NICHINO CHEMICAL INDIA PVT. LTD.

PLOT. NO. 54 TO 56, 58 TO 61, PHASE II IDA PASHAMYLARAM, PATANCHERU MANDAL, SANGAREDDY DISTRICT, TELANGANA

RISK ASSESSMENT REPORT

SUBMITTED TO
MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE
GOVERNMENT OF INDIA
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7.0 Introduction

This chapter presents the risk assessment study results for the plant operations, transport and storage of raw materials, and identifies maximum credible accident scenarios to draw the emergency management plan addressing various credible scenarios identified.

7.1. Objectives and Scope

The production of Synthetic Organic chemicals involves usage of many chemicals which are both hazardous and toxic in nature. The risks associated with the chemical industry are commensurate with their rapid growth and development. Apart from their utility, chemicals have their own inherent properties and hazards. Some of them can be flammable, explosive, toxic or corrosive etc. The whole lifecycle of a chemical should be considered when assessing its dangers and benefits. In order to ensure the health and safety of persons at or near the facilities, Govt. has approved some regulations.The regulation requires Employers to consult with employees in relation to:

- Identification of major hazards and potential major accidents
- Risk assessment
- Adoption of control measures
- Establishment and implementation of a safety management system
- Development of the safety report

The involvement of the employees in identification of hazards and control measures enhances their awareness of these issues and is critical to the achievement of safe operation in practice. In order to comply with regulatory authorities, M/s Nichino Chemical India Pvt. ltd. have entrusted Team Labs and Consultants, Hyderabad to review and prepare Hazard analysis and Risk assessment for their facility along with an approach to on-site emergency preparedness plan asrequired under the acts and rules. (Manual on emergency preparedness for chemical hazards, MOEF, New Delhi).In this endeavor, the methodology adopted is based on;

- visualizing various probable undesirable events which lead to major accidents

- detailed and systematic assessment of the risk associated with each of those hazards, including the likelihood and consequences of each potential major accident event; and
- identifying the technical and other control measures that are necessary to reduce that risk to a level that is as low as reasonably practicable

The strategy to tackle such emergencies, in-depth planning and person(s) or positional responsibilities of employees for implementation and coordination of timely and effective response measures are described in onsite detail in Emergency Plan.

7.2 Project Details

The project site of 5.31 acres is located at Plot. Nos. 54 to 56, 58 to 61, Phase II IDA Pashamylaram, PatancheruMandal, Sangareddy District, Telangana. The industrial development area was developed by TSIIC mainly to be used by chemical industries. Accordingly the IDA has a number of chemical manufacturing units. The site is situated at 17^0 32′26″ (N) latitude and 78^0 10′ 52″ (E) longitude. The site is surrounded by internal IDA road in north, south and west directions, sunny textiles in east directions. The nearest village from the site is Isnapur located at a distance of 1.5 Km in north direction. The main approach road is NH9 (Hyderabad – Mumbai) passing at a distance of 1.7 km in north direction. The nearest railway station is Lingampally at a distance of 15 km in southeast direction and nearest airport is Shamshabad at a distance of 40 km in southeast direction. Nakkavagu stream is at a distance of 6.5 km in northeast direction, flowing from north to south, Isnapur cheruvu is at a distance of 0.2 km in north direction, Kottacheruvu is at a distance of 1.5 km in northwest direction, Lakdaramcheruvu is at a distance of 5 km in north direction and Peddacheruvu is at a distance of 3.7 km in northeast direction. There is no reserve forest, national parks, wildlife sanctuary, ecologically sensitive area, biosphere reserve, tiger reserve, elephant reserve, critically polluted areas and interstate boundary within 10 km radius of the site within the impact area of 10 km. The site is located at a distance of 6.17 Km from the critically polluted area of Patancheru and

Bollaram. The manufacturing capacity is presented in **Table 7.1** and list of by-products after expansion is presented in **Table 7.2**Chemical inventory is presented in **Table 7.3**

Table 7.1Manufacturing Capacity

S.No	Name of Product	CAS No.	Capacity (TPD)	
			Permitted*	After Expansion
1	Acephate	30560-19-1	0.83	**2.53**
2	Imidacloprid	138261-41-3	0.5	0.14
3	Thiomethoxam	153719-23-4	0.5	**2.0**
4	Acetamiprid	160430-64-8	0.33	0.07
5	Buprofezin	69327-76-0	0.15	**2.25**
6	Pretilachlor	51218-49-6	0.5	**1.5**
7	Tricyclazole	41814-78-2	0.28	0.14
8	Hexaconazole	79983-71-4	0.17	0.06
9	Clodinafop Propargyl	105512-06-9	0.33	**0.72**
10	Ethion	563-12-2	0.44	0.07
11	Cloquintocet Mexyl	99607-70-2	0.15	0.06
12	Sulfosulfuron	141776-32-1	0.1	0.06
13	Fipronil	120068-37-3	0.07	0.01
14	Dimethoate	60-51-5	0.15	0.25
15	Thiodicarb	59669-26-0	0.07	0.03
16	Bispyribac Sodium	125401-92-5	--	0.06
17	Quizalofop Ethyl	76578-14-8	--	0.04
18	Pymetrozine	123312-89-0	--	0.04
19	Azoxystrobin	131860-33-8	--	0.04
20	Bifenthrin	82657-04-3	--	0.04
Total Worst Case: 5 Products on campaign basis after expansion at any point of time			**2.33**	**9**
	R&D and Pilot Plant Products		--	0.1
	Formulations		16.67 KLM	80 KLM

**** At any point of time only 5 products are manufactured***

Table 7.2 List of By-products – After Expansion

S.No	Name of Product	Name of By-Product	Quantity (Kg/day)
1	Acephate	Ammonium Acetate	1065.6
2	Thiomethoxam	Potassium chloride	1021
3	Buprofezin	Calcium Chloride (30%)	4267.5
4	Ethion	Sodium Bromide	37.6
5	Pretilachlor	Lean HCl (20-25%)	600

Table 7.3 List of Raw Materials and Inventory *(Terms of Reference No. 3(iv) & (3(v))*

S.No	Name of the Raw Material	Maximum storage (Kgs)	Physical Form	Type of Hazard	Mode of Storage	Mode of Transport
1	[2-Ethylsulfonyl imidazo [1,2-a] pyridine-3-sulfonamide] Sulfonamide	200	Crystalline	Irritant	Bags	By Road
2	[4,6-Dimethoxy-2-(phenoxycarbonylamino)-pyrimidine] Carbamate	200	Crystalline	Irritant	Bags	By Road
3	1,2,4-Triazole	100	Scales	Corrosive	Carboys	By Road
4	2,4-Dichloro Valerophenone	300	Liquid	Irritant	Drums	By Road
5	2,6-dichloro quinoxaline	150	Liquid	Corrosive	Drums	By Road
6	2,6-Diethyl Aniline	4500	Liquid	Irritant	Drums	By Road
7	2,6-dihydroxy benzoic acid	100	Powder	Irritant	Carboys	By Road
8	2-Chloro-(5-chloromethyl) thiazole	5000	Liquid	Toxic	Drums	By Road
9	2-chloro-5-chloromethyl pyridine	500	Solid	Corrosive	Carboys	By Road
10	2-Cyanophenol	100	Solid	Irritant	Carboys	By Road
11	2-Heptanol	100	Liquid	Flammable	Drums	By Road
12	2-Hydrazino-4-Methyl Benzothiazole	800	Solid	Toxic	Bags	By Road
13	2-methyl-3-biphenyl methyl alcohol (BPA)	150	Solid	Corrosive	Bags	By Road
14	3-methyl-4-nitroiminoperhydro-1,3,5-oxadiazine	6000	Liquid	Flammable	Drums	By Road
15	4,6-dimethoxy-2-methyl sulfonyl pyrimidine	300	Solid	Corrosive	Bags	By Road
16	4-Amino-6-methyl-3-oxo-2,3,4,5-tetrahydro-1,2,4-triazine hydrochloride	200	Liquid	Corrosive	Drums	By Road
17	5-Amino-3-cyano-1-(2,6-dichloro-4-trifluoromethylphenyl)pyrazole	100	Liquid	Irritant	Drums	By Road
18	5-Chloro-2,3-difluoropyridine	2500	Liquid	Flammable	Drums	By Road
19	6-chloro pyridin-3-yl methyl amine	350	Liquid	Irritant	Drums	By Road
20	8-Hydroxy-5-chloroquinoline	200	Powder	Toxic	Bags	By Road
21	Acetic Anhydride	37000	Liquid	Flammable	Storage Tank	By Road
22	Acetone	800	Liquid	Flammable	Drums	By Road
23	Ammonia (21%)	500	Liquid	Corrosive	Drums	By Road
24	Ammonium bicarbonate	6500	Liquid	Non-Flammable	Drums	By Road
25	C S Lye (30%)	50	Liquid	Corrosive	Drums	By Road

