	Personal Protective Equipment	--

Alarm Raiser:

- No fixed person can be appointed as alarm riser.
- Any person who has observed any abnormal situation such as fire, gas leaks, chemical leak outs etc., can raise alarm to warn / inform all working in plant.
- Shout Danger-Danger
- Ring the brass bell and run fast to inform people around by shouting danger
- Inform security gate / respective control room about the abnormal situation
- If possible attempt to contain / control about the incidence with available resources without risk to life.
- Inform the shift in charge.

Nominated Person to Declare Major Emergency

- All shift in charges
- Unit Head
- Plant HOD

Immediately being aware of the emergency (On hearing the Siren of on being about emergency) he will proceed to the scene / location and on arrival he will:

- Assess the scale of emergency and decide if a major emergency exists
- Take a decision to declare MAJOR EMERGENCY
- Activate the on-site plan and if necessary the Off-Site emergency plan
- Inform Site-main controller about shifting down and evacuation of plant and areas likely to be affected by emergency
- Ensure that outside emergency services, including Mutual – Aid have been called
- Direct / advise to public address system in charge to activate public address system and to inform / advice Off-Site population for evacuation and precaution to be observed during emergency.

Site Main Controller:-

Unit Head & Dy. General Manager - Production in general shift & shift in charge of CCP acts as SMC till unit head arrive the site.

Duties / Functions of SMC: Immediately on being aware of the emergency, he will go to the emergency control center (ECC) on arrival he will:

- Relieve the incident controller of responsibility for overall main control
- In consultation with the incident controller decide whether major emergency exists and on declaration of a major emergency ensure that the outside emergency services and mutual help are called, the off-site plan activated and if necessary, nearby factories and population are informed.
- Ensure that the key personnel are called.
- Exercise direct operational control of those parts of the work outside the affected area.
- Continuously review and assess possible developments to determine the most probable cause of event.
- Direct the safe close down and evacuation of plants in consultation with the incident controller and key personnel. If necessary arrange for evacuation of neighboring population.

- Ensure that causalities are receiving adequate attention. Arrange for hospitalization of victims and additional help if required. Ensure that their relatives are informed.
- Informed and Liaison with police services, instruct emergency authority and the factory inspectorate and experts on health and safety, provide advice on possible effects on area outside the factory.
- In the cases of prolonged emergencies involving risk to outside area by windblown materials, contact meteorological office to receive early notification of impending changes in weather conditions.
- Ensure the accounting for personnel and rescue of missing persons.
- Control traffic movement within the factory
- Arrange for a chronological record of the emergency to be maintained.
- Where the emergency is prolonged arrange for relief of personnel and the provision of catering facilities.
- Issue authorized statements to the news media where necessary, inform head office.
- Ensure that proper consideration is given to the preservation of evidence. Arrange for photographs / video.
- Control rehabilitation of affected areas and victims on cessation of the emergency. Do not restart the plan unless it is ensured safe to start and authorized the sounding the "All clear" siren which will be one continuous long siren for three minutes".

Incident Controller: - All shift In-charge of respective plant / HOD of plant / Unit Head

Dy.Incident Controller: - Sr. Executive / Executive (Prod.)

Duties / functions: - Immediately on being aware of the emergency and its location he will proceed to the scene. On arrival he will take charge of accident and operate from scene as well as plant control. He will:

- Assess the scale of emergency and decide if a minor emergency exists or is likely. On his decision, he will activate the on-site emergency plan and if necessary the off-site emergency plan.
- Inform site main controller and perform as site main controller till his arriving and he will deputed his Dy. Incident controller on the scene and he will go to the emergency control center. Particularly he will:
  - Direct the shutting down and evacuation of plan and areas likely to be affected by the emergencies.
  - Ensure that outside emergency services, including mutual - aid have been called in.
  - Ensure that key personnel have been called in.
- Direct all operations within the affected area with the following priorities:
  - Secure the safety of the personnel.
  - Minimize damage to plant, property and the environment.
  - Minimize loss of material.
- Direct rescue and firefighting operation until the arrival of the outside fire brigade, when he will relinquish control to the head of the fire brigade.
- Search for causalities.
- Evacuate non-essential workers to the assembly points.
- Set up a communication point and established telephone / messenger contact an appropriate with the emergency controller center.

- Give advice and information as requested, to the head of the fire brigade and other emergency services.
- Brief the site main controller and keep informed of developments.
- Preserved evidence that will be necessary for subsequent inquiry in to the cause of the emergency and concluding preventive measures.

Safety In charge:-

On being informed about the incident proceed to the scene of incident and assess the situation, report to the site main controller.

- Help the incident controller / site main controller in firefighting / incident control operation by organizing supervising firefighting / incident control crew. Provide necessary PPE to incident control crew.
- Liaison without side emergency services for mutual aid, evacuation shelter, Ambulance, Medical help and others.
- To maintain ECC necessary items, checks and report inadequacy
- To carry out / CO- ordinate pre emergency activities for preparedness.

Traffic /Security In charge:-

- Security officer
- Security supervisor
- Stores – Executive
    - Maintain list of numbers of contractors employees, visitors present on site.
    - On hearing the siren inform fire team about location and accompany proceed to the site of incident along with all the security personnel with the exception of essential at the gate.
    - Control the traffic movement in the factory premises. Cordon off area as required
    - Remove unauthorized and untrained persons from the scene of incident and instruct them to report at assembly point.
    - Help fire rescue, evacuation team for control.
    - Not to allow entry / exit without permission of IC/SMC
    - Keep gate clear for emergency site vehicle, tender from outside.

FIRE TEAM INCHARGE:-

- Fire officer
- Security officer
- Security supervisor
    - On hearing the siren report to incident site and keep contact with ECC Co-ordination with fire station, security IC and form fire squad
    - Organize fire squad and arrange to extinguish the fire / control the incident with the help of trained personnel
    - Take charge of fire hydrant pump room and see that fire pumps will work as required.
    - Provide additional hoses, branch pipes, foam compound and spray nozzles to fire squad
    - Provide all necessary help / direction to fire / gas control squad
    - Inform SMC / IC if need of mutual aid is required
    - To maintain fire protection systems apparatus in working condition.

Leak / Spill Control In charge:-

- Officer – Prod
- Executive – Eng.
- Executive – QAD

    - On hearing the siren report to ECC and or incident site IC
    - Follow instructions from incident controller / SMC
    - Organize squad to control spreading of pollution in to atmosphere etc.
    - Inform SMC / IC if need of mutual aid is required.

Transport In charge:-

- Duty officer
- Security supervisor
- Asst. Manager – P&A

    - Arrange transport for evacuated persons to shift to outside shelter.
    - On being informed about the incident proceed to the emergency control center (ECC)
    - Take charge of all transport vehicles available on – site and keep drivers ready
    - Arrange to transfer causalities to nearest hospital
    - Co-ordinate with the SMC and follow his instructions
    - To maintain arrangements of transport.

Mechanical Aid In charge:-

- Manager – Mech.
- Executive – (Eng. / Utility)
- Asst. Manager – Instrumentation
- Executive – Instrumentation
- Manager – Elec.
- Executive – Elec.

    - On being informed about the incident to the scene of incident and report to ECC
    - Follow instructions from IC
    - Ensure that emergency engineering services are in working condition
    - Render all engineering help to the IC in controlling the incident.
    - Arrange / provide help for heavy vehicle as per requirement.

