FCHAPTER - 7
OCCUPATIONAL HEALTH, RISK ASSESSMENT AND DISASTER MANAGEMENT PLAN

7.1 Introduction

M/s. RL Fine Chem Private Limited, is an existing Drug Intermediates manufacturing unit located at Plot. No.165 to 182 APIIC, IDA Thumukunta (V), Hindupur (M) Anantapur (D), Andhra Pradesh state.

7.2 Site Location and Surroundings

M/s. RL Fine Chem Private Limited is located in industrial area and surrounded by other Industries of IDA Thumukunta. Varahi Pharma is on the North side, Sadguru industries is on the south, Wipro and APIIC Land is on the East and Aditya Green industries and PVM Construction is located on the western side of the industry.

The company is having following blocks/Areas in the plant

- Production blocks
- Ware House
- QC/QA laboratory
- Utilities Block
- Boiler room
- Generator Room
- Bulk Storage area
- Effluent Treatment Plant
- Cooling towers
- Purified Water system
- Admin block

7.3 Objectives and Scope

The production of synthetic organic chemicals involves usage of many chemicals which are both hazardous and non-hazardous in nature. Risk analysis has been carried out to identify the hazardous materials and quantify the hazards to arrive at safe disaster management plan and

emergency preparedness plan for storage and handling of the potentiality hazardous materials. Also the purpose of carrying out risk assessment study for M/S RL Fine Chem Private Limited is to obtain clearance from the Ministry of Environment and forests (MOEF) which calls for a study on nature of hazards due to proposed location of process and storage units and also to study whether any accident, if occurs leads to any off-site disaster. In this endeavour, the study objectives are outlined here under.

i) Hazard identification and Visualization of Maximum Credible Accident Scenarios.

To identify major hazards relating to fire, explosion and toxicity due to chemicals, processes and storages of the proposed units.

ii) Hazard Analysis and Risk Assessment

Hazard analysis is the process of determining the release probabilities and quantities, emission or release rates, the routes/pathways by which the released substances could reach the receptors, the fate of the substances in environmental media through which they are transported or moved and the characteristics of the receptors at risk.

iii) Disaster Management To provide guidelines for Disaster Management Plan(DMP) for on-site emergencies and Emergency Preparedness Plan(EPP) for off-site emergency, based on above i) & ii) studies of proposed plant.

7.4 Production Details

The manufacturing capacities proposed after expansion are presented in **Table 7.1**

Table 7.1 Production capacity after expansion

S.No	Name of the Products	Quantity in TPM	Product Description	Therapeutic category
1	Nortrytyline HCl	1.12	API	Anti depressant
2	Desipramine HCl	0.13	API	Anti depressant
3	Cyproheptadine	0.09	API	antihistamine

	HCl			
4	Pitofenone HCl	0.09	API	Antispasmodic
5	Pyrimethamine	0.07	API	Antimalarial
6	Cyclobenzaprine HCl	0.12	API	Anti depressant
7	Clomipramine HCl	0.08	API	antiobsessional drug
8	Chloropromazine HCl	0.16	API	antipsychotic
9	Doxlamine Succinate	0.14	API	Antiemetics
10	Trimipramine Maleate	0.06	API	antidepressant
11	Flupentixol HCl	0.03	API	Antipsychotic
12	Melitracen HCl	0.05	API	Antidepressant
13	Carbinoxamine Maleate	0.09	API	Respiratory Agent
14	Opipramol HCL	0.05	API	Antidepressant
15	Sulfadoxine	0.25	API	Antimalarial
16	Doxiepin HCl	0.05	API	antidepressant.
17	Dothiepin HCl	0.12	API	Antipsychotic
18	Flunarazine HCl	0.07	API	Antihistamines
19	Duloxetine HCl	0.10	API	Antidepressant.
20	Dapoxetine HCl	0.05	API	selective serotonin reuptake inhibitors
21	Desvenlafaxine HCl	0.06	API	antidepressant
22	Trihexyphenaldyl HCl	0.10	API	Antiparkinsonian
23	Tramadol HCl	0.27	API	Analgesics
24	Sulfamethoxy Pyrazine HCl	0.06	API	Antimalarial
25	Buclazine HCl	0.08	API	Antihistamines
26	Meclazine HCl	0.07	API	Antiemetic
27	ORPHENADRINE BASE	8.00	Drug Intermediate	

28	CARBAMEZAPINE	2.00	Drug Intermediate	
29	Hydroxy dimethyl dibenzyl Intermediate	0.60	Drug Intermediate	
30	Piperidine propiophenone	1.00	Drug Intermediate	
31	Cinnarizine crude	2.00	Drug Intermediate	
32	Doxiepinone	0.60	Drug Intermediate	
33	Ditheipinone	1.00	Drug Intermediate	
34	Methoxy Dichloro Pyrimidine	2.00	Drug Intermediate	
35	P- t- Butyl benzyl chloride	1.00	Drug Intermediate	
36	Chloro Acetyl benzo phenone	1.50	Drug Intermediate	
37	Chloro ethyl piperidino Hydrochloride	1.00	Drug Intermediate	
38	Dibenzo suberone	8.00	Drug Intermediate	
39	Hydroxy dimethyl amino thiophene	0.50	Drug Intermediate	
40	ChloroImino di benzyl	3.00	Drug Intermediate	
41	Benzophenone methyl ester	1.00	Drug Intermediate	
42	2-Amino Nitro Benzo Phenone	0.80	Drug Intermediate	
43	Dimethylamino cyclo hexanone	2.50	Drug Intermediate	
44	Bromo anisole	2.50	Drug Intermediate	
45	Chloro Pheno thiazine	2.00	Drug Intermediate	
46	Iso propyl propionate (Ester)	1.00	Drug Intermediate	
47	Di Methyl amino propyl chloride	3.00	Drug Intermediate	

7.4.1 Process Description

The details of process are given in **Chapter 2**

7.5 Hazard Analysis and Risk Assessment

7.5.1 Introduction

Hazard analysis is the process of determining the release probabilities and quantities, emission or release rates, the routes/pathways by which the released substances could reach the receptors, the fate of the substances in environmental media through which they are transported or moved and characteristics of the receptors at risk. The basis of risk estimation is to determine the dose-effect relationship between an indicator chemical and receptor. Estimation of risk follows only when the hazard analysis shows a frequency or occurrence, which is significant.

Risk evaluation is the process of identifying, whether the estimated level of risk is tolerable. Tolerable risk is not equated with acceptability; it refers to a willingness to live with a risk so as to secure certain risk benefits, and in the confidence that the risk is being properly controlled.

Hazard analysis involves the identification and quantification of the various hazards (unsafe conditions) that exist in the plant. On the other hand, risk analysis deals with the identification and quantification of risks, the plant equipment and personnel are exposed to, due to accidents resulting from the hazards present in the plant.

7.5.2 Common definitions

The common terms used in risk Assessment and Disaster Management are elaborated below:

"Risk" is defined as a likelihood of an undesired event (accident, injury or death) occurring within a specified period or under specified circumstances. This may be either a probability depending on the circumstances.

"Hazard" is defined as a physical situation, which may cause human injury, damage to property or the environment or some combination of these criteria.

"Hazardous substance" means any substance or preparation, which by reason of its chemical or physic chemical properties or handling is liable to cause harm to human beings, other living creatures, plants, micro-organisms, property or the environment.

"Hazardous process" is defined as any process or activity in relation to an industry which may cause impairment to the health of the persons engaged or connected therewith or which may result in pollution of their general environment.

"Disaster" is defined as a catastrophic situation that causes damage, economic disruptions, loss of human life and deterioration of health and health services on a scale sufficient to warrant an extraordinary response from outside the affected area are community. Disasters occasioned by man are factory fire explosions and release of toxic gases or chemical substances etc.

"Accident" is an unplanned event, which has a probability of causing personal injury or property damage or both.

"Emergency" is defined as a situation where the resources out pass the demand. This highlights the typical nature of emergency; it will be after experiences that enough is not enough in emergency situations. Situations of these kinds are avoidable but it is not possible to avoid them always.

In the sections below, the identification of various hazards, probable risks in a process industry manufacturing optical brighteners, maximum credible accident analysis, consequence analysis are addressed which gives a broad identification of risks involved in the plant.

7.5.3 Hazard Identification

Identification of hazards in the synthetic organic chemicals plant is of primary significance in the analysis, quantification and cost effective control of accidents involving flammable compounds. A classical definition of hazard states that hazard is not in fact the characteristic of system/plant/storage that presents potential for an accident. Hence, all the components of a system/ plant/ process need to be thoroughly examined to assess their potential for initiating or propagating an unplanned event/sequence of events which can be termed as an accident.

