7 ADDITIONAL STUDIES

A. RISK ASSESSEMENT

This chapter includes a brief description of Risk & Hazard study of M/s. Kumar organic products limited. The company proposes to increase its production capacity from 162.17 MTM to 409.17 MTM with inclusion of 4 new products (Ammonium Thioglycolate, PCMX Brown, Sodium Pyrithione and Benzalkonium Chloride 80%) and increase in the capacity of some existing products as well. Company will expand its production capacity by expanding its facility at Plot no.: 395 adjacent plot to existing unit at Plot no.: 379, Canal Road, Luna Village, Padra Taluka, Vadodara District, Gujarat-391440.

Company shall handle chemicals, some of which are hazardous in nature by virtue of their intrinsic chemical properties or their operating temperatures or pressures or a combination of them. Fire, toxic release or combinations of them are the hazards associated with industrial plants using hazardous chemicals. More comprehensive, systematic and sophisticated methods of Safety Engineering, such as, Hazard Analysis and Qualitative/Quantitative Risk Assessment have been developed to improve upon the integrity, reliability and safety of industrial plants, the same has been discussed in detail under their respective headings.

Scope of Study

1. Hazard Identification
2. Risk Management
3. Disaster management Plan
4. Occupational Health Safety

7.1 METHODOLOGY

The steps involved in risk assessment methodology are as follows:

1. Hazard Identification - by studding the information on plant location, layout of the equipment & process condition
2. Hazard Assessment - by qualitative risk analysis and quantitative risk analysis. Quantification of Hazard involves selection of most credible scenario or worst case scenario; Estimate consequences scenarios in the plant such as fire, explosion and toxic effect; Estimate frequency of occurrence of any incident is to be found out by reliability analysis
3. Prioritize and Reduce Risk - by providing control / mitigation measures
4. Preparing Disaster Management Plan - to face any accident and disaster caused by the project operations.

7.2 HAZARD IDENTIFICATION

7.2.1 HAZARDOUS MATERIALS STORAGE DETAILS & LAYOUT

The solid raw materials will be received in bags or drums and will be stored in chemicals storage area. The products will be packed in bags or drums and stored in storage area as per market demand. The bulk storages of hazardous materials are given in the **Table 7.2** below. In addition unit will store fuels mainly agro waste, briquette for boiler, and HSD (in limited quantity) for D.G. Set (during power failure only).

The solid material powder or granules spillage can results in polluting small area only. The damage to personnel can be through ingress- dermal (if individual come in contact), oral (if individual food gets infected through fugitive dust) or inhalation (fugitive dust).

The main route is fugitive dust which in covered area will move to short distance only. The risk is through liquid products which are volatile material. The toxic vapours due to spillage of such material can travel to some distance (as they are stored in covered storage area) and cause damage.

TABLE 7.1: STORAGE FACILITY OF RAW MATERIALS

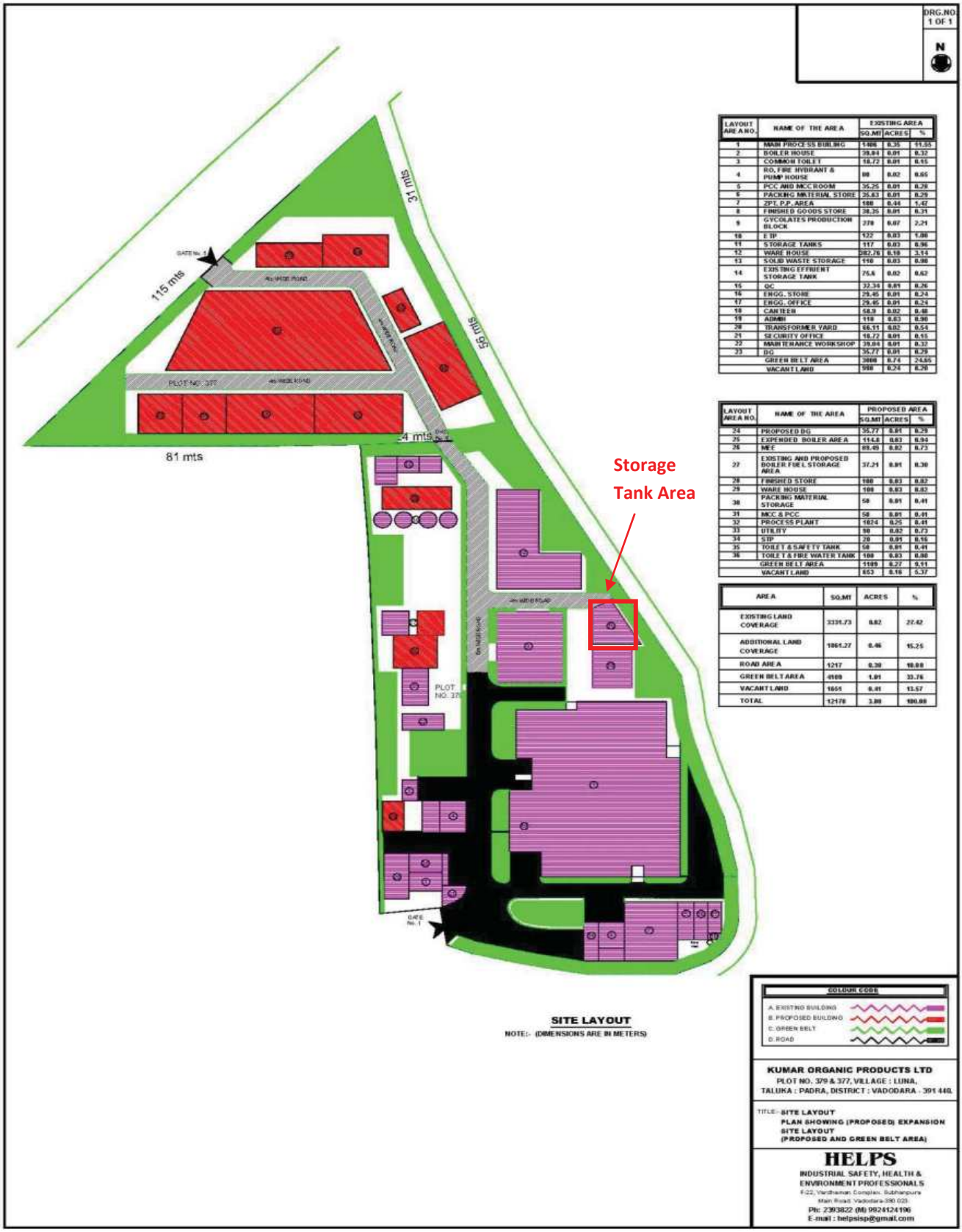
Sr. No.	Type	Mode	Area Provided
1	Raw Material	Bags, Drums & Tank	117 m^2

TABLE 7.2: BULK STORAGE OF HAZARDOUS CHEMICALS

Sr. No.	Raw Material	Height	Width	Capacity (MT)	MOC
1	Potassium Hydroxide	76 cm	48 cm	9.8	PP Bags
2	Thioglycolic Acid	89 cm	30 cm	50.8	HDPE Drums
3	Ammonia Sol.	100 cm	30 cm	10.0	MS Drums
4	HCl 28%	2510 mm	OD 2550 mm	2200	PP FRP
5	Chlorine	MS Tonners		9.9 (900 kg × 11 Nos.)	MS
6	Benzyl chloride	89 cm	30 cm	7.0	HDPE Drums
7	Isopropyl Alcohol	89 cm	30 cm	0.9	MS Tank

LAYOUT MAP

The storage facilities for the raw material have been shown in the layout map as shown in Figure: 7.1.



LAYOUT AREA NO.	NAME OF THE AREA	EXISTING AREA		
		SQ.MT	ACRES	%
1	MAIN PROCESS BUILDING	1406	0.35	11.55
2	BOILER HOUSE	38.84	0.01	0.32
3	COMMON TOILET	18.72	0.01	0.15
4	R.O. FIRE HYDRANT & PUMP HOUSE	80	0.02	0.66
5	PCC AND MCC ROOM	35.25	0.01	0.29
6	PACKING MATERIAL STORE	35.83	0.01	0.29
7	ZPT, P.P. AREA	180	0.04	1.47
8	FINISHED GOODS STORE	38.35	0.01	0.31
9	GYCOLATES PRODUCTION BLOCK	270	0.07	2.21
10	ETP	122	0.03	1.00
11	STORAGE TANKS	117	0.03	0.96
12	WARE HOUSE	382.76	0.10	3.14
13	SOLID WASTE STORAGE	110	0.03	0.90
14	EXISTING EFFRIENT STORAGE TANK	75.6	0.02	0.62
15	QC	32.34	0.01	0.26
16	ENGG. STORE	29.45	0.01	0.24
17	ENGG. OFFICE	29.45	0.01	0.24
18	CANTEEN	58.9	0.02	0.48
19	ADMIN	110	0.03	0.90
20	TRANSFORMER YARD	66.11	0.02	0.54
21	SECURITY OFFICE	18.72	0.01	0.15
22	MAINTENANCE WORKSHOP	38.84	0.01	0.32
23	DG	35.77	0.01	0.29
	GREEN BELT AREA	3000	0.74	24.55
	VACANT LAND	980	0.24	8.02

LAYOUT AREA NO.	NAME OF THE AREA	PROPOSED AREA		
		SQ.MT	ACRES	%
24	PROPOSED DG	35.77	0.01	0.29
25	EXPENDED BOILER AREA	114.8	0.03	0.94
26	MEE	85.49	0.02	0.73
27	EXISTING AND PROPOSED BOILER FUEL STORAGE AREA	37.21	0.01	0.30
28	FINISHED STORE	100	0.03	0.82
29	WARE HOUSE	100	0.03	0.82
30	PACKING MATERIAL STORAGE	50	0.01	0.41
31	MCC & PCC	50	0.01	0.41
32	PROCESS PLANT	1024	0.25	8.41
33	UTILITY	90	0.02	0.73
34	STP	20	0.01	0.16
35	TOILET & SAFETY TANK	50	0.01	0.41
36	TOILET & FIRE WATER TANK	100	0.03	0.80
	GREEN BELT AREA	1100	0.27	9.11
	VACANT LAND	653	0.16	5.37

AREA	SQ.MT	ACRES	%
EXISTING LAND COVERAGE	3331.73	0.82	27.42
ADDITIONAL LAND COVERAGE	1861.27	0.46	15.25
ROAD AREA	1217	0.30	10.00
GREEN BELT AREA	4100	1.01	33.76
VACANT LAND	1665	0.41	13.57
TOTAL	12176	3.00	100.00

Figure 7.1: Layout Plan Showing Storage Facilities

7.2.2 HAZARD AND DAMAGE ASSESSMENT

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

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

Consequences of Fire/ Heat Wave

The effect of thermal radiation on people is mainly a function of intensity of radiation and exposure time. The effect is expressed in term of the probability of death and different degree of burn. The consequence effects studied to assess the impact of the events on the receptors are provided in **Table: 7.3.**

TABLE 7.3: DAMAGE DUE TO RADIATION INTENSITY

Radiation (kW/m2)	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 overpressure and a few hundred kilopascals (kPa). Whereas dwelling are demolished and windows and doors broken at overpressures as low as 0.03- 0.1 bar. Direct injury to people occurs at greater pressures. The pressure of the shock wave decreases rapidly with the increase in distance from the source of the explosion. The overpressure damage is shown in **Table 7.4**.

TABLE 7.4: OVERPRESSURE DAMAGE

Overpressure (bar)	Damage
0.02068	Limited minor structural damage, Glass damage
0.21	Corrugated asbestos shattered; corrugated steel or aluminium panels, fastenings fail, followed by buckling, wood panels (standard housing) fastenings fail, panels blown in, structural damage to Buildings
1	Fatality

Source: CCPS Consequence Analysis of Chemical Release

Consequences of Toxic Release

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

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

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

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

Following are some of the common terms used to express toxicity of materials.

- **Threshold Limit Value (TLV):** It is the permitted level of exposure for a given period on a weighted average basis (usually 8 hr./day, 40h/week)
- **Short Time Exposure Limit (STEL):** It is the permitted short term exposure limit usually for a 15 minutes exposure.
- **Immediately Dangerous to life and health (IDLH):** It represents the maximum concentration of a chemical from which is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment.
- **Lethal Concentration Low (LCLo):** It is the lowest concentration of a material in air, other than LC50, which has been reported to cause a death in human or animals.
- **Toxic Concentration Low (TCLo):** It is the lowest concentration of a material in air, to which humans or animals have been exposed for any given period of time that has produced a toxic effects in humans or produced carcinogenic, neoplastigenic or tetratogenic effect in humans or animals.
- **Emergency Response Planning Guidelines1 (EPRG1):** The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour (without a respirator) without experiencing other than mild transient adverse health effects or without perceiving a clearly defined objectionable odor.
- **Emergency Response Planning Guidelines2 (ERPG2):** The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.
- **Emergency Response Planning Guidelines3 (ERPG3):** The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.

7.2.3 CHEMICAL PROPERTIES

The information on the hazardous properties from MSDS of the chemicals handled at the site has been reviewed to identify the associated hazards. The Physico-chemical properties of various chemicals are listed along with relevant hazard as per given in Table7.5.

TABLE 7.5: PHYSICO-CHEMICAL PROPERTIES OF CHEMICALS

Sr. No.	Raw Materials/ Products	Formula	State	Flash Point (°C)	Melting Point (°C)	Boiling Point (°C)	IDLH (ppm)	Hazard	UEL %	LEL %	LD50/ LC50	Vapor Density	Odour threshold (ppm)
1	KOH Flakes	KOH	Solid	N.A.	360	1320	NA	Class - 8	N.A.	N.A.	LD50 Oral 333 mg/kg (Rat)	N.A.	N.A.
2	Thioglycolic acid 80%	$C_2H_4O_2S$	Liquid	131	-160	1200	NA	Class - 8	N.A.	N.A.	N.A.	3.2	N.A.
3	Ammonia Sol.	NH_3	Liquid	N.A.	-77	-33	300	Class - 6/ 8	25	16	LC50 2000 ppm/4H	0.62	N.A.
4	Hydrochloric Acid 28%	HCl	Liquid	N.A.	NA	50.55	50	Class - 6/ 8	N.A.	N.A.	N.A.	N.A.	N.A.
5	Chlorine	Cl_2	Gas	N.A.	-101	34.6	10	Class - 6/ 8	N.A.	N.A.	LC50 inhalation 146.5 ppm/4h (Rat)	N.A.	N.A.
6	Benzyl chloride	C_7H_7Cl	Liquid	67	-43	179	10	Class - 8	N.A.	N.A.	N.A.	4.36	0.041
7	Isopropyl alcohol	C_3H_8O	Liquid	11.6	-88.5	82.5	2000	Class - 3	N.A.	N.A.	LD50 Oral Acute: 5045 mg/Kg (Rat)	2.07	22

N.A.: Not Available

TABLE 7.6: TOXICITY INDEX AS PER MSIHC RULE 2000

Sr. No.	Toxicity	Oral toxicity LD50 (mg/kg)	Dermal toxicity LD50 (mg/kg)	Inhalation toxicity LC50 (mg/l)
1	Extremely Toxic	>5	<40	<0.5
2	Highly Toxic	>5-50	>40-200	<0.5-2.0
3	Toxic	>50-200	>200-1000	>2-10

TABLE 7.7: THRESHOLD STORAGE QUANTITIES AS PER MSIHC RULES

Sr. No.	Chemicals	Threshold Quantities (Tons)	
		[For application of rules 4,5,7 to 9 and 13 to 15]	[For application of rule 10 to 12]
1	Ammonia	60	600
2	Chlorine	10	25
3	Flammable gases	15	200
4	Extremely Flammable Liquids	1000	5000
5	Very Highly Flammable Liquids	1500	10000
6	Highly Flammable Liquids (pressurized form)	25	200
7	Highly Flammable Liquids (Ambient Pressure)	2500	20000
8	Flammable Liquid	5000	50000

As per MSIHC Rule No.:

Rule No. 4: General responsibilities of the occupier
Rule No. 5: Notification of industrial activity
Rule No. 6: Industrial activity to which rules 7 to 15 apply
Rule No. 7: Approval and notification of sites
Rule No. 9: Transitional provision
Rule No. 10: Safety report
Rule No. 11: Updating of safety report
Rule No. 12: Requirements for further information
Rule No. 13: Preparation of onsite emergency plan
Rule No. 14: Preparation of off site emergency plan
Rule No. 15: Information to be given to person likely to be affected by a Major accident.