26	Carbon	50	Solid	Flammable	Carboys	By Road
27	Caustic Lye (48%)	100	Liquid	Corrosive	Drums	By Road
28	Chloro Acetic Acid	100	Crystalline	Toxic	Carboys	By Road
29	Chloro Acetyl Chloride	3000	Liquid	Combustible	Drums	By Road
30	Dichloromethane (DCM)	30000	Liquid	Carcinogenic	Storage Tank	By Road
31	Diethyl Thiophosphoric Acid	400	Crystalline	Toxic	Bags	By Road
32	Dimethyl amine (40%)	10	Liquid	Flammable	Drums	By Road
33	Dimethyl formamide	10000	Liquid	Flammable	Storage Tank	By Road
34	Ethyl Acetate	30000	Liquid	Flammable	Storage Tank	By Road
35	Ethyl-2-chloropropionate	100	Liquid	Flammable	Drums	By Road
36	Ethylene dichloride	15000	Liquid	Carcinogenic	Storage Tank	By Road
37	Ethyl-N-Cyano Acetaimidate	250	Powder	Toxic	Bags	By Road
38	Formic Acid	200	Liquid	Flammable	Drums	By Road
39	Hexane	15000	Liquid	Flammable	Storage Tank	By Road
40	Hydrochloric Acid	300	Liquid	Corrosive	Drums	By Road
41	Hydroquinone	100	Solid	Irritant	Carboys	By Road
42	Lambda Cyhalothric acid (MTH Acid)	150	Solid	Corrosive	Bags	By Road
43	Methanol	20000	Liquid	Flammable	Storage Tank	By Road
44	Methomyl	150	Solid	Non-Hazard	Bags	By Road
45	Methyl 2-[2-(6-chloropyrimidin-4-yloxy)phenyl]-3,3- dimethoxy propanoate	250	Solid	Corrosive	Bags	By Road
46	Methyl Amine (40%)	200	Liquid	Corrosive	Drums	By Road
47	Methylene Dibromide	200	Liquid	Irritant	Drums	By Road
48	Xylene	300	Liquid	Flammable	Drums	By Road
49	n-Butanol	1500	Liquid	Flammable	Drums	By Road
50	N-Chloro methyl N-phenyl Carbamoyl chloride	8000	Solid	Corrosive	Bags	By Road
51	N-nitroiminoimidazolidine	350	Liquid	Irritant	Drums	By Road
52	n-PropoxyEthylchloride	3500	Solid	Irritant	Bags	By Road
53	N-Tertiary butyl N-isopropyl thio urea	7000	Liquid	Flammable	Drums	By Road
54	O,O-Dimethyl Phosphoramidothionate	8000	Crystalline	Irritant	Bags	By Road
55	O,O-dimethyl S-[methylaceto] dithiophosphate	1500	Crystalline	Corrosive	Bags	By Road
56	Potassium bisulphate	150	Solid	Corrosive	Bags	By Road

57	Potassium carbonate	7500	Crystalline	Irritant	Bags	By Road
58	Potassium Hydroxide	100	Solid	Corrosive	Carboys	By Road
59	Propargyl chloride	1000	Liquid	Flammable	Drums	By Road
60	P-toluene sulfonic acid mono hydrate	50	Liquid	Flammable	Drums	By Road
61	Pyridine	100	Liquid	Flammable	Drums	By Road
62	Pyridine-3-carbaldehyde	150	Liquid	Flammable	Drums	By Road
63	R-(+)-2-[4-5(-chloro-3-fluoropyridin-2-yloxy)phenoxy]propionic acid	2000	Liquid	Corrosive	Drums	By Road
64	Sodium Bicarbonate	2000	Crystalline	Irritant	Bags	By Road
65	Sodium hydroxide	1500	Liquid	Corrosive	Drums	By Road
66	Sodium trifluoromethanesulfinate (65%)	50	Powder	Irritant	Carboys	By Road
67	Sulfur Dichloride	50	Liquid	Corrosive	Drums	By Road
68	Sulfuric Acid	20000	Liquid	Corrosive	Storage Tank	By Road
69	Tetrabutyl ammonium bromide	20	Solid	Irritant	Carboys	By Road
70	Thionyl chloride	100	Liquid	Toxic	Drums	By Road
71	Toluene	15000	Liquid	Flammable	Storage Tank	By Road

7.3 Process Description

The manufacturing process for all the products is presented in Chapter 2.(**Page No. 2-2 to 2-50**) of the report.

7.4 Plant Facilities

The following are the facilities provided at manufacturing facility

1) Production blocks
2) Utilities
3) Quality Control, R&D lab
4) Effluent Treatment plant
5) Warehouses
6) Tank farm area
7) Cylinder Storage
8) Administrative Office
9) Solvent recovery area
10) Coal and Ash Storage Area

The production facilities shall be designed for proper handling of materials andmachines. Safety of operators, batch repeatability and process parameter monitoring shall be themajor points of focus in the design of facility. The current GoodManufacturing Practices (GMP) guidelines shall be incorporated as applicable tosynthetic organic chemicals manufacturing facilities.

7.4.1 Production Blocks:

The Production blocks will consist of SS and glass lined reactors, storage tanks, shell&tube heat exchangers, evaporators, vacuum pumps, packed columns, Agitated Nutche Filter and Dryers, crystallizers,layer separators etc. The area shall be provided with proper concealeddrainage facility and all process facilities shall be performed under protectiveenvironment.

7.4.2 Utilities:

No additional boilers are proposed for expansion, existing 1 x 5 TPH and 1 x 1.5 TPH boilers will meet the steam requirement both for process and effluent treatment system. It is proposed to establish 1 x 6 lac.k.cal/hr coal based and 1 x 2 lac.k.cal/hr HSD based thermic fluid heaters for process requirement. Existing DG sets of capacity 1 x 600 kVA, 2 x 225 kVA and 1 x 125 kVA will meet the emergency power requirement during load shut down. The estimated emergency power requirement is 1175kVA. The list of utilities is presented in the following **Table 7.4.**

Table 7.4List of Utilities

S.No	Utility	Permitted	Proposed	After Expansion
1	Coal Fired Boilers (TPH)	1 x 5 1 x 3* 1 x 1.5	---	1 x 5 1 x 3* 1 x 1.5
2	Thermic Fluid Heater - Coal Based (Lac. K.cal/hr)		1 x 6	1 x 6
3	Thermic Fluid Heater - HSD Based (Lac. K.cal/hr)		1 x 2	1 x 2
4	DG Sets (kVA)**	1 x 600 2 x 225 1 x 125	---	1 x 600 2 x 225 1 x 125

** 3 TPH Boiler shall be kept as standby.*
***DG sets will be used during load shut down by TRANSCO*

7.4.3 Quality Control, R&D Lab

The QC department shall comprise of an in-process lab with instruments like HPLC,GC etc. It will be maintained by highly qualified and trained people. The activitiesinclude:

- In-process quality check during manufacturing
- Validation of facilities
- Complaint handling

Also a process development laboratory for in-house process development, initial evaluation of process technology in case of technology transfer, back-up for production department to address any issues arising during commercial production

7.4.4 ETP and Solid waste storage

The total effluents segregated into two streams High COD/ TDS and Low COD/ TDS streams based on source of generation. These effluents are treated in Zero Liquid Discharge system and the treated effluents are reused for cooling towers make-up.

7.4.5 Ware Houses:

The plant shall have sufficient storage facility for safe handling of raw materials. Allsolid raw materials shall be stored in marked areas with proper identification. Liquid raw materials and solvents like which are available in drums will be stored according to material compatibilities and flammability. Adequate firefighting facilities shall be provided as per NFPA norms.

7.4.6 Tank Farm Area:

A separate tank farm area shall be provided for storing liquid raw materials, especially solvents with high inventory and also for toxic, corrosive chemicals. Dykes shall be provided to ensure safety in case of tank failure. Acid proof lining for the dykes shall be provided for acid storage tanks. Condensers for low volatile solvent storage tanks vents.

7.4.7 Cylinders storage Area:

Gas cylinders storage should conform to SMPV-Unfired rules-1981.Hydrogen cylinders should be stored in approved Gas Storage pad. Chained and capped when not in use. Operational cylinder should be firmly secured. Pressure regulator, metal piping, non-return valve, and safe residue bleed off arrangement should be incorporated in installation design. Strict hot work control and display of danger signs should be ensured.

7.4.8 Administrative Office:

An Administrative office shall be provided at the entrance of the factory to ensure the entry of authorized personnel only into the premises.

7.4.9 House Keeping:

A regular housekeeping schedule with adequate preventive maintenance shall beensured so that the plant is consistently maintained as per GMP standards.

7.4.10 Coal and Ash Storage:

Coal will be stored under covered shed with water sprinkler system in emergency. Ash silos will be provided for storage and handling of ash generated from combustion of coal.