Typical schemes of predictive hazard evaluation and quantitative risk analysis suggest that hazard identification step plays a key role in estimation of probability of an unexpected event and its consequences from the basis of quantification of risk in terms of damage to property, environment or personal. Therefore the type, quantity location and conditions of release of a toxic or flammable substance have to be identified in order to estimate its damaging effects, the area involved, and the possible precautionary measures required to be taken.

Some of the hazard identification procedures are as follows:

1. Fire Explosion and Toxicity Index(FETI) Approach;
2. HAZOP studies
3. Maximum Credible Accident and Consequence Analysis(MCACA);

7.5.3.1 Identification of Major Hazards from the unit

The Hazard identification process adopted is to identify hazardous chemicals as per the statutory requirements of Manufacture storage and import of Hazardous Chemical Rules, 1989

The identified chemicals for the risk assessment are presented in the following **Table 7.2**

Table 7.2

List of Raw materials and Inventory

S.No	Name of the Raw Material	Quantity (Kgs)	Physical Form	Nature of Storage	CAS NO.
1	2-acetyl thiophene	6.93	Liquid	Drums	88-15-3
2	2-Acetyl pyridine	8.4	Liquid	Drums	1122-62-9
3	2-Chloro pheno thiazine	19.80	Solid	Bags	85-52-9
4	2-dimethyl amino methyl cyclohexanone	25.57	Solid	Bags	2516-96-3
5	2-methyl Benzophenone	982.35	Liquid	Drums	131-58-8
6	3-Chloro propio phenone	4.76	Liquid	Drums	131-58-8
7	3-chlorolmino dibenzyl	9.2	Liquid	Drums	108-24-7
8	Acetone	2635	Liquid	Tank Form	67-64-1
9	Acetophenone	6.6	Liquid	Drums	98-86-2
10	Activated carbon	3.7	Solid	Bags	7440-44-0
11	Alfa Naphthol	4.2	Solid	Bags	7446-70-0
12	Ammonia	50.32	Liquid	Drums	7664-41-7
13	Bromo chloropropane	3.12	Liquid	Drums	71-43-2
14	Carbon	32.42	Solid	Bags	119-61-9
15	Chloro benzene	7.84	Liquid	Drums	109-70-6
16	Chloro ethyl piperdine	5.88	Solid	Bags	7440-02-0
17	Cinanamyl alcohol	4.02	Solid	Bags	104-54-1
18	Conc.Hcl	81.75	Liquid	Drums	79-04-9
19	Cyclo Hexanone	16.17	Liquid	Drums	108-90-7
20	Cyclo hexyl chloride	6.49	Solid	Bags	104-54-1
21	Di benzo Suberenone	146.64	Solid	Bags	2222-33-5

22	Di methyl amino propyl chloride	84.6	Liquid	Drums	5407-04-5
23	Dibenzo suberenone	25.75	Solid	Bags	2222-33-5
24	Dichloro pyazine	5.92	Solid	Bags	4858-85-9
25	Diethylamino ethyl chloride	7.49	Solid	Bags	869-24-9
26	Difluro Benzhydrol	6.6	Solid	Bags	91-01-0
27	Dimethylamine	11.16	Liquified Gas	Cylinder	124-40-3
28	Dimethyl anthrone	6.6	Liquid	Drums	77-78-1
29	Dimethylamino Ethyl chloride	4.28	Liquid	Drums	108-01-0
30	Dimethylamino methylpropyl chloride	4.05	Solid	Bags	16968-19-7
31	Dimethylamino propul chloride	49.37	Liquid	Drums	68-12-2
32	Dimethyl amino Ethanol	441.22	Liquid	Drums	108-01-0
33	DMF	60	Liquid	Drums	141-78-6
34	DMSO	33	Liquid	Drums	67-68-5
35	Dothiepinone	15.82	Solid	Bagsc	216-241-1
36	Ester	6.38	Liquid	Drums	111-82-0
37	Ether	7.56	Liquid	Drums	60-29-7
38	Flunarizine crude	12	Solid	Bags	52468-60-7
39	Fluro naphthalene	7.97	Liquid	Drums	323-09-1
40	Formaldehyde	8.25	Liquid	Drums	50-00-0
41	Guanidine	3.3	Solid	Bags	113-00-8
42	H2S gas	0.11	Gas	Cylinder	7783-06-4
43	HCl	1050.5	Liquid	Drums	7649-01-0
44	HCl gas	25.7	Gas	Cylinder	7649-01-0

45	Hydrogen	9.99	Gas	Cylinder	1333-74-0
46	Imino di benzyl	22.42	Solid	Bags	494-19-9
47	Imino stilbene	289.48	Solid	Bags	205-970-0
48	IPA	82.5	liquid	Drums	67-633-0
49	KHCO3	4	Solid	Bags	298-14-6
50	KOH	12.71	Solid	Bags	1310-58-3
51	Magnesium	30.35	Solid	Bags	7439-95-4
52	Maleic acid	7.62	Solid	Bags	110-16-7
53	Mono Ethylene Glycol MEG	3.41	Liquid	Drums	107-21-1
54	Meta methyl benzyl chloride	4.2	liquid	Drums	620-19-9
55	Meta bromo methoxy anisole	30.85	Liquid	Drums	2398-37-0
56	Methane sufonic acid	2.66	Liquid	Drums	75-75-2
57	Methanol	5611	liquid	Tank Form	67-56-1
58	Methanolic HCL	26.65	liquid	Drums	67-56-1 7649-01-0
59	Methoxy di chloro pyrimidine	25.06	Solid	Bags	5018-38-2
60	Methyl ester intermediate	10.24	Liquid	Drums	111-11-5
61	n-butanol	705	Liquid	Drums	71-36-3
62	NaOH	297.4	solid	Bags	1310-73-2
63	Nitro Benzaldehyde (NBA)	85	Solid	Bags	552-89-6
64	Ni Cat	3.58	Solid	Bags	7440-02-0
65	N-Methyl chloro piperidine	7.315	Liquid	Drums	5570-77-4
66	Opipramol base	7.24	Solid	Bags	315-72-0
67	P- Chloro Benz hydryl Piperizine	17.16	Solid	Bags	303-26-4
68	Para amino Sulphonamide	30.96	Solid	Bags	63-74-1

69	Para Chloro Benzyl Chloride (PCBC)	8.25	Liquid	Drums	104-83-6
70	Piperidine	7.25	Liquid	Drums	110-89-4
71	Piperizino ethanol intermediate	2.8	Liquid	Drums	103-76-4
72	Piperidino ethanol	2.6	Liquid	Drums	110-89-4
73	Potassium bicarbonate	4	solid	Bags	298-14-6
74	Potassium Methoxide	2.8	solid	Bags	865-33-8
75	P-tetra butyl benzyl chloride	5.46	Liquid	Drums	19692-45-6
76	Pyridine benz hydrol	8.8			
77	Sodamide	6.04	solid	Bags	7782-92-5
78	Sodium methoxide	7.56	solid	Bags	124-41-4
79	Succinic acid	11.06	solid	Bags	110-15-6
80	THF	40.92	Liquid	Drums	109-99-9
81	Toluene	9144.2	Liquid	Tank Form	108-88-3
82	Tramadol Grignard base	43.72	Solid	Bags	73806-49-2
83	Triflurothioxanthone	3.92	solid	Bags	1693-28-3
84	Triphosgene	148	solid	Bags	32315-10-9
85	Venalafaxine HCl	9.39	solid	Bags	99300-78-4

Table 7.3

List of hazardous chemicals (Listed in part II of schedule I of MSIH Rule, 2016)

S.No	Raw material	Physical form	Type of hazard	Maximum Storage quantity (Kgs)	Threshold Quantity (Rule 5,7,9 and 13 &15	Threshold Quantity (Rule 10 to 12	Level of Hazard
1	Acetone	Liquid	Flammable	2635	Not specified	Not specified	Level 1 Hazard

2	Ammonia	Liquid	Flammable	50.32	60 t	600t	Level 1 Hazard
3	Chloro benzene	Liquid	Flammable	7.84	Not specified	Not specified	Level 1 Hazard
4	Cyclo hexanone	Liquid	Flammable	16.17	Not specified	Not specified	Level 1 Hazard
5	Di methyl amine	Liquid	Flammable	11.16	Not specified	Not specified	Level 1 Hazard
6	Formaldehyde	Liquid	Flammable	8.25	5 t	50 t	Level 1 Hazard
7	Hydrochloric Acid	Liquid	Corrosive	1050.5	25 t	250 t	Level 1 Hazard
8	Hydrogen	Gas	Explosive	9.99	2 t	50 t	Level 1 Hazard
9	Isopropyl Alcohol	Liquid	Flammable	82.5	Not specified	Not specified	Level 1 Hazard
10	Magnesium	Solid	Flammable	30.35	Not specified	Not specified	Level 1 Hazard
11	Methanol	Liquid	Flammable	5611	Not specified	Not specified	Level 1 Hazard
12	n-Butanol	Liquid	Flammable	705	Not specified	Not specified	Level 1 Hazard
13	Potassium Hydroxide	Solid	Corrosive	12.71	Not specified	Not specified	Level 1 Hazard
14	Sodium Hydroxide	Solid	Corrosive	297.4	Not specified	Not specified	Level 1 Hazard
15	Nickel	Solid	Toxic	0.14	Not specified	Not specified	Level 1 Hazard
16	Piperidine	Liquid	Flammable	7.25	Not specified	Not specified	Level 1 Hazard
17	THF	Liquid	Flammable	40.92	Not specified	Not specified	Level 1 Hazard
18	Toluene	Liquid	Flammable	9144.2	Not specified	Not specified	Level 1 Hazard