First – Aid Medical Treatment Incharge:-

- Trained first aiders
- Male Nurse

    - On being informed about the incident proceed to the scene of incident and report to ECC/OHC
    - Take charge of Ambulance, OHC
    - Arrange to give first – aid and maintain record
    - Decide for further treatment & Co-ordinate with transport in charge & keep record
    - Assess need of extra medical, Ambulance help & co-ordinate with IC / SMC
    - Maintain arrangements of OHC, Ambulance.

Telephone / Communication In charge:-

- Duty officer
- Officer – P&A
- Telephone operator
    - On being informed about the incident maintain contact with emergency control room or report to ECC
    - Take charge of all external telephones
    - Receives inward message and keep record of it
    - Arrange and make one or two lines free for inward message
    - Inform emergency services and make them alert to come on second call. Also keep record of all outward message on separate paper.
    - Also record any emergency message for mutual aid, in specified format in detail
    - Follow instructions from SMC/IC

Assembly point In-charge:-

- Officer – QAD
- Executive – Inst.
- Executive – Eng.

a) On being informed about the incident, proceed to the site and report to site main controller / incident controller at ECC
b) If evacuation call is given :-
    - Arrange to record names / department of those persons assembled (evacuated) at assembly points. Inform SMC about missing personnel if any
    - Follow instruction from SMC
    - If required arrange for transport to shift all evacuated persons to shelters in CO-ordination with transport In-charge.
    - During extended emergency he will shift all the assembly at another safe area and allow visitor, contract employee to go out of premises as per instruction of IC / SMC with exit proof signature.

Emergency Response:-

Emergency Response for Chlorine Evaporation Unit at MFL Dahej is as follows:-

- Electrically operated fire sirens are provided in the complex. In addition to the above, hand operated sirens are provided in the plant.
- Emergency control organization chart with the duties has been displayed at the Control Room.
- Any employee/person (incident informer) noticing a fire will shout "FIRE FIRE" to attract attention of others nearby. He shall blow the fire alarm at the nearest location or inform to security through intercom for blowing the fire siren. Any other persons who heard the shouting of "FIRE FIRE" will run to security to inform and for blowing the fire alarm.
- On hearing the fire alarm, Operations Engineer will proceed to affected area and take charge. He will inform site Controller/Incident Controller immediately.
- Site Controller will proceed to control room on hearing alarm on getting report from incident informer/incident controller.
- Firefighting coordinator or alternate will proceed to pump station and start fire water pump.

- Power and Utility coordinator will take charge of other utilities and stand by for orders from Incident Controller.
- All other officers will carry out the operations as applicable to them and stand by for instructions from Incident Controller.
- Administration Coordinator and Communication Coordinator will proceed to their respective position and await instructions from incident controller or site controller.
- Security supervisor or alternate will take control of the main gate to control traffic and to provide assistance in firefighting.
- Company Doctor on receiving the information will prepare to receive casualties, if any. He will wait for instructions from incident Controller/site controller to organize external medical and ambulance services.
- In case of a major fire due to electricity operations officer will take action to stop electricity.
- It is the responsibility of the Head Security Guards to take control of the traffic. He will organize the movement of employees in such a way that none of the roads within the plant premises are blocked. He will also control the movement of traffic at all the main gates in order to ensure smooth movement of fire-fighting vehicles or ambulances, as the case may be.
- The incident controller will rush to the scene of fire and organize emergency response activity with the following three team viz. Fire Combat Team, Rescue Team and Auxiliary Team. Each team shall have a minimum strength of 2 to 3 employees. One employee in each team will be the team in-charge.
- The duties of each team is as detailed below:-

Fire combat team:-The team members to go into action as per the specific assignments such as:

- Collecting the fire extinguishers, hoses, nozzles and rush to spot of emergency.
- Connecting maximum number of fire hoses with the nearby hydrant points.
- Operate fire water monitor by setting them properly to the direction of fire.
- Use Foam and other means as suitable for firefighting.
- Switch on the sprinkler system manually. (Wherever applicable)
- Rush to the spot of the fire with all available fire extinguishers and try to put out the fire at the quickest possible time.
- Stop all activities and concentrate only on fire fighting and try to prevent the fire from spreading.
- As others rush to the scene of fire, tell them what the type of fire is and what extinguisher is to be used.

Rescue team:-Team members to go into specifically assigned operation such as:-

- Inform site controller, communication coordinator about the situation from time to time. Restrict entry of unauthorized persons to the location.
- Remove important documents to a safe location from the scene of emergency. Ensure that trucks are taken out and they do not block the passage.
- Bring stretchers from the dispensary and move the injured/casualties to the dispensary.

Auxiliary team: -The team members to go into action as per specific assignments such as:

- Stop all operations in the field.
- Close all ROV's and other important valves. Switch off electrical mains as instructed.
- Bring additional fire extinguishers and other firefighting equipment for continuous firefighting.
- Replace all firefighting equipment used during combating of fire after normalcy is restored.
- Emergency Response to All

- If you notice the fire first rush to the spot of fire with a fire extinguisher simultaneously shouting "FIRE FIRE" for help from other employees who will arrange to sound the fire alarm. Inform the location of fire.
- Remember "MAXIMUM SAVING, MINIMUM LOSS" while fighting the fire. First three minutes of fire is the most vital. After this period it spreads beyond control.

Emergency Response to All

If you notice the fire first rush to the spot of fire with a fire extinguisher simultaneously shouting "FIRE FIRE" for help from other employees who will arrange to sound the fire alarm. Inform the location of fire.

Remember "MAXIMUM SAVING, MINIMUM LOSS" while fighting the fire. First three minutes of fire is the most vital. After this period it spreads beyond control.

Emergency Do's and Don'ts

Table 1-24: Do's and Don'ts during Emergency

Do's	Don'ts
Anyone noticing an emergency	
• Actuate nearest emergency push button and/ or inform the Shift in Charge. Get back to your normal workstation (if safe) or else report to the assembly point.	• Do not panic and avoid running all over the place prevent others from doing so. • Do not enter the site unless instructed if you are outside and disaster alarm is heard.
Contractor Personnel	
• Stop work on hearing alarm and assemble at the Assembly Point and be ready to evacuate.	• Do not enter the site until it is cleared for the normal work by Incident Controller.
Security	
• Keep the gate manned. • Keep the road clear for movement of fire tenders. • Control traffic at gates.	• Do not allow unauthorized visitors free to enter.
Visitors	
• Leave the place & assemble at assembly point	• Do not enter the site if emergency alarm is heard
All other employees on site	
• On hearing emergency siren • Get back to work place (if safe) and get instructions from supervisor	• Do not panic/ run • Do not go to the scene of emergency unless specifically instructed by Incident Controller

Members of emergency response team:

In each shift fire officer collects the name of the team members (10Nos) from decided areas in consultations with area supervisor / In-charge. 10 members will work as emergency response team during the shift. To provide urgent help in the affected area. Emergency response team will come in action after on – site emergency declaration. They will:

- On hearing of first siren keep alert locate place of incident look for wind direction, keep BA Set ready.
- On hearing of second siren of advised proceed to the scene of incident with BA Set.

- Help incident controller in emergency control activity like fire, gas leak rescue, search and evacuation operations as per the need and instruction of IC / SMC.