Water sprinkling system shall be installed on stocks of coal in required scales to prevent spontaneous combustion and consequent fire hazards. The stack geometry shall be adopted to maintain minimum exposure of stock pile areas towards predominant wind direction

7.4.11 Facility layout and design:

The layout of all the various areas required for the facility, as mentioned above is considered. In laying out the above areas, isolation of the various process areas from the utilities and non-process areas is considered in view of both containment and GMP. A tentative plant layout is shown in **Fig 7.1.**

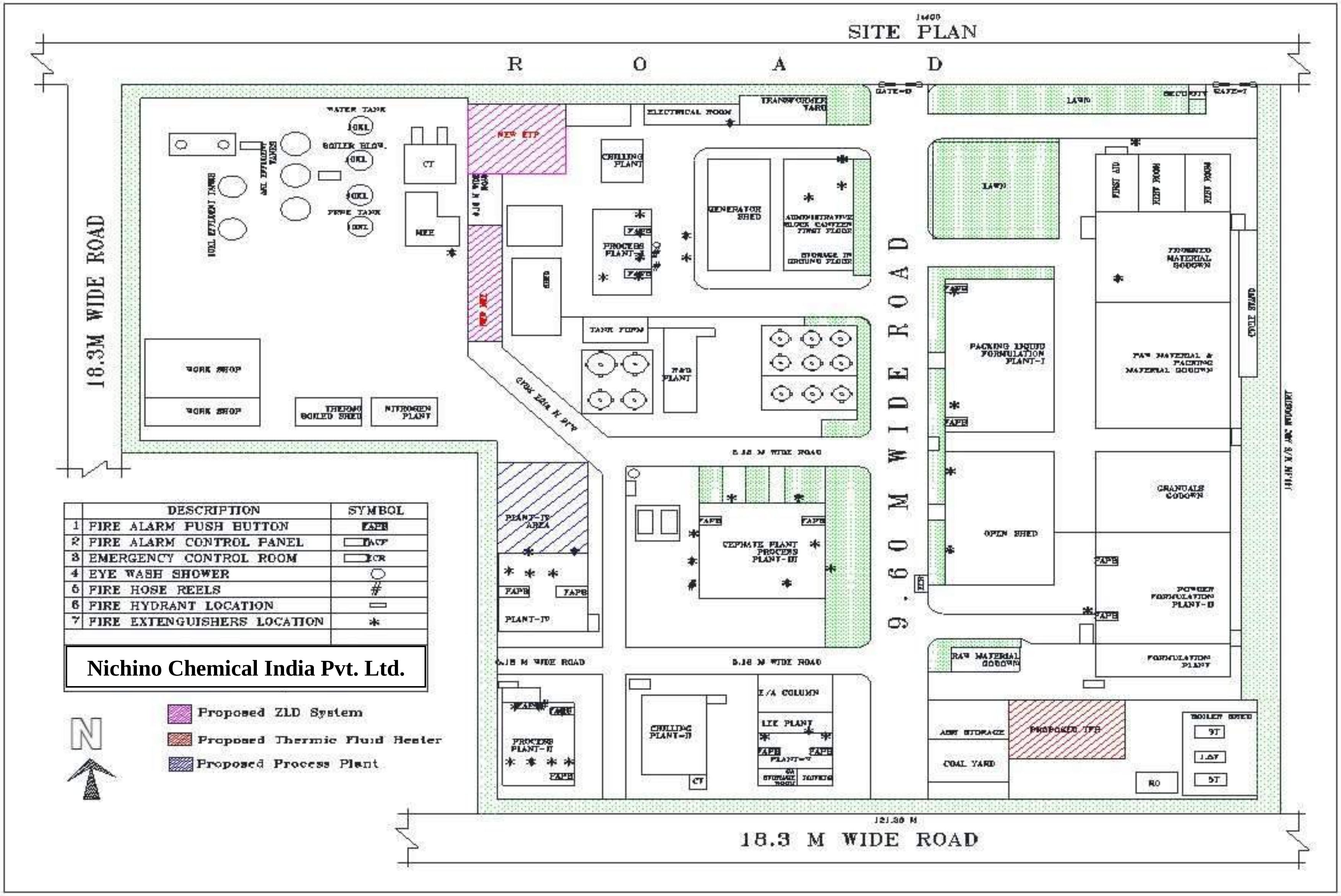

Fig 7.1 Plant Layout of Nichino Chemical India Pvt. Ltd.

Table 7.5Risk Control Measures

Significant Risks	Control Measures
Solvent Tank Farm and Chemical Tank Farm	
Fire/ Explosion	• Solvent Tank Farm licensed by PESO. • Restrict inventory to licensed quantities in Solvent Tank Farm. • Fenced Solvent Tank Farm. • Fenced Solvent Tank Farm capable of being locked when not in use. • Access Control and control of visitors • Control of ignition sources. • All electrical equipment and fittings to be flameproof as per area classification. • Provision of foam cover to cover the largest dyke area • Water spray cooling arrangements for all tanks • Fire hydrants and fire monitors • Solvent Storage Tanks to have N_2 blanketing • Earthrite system for earthing of tankers carrying solvents. • Spark arresters on vehicles • Wetting of road and tyres before unloading • NO dry grass inside the fenced area • No parking inside/ near the tank farm. • No obstruction on the road for free movement of fire tender. • No solvent pumping in night shift – Daytime operations only.
Loss of Containment and Spillage	• Dykes for all tanks (Dyke capacity to be min. 110% of tank capacity and dyke distance from tank to be min half the tank height). • Tanker unloading area (road) to be dyked. • Availability of the Spill control kit.
Injury at the time of loading/ unloading	• Provision of PPE to stores personnel. • Operations by trained stores personnel only.
Bulk Materials Store (liquid chemicals) Drum Yard and Special Chemicals Store	
Fire/ Explosion	• Fenced area, Access Control and control of visitors • Building capable of being locked when not in use. • Control of ignition sources. • Control of inventory to minimum possible • Segregation of materials. • Smoke/ Heat detection system (non-electricity based) • No water-basedfirefighting setup around the store. • Adequate CAUTION displays • Fire hydrants and fire monitors • Provision of foam • No electrical installation inside the Store • Adequate natural light and ventilation. • Daily night inspection by Shift Manager.

Significant Risks	Control Measures
	• No dry grass inside the fenced area • Emergency exit.
Loss of Containment Spillage	• Arrangements of drums in rows of two (two levels max) and a gap of at least 2 feet between rows and from the walls all around. • Storage in open area on hard impervious floor surrounded by a dyke/ sill. (*For Bulk Materials Store and New Solvent Drum Shed*) • Availability of the Spill control kit
Ergonomics – Poor posture leading to illness/ injury. Injury at the time of loading/ unloading	• Provision of PPE to stores personnel. • Loading/ unloading only by trained stores personnel.
Raw Materials Warehouse, Finished Goods Warehouse, Packing Materials Warehouse, and Engineering Store	
Fire	• Access Control and control of visitors • Fenced area • Building capable of being locked when not in use. • Control of ignition sources. • Control of inventory to optimal levels • Segregation of flammable materials. • Segregation of materials. • Battery charging not to be done inside the warehouse except for penicillin warehouse, that too during daytime only. • Installation of Smoke/ Heat detectors • Adequate hydrant points outside/around the building • NO dry grass in open areas. • Daily night inspection by Shift Manager. • Emergency exit. • Availability of DCP, Foam and CO_2 fire extinguishers, Spill Control kit.
Spillage	• Availability of the Spill control kit
Falling Objects	• Mandatory head and foot protection when inside the warehouse.
Ergonomics – Poor posture leading to illness/ injury. Injury at the time of loading/ unloading	• Provision of other PPE to stores personnel. • Loading/ unloading only by trained stores personnel.

7.5Hazard Analysis and Risk Assessment

7.5.1 Introduction.

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 an extensive hazard analysis. It involves the identification and assessment of risks; the neighboring 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.

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

7.5.2 Hazard Identification *(Terms of Reference No. 3(ix))*

The Hazard identification process must identify hazards that could cause a potential major accident for the full range of operational modes, including normal operations, start-up, and shutdown, and also potential upset, emergency or abnormal conditions. Employers should also reassess their Hazard identification process whenever a significant change in operations has occurred or a new substance has been introduced. They should also consider incidents, which have occurred elsewhere at similar facilities including within the same industry and in other industries.

Hazard identification and risk assessment involves a critical sequence of information gathering and the application of a decision-making process. These assist in discovering what could possibly cause a major accident (hazard identification), how likely it is that a major accident would occur and the potential consequences (risk assessment) and what options there are for preventing and mitigating a major accident (control measures). These activities should also assist in improving operations and productivity and reduce the occurrence of incidents and near misses.

The chemical and process industries have been using a variety of hazard identification techniques for many years, ranging from simple screening checklists to highly structured Hazard and Operability (HAZOP) analysis. Each technique has its own strengths and weaknesses for identifying hazards. It is impossible to compare hazard identification techniques and come to any conclusion as to which is the best. Each technique has been developed for a specific range of circumstances taking many factors into account including the resources required to undertake the analysis, expertise available and stage of the process. While HAZOP is primarily a tool for hazard identification, the HAZOP process can also include assessment of the causes of accidents, their likelihood and the consequences that may arise, so as to decide if the risk is acceptable, unacceptable or requires further study. Moreover, a formal guidance for applying this technique is available. Collaboration between management and staff is fundamental to achieving effective and efficient hazard identification and risk assessment processes.

After identifying hazards through a qualitative process, quantification of potential consequences of identified hazards using simulation modelling is undertaken. Estimation of probability of an unexpected event and its consequences form the basis of quantification of risk in terms of damage to property, environment or personnel. 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.

Considering operating modes of the facility, and based on available resources the following hazard identification process chosen are:

a) Fire Explosion and Toxicity Index (FETI) Approach;
b) HAZOP studies;
c) Maximum Credible Accident and Consequence Analysis (MCACA);
d) Classification of Major Hazard Substances;
e) Manufacture Storage and Import of Hazardous Chemical Rules, 1989 (GOI Rules, 1989);
f) Identification of Major Hazardous Units.