Note :

Level I Hazard: Chemical is listed in schedule of chemicals but threshold limit did not crossed 1st threshold or 2nd threshold limit as per the schedule I of MSIHC Rules 2016

7.5.3.1.1 Physical properties of Hazardous Chemicals

The Physical properties of the key hazardous chemicals identified & stored are presented in the following **Table 7.4**

Table 7.4
Physical properties & Hazard characteristics of Key Raw materials

S.No	Name of the Material	Boiling point °C	Flash Point in °C	Explosive Limits volume % in air	NFPA Rating		
					Health	Fire reactivity	Reactivity
1	Acetone	55.6	-17.8	2.5-12.8	2	3	0
2	Acetophenone	201.7	37.8-93.3	76	1	2	0
3	Bromo chloro	145	45	3.2-8.6	2	2	0
4	Chloro benzene	132	29.44	1.3-11	2	3	0
5	cyclohexanone	155.6	43.88	1.1-9.4	2	2	0
6	Di Methyl amine	100	37.8	2.8-14.4	3	1	0
7	Dimethyl formamide	153	37.8-93.3	2.2-15.2	2	2	0
8	Ether	34.6	-45	1.9-36	2	4	0
9	Formaldehyde	98	50	7-73	3	2	0
10	Hydrogen	108.58	-	-	3	0	1
11	Isopropanol	82.5	11.7-13	2-12.7	2	3	0
12	Methanol	64.5	12	6.7-36	2	3	0
13	n- Butanol	117.7	37.8	1.7-12.0	1	3	0
14	Piperidine	106	16.1	2.5-13	3	3	0
15	Toluene	110.6	4.44	1.2-6.75	2	3	0
16	THF	65	37.8	2-11.8	2	3	0

7.5.3.1.2 Bulk Storages

Based on the discussions with the project proponents, following bulk storages are proposed in the plant after expansion. Following table gives the bulk storages of chemicals after expansion activity.

Table 7.5
Bulk Storages after expansion

Sr No	Name of the solvent	MOC	Above/ below ground	No. of tanks	Diameter (m)	Length (m)	Total Capacity (KL)
	Existing						
1	Methanol	MS	Below ground	2	2	3.25	10*2
	Methanol	MS	Below ground	1	1.8	4.72	12
2	Toluene	MS	Below ground	2	1.95	5.09	15*2
3	Sulphuric acid	MS	Above ground	1	1.63	3.0	5
4	HCl	PP	Above ground	2	1.63	2.65	6*2
	Proposed						
5	Acetone	MS	Below ground	2	1.95	5.09	2 X15

7.6 Fire & Explosion Index (F&EI):

7.6.1 Methodology

Dow Chemical Company issued a guideline for hazard determination and protection. By this method a chemical process unit is rated numerically for hazards. The numerical value used is the Fire and Explosion Index (F&EI) which is most widely used for hazard evaluation in chemical process industries.

The guide applies to process unit only and not to auxiliary units such as power generating stations, plant water systems, control rooms, fired

heaters, structural requirements, corrosive nature of material handled and personal safety equipment. These are regarded as basic features that do not vary according to the magnitude of the fire and explosion hazard involved. The guide also does not cover the processing and handling of explosives such as dynamite, TNT etc.

7.6.2 Computation of F&EI

The computation of fire and explosion index of each unit is based on the material factor. This is a measure of the intrinsic rate of potential energy release from fire explosion of most hazardous material or mixture of materials present in significant quantity, whether it is raw material, intermediate, product, solvent etc., by combustion or chemical reaction. "In significant quantity" here means such quantity that the hazard represented by the material actually exists. The Nationality Fire Protection Agency of USA (NFPA) have specified standard values for material factor which should be used for F&EI calculations and are available in DOW's hazard classification guide in case it is not readily available, it can be calculated using the heat of combustion, flammability indices etc.

General process hazard are factors that play a primary role in determining the magnitude of loss of incident. It takes into account the nature of the reaction, ventilation of the unit, accessibility of the unit, drainage facilities etc., special process hazards are factors that contribute primarily to the probability of a loss incident. They consist of specific process conditions that have shown themselves to be major causes of fire and explosion incidents. It takes into account toxicity of the material, operating pressure, operation near flammable range, quantity of material, joints and packing, use of hot oil exchange system etc., The F&EI calculated as a product of material factor, general process hazard factor, and special process hazard factor.

7.6.3 Hazard Ranking

The hazard ranking based on F&EI value is as follows

Table 7.6
Degree of Hazard for F&EI

F&EI Index Range	Degrees of Hazard
1-60	Light
61-96	Moderate
97-127	Intermediate
128-158	Heavy
159 & above	Severe

7.6.3.1 Maximum Credible Accident Analysis and Its Mitigation Measures

A Maximum Credible Accident (MCA) can be characterized as the worst credible accident. In other words: an accident in an activity, resulting in the maximum consequence distance that is still believed to be possible. A MCA-analysis does not include a quantification of the probability of occurrence of the accident. Another aspect, in which the pessimistic approach of MCA studies appears, is the atmospheric condition that is used for dispersion calculations.

The Consequence Analysis has been done for selected scenarios by ALOHA (version 5.4.7) of EPA. The details of software used for MCA analysis are described below.

- A computer based version ALOHA 5.4.7 is used to calculate toxic and explosive effect of the accidental release of liquid chemicals within the plant area.
- ALOHA (Areal Locations of Hazardous Atmosphere) is a computer program designed especially for use by people responding to chemical release as well as for emergency planning and training.
- ALOHA was jointly developed by the National Oceanic and Atmospheric Administration (NOAA) and the Environment Protection Agency (EPA).
- The mathematical model is based on the Emergency Response Planning Guidelines (ERPGs) which gives Toxic Levels of Concern

(LOCs) to predict the area where a toxic liquid concentration might be high enough to harm people.

- ALOHA models key hazards-toxicity, flammability, thermal radiation (Heat), and over pressure (expansion blast force)-related to chemical releases that result in toxic gas dispersion, fire and/or explosion

7.6.3.2 Heat Radiation & Vapour cloud Fire distances of Hazardous Storages

Out of the 5 bulk storages, 3 chemicals have Fire threat possibilities. The heat radiation distances in case of pool fire for flammable storage tanks are presented in the below **Table 7.7** below

Table 7.7

Heat Radiation Damage Distances for storage tanks – Tank farm

S.No	Name of Raw material		Storage Tank Details				Scenario Details(Pool fire –Leaking tank)			
		FEI Index	Tank Capacity (KL)	No.s	Diameter (m)	Height (m)	Release Rate (Kg/min)	Heat radiation damage distances in m for KW/m2		
								10	5	2
1	Acetone	95	15	1	1.95	5.09	23.3	<10	<10	12
2	Toluene	100	15	1	1.95	5.09	24.5	<10	11	14
3	Methanol	68	5	1	1.8	2.25	23.4	<10	<10	<10
4										

Note:

2 kW/(sq m) -- people will feel pain after 45 seconds and receive second degree burns after 3 minutes;

- **5 kW/(sq m)** -- people will feel pain after 13 seconds and receive second degree burns after 40 seconds; and
- **10 kW/ (sq m)** -- people will feel pain after 5 seconds and receive second degree burns after 14 seconds.

The storage is a small capacity facility and accordingly the F& E index value is found to be moderate reflecting the threshold limits as prescribed in MSHC rules. As can be seen, the heat radiation distances are confined to plant area only.

7.6.3.3 Toxic chemicals storage and toxic impact distances:

Following 6 chemicals are classified as toxic chemicals used by the company. Toxic influence distances are estimated using ALOHA model in case of Drum Leakages/Tank leakages and presented below

Table 7.8
Toxic threat zones on release of chemicals

S.No	Name of the chemical	Storage capacity		Scenario Details							IDLH Values
			Maximum drum capacity	Release rate	AEGL-3 Red (m)	AEGL-3 Red (ppm)	AEGL-2 Orange (m)	AEGL-2 Orange (ppm)	AEGL-1 Yellow (m)	AEGL-1 Yellow (ppm)	
1	Acetone	15 KL	TANKS	20.5 Kg/min	<10	5700	11	3200	92	200	2500 PPM
2	Ammonia	50.32 Kgs	200Kg	3.33 Kg/sec	249	1100	727	160	1600	30	300 PPM
3	Toluene	15 KL	TANKS	17.8 Kg/min	<10	3700	20	560	115	67	700 PPM
4	Chloro Benzene	7.84 Kgs	200 Kg	3.33 Kg/sec	223	400	389	150	1500	10	1000 PPM

Note :

AEGL-1 (Yellow zone): The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic non sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

AEGL-2 (Orange zone): The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.