Emergency Evacuation

If it becomes necessary to have an emergency evacuation the decision will be made by the Site Controller/Incident Controller as the case may be. The following procedure will be adopted during evacuation:-

Personal Evacuation:

- Incident Controller/Fire Fighting Coordinator/Shift Operations Officer will give instructions to the employees in their sections to go to an assembly point. They will keep a list of employees evacuated from their sections. Shift Operations Officer will contact the Incident Controller if anybody from their department is left behind needing any special help. Shift Operation Officers will be responsible for evacuating all from different sections. Incident Controller will organize the special help required to rescue the employees left behind. Shift Operations Officer will also decide an evacuation route depending on wind direction.
- If there are any employees left behind in different sections, the Incident Controller will organize a rescue team which will go from section to section with proper protective appliance in order to remove all the entrapped employees.
- Decision to allow re-entry into the terminal for resuming operations will be made jointly by Incident Controller/Site Controller.

In certain situations like a major fire it may become necessary to evacuate the people in the nearby areas. In such a case following action will be taken.

- Incident Controller, in consultation with the Site-Controller, will decide the evacuation plan. While deciding the evacuation plan, they will keep the following points in mind.
- While handling evacuation in case of a major fire, the direction of the wind is extremely important.
- The location of the terminal showing the population density in all the directions surrounding the terminal has been prepared. This will be used to decide number of people to be evacuated.
- Depending on the nature of the fire and the wind direction, the Incident and Site-Controller will draw an evacuation plan.
- It is the responsibility of the Incident Controller to contact the Site-Controller after alerting local police-in-charge and Local Authorities. Site-Controller will inform Collectors Office and organize additional help and emergency services.
- While contacting all the people mentioned above, the Incident-Controller will give information regarding the wind direction so that help can reach the affected areas without getting affected by the gas.
- Incident Controller/Site Controller will alert local hospitals regarding the emergency.

Communication System

Communication is the lifeline of handling an emergency. When an emergency occurs it is necessary to raise the alarm immediately, to declare an emergency, to inform the emergency controllers, to inform the plant emergency services and affected areas within the plant as well as outside if necessary.

Therefore, the following facilities are provided in the plant for an effective two way communication:

- Intercoms, public address system, company mobiles and walkie talkie for normal and emergency in-plant communication
- Fire and emergency sirens for raising an alarm for emergency and alerting all essential services
- Non-dedicated external telephone for emergency contacts with works emergency controllers, fire brigades, hospitals and police and for all other contacts including district authorities, Government agencies, neighboring industries etc.

When the external telephones are not working, an emergency vehicle with a messenger could also be used for outside communication. Communication to the neighboring public, if necessary, should always be made through police and their wireless van.

Addition to the above, there will be siren system, which will be sounded for different stages of emergency.

Warning, Alarm and Safety and Security Systems Sirens

1. Motor Operated

Emergency Sirens are installed at heights on the top of the roofs of buildings structures and the push button switches will be provided at suitably approachable inside the premises.

2. Hand Operated

Hand sirens are installed inside the premises.

Emergency Siren Codes

Table 1-25: Siren Codes during Emergency Situation

Emergency	Wailing siren for one minute (e.g. police wailing siren).
Evacuation	Wailing siren for three minutes. To be blown only on instructions from SMC.
All Clear	Continuous siren for one minute.

Testing Of Sirens/ Security/ Safety Systems

Every Monday at 10.00 hours all the sirens will be sounded for testing purpose. Emergency Alarm is located at fire hydrant tank pumping station as marked on the site plan.

On hearing siren the Incident Controller will activate the action on Disaster Control Plan by giving proper instructions or predetermined signals.

Security Systems

Security Officer is in charge of Security. Sufficient numbers of Assistant Security Officers and guards will be deployed at main gate and other vulnerable areas in each shift. Security staff assists in firefighting and traffic control during emergencies.

Emergency Response

- Incidence observer will communicate the emergency to Site controller & raise the alarm.
- On hearing the alarm or getting information about emergency, site controller will proceed to control room & take charge. He will inform incident controller immediately.
- Incident controller will proceed to affected area on hearing alarm or on getting report from Site Controller.

- Fire pump attendant will proceed to Fire pump house & start fire water pump. All other persons will stand by for instructions from incident controller.
- Incident controller will organize emergency response activity & emergency response teams. He will also decide for the need for outside assistance.
- F & S officer will proceed to his position & control emergency with the help of Emergency crew personnel.
- Administration In-charge will take control of main gate to control traffic. He will guide outside assistance like fire brigade, ambulance van etc.

Emergency Evacuation

- For the purpose of evacuating personnel, safe assembly points are chosen and clearly marked. The assembly points are selected in the upwind direction / perpendicular to the wind direction so as to eliminate the downwind hazards due to fire and toxic release. We have an on line weather monitoring station. Wind direction and wind speed data is recorded and used in case of toxic release to facilitate evacuation and to know dispersion speed of chemicals

Decision for evacuation of personnel will be taken by Incident Controller, who will ensure that the

- Person is to be assigned for each assembly point personnel to be evacuated are informed on public address system
- Injured and trapped personnel are rescued by fire squad equipped with protective gear
- Head count is taken with the help of senior most people available at the assembly point and a list of personnel evacuated is made.

Instructions are given to vehicle drivers on the route to be followed and safe place where the personnel are to be taken.

All Clear Signal

- Investigation to avoid recurrence, recommendations and records – Safety Officer.
- Resetting the operations – Incident Controller.
- Permission from different Authorities and Final Clearance - Site Controller.

On-Site Emergency Plan

Emergency procedures

Handling of an emergency calls for critical planning and ensuring a state of readiness at all times. Proper handling of the actual emergency needs certain actions to be taken before the emergency to ensure that all systems are ready and the emergency can be handled smoothly. Similarly after an emergency rehabilitation and reconstruction programs are necessary. The actions to be taken before, during and after an emergency are described below:

General Instructions

Leakage of chlorine is the major emergency although other emergencies due to fire, explosion or spillage of chemicals may occur. Immediate steps should be taken to stop the leak.

The general instructions are as follows:

- Chlorine is heavier that air and settles at ground level. It does not diffuse quickly in atmosphere.

- Always stand in the upwind direction, while attending the leakages or standing near the leakage.
- Always stand in the upwind direction, while attending the leakage or standing near the leakage
- The best effort should be made to contain the spilled liquid it should be recovered to the extent possible and neutralized before it is discharged in to the effluent stream
- Effluent treatment plant should be informed immediately to take corrective action.
- Only trained employees should be allowed to go near the danger area with proper safety equipment kit to stop the leak
- All other employees should assemble as per the instruction of incident controller.

Actions to be taken before the Emergency

- Training programs should be conducted at regular intervals for:
    - Use of Personnel Protective Equipment's
    - Use of chlorine kit
    - Fire fighting
    - First Aid
- Drills to be conducted for testing of emergency plans once in a six month
- Safe handling procedures (MSDS) for the chemicals handled in the plant should be written and copy made available in plant area

Actions to be taken during the Emergency

For major emergency situations the various actions to be taken during emergency are as follows:

Emergency Response to Toxic Material Release

Among the hazardous chemicals handled at the facility, the worst emergency situation will involve release of chlorine gas. At present 20 Cl_2 sensors are placed at various locations within premises namely: Cell House (5 Nos), Cl_2 Bottling (6 Nos.), Cl_2 Storage (2 Nos), 1 no. each at HCl synthesis, hypo storage, Cl_2 and H_2 washing area, Dechlorination section, Captive SLF, Reservoir and Security gate.

