CHAPTER-6

RISK ASSESSMENT AND DISASTER MANAGEMENT

6.1 INTRODUCTION

M/S. EmmennarPharma(P) Ltd. proposes to set up a Bulk Drugs &Drug Intermediates manufacturing facility at Survey No.10, IDA Gaddapotharam (V), Jinnaram (M), Medak District, Telangana.

The project site co-ordinates are between $17^{0}35'19.3''$ N Latitude&$78^{0}22'51.0''$E Longitude. The nearest village to the plant site is Gaddapotharam which is located at about 2.0 km from the site. Theland area of the plant is 8.5acres.There are no ecologically sensitive areas like national parks,sanctuaries within 10 km radius of the site.

6.2 OBJECTIVES AND SCOPE

The production of Bulk Drugs &Drug Intermediates 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 material also.The purpose of carrying out risk assessment study for**M/S. EmmennarPharma(P) Ltd.**Industries 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,ifoccurs,leads to any off-site disaster. In this endeavour, the study objectives are outlined here under.

1. **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.
2. **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.
3. **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 1& 2 studies of proposed plant.

6.3 HAZARD ANALYSIS AND RISK ASSESSMENT

6.3.1 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.

Hazard and risk analysis involves very extensive studies, and requires a very detailed design and engineering information. The various hazard analysis techniques that may be applied are hazard and operability studies, fault-tree analysis, event-tree analysis and failure and effects mode analysis.

Risk analysis follows as extensive hazard analysis. It involves the identification and assessment of risks; the neighbouring populations are exposed to as a result of hazards present. This requires a thorough knowledge of failure probability, credible accident scenario, vulnerability of population’s etc. Much of this information is difficult to get or generate. Consequently, the risk analysis is often confined to maximum credible accident studies.

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.

The term **"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.

6.3.2 Hazard Identification

Identification of hazards in the synthetic chemicals organic 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. 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,thetype,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);

6.3.3 Hazards related to materials

EmmennarPharma (P) Limited Proposed tomanufacture Bulk drugs andDrugIntermediates. Capacities of are presented in **Table 6.1.** Raw materials – inventory is presented in **Table 6.2.**

Table 6.1

Products proposed

S.No	Product Name	Production Capacity TPM
Bulk Drugs		
1	Ciprofloxacin	60.0
2	Tramadol Hydrochloride	90.0
Total Bulk Drugs		**150.0**
Drug Intermediates		
1	Methyl Isothiocyanate	195.6
2	2-Nitro-1-(Methylamino)-1-(Methylihio) Ethane (NMSM)	90.0
3	Diethyl-D-Tartarate	33.75
4	Diethyl-1,3-Acetone Dicarboxylic Acid	27.3
	Total Drug Intermediates	**346.65**
1	R&D Activity	0.15

Table 6.2

List of Raw Materials and Inventory

Sl. No	Chemical	Kgs/day	Physical form	Nature of Storage	Maximum storage quantity Kgs	CAS No.
1	Acetic Acid	1271.74	Liquid	Drums	3850	64-19-7
2	Acetone	8550.0	Liquid	Tank farm	25000	67-64-1
3	Acetophenone	1984.54	Liquid	Drums	6000	98-86-2
4	Carbon	121.6	Solid	Bags	400	7440-44-0
5	Carbon Disulfide	7664.0	Liquid	Tanks	15350	75-15-0

6	Catalyst	80.0	Solid	Bags	250	29-2760
7	CS Flakes	2999.06	Solid	Bags	9000	1310-73-2
8	Citric Acid	2100.0	Solid	Bags	6300	77-92-9
9	CycloPropylAmine	420.5	Liquid	Drums	1300	765-30-0
10	Cyclohexanone	1080.0	Liquid	Tank farm	50000	108-94-1
11	D(-) Tartaric Acid	1126.0	Powder	Bags	3400	147-71-7
12	Dimethyl Carbonate (DMC)	1282.0	Liquid	Drums	3900	616-38-6
13	Dimethyl Formamide (DMF)	717.92	Liquid	Drums	2200	68-12-2
14	Dimethyl Sulphide	5796.4	Liquid	Tank Farm	17400	75-18-3
15	Di methylamineHCl	999.0	Solid	Bags	3000	506-59-2
16	Dimethyl Sulphoxide	19359.0	Liquid	Tank	25000	67-68-5
17	Ethanol	7524.0	Liquid	Drums	22600	64-17-5
18	Ethylene Dibromide	15.0	Liquid	Drums	50	106-93-4
19	Hydrochloric Acid	4789.61	Liquid	Tank farm	20000	4647-01-0
20	Hyflow	10.26	Solid	Bags	50	68855-54-9
21	Isopropyl Alcohol	11340.0	Liquid	Tank farm	50000	67-63-0
22	Potassium Hydroxide	2208.0	Solid	Bags	6700	1310-58-3
23	Magnesium Turnings	270.0	Solid	Bags	850	7439-95-4
24	Meta chloro Anisole	2265.0	Liquid	Tank farm	25000	2845-89-8
25	Methanol	10256.0	Liquid	Tank farm	75000	67-56-1
26	Methyl IsoThioCyanate	2400.0	Solid	Bags	7200	556-61-6
27	Methylene Dichloride	43190.0	Liquid	Tank farm	50000	75-09-2
28	Mono Methylene Amine	3504.0	Liquid	Drums	10550	74-89-5
29	N-Butanol	1435.84	Liquid	Tank farm	25000	71-36-3
30	Nitric Acid	693.0	Liquid	Tank farm	25000	7697-37-2
31	Nitro Methane	2160.0	Liquid	Drums	6500	75-52-5
32	Oxygen Gas	2000.0	Gas	Cylinder	6000	7782-44-7
33	Paraformaldehyde	333.0	Solid	Bags	1000	30525-89-4
34	Piperazine	1538.4	Solid	Bags	4650	110-85-0
35	PTSA	136.0	Solid	Bags	450	104-15-4
36	Sodium Hydride	425.62	Solid	Bags	1300	7646-69-7
37	Sodium Bicarbonate	140.0	Solid	Bags	450	144-55-8
38	Sulphuric Acid	10245.0	Liquid	Tank farm	25000	7664-93-9
39	Tetrahydrofuran	4200.0	Liquid	Tank farm	25000	109-99-9
40	Toluene	31168.2	Liquid	Drums	93550	108-88-3