AEGL-3 (Red zone): The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life threatening health effects or death.

7.6.3.4 Analysis of quantitative risk assessment data:

Based on the above quantitative risk assessment, following conclusion can be made.

- Flammability threat zones and heat radiation zones for flammable chemicals are within the plant premises
- FEI index for flammable chemicals is moderate for acetone and methanol and intermediate for Toluene.
- Storage quantities of flammable chemicals are well below the threshold quantities
- Toxic threat zones for all chemicals are within the plant boundary
- However Toxic threat zone Orange category and Yellow zone concentrations are well within IDLH values of the chemicals

7.6.3.5 Health Hazards from exposure to hazardous substances and control measures.

Based on analysis 4 chemicals are identified as toxic chemicals in liquid form. Toxic concentrations distances are determined based on the modeling data and presented. Following table summarizes the health hazards, antidotes if any and PPEs recommended for people & other suggested measures to control the escape/leakage of chemicals.

Table 7.9
Safety precautions for handling of toxic chemicals

S.No	Chemical	Health Hazards	PPE's proposed	Antidotes if any suggested	Storage and handling precautions suggested
1	Acetone	Hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation. Slightly hazardous in case of skin contact (permeator).	Splash goggles. Lab coat. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.	No specific antidote	Storage: Store in a segregated and approved area (flammables area). Keep container in a cool, well-ventilated area. Keep container tightly closed and sealed until ready for use. Keep away from direct sunlight and heat and avoid all possible sources of ignition (spark or flame). Precautions: Keep locked up.. Keep away from heat. Keep away from sources of ignition. Ground all equipment containing material. 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 oxidizing agents, reducing agents, acids, alkalis. in closed condition
2	Ammonia	Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (irritant), of ingestion, . Non-corrosive to the eyes. Non-corrosive for lungs. Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract. Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath. Severe over-exposure can result in death. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering	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.	No specific antidotes suggested	Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area. Do not store above 25°C (77°F). Precautions: Keep locked up.. Keep container dry. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Never add water to this product. 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, acids.
3	Toluene	Hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of	Splash goggles. Full suit. Vapor respirator. Boots.	No specific antidotes suggested	Storage: Store in a segregated and approved area. Keep container in a cool, well-ventilated area. Keep

		inhalation. Slightly hazardous in case of skin contact (permeator).	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.		container tightly closed and sealed until ready for use. Avoid all possible sources of ignition (spark or flame). Precautions: Keep away from heat. Keep away from sources of ignition. Ground all equipment containing material. 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 oxidizing agents.
4	Chlorobenzene	Very hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation. Hazardous in case of skin contact (corrosive, sensitizer, permeator). Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or,	Splash goggles. Lab coat. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.	No specific antidotes suggested	Storage: Flammable materials should be stored in a separate safety storage cabinet or room. Keep away from heat. Keep away from sources of ignition. Keep container tightly closed. Keep in a cool, well-ventilated place. Ground all equipment containing material. A refrigerated room would be preferable for materials with a flash point lower than 37.8°C (100°F).

		occasionally, blistering			Precautions: Keep container dry. Keep away from heat. Keep away from sources of ignition. Ground all equipment containing material. Do not ingest. Do not breathe gas/fumes/ vapour/spray. Never add water to this product 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

7.7. Specific recommendations based on site observations

S.No	Area	Site Observations	Specific recommendations
1	Production Area	➢ All the reactor and centrifuges are very neatly placed ➢ Earthing strips are provided ➢ Belt guards are provided to all motor driven equipment ➢ Safety valves are placed on all reactors ➢ Dip pipes are provided wherever solvents are charged.	➢ Housekeeping at filter press area needs improvement.
2	Centrifuges	➢ Vent lines are taken outside of the room ➢ Specific anti static belts only are used ➢ Suitable PPE are being used by operators	➢ Centrifuge feeding should not be done keeping the lid of the centrifuge open while running it. ➢ SOP's are to be exhibited. ➢ Two earth strips are to be provided and jumper at the joints for earthing of the equipment. ➢ Anti static belts are to be provided with proper guards ➢ An alarm is to be provided for Emergency situation
4	Liquid raw materials storage	➢ Underground tanks are provided for solvents ➢ Vent lines are connected with flame arrestors ➢ A spray nozzle system with water and foam is provided in tank form	➢ All the tankers are to be provided sparks arresters in the exhaust lines and to be earthed during transfer of solvents
5	Raw materials Stores	➢ Room is maintained neatly stranded weights, balance Approved materials are earmarked with green rope	➢ Placards should be placed near materials with

			names written on it. ➢ Fire fighting equipments should be in good number with easy accessibility. ➢ Flame proof fitting should be provided.

Other Recommendations

DRIER ROOMS

1. Fire suit made available for emergency use.
2. Double earthing is to be provided to the unit

BOILER HOUSE

- Safety valve on steam boiler is to be checked every day for its functioning
- Pressure guage to be monitored regularly

CHILLING PLANT

- Thickness tests for NH_3 receivers Oil Separator, Condenser, Evaporator etc., should be conducted once in a year and maintain such record
- Auto tripping devices are to be provided for various components in the unit when the stipulated parameters vary.

Expected hazards from the Industry

DEPT/AREA	HAZARD	SEVERITY	EFFECTED AREA	EFFECTED POPULATION	PRECAUTION TAKEN	MITIGATION MEASURES
RM Packing Room, **Stores.**	FIRE & EXPLOSION	moderate	In the radius of about 10 mtrs	About 2 people.	✓ 0pen drums storage prohibited ✓ Secondary containment provided. ✓ Ignition sources of all types controlled/eliminated ✓ Adequate ventilation provided. ✓ Smoking in area prohibited ✓ Standard operating procedures in operation. ✓ Sufficient fire extinguishers of various capacity and type is provided	• Fire extinguishers and foam monitoring system available • 20% of workers trained in Fire fighting • 20% of workers trained in first aid • Activities are carried out as per written procedures • Each and every step is strictly double checked by means of doer and checker method • Smoke detectors proposed. • Inertisation procedure is followed wherever required • Earhting and bonding procedures are followed for transfer of flammable liquids • Continuity is checked for all equipment at regular intervals

	SPILLAGE	No severity in case of spillage	---	----	✓ No open drums stored ✓ Secondary containment provided. ✓ Smoking in area prohibited ✓ Standard operating procedures in operation.	• Periodic preventive maintenance of the equipment is carried out as per the schedule • Level indicators are in place to prevent the overflow and spillage • Appropriate No. of Spill control kits are provided in the department • Trained personnel are available in each shift to do the spill control operations. • Spill control sop
	TOXIC RELEASE	---	about 1-3mts	2 employees	✓ No open drums stored ✓ Secondary containment provided. ✓ Standard operating procedures in operation.	• Appropriate personal protective equipments are used as barriers against inhalation of the toxic gases • Adequate scrubbing system is available to neutralize the gases evolved during the process • Wind socks are installed to show the wind direction in all locations • Emergency preparedness and response is in place

						• Proper ventilation is provided to prevent accumulation of vapors • Persons are trained to handle hazardous material and steps to be taken during emergencies • MSDS available for all materials • Ambulance facility to shift the victim to hospital in time • Agreement with nearby hospital
SOLVENT YARD	FIRE & EXPLOSION	Severity mapping is made available	Severity mapping is made available	Severity mapping is made available	✓ Flame arresters provided for tank vents. ✓ Ignition sources of all types controlled/eliminated. ✓ No open tanks /drums stored ✓ Smoking in area prohibited ✓ Standard operating procedures in operation. ✓ Sufficient fire extinguishers of various capacity and	• Fire extinguishers and foam monitoring system available • 20% of workers trained in Fire fighting • 20% of workers trained in first aid • Activities are carried out as per written procedures • Each and every step is strictly double checked by means of doer and checker method • Inertisation procedure is followed wherever required

					type is provided	• Earhting and bonding procedures are followed for transfer of flammable liquids • Continuity is checked for all equipment at regular intervals • Antistatic pads provided at entrance of hazardous locations to discharge static charge developed on human • Risk analysis is done to all activities • Regular safety audits are conducted to ensure the safe operation and the equipment • Flameproof electrical appliances provided to mitigate electrical ig source
	SPILLAGE	moderate	Max. threat zone of 30 mts	About 2 employees could be affected	✓ No open drums stored ✓ Secondary containment provided. ✓ Standard operating procedures in operation.	• Periodic preventive maintenance of the equipment is carried out • Level indicators are in place to prevent the overflow and spillage • Appropriate No. of Spill control kits are provided

						in the department • Trained personnel are available in each shift to do the spill control operations. • Spill control sop
	TOXIC RELEASE		Same as above	Same as above	✓ No open drums stored ✓ Secondary containment provided. ✓ Standard operating procedures in operation.	• Appropriate personal protective equipments are used as barriers against inhalation of the toxic gases • Adequate scrubbing system is available to neutralize the gases evolved during the process • Wind socks are installed to show the wind direction in all locations • Emergency preparedness and response is in place • Proper ventilation is provided to prevent accumulation of vapors • Persons are trained to handle hazardous material and steps to be taken during emergencies • MSDS available for all materials