7.2.4 SUMMARY

The chemical properties shown in the above table describes the nature of hazard associated to the chemicals i.e. Flammable, Toxic & Corrosive. The chemical like isopropyl alcohol having less flash point from other chemicals like benzyl chloride, & thioglycolic acid etc. used in the manufacturing process. The safety measures and mitigation for the Acids, highly flammable, toxic chemicals refer section 7.3.

7.3 QUALITATIVE RISK ASSESSMENT

Many a times Risk involved in various processes / process equipment's cannot be addressed completely by Consequence Analysis. As a conservative approach, these risks have been considered separately under this topic. The approach is to identify hazards associated in operation of equipment as well as in processes, assessing its impacts, ranking the risk posed by it and finally to propose remedial actions/mitigation measures such that the risk is minimized to tolerable level.

Qualitative Risk Assessment has been carried out for the following areas:

- Storage and Handling of Acids;
- Storage and Handling of Flammable Chemicals;
- Storage and Handling of Toxic Chemicals;
- Storage and Handling of other Solid Chemicals;

In Qualitative Risk Assessment, risk has been analysed using methodology called HIRA-Hazards Identification & Risk Assessment. In HIRA, major manual activities carried out by plant personnel as well as contract labours have been considered. The Risk Matrix presented in **Table 7.8**, is referred in evaluating the assessment. Risk acceptability criteria given in **Table 7.9.**

TABLE 7.8: RISK MATRIX FOR QUALITATIVE RISK ASSESSMENT

LIKE HOOD/ PROBABILITY		SEVERITY				
		Catastrophic (Death/ System Loss)	Major/ Critical (Serious injury/ Illness)	Moderate (Less Serious Injury/ Illness)	Minor/ Marginal (Minor Injury/ Illness)	Insignificant/ Negligible (No injury/illness)
		5	4	3	2	1
Almost Certain	E	H	H	H	M	M
Likely	D	H	H	M	M	L
Possible	C	H	M	M	M	L
Unlikely	B	M	M	M	L	L
Impossible	A	M	M	L	L	L

TABLE 7.9: RISK ACCEPTABILITY CRITERIA

Risk Range	Risk Acceptability Criteria	Remarks
H	Unacceptable/ High	Management's Decision/Action Plan Required. Potential off-site Impact.
M	Medium	Generally Minor Impact. Acceptable with Management's Review. Specific monitoring or SOP to be followed.
L	Low	Acceptable without Review. Manage through Routine Procedure.

TABLE 7.10: HAZARD IDENTIFICATION AND RISK ASSESSMENT

Sr. No.	Process Or Activity	Associated Hazards	Health & Safety Impact (Risk)	Initial Risk			Control / Mitigation Measures	Residual Risk		
				Severity	Likelihood	Risk		Severity	Likelihood	Risk
A	**Storage and Handling of Acids**									
1	Loading & Unloading of acids like HCL, Thioglycolic Acid (80%),	Exposure to acid fumes due to leakage /spillage in pipe/container/ valves etc.	Skin/Eye irritation. Toxic Vapor inhalation etc.	2	C	**M**	Use of right MOC. Periodic Inspection of flanges/ferrule joints is carried out. Loading & Unloading activity will be carried out in well-ventilated area. Neutralization media is made available in areas where acid are stored/handled/used. Acid proof flooring will be done at storage and handling area. Use of acid resistant glove, apron, face shield, eye goggles, nose mask, gumboot & helmet.	2	B	**L**
B	**Storage and Handling of Flammable Chemicals**									
1	Unloading and use of Isopropyl alcohol	Spillage/ Leakage. Fire Explosion	Fire Burn injury Damage to equipments and facilities	2	C	**M**	Spill containment is done. No hot work is carried out nearby. Ignition sources are avoided in such areas. Fire extinguishers are kept available. Appropriate PPEs like Safety Goggles, Butyl or Nitrile rubber gloves, gumboot, plastic apron etc. will be used.	2	B	**L**

Sr. No.	Process Or Activity	Associated Hazards	Health & Safety Impact (Risk)	Initial Risk			Control / Mitigation Measures	Residual Risk		
				Severity	Likelihood	Risk		Severity	Likelihood	Risk
C	**Storage and Handling of Toxic Chemicals**									
1	Handling of Chemical (Ammonia, Chlorine, Benzyl Chloride)	Spillage / Leakage	Skin/Eye irritation Toxic Vapor inhalation	2	C	**M**	Operators/Workers to be trained for Safe Work Practices. Spillage will be cleaned or neutralized with suitable media. Chemical handling bags to be labeled properly. Chemicals will be stored in an isolated storage rooms having provision for natural & forced ventilation. Certified Dust respirator shall be used. Use of Suitable protective clothing, gloves, and boots shall be used.	2	B	**L**
D	**Storage and Handling of other Solid Chemicals**									
1	Handling, Cleaning of Solid Chemicals (KOH flakes)	Chemical Exposure	Skin/Eye irritation	2	C	**M**	Loading & Unloading activity shall be carried out in well-ventilated area under proper supervision. Immediate collection of spilled chemicals. Rubber or neoprene gloves and additional protection including impervious boot, apron shall be used. PPEs like chemical safety goggles, apron and full face shield.	2	B	**L**

7.4 QUANTITATIVE RISK ASSESSMENT

Quantitative Risk Assessment (QRA) is a structured approach to identifying and understanding the hazards and risks associated with Storage and Handling of flammable/ toxic chemicals. The assessment starts by taking into account an inventory of hazardous chemicals stored, likelihood of leakage/ spillage associated with it and selecting the worst case scenario for consequence estimation. Finally, suggesting the measures to minimize or mitigate risks to meet appropriate acceptability criteria. The planning for emergency evacuation shall be borne in mind whilst interpreting the results.

7.4.1 CONSEQUENCES ANALYSIS

In a plant handling hazardous chemicals, the main hazard arises due to storage and handling of hazardous chemicals as mentioned above. If these chemicals are released into the atmosphere, it may cause damage due to resulting fires or vapor clouds. Blast overpressures depend upon the reactivity class of material between two explosive limits.

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 behaviour 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.

7.4.2 DAMAGE CRITERIA

In consequence analysis studies, in principal three types of exposure to hazardous effects are distinguished:

1. Heat radiation from jet fire, pool fire, a flash fire or a BLEVE
2. Explosion
3. Toxic effects, from toxic materials or toxic combustion products

The chosen damage criteria are given and explained as per the Guidelines for QRA – PHAST Software, version 6.7 (DNV) & Yellow Book (Consequence Modelling), Purple Book (Risk Assessment) for QRA released by Centre for Chemical Process Safety (CCPS).

The details of planning including classification of events, consequence of Fire, Consequence of Overpressure, Consequence of Toxic release, and Pasquill stability classes area given in Annexure: J

7.4.3 WEATHER CONDITION

TABLE 7.11: WEATHER CONDITION SELECTED FOR CONSEQUENCE ANALYSIS

Time	Remarks	Weather Condition		
		Temperature in °C	Wind speed m/s	Stability Class
Day Time	Prevalent during the day, most times of the year	20	2	E
Night Time	Prevalent during the night, most times of the year	19.9	2	D
Monsoon Period	Prevalent during the monsoon months	19.9	2	F

7.4.4 ABOUT THE SOFTWARE – PHAST, VERSION 6.7

The consequence analysis for the modelled scenarios has been done using DNV's software PHAST (Process Hazard Analysis Software Tool) 6.7.

PHAST is integrated into safety and meets regulatory requirements. It uses unified dispersion modeling to calculate the results of the release of material into atmosphere. Various salient features along with assumption are given in Annexure: K

7.4.4.1 Input data for software (modeling)

For consequence analysis, input data considered given in **Table 7.12.**

TABLE 7.12: INPUT DATA

Input data	Consideration
Volume inventory	Quantity of material
Scenario	Leak, Catastrophic Rupture, Line Rupture
Leak size	Catastrophic, 13 mm and 25 mm diameter hole failure rates for Benzyl chlorid storage tank; Catastrophic, 5 mm and 25 mm diameter hole failure rates for Isopropyl alcohol storage tank; Catastrophic, 5 mm and 10 mm diameter hole failure rates for ammonia storage; 2 mm, 5 mm and 10 mm diameter hole failure rates for Chlorine storage.
Storage conditions	Pressure, Temperature
Tank details	Height, Diameter
Bund details	Bund height, Bund area
Weather condition	Wind speed, Pasquill stability, Atmospheric temperature, Relative humidity

7.4.5 WEATHER CONDITION 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).

Selection of Maximum Credible Loss Scenarios (MCLS')

Following points are considered while selecting the release scenarios:

- Flash point for flammable chemicals
- IDLH of Toxic chemicals & Total inventory of the material

Operating/ Storage Temperature and Pressure of the material

TABLE 7.13: SCENARIO OF SIMULATION

Sr. No.	Chemical Name	Hazard involved	Storage Capacity (MT)	Storage Parameters		Scenario Considered	Consequences Studied
				Press. (bar)	Temp. (°C)		
1	Ammonia	Toxic	10.0	Atm.	Ambient.	Leak from 5 mm & 10 mm dia hole in storage tank	Pool Fire & Explosion
						Catastrophic Rupture of storage tank	
2	Chlorine	Toxic	9.9	Atm.	Ambient.	Leak from 1 mm & 2 mm dia hole in storage tank	Toxic Dose
3	Benzyl Chloride	Toxic & Combustible	7.0	Atm.	Ambient.	Leak from 13 mm & 25 mm dia hole in storage tank	Pool Fire & Toxic Dose
						Catastrophic Rupture of storage tank	
4	Isopropyl Alcohol	Highly Flammable	0.9	Atm.	Ambient.	Leak from 5 mm dia hole in storage tank	Pool Fire & Explosion
						Leak from 25 mm dia hole in storage tank	
						Catastrophic Rupture of storage tank	

7.4.6 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 in **Table 7.14.**

TABLE 7.14: 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

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

7.4.7 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

7.4.7.1 Ammonia

Radiation level & Overpressure effect distance due to release of Ammonia from storage tank is presented in **Table 7.15.**

TABLE 7.15: EFFECT DISTANCE DUE TO RELEASE OF AMMONIA

Chemical (Storage Tank)	Failure Scenario	Consequence	Met Data	Effective Distance in meter to Radiation Level			Overpressure Distances in Meters		
				4 kW/m^2	12.5 kW/m^2	37.5 kW/m^2	0.02 bar	0.13 bar	0.2 bar
Ammonia	5 mm Leak	Late pool fire	2/E	9	6	NR	-	-	-
			2/D	9	7	NR	-	-	-
			2/F	10	7	NR	-	-	-
	10 mm Leak	Jet fire	2/E	24	NR	NR	-	-	-
			2/D	24	NR	NR	-	-	-
			2/F	20	NR	NR	-	-	-
		Late pool fire Late ignition	2/E	18	12	NR	33	23	23
			2/D	18	12	NR	33	23	23
			2/F	18	13	NR	32	23	22
	Catastrophic Rupture	Late pool fire Late ignition	2/E	68	45	NR	170	93	90
			2/D	68	45	NR	170	93	90
			2/F	68	45	NR	142	142	139

NR: Not reached.

The contour for effect distance generated at mentioned weather condition due to release of Ammonia is presented below.

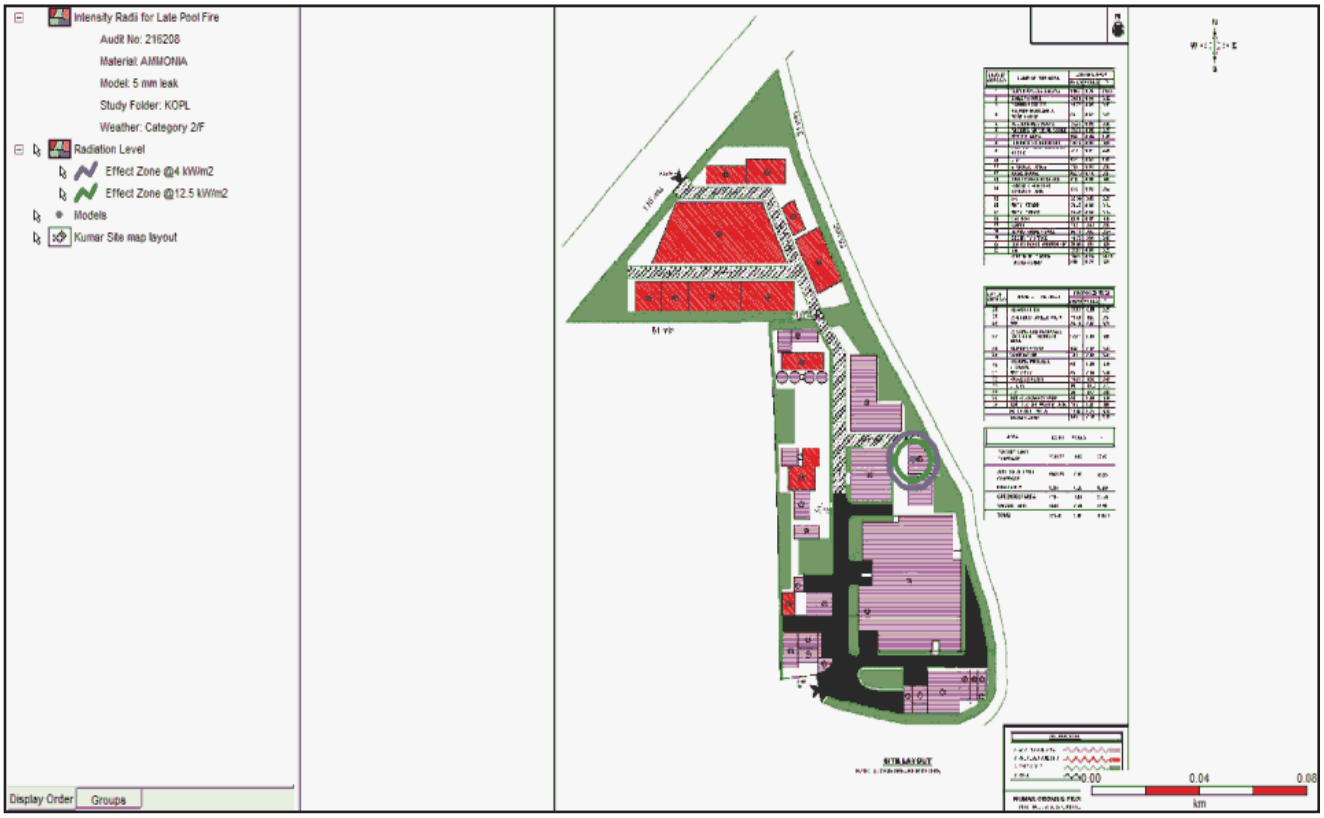


Figure 7.2: Late pool fire effect distance contour (5 mm leak, Ammonia storage tank at WC 2/F)