The physical properties of solvents used in the process are presented in Table 6.2 which forms the basis for identification of hazards during storage and interpretation of the Manufacture, Storage and Import of Hazardous Chemical Rules, 1989 (GOI Rules, 1989)

The interpretation of "The Manufacture Storage and Import of Hazardous chemicals" issued by the Ministry of Environment and Forests, GOI, which guides the preparation of various reports necessary for safe handling and storage of chemicals shows that the present project requires preparation of safety reports before commencing operation and risk assessment is not mandatory. The applicability of various rules is presented in **Table 7.6.**

Table 7.6 Applicability of GOI Rules to Storage/Pipeline

S.No	Name of Chemical	Inventory KL	Threshold Quantity (T) For Application of Rules		Applicable Rules
			5,7-9, 13-15	10 - 12	
1	Acetic Anhydride	37	1500	10000	4 (1) (a), (2), 5,15
2	Dichloromethane	30	1500	10000	4 (1) (a), (2), 5,15
3	Dimethyl formamide	10	1500	10000	4 (1) (a), (2), 5,15
4	Ethyl Acetate	30	1500	10000	4 (1) (a), (2), 5,15
5	Ethylene dichloride	15	1500	10000	4 (1) (a), (2), 5,15
6	Hexane	15	1500	10000	4 (1) (a), (2), 5,15
7	Methanol	20	1500	10000	4 (1) (a), (2), 5,15
8	Sulfuric Acid	20	1500	10000	4 (1) (a), (2), 5,15
9	Toluene	15	1500	10000	4 (1) (a), (2), 5,15

Table 7.7 Physical Properties of Raw Materials and Solvents

S.No	Name of Raw material	TLV (ppm)	Toxicity Level			Flammable Limit					Chemical Class (As per MSIHC Rules)
			LD50 Oral (mg/kg)	LD50 Dermal (mg/kg)	LC 50 (mg/1)	LEL (%)	UEL (%)	FP (^OC)	BP (^OC)	Class (As per Petroleum Classification	
1	Acetone	1000	5800	20000	5540	2.6	13.0	<-20	56.2	B	Highly Flammable
2	Dichloromethane	50	670	2800	2270	6.0	11.4	13	40.0	B	Carcinogenic
3	Dimethyl formamide	10	2800	1500	15	2.2	16.0	58)	153	C	Flammable
4	Ethyl Acetate	400	5620	18000	2500	2.1	11.5	-4	77	B	Highly Flammable
5	Ethylene dichloride	10	670	2800	1000	6.0	11.4	13)	84	A	Flammable & Toxic
6	n-Hexane	50	28710	2000	>20	1.0	8.1	-22	69	B	Flammable
7	Methanol	200	5628	15800	64000	5.5	36.5	11	64.5	A	Flammable
8	Xylene		2119	1750	5000	1	7	24	138.5	B	Flammable
9	Monomethyl amine	10	100	16	1860	4.9	20.8	29.9	-6.3		Flammable
10	n-Butanol	100	2733	2000	---	2.3	8.0	14	83	B	Flammable
11	Toluene	200	636	12124	313	1.2	8.0	4	110.6	B	Flammable

7.5.3 Fire & Explosion Index (F & EI):

7.5.3.1 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.

Computation of F&EI

The F&EI is calculated as a product of Material factor, General process hazard factor, and special process hazard factor The Material factor is a measure of the intrinsic rate of potential energy release from fire or 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 National 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 hazards 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 of 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 index is calculated as a product of Material factor, General process hazard factor, and Special process hazard factor.

Hazard Ranking

The hazard ranking based on F&EI value is presented in **Table 7.8.**

Table 7.8 Degree of Hazard for F&EI

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

The estimated values of F&EI and hazard ranking are given in the **Table 7.9.**The radius of exposure is determined by 0.26meter x respective F&EI. 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 7.9 Fire & Explosion Index for Tank farm

S. No.	Name of Solvent	Fire & Explosion Index (F1*F2*MF)	Radius of Exposure (m) F&EIx0.26	Degree of Hazard
1	Acetic Anhydride	76.89	20.00	Moderate
2	Dichloromethane	93.62	24.34	Moderate
3	Dimethyl formamide	76.22	19.82	Moderate
4	Ethyl Acetate	76.28	19.83	Moderate
5	Ethylene dichloride	91.42	23.77	Moderate
6	Hexane	74.95	19.49	Moderate
7	Methanol	71.52	18.60	Moderate
8	Toluene	81.28	21.13	Moderate

F& E index value calculated considering the maximum storage capacity of chemical and values are found to be moderate for all other solvents storage reflecting the threshold limits as prescribed in MSHC rules.

7.5.4 Hazard and Operability Study (HAZOP)

Hazard and Operability Study (HAZOP) is a highly structured and detailed technique, developed primarily for application to chemical process systems. A HAZOP can generate a comprehensive understanding of the possible 'deviations from design intent' that may occur. However, HAZOP is less suitable for identification of hazards not related to process operations, such as mechanical integrity failures, procedural errors, or external events. HAZOP also tends to identify hazards specific to the section being assessed, while hazards related to the interactions between different sections may not be identified. However, this technique helps to identify hazards in a process plant and the operability problems. It is performed once the engineering line diagrams of the plant are made available. It is carried out during or immediately after the design stage. The purpose of the study is to identify all possible deviations from the way the design/operation is expected to work and all the hazards associated with these deviations. A multi-disciplinary team was constituted with chemical, mechanical and instrumentation engineers, R&D chemist and production manager. 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. The group discussion is facilitated by a Chairman and the results of the discussion are recorded by a Secretary. Every investigation must be led by Chairman who is familiar with the HAZOP study technique, which is primarily concerned with applying, controlling the discussions and stimulating team thinking.

The preparative work for HAZOP studies consisted of four stages i.e., obtaining the data, converting into usable form, planning the sequence of the study and arranging the necessary meetings. The documents referred to for the study include process description, process flow diagrams, P&I diagrams plant layout, operating manuals including startup

& shutdown, safety instructions etc., The parameters such as temperature, pressure, flow, level were investigated for deviation and hazard situations are identified.

Some basic definitions of terms frequently used in HAZOP studies are deviation, causes, consequences and guide words etc., Deviations are departures from the design intent which are discovered by systematically applying the guide words. Causes are the reasons why deviations might occur. Consequences are the reasons why deviations should they occur. Guide words are simple words used to understand a particular plant section in operating condition in order to guide and simulate the creative thinking process and so discover deviations. NO, less, more, as well as, part of, reverse, other than are guide words used.

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).

7.5.5 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:

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

7.5.6 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
- Improving 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

Failures of Human Systems

An assessment of past chemical accidents reveals human factor to be 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, unfavorable 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 analyzed 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 following **Tables 7.10 and 7.11**.

Table 7.10 Failure Rate Data

S. No	Item	International Data
1.	Process Controllers	2.4×10^{-5} hr^{-5}
2.	Process control valve	2.0×10^{-6} hr^{-1}
3.	Alarm	2.3×10^{-5} hr^{-1}
4.	Leakage at biggest storage tank	5.0×10^{-5} yr^{-1}
5.	Leakage of pipe line	1×10^{-7} m^{-1} yr^{-1}
6.	Human Failure	1×10^{-4} (demand)$^{-1}$

Table 7.11 Ignition 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.	Mechanical sparks	2%
11.	Molten substances	1%
12.	Chemical actions	1%
13.	Static sparks	1%
14.	Lightening	1%
15.	Miscellaneous	1%

7.6 Maximum Credible Accident and Consequence Analysis (MCACA)

The potential hazards due to flammable and toxic nature of the raw materials, process streams and products can be quantified. However, it is necessary to carry out a hazard analysis study to visualize the consequences of an unexpected release from chemical plant, which consists of a number of process units and tank farm facilities. The present study provides quantified picture of the potential hazards and their consequences.

7.6.1 Methodology

MCACA aims at identifying the unwanted hazardous events, which can cause maximum damage to plant and personnel. At the first instance, all probable accident scenarios are developed. Scenarios are generated based on properties of chemicals, physical conditions under which reactions occur or raw materials stored, as well as material strength of vessels and conduits, in-built valves and safety arrangements, etc. Creating a scenario does not mean that it will occur, only that there is a reasonable probability that it could. A scenario is neither a specific situation nor a specific event, but a description of a typical situation that covers a set of possible events or situations.

The following steps are involved in identifying the maximum credible accident scenarios.

a. A detailed study of the process and plant information including process flow diagrams and piping & instrumentation diagrams.

b. Hazard classification of chemicals, operations and equipment.

c. Identification of representative failure cases of vessels and the resulting release scenarios

d. Establishment of credibility of visualized scenarios based on past accident data.