						• Antidotes are available for hazardous chemicals • Ambulance facility to shift the victim to hospital in time • Agreement with nearby hospital
PRODUCTION /PROCESS AREAS.	FIRE & EXPLOSION	moderate	A threat zone of 50m as per F&EI	No of affected people about 5	✓ Flame arresters provided for reactors and storage tank vents. ✓ Electrical and mechanical sources of ignition controlled/eliminated. ✓ Non-sparking tools. ✓ Smoking in area prohibited ✓ Standard operating procedures in operation. ✓ Sufficient fire extinguishers of various capacity and type is provided	• Fire extinguishers and foam monitoring system available • 20% of workers trained in Fire fighting • 20% of workers trained in first aid • Activities are carried out as per written procedures • Each and every step is strictly double checked by means of doer and checker method • Inertisation procedure is followed wherever required • Earthting and bonding procedures are followed for transfer of flammable liquids • Continuity is checked for all equipment at regular intervals

						• Antistatic pads provided at entrance of hazardous locations to discharge static charge developed on human • Risk analysis is done to all activities • Regular safety audits are conducted to ensure the safe operation and the equipment • Flameproof electrical appliances provided to mitigate electrical ig source
	SPILLAGE	---	No severe effect	No severe effect	✓ Adequate ventilation to prevent accumulation of chemical and solvent vapours. ✓ Standard operating procedures in operation.	----
	TOXIC RELEASE	moderate	About 10 mts	No of people affected 5	✓ Adequate ventilation to prevent accumulation of chemical and solvent vapours. ✓ Standard operating procedures in	• Appropriate personal protective equipments are used as barriers against inhalation of the toxic gases • Adequate scrubbing system is available to

					operation.	neutralize the gases evolved during the process • Wind socks are installed to show the wind direction in all locations • Emergency preparedness and response is in place • Proper ventilation ~~(AHU)~~ is provided to prevent accumulation of vapors • Persons are trained to handle hazardous material and steps to be taken during emergencies • MSDS available for all materials • Antidotes are available for hazardous chemicals • Ambulance facility to shift the victim to hospital in time • Agreement with nearby hospital
LABS (QC AND R&D)	FIRE & EXPLOSION	moderate	About 1-2 mts	No of affected people-1	✓ Solvent and chemical containers provided with secondary containment. ✓ Smoking in area prohibited	• Fire extinguishers and foam monitoring system available • 20% of workers trained in Fire fighting • 20% of workers trained in

					✓ Standard operating procedures in operation. ✓ Sufficient fire extinguishers of various capacity and type is provided	first aid • Activities are carried out as per written procedures • Each and every step is strictly double checked by means of doer and checker method
	SPILLAGE	Same as above	About 1-2mts	No severe effect	✓ Standard operating procedures in operation. ✓ Training to all workmen and staff.	AS ABOVE
	TOXIC RELEASE	Same as above	About 1-2mts	Affected people-1-2	✓ Standard operating procedures in operation. ✓ Training to all workmen and staff	AS ABOVE
ELECTRICAL PANELS	FIRE	---	About 1to 2mts	Affected people-1	✓ Standard operating procedures in operation. ✓ Training to all workmen and staff. ✓ Smoking in area prohibited ✓ Sufficient fire extinguishers of various capacity and type is provided	Standard operating procedures. Training to all workmen and staff. PPE issuance. Arc splash suit. Work permit system

DG ROOM	FIRE	moderate	About 10mts	Affected people-1	✓ Standard operating procedures in operation. ✓ Training to all workmen and staff. ✓ Smoking in area prohibited ✓ Sufficient fire extinguishers of various capacity and type is provided	• Fire extinguishers and foam monitoring system available • 20% of workers trained in Fire fighting • 20% of workers trained in first aid • Activities are carried out as per written procedures • Each and every step is strictly double checked by means of doer and checker method
	SPILLAGE	----	About 5m radius	Affected people-2	✓ AS ABOVE	AS ABOVE
UTILITY AND MAINTENANCE	FIRE	---	About 2m	Affected people-2	✓ AS ABOVE	AS ABOVE
	EXPLOSION	--	As above	As above	✓ AS ABOVE	AS ABOVE
UNIT OPERATIONS **CENTRIFUGAT**	FIRE & EXPLO	moderate	About 5m	Affected people-2	✓ Adequate ventilation to prevent accumulation of chemical and solvent vapors'.	AS ABOVE

ION **LEAF FILTRATION** **NUTSCH FILTRATION**	SION				✓ Smoking in area prohibited ✓ Standard operating procedures in operation. ✓ Sufficient fire extinguishers of various capacity and type is provided	
	SPILLAGE	As above	About 2m radius	Affected people-2	✓ Adequate ventilation to prevent accumulation of chemical and solvent vapours.	AS ABOVE
	TOXIC RELEASE	As above	About 5m radius	Affected people-2	✓ Adequate ventilation to prevent accumulation of chemical and solvent vapours	AS ABOVE
FINISHING AREA	FIRE	---	About 5m	Affected people-1	✓ Standard operating procedures in operation. ✓ Training to all workmen and staff. ✓ Smoking in area prohibited ✓ Sufficient fire extinguishers of various capacity and type is provided	AS ABOVE

7.7.1 Emergencies identified and Mitigation measures

Emergency Identified	Mitigation Measures – Control and Monitoring
Spillage/Overflow/Leakage (Reaction Mass /Chemicals/Effluent)	• Isolate the affected area to prevent unauthorized access and evacuate if required • Use appropriate Personal Protective Equipment • Isolate the source of leak or spillage to prevent further loses(if it is safe to do) • Appropriate spill control measures are adopted to contain or control the spillage/overflow/leakage of reaction mass • Spill control kit are available at identified locations as mentioned below • Trained ERT is available to combat any situation in any area of the plant premises. Transfer residual contents and contaminated absorbents for safe disposal • Decontaminate surfaces drains with suitable procedures • Inform to government agencies if it caused major environmental damage • Level indicators are provided for required equipment to avoid the overflow of the reaction mass/solvents etc • The effluent is pumped to the effluent treatment plants without any delay to avoid the overflow of the effluent pits • Adequate dyke walls are constructed to avoid the overflow. • Any major overflow/spillage will pass through acid proof drainage line to collection tank of ETP for further treatment
Fire / Explosion	• Earthing and bonding for the equipment and storage tanks to prevent static electricity generation • Antistatic polybags and PPE are used • Antistatic pad provided to discharge static charge generated on employees • Solvent charging to the reactor will be done through closed pipe loops and

	interlock will be provided with level control • Jumper provided at pipe line flange end to avoid static accumulation • Double earthing to all electrical motors and body earthing provided to process equipments • Double heat exchanger with cooling and chilling circulation to avoid loss of vapor provided • All reactor vent lead to outside the department with fire arrester • SRV with rapture disc to reactor which is again connected through pipe line to separate vessel to safely discharge reaction mass if any runaway or pressurization • Adequate number of fire extinguishers in respective areas. • Fire alarm system with smoke and heat detectors • Nitrogen blanketing facility to all the equipment where solvents are handled • Instruments for measuring explosive mixtures • Process safety experiments are conducted to identify the hazard • Risk analysis is carried out for unit operations / unit process • Emergency exits and escape routes are defined and displayed • Get the help from neighboring industries/fire brigade if required • All equipment are flameproof in areas which are expected to have flammable vapors • Explosion vents, safety relief valve and rapture disc installed for all critical equipments • Emergency preparedness and response is in place • Skilled and trained personals only allowed to operate the process and process equipment
Toxic leak / Release to atmosphere	• Appropriate personal protective equipments are used as barriers against inhalation of the toxic gases

	• Adequate scrubbing system is available to neutralize the gases evolved during the process • Wind socks are installed to show the wind direction in all locations • Emergency preparedness and response is in place • Proper ventilation is provided to prevent accumulation of vapors • Persons are trained to handle hazardous material and steps to be taken during emergencies • MSDS available for all materials • Antidotes are available for hazardous chemicals • Ambulance facility to shift the victim to hospital in time • Agreement with nearby hospitals