6.3.3.1 HAZARDOUS CHARACTERISTICS OF RAW MATERIALS

Out of the total40 raw materials, 17 chemicals were listed in Part II of Schedule I of MSHIS Rules, 1989. None of the chemical inventories are exceeding threshold quantities listed in schedule III of MSHIS Rules. Out of the 17 chemicals listed bulk storages proposed is only for 14 chemicals. List of Hazardous chemicals and Hazardous characteristics of key raw materials are given in **Table 6.4**. List and quantities of bulk Storages proposed at the site are given in **Table 6.5**

Table 6.3

List of Hazardous Chemicals (Listed in Part II of Schedule I)

S.No	List of Hazardous Chemicals	Physical Form	Type of hazard	Maximum Inventory	Units	Threshold storage quantities specified in MHSIS Rules		Whether storage quantity comes under any threshold
						Under Rule 5,7,9 &13 and 15	Under Rule 10&12	
1	Acetic Acid	Liquid	Flammable	3.8	KL	Not specified	Not specified	1st level hazard only
2	Acetone	Liquid	Flammable& Toxic	25.0	KL	Not specified	Not specified	1st level hazard only
3	Carbon disulphide	Liquid	Toxic	15.3	Tons	20 T	200 T	1st level hazard only
4	Cyclohexanone	Liquid	Flammable & Toxic	50.0	KL	Not specified	Not specified	1st level hazard only
5	Di methyl sulphide	Liquid	Flammable & Toxic	25.0	KL	Not specified	Not specified	1st level hazard only
6	Ethanol	Liquid	Flammable	22.6	KL	Not specified	Not specified	1st level hazard only
7	Ethylene di bromide	Liquid	Toxic	25.0	KL	5 T	50 T	1st level hazard only
8	HCl	Liquid	Corrosive	20.0	KL	Not specified	Not specified	1st level hazard only
9	IPA	Liquid	Flammable	50.0	KL	Not specified	Not specified	1st level hazard only
10	Potassium Hydroxide	Solid	Non-Flammable	6700	Kgs	Not specified	Not specified	1st level hazard only

S.No	List of Hazardous Chemicals	Physical Form	Type of hazard	Maximum Inventory	Units	Threshold storage quantities specified in MHSIS Rules		Whether storage quantity comes under any threshold
						Under Rule 5,7,9 &13 and 15	Under Rule 10&12	
11	Magnesium Turnings	Solid	Flammable	850	Kgs	Not specified	Not specified	1st level hazard only
12	Methanol	Liquid	Flammable	75.0	KL	Not specified	Not specified	1st level hazard only
13	Methyl IsoThioCyanate	Solid	Flammable	7200	Kgs	Not specified	Not specified	1st level hazard only
14	Methylene di chloride	Liquid	Toxic	50.0	KL	Not specified	Not specified	1st level hazard only
14	N- Butanol	Liquid	Flammable	25.0	KL	Not specified	Not specified	1st level hazard only
15	Nitric acid	Liquid	Reactive / Corrosive	25.0	KL	Not specified	Not specified	1st level hazard only
16	Tetra hydro furan	Liquid	Flammable/Toxic	25.0	KL	Not specified	Not specified	1st level hazard only
17	Toluene	Liquid	Flammable	93.5	KL	Not specified	Not specified	1st level hazard only

Table 6.4

List of Hazardous Chemicals

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	Methylene dichloride	40	-	15.5-66.4	2	1	0
2	Di Methyl Sulphoxide	189	89	2.6-42	2	2	0
3	Di Methyl Sulphide	37	-38	2.2-9.7	2	4	0
4	Cyclohexanone	155.6	43.8	1.1-8.1	1	2	0
5	Iso Propyl	82.5	12.77	2-12.7	1	3	0
6	Acetone	55.6	-17.8	2.5-12.8	1	3	0
7	Tetra Hydro Furan	65	-14.5	1.8-11.8	2	3	1
8	Meta Chloro Anisole	193	73	-	1	2	0
9	Methanol	65.5	16	6.3-6.5	1	3	0
10	N- Butanol	117.7	28.9	1.7-12	1	3	0
11	Ethylene Dichloride	83.5	13	6.2-15.6	2	3	0
12	Carbon Di-Sulphide						
13	Sulphuric acid	270	-	-	3	0	2
14	Nitric acid	121	-	-	4	0	0
15	HCl	108.58	-	-	3	0	1

Table 6.5

List of bulk storages & quantities proposed at the site

S.NO	Chemical/Solvent	Total storage quantity KL	MOC
1	Methylene dichloride	50	MS
2	DMSO	25	MS
3	DMS	25	MS
4	Cyclohexanone	50	MS
5	Iso Propyl Alcohol	50	MS
6	Acetone	25	MS
7	Tetra Hydro Furan	25	SS
8	MCA	25	SS
9	Methanol	1x 25, 1x 50	MS
10	N- Butanol	25	MS
11	Ethylene Dichloride	25	MS
12	Sulphuric acid	25	MS
13	Nitric acid	25	SS
14	HCl 30%	20	PP/FRP

6.3.4 Fire& Explosion Index (F&EI):

6.3.4.1 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.

6.3.4.2 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, operatingpressure, 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.

6.3.4.3 Hazard Ranking

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

Table 6.6

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

The estimated values of F&EI reflect light hazard in view of the low volume of chemicals.

The fire and explosion index evaluation can be very useful in developing plant layouts or adding equipment and buildings to existing plants. Evaluation of the F&EI calculations and layout considerations will result a safe operable, maintainable and cost effective arrangement of equipment and buildings

Table 6.7

Heat Radiation Damage Distances(flammable) – Tank Farm

S.No	Name of the solvent	FEI Index	Storage Tank Details				Scenario Details				
			Tank Capacity (KL)	No.s	Diameter (m)	Height (m)	Hole Dia (cm)	Release Rate/Burn rate (Kg/min)	Heat radiation damage distances in m for KW/m2		
									10	5.0	2.0
1	DMSO	16	25	1	2.5	5.0	2.54	27.6	10	10	12
2	Cyclohexanone	42	50	1	3.5	6.0	2.54	26.0	10	10	13
3	Iso Propyl Alcohol	90	50	1	3.5	6.0	2.54	23.8	10	10	12
4	Acetone	95	25	1	2.5	5.0	2.54	23.4	10	10	13
5	Tetra Hydro Furan	108	25	1	2.5	5.0	2.54	24.8	10	10	14
6	Methanol	68	25	1	2.5	5.0	2.54	23.5	10	10	11
7	N- Butanol	78	25	1	2.5	5.0	2.54	23.7	10	10	14
8	Ethylene Dichloride	98	25	1	2.5	5.0	2.54	29.5	10	10	10

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. Based on MSHC rules and F & E index the risk levels are restricted to premises only.