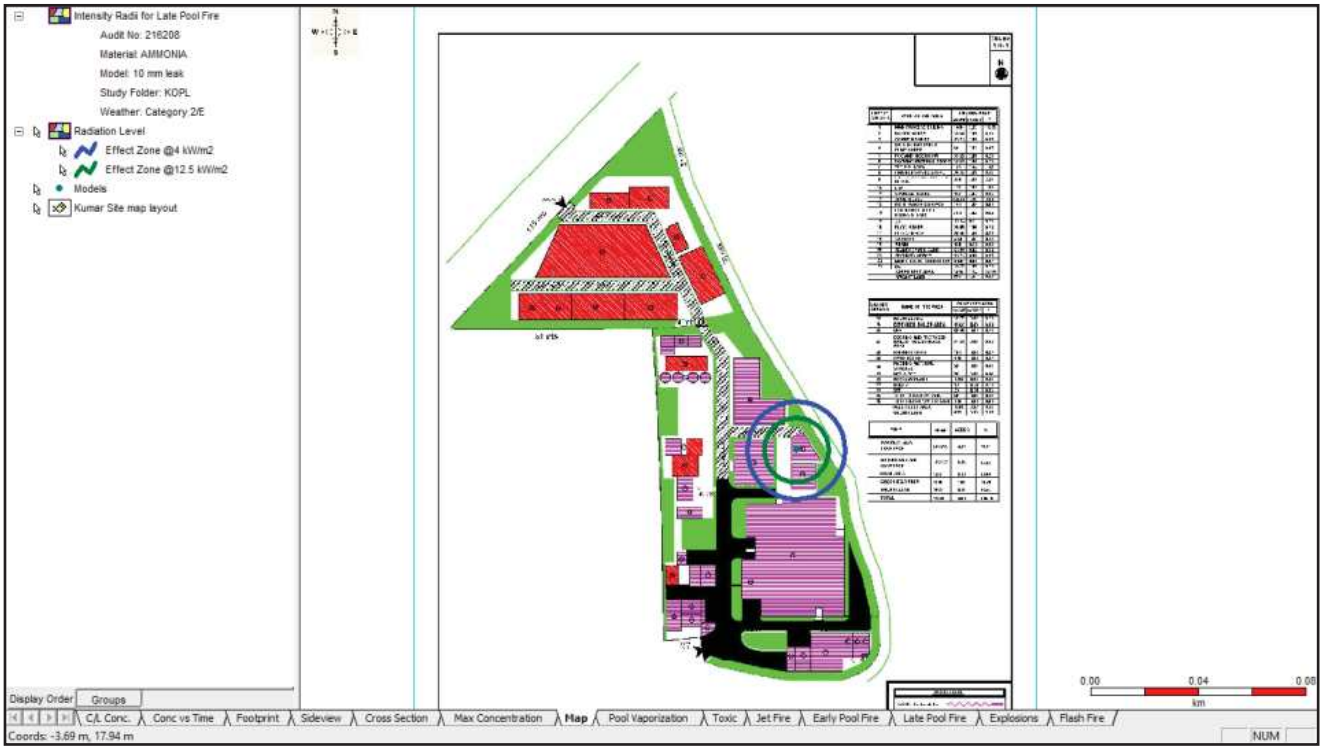


Figure 7.3: Late pool fire effect distance contour (10 mm leak, Ammonia storage at WC 2/E)

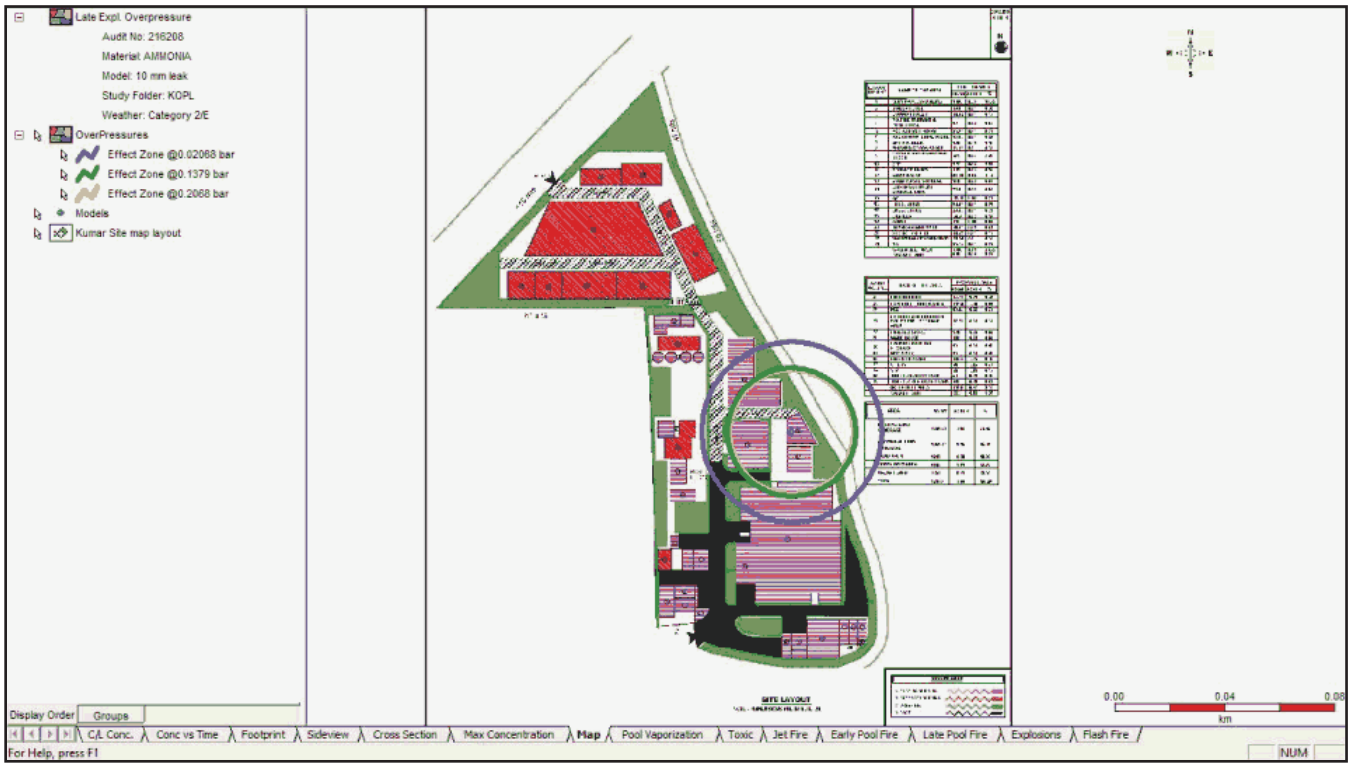


Figure 7.4: Late explosion overpressure effect distance contour (10 mm leak, Ammonia storage tank at WC 2/E)

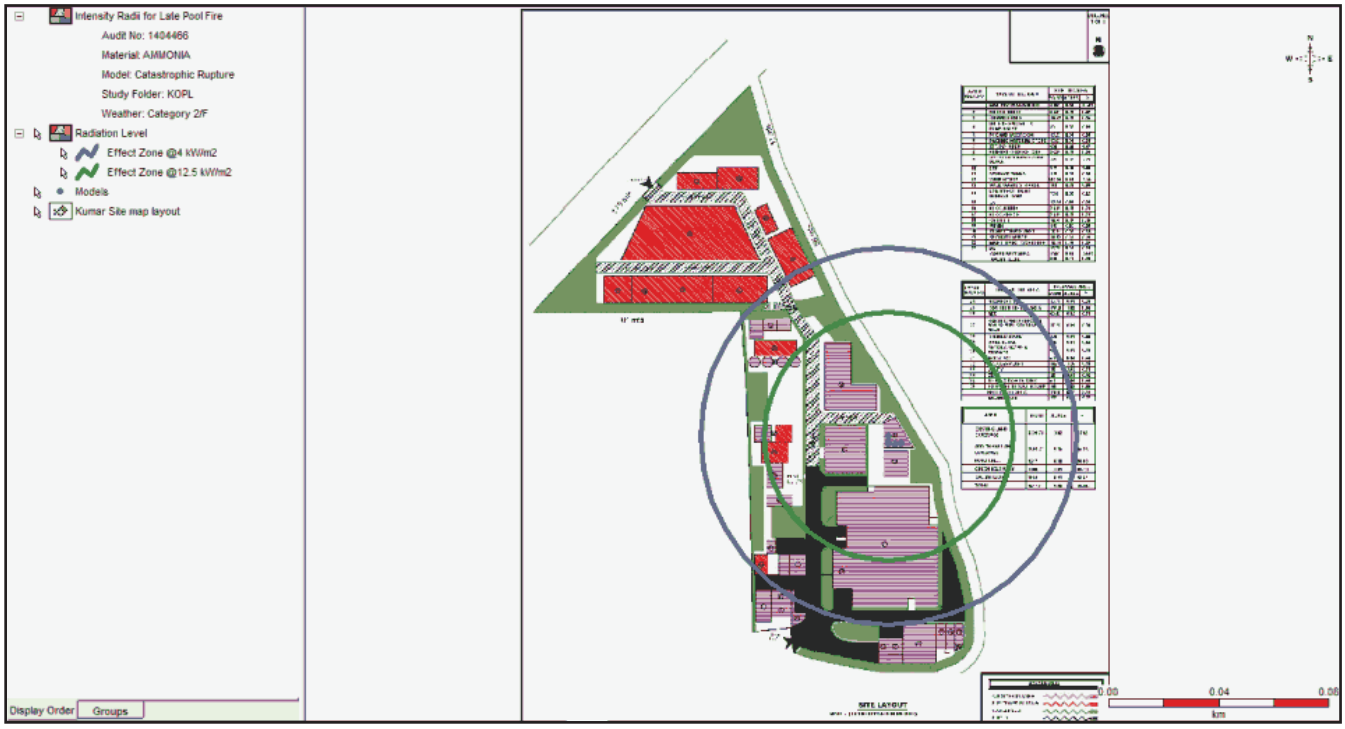


Figure 7.5: Late pool fire effect distance contour (Catastrophic Rupture, Ammonia storage tank at WC 2/F)

7.4.7.2 Chlorine

Toxic dose effect distance due to release of Chlorine from storage tank is presented in **Table 7.16.**

TABLE 7.16: EFFECT DISTANCE DUE TO RELEASE OF CHLORINE

Chemical (Storage Tank)	Failure Scenario	Consequence	Met Data	Toxic Dose Effect Distance in meter
				IDLH (10 ppm)
Chlorine	1 mm Leak	Toxic Dose	2/E	26
			2/D	26
			2/F	42
	2 mm Leak	Toxic Dose	2/E	61
			2/D	61
			2/F	108

The contour for effect distance generated due to release of Chlorine is presented below:

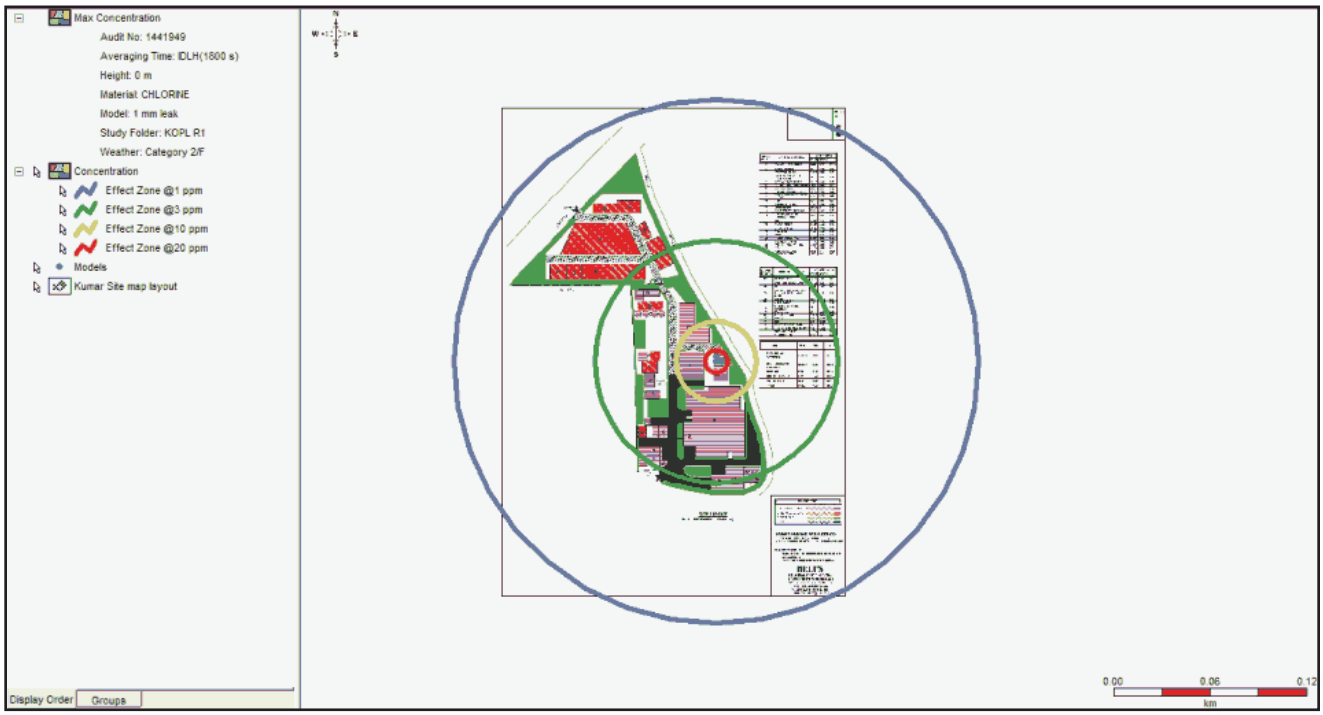


Figure 7.6: Toxic dose effect distance contour of Chlorine (1 mm leak at weather condition 2/F)