A chlorine and Benzene leak in easily detected due to its peculiar odour. As soon as a leak in piping or equipment handling chemical is noticed, the immediate action should be to evacuate the downwind area and make efforts to isolate the source of supply.

Personnel performing such emergency operations should wear all personal protective equipment including air line or self-contained breathing apparatus.

Immediately on report of a leak, the Incident Controller should take following actions.

- Declare the EMERGENCY
- Evacuate the downwind area. If the consequences are likely to affect outside population, use available means to inform the public and nearby installations about the incident and possible effects and actions
- Instruct to isolate the system supplying chemical to source of leak and arrange safe shutdown of the plant.
- If emergency situation permits, attempt repair using necessary precautions
- Perform all other responsibilities as per the Emergency Response Plan

The following actions to be taken for the hazardous chemicals handled in the plant:

Emergency Action Plan for Chlorine Leakage

- On detection of chlorine leakage inform shift in charge.
- The SMS / IC will assess the situation at the site.
- Check wind direction and wind speed.
- Identify source of leakage by approaching from up wind direction using PPEs like SCBA set, airline respirator, PVC gloves and gumboot.
- SMC / IC will decide for evacuation of affected downwind area and arrange for search and rescue as required.
- Stay up wind, cordon off area, and prevent entry of unwanted personnel.
- Try to isolate leaky portion of plant, pipeline, and equipment by closing isolation valve on both side of leak. Consider following points before isolation.
- Whether isolation affect the specific plant / equipment operation, then think of safe shut down of that plant / equipment.
- Try to stop / reduce leakage if it can be done without risk using PPEs and special tools and kits or by lowering pressure / creating negative pressure by available methods.
- Start water spray in atmosphere to knock down vapors. Do not spray water on the source of leak.

Tonners:

- As soon as there is any indication of the presence of chlorine in the air immediate steps should be taken to remedy the situation. The leak source can be detected with the help of ammonia torch (a wooden stick with piece of cloth at one end. It is soaked in ammonia solution. When taken near the leak source, it will give dense white fumes.) leakages, if any should be immediately reported to the supervisor
- Leakage once detected, should be attended immediately, to avoid further deterioration of leakage.
- Use personal protective equipment's such as gas mask with canister, on line air breathing apparatus, self-contained B.A. set while entering the leakage zone
- Leakage point should be preferably approached from higher elevation and upwind direction
- Isolate the system as quickly as possible and evacuate the area. Only persons required for combating the leakage should be allowed to enter the area
- Water should never be sprayed on a chlorine leak. To do so will make the leak worse because of the corrosion action of wet chlorine. Moreover, heat from water increases evaporation rate of chlorine
- The severity of a chlorine leak may be lessened by reducing the pressure on the leaking container. These may be done by absorbing chlorine gas (not the liquid) from the container in a solution of caustic soda, soda ash or hydrated lime
- If there is leakage from the valve seat, valve body or valve inlet threads, use tie rod assembly from tonner safety kit to plug the leak
- If there is hole in the container body, use chain assembly from tonner safety kit.
- If the leak cannot be plugged, reduce pressure in the container or remove it to an isolated area
- Review spreading of chlorine gas and cloud formation and level of emergency accordingly declare activate on-site of off-site emergency plan
- Arrange for first aid, hospital treatment for affected personnel.
- Cut off power supply if required for selected plant / equipment.

Storage Tank

- In case the leakage is from below first isolation valve of storage tank which cannot be controlled by isolation method arrange for emergency transfer in to stand by empty tank from leaky tank.
- Create negative pressure in stand by empty tank through Hypo
- Keep local exhaust hood near to source of leakage close other exhaust hood to increase effectiveness
- If liquid has spilled in dyke area start selected floor exhaust to suck chlorine vapor to hypo.
- SMC / IC review effectiveness of action taken and if situation does not come under control decide for safe shut down of plant
- Review spreading of chlorine gas and cloud formation and level of emergency accordingly declare / activate on-site of off-site emergency plan
- Arrange for first aid, hospital treatment for affected personnel.
- Cut off power supply if required for selected plant / equipment.

Emergency Action Plan for Chloroform & Carbon Tetrachloride Leakage

Small Spill: Absorb with an inert material and put the spilled material in an appropriate waste disposal.

Large Spill: Absorb with an inert material and put the spilled material in an appropriate waste disposal. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Emergency Action Plan for Leakage/Spillage of HCl/H2SO4/HNO3

- For small sprinkle soda ash over spillage and collect it in drum for later disposal to ETP
- Wash floor using water in excess quality.

Emergency Action Plan for Caustic Lye

This is a highly reactive liquid and causes burns on contact with skin. Utmost precaution should be taken while carrying out maintenance jobs or while attending leakages.

- Put on all required personal protective equipment's such as face mask / safety goggles, hand gloves, helmet, apron, gasmask, gum boots etc. while attending the leakages or approaching to leakage point
- Do not attempt to attend leakages on pressurized line/vessel or on running equipment
- A small quantity of caustic lye may be diluted with a large quantity of water

Emergency Action Plan for Pyradine

Small Spill:

- Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container.

Large Spill:

- It is Flammable liquid so keep away from heat and sources of ignition.
- Stop leak if without risk and Absorb with DRY earth, sand or other non-combustible material.

- Do not touch spilled material or Prevent entry into sewers, basements or confined areas; dike if needed.
- Be careful that the product is not present at a concentration level above TLV.

Emergency Action Plan for Acetic Anhydride

Small Spill:

Absorb with an inert material and put the spilled material in an appropriate waste disposal.

Large Spill:

- It is Flammable and Corrosive liquid. Keep away from heat and sources of ignition.
- Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material.
- Do not get water inside container. Do not touch spilled material.
- Use water spray curtain to divert vapor drift.
- Prevent entry into sewers, basements or confined areas; dike if needed.
- Call for assistance on disposal. Be careful that the product is not present at a concentration level above TLV.

Emergency Response to a Storage Tank Fire/ Coal fire / Explosion

Following possible approach may be used to handle an emergency situation involving a tank fire / coal fire / explosion:

- Assesses the situation and gather required information on the accident including suspected casualties, rescue operations required, materials involved, tank details, pipe line / flange details, weather conditions and resources available.
- Consider possible alternatives to bring the situations under control and make decisions with reference to line of action i.e. whether to attempt to extinguish the fire or only to control its spread, requirement of emergency response personnel or not etc.
- Take appropriate response actions :
    - Isolate the area and remove all nonessential personnel
    - Isolate / shut off the valve of source of fuel from up wind direction
    - Switch off all power supply specifically temporary power supply
    - To stop welding, gas cutting and all hot job in surrounding areas and specifically in down wind direction
    - Evaluate the area downwind of the fire or possible vapor clouds
    - If remote isolation of the vessel is possible, provide for doing so, to avoid flammable vapor cloud formation
    - Attempt to extinguish the fire using the appropriate extinguishing agents and methods
    - Approach to fire from upwind. The personnel involved should wear appropriate protective equipment
    - Cool the vessel involved in fire and adjacent vessel with water to prevent spread of the fire
    - Prevent the overflowing of fire water from dykes and other containment systems

Actions to be taken after the Emergency

After decision has been made by Site Main Controller to call off the emergency, following necessary actions are recommended:

- Analysis of the incident
- Rehabilitation of plant and offsite personnel
- Repairing the plant machinery and reconstruction of structure
- Availability of On-site emergency plan

Safety control measures for Handling and storage of most Hazardous Chemicals

1. Benzene

Benzene is known as Hazardous Chemical.