In regards to toxic chemicals, 6 chemicals are identified as potential toxic threats. Based on Modelled data (Using ALOHA), Toxic threat distances in case of leakages are presented in **Table 6.8** and **Table 6.9** below

Table 6.8

Toxic threat zones on release of chemicals

S.No	Name of the solvent	Storage Tank Details				Scenario Details				
		Storage Capacity (KL)	No.s	Diameter (m)	Height (m)	Hole Dia (cm)	Release Rate/Burn rate (Kg/min)	Toxic concentration distances in m		
								AEGL-3 Red	AEGL-2 Orange	AEGL-1 Yellow
1	Methylene Di-chloride	50	2	2.5	5.0	2.54	27.0	21	87	154
2	Ethylene dibromide	50Kg	Drum storage				50.0	291	401	468
3	Cyclo - hexanone	50	1	3.5	6.0	2.54	0.167	10	11	11
4	Acetone	25	1	2.5	5.0	2.54	20.1	22	32	157
5	Tetra Hydro Furon	25	1	2.5	5.0	2.54	20.4	21	88	205
6	Carbon Di-Sulphide	50 Kg	Drum storage				50.0	23	43	153

Table 6.9

Concentration levels and toxic zone distances

S.NO	Chemical	TLV PPM	IDLH PPM	Red zone PPM	Distance in Meters	Orange Zone PPM	Distance in Meters	Yellow Zone PPM	Distance in Meters
1	Methylene Di-chloride	25	2300	6900	21	560	87	200	154
2	Ethylene dibromide	20	400	46	291	24	401	17	468
3	Cyclo - hexanone	20	500	5000	10	20	11	20	11
4	Acetone	500	2500	5700	22	3200	32	200	157
5	Tetra Hydro Furon	200	2000	5000	21	500	88	100	205
6	Carbon Di-sulphide	10	500	480	23	160	43	13	153

6.3.4.4 Analysis of quantitative risk assessment data :

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

- Flammability threat zones and heat radiation zones for flammable chemicals are within the plant premises (10 -14 Meter radius)
- FEI index for flammable chemicals is moderate for all chemicals
- Storage quantities of flammable chemicals are well below the threshold quantities
- Toxic threat zones (red, Orange & Yellow) are within factory premises for 4 chemicals and beyond factory premises for two chemicals. However in all cases IDLH levels (Immediate Danger to Life or health) are well within the specified limits for all chemicals

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

Existing hazards considered from operational/equipment manuals. Detailed Hazard identification and health based risk assessment of various operations and processes are carried out.

Based on analysis 3 chemicals are identified as toxic chemicals in liquid form. Toxic concentrations distances are determined based on the modeling data and presented.

Based on the data following risk measures are suggested

- Material data sheets shall be available at user places.
- Engineering controls for leak detection and control of storage tanks
- Availability of neutralization agents to control impact of any leakages of chemicals
- Closed material handling system through pipes
- Spill control kits and procedures are established.
- Good Manufacturing practices and housekeeping practices are established.
- Provide personal protective equipment (PPE) such as gloves, goggles and respirators.
- Operators training on control measures by on job training/induction training.
- Carry out practice drills for cleaning up spills safely – do this before any spillages happen.
- Annual health checks are being carried out for all employees.
- Information to District authorities to tackle off-site emergency situations

Ensuring availability of antidotes in the plant and nearby public hospital to tackle any off-site emergency situation

6.4 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 6.10**

Table 6.10

Hazardous processes and precautions suggested

UNIT PROCESS	Chemicals Involved	Equipment& Utilities	Temp/ pressure	Emissions	Safety Measures
Product : TRAMADOL .HCl					
STAGE-I	DMA HCl, para Formaldehyde, Cyclohexanone, IsopropylAlcohol, HCl 30%, Water.	GLR, SS316Reactor. **UTILITIES:** Steam, cooling tower water, chilled water(+5°C)	25-95°C Atmospheric pressure	NIL	Safety Relief valve, PPE to be used by work force
STAGE-II	Stage-I, Mg Turnings, THF, Meta chloro anisole, Ethylene di bromide, Sulfuric acid, Caustic Flakes, Nitric acid ,	GLR, SS316Reactor, Centrifuge, Fluidized bed dryer, Blender. **UTILITIES:**	25-80°C Atmospheric pressure	NIL	Safety Relief valve, Rupture disk &PPE to be used by work force

	Isopropyl Alcohol	Steam, cooling tower water, chilled water(+5∘C)			
Product : CIPROFLOXACIN .HCl					
STAGE-I	2-4Dicloro 5 floroAcetophenone , Dimethyl carbonate, sodium hydride, cyclopropylamine, toluene.	SS316Reactor with hot oil circulation. **UTILITIES:** Steam, cooling tower water, chilled water(+5∘C)	25-60°C Atmospheric pressure	NIL	With indirect heating & cooling, Safety Relief valve, PPE to be used by work force
STAGE-II	Stage-I product, Toluene Caustic flakes	SS316Reactor, **UTILITIES:** Steam, chilled water(+5∘C)	25-100°C Atmospheric pressure	NIL	Safety Relief valve, Rupture disk &PPE to be used by work force
STAGE-III	Stage-II compound, n-Butanol, piperzine.	SS316Reactor, **UTILITIES:** Steam, cooling tower water, chilled, water(+5∘C)	25-120°C Atmospheric pressure	NIL	Safety Relief valve, Rupture disk &PPE to be used by work force
STAGE-IV	Stage-III compound, methanol, HCl	GLR. **UTILITIES:** Steam, chilled water(+5∘C)	25-60°C Atmospheric pressure	NIL	Safety Relief valve, Rupture disk &PPE to be used by work force
Product : METHYL THIO ISO CYANATE					
STAGE-I	Carbon di sulfide, monoMethylamine, methylene di chloride(MDC),	SS316Reactors, nutch filter, distillation	25-100°C 1.2	NIL	Safety Relief valve, Rupture disk &PPE to be