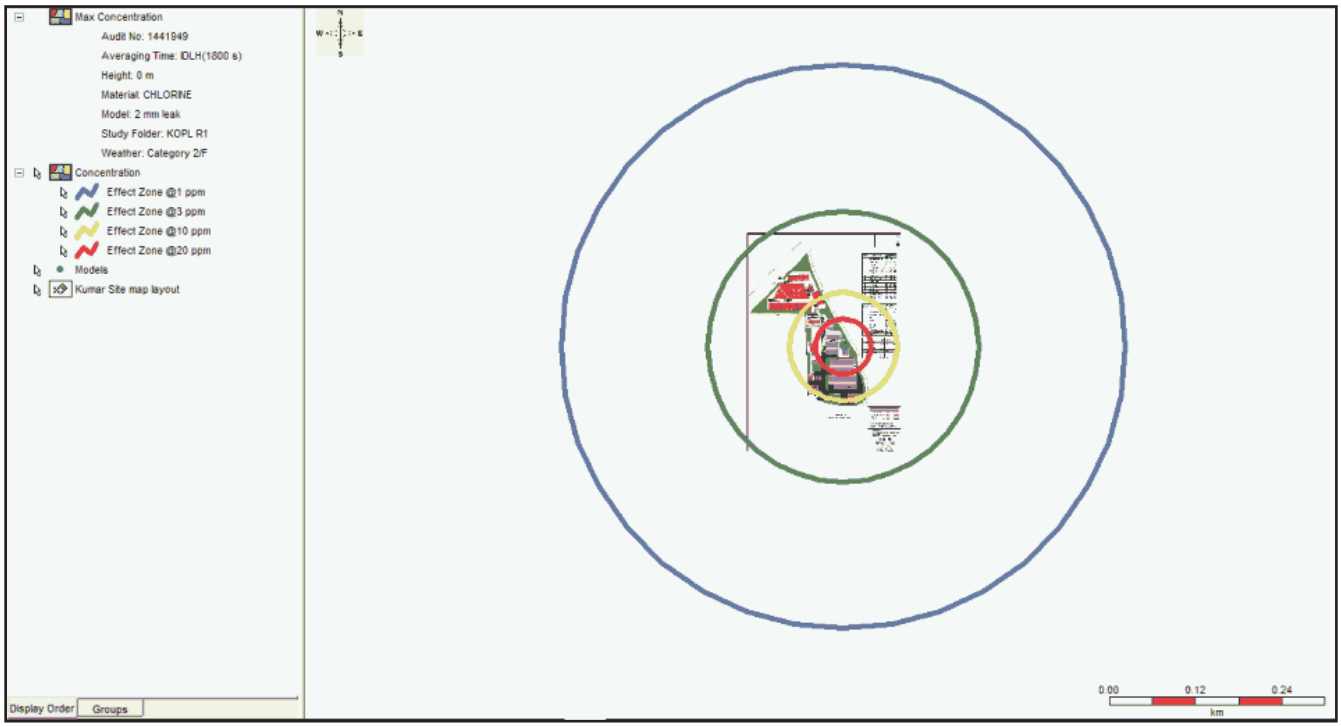


Figure 7.7: Toxic dose effect distance contour of Chlorine (2 mm leak at weather condition 2/E)

7.4.7.3 Benzyl Chloride

Radiation level & Toxic dose effect distance due to release of Benzyl chloride from storage tank is presented in **Table 7.17.**

TABLE 7.17: EFFECT DISTANCE DUE TO RELEASE OF BENZYL CHLORIDE

Chemical (Storage Tank)	Failure Scenario	Consequence	Met Data	Effective Distance in meter to Radiation Level			Toxic Dose Effect Distance in meter			
				4 kW/m^2	12.5 kW/m^2	37.5 kW/m^2	EPRG 1 (1ppm)	EPRG 2 (10 ppm)	EPRG 3 (50 ppm)	IDLH (10 ppm)
Benzyl Chloride	13 mm Leak	Late pool fire Toxic Dose	2/E	52	23	NR	992	138	69	210
			2/D	52	23	NR	394	138	69	210
			2/F	52	23	NR	229	177	60	313
	25 mm Leak	Late pool fire Toxic Dose	2/E	57	29	NR	1509	148	71	234
			2/D	57	29	NR	695	148	71	234
			2/F	66	29	NR	304	194	65	394
	Catastrophic Rupture	Late pool fire Toxic Dose	2/E	53	22	NR	800	99	9	213
			2/D	52	22	NR	800	99	9	213
			2/F	62	25	NR	1641	191	9	426

The contour for effect distance generated due to release of Benzyl chloride is presented below:

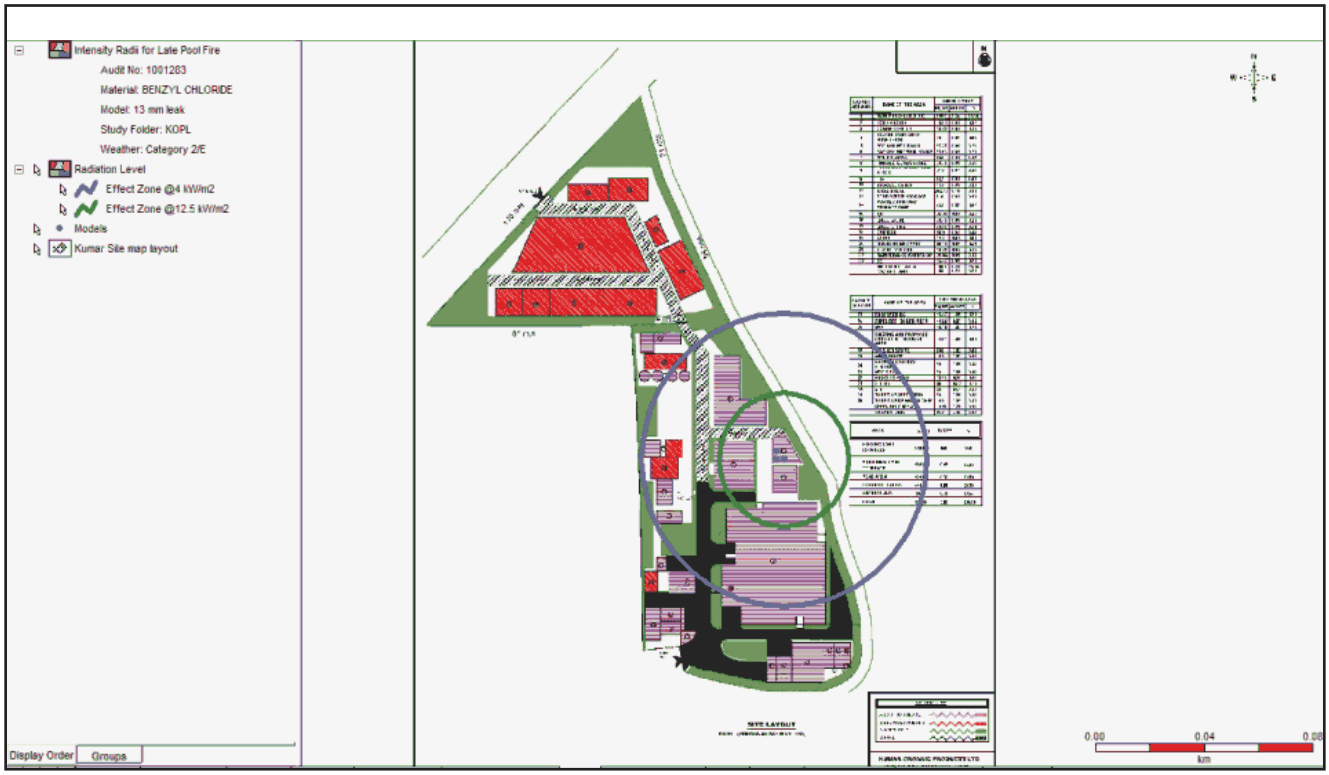


Figure 7.8: Late pool fire effect distance contour of Benzyl chloride (13 mm leak from storage tank at weather condition 2/E)

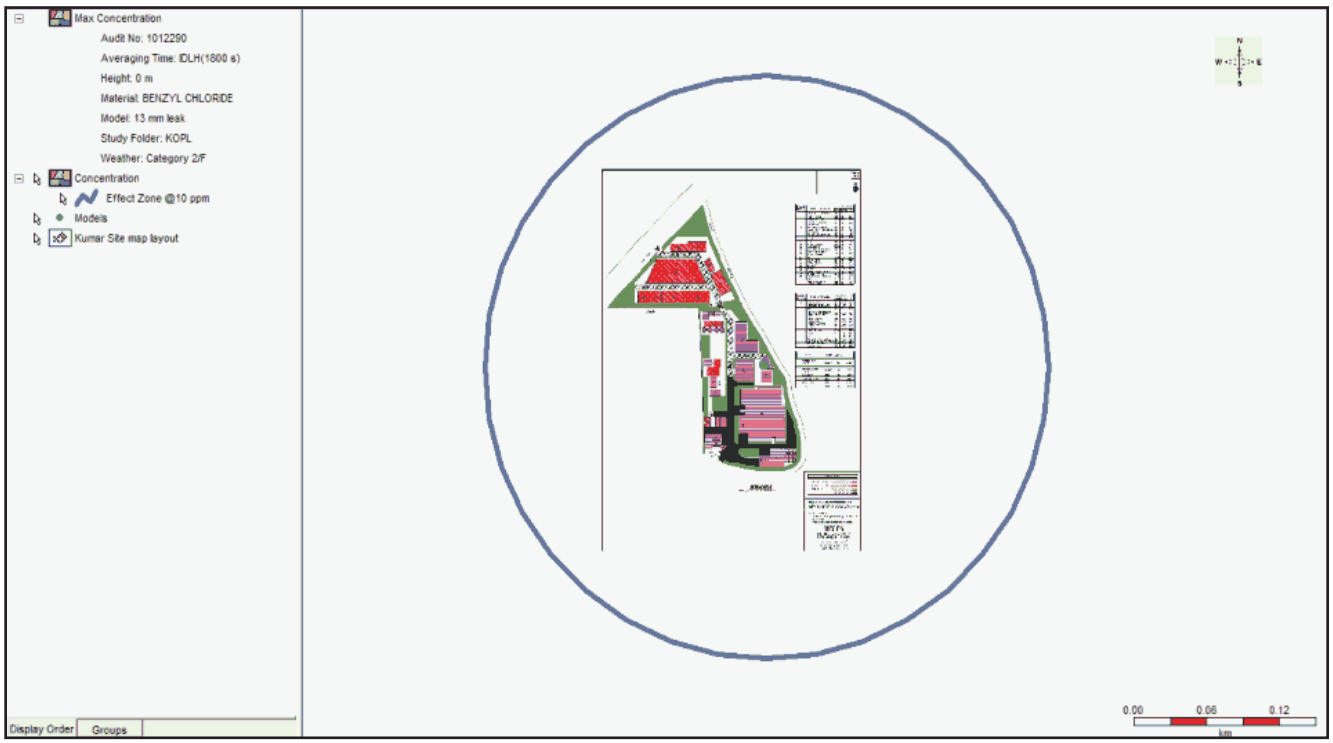


Figure 7.9: Maximum concentration effect distance contour of Benzyl chloride (13 mm leak from storage tank at weather condition 2/F)

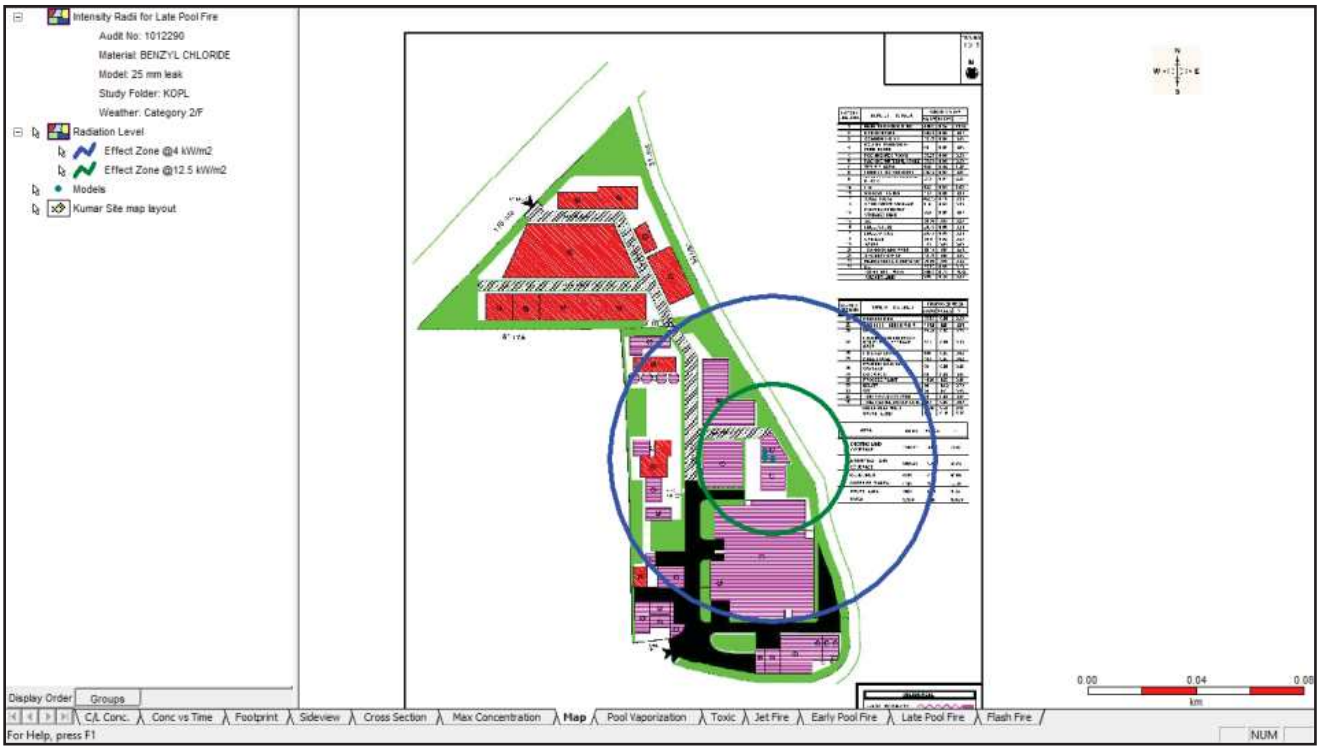


Figure 7.10: Late pool fire effect contour distance of Benzyl chloride (25 mm leak from storage tank at weather condition 2/F)

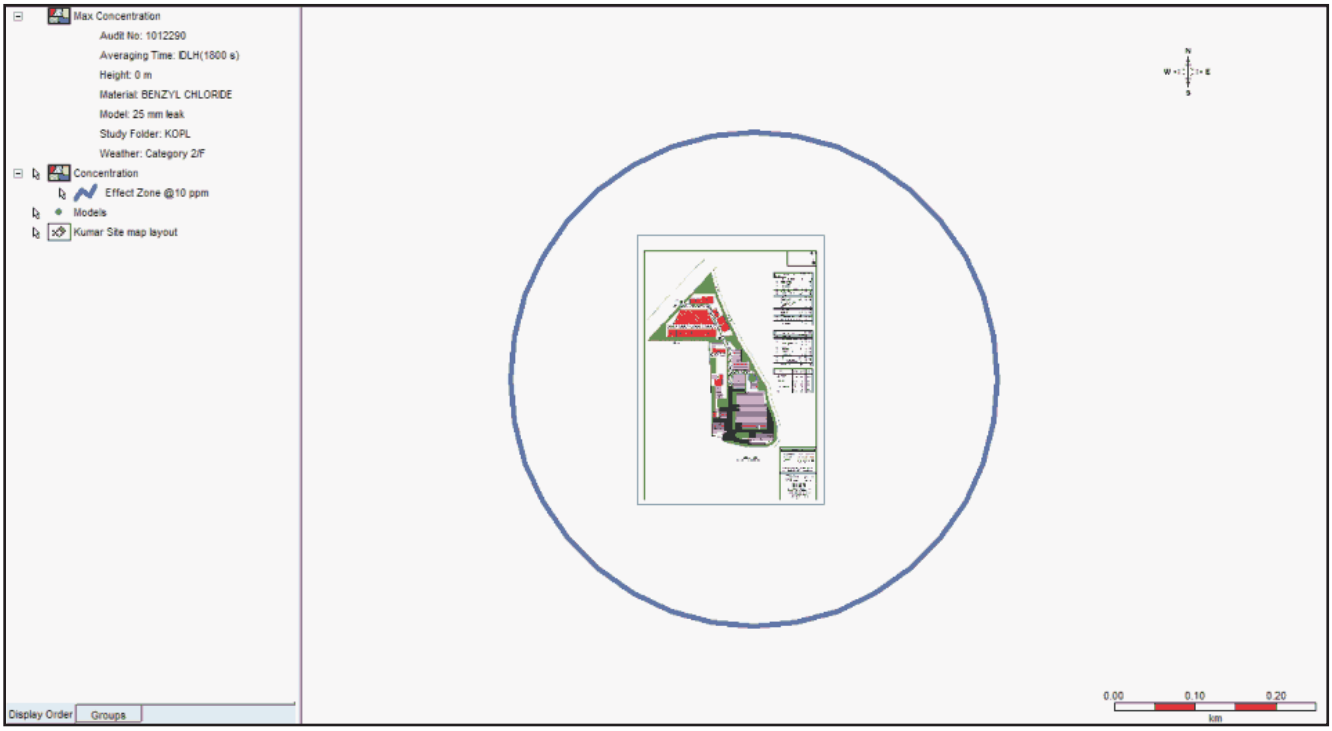


Figure 7.11: Maximum concentration effect contour distance of Benzyl chloride (25 mm leak from storage tank at weather condition 2/F)