7.6.2 Identification of Vulnerable Areas

The unit operations in the process and storage areas involve mass and energy transfer operations to effect the necessary physical changes. Nature of chemicals and the operating conditions create special hazardous situations. In the present case the chemicals handled are flammable and toxic in nature. With these factors in mind a thorough examination of the process information is carried out and a list of inventories of the hazardous chemicals is prepared to identify the hazardous situations. Based on the raw material consumptions determined from the pilot scale studies, experience in handling commercial scale processes and logistics in procurement of raw materials, the inventories to be maintained for each of the raw material and its mode of storage is determined. High inventory liquid raw materials like solvents are usually stored in tank farms, while solids and other low inventory liquids are stored in ware house based on compatibility, reactivity, toxicity etc. with appropriate safety and firefighting facilities to handle any kind of emergencies.

7.6.3 Representative Accident Scenarios

A study of past accidents, which took place in similar process units and the present plant, provides reasons and course of accidents and there by focusing on most critical areas. A thorough examination of engineering details indicated many possible scenarios like gasket leak, pinholes in pipes and vessels apart from rupture of pipelines and vessels and catastrophic failure of vessels resulting in a pool. Heat radiation damage distances for Pool fire were considered.

Failure Frequency:

The release scenarios considered above can be broadly divided in to two categories

(i) Catastrophic failures which are of low frequency and

(ii) Ruptures and leaks which are of relatively high frequency

Vapor or liquid release from failure of gasket, seal and rupture in pipe lines and vessels fall in second category whereas catastrophic failure of vessels and full-bore rupture of pipe lines etc., fall in to first category. Typical failure frequencies are given in **Table 7.12.**

Table 7.12 General Failure Frequencies

Item	Mode of failure	Failure frequencies
Pressure Vessel	Serious leak	$1.0*10^{-5}$/Year
	Catastrophic	$3.0*10^{-6}$/Year
Pipe lines		
=50 mm dia	Full bore rupture	$8.8*10^{-7}$/m .year
	Significant leak	$8.8*10^{-6}$/m.year
>50 mm =150 mm dia	Full bore rupture	$2.6*10^{-7}$/m.year
	Significant leak	$5.3*10^{-6}$/m.year
>150 mm dia	Full bore rupture	$8.8*10^{-8}$/m.year
	Significant leak	$2.6*10^{-6}$/m.year
hose	Rapture/Failure	$4.0*10^{-5}$/hr
Unloading arm	Rapture/Failure	$3.0*10^{-8}$/hr
Check valve	Failure on demand	$1.0*10^{-4}$/on demand
motor operated valve	Failure on demand	$1.0*10^{-3}$/ on demand
Flange	Leak	$3.0*10^{-4}$/ Year

Pump seal	Leak	5.0*10^{-3}/ Year
Gasket failure	Failure	5.0*10^{-5}/ Year
Process safety valve(PSV)	Lifts heavily	4.0*10^{-3}/ Year
	Blocked	1.0*10^{-3}/ Year
	Lifts lightly	6.0*10^{-2}/ Year

7.7Consequence Analysis

The accidental release of hazardous chemicals leads to subsequent events, which actually cause the damage. The damages are of three types.

1) Damage due to heat radiation.

2) Damage due to over pressure effects subsequent to explosion

3) Damage due to toxic effects

The type of damage and extent of damage depends on nature of chemical, the conditions of release, atmospheric conditions and the subsequent events. The sequence of probable events following the release of a hazardous chemical is schematically shown in **Figure 7.2.**The best way of understanding and quantifying the physical effects of any accidental release of chemicals from their normal containment is by means of mathematical modeling. This is achieved by describing the physical situations by mathematical equations for idealized conditions and by making corrections for deviation of the practical situations from ideal conditions. In the present study ALOHA software from USEPA. These models for various steps are described in the following sub-sections.

7.7.1 Release Models and Source strength

This depends on the nature of failure of the unit and the content of the unit and operating temperature and pressure of the unit. The release may be instantaneous due to total failure of storage unit or continuous due to leakage or rupture of some component of the storage facility. The material discharged may be gas or liquid or the discharge could be manifested through two phase flow. The models that are used to calculate the quantity of liquid/vapor released are:

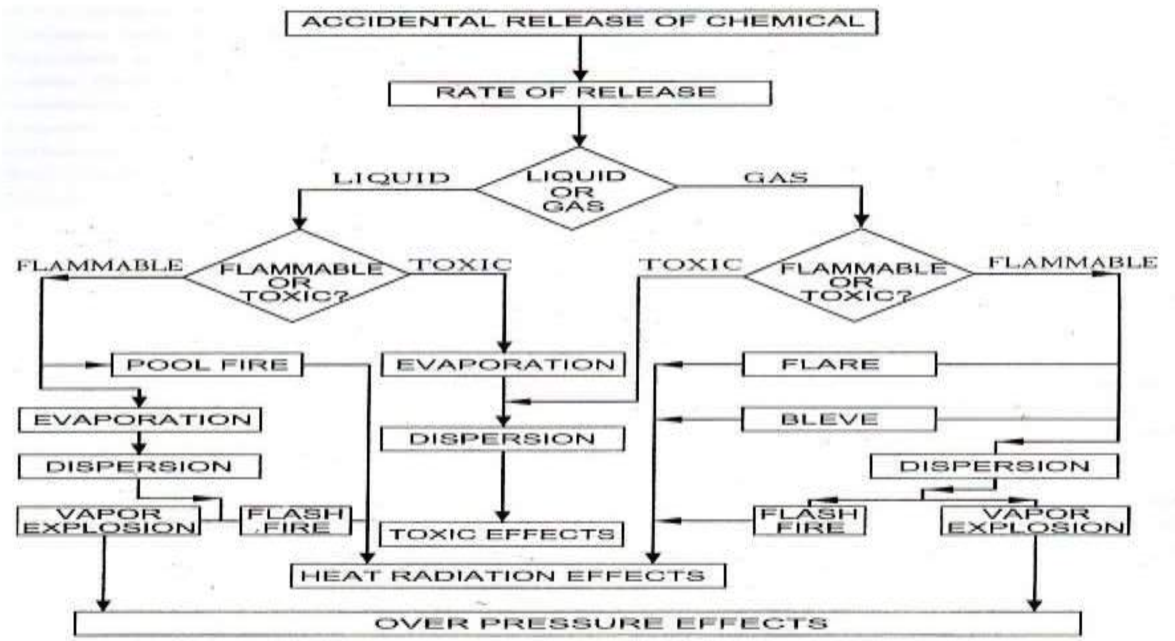

Fig 7.2 Steps in Consequence Calculations

The following criteria tables present heat radiation intensities (**Table 7.13**), radiation exposure and lethality (**Table 7.14**), and damage due to peak over pressure is presented in **Table 7.15.**

Table 7.13Damage Due to Incident Radiation Intensities

S. No	Incident Radiation (KW/m2)	Type of Damage Intensity	
		Damage to Equipment	**Damage to the People**
1	37.5	Damage to process Equipment	100% lethality in 1 min. 1% lethality in 10 sec.
2	25.0	Minimum energy required to ignite wood at indefinitely long exposure without a flame	50 % lethality in 1min. Significant injury in 10 sec.
3	19.0	Maximum thermal radiation intensity allowed n thermally Unprotected adjoining equipment.	---
4	12.5	Minimum energy to ignite with a flame, melts plastic tubing	1% lethality in 1 min.
5	4.0	--	Causes pain if duration is longer than 20 sec, however blistering is unlikely(First degree burns)
6	1.6	--	Causes no discomfort on Longer exposure

Source: Techniques for Assessing Industrial Hazards by World Bank

Table 7.14 Radiation exposure and lethality

Radiation Intensity (KW/m2)	Exposure Time (seconds)	1% Lethality	Degree Burns
1.6	--	0	No Discomfort even after longer exposure
4.5	20	0	1st
4.5	50	0	1 st
8.0	20	0	1 st
8.0	50	<1	3 rd
8.0	60	<1	3 rd
12.0	20	<1	2 nd
12.0	50	8	3 rd
12.5	--	1	--
25.0	--	50	--
37.5	--	100	--

Table 7.15Damage Due to Peak Over Pressure

Human Injury		Structural Damage	
Peak Over Pressure(bar)	Type of Damage	Peak over Pressure(bar)	Type of Damage
5 – 8	100% lethality	0.3	Heavy (90%Damage)
3.5 – 5	50% lethality	0.1	Repairable (10%Damage)
2 – 3	Threshold lethality	0.03	Damage of Glass
1.33 – 2	Severe Lung damage	0.01	Crack of Windows
1 – 1$^{1/3}$	50% Eardrum rupture	-	-

Source : Marshall, V.C.(1977)' How lethal are explosives and toxic escapes.

7.7.2 Results of Consequence Analysis

The damages due to the accidental release of chemicals are of three types.

a) Damage due to heat radiation

b) Damage due to over pressure effects subsequent to explosion

c) Damage due to Toxic effects

7.7.2.1 Analysis of Hazardous Scenarios

The hazardous chemicals involved are stored within the threshold limits of storage and hence few representative chemicals mainly solvents were studied.