	catalyst, oxygen, Water.	column. **UTILITIES:** Steam, cooling tower water, chilled water(+5∘C)	kg/m2(s)		used by work force
Product : (2-NITRO-1-(METHYLAMINO)-1-(METHYLTHIO)ETHANE {NMSM}					
STAGE-I	Methyl Isothiocyanate, Nitromethane, DMSO,DMS,KOH Flakes, Water.	SS316Reactor, centrifuge, distillation column, steam tray dryer. **UTILITIES:** Steam, cooling tower water, chilled water(+5∘C), chilled brain(-10∘C)	0-120°C Atmospheric pressure	NIL	Safety Relief valve, Rupture disk &PPE to be used by work force
Product : DIETHYL-D-TARTARATE					
STAGE-I	D-Tartaric Acid, Ethanol, Toluene, PTSA, Water.	SS316Reactor. **UTILITIES:** Steam, cooling tower water, chilled water(+5∘C)	30-70°C Atmospheric pressure	NIL	Safety Relief valve, PPE to be used by work force
Product : DIETHYL-1,3-ACETONE DI CARBOXYLIC ACID					
STAGE-I	Citric Acid(food grade), Ethanol, Sulphuric Acid(98%),	GLR. **UTILITIES:** Steam, cooling	10-50°C Atmospheric pressure	NILL	Safety Relief valve, PPE to be used by work

	Methylene Dichloride, Sodium Hydroxide, Water.	tower water, chilled brain (-10∘C)			force

6.4.1 HAZOP STUDY GUIDELINES

A checklist of guide words is applied to each stage of the process in turn thereby generating deviations opposite of all conceivable eventualities. **Table 6.11**gives the checklist of guide works.

A team chosen carefully to provide the knowledge and experience appropriate to the objectives of the examination carries out HAZOP study. It is important to keep the team small enough to be efficient, while retaining a sufficient spread of skills and disciplines for all aspects of the study to be covered comprehensively. Every investigation must be led by someone familiar with the HAZOP study technique, who is primarilyconcerned with applying, controlling the discussions and stimulating team thinking, but who may also make an active technical contribution provided that these primary requirements are being met.

Table 6.11 Checklist of guide words in HAZOP

NO,NOT,NONE The activity is not carried out of ceases	No activity or operation takes place. There is no forward flow when should be. A task may not be done, something may not be done, something may not be delivered or be there. There may be no action in response to activating signal. A check is omitted.no catalyst present.
MORE OFF A quantitative increase	There is more of something. More of any physical quantity than there should be. For

in an activity	example, of Temperature, pressure quantity of flow. More of a task can be carried out.An activity is done for a longer time
LESS OFF A quantity decrease in an activity	There is loss of something present. Less of an activity is carried out. Less time is taken
PART OF Incomplete Performance of an activity	Only part of an action is carried out. There might be a transfer of part of a load or batch. More components or an extra phase or impurities might be present.
REVERSE Inversion of an activity	Something happens backwards. A back siphon occurs. Heating rather than cooling occur. This keyword can also be used to generate ideas as to how to recover from a situation
OTHER(THAN)	A gas X can be sent down the line instead of gas Y.An operator might press the wrong bottom or open the wrong valve. This key word is also used to identify what needs to happen other than normal operation—for example, start-up, shutdown, regeneration, maintenance.
AS WELL AS Another activity occurs as the original activity	Can button A and B pressed only A was meant be pressed? Can both gas X and gas Y be sent down the line? What happens if the operator eats his lunch at the same time as packing cyanide?
SOONER/LATER THAN An activity occurring at the wrong time/relative to others	Every system has its running clock. What happens if task G is done before task K? what if batch reaction is not completed in the normal time

Potential problems as represented by the consequences of the deviation should be evaluated as they arise and a decision reached on whether they merit further consideration or action. Except for major risk areas where a fully quantitative assessment is required this decision is made semi-quantitatively on the consequence (usually scaled as trivial, important or very probable)

There are no temperature and pressure conditions in this process. Hence only flow is considered for the HAZOP.The sheets of HAZOP study are presented below;

6.4.2HAZOP WORK SHEETS

Following work sheets shall be used for development of safety measures

Table 6.12

HAZOP Work Sheet – Raw Material Flow

S. No	Deviation	Causes	Consequences	Safety Features/Measures	Remarks
1	No Flow	No supply Malfunctioning of pump Power failure	No Reaction	Operation control devices and emergency plant shut down procedure, alarm system etc. Alternative Automatic power source	Inspect Operations Frequently
2	Less Flow	Malfunctioning of pump Malfunctioning of Shut off valve Valve on charging line not opened	Operational trouble in reactors	Operation control devices and emergency plant shutdown procedure, alarm systems etc.	Check the shut off valve. Ensure the feed valve is opened
3	More Flow	Malfunction of control valve	Operational trouble in reactor	Flow regulators, Excess flow diversion devices to Alternative storage or Flare etc.	Flow control devices inspection and examination and maintenance will be continuous

Table 6.13

HAZOP Work Sheet– Pressure

S. No	Deviation	Causes	Consequences	Safety Features/Measures	Remarks
1	No Pressure	--	--	--	Not Envisaged during operation
2	Low Pressure	Malfunctioning of pump Malfunctioning of Shut off valve Valve on charging line not opened Leakages in pipe line	Operational trouble in reactors	Periodic inspection &Examination, Maintenance Leak detect system Shut off valve Low pressure alarm/indicators shall be provided	Pipe line and flow control devices examined frequently
3	High Pressure	High Temperature Excess supply Malfunction of control valve	Operational trouble in reactor Rupture of pipe line Fire or Explosion	Periodic inspection &Examination, Maintenance Pressure relief system Automatic flow diverter Alternative storage system	Pipe line and flow control devices examined frequently

Table 6.14

HAZOP Work Sheet: Temperature

S.No	Deviation	Causes	Consequences	Safety Features/Measures	Remarks
1	No Temperature	--	--	--	Not envisaged during operation
2	Low Temperature	Malfunctioning of Temp. Indicator External cooling	--	Calibration of Temperature indicators, periodic Inspection Examination	Examine the pipe line and control devices working conditions frequently
3	High Temperature	Malfunctioning of Temp.Indicator External fire/Heating	Rupture/ failure in pipe line	Calibration of Temp.Indicator, periodic Inspection Examination Thermal Insulation Around the pipe Radiation Detectors/Sensors will be provided	Examine the pipe line and control devices working conditions frequently

6.4.3 Hazard Factors

A study of past accident information provides an understanding of failure modes and mechanisms of process and control equipment and human systems and their likely effects on the overall plant reliability and safety.