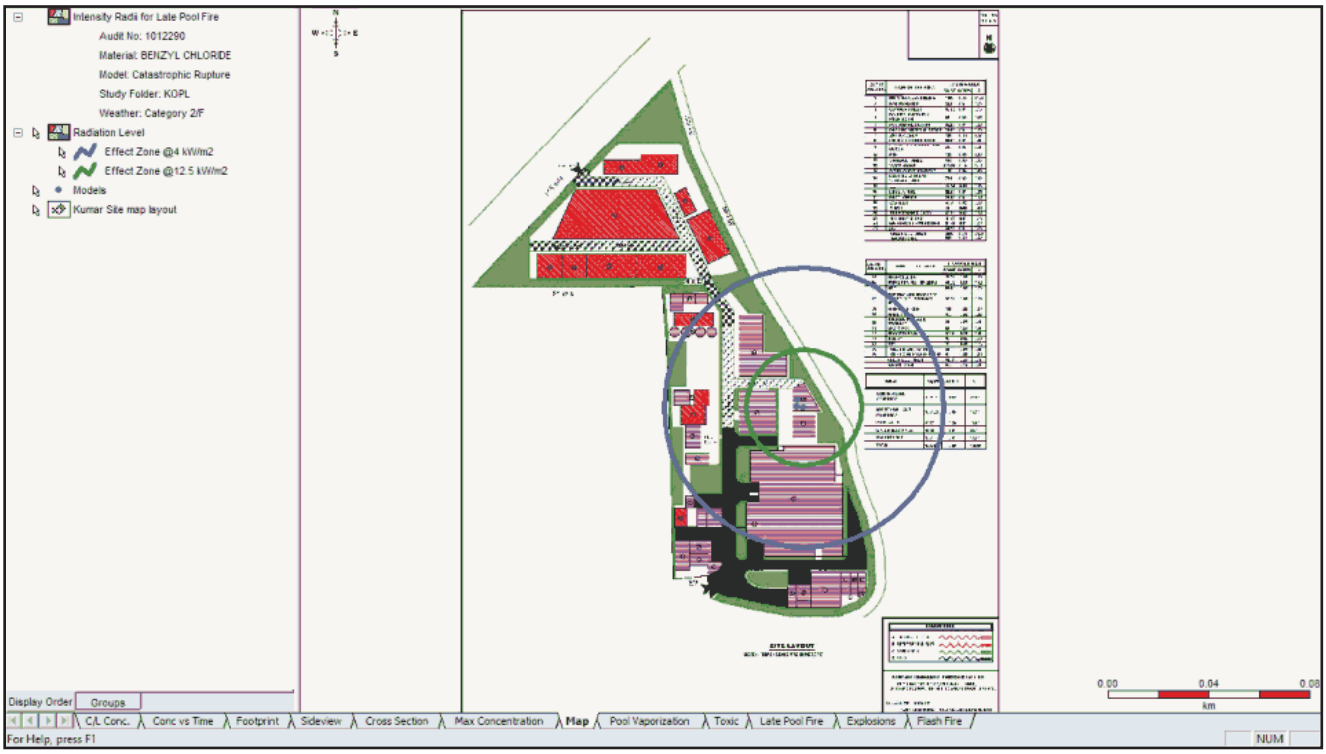


Figure 7.12: Late pool fire effect contour distance due to catastrophic rupture in storage tank of Benzyl chloride at weather condition 2/F

7.4.7.4 Isopropyl Alcohol

Radiation level & Overpressure effect distance due to release of isopropyl alcohol from storage tank is **Table 7.18.**

TABLE 7.18: EFFECT DISTANCE DUE TO RELEASE OF ISOPROPYL ALCOHOL

Chemical (Storage Tank)	Failure Scenario	Consequence	Met Data	Effective Distance in meter to Radiation Level			Overpressure Distances in Meters		
				4 kW/m^2	12.5 kW/m^2	37.5 kW/m^2	0.02 bar	0.13 bar	0.2 bar
Isopropyl Alcohol	5 mm Leak	Late pool fire	2/E	38	26	13	-	-	-
			2/D	38	26	14	-	-	-
			2/F	39	26	14	-	-	-
	25 mm Leak	Late pool fire Late Ignition	2/E	49	34	19	20	13	12
			2/D	49	34	19	20	13	12
			2/F	49	34	19	19	12	12
	Catastrophic Rupture	Late pool fire Late Ignition	2/E	44	28	13	48	20	18
			2/D	44	28	13	48	20	18
			2/F	44	28	13	48	20	18

The contour for effect distance generated due to release of isopropyl alcohol is presented below.

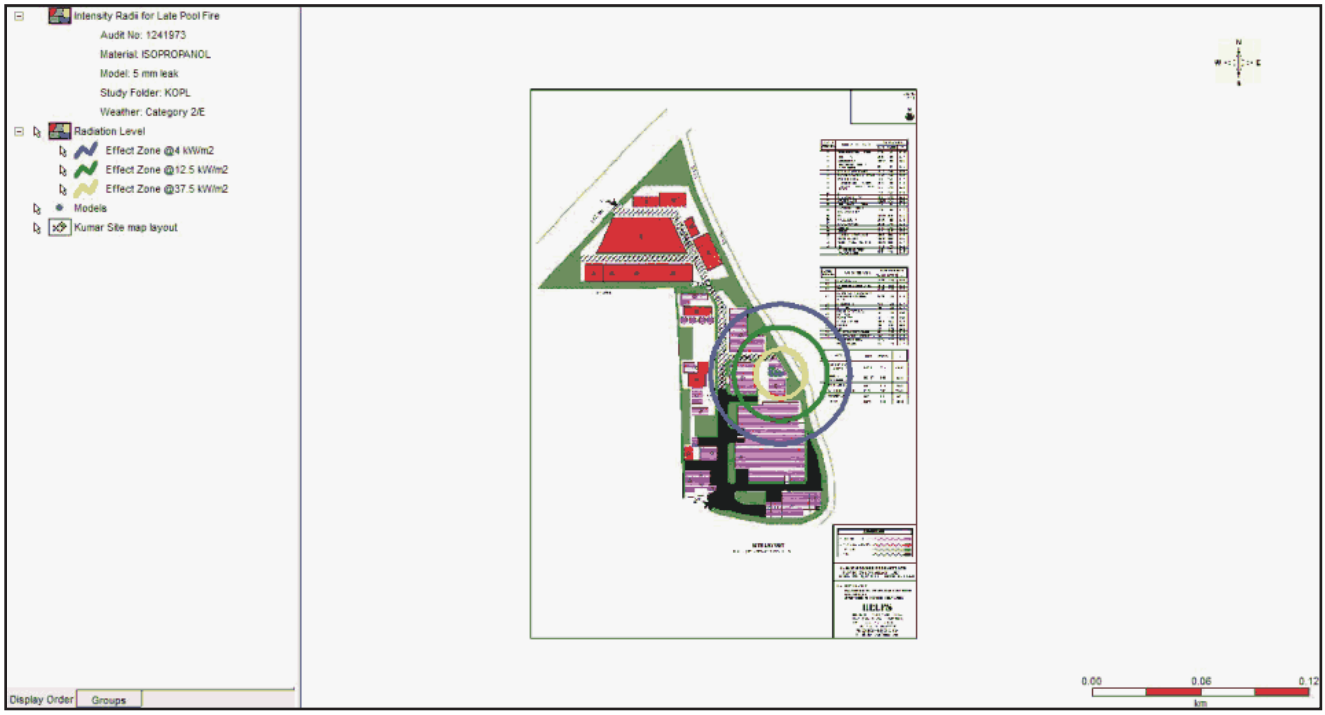


Figure 7.13: Late pool fire effect distance contour of Isopropyl Alcohol (5 mm leak at weather condition 2/E)

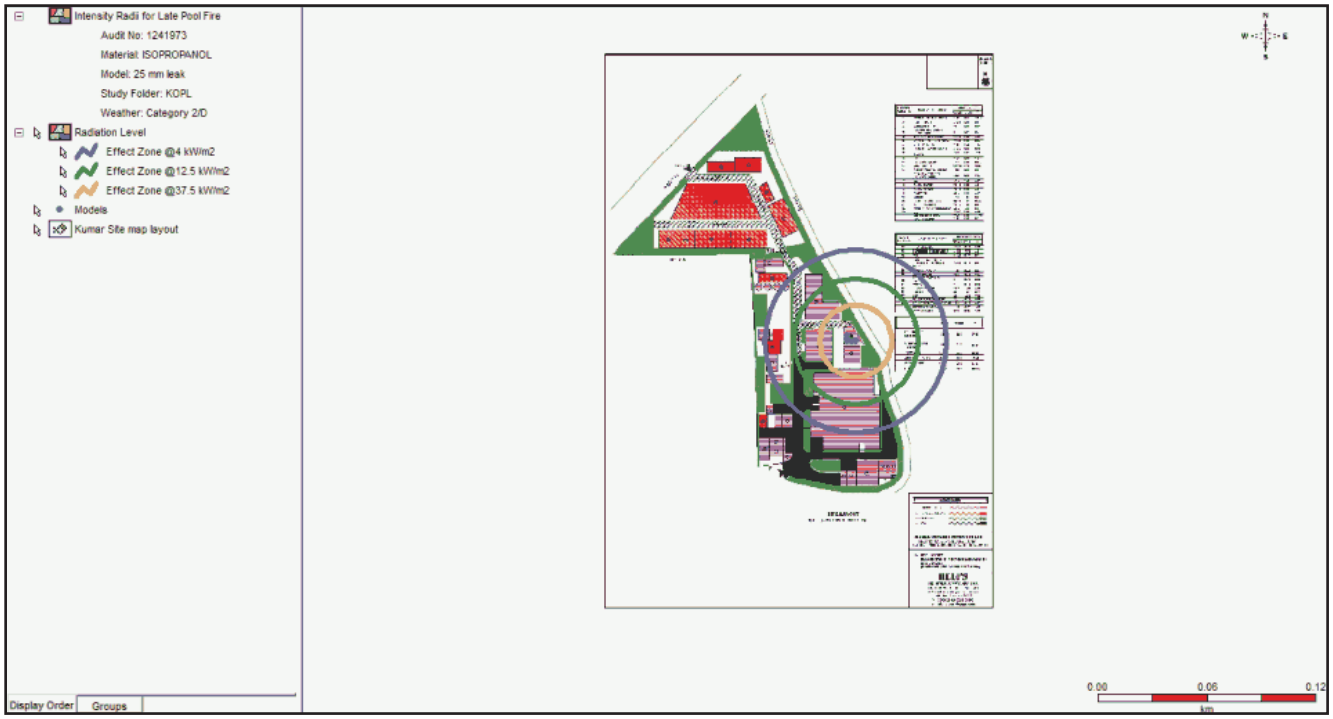


Figure 7.14: Late pool fire effect distance contour of Isopropyl Alcohol (25 mm leak at weather condition 2/D)

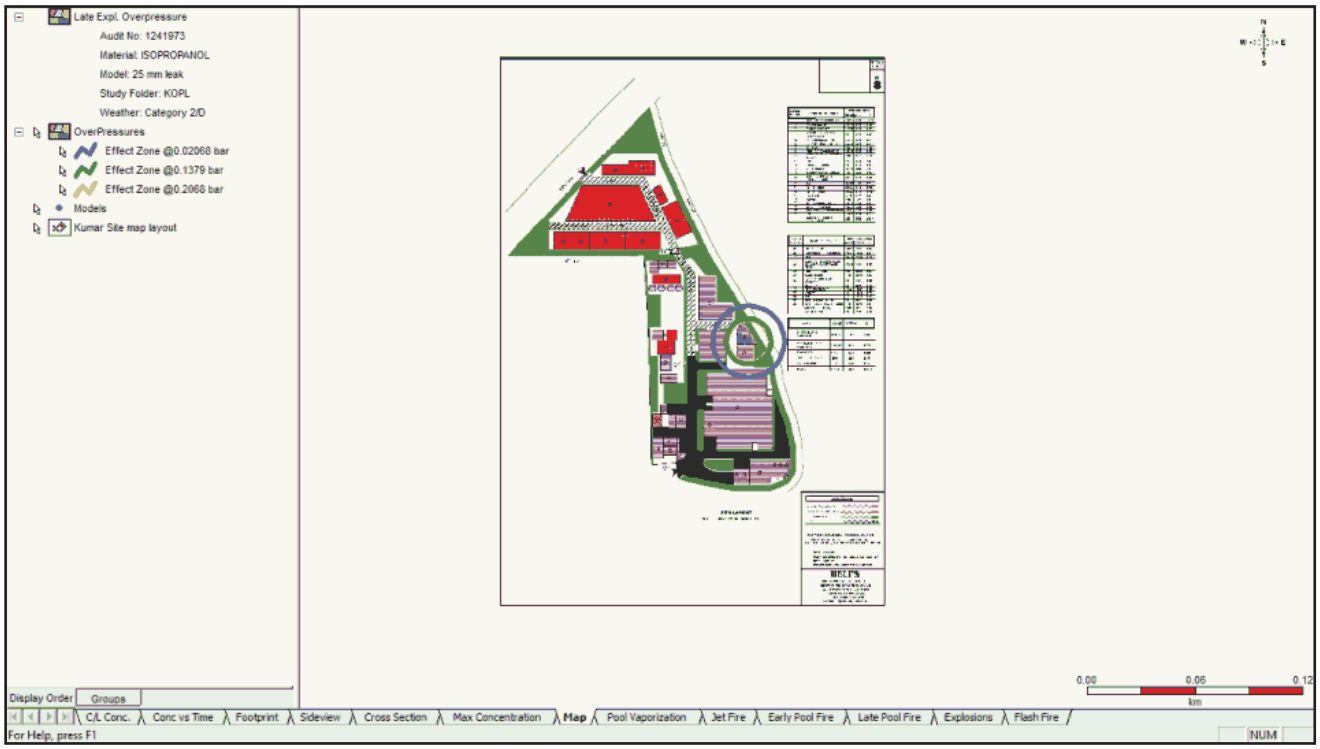


Figure 7.15: Overpressure distance contour of Isopropyl Alcohol (25 mm leak at weather condition 2/D)