- Benzene is a clear colorless and volatile liquid.
- Aeromatic odor
- Highly flammable liquid and vapor
- Distant ignition and flashback are possible.
- Can accumulate static charge.
- Can float on water and spread fire.

Hazards

- Irritant: Causes moderate or severe eye and skin irritation.
- Aspiration Hazard: May be fatal if swallowed and enters airways.
- Very Toxic: Prolonged or repeated exposure causes damage to blood, immune system
- PEL of Benzene: 0.5 ppm (1.5 mg/m3)
- LEL% of Benzene: 1.3
- Cancer Hazard: May cause cancer
- Mutagen: May cause genetic defects

Safety Control Measures:

- The enclosed system will be provided for entire process & operation for manufacturing of finished goods & its derivatives to minimize the emissions & volatility.
- Underground storage in adequate vessels/ tanks as per prescribed rules of Petroleum Act with Flame Arresters & Breather Valves devices to minimize the risk of fire, evaporation etc.
- Alternate Level Indicator Transmitters, Pressure Gauges and Flow switches will be provided to the system to find out the accuracy. Auto control (PLC) system with Audio-visual Alarm system will be provided
- Separate Fenced with adequate Dyke wall provision will be done to prevent unauthorized entry & barricade the spilled, flooded chemical entry in gutter/ drain.
- Precautionary Tags/ Boards will be displayed in this premises for cautionary intimation among working personnel.
- Fire Fighting system (Fire Hydrant system, Fire Escape Hydrants, Water Sprinkler system/ Curtain, Foam cum water monitors will be provided to douse the Minor & Blaze Fire.
- Alternated continuity jumpers will be provided thoroughly to entire joints to remove Static charge to prevent accumulation charges, sparks & ignition due to generation of static charge of electrons.
- Double Earthing provision to the entire storage, Day tanks & utility tanks as well as entire network will be earthed alternatively with strips good conductor.
- Regular checkup of Earthing& their Resistance monitoring will be done periodically as scheduled frequency by competent authority.

- Sufficient Ventilation to the process & operational area will be provided to disperse the fumes in atmosphere to prevent their accumulation & detonations.
- Specific Personnel Protective Equipments (PPEs) like Safety Shoes, Safety Helmet, Full body Apron, Splash proof Goggles Respirators & Mask will be provided to working personnel to avoid inhalation, ingestion, contamination, swallow & dermal exposure etc.
- Safety Induction training, First Aid & life Saver training, Hazardous handling & practical training on SOP will be provided to the working personnel.
- Daily routine base Gas test from LEL% Monitor will be done to check the availability of flammable gases, hazardous gases in working environment.
- Medical examinations camp will be organized from management periodically to examine the health of entre factory personnel.
- Appointment of Certifying surgeon/ Medical Expert will be done to check up the health of personnel 4 day in month.
- Antidotes, First Aid appliances & Medical facility will be provided in the factory.
- Safety Showers will be provided around the plant & on elevated multistory building to decontaminate & dilute the splashed chemicals in case of exposure on the body.
- Sufficient Lighting provision will be provided in the plant. Entire electrical devices, fittings & fixtures are designed as intrinsically safe IP: 55/ 65, Ex-d, Flame proof type.
- Sufficient Emergency Exits & Fire Escape ladders will be provided to the plant.
- Efficient drainage system up to the ETP plant will be designed and constructed.

2. Chlorine

Chlorine also has a multitude of industrial uses including making bulk materials like bleached paper products, plastics such as PVC and the solvents tetra chloromethane, chloroform and dichloromethane. It is also used to make dyes, textiles, medicines, antiseptics and paints.

MFL comes into MAH (Major Accident Hazards) category due to bulk storage & handling of Cl_2 above Threshold Quantity (THQ).

Chlorine is a toxic gas (B. P. is -34^{o}C). In liquefied form chlorine is a clear amber dense liquid. The gas is greenish-yellow, about 2.5 times as dense as air, and non-flammable. Liquid chlorine causes severe irritation and blistering of skin. The gas has a pungent suffocating odour and is irritant to the nose and throat. It is an extremely powerful vesicant and respiratory irritant.

Hazards:

- Irritant: Causes moderate or severe eye and skin irritation.
- Aspiration Hazard: May be fatal if swallowed and enters airways.
- Very Toxic: The exposure of hazardous chemicals are lower than their permissible exposure limits (PELs)
- PEL of Chlorine: 1 ppm (3 mg/m^3)
- CEL of Chlorine: 8 ppm
- IDLH of Chlorine: 25 ppm

Safety Control Measures:

- The enclosed system will be provided for entire process & operation for manufacturing of finished goods & its derivatives to minimize the emissions.

- Compressed Cylinder storage in tested & certified Tonner as per prescribed Compressed Cylinder storage regulations etc.
- Alternate Level Indicator Transmitters, Pressure Gauges and Flow switches have been provided to the system to find out the accuracy. Auto control (PLC) system with Audio-visual Alarm system will be provided.
- Ventilated Separate Fenced Shed provision will be done to prevent un-authorize entry.
- Precautionary Tags/ Boards have been displayed in this premises for cautionary intimation among working personnel.
- Fire Fighting system (Fire Hydrant system, Water Curtain) to create fire wall boundary between adjacent system in case of fire to prevent cylinder explosion by overheating.
- Specific Chlorine Detector Alarm panel with localized Hooter will be provided at the centre of plant operational & storage unit to detect, sense & indicate alarm to draw attention of working personnel.
- Chlorine Scrubber System with double efficient blower will be provided to neutralize the Cl_2 gas & scrub them.
- Regular checkup of Chlorine Safety System done periodically as scheduled frequency by competent authority.
- Sufficient Ventilation to the process & operational area will be provided to disperse the fumes in atmosphere.
- Specific Personnel Protective Equipment (PPEs) like Safety Shoes, Safety Helmet, Full body PVC Apron, Splash proof Goggles Respirators & Mask will be provided to working personnel to avoid inhalation, ingestion, contamination, swallow & dermal exposure etc.
- Safety Induction training, First Aid & life Saver training, Hazardous handling & practical training on SOP provided to the working personnel.
- Sufficient & dual alternate Breathing apparatus (SCBA & Airline Mask, Cl_2 Cartridge Mask & Gas mask) have been provided.
- Medical examinations camp organized from management periodically to examine the health of entre factory personnel.
- Appointment of Certifying surgeon/ Medical Expert will be done to check up the health of personnel 4 day in month.
- Antidotes, First Aid appliances & Medical facility will be provided in the factory.
- Safety Showers have been provided around the plant & on elevated multistory building to decontaminate & dilute the splashed chemicals in case of exposure on the body.
- Sufficient Lighting provision will be provided in the plant.
- Sufficient Emergency Exits will be provided to the plant.
- EOT crane has installed to lifting shifting the 1.5 T weighted Toners safely.
- Double Safety Hoods have kept inside plant at designated point to tackle the Cl_2 leakage emergency.
- Caustic Tank with dual alternate pump will be provided with Scrubber system to pump the Caustic Solution to the Top of Scrubber Column to sparer them to neutralize the Cl_2.
- Provision of online chlorine sensors at various locations and connected with DCS is given in ***Table 1-26.***