Some of the major contributing factors for accidents in chemical industries are:

Table 6.15

Contributing factors for accidents

S.No	Contributing Factor	Per cent Loss
1	Equipment design faults	41
2	Process design faults	10
3	Operator errors	31
4	Maintenance deficiencies	12
5	Material Hazards	6

A study AICHE (1972) indicates that majority of equipment of component failures involve compressors, furnaces and heat exchangers as there are lesser opportunities to take them off for maintenance. The frequency of equipment or component failures is observed as follows:

Table 6.16

Failure frequency statistics of key equipment

S.No	Equipment	Frequency (%)
1	Compressors	30
2	Furnaces	18
3	Heat Exchangers	17
4	Process Vessels	18
5	Others	17

However, failures of storage vessels and those during transportation have been reported more frequently than cases of plant failures. The failure rate of various equipment in a typical power plant is provided in the following table.

6.4.4EQUIPMENT FAILURE RATES

(Data from reliability Technology by A.E.Green and J.R Bourne, Copyright C,1972,reproduced with permission of John Wiley and Sons,Inc)

Table 6.17

Equipment failure rates

Equipment	Failure Rate(Failures/10^6h)
Electric Motors	10
Transformers(<15 kv)	0.6
Transformers(132-400k V)	0.7
General, (33k V)	2
Circuit breakers	10
Pressure vessels(general)	3
Pressure vessels (High standard)	0.3
Pipes	0.2
Pipe joints	0.5
Ducts	1
Gaskets	0.5
Bellows	5
Diagrams(metal)	5
Diagrams(Rubber)	8
Unions and junctions	0.4
Hoses(heavily stressed)	40
Hoses(Lightly stressed)	4
Ball bearings(heavy duty)	20
Ball bearings(Light duty)	10
Roll bearings	5
Sleeve bearings	5
Shafts(heavily stressed)	0.2

Shafts(Lightly stressed)	0.02
Relief valves leakage	2
Relief valves blockage	0.5
Hand-operated valves	15
Control valves	30
Ball valves	0.5
Solenoid valves	30
Rotating seals	7
Sliding seals	3
‘O’ring seals	0.2
Couplings	5
Belt drives	40
Spur gears	10
Helical gears	1
Friction clutches	3
Magnetic clutches	6
Fixed orifices	1
Variable orifices	5
Nozzle and flapper assembles: blockage	6
Nozzle and flapper assembles:breakage	0.2
Filters: blockage	1
Filters: Leakage	1
Rock and pinion assembles	2
Knife edge fulcrum: wear	10
Springs(heavily stressed)	1
Springs(Lightly stressed)	0.2
Hair springs	1
Calibration springs: creep	2
Calibration springs: Breakage	0.2
Vibration mounts	9

Mechanical joints	0.2
Grub Screws	0.5
Pins	15
Pivots	1
Nuts	0.02
Bolts	0.02
Boilers(all types)	1.1
Boilers feed pumps	1012.5
Cranes	7.8

6.4.5 Common Causes of Accidents

Engineering and Instrumental

Based on the analysis of past accident information, common causes of major chemical plant accidents are identified as:

- Poor house keeping
- Improper use of Tools,equipment,facilities
- Unsafe or defective equipment facilities
- Lack of proper procedures
- Unsafe procedures
- Failure to follow prescribed procedures
- Jobs not understood
- Lack of awareness of hazards involved
- Lack of proper tools, equipment, facilities
- Lack of guides and safety devices
- Lack of protective equipment and clothing

6.4.6 Failures of Human Systems

An assessment of past chemical accidents reveals human factor to the cause for over 60% of the accidents while the rest are due to other plant component failures. This percentage will increase if major accidents alone are considered for analysis. Major causes of human failures reported are due to:

- Stress induced by poor equipment design, unfavourable environmental conditions, fatigue, etc.
- Lack of training in safety and loss prevention
- Indecision in critical situations.
- Inexperienced staff being employed in hazardous situations

Often, human errors are not analysed while accident reporting and accident reports only provide information about equipment or component failures. Hence, a great deal of uncertainty surrounds analysis of failure of human systems and consequent damages.

The number of persons/materials are potentially exposed to a specific hazard zone is a function of the population density and distribution near the accident location. The failure rate data and ignition sources of major fires are presented in the **Tables 6.17 and 6.18**

Table 6.18Ignition Sources of Major Fires

S. No	Ignition source	Percent
1	Electrical (wiring of motors)	23%
2	Smoking	18%
3	Friction	10%
4	Overheated material	8%
5	Burner flames	7%
6	Combustion sparks	5%
7	Spontaneous ignition	4%
8	Cutting & Welding	4%
9	Exposure (fires jumping into new areas)	3%
10	Incendiarism (fires maliciously set)	2%
11	Mechanical sparks	2%
12	Molten substances	1%
13	Chemical actions	1%
14	Static sparks	1%
15	Lightening	1%
16	Miscellaneous	1%

6.5 Suggested safety measures for storage of chemicals

Following measures are suggested for safe handling of chemicals in EmmennarPharma(P) Ltd.

- Containers shall be labelled and level indicators shall be installed.
- AppropriateSafetysignsshall be posted.
- Material safety Data sheets shall be made available.
- Chemical safety training shall be provided and an inventory of hazardous chemicals is maintained.
- Proper preventive measures on electrostatic hazards.
- Follow good CGMP and dispensing practices.
- Regular inspection and checking to assure risk control (proper earthling, functioning of safety interlocks, bonding, transferring in closed system and no spillages).
- Dykes shall be provided for all storage tanks as per the statutory norms.
- Preventive maintenance of storage vessels shall be followed.