7.7.2.1.1 Heat radiation effects *(Terms of Reference No. Sp. TOR (13))*

When a non-boiling liquid spills, it spreads into a pool. The size of the pool depends on the availability of the bund and obstacles. The heat load on objects outside a burning pool of liquid is calculated with the heat radiation model. The average heat radiation intensity, the diameter-to-height ratio dependent on the burning liquid, geometric view, distance from the fire, relative humidity of air, horizontal or vertical orientation of the object radiated with respect to fire are factored. All storage tanks in tank-farm area are provided with dykes. For each of the hazardous chemicals involved various scenarios such as pipe line leaks of 5mm or pipeline ruptures or catastrophic vessel ruptures of the inventories as outlined have been considered and damage distances for Lower Flammability Limits (LFL) and heat radiation effects for the three levels of intensity are calculated and presented in **Table 7.16**. Heat radiation damage distances for most of the scenarios are not occurring in the case of release from 25 mm holes at a height of 0.1 m from the bottom of the tank for one hour, in the storage tanks. In case of pipeline leaks, 5 mm leaks are considered for 15 mm and 50 mm pipe sizes. The release rates from 5 mm leaks are observed to be low, and these leaks have low incident hazard. The concentration of the flammable material in the vapor cloud was found to be below the lower flammability limits. Heat radiation damage distances are presented in **Fig 7.3 to 7.6.**

Table 7.16 Heat Radiation Damage Distances – Tank Farm (Pool Fire)

S.No	Name of Raw material	Tank Capacity (KL)	Diameter (m)	Height (m)	Hole Dia (mm)	Release Rate (Kg/sec)	Heat radiation damage distances in m for KW/m2		
							37.5	12.5	4.0
1	Acetic Anhydride	37	3.2	4.8	25	0.44	<10	<10	<10
2	Dichloromethane	30	3.2	3.7	25	2.07	<10	<10	12
3	Dimethyl formamide	10	2.0	3.2	25	0.42	<10	<10	<10
4	Ethyl Acetate	30	3.2	3.7	25	0.40	<10	<10	<10
5	Ethylene dichloride	15	2.5	3.0	25	0.48	<10	<10	12
6	Hexane	15	2.5	3.0	25	0.35	<10	<10	11
7	Methanol	20	2.5	4.0	25	0.38	<10	<10	<10
8	Toluene	15	2.5	3.0	25	0.10	<10	<10	11

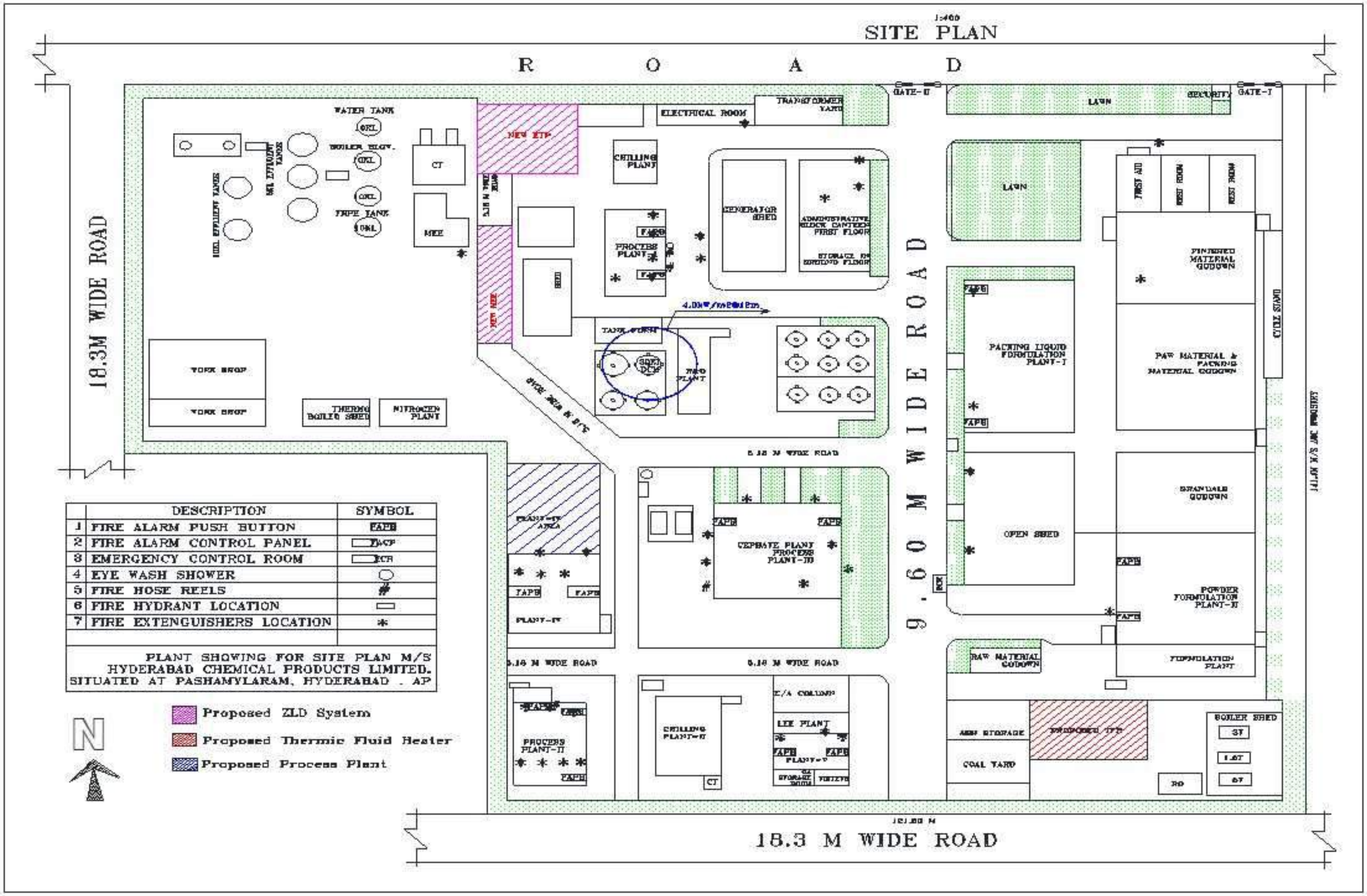

Fig 7.3 Heat Radiation Damage Distance – 30 KL Dichloromethane Tank –Pool Fire

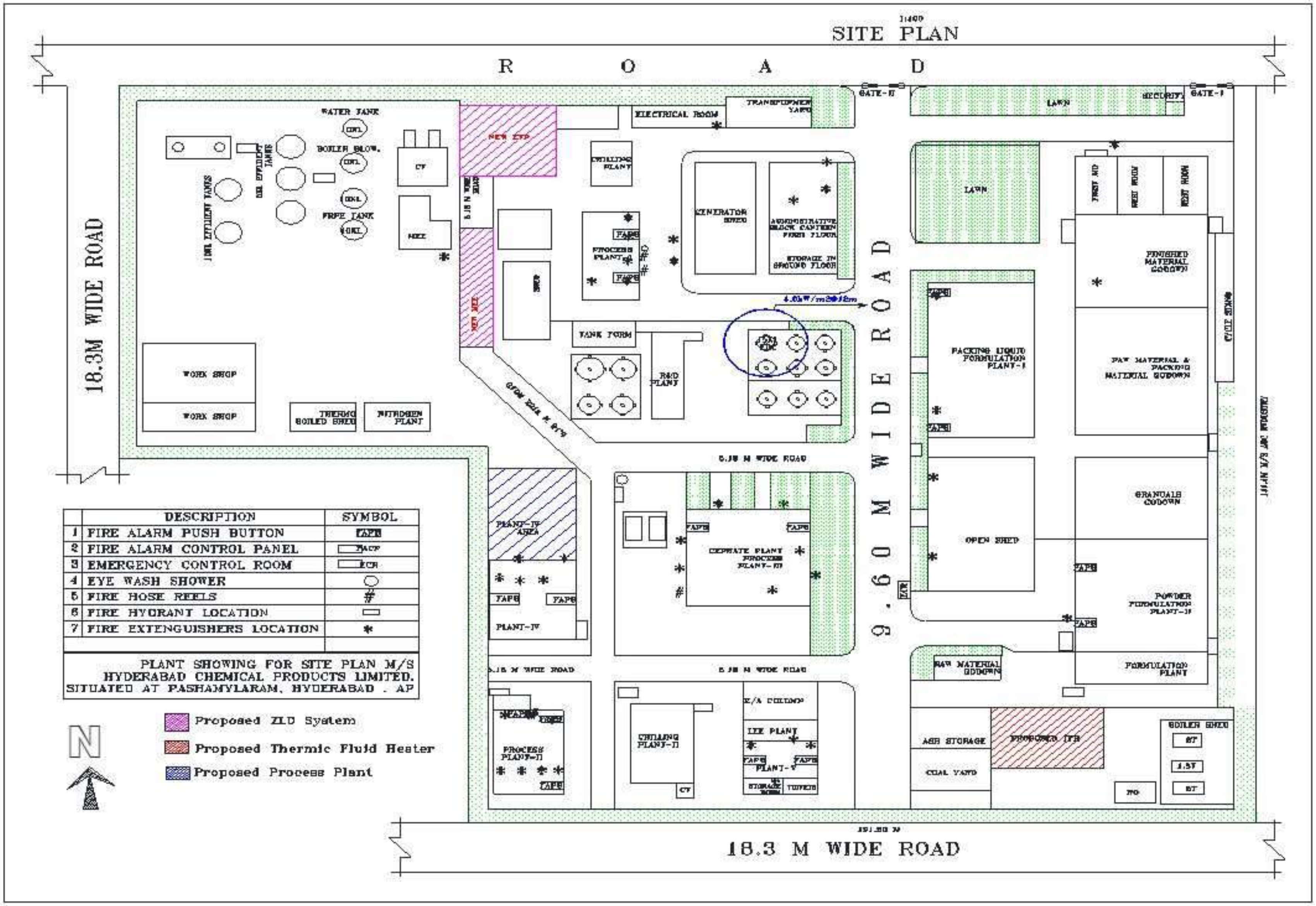

Fig 7.4 Heat Radiation Damage Distance – 15 KL Ethylene Dichloride Tank –Pool Fire