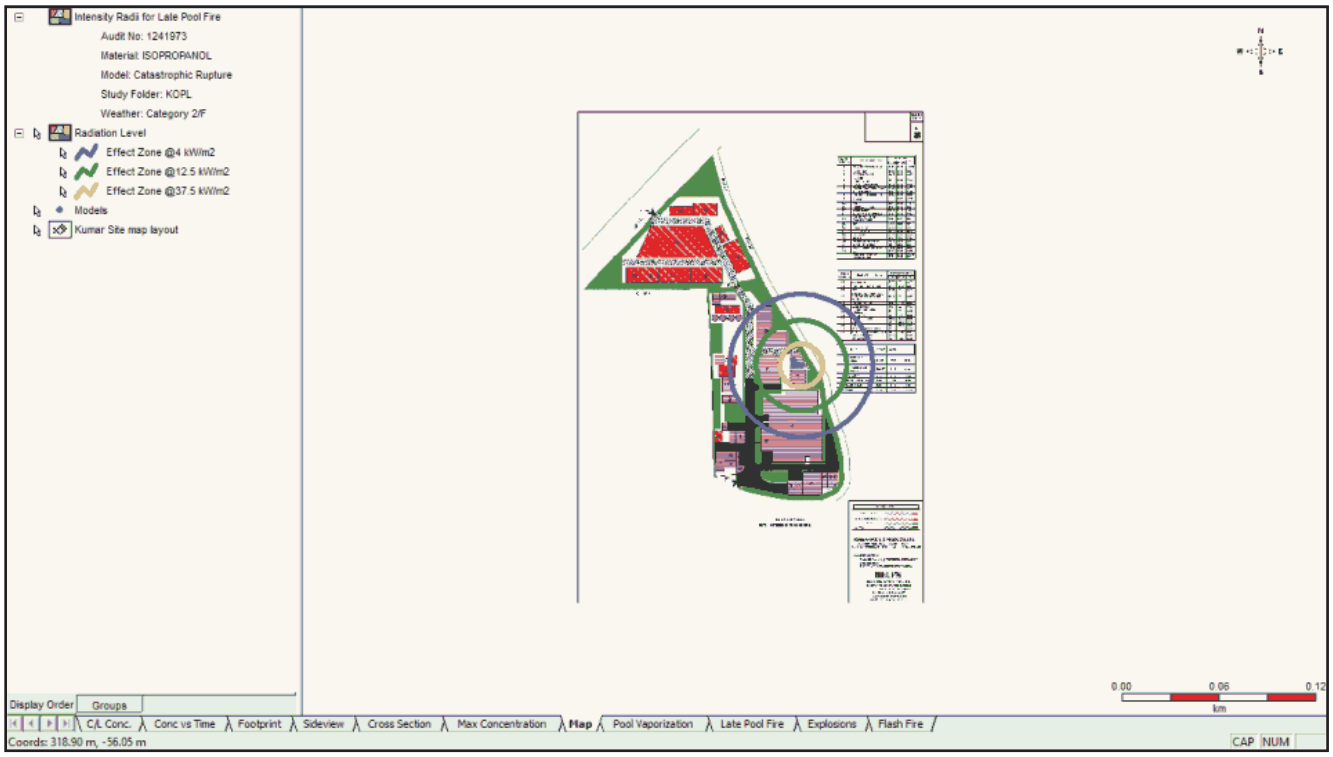


Figure 7.16: Late pool fire effect distance contour due to Catastrophic rupture of Isopropyl Alcohol (25 mm leak at weather condition 2/F)

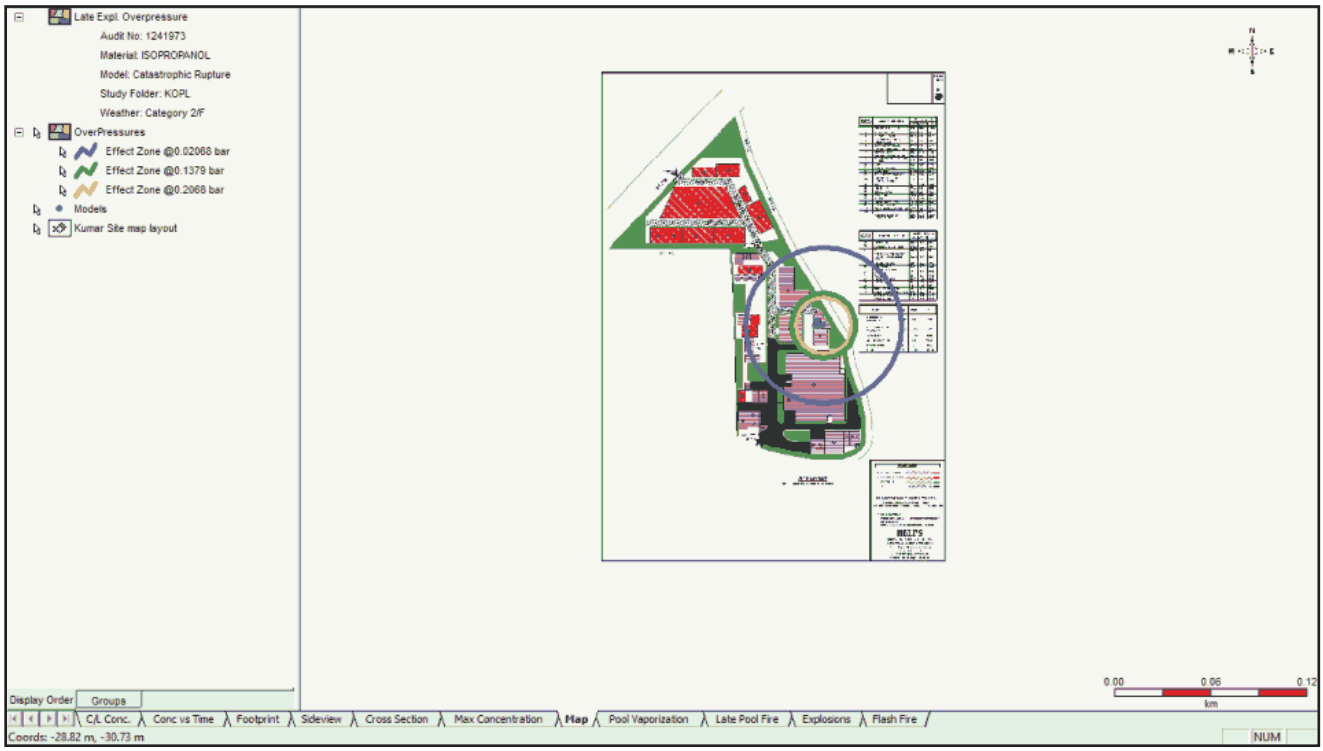


Figure 7.17: Overpressure effect distance contour due to Catastrophic rupture of Isopropyl Alcohol (25 mm leak at weather condition 2/F)

7.4.8 RESULTS OF CONSEQUENCE ANALYSIS

- It can be seen from the summarized table below that the risk of toxic dose effect is highest in worst case scenario of release of benzyl chloride in 2/F weather condition.
- Summary of effect distance (in meter) for worst case scenario of hazardous chemical considered for consequence analysis are given **Table 7.19.**

TABLE 7.19: SUMMARY OF EFFECT

Chemical/ Scenario	Effect Distance in Meters at specific Weather condition		
	At Radiation Level 4 kW/m^2	At Overpressure 0.02 bar	At IDLH Concentration (in ppm)
Ammonia	81	241	-
Chlorine	-	-	108
Benzyl Chloride	66	-	1641
Isopropyl Alcohol	49	48.2	-

7.5 CONTROL / MITIGATION MEASURES

Based on the risk assessment analysis following precautionary mitigation measures are recommended for the project.

1. Work permit procedure to be followed;
2. Use of P.U.C Certified Vehicles;
3. Periodic Inspection of flanges/ferrule joints is carried out;
4. Acid proof flooring will be done at storage and handling area;
5. Inspection of Bags;
6. Fire extinguishers are kept available;
7. Use of Suitable protective clothing, gloves, and gumboot

7.5.1 SAFETY MEASURES FOR TRANSPORTATION, STORAGE AND HANDLING OF CHEMICALS

A. General safety measures for Transportation, Storage & Handling

- Layout and location of hazardous chemical storage area will be based on natural and Mechanical ventilation.
- Spare barrels of sufficient quantity will be kept ready for any emergency spillage or leakage.
- Regular inspection of all the storage tanks of hazardous chemicals will be carried out.
- Display Boards will be provided on all storage tanks which include the name of the chemicals, Calibration of tanks and date of Painting.
- All equipments related to hazardous chemical storage will be maintained and calibrated regularly.
- SOP for handling will be displayed in local language for safe operating procedure.
- Standard procedure for unloading will be in place and will be implemented for safe unloading of road tanker.
- Muffler on the silencer of the tanker during entering in factory premises.
- Water showering system (Automated sprinkling system) will be provided to the flammable chemical storage area.
- On site detectors for fire based on heat &/or smoke detection with alarm system will be provided as required.
- Adequate firefighting system will be provided as required. Details of the same are elaborated in related section.
- First aids boxes will also be provided at prominent places in the plant.
- Area will be declared as “NO SMOKE ZONE”.

B. Provisions of PESO standards for Storage & Handling of Cl_2

Storage

- Cylinders shall be stored in a cool, dry, well ventilated place under cover, away from boilers, open flames, steam pipes or any potential sources of heat and such place of storage shall be easily accessible.
- The storage room or shed shall be of fire resistant construction.
- Gas cylinders shall not be stacked in a horizontal position.
- Cylinders shall not be stored under conditions, which will cause them to corrode.
- Cylinders shall not be stored along with any combustible material.
- Empty cylinders shall be segregated from the filled ones and care shall be taken that all the valves are tightly shut.

Handling

- Cylinders shall be adequately supported during handling.
- Conveyors, trolleys and cradles of adequate strength shall, as far as possible, be used when moving the cylinders.
- The cylinders shall be handled carefully and not be allowed to fall upon one another or otherwise subjected to any undue shock.
- Sliding, dropping or playing with cylinders is prohibited.
- Cylinders used in horizontal position shall be so secured that they cannot roll.
- Open flames, lights, mobile phones, lighting of fires, welding and smoking shall be prohibited.
- Working places shall not be classified as storage places for the purpose of licensing.

C. Safety Measures for Transportation of Raw Material

- Training will be provided to driver and cleaner regarding the safe driving, hazards of Flammable chemicals, emergency handling and use of SCBA sets.
- TREM card will be kept with Threshold Limit.
- SCBA set will be kept with TL.
- Fire extinguishers will be kept with TL.
- Flame arrestor will be provided to TL exhaust.
- Instructions will be given not to stop road tanker in populated area.
- Hazard Identification symbol and emergency telephone number will be displayed as per HAZCHEM CODE.
- Appropriate PPEs will be kept with TL.
- In case of leak or spill:
    1. Area will be isolated.
    2. Container shall be isolated.
    3. Source of leakage will be checked.

4. Damaged containers or spilled material shall not be attended without wearing appropriate protective clothing.
5. Leakage will be stopped, if possible to do so without risk.
6. Water spray will be used to reduce vapors (but do not put water directly on leak, spill area or inside container).
7. Combustibles (wood, paper, oil, etc.) will be kept away from spilled material.

D. Safety Measures for Unloading of Raw Material from Tanker

- Priority will be given to Tanker to immediately enter the storage premises at site and will not be kept waiting near the gate or the main road.
- Security person will check License, TREM CARD, Fire extinguisher condition; SCBA set condition, Antidote Kit, required PPEs as per SOP laid down.
- Store officer will take sample as per sampling SOP from sampling point.
- After approval of QC department unloading procedure will be allowed be started, as per rules & guidelines.

E. Safety Measures for Drum Storage and Handling

- Drums will be stored at designated location or secured in a safety storage cabinet.
- Approved methods of equipping a drum and dispensing liquids from it will be followed.
- Drums, carboys and related accessories will be inspected on regular basis for maintenance purpose.
- All the vessels and equipments will be earthed properly and protected against static electricity. Also, proper earthing facilities shall be provided for drums.
- Materials will be transferred by pumping through pipeline or by vacuum, from drums.
- Drums for flammable liquids will have proper closures that can withstand the expected handling conditions without leaking.

F. Storage area Safety

- Pipes and equipment shall be inspected at regular intervals.
- Entry of unauthorized persons is prohibited.
- Spark-resistant tools will be used.
- Combustibles (wood, paper, oil, etc.) shall be kept away from spilled material.
- SS storage tank will be provided as per IS code.
- Dyke wall will be provided to storage tank.
- Level transmitter will be provided with low level/high level auto cut-off provision.
- Fire hydrant monitor with foam attachment facility will be provided.
- Suitably eye-wash, showers and water showers to body is provided nearby acid and Caustic Storage area.
- FLP type pump & electrical fittings will be provided.
- All storage areas shall be isolated from all sources of open flame and well posted with' NO SMOKING' signs and will provided with adequate firefighting/extinguishing system.

G. Ways to Minimize the Manual Handling of the Hazardous Chemicals

- SOPs, work instructions will be prepared and followed.
- Fork lifts will be used for unloading chemical bags, bags movements within plant, etc.
- Cranes, hoists, pallet trucks, conveyors, etc. shall be used as per the requirement, to eliminate manual handling.
- Lifting tools & tackles will be used, wherever required.
- Trainings will be provided to relevant staff, operators, workers for the risk associated with manual handling of hazardous chemicals, ways to overcome those risk, etc.

H. Process Safety Measures

For the safety in production area some important critical safety measures must be provided within the process technology/equipment itself.

The details of the general safety measures for process unit are as below;

- Process parameters control will be provided vide Standard Operating Procedures.
- All reaction vents will be connected to either vapor condensers system or gaseous scrubber system.
- Trained person will be engaged for handling of hazardous materials.
- Proper safety precautions will be taken during handling of hazardous materials.
- Further all the vessels will be examined periodically by a recognized competent person.
- All the vessels and equipments will be well earthed appropriately and well protected against Static Electricity. Also for draining in drums proper earthing facilities have been provided.
- Reaction column pressure and temperature data will be regularly monitored and assessment of properties of flammable chemicals will be evaluated to avoid fire/explosion scenarios.
- Temperature indicators will be provided near all reactors.
- Caution note, safety posters, stickers, periodic training & updating in safety and emergency preparedness plan will be displayed and conducted.
- Total reaction will be carried out in closed jacketed vessel having cooling water supply to control temperature in case of run-away reaction.
- Emergency reactor shutdown system will be implemented.

I. Preventive safety

The safety measures in form of the general Do's & Don'ts for safety in process & other plant area are as below:

- Check VOC content for flammable and make sure that no flammable vapor contents.
- Keep proper and adequate fire extinguisher near work area.
- Check all motors are disconnected and fuse pulled out before maintenance.
- Work in any equipment must be conducted in presence of supervisor.
- Make sure all process lines are disconnected.
- Do not work on equipments without permission from plant head and maintenance head.
- Do not allow any employment without pre medical checkup or without checking fitness.
- Use proper PPE’s.