Table 1-26: Online Chlorine Sensors

S. No	Location	No. of Sensors Installed
1	Cell House	2

S. No	Location	No. of Sensors Installed
2	Dechlorination Area	2
3	Chlorine Compressor area	2
4	Chlorine Storage area	2
5	Brine ETP Pit	1
6	Chlorine Bottling area	6
7	HCl Scrubber area	1
8	Chlorine Blower Absorber Hypo area	1
9	Solid Waste Area	1

Safety System for Chlorine Bottling, Handling and transportation:

- Weighing arrangement provided in the each EOT crane to check the weight of receiving / dispatch tonners
- Degassing of tonner is done in Sodium Hypochlorite plant.
- Hydro testing – Every two years / need basis.
- Hydro testing tonners is segregated separately. If wt. loss is more than 5% it is rejected
- Auto filling system provided
- Load cell provided on each filling post to measure the weight and calibration of load cells done on daily basis
- Before dispatch the tonners, it is observed for one day for any abnormality
- Valves are covered with metallic cover hood
- Four chlorine sensors are installed. These sensors are connected with DCS. Local hotter also provided.
- Suction hood covering complete tonners is provided
- Tonner tracking system

3. Hydrogen

Hydrogen is a colorless and odorless gas. It is flammable and explosive gas and result in violent reaction with air. It forms sensitive explosive mixers with bromine and chlorine. Lower and upper explosive limits of hydrogen gas area (LEL & UEL) are 4.1 % and 74.2 %, respectively. It can spark by heat, spark or flame. Once ignited it burns with a pale blue, almost invisible flame.

Safety Control Measures:

- On-line monitoring of Hydrogen in Chlorine
- In Hydrogen compressors area all electrical appliances shall be flameproof.
- Hydrogen gas detectors shall be installed at Hydrogen compressor and activates alarm in case of Hydrogen leakage
- TAC approved fire hydrant system throughout the plant
- Water sprinkler provided around transformers
- Round the clock availability of full size own fire tender
- Mutual aid schemes with the adjoining industries

Other safety measures:

- Four levels of communication (Telephone, P A system, Walkie talkie, Siren system)

- Incident investigation and corrective system including near-miss cases

4. Chloroform/ *Carbon tetrachloride/ Pyradine/ Acetic Anhydirde*

Precautions:

- Do not ingest. Do not breathe gas/fumes/ vapor/spray.
- Wear suitable protective clothing.
- In case of insufficient ventilation, wear suitable respiratory equipment.
- If ingested, seek medical advice immediately and show the container or the label.
- Avoid contact with skin and eyes. Keep away from incompatibles such as metals, alkalis.

Storage:

- Keep container tightly closed in a cool, well-ventilated area. Sensitive to light.
- Store in light-resistant containers.

Exposure Controls/Personal Protection

Engineering Controls: Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the workstation location.

Personal Protection: Splash goggles. Lab coat. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill: Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self-contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

5. Safety System for Coal storage and Handling

- Coal stock yard shall be minimum 500 meters away from the residential area, school/colleges, Historical Monuments, Religious Places, Ecological sensitive area as well as forests area
- Coal will be stored in such a way that coal heap will not be higher than 5 meter and clear distance between two adjoining heaps will be 5 meters, so that in case of fire, approach is available
- Mechanized loading/ unloading system from the loading /unloading area to the stacking yards and in to the vehicles will be adopted
- Compound wall all along periphery of the premises with minimum 9 meters height will be constructed
- Continuous water sprinkling will be carried out on the top of the heap at regular intervals to prevent dusting, fire & smoke.
- To prevent fugitive emission during loading/unloading, fixed pipe network with sufficient water storage and pump shall be installed.
- Water sprinkling shall be carried out at each and every stage of handling to avoid generation of coal dust or other dust within premises
- Regular sweeping of coal dust from internal and main road and also ensure that there is adequate space for free movement of vehicles.
- Dust containment cum suppression system for the coal stack, Loading and unloading

- Construction of effective wind breaking wall suitable to local condition to prevent the suspension of particles from the heaps.
- Construction of metal road & RCC Pucca flooring in the plot area/ godown etc.
- System for regular cleaning and wetting of the floor area within the premises.
- Entire coal storage area/ godown will be covered with permanent weather shed roofing and side walls i.e., in closed shed, in case of crushing/sieving/grading activity is carried out (i.e. G. I. Sheet) along with adequate additional APCM.
- Three rows plantation with tall growing tress all along the periphery of the coal handling premises, inside & outside of the premises along with road will be developed
- Proper drainage system shall be provided in all coal storage area so that water drained from sprinkling & runoff is collected at a common tank and can be reused after screening through the coal slit or any other effective treatment system.
- All the engineering control measures and state of art technology including covered conveyer belts mechanized loading and unloading, shall be provided in addition to the measures recommended in the environmental guidelines for curbing the pollution.
- TAC approved fire hydrant system
- Fire tender with firefighting crew

Occupational Health

Well-equipped occupational health center will be manned by qualified MBBS doctor. The work of occupational health center includes:

- For new employees: Pre- employment medical checkup
- Six-monthly health check-ups of all the employees (periodic medical examination)
- Physical examinations such as height, weight, chest, blood pressure, eye vision and skin test
- Lab test such as hemoglobin (TC, DC and ES tests), urine – complete tests (physical examination, macro test, micro tests like RBC, WBC, crystals, albumin, globulin, sugar)
- Spirometry test (lung function) for pulmonary impairment detection.
- Audiometry test – for the employees exposed to noise
- Counseling with employees for improvement in health conditions
- Medical check-up carried out to study the effects of vibration
- Regular health survey is carried out with specific objective to address physical, biological and ergonomic issues of employees
- Workplace monitoring survey
- Health assessment of Employees after illness/injury
- Post-employment medical check up

Off-Site Emergency Plan

Need of the Off-Site Emergency Plan

The off-site emergency plan prepared herein will deal with the incident, the onsite plan which has the potential to harm persons or the environment outside the boundary of the factory premises.

The most significant risk to outside areas is that associated with a large release of chlorine and Benzene. Spread of its effected outside the works may require traffic control, evacuation, shelter arrangement.

Off-site emergency plan has been drawn up with a view to mobilize resources and integrate with district contingency plan for an effective system of command and control in combating the emergency.

Thus the main purpose of the off-site emergency plan is:

- To provide the local / district authorities, police, fire brigade, doctors, surrounding industries and the public, the basic information of risk and environment impact assessment and to appraise them of the consequences and the protection prevention measures and control plans and to seek their help to communicate with the public in case of major emergency.
- To assist the district authorities for preparing the off-site emergency plan for the district or particulate area and to organize rehearsal from time to time and initial corrective action based on the lesson learnt.

Structure of the Off-Site Emergency Plan

The off-site emergency plan will be integrated properly with the district contingency plan to tackle any kind of emergency. The site main controller will keep liaison for this purpose with the district authorities.

External telephone facilities from MFL to GIDC (Fire), will be established for quick communication.

The names of the key persons will be defined to establish contacts and CO-ordinate the activities with the help of the collectorate and disaster management center in case of major emergency.