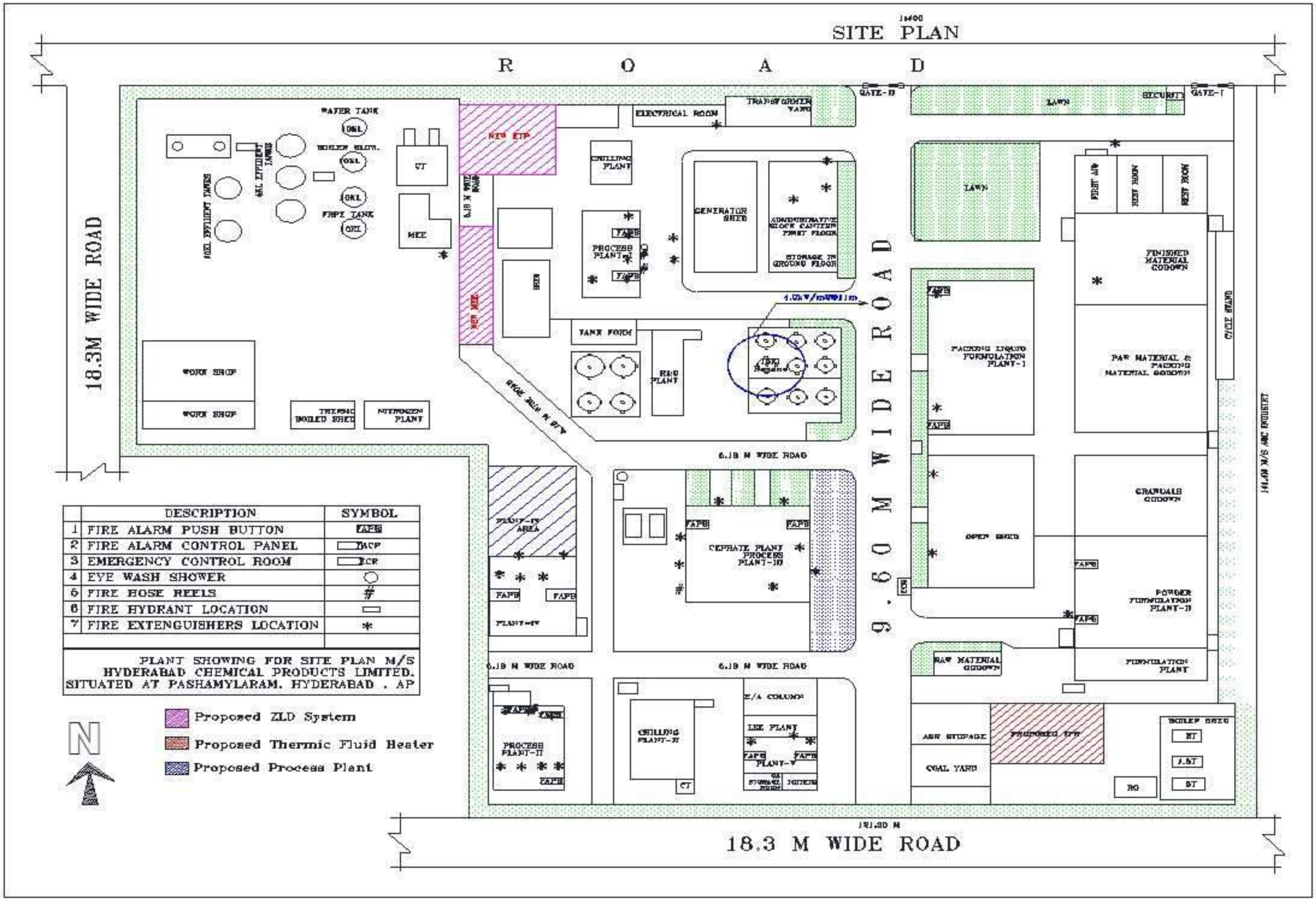
SITE PLAN
ROAD
18.3M WIDE ROAD
9.60 M WIDE ROAD
18.3 M WIDE ROAD
GATE-II
GATE-I
SECURITY
LAWN
TRANSFORMER YARD
ELECTRICAL ROOM
NEW ETP
WATER TANK
CT
MEE
CHILLING PLANT
GENERATOR SHED
PROCESS PLANT-I
TANK FORM
WORK SHOP
WORK SHOP
THERMIC BOILER SHED
NITROGEN PLANT
NEW MEE
FIRST AID
REST ROOM
REST ROOM
FINISHED MATERIAL GODOWN
RAW MATERIAL & PACKING MATERIAL GODOWN
CYCLE STAND
6.18 M WIDE ROAD
PLANT-IV AREA
PLANT-IV
OPEN SHED
GRANULES GODOWN
POWDER FORMULATION PLANT-II
FORMULATION PLANT
RAW MATERIAL GODOWN
PROCESS PLANT-II
CHILLING PLANT-II
ICE PLANT
PLANT-V
ASH STORAGE
COAL YARD
PROPOSED TFH
BOILER SHED
RO
DESCRIPTION
SYMBOL
1 FIRE ALARM PUSH BUTTON
2 FIRE ALARM CONTROL PANEL
3 EMERGENCY CONTROL ROOM
4 EYE WASH SHOWER
5 FIRE HOSE REELS
6 FIRE HYDRANT LOCATION
7 FIRE EXTENGUISHERS LOCATION
PLANT SHOWING FOR SITE PLAN M/S HYDERABAD CHEMICAL PRODUCTS LIMITED. SITUATED AT PASHAMYLARAM, HYDERABAD . AP
Proposed ZLD System
Proposed Thermic Fluid Heater
Proposed Process Plant
N