6.6 Disaster Management Plan

6.6.1 Introduction

A disaster is a catastrophic situation in which suddenly, people are plunged into helplessness and suffering and, as a result, need protection, clothing, shelter, medical and social care and other necessities of life.

Disasters can be divided into two main groups In the first, are disasters resulting from natural phenomena like earthquakes, volcanic eruptions, storm surges cyclones, tropical storms. Floods, avalanches, landslides, and forest fires. The second group includes disastrous events occasioned by man, or by man's impact upon the environment. Examples are armed conflict. Industrial accidents, radiation accidents, factory fires, explosions and escape of toxic gases or chemical substances, river pollution, mining or other structural collapses, air, sea rail and road transport accidents and can reach catastrophic dimensions in terms of human loss.

There can be no set criteria for assessing the gravity of a disaster in the abstract since this depends to a large extent on the physical, economic and social environment in which it occurs. However, all disasters bring in their wake similar consequences that call for immediate action, whether at the local, national or international lever, for the rescue and relief of the victims. This includes the search for the dead and injured, medical and social care, removal of the debris, the provision of temporary shelter for the homeless, food, clothing and medical supplies, and the rapid re-establishment of essential services

An emergency may be said to begin when operator at the plant or in charge of storage of hazardous chemicals cannot cope up with a potentially hazardous incident, which may turn into an emergency. The emergencies could be a major fire or explosion or release of toxic gas or a combination of them

The proposed plant will store fuels, which are flammable in nature, and the storage will be as per the Controller and the project is still in the initial stages of designing. Hence a tentative disaster management plan is prepared to be suitably modified before commissioning of the plant.

6.6.2 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 localize the emergency and if possible eliminate it;
- To minimize the consequences of an emergency;
- To prevent spreading of the damage in other areas
- To give necessary warning to plant personnel and neighbourhood;
- To maximize resource utilization and combined efforts towards the emergency operations;
- To mobilize internal resources and utilize them in the most effective way;
- To arrange rescue of persons, transport and treatment of causalities;
- To seek necessary help from industries in neighbourhood or local authorities;
- To provide information to government agencies and to provide information to public

During Normal Time:

- To keep the required emergency equipment in stock at right places and ensure their working condition;
- To keep the concerned personnel fully trained in the use of emergency equipment;
- Preserving records, evidence of situation for subsequent emergency etc.

6.6.3 Scope of ONSEP

This ONSEP is prepared for industrial emergencies like fired, explosions, toxic releases, asphyxia and does not cover natural calamities and societal disturbances related emergencies (like strikes, bomb threats, civil Commissions etc.) Also, the scope this ONSEP is limited to onsite emergencies and does not include measures for offsite Emergency Management.

Necessary information with regards to Off Site Emergency Management will be furnished to district authorities.

6.6.4 Methodology of Development ONSEP

The consideration in preparing this Emergency Plan includes the following steps:

- Identification and assessment of hazards and risks;
- Identifying, appointment of personnel & Assignment of Responsibilities;
- Identification and equipping Emergency Control Center;
- Identification of Assembly, Rescue points, Medical facilities;
- Training, Rehearsal & Evaluation;
- Action on site.

Earlier, a detailed Hazards Analysis and Risk Assessment were carried out for the plant facilities and the hazards are quantified. The likely location of hazards and consequences are evaluated, duly following the standard procedure.

6.6.5 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

6.6.5.1 Emergencies Identified

Typical emergencies identified in this type of industries

- Fire accidents at Bulk solvent storage &HSDareas
- Fire accidents at Boiler area, DG area
- Fire in reactors area
- Food /Water Contamination..
- Fire accidents in QC Laboratory.
- Major Spillage of solvents & HSD.
- Fire accident in scrap yard.
- Electric shocks.
- Reaction hazardsin Hydrogenation area
- Cylinder explosion
- Catalyst fire

Priority of protection in the event of an emergency is; Life and Safety of personnel, preservation of property, restoration of normalcy.

6.6.5.2 Emergency Organization

The project employs a total of 100people in 3 shifts. The general shift will be for the administrative employees, while the three shifts of 8 hours each are for technical employees. Key personnel and essential employees are identified and are assigned emergency responsibilities. The organogram of the essential organization are presented below:

Security personnel, all operators, filters, electricians etc. in the shifts are designated essential employees. During emergencies, their services are drafted for essential operations.

6.6.5.3 Emergency Facilities

1. Emergency Control Centre (ECC)

It is a location where all key personnel like chief coordinator; Emergency controller maintenance coordinator can assemble and monitor aspects related to emergency and take decisions related to emergency. The office room is designated as ECC. In case if this area is affected, zone security room is designated as alternative ECC.

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
- P&I diagrams, electrical connections plans indicating locations of hazardous inventories, sources of safety equipment, hydrant layout, location of pump house, road plan, assembly by points, vulnerable zones, escape routes;
- Hazard Chart;
- 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 will be made available at alternate ECC (Security point):

- Fire proximity suit/Gloves/Helmets;
- Hand tools suitable for pipelines (non sparking type);
- Gaskets;
- Teflon tape;
- Gas Explosimeter;
- Flame proof torches/batteries;
- ½ crow bar;
- Spade;
- Manila rope;
- Spark arrestor;
- Spare fan belt for truck;
- First aid box;
- Special fire fighting information related to hydrocarbon fuels;
- Public address megaphone, hand bell, emergency torch.

2. **First Air center :**A full fledged first aid center is in place in the company to provide first aid for the people injured**.** Eye wash stations and safety showers are provided at different places in plant and laboratory

3. **Safe Assembly Points**

Safe assembly points shall be identified and notified to all employees

4. Fire Fighting Facilities

The fire fighting facilities which shall be provided are presented in **Table 6.19**

Table 6.19

List of Fire Extinguishers

S.No.	Description of Item	Quantity
1	DCP 10 Kg	6Nos
2	Foam 50 ltrs	6 Nos
3	CO_2 22.5 Kg	10 Nos
4	CO_2 6.8 Kg	30 Nos
5	ABC Soda Acid 5 Kg	3Nos
6	ABC Soda Acid 1 Kg	9Nos
7	Fire Buckets with Stand	15 Nos
8	Fire reel holes of 30mmx 1’’	6 Nos
9	Fire hydrant system	
	140 m3/hr x 70m head	1 Nos
	jacking pump	1 Nos
	Electrical motor pump	1 Nos
	Diesel drum pump(standby)	1 Nos
	Storage Tank	300KL
	Fire hydrant points	15 Nos (15 m x2) fire hoses
	Fire Nozzle	15 Nos
	500 L AFF Foam nozzles	2 Nos

4. Location of First Aid Boxes

The first aid boxes will be located at the following places; preparation areas, administrative office, time office, and will be under the change of security coordinator

5. Emergency Siren

Emergency siren will be provided with 1.0km range of audibility and the location will be time office. The siren will operate on regular supply and also on emergency electrical supply. Shift electrical engineer of plant on receipt of information from shift in-charge, is authorized to operate the siren.