J. *DO's & DON'Ts*

- Management has listed some of the Do's & Don'ts activities to strengthen the SAFETY AT WORK, which will be followed strictly:

For Preventive Maintenance

Do's:

- Ensuring that operators/workers etc. follows the SOPs, Safety procedures & standards, work permit system etc.
- Inspection of Storage Area, Earthling & Bonding system.
- Inspection of all Fire Fighting Facilities /Check Alarms operation.
- Checking the availability of Spill Containment Kit.
- Make sure existing fire extinguishers are fully charged and ready for action.
- Inspections of plant, machinery, tools, equipment, premises, work practices, processes, procedures and general environment must be carried out for the health and safety of plant, people and surrounding.
- On-site and Offsite Emergency Plans shall be reviewed and updated, as per the requirement.

Don'ts:

- Don't allow anyone who hasn't received specific safety and operational training to get indulge in any site activity.
- Don't perform any activity without proper permit.
- Don't perform your own maintenance.
- Don't compromise on Design and Engineering part.
- Don't panic if you are in a risky situation.
- Don't allow spilled chemicals to drain to sewers/gutters etc.

7.5.2 OCCUPATIONAL HEALTH AND SAFETY

The main effects of chemicals especially VOCs are anticipated in proposed expansion project. No other source of adverse effects on occupation health & safety is likely to occur. However, MSDS of hazardous chemicals will be prepared & made available with the management as well as concern personnel working with the materials or area likely to be affected by the materials.

In general following are the key safety measure recommended for the proposed project.

- Provision of drinking water supply for the employees as per standard of the drinking water as per WHO guidelines.
- Availability of proper sanitary facilities for the employees so that they do not suffer from any health ailments.
- Provision of all necessary equipment like portable detector, online detectors and other laboratory equipments as proposed for regular monitoring of workplace air and other conditions.
- Establish the safety policy.
- Organize training program for information on accident prevention, proper control and maintenance of equipment, first aid training and safe material handling practices.

- Monitoring of occupational hazards like noise, ventilation, chemical exposure will be carried out at frequent intervals.
- Provision of ear muffs/ ear plugs to the workers exposed to higher noise level.
- Provision of proximity suits and self-breathing apparatus.

Provision and compulsory use of necessary PPEs like helmet, safety goggles, face mask, hand gloves and safety shoes etc. for all workers.

7.6 DISASTER MANAGEMENT PLAN (DMP)

The Disaster Management Plan (DMP) is a guide, giving detailed organizational responsibilities, actions, reporting requirements and support resources available to ensure effective and timely management of emergencies likely to arise from planned operations. The DMP has been prepared for the dye production plant on the basis of the Risk Assessment and related findings covered in the foregoing topics in this report.

7.6.1 STRUCTURE

The DMP is supposed to be a dynamic, changing, document focusing on continual improvement of emergency response planning and arrangements. A structure working on a Plan, Do, Check and Review (PDCR) cycle has been therefore suggested. Another advantage of doing this is to have a system that is in synchronicity with commonly used EHS systems such as ISO: 14001 and OHSAS: 18000. The DMP is covered in further detail in the remaining sections of this Chapter.

7.6.2 POLICY

The Environment, Health and Safety (EHS) policies are to be made accessible to all personnel at site and to other stakeholders. The policies must be framed considering statutory compliance, stakeholder involvement, continual improvement, and management by objectives. If required, the explanation for the EHS policies will be provided in simple language which could be easily understood by the personnel.

7.6.3 PLANNING

1. Identification and Prevention of Possible Emergency Situations
2. Possible emergency situations in the fertilizer plant can broadly be classified into unintended explosions, fire, electrical short-circuits and resultant fire, vehicle collision, and inundation. Additional emergency situations can be developed on the basis of audit or other procedures prior to commencement of operations.
3. Emergency Prevention

Some of the ways of preventing emergencies are as follows:

- Preparation of a preventive maintenance programme covering periodic maintenance schedules for all the equipments, instruments and system as a whole as per recommendations provided in the Operation and Maintenance manual supplied by the respective manufacturers. The maintenance schedule may also incorporate additional recommendations based on the hands-on experience of engineers gained from working in similar plants.

- Importantly, it is of great importance to collect and analyze information pertaining to minor incidents and accidents at similar sites, as well as for recording near misses or emergencies that were averted. This information gives an indication of how likely or unlikely it is for the site to face actual emergencies and what should be further done to prevent them from occurring.
- Establishment of an ongoing training and evaluation programme, incorporating the development of capabilities amongst employees about potential emergencies and ways and means of identifying and averting the same. Most emergencies do not occur without some incident or an abnormal situation. Hence, there is always sometime of few seconds to few minutes to arrest an incident of abnormal situation from turning into an emergency. This is the role of the shift in-charge who is generally the incident controller (IC) along with his shift team.

7.6.4 CLASSIFICATION OF EMERGENCY

The Level of Emergency can be classified in three Categories, which is given in **Table 7.20.**

TABLE 7.20: EMERGENCY TYPES

Classification	Description	Causes	Applicability
Level – 1	The leakage or emergency, which is confinable within the plant/area.	• Small pipe/valve rupture or similar leakages that do not affect outside premises. • Release of toxic chemicals for short duration. • Small fire in the plant.	• Thioglycolic Acid (80%) • HCl (28%)
Level – 2	The emergency, which is confinable within the factory premises.	• Leakage of toxic chemicals for long duration. • Medium scale explosion confined to the factory premises. • Medium scale fire inside the factory premises.	• Ammonia • Benzyl Chloride
Level – 3	The emergency, which is not confinable within the factory premises and general public in the vicinity are likely to be affected.	• Heavy / Profuse leakage of toxic / flammable gases for a long duration. • Explosion of high magnitude affecting the adjacent area. • Major fire inside the factory premises.	• Isopropyl Alcohol • Chlorine

7.6.5 EMERGENCY PLAN OBJECTIVES

Specific objectives of the Emergency Response Plan are listed with regards to the responses desired for successful management of the possible emergency situations. Suggested Objectives would include:

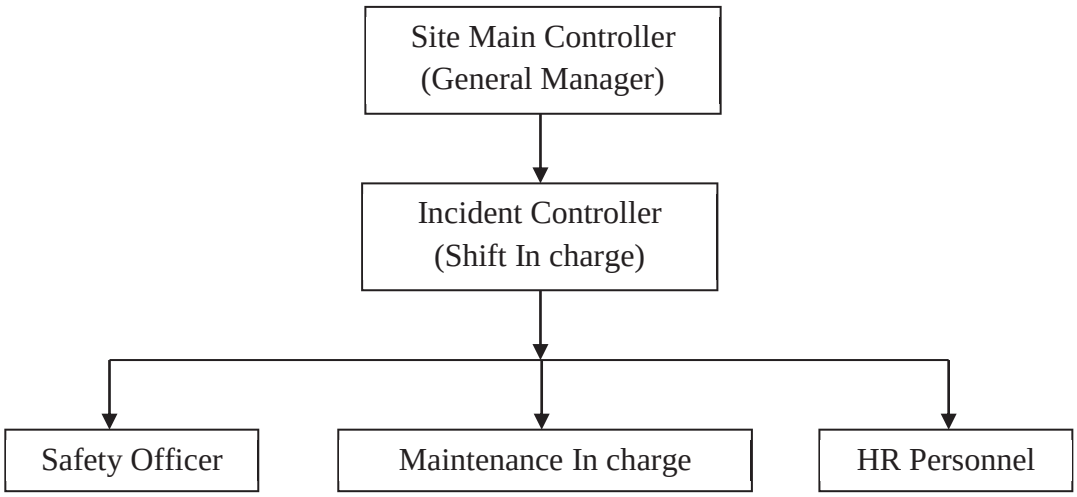
- To define and assess emergencies
- To control and contain incidents.
- To safeguard the employees.
- To minimize damage to the property and/or the environment.
- To inform the employees, the general public residing around the plant and the authority on the hazards/risks assessed.
- To safeguard provided residual risk, if any, and the role to be played by the employees in the event of emergency.
- To inform the state authorities like Police and Fire Departments, Mutual Aid Centers, Medical Centers to come up for help.
- To effectively rescue and to provide treatment of casualties and to count the injured.
- To identify and list fatal accidents, if any.
- To secure the safe rehabilitation of affected areas and to restore normally.
- To provide authoritative information to the news media for the incident.
- To preserve records, equipments, etc. and to organize investigation into the cause of the emergency and to suggest preventive measures to stop its recurrence.
- To ensure safety of staff and patients and resume work.
- To work out a plan with all provisions to handle emergencies and to provide for emergency.

7.6.6 ON-SITE EMERGENCY

On-site emergency plan: deals with, measures to prevent and control emergencies within the factory.

EMERGENCY ORGANIZATION CHART

Emergency management cell as shown below.



Incident Controller

Incident Controller's role is to control the emergency at the incident site.

Responsibility of Incident Controller

Incident Controller will proceed to the place of emergency after hearing siren/announcement. He will:

- Assess the scale of emergency and decide if a major emergency exists or is likely, accordingly activate emergency procedure.
- Immediately give his feedback to Emergency Control Center (ECC) regarding emergency.
- Direct all operations within the area with following priorities.
- Secure the safety of personnel
- Minimize damage to plant property and environment
- Minimize loss of material.
- Direct rescue and fire fighting operations till the arrival of the outside fire brigade; he will relinquish control to Sr. Officer of Fire Brigade.
- Ensure that the affected area is searched for causalities.
- Ensure that all non-essential workers in the affected area evacuate to the appropriate assembly point.
- Set up communication point to establish Radio/Telephone/Messenger contact as with emergency control center.
- Pending arrival of works site controller, assume the duties of the post in particular to:
  - Direct the shutting down and evacuation of plant and areas likely to be threatened by emergency.
  - Ensure that the outside emergency services have been called in.
- Ensure that the key personnel have been called in.
- Report all significant development to the Site Main Controller.
- Provide advice and information, as required to the Senior Officer of the Fire Brigade.
- Preserve evidence that would facilitate any subsequent inquiry into the cause and circumstances of emergency.
- **Deputy Incident Controller** will carry out above said duties in absence of Incident Controller.

Site Main Controller

Site Main Controller will be overall in-charge of emergency organization

Responsibility of Site Main Controller

- The Incident Controller of responsibility of overall main control.
- Co-ordinate ECC or if required, security for raising evacuation siren and also all clear siren, in case emergency is over.
- Declaration of major emergency ensures that outside emergency services will be called and when required nearby firms will be informed.
- Ensure that key personnel will be called in.
- Exercise direct operational control on parts of the works outside the affected area.

- Maintain a speculative continuous review of possible development and assess these to determine most possible cause of events.
- Direct the shutting down and evacuation of plants in consultation with key personnel.
- Ensure causalities are receiving adequate attention; arrange for additional help if required. Ensure relatives are advised.
- Ensure the accounting of personnel.
- Control traffic movement within the work.
- Arrange for a chronological record of the emergency to be maintained during prolonged emergency, arrange for the relief of the personnel and provision of catering facilities.
- Contact the local office to receive early notification of impending changes in weather conditions, in case of prolonged emergency.
- Issue authorized statements to the news media and informs H.O.
- Ensure that proper consideration is given to the preservation of evidence.
- Control rehabilitation of affected areas after control of the emergency.
- Deputy Incident Controller shall take charge at site of emergency in the absence of Site Main Controller.
- When Site Main Controller shall be present at the site of incident, Deputy Incident Controller shall assist Site Main Controller or take charge at another location, if emergency exists at more than one place.

Responsibility of Other Key Personnel

The key personnel required for taking decision about further action for shutting down the plant, evacuate the personnel, and carry out emergency engineering works in consultation with Site Main Controller in light of the information received. Maintenance incharge/Safety officer/ Section Heads/HR Personnel will be responsible for safety, security, fire, gas and pollution control, spillage control, communication system including telephone, wireless etc. Also medical services, transport, engineering, production, technical services, will form part of advising team.

Responsibilities of Essential Workers

A task force of essential trained staff will be made available to get work done by Incident Controllers. Such work would include:

- Firefighting using portable extinguishers / hydrants (as feasible) and controlling the spill, if any, till fire department people take the charge.
- To help the fire brigade, if required.
- Emergency engineering work e.g. isolating equipment, shifting materials, urgent repairing or replacement, electrical work etc.
- Provision of emergency power, water, lighting, material etc.
- Direct movement of people, equipment, special vehicle and transport to or from the scene of the incident and provide barricade to area of incident to prevent unauthorized trespassing.
- Search, evacuation, rescue and welfare, first-aid and medical help.
- Manning of assembly points to record the arrival of evacuated personnel.

- Manning of outside shelters and welfare of evacuated persons there.
- Assistance at casualty's reception areas to record details of casualties.
- Assistance at communication center to handle outgoing and incoming calls and to act as messengers, if necessary.
- Control of traffic at the premises.

SETTING UP OF EMERGENCY INFRASTRUCTURE

To enable the key persons to implement the DMP, the following infrastructure will be set up:

Assembly Points

In case of emergency, the site needs to be evacuated immediately. On evacuation, the personnel working in the plant will go to pre-assigned assembly points. The charge will be taken by Shift-in-charge, and in his absence, a person deployed by Commander will be in charge of respective assembly points and will supervise Assembly and Head Count. The sign boards indicating the Assembly Point with number having relevant information will be placed at all such point for guidance. Each assembly point will be earmarked for the personnel from specific plant areas for assembly in the event of emergency.

Task Force of Essential Staff

A task force of essential trained staff will be made available to get the work done by Commander. Task Force personnel will be trained to perform various tasks as mentioned above.

Emergency Control Centre

A small separate room (generally located near Security Office at Main Entry Gate) will be provided to facilitate Emergency Control Centre. This room will be equipped with dedicated and direct communication facilities. The Control Centre will be situated in this area, which is of minimum risk with immediate availability of security personnel nearby. Moreover, the area will be on the arterial road to allow easy access by a vehicle, if other systems fail or extra communication facilities needed to be set up. The Emergency control center will consist of following items:

- Internal and external telephone including STD facility
- Telephone directory/ Telephone nos. of mutual aid centers
- First Aid
- Muster roll of Workers
- Identity card register
- Layout plan of the factory showing the location of hazardous materials, assembly point and first aid centers etc.
- Map of surrounding area with Fire Extinguishers location
- M.S.D.S.
- Copy of ON SITE OFF SITE PLAN
- Stationeries like- note book, pen, pencils etc.
- S.B. Apparatus
- List of Government Agencies /Local press agencies with phone No
- Sand Buckets & Hydrant Network
- Adequate numbers of PPE's

Fire Fighting

The personnel working in the plant, in case of noticing fire, will immediately raise an alarm and ask the nearest personnel to inform Manager. He may make an attempt to extinguish the fire depending on intensity using a portable fire extinguisher along with other personnel working with him. The severity of fire will be assessed and if it is likely to be severe, will take following steps:

- Call his departmental head/Shift-in-charge to inform about the incident.
- Call fire tenders and mobile trailer pump from nearby fire department.
- Call nearby personnel to move away from the site of incident and go to assembly points.
- Arrange for switching off electricity supply to that specific area of incident.
- Manager shall review the steps taken by Shift-in-charge in his capacity as COMMANDER and will reach "Emergency Control Room".