An on-site emergency control room will be identified which can be activated / used for emergency control and manned round the clock.

As far as off-site emergencies are concerned, information shall be received first by the police control room, GIDC, next information to fire brigade GIDC and to disaster management center. The police / fire brigade control room shall in turn inform police commissioner, collector and Municipal Commissioner.

1.1.6 Traffic Risk Assessment

Traffic risk assessment for vehicle movement in the plant premises:

- A dedicated gate will provided only for Jeeps entry and exit
- Speed limits boards (20 kms) are provided to control speed
- Roads are RCC type and suitable for heavy vehicle movement
- Convex mirrors are installed for easy identification of opposite vehicle movement
- Bumpers will be installed for speed control
- Main roads are wide and opposite vehicle movement is clearly visible
- Traffic movement is controlled by providing additional security guards at various locations
- To avoid fire hazard it is ensure that all vehicles entering in the factory have spark arrestors and it will also be ensured that smoking items and explosives are not being carried inside the factory
- It is ensured that no driver enters the plant premises under the influence of Alcohol
- Parking area have been defined and sign boards will be provided
- No entry signs have been defined will be provided
- One way traffic movement routes have been defined will be provided
- Zebra crossings will be marked
- Pedestrian markings will be provided for personal movement

Following requirements will be ensured for transportation of vehicles carrying hazardous goods:

- Spark Arrestor
- Manner of display of class labels
- Emergency information panels
- Class label
- Valid registration to carry the said goods
- The vehicle is equipped with necessary first aid, safety equipment, toolbox and antidotes as may be necessary to contain any accident
- The driver holds an appropriate driving license, which authorizes him to carry hazardous goods
- All relevant information is given to the driver in writing in the form of Transport Emergency Card (TREM) (Road) and MSDS
- Safe routes for transportation of goods are identified

It will be ensured that the vehicle goes out with following documents:

- Invoice issued by Sales Coordination Department
- Tests reports wherever desired
- Material Safety Data Sheet (MSDS)
- TREM Card
- HAZCHEM Poster
- Logistic Tracking Agency List

Safety during Road Transportation

The Hazard Information System plays an important role in the safe transport of hazardous substances. The Hazard Information System consist of the following:

- Material Safety Data Sheet (MSDS)
- Transport Emergency Card (Tremcard)
- Hazchem Code
- Emergency Information Panel on Vehicles
- Drivers Training

The transporter is responsible for the safe transport of Hazardous material by road from the loading point to the discharge point. Special consideration should be given to the following:

Safe parking

Drivers must ensure that the vehicle is either supervised or is parked in a secure place. No potential source of heat or fire must exist in the vicinity, and the vehicle must be capable of being easily removed in an emergency. Drivers must inform the hauler of their overnight parking location. The overnight parking locations must be selected in accordance with regulations.

Severe weather conditions

When severe weather conditions are experienced during transport, for example rainy roads or poor visibility, the delivery should be stopped at the next suitable parking place

Delays or accidents

All delays during transport, whether due to severe weather conditions, breakdown or other reasons must be reported to the consignor as soon as possible. Transport accidents must also be reported to the consignor as soon as possible.

Pressure and temperature checks

For road transport the pressure and/or temperature of the tank contents should be checked regularly and recorded on a checklist or in a logbook

Emergency procedure

Drivers should be given precise instructions as to the acceptable pressure and temperature rise during the journey, and the emergency action to be taken in the event that readings in excess of acceptable levels are observed.

Recommended instructions are given below

If the appropriate transport regulations are complied with, and the requirements set out in this document are adhered to, the risk of a transport emergency involving material is very small. Nevertheless, it is essential that drivers should be aware of the appropriate action to be taken should an emergency occur.

1. Increase of temperature or pressure in the tank

During the journey, the temperature of the material should not increase. Normally the pressure in the tank should not increase, and under normal circumstances will only do so if the temperature increases. If a more rapid rate of temperature increase is observed, or a significant increase in pressure is observed, apply the following emergency procedure:

- Do everything possible to drive the vehicle to an open space away from buildings and populated areas. Park and leave the vehicle, taking with you:
    - Any temperature/pressure records,
    - The transport emergency card,
    - The transport documents.
- Alert everybody in the surroundings and keep people away.
- Contact immediately the local Police and the Fire Brigade.
- Ensure that the consignor is notified as soon as possible and provide detailed information - when the increase started, how long has the temperature/ pressure been increasing, what is the present temperature/pressure.
- Assist the local authorities and hand over the transport emergency card.

2. Vapour/liquid leakages and/or fire

- Abandon the vehicle immediately.
- Alert everybody in the surroundings and keep people as far away from the vehicle as possible.
- Contact immediately the local Police and the Fire Brigade.
- Ensure that the consignor is notified as soon as possible.

3. In the case of accident involving injury or immobilization of the vehicle, but no leakage or fire

- Contact immediately the local Police.
- Ensure that the consignor is notified as soon as possible.
- If the vehicle cannot be moved, the emergency flashing lights should be positioned to protect the front and rear of the vehicle. Checks of the temperature and pressure of the tank should continue to be made and recorded.

Routine inspection of road tankers and tank containers at loading terminals

If any of the following conditions are not met, the loading operation must be stopped and the situation rectified before loading is allowed to continue.

1. Before loading

- The consignor has to ensure goods carriage has a valid registration to carry the hazardous goods.
- The vehicle is equipped with necessary First-aid, Safety equipments and Antidotes.
- The transporter or owner of the goods carriage has full and adequate information about the dangerous or hazardous goods being transported.
- The owner of the goods carriage should ensure that the driver holds a driving license as per provisions of the Central Motor Vehicle Rules.
- The driver of the goods carriage is to be trained during transport of such goods.
- The owner of the goods carriage carrying dangerous or hazardous goods and the consignor of such goods shall lay down the route for each trip or permitted otherwise by police authorities.
- Are there any visual objections on the truck against safe driving?
- For tank containers, is the tank container plate valid?
- Are all 'dangerous goods' labels fitted, are the identification numbers attached.
- Provide a Tremcard (Transport Emergency Card) contains details regarding the type of cargo, nature of hazards, emergency action, the protective devices, spillage control, first aid, etc. to driver.
- For road transport: is the Tremcard in all required languages on board?
- Does the driver possess all the items of protective clothing and safety equipment? (as specified by the Tremcard)
  Determine the maximum payload based on :
- tare weight
- country of destination
- transport mode
- maximum filling degree
- Are all the valves closed upon arrival?
- Is the tank placed at the correct loading position?
- Are the wheels of the tank blocked by wheel blocks or other tools?
- Do all valves function correctly?

2. Whilst loading

Is the maximum degree of filling not exceeded?

3. After loading

- Is the maximum gross weight not exceeded? (check by weighbridge)

- Is a leakage test performed (bottom valve and end valve)?
- Are all valves closed and blinded, with all bolts in place or are all dry disconnect couplings / metal caps in place?
- Are all seals or locks in place?