7.8 Hazard and Operability Study (HAZOP)

Safety and reliability of modern processing plant can be improved by using procedures that recognize and eliminate potential problems in the design stage. This is especially important because of the increasing need to operate the different units, for economic reasons, more closely to known risk situations. Hence, it requires refined methods like HAZOP study technique for identifying hazardous situations and problems and eliminating them at the design stage. Based on process reactions, a list of process reactions were identified for taking additional care precautions and presented in **Table 7.10**

Table 7.10
Hazardous processes and precautions suggested

Unit process	Chemicals involved	Equipment &utilities	Temp/ Pressure	Emissions	Safety measures
Orphenadrine base	Stage 1: reaction 2-methyl benzophenone Methanol Ni ca/Hydrogen Water	SSR,CFR, **Utilities** :: cooling water , chilling water	45-50^{o}C	-	Earthing, Limit switch CF , Flame proof fittings
	STAGE 2: Isolation, Cooling, Centrifuge HCl DMAE Toluene Naoh Water	GLR,SSR,CFG **Utilities** :: cooling water , chilling water	120^{o}C	-	Earthing, Limit switch CF , Flame proof fittings
Di benzo Subranone	Stage 1: Condensation Phthalic anhydride, Phenyl acetic acid, sodium acetate,	SSR, condenser ,CF, DRIER, **Utilities** :: Hot oil , cooling water , chilling water	240^{o}C	CO2	Cyclone scrubbing , Earthing, Limit switch CF , Flame proof fittings
	Stage 2: Hydrogenation water, Raney nickel catalyst, Hydrogen Nitrogen	SSR hydrogenator **Utilities**: Steam , Cooling water,	70-75*c	--	Rupture disc , earthing ,NRV, fire arrester Safety valve.

	Stage3: Acid , water	PP FRP, CF	<35*C	---	----
CARBAMEZAPANE CRUDE	Stage-1: Reaction Toluene, Iminostilbene, Triphosgene,	SSR, condenser **Utilities** Cooling water, Boiler	<15*C	HCL	Earthing, Limit switch, Flame proof electrical equipment
	Stage-2: Precipitation Gas purging Ammonia Gas	SSR, CF, Dryer **Utilities** Cooling water, Chilling Plant	<15*C		Earthing, Limit switch, Flame proof electrical equipment, Gas regulator
Hydroxy Dimethyl Dibenzyl Intermediate	2-Benzoyl Benozoic acid, Methanol, Hydrogen, Toluene, Cation resin, Methyl magnesium Chloride in THF, Acetone	SSR, CF, Drier**,** **Utilities** Cooling water, Boiler	50^{o}C	-	Earthing, Limit switch, Flame proof electrical equipment
Piperidine Propiophenone	Acetophenone, Formaldehyde, Toluene, Piperidine	GLR, CF, SSR **Utilities** Cooling water, Boiler	30-120^{o}C	-	Earthing, Limit switch, Flame proof electrical equipment
Cinnerazine Crude	Stage 1 : reaction R Benzophenone Hydrogen Methanol RaneyNi Water	SSR,NF,TD,CF **Utilities** Cooling water, Boiler	50-55^{o}C <15*C	-	Earthing, Limit switch, Flame proof electrical equipment

	Stage 2 : PIPERIZINE Cinmayl Alcohol Toluene NAOH,HCL,WATER	SSR,CFG,TD **Utilities** Cooling water, Boiler	<15*C 120^{o}C	-	Earthing, Limit switch, Flame proof electrical equipment
Doxiepinone	Phthalide,Phenol, DMF, Methanol	SSR, CF, Drier, **Utilities** Cooling water, TFH, Boiler	200-220^{o}C	-	Earthing, Limit switch, Flame proof electrical equipment
Dothiepinone	Phthalide, Thiophenol, DMF, Methanol	SSR, CF, **Utilities** Cooling water, TFH, Boiler	200-220^{o}C	-	Earthing, Limit switch, Flame proof electrical equipment
Methoxy Dichloro Pyrimidine	Stage 1: reaction Methoxydimethyl ester, Toluene, Formamide in acetate water sodium methoxide	SSR,CF,Drier **Utilities** Cooling water, Boiler, Chiller	<15*C 80-90^{o}C	-	Earthing, Limit switch, Flame proof electrical equipment
	Stage 2 : Isolation, cooling Acetone HCL	SSR,GLR,Drier, CFG **Utilities** Cooling water, Boiler, Chiller	<15*C 110-120^{o}C	-	Earthing, Limit switch, Flame proof electrical equipment
P-T-Butyl Benzyl Chloride	Tetra Butyl Benzene, Formaldehyde, HCL	GLR, **Utilities** Cooling water,	30-40^{o}C	-	Earthing, Limit switch, Flame proof electrical equipment

		Boiler			
Chloroacetyl chloridebenzo phenone	nitro benzo phenone Toluene Sodium bicarbonate Chloroacetyl chloride	GLR,CFG,SSR,TD **Utilities** Cooling water, Boiler, Chiller	50-55^{o}C <15*C	CO2	Earthing, Limit switch, Flame proof electrical equipment
Chloro Ethyl Piperidine HCL	Piperidino ethanol, Thionyl Chloride, Toluene, Methanol	GLR, CF, SSR, Drier, **Utilities** Cooling water, Boiler	90^{o}C	SO2	Earthing, Limit switch, Flame proof electrical equipment
Hydroxy Dimethylamino Thophene	2-acetyl thiophene, Formaldehyde, Toluene, DMA, Methanol, Hydrogen, Ni Cat, Ethyl acetate	GLR, CF, SSR, Drier, **Utilities** Cooling water, Boiler	45^{o}C	-	SRV, N2, Rapture disc, Earthing, Limit switch, Flame proof electrical equipment
Imino Dibenzyl	Stage 1 :reaction Dinitro di benzyl Iron powder Ammonium chloride Methanol	CF, SSR, Drier, **Utilities** Cooling water, Boiler	80^{o}C	-	Earthing, Limit switch, Flame proof electrical equipment
	Stage 2 : vaccum distillation Phosphoric acid Xylene	Vaccum distillation unit		O2	Earthing, Limit switch, Flame proof electrical equipment
Benzo Phenone Methyl ester	Phenolphthalein, Hydroxylamine sulphate, Toluene, NaoH,	SSR, CF, Drier, **Utilities** Cooling water,	80-85^{o}C	-	Earthing, Limit switch, Flame proof electrical equipment

	Methanol, Cation Resin	Boiler			
2-amino nitro benzo phenone	Stage 1: reaction 2-chloro 5-nitro benzoic acid Toluene Thionyl chloride	GLR, **Utilities** Cooling water, Boiler, Caustic scrubber	55-60^{o}C	SO2,HCL	Earthing, Limit switch, Flame proof electrical equipment
	Stage 2 : isolation cooling Benzene Aluminium chloride Water	GLR,CF **Utilities** Cooling water, Boiler, Caustic scrubber	50-55^{o}C	HCL GAS	Earthing, Limit switch, Flame proof electrical equipment
	Stage 3 : Centrifuge Methanol NH3 WATER	SSR,CFG,Drier **Utilities** Cooling water, Boiler	<15^{o}C	-	Earthing, Limit switch, Flame proof electrical equipment
Bromo anisole and dimethylamino cyclo hexanone	Stage 1 :Reaction Cyclohaxanone Formaldehyde Dimethylamine Toluene Water	GLR,CFG **Utilities** Cooling water, Boiler, Vaccum pump	25-30^{o}C 100^{o}C	-	Earthing, Limit switch, Flame proof electrical equipment
	Stage 2 : isolation cooling centrifuge M-bromo phenol Dimethyl sulphate Toluene	GLR, **Utilities** Cooling water, Boiler, Vaccum pump	<25^{o}C 55-60^{o}C	-	Earthing, Limit switch, Flame proof electrical equipment

Chloro phenothiazine	Stage 1: reaction M chloro anilnine Iron O-Chlorobenezic acid NaOH WATER TOLUENE	SSR,NF,CF,Drier **Utilities** Cooling water, Boiler, Vaccum pump	80-85^{o}C	CO2	Earthing, Limit switch, Flame proof electrical equipment
	Stage 2 :isolation, cooling, centrifuge Chloro Benzene, Sulphur	SSR,CF,Drier **Utilities** Cooling water, Boiler, Vaccum pump	140^{o}C <15^{o}C	H2	Earthing, Limit switch, Flame proof electrical equipment
Ester	Stage 1 :Reaction Iso propanol Toluene Propionic acid Water P-Toluene sulfonic acid	SSR,GLR, **Utilities** Cooling water, Boiler,Chiller,Vaccum pump	110-120^{o}C	-	Earthing, Limit switch, Flame proof electrical equipment
Dimethylamino propyl chloride	Stage 1:reaction ,isolation, washing Bromo chloro propane Dimethylamine 40% solution Toluene NaOH NaCL Water	SSR, **Utilities** Cooling water, Chiller, Vaccum pump	<25^{o}C	-	Earthing, Limit switch, Flame proof electrical equipment

7.9 Occupational Safety and Health

The Bulk drugs industry involves handling of various chemicals. The manufacturing process may generate fugitive emissions, which will pose hazards in the production area to the employees. The occupational safety and health plan shall follow the guidelines based on Factories Act 1948 and shall be finalized in consultation with the local factories inspectorate.