6. Emergency Escapes

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

7. Wind Sock

Wind socks are located at the following locations

S.No.	Location
1.	Top of Production Block
2.	Top of Boiler house
3.	Top of Administration Building

6.6.5.4 Emergency Procedures

1. Procedure for Raising Emergency alarm

Whenever and whoever notices an emergency or a situation with a potential emergency should forth wise raise alarm by calling on the available communication network or shouting or approaching the shift in charge, furnishing details. Anybody noticing fire should inform the plant control room immediately. The shift electrical engineer at control room informs the site controller.

2. Control room staff

if an emergency is reported then plant control room staff must, request for the location nature and severity of emergency and obtain the caller's name, telephone number and inform the shift in charge or site controller whoever are available in the shift.

3. Emergency Communication

The following communications will be used during emergencies; P&T Telephones, intercom, walkie-talkies, hand bell and siren. If any of the equipment is not working, runners would be engaged to send the communication.

4. Warning/Alarm Communication of Emergency

Emergency siren would be operated to alert all other employees on the orders of manager (electrical). The emergency is communicated by the Emergency siren mode of walling for 3 minutes when the emergency has been brought under control, the Emergency Controller will direct plant control staff giving 'all clear signal', by way of normal siren (continuously for 3 minutes).

6.6.5.5 Rescue and Rehabilitation

Emergency vehicle will be made available round the clock under the charge of manager (electrical) who is emergency coordinator. Security personnel are trained in rescue operations. Persons rescued would be taken to First aid centre for further medical attention or Safe Assembly Points as per the condition of the rescued person.

1. Transport Vehicles and Material Trucks

The transport vehicles and vehicles with materials would immediately withdraw to outside the factory. Security guard of the shift is responsible for this. Transport vehicles would wait at the security at the main entrance to provide emergency transport. This is ensured by security coordinator.

2. Mock drill

Occasional mock drill is essential to evaluate that the ONSEP is meeting the objectives. Adequate training is given to all staff members before conducting the mock drill. Mock drills will be initiated with table top exercise, followed by pre-informed mock drills, and few uninformed mock drills in the first phase. Functional exercises (communication, Emergency shutdown, fire fighting at different locations, rescue etc.) are carried out in the second phase. Mock drills will familiarize the employees with the concept and procedures and help in evaluating their performance. These scheduled and unscheduled mock drills are conducted during shift change, public holidays, in night shift once in 6 Months. Response time, strict adherence to discharge of responsibilities, difficulties and inconsistencies experienced are recorded and evaluated. Fire officer will assists Emergency coordinator in designing and extending such mock drills and in evaluating the response.

3. Review

The Emergency Plan is reviewed periodically to evaluate the effectiveness, and during change in organizational structure, isolation of equipment for longer duration, and during increase in Inventory of fuel and other chemicals. Manger Electrical and emergency co-coordinator initiates and authorizes such review as and when required, and the changes if any will be duly informed to all the employees concerned.

6.6.5.6 Emergency Responsibilities

1. Chief Coordinator

The chief coordinator shall be General Manager and Alternate is Manager Electrical.

- He is overall in charge of emergency operations.
- He reaches emergency control centre as soon as he receives emergency information.
- He coordinates with emergency controller, maintenance coordinator.

- He provides necessary resources required at the emergency site.
- He will inform the inspector of factories, and other statutory authorities.
- Prepares accident report/ investigation.
- Arranges for keeping records of chronological events and orders an investigation report and preserves evidence.
- Gives a public statement if necessary.

2. Emergency controller – Shift in charge

On receiving the message about emergency;

- He will assume charge as chief coordinator till general manager arrives at scene and takes charge as a chief coordinator.
- Takes actions to minimize the consequences and directs emergency management and fore control/ other causes with available personnel to put off or to reduce the consequences.
- On the arrival of chief coordinator, he will hand over the charge of chief coordinator and assists him.
- He will identify the need of evacuating any personnel in the vicinity of the affected zone.
- Exercises operational control of the installation and outside the affected area and directs emergency operations.
- Declares emergency and orders plant control room for operation of emergency siren.
- Continuously reviews and assesses possible development to determine most probable courses of events
- Initiates suspension of all work permits during the period of major emergency for safe guarding the plant and other personnel.

3. Incident Controller

The supervisor assumes the role of incident controller in the following instances of emergencies.

- Protects him and proceeds to site quickly.
- Assess the magnitude of the incident.
- Initiates the emergency procedure to secure the safety of the workers and minimize damage to installation and property.
- He will undertake all possible steps for safe isolation of plant systems, first aid and fire fighting.
- He keeps in touch with plant control room till emergency controller arrives at the scene of emergency.
- Organizes essential employees present in the shift.
- Ensures that adequate personal protective equipment is available for essential employees.
- Arranges for search of causalities.
- Arranges evacuation of non-essential workers to assemble at designated assembly points.
- During the fire fighting operations seeks help from electrical / mechanical maintenance personnel for isolation of machine / section involved in fire as the need arises.
- Once the situation is under control, guides different persons for salvage and cleanup operations.
- Assists in assessing the loss, preparation of accident report with assistance of security officer and senior officials of respective departments present during the accident, investigates the fire with a view to find out causative factors and action needed to prevent recurrence.

4. Communicator – production supervisor

- The Control room Shift Electrical Engineer assumes the role of Communicator and passes the information related to emergency to Incident Controller and Chief Coordinator.