General actions to be taken during emergency

- If possible drive out of populated areas.
- Identify the cargo, refer labels, TREM Card, instructions.
- In case of a major leak of highly inflammable gas/ Vapour, do not start the engine.
- Order on lookers to leave the affected area.
- Stop pilferage of the leaked substance, it can be dangerous.
- Secure the accident area and divert traffic.
- Remove affected persons for first aid.
- In the event of electrical fire, isolate the battery of the vehicle.
- In case of fire, inform Fire Station, avoid inhalation of fumes, and use gas masks if required.
- In case of leaks, see if it can be arrested easily.
- Contain small spills by covering with sand.
- Avoid direct contact with skin, wash with water and use necessary protective clothing like PVC apron.
- In case of contact with eyes or skin wash with plenty of water. For any major contamination, remove clothing immediately

1.1.7 Training Rehearsal and Records

Need for Training and Rehearsal

It is important that every emergency plan, when finalized should be written down and communicated to all concerned. After making persons aware of such plants, the plan itself should be put to test, preferably in parts, to begin with, so that the effectiveness can be assessed and alternatives developed. After this more extensive exercise can be conducted once a year involving outside agencies also. This will not only enable the industrial plant personnel to enhance their speed of mobilization, but also will help the outside agencies to improve their effectiveness in responding to emergencies.

These exercises will help to refine the procedures by identifying deficiencies and difficulties. At this stage more elaborate exercise can be planned to involve the outside services who should be closely involved at the planning stage services who should be closely involved at the planning stage. Each exercise should be monitored by a member of independent observers located at various positions.

Mock Drill Records & Observation:

We will carry out mock drill and record of that will be maintained. Observation made during each mock drill will be recorded and corrective action will be taken to correct any short fall or in action plan. Emergency plan will be updated based on this deficiencies omissions of short comings identified during the rehearsal will be reviewed and incorporated in the on-site emergency plan for continual updating of the plan.

ANNEXURES

Annexure 1: Methodology of Risk Assessment and Hazard Identification

Methodology

Hazards that can lead to accidents in operations are discussed in this section. Important hazardous events are classified as under.

Event Classification

Type of Event	Explanation
Explosion	A release of large amount of energy that form a blast wave
Fire	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
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 (Vapour 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 shown below:

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 vapor 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.

Overpressure Damage

Overpressure (bar)	Damage
0.020	projectile limit; some damage to house ceilings; 10% window glass broken
0.088 to 0.136	Steel frame of clad building slightly distorted Partial collapse of walls and roofs of houses
0.204 to 0.272	Frameless, self -framing steel panel building demolished; rupture of oil storage tanks

Source: CCPS Consequence analysis of chemical release

Meteorology

Atmospheric stability plays an important role in the dispersion of the chemicals. "Stability means, its ability to suppress existing turbulence or to resist vertical motion".

Atmospheric stability plays an important role in the dispersion of chemicals. "Stability means, its ability to suppress existing turbulence or to resist vertical motion".

Variations in thermal and mechanical turbulence and in wind speed are greatest in the atmospheric layer in contact with the surface. The air temperature has influenced these turbulences greatly and air temperature decreases with the height. The rate at which the temperature of air decreases with height is called Environment Lapse Rate (ELR). It will vary from time to time and from place to place. The atmosphere is said to be stable, neutral or unstable according to ELR less than, equal to or greater than Dry Adiabatic Lapse Rate (DALR), which is a constant value of 0.98 ºC per 100 meters.

When the atmosphere is unstable and wind speeds are moderate or high or gusty, rapid dispersion of vapors will occur. Under these conditions, air concentrations will be moderate or low and the material will be dispersed rapidly. When the atmosphere is stable and wind speed is low, dispersion of material will be limited and air concentration will be high.

Weather Conditions

Weather categories selected for consequence analysis is tabulated below:

Weather Condition Selected

Time	Remarks	Weather Condition		
		Temperature in ºC	Wind speed m/s	Stability Class
Day Time	Prevalent during the day, most times of the year	25.4	3.3	B
Night Time	Prevalent during the night, most times of the year	21.9	2.7	E
Monsoon Period	Prevalent during the monsoon months	25.0	3.1	B

Consequences Analysis using PHAST 7.1 Software

The consequences of the release of Hazardous substances by failures or catastrophes and the damage to the surrounding area can be determined by means of models. Models help to calculate the physical

effects resulting from the release of hazardous substances and to translate the physical effects in terms of injuries and damage to exposed population and environment. To assess the damage level caused by the various accidental events, it is essential to firm up the damage criteria with respect to different types of accidents e.g. thermal radiation, toxicity, explosion overpressure etc.

Consequence analysis involves the application of mathematical, analytical and computer models for calculation of effects and damages subsequent to a hydrocarbon release accident. Consequence models are used to predict the physical behavior of the hazardous incidents. The techniques used to model the consequences of hydrocarbon and other hazardous material releases cover the following:

- Modeling of discharge rates when holes develop in process equipment/pipe work/pipeline.
- Modeling of the size and shape of flammable and toxic gas clouds from releases in the atmosphere
- Modeling of the flame and radiation field of the releases that are ignited and burn as jet fire, pool fire, flash fire and BLEVE/ Fire ball
- Modeling of the explosion fields of releases, which are ignited away from the point of release

The information normally required for consequence analysis includes meteorological conditions, failure data of equipment and components, ignition sources, population characteristics within and outside the plant, acceptable levels of risk etc.

MCAS Development Techniques

As a first step towards risk assessment is to identify the possible release scenarios based on available information about scenario development for Maximum Credible Accident Scenarios (MCAS).

Maximum Credible Accident Scenarios with their causes which can take place are shown below:

Details of Accident Scenario with its causes

S. No.	Accident Scenario	Causes
1	Minor Spill	Hose failure during road tanker unloading to storage tank, Pipeline/ pump gland leakage, Gasket failure, Spill of acidic/ flammable material
2	Large Spill	Failure of bottom valve or catastrophic failure of reactor/ storage tanks, evaporator Overturning of tanker
3	Explosion. Release of high velocity Fragments of ruptured Equipment due to over pressure condition.	Run away Reaction, Uncontrolled exothermic reaction, Pressure development
4	Fire	Any spill of flammable material catching fire on finding of ignition source
5	Fire & Explosion due to leak of Hydrogen	Improper operations, handling, failure of operational/ process control.
6	Electric Fire	At electrical installations, Transformer area, Loose cable, Overloading on cables etc.
7	Fall of Structure	Earthquake, poor maintenance
8	Release of toxic flammable vapors	Failure of equipment and/or storage
9	Air, Water, Soil Pollution	Leak of spill of any material- Solid, Liquid or Gaseous. Toxic gas release from the neighboring company.

S. No.	Accident Scenario	Causes
10	Heavy rain fall/ Flooding	Natural calamity
11	Risk from surrounding Company	Due to leak of toxic gas from the process/ storage tank/ cylinders etc. Explosion in reactor or tank due to overpressure
12	Fire in nearby company	Due to unsafe material handling loading- unloading and failure in process control.

Failure Rates

A leak or rupture of the tank / pipe, releasing some or all of its contents, can be caused by brittle failure of the tank walls, welds or connected pipework due to use of inadequate materials, combined with loading such as wind, earthquake or impact. The failure rates are the deciding factor for selecting the MCAS'. The failure rates for selected MCAS' are given below:

Failure Frequencies for Storage Tanks

Categories	Catastrophic Rupture Frequency (per tank per year)	Leak Frequency (per year)
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

Internationally recognized yardsticks for measuring risk

Risk assessment is considered using certain internationally recognized yardsticks for measuring risk. These first need to be explained, and this is done as per table shown below:

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, avoid air travels
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.

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Environment for Development

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