Steps in Case of Spreading of fire

Commander, after taking charge of the situation, will continuously assess the situation and if it is not being controlled then ensure:

- Ensure evacuation, in orderly fashion and assembly of all persons at the assembly points.
- Arrival of fire tenders and/or Mobile Trailer Pump from outside resources.
- Ensure that any vehicle parked near the fire site is taken away to safe area.

Communication System

Declaring the Emergency

In case of any emergency in the plant, speedy and effective communication of the same to all concerned in least possible time is the most important aspect of any emergency-handling plan. An early communication increases the chances of control of emergency in the bud stage. Blowing siren will be adopted as method of communication of emergency, to all employees in the plant.

Type of Sirens

Three different types of sirens have been identified for communication of emergency.

Alert Siren: Single Continuous Siren for One Minute.

This indicates that there is some accidental happening in the plant. All have to become alert. Incident controller will be rush to the site of emergency. Plant area people have to start safe shut down. Rescue team and other emergency control teams have to reach at the site of emergency.

Siren for evacuation: wailing & waning siren for three minutes.

This siren indicates that emergency is of serious proportion and everybody has to leave his work place. All people having their role in emergency control have to assume their assigned role. All non-essential workers have to proceed immediately to assembly area and wait for further instruction.

All clear siren: Long continuous siren for two minutes.

This is a sign of return of normalcy. On hearing this siren everybody should go back to his or her respective workplace.

Location of Siren

Siren will be located in centre of the pant for wide coverage of the whole campus. Switch for siren will be provided at security gate. The switch at Security gate should be operated only as a

general rule. Emergency manual call bell will be installed which will be used in case of total failure of electricity. It is responsibility of HOD (HSE) to maintain the upkeep of electric call bell and HOD- Security and administration to maintain manual and Hand operated siren.

Raising Alarm

Any person noticing any emergency situation in the plant should immediately call security gate with following information:

- Identify oneself
- State briefly the type of emergency i.e. whether fire, explosion, toxic gas release etc.
- Give the location of the incident
- Estimated severity of the incident

Security personnel after ensuring genuineness of the call shall raise the ALERT SIREN. At the same time he will also contact the incident controller and ECC in order and inform about the incident. He will keep the gate open and rush his two security personnel at the site of emergency with appropriate PPEs. ECC will be located at the office of Head-Operations on normal working hours and at Security gate after normal working hours (during night). ECC shall be immediately manned on hearing alert siren. If the authorized people to handle ECC are not available, any senior most people out of the available person nearby shall occupy ECC till authorized person comes. Incident controller, on hearing alert siren or by any other way of information of the emergency, will immediately reach at the site of incident and assess the situation. He will immediately give his feed back to ECC. ECC shall direct security gate to raise evacuation siren, if the need arise. SIREN FOR EVACUATION shall be raised on instruction from Site Main Controller or any Manager of the plant in the ECC. Security gate person will be authorized to raise ALL CLEAR SIREN on instruction from Site Main Controller or ECC, after the emergency is over. Incident controller shall assume the responsibility of site main controller in his absence.

Medical Arrangements

Availability of first aid facilities in sufficient quantity will be always ensured. In case of emergency arrangements will be made to avail outside medical help immediately. Emergency transport facility will be available.

Communication to the Authorities

The emergency will be immediately communicated to the government officers and other authorities such as SPCB, police, district emergency authority, Factory Inspectorate, hospital etc. by Emergency Control Center.

Communication to Neighboring Firms & the General Public

In case of emergency having its outside impact, public will be cautioned regarding the same. Co-ordination of police will be sought for speedy action. This is to be ensured by ECC.

Response Time-Minutes

Hazard	Fire Fighting	Police	Medical Services
Fire & Explosion	Immediate with whatever facilities available with the plant	15 minutes	10 minutes
	External Help within 15 minutes		

Pre-emergency activities

Internal Safety survey with regard to identification of hazards, availability of protective equipment's, checking for proper installation of safety devices will be carried out periodically.

- Periodic pressure testing of equipment
- Periodic pressure testing of lines
- Periodic safety/relief valve testing
- Periodic fire hydrant system testing
- Mock drill to check up level of confidence, extent of preparedness of personnel to face emergency is being contemplated
- Regular training is being imparted to all personnel to create awareness
- Adequate safety equipment will be made available
- Periodic check-up of emergency lights
- Safer assembly points will be identified
- Storage of adequate first aid treatment facilities

Post Emergency Activities

→ **Evacuation and Transportation**

In case of emergency, evacuation and transportation of non-essential workers will be carried out immediately. The affected personnel will be transported for medical aid.

→ **Safe Close Down**

During emergency plant shut down will be carried out if situation warrants. This will be as per the instruction of site main controller under guidance of incident controller.

→ **Use of Mutual Aid**

Mutual aid agreement with nearby industries will be ensures to provide help to each other in the emergency

→ **Use of External Authorities**

As and when necessary, statutory authorities, police, pollution control personnel, medical aid/center, ambulance etc. will be contacted.

→ **Medical check up**

Medical check-up of affected persons in the incident, if any, will be carried out and suitable medical aid shall be provided to set right the problem.

→ **Accounting for Personnel**

Proper accounting for personnel will be laid down in all the shifts. The number of persons present inside the plant premises, their duty etc. will be available with the P & A. This record will be regularly updated and will be made available.

→ **Rehabilitation**

The affected area will be cleared from emergency activities only after positive ascertaining of the system in all respects. The entry to affected area will have to be restricted until statutory authorities visit and inspect the spot of incident. Nothing should be disturbed from the area till their clearance. The site main controller will be in charge of the activities to be

undertaken. The plan will cover emergencies, which can be brought under control by the works with the help of emergency team/fire services. The DISASTER CONTROL PLAN for gas leak and fire will be prepared for entire factory.

→ **Collection of Records**

All possible evidences will be collected along with shift logs and personnel nearby or connected with the incident will be called for narrating the details so as to facilitate finding of the most probable and convincing cause of incident and emergency situation. The proposed procedure will help in suggesting the remedial measures for preventing recurrence.

→ **Inquiry**

Detailed inquiry for the incident will be carried out to find out the cause, which will be in the form of fact finding mission and recommendations made to the suitable authority.

→ **Training**

Regular training program for all the concerned personnel will be conducted to enable them to face any type of emergency situation, be it natural disaster, fire in equipment, building or any explosion in equipment.

→ **Review of Emergency Performance**

The site/head office management will review the findings of the audit and the non-compliances. It will consider whether the DMP is providing adequate safety assurance to the management, delivering performance as desired, and whether it continues to be in the spirit of Environment, Health and Safety Policies and changing requirements. On the basis of these, the management will record its decisions and consider modifying the DMP, as deemed appropriate.

7.6.6.1 Occupational Health and Safety Programme

M/s. KOPL has prepared the Occupational Health Surveillance Programme which shall be followed right from the project construction & erection phase and the same shall be updated for the upcoming new facility, if required.

The details of the same are described in the following sections.

1. First Aid - The First Aid kit as per Gujarat Factory Rules.
2. Plan for Periodic Medical Check-up - As per Gujarat Factory Rules.
3. Safety Trainings & Mock Drills - Safety trainings (on Safe Material Handling, First Aid, & all Safety Aspects) shall be provided by the Safety Officers.
4. Mock Drills - To evaluate the effectiveness of emergency preparedness and to spread the awareness among employees mock drill will be carried out at the interval of every six months. After completion of the mock drill, summary report shall be made and corrections will be done if any weakness has been observed.

7.6.7 OFF-SITE EMERGENCY

- **NEED OF THE SITE EMERGENCY PLAN**

  Depending upon the wind direction and velocity of the effects of accident in factory may spread to outside its premises. To avert major disaster it is essential to seek guidance/assistance of statutory authorities, police and health department. The movement of traffic may have to be restricted. Required information will be given to the authority and consultation will be sought for remedial measures.

- **A PURPOSE OF THE OFF-SITE EMERGENCY PLAN**

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

  To assist district authorities for preparing the off-site emergency plan for district or particular area and to organize rehearsals from time to time and initiate corrective actions on experience.

- **ROLE OF THE FACTORY MANAGEMENT**

  The site main controller will provide a copy of action plan to the statutory authorities in order to facilitate preparedness of district/area off-site emergency plan.

- **DISCLOSURE OF INFORMATION TO NEIGHBORING ORGANIZATION & POPULATION**

  KOPL will prepare booklet and circulate among neighboring organization and population containing hazardous operation and chemicals. Preventive steps will be taken to control emergency. Emergency warning siren code system, to make them aware in advance KOPL will carry out group get together, acquaintance round, meeting with neighboring public, population to train and make them aware about our operation and preparedness. The same groups along with external emergency control organization were invited during mock drill, rehearsals for training and acquaintance.

- **LOCAL CRISIS GROUP**

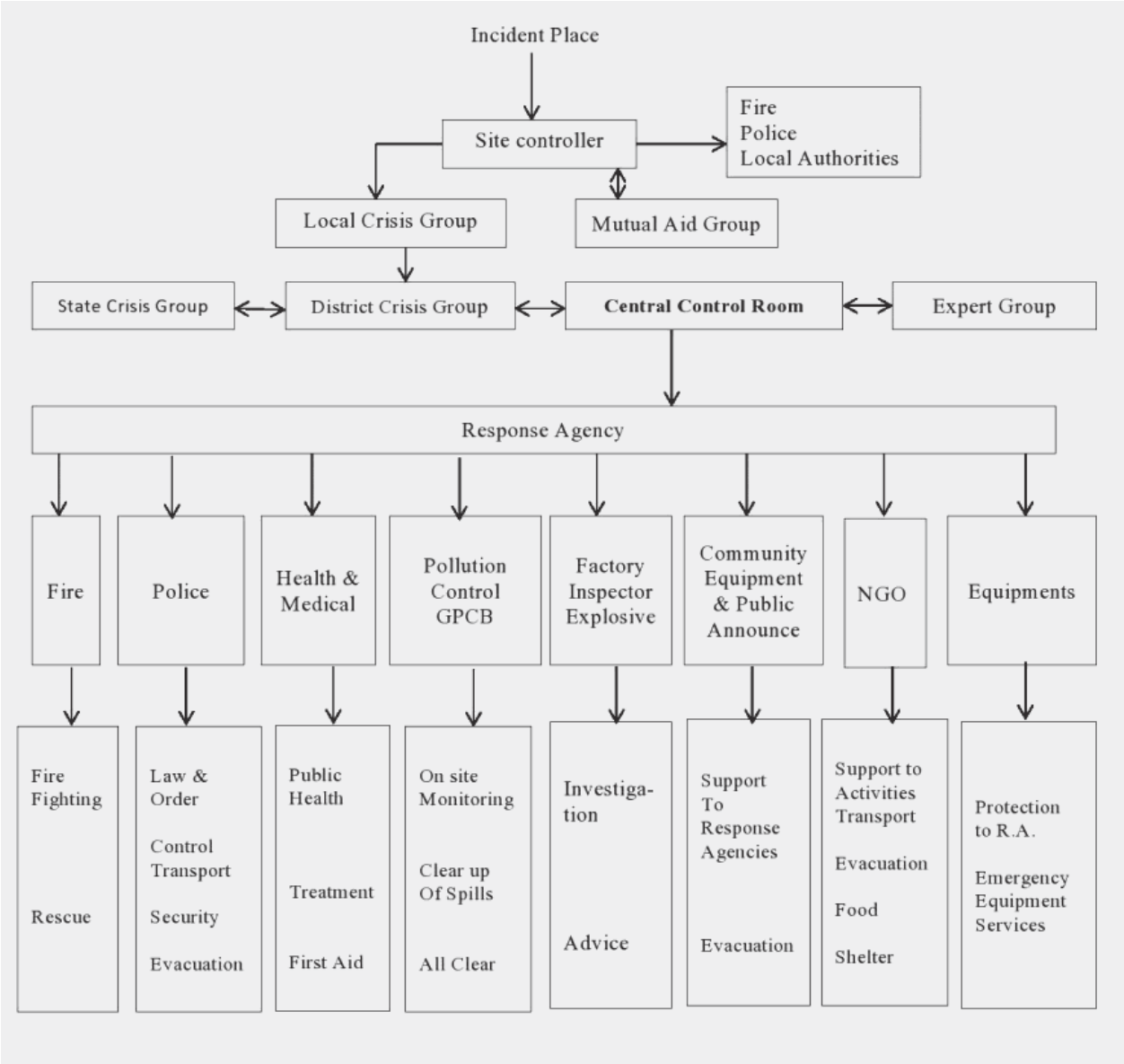
  As per central government notification and DISH office for preparation of offsite emergency plan, KOPL will become member of local level crises group, will set up disaster management centre of industrial area using existing available facility of industries in the area with facility and emergency contact phone numbers.

  During emergency with in local group reach in and around industrial area any one can contact DMC – control room situated in both the factories and manned round the clock will initiate actions and arrange to organize resource mobilization and communication.

- **COMMUNICATION AND WARNING BY DISASTER MANAGEMENT CENTER**

  When a disaster occurs, the industry affected by the disaster will immediately inform the disaster management center with all available information, the DPMC will act as per the contingency plan and DPMC will also communicate immediately to district Collector. The

integration of on – site plan with district contingency plan and various functions to be carried out are mentioned in chart OFF – SITE emergency plan as following:



- **Role of District Authority**

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

- **Role of Fire Authorities**

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

- **Role of the Police and Evacuation Authorities**

  Senior Police Officer designated, as emergency co-ordination officer shall take over all control of an emergency. The duties include protection of life, property and control of traffic movement. Their functions include controlling standards, evacuating public and identifying

dead and dealing with casualties and informing relatives of dead or injured. There may be separate authorities/agencies to carry out evacuation and transportation work. Evacuation depends upon the nature of accident, in case of fire only neighboring localities shall be alerted. Whole areas have to be evacuated in case of toxic release.

- **Role of Health Authorities**
  After assessing the extent of effect caused to a person the health authorities will treat them.

- **Role of Mutual Aid Agencies**
  Various types of mutual aid available from the surrounding factories and other agencies will be utilized.

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

B. SOCIAL IMPACT / R&R ACTION PLAN

The socio-economic study of the study area was carried out and related details are presented in **Chapter-3, section-3.13**. The proposed project to be set-up by expanding its facility at adjacent to existing unit and there is no displacement of villagers/peoples. Therefore, the R&R (Rehabilitation & Resettlement) policy/plan is not undertaken. However, the direct financial and social benefits with special emphasis on the benefit to the local people including tribal population will be preferred and the proposed budgets for Enterprise social commitment (ESC) activities are summarized in **Chapter- 10, section- 10.9**.

C. PUBLIC CONSULTATION

The public hearing was conducted by GPCB on 03/01/2020 on the basis of the draft EIA/EMP incorporating the Terms of References. Minutes of Meeting of Public Hearing is attached as **Annexure-P**. Time bond action plan for implementation of points raised during public hearing along with budgetary provision is given in Table 7.21 below.

TABLE 7.21: SUMMARY OF PUBLIC HEARING ISSUES AND TIME BOUND ACTION PLAN WITH BUDGETARY PROVISION

Issue	Budgetary Provision	Timeframe/ Clarification
Quality of Ground water of Luna & nearby villages	---	Presently wastewater generation is 45.2 KLD. Effluent is being treated in company's ETP and treated effluent is being sent to CETP of M/s. EICL, Umraya for further treatment and disposal. For Expansion project, proposed additional waste-water generation will be