- Other vulnerable installation in the plant is altered about the emergency.
- On the Instructions from Chief Coordinator, neighbouring installations are altered about the emergency.
- On the instructions from Chief Coordinator, mutual assistance is called from neighbouring industries.
- On the instructions from Chief Coordinator, seeks help from fire brigade.
- Provides emergency Telephone rosters are provided in plant control room and Fire Station.

5. Maintenance Coordinator

Dy. Manager Mechanical shall assume the role of maintenance coordinator. His responsibilities include;

- Protecting him self
- Reaching the emergency spot.
- Arranging all resources for assisting Emergency controller to mitigate the Emergency scene, with respect to maintenance requirements.
- Assisting Emergency controller in arranging the needed containment measures.
- Undertaking post emergency maintenance work upon termination of emergency.
- Ensuring availability of adequate quantities of protective equipment and other emergency materials, spare parts etc at Emergency control centre.
- Ensuring upkeep of fire systems, emergency lighting in order.

6. Resource Coordinator

Shift in charge shall assume the responsibility of resource coordinator.

- Arranges first aid, rescue acts, ambulance, attendance roster checking and security.
- Interacts with chief coordinator with necessary data and coordinates the emergency activities.
- Assists chief coordinator with necessary data and coordinates the emergency activities.
- Maintains liaison with civil administration and mutual aid agencies- neighbouring industrial management
- Ensures availability of humanitarian needs and maintenance of rehabilitation centre.
- Ensures emergency transport facility.
- Mobilizes extra medical help from outside if necessary.
- Maintains first aid and medical emergency requirements.
- Keeps list of qualified first aid providers and seeks their assistance.
- Ensures availability of necessary cash for rescue/ rehabilitation and emergency expenditure.
- Coordinates mutual aid
- Participates in reviewing Emergency plan and arranges revision if required.

7. Security Coordinator

The production supervisor will assume the responsibilities of security coordinator, and his responsibilities are;

- On receipt of fire call from plant control he prepares for fire fighting and collects necessary equipment.
- Organizes rescue of persons trapped in work areas
- Assists administration coordinator in organizing Mock drills, evaluation and debriefing.
- During normal situations keeps the fire fighting capabilities in fully ready condition by maintaining equipment.
- Organizes fire drills on periodic basis and evaluates the same

- Arranges to clear off unconnected persons and trucks from the vicinity and off the mail gate.
- Instructs security guards posted on duty in the nearby industries to cordon off the affected section and to control the crowd at the scene of fire.
- Arranges to control law and order till local authorities for law and order till police arrive at site
- Post security guard at the scene of fire to check for possible re-ignition, after the emergency is over.
- Assists Resource coordinator in organizing Mock Drills, evaluation and debriefing.

8. Person Noticing Fire

Any employee on noticing fire will take the following steps;

- Takes protection.
- Raises alarm – shouts fire! Fire!!Fire!!! or other emergency.
- Informs Shift In charge, or at the control room over telephone giving clear message about the exact location of fire and names of equipment/ machinery involved in fire.
- If telephone is not working, quickly goes to either Plant Control Room and informs.

9. Trained Fire Fighting Person;

The employees trained in fire fighting will take the following steps in the event of fire apart from following the instructions of security coordinator apart from;

- Protects self
- Raises alarm
- Attempts to put out the fire using fire extinguishers
- If necessary, operates fixes fire fighting equipment.
- Stands by in safety for further instructions.

6.6.6 REMEDIAL ACTION

The cause of emergency is identified and action is taken from operation point of view such as isolating or shutdown etc.

1. **Failure of pipelines:** Feeding into the pipeline is stopped. Isolate the leaking pipeline by closing the relevant valves. Transfer the material present to other pipelines. Shutdown the pump. Close the suction and discharge valves of the pump.
2. **Personal protection:**The people, who are assigned to the rescue operations, must wear suitable personnel protective equipment such as self- contained breathing apparatus and fire suit. They should remain in the incident area as long as he can safely stay there. Inspire of the wearing safety protective equipment if he is unable to stay in the contaminated area, he should leave immediately.

6.6.7 BASIC ACTION IN EMERGENCIES

Immediate action is the most important factor in emergency control because the first few seconds count, as fires develop and spread very quickly unless prompt and efficient action is taken.

1. Take immediate steps to stop leakage/ fire and raise alarm simultaneously.
2. Initiate action as per fire organization plan or disaster management plan, based on gravity of the emergency.
3. Stop all operations and ensure closure and isolation valves.
4. All efforts must be made to contain leakage / fire.
5. Saving of human life shall get priority in comparison to stocks/ assets.
6. Plant personnel with specific duties should assemble at the nominated place.

7. All the vehicles except those required for emergency use should be moved away from the operating area, in an orderly manner by the predetermined route.
8. Shift the injured to the nearest first aid centre located in chintal, shapurnagar /Ram Hospital,Hyderabad
9. Electrical system except for control suppliers, utilities, lighting and fire fighting system should be isolated.
10. If the feed to the fire cannot be cut off, the fire must be controlled and not extinguished
11. Start water spray system at areas involves or exposed to fire risks to avoid domino effects.
12. In case of leakage of chemicals without fire and inability to stop the flow, take all precautions to avoid source of ignition.
13. Block all roads in the adjacent area and enlist police support for the purpose if warranted.

6.6.8 Fire Fighting System

- Enlist support of local fire brigade
- Fire fighting personnel working in or close to uninvitedvapour clouds or close to fire must wear protective clothing and equipment including safety harness and manned lifeline. They must be protected continuously by water sprays. Water protection for fire fighters should never be shut off even though the flames appear to have been extinguished until all personnel are safety out of the danger area.
- Exercise care to ensure that static charge is not generated in vapour cloud. For this purpose solid jet of water must be avoided, instead fog nozzles must be used.
- Fire fighters should advance towards a fire in down wind direction.
- If the only valve that can be used to stop the leakage is surrounded by fire, it may be possible to close it manually. The attempt should be directed by trained persons only. The person

attempting closure should be continuously protected by means of water spraying (through fog nozzles), fire entry suit, water jet blanket or any other approved equipment. The person must be equipped with a safety harness and manned lifeline.

- Any rapid increase in pressure or noise level of should be treated as a warning of over pressurization. In such case all personnel should be evacuated immediately.
- In case of any emergency situation, it is of paramount importance to avoid endangering human life in the event of fire, involving or seriously exposing plant equipment.