The occupational safety and health plan is prepared to identify the hazards due to the operations and process, with the mitigation measures. The mitigation measures are mainly engineering controls, production area conditions, personal protective equipment and training and education.

7.9.1 Health Surveillance Plan

The health surveillance plan consists of medical checkup on recruitment to ascertain the health status of the employees. The data to be obtained includes;

Baseline health data such as height, weight and Vital statistics, A detailed history of previous diseases and occupational exposures. The focus will be on previous lung problems and precious exposure to lung toxins such as silica, asbestos, irritant gases etc., A history of personal hobbies or activities that might involve exposures to potential toxicants, particularly those that might affect target organs of concern of metal species, Past history of any allergies, including asthma. Identification of personal habits (smoking, hygiene, alcohol consumption, fingernail biting) that may be relevant to work. Histories will be sufficiently detailed, complete physical examination with special attention to respiratory, the appropriate respiratory equipment (if any) that may be worn, X-ray, Blood tests and urine tests.

Annual health check up for all employees who are working in production areas and stores areas, including casual workers, is done through the hospital. It is suggested to including general health check up, lung function test, Liver function tests, urine and blood examinations & Records are maintained. It is suggested to maintain Antidotes as suggested for toxic gas hazards in the referral hospital always to meet any emergencies

7.9.2 First Aid centre

RL Fine Chem private Limited has the occupational health center with the following emergency handling facilities

- Stretcher
- Bed
- Self breathing equipment
- First aid boxes
- Ambulance is on call
- Two vehicles will be made available in day and night shifts

7.9.3 Tie up with Local Hospitals:

Government Hospital, ESI Hospital, Wipro health Centre and Balaji Nursing Home are available in the nearby area. occupational health centre for treatment and first aid activities is provided. If any major injuries are observed at that time we will admit in the authorised and approved insurance facility hospitals.

7.10 Disaster Management Plan

This Disaster Management Plan (DMP) has been designed based on the range, scales and effects of "Major Generic Hazards" described in the Risk Assessment Report just mentioned and on their typical behaviours predicted therein. The DMP addresses the range of thermal and mechanical impacts of these major hazards so that potential harm to people onsite and off-site, plant and environment can be reduced to a

practicable minimum. The scenarios of loss of containment are credible worst cases to which this DMP is linked.

The project is in its formative stage and detail engineering is yet to be done, so the elements of the DMP are based on concepts.

The emergency plan envisaged will be designed to intercept full range of hazards specific to Pharmaceutical industry. In particular, the DMP will be designed and conducted to mitigate those losses of containment situations, which have potentials to escalate into major perils.

Emergency medical aids to those who might be affected by chemical spills and toxic exposure will be inherent in the basic capabilities. The most important capability of this DMP will be the required speed of response to intercept a developing emergency in good time so that disasters such as explosion, major fire etc. are never allowed to happen.

7.10.1 Disaster Control Philosophy

The emergency control philosophy of the plant is in line with its normal operational controls. The emergency control room will be the plant's Central Control Room, which will employ Distributed Control System (DCS). All emergency operations, which may involve shutdown of the plant, will be controlled from the Central Control Room by the same operator(s) using dedicated "Shut-Down Consoles". The consoles will send commands to initiate the shutdown procedure. Plant shutdown system will be performed by DCS.

The principal strategy of DMP of the plant is "Prevention" of identified major hazards. The "Identification" of the hazards will employ one or more of the techniques [e.g. Hazard and Operability Study (HAZOP), accident consequence analysis etc.]. Since these hazards can occur only in the event of loss of containment one of the key objectives of technology selection, project engineering, construction, commissioning and operation is "Total and Consistent Quality Assurance". The Project Authority will be committed to this strategy right from the conceptual

stage of the plant so that the objective of prevention can have ample opportunities to mature and be realised in practice

The DMP or Emergency Preparedness Plan (EPP) will consist of:

A. On-site Emergency Plan

B. Off-site Emergency Plan

Disaster Management Plan preparation under the headlines of On-site Emergency Plan and Off-site Emergency Plan is in consonance with the guidelines laid by the Ministry of Environment and Forests (MOEF), Govt of India."Occupier" of the facility is responsible for the development of the On-site Emergency Plan as per the guidelines given by the Government. The Off-site Emergency Plan should be developed by the Government (District Authorities).

7.10.2 ONSITE EMERGENCY PLAN

Objectives of Emergency Management Plan (On-Site)

A quick and effective response during emergency can have tremendous significance on whether the situation is controlled with little loss or it turns into a major emergency therefore, the objectives of this onsite emergency plan (ONSEP)

During Emergency: is to provide basic guidance to the personnel for effectively combating such situations to minimize loss of life, damage to property and loss of property.

- To provide a means of direction to successfully prevent and mitigate any emergency which may occur.
- To localize the emergency and if possible eliminate.
- To control and contain the incident as early as possible and to prevent it from spreading out.
- To safe guard the employees by evacuating them to safe assemble point.
- To rescue the victims and organize medical treatment.

- To minimize the loss and damage to the plant, material and to limit environment pollution.
- To re-establish normal conditions.

During Normal Time:

- To keep the required emergency equipment in stock at right places and ensure their working condition;
- To provide proper guidelines to all personnel for emergency operations and escape
- Preserve relevant records and evidence for the emergency case and subsequent enquiry
- Investigation and remedial measures to avoid reoccurrence of the hazard

7.10.3 Elements of onsite Emergency Plan

- Important elements considered in this plan are:
- Identification of emergencies
- Emergency organization
- Emergency facilities
- Emergency procedure
- Communications during emergency
- Rescue, Transport and Rehabilitation
- Roles and responsibilities of key personnel and essential employees
- Mutual aid

7.10.4 Emergencies Identified

Following are the potential emergencies anticipated from RL Fine Chem private Limited

- Fire accidents at Bulk solvent storage
- Fire accidents at Boiler area, DG area
- Fire accidents in drier area
- Toxic gas release from storage of chemicals
- Major Spillage of solvents & other chemicals
- Fire/Explosion/Toxic gas release from cylinders

7.10.5 Emergency Organization

The responsibilities of key personnel for emergencies are clearly defined as follows

An emergency control room as the focal point has been earmarked. The control room flashes information to various agencies as shown in the chart. This is located in an area of minimum risk and close to road. Security and Time office room is the emergency control point.

7.10.6 Emergency Facilities

a) Emergency Control Centre (ECC)

It is a location where all key personnel like Site Controller, Emergency Coordinators can take stock of situation or can assemble and monitor aspects related to emergency and take decisions related to emergency.

The following information and facilities would be maintained at the ECC Plant control room: Latest copy of Onsite Emergency Plan and Off Site Emergency Plan (as provided by District Emergency Authority)

- Intercom Telephone
- P&T Telephone
- Telephone Directories (internal and P&T)
- Factory Layout, Site Plan
- Electrical cable rooting plan, locations of hazardous inventories, sources of safety equipment, hydrant layout, location of pump house, road plan, assembly by points, vulnerable zones, escape routes;
- Emergency shutdown procedures for generators and fuel supply system;
- Nominal roll of employees;
- List and addresses of key personnel;
- List and addresses of first aid providers;
- List and addresses of employees trained in fire fighting;
- List and addresses of qualified trained persons;
- Material safety data sheets of raw materials;

- Duties of key personnel;
- Important addresses and telephone numbers including those of fuel supplying company, government agencies, neighbouring industries and other sources of help, outside experts;

The following emergency equipment shall be made available at alternate ECC (Security point):

- Fire proximity suit/Gloves/Helmets;
- Hand tools suitable for pipelines (non sparking type);
- Teflon tape;
- Flame proof torches/batteries;
- Manila rope;
- Spark arrestor;
- First aid box;
- Public address megaphone, hand bell, emergency torch.

b) Assembly Points

Assembly points are those locations where the persons who are not connected with emergency operations can await either for further instructions or for rescue transport and rehabilitation. Assembly point is located opposite to Security and Time Office room which is located far away from production area.

c) Emergency control systems present

The following emergency control systems are in place in M/s. RL Fine Chem private Limited.

1. Lightening protection for all buildings and high raised chimneys.
2. Double Earthing & Bonding for electrostatic hazards for all reactors
3. Mobile earthing for drums while charging material
4. Closed arrangement for solvent transferring.
5. Pressure Relief system & Rupture Discs
6. Earth Rite system for road tanker loading and unloading.
7. FLP fittings at Flammable materials handling areas.
8. Fire protection systems :
    - Portable Fire Extinguishers

9. Wind Sack on ware house building
10. Occupational Health Centre.
11. Safe handling procedures.
12. Spill Control kits.

d) Location of First Aid Boxes

The first aid boxes are located at the following places production blocks, administrative office, time office, and will be under the charge of EHS in-charge.

e) Fire protection system

An elaborate fire protection system is in place in M/s. RL Fine Chem private Limited. Fire Hydrant system is in place to cover the entire plant including manufacturing blocks, Bulk storage tanks and utility areas. Fire station (Hindupur) is 15 KM from the site.

h) Emergency Escapes

Emergency escapes in the plant area and floor wise emergency are conspicuously marked.

7.10.7 ORGANISATION

General Manager is the over all in-charge of the plant operations and is assisted by all Plant Manager & department heads. Production activities are looked after by both the Production Head/Managers, EHS activities Safety I/C, Engineering aspects by head (Maintenance) Plant Electrical maintenance by Electrical Engineer, material inventory by stores head, Personnel & Administration wings, other department heads are directly reporting to General Manager.

MAN POWER

All Chemists/Executives/Assistants/Managers are well qualified and experienced in finished dosage manufacturing Industry. Experience is varying from 5 to 15 years in the similar field.

SHIFT TIMINGS

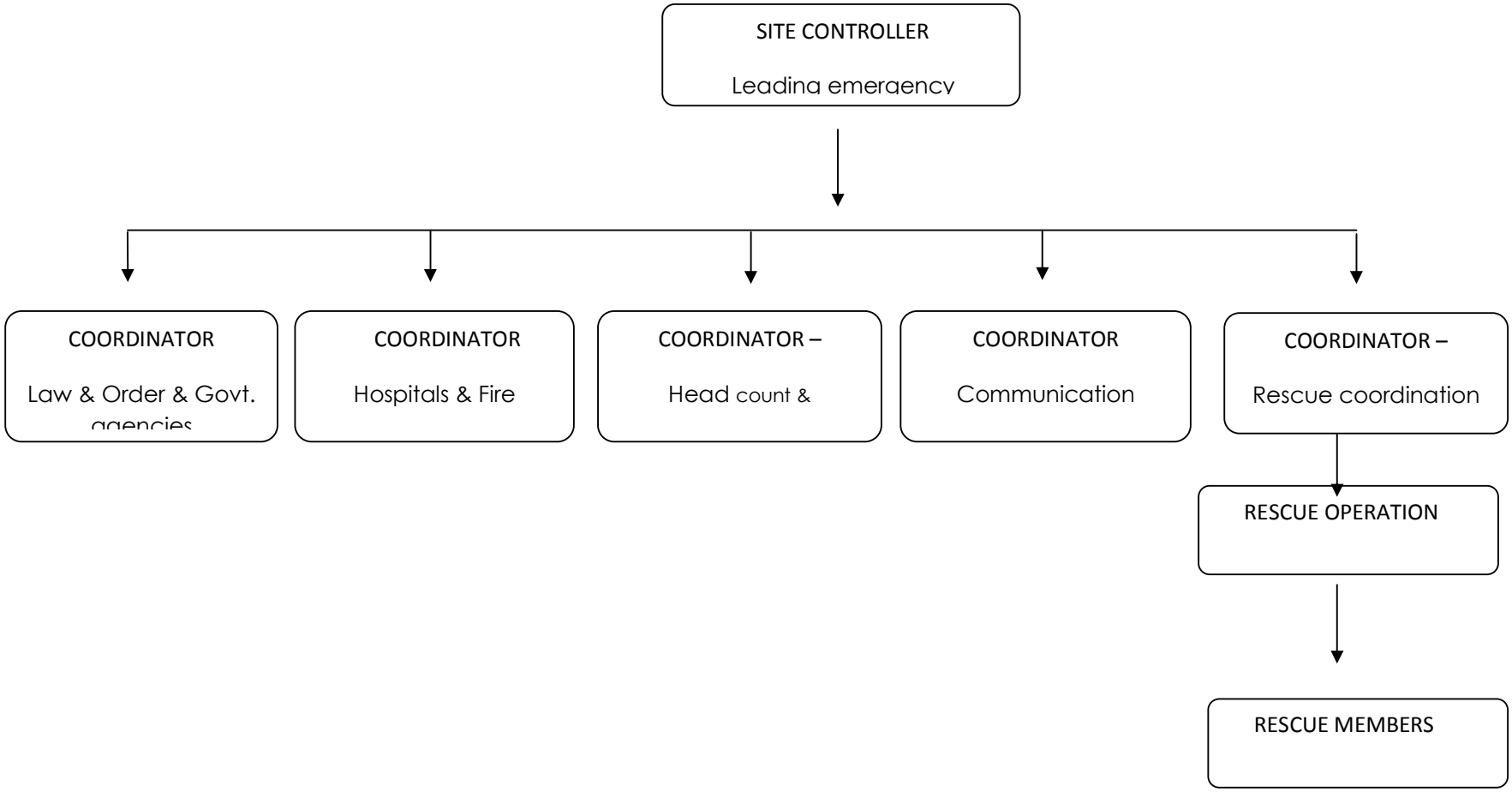
SHIFTS	HOURS	NO OF WORKERS PRESENT
A Shift	07.00 Hrs – 15.00 Hrs	22
B Shift	14.00 Hrs – 22.00 Hrs	20
C Shift	22.00 Hrs– 07.00 Hrs	15
General Shift	9.00 Hrs – 6.00 Hrs	12

EMERGENCY ORGANISATION

An emergency organisation is drawn up to execute emergency operations. General Manager is designated as the Site Controller. He reports to Managing Director along with other functionaries like Q.C., Process Development. Production Manager is designated as site controller. Area Incharge is designated as the Incident Controller. In the absence of Production Manager, Area Incharge assumes role of Site Controller. Personnel Executive is Emergency Coordinator for Rescue, Rehabilitation. Shift Incharge, Chargemen, Boiler Operators, Chilling Plant Operator, Electrical Incharge, Chemists are designated as Essential Employees and would assist Incident Controller, Emergency Co-ordinators in mitigating the effects of emergency and also in rescue, rehabilitation, first aid etc. Detailed duties are laid out along with General Organisation Chart and Emergency Chart.

All Managers are usually present during day shift are designated as Key Personnel and Coordinate different functions during non-emergency and emergency situation

EMERGENMCY ORGANIZATION CHART



7.11 Mock drill

Mock Drills would be organized once in six months to evaluate the preparedness and functioning of OSEP. It is also planned to undertake few informed and non formed mock drills (or rehearsals) for meeting emergencies. Such rehearsals would be carefully analyzed and shortcomings would be identified and necessary corrections would be taken up. Site controller is responsible for planning and execution and evaluation of mock drills. Also information would be given to statutory authorities. It is proposed to at-least conduct two mock drills in a year and over a period of time all the sections in all the shifts would be covered. When truck drivers carrying product are in the plant, they also would be trained regarding transportation emergencies and how to react to minimize the damage or effect on people.

7.12 Review of Onsite Emergency Plan

1. Onsite Emergency Plan would be reviewed whenever there is a change in product, or product route of manufacture, or addition of new equipment or change in Site Controller.
2. Site Controller is responsible for such update and making available latest copy or Onsite Emergency Plan to all concerned in the organization as will as to the Statutory Authorities.

7.13 Incident recording and revision of Disaster Management Plan

Every incident/accident in RL Fine Chem private Limited shall be recorded by safety & environmental officer. Root cause analysis and corrective actions shall be taken by responsible I/C of area and shall be reviewed by top management in safety committee meeting once in two months time

The Disaster Management Plan would be periodically revised based on accident/incidents and experienced gained from the mock drills.

7.14 Off site emergency plan

This is a brown field pharmaceutical unit. There are 17 chemicals which come under Manufacture, Storage and Import of hazardous Chemicals (MSIHC) Rules, 2016. No chemicals crossed the 1st or 2nd threshold limits prescribed in MSIHC Rules. Modelling data on potential hazards indicates that the impacts will be limited to plant premises. 4 Toxic chemicals are stored in liquid condition. Information on quantities of chemicals stored, emergency centre and mitigation will be submitted to Authorities under MSIHC Rules and chemical Accidents (Emergency Planning preparedness and response) Rules. The unit will also participate in mutual aid program with other units in the area to get help from other units and also to help other units in case of emergency situations. Accessibility to all bulk storages will be maintained without any obstructions and all chemical storages will be provided with dyke walls to contain any accidental spills or leaks. Unit will coordinate with IDA Thumukunta Authorities and District Administration to give information to public in case of any emergency situation.