Fig 7.5 Heat Radiation Damage Distance – 15 KL Hexane Tank –Pool Fire

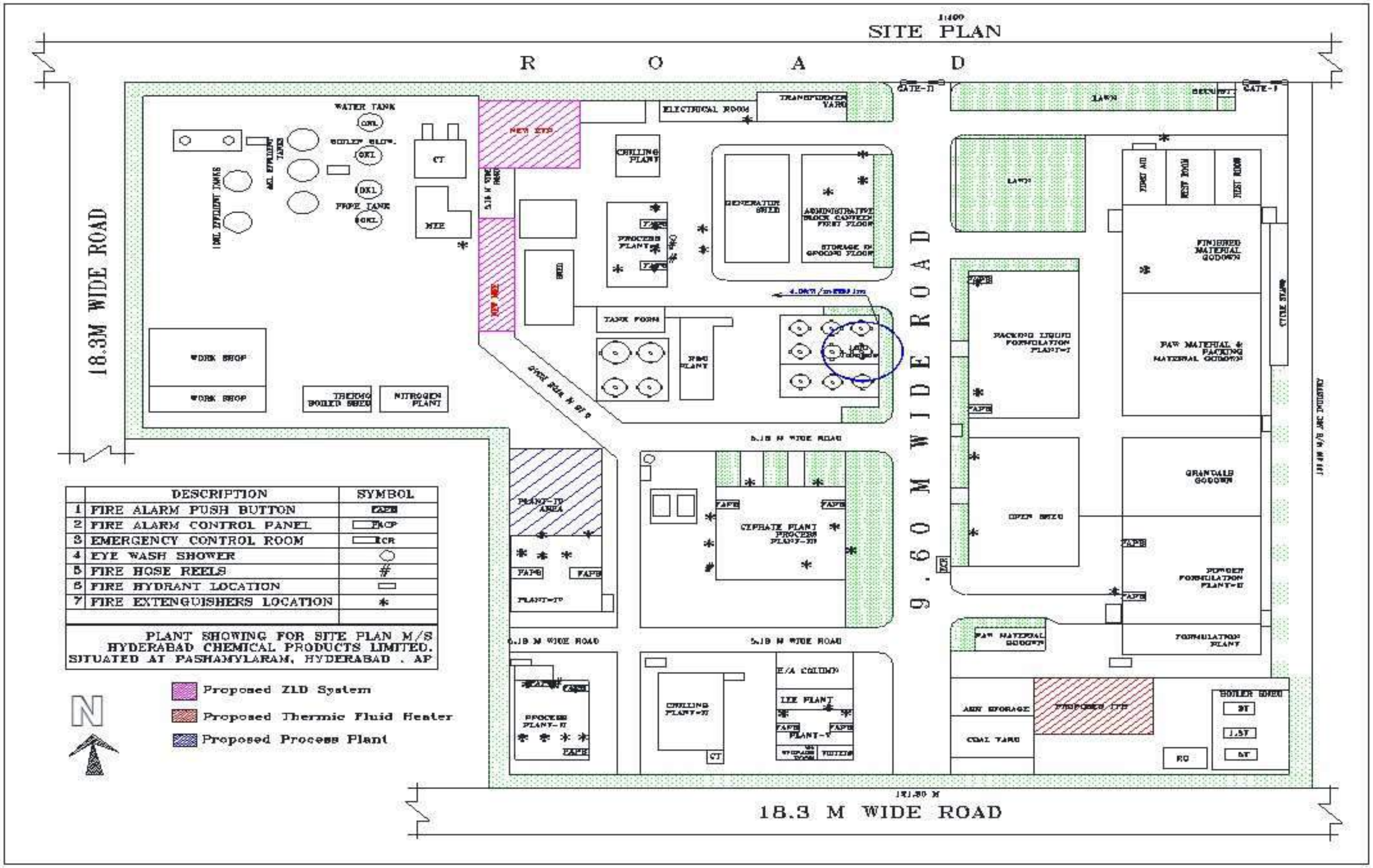

Fig 7.6 Heat Radiation Damage Distance – 15 KL Toluene Tank –Pool Fire

Table 7.17 Heat Radiation Damage Distance – Hydrogen Cylinders

S. No.	Scenario Description	Release Rate Kg/sec	Storage Tank Details			Heat radiation damage distances in m for KW/m2		
			Height (m)	Diameter (m)	Storage Pressure	37.5	12.5	4.0
1	Hydrogen Gas Cylinder (50Kg)	5.42	0.87	0.27	350 Bar	<10	12	20

7.7.2.1.2 Overpressure effects:

When an unignited gas cloud mixes with air and reaches the flammable range and if the cloud ignites wither a flash fire or flash fire explosion can occur. Since the burning time is shorter, instead of heat radiation from a flash fire, peak overpressure as a function of distance from the center of the cloud is derived. In case of pipeline leaks, damage distances due to overpressure effects are not observed. The values are found to be similar as there are no pressurized storage tanks in the tank farm, and the over pressure distances are contingent on the tank capacity.

7.7.3 Observations:

From the previous incident records published in literature and hydrocarbon release data bases, it has been observed that pinhole leaks contribute highest percentage whereas the second cause is small sized leaks of 25 mm diameter in tank farm. Accordingly, the consequence analysis was carried out for 25 mm sized leaks in the tank farm.

7.7.4 Recommendations:

The following are the recommendations to minimize the hazards and improve the safety of plant. Plants of this nature, which handle a variety of chemicals, face problems of fire and vapor cloud explosions. It has been observed that the damage distances are more or less confined to the plant area only. Taking precautionary safety measures as outlined below can further minimize these effects.

- In view of hazardous nature of operations, it is recommended to adopt best practices with respect to design, operation and maintenance.

- It is recommended that all flammable areas and process area be maintained free of ignition sources. Ensure that sources of ignition, such as pilot lights, electrical ignition devices etc., at strategic locations like solvent storage areas are avoided**.**
- All electrical fittings involved in and around the pipeline and operation system should conform to flame/explosion proof regulations.
- Strict hot work control and display of danger signs should be ensured.
- It is recommended to provide one fire hydrant point in the tank-farm area to take care of any emergency. Installation of fire water hydrant network is suggested.
- It is suggested to provide fire extinguishers in process plant at solvent storage area and the vents of solvent tanks to be provided with PESO approved flame arrestors.
- Fire protection equipment should be well maintained so that it is available when required. They should be located for quick accessibility. Provide carbon dioxide fire extinguishers and DCP extinguishers for Electrical fires.
- It is suggested to have a periodical review of safety awareness and safety training requirements of plant employees with respect to hazards present in the plant.
- In general, all pipelines carrying flammable liquids/vapor are periodically checked for their integrity. Spillages have to be avoided and disposal should be done quickly.

7.7.5 Toxic Management Plan *(Terms of Reference No. Sp. TOR (14))*

The list of chemicals identified to have toxic or carcinogenic nature is presented in **Table 7.18.**

Table 7.18 List of Toxic/Carcinogenic Chemicals and Mode of Storage/Transport

S. No	Name of the Raw Material	Maximum storage (Kgs)	Physical Form	Type of Hazard	Mode of Storage
1	2-Chloro-(5-chloromethyl) thiazole	5000	Liquid	Toxic	Drums
2	2-Hydrazino-4-Methyl Benzothiazole	800	Solid	Toxic	Bags
3	8-Hydroxy-5-chloroquinoline	200	Powder	Toxic	Bags
4	Chloro Acetic Acid	100	Crystalline	Toxic	Carboys
5	Dichloromethane	30000	Liquid	Carcinogenic	Storage Tank

6	Diethyl Thiophosphoric Acid	400	Crystalline	Toxic	Bags
7	Ethylene dichloride	15000	Liquid	Carcinogenic	Storage Tank
8	Ethyl-N-Cyano Acetaimidate	250	Powder	Toxic	Bags
9	Thionyl chloride	100	Liquid	Toxic	Drums

Handling: Storage & handling in compliance with MSDS. The transfer of solvents shall be mainly by closed pipeline systems, while solvents are transferred from drums by using air operated diaphragm pumps in closed hoods. Solid phase raw materials are charged by using closed hoppers to avoid dust emissions and hazard of static electricity. SOP's for better operational control.

Engineering Control Measures: All the operations filtration and drying are conducted in closed conditions. Forced dry ventilation system to hoods. Vent condensers in series to reactors, distillation columns, driers and centrifuge to mitigate atmospheric emissions of toxics. Solvents with low boiling point will be stored in double limpet coil storage tanks with coolant circulation.

Vents of secondary condensers connected to vacuum pumps followed by tertiary condenser. Common headers connecting all the process vents and the same are connected to scrubbers. Low boiling solvents tanks are connected with reflux condensers to minimise the loss. The transfer pumps shall be provided with mechanical seals.

Personnel Protective Equipment: Personal protective equipment shall be provided to all employees including contract employees. All the employees shall be provided with gumshoe, helmet, masks, and goggles. The other equipment like ear muffs, gloves, respirators, aprons etc., will be provided to employees depending on the work area allocated to them. The PPE selection shall strictly follow the prescribed guidelines of MSDS.

Health Monitoring of Employees: The pre-employment screening and periodic medical examination shall follow the guidelines of factories act. The pre-employment screening shall obtain medical history, occupational history followed by physical examination and baseline monitoring for specific exposures.

Frequency of Health Monitoring

Occupation	Type of evaluation		Frequency
Process area	Physical Observation	Height Weight	Once a year for regular employees. Half yearly for contract employees
	Eyes	Color vision	
	Detailed Test	Hearing Ability; Physical Status General Condition; Previous Accidents Skin Infections; Any Physical Handicap	
	Clinical Observation	Lungs; Heart; Hydrocele; Central Nervous System; Liver functioning; Diabetes; Any operations undergone; Symptoms of communicable and other contagious disease and Medical fitness	
Noise Area	Audiometry		Annually

7.7.6Transportation (*Terms of Reference No. 7(iii)*)

All the raw materials and finished products are transported by road. Dedicated parking facility will be provided for transport vehicles. The plant is located near national highway, and there will not be any unauthorized shop or settlements along the road connecting the plant site. There will be 15-20 truck trips per day to the factory. Safety signage is placed at various locations in the battery limit. The drivers of the vehicles will be provided with TREM cards and will be explained the measure to be adopted during various emergencies.

Transportation of raw materials may result in accidents due to high speed collision, low speed collision, overturning and non-accident-initiated release. The initiating and contributing causes are presented in **Table 7.19**

Table 7.19 Truck Incidents – Initiating and Contributing Causes

Human Errors	Equipment Failures	System or Procedural Failures	External Events
Driver Impairment Speeding Driver Overtired Contamination	Non-dedicated trailer RR crossing guard Failure Leaking Valve	Driver incentives Driver training Carrier selection Container Specification	Vandalism/ Sabotage Rain Fog Wing

Overfilling	Leaking Fitting	Route selection	Flood/washout
Other Vehicle's Driver	Brake Failure	Emergency response training	Fire at rest areas/parking areas
Taking Tight	Insulation/Thermal Protection Failure	Speed Enforcement	Earthquake
Unsecured Load	Relief device failure Tire failure Soft shoulder Overpressure Material defect Steering failure Sloshing High center of gravity Corrosion; Bad Weld; Excessive Grade Poor Intersection design Suspension system	Driver rest periods Maintenance Inspection Time of day Restrictions	Existing accident

The scenarios presented for storages are calculated for transport related incidents/accidents and presented in **Table 7.20.**

Table 7.20 Transportation Specific Concerns

Concern	Road
Spill on Water	Over or near a body of water
Unconfined Pools	In an undisturbed flat area
BELVE-Induced catastrophic vessel failure	Possible if sufficient quantity in car with small leak to feed fire or if double tank trailer or burning fuel leak
Toxic products of combustion or reaction	Dependent on material and whether ignition occurs

7.7.7Control Measures for Accidental Spillage of Chemicals

Name of the Chemical Stored	Storage Details		Hazard Rating Systems			Type of Hazards Involved	Persons Effected	Control Measures
	Quantity (KL)	Pressure/ Temp	TLV (PPM)	STEL (PPM)	FP (^{O}C)			
Dimethyl Formamide	30	NTP	10		58	Flammable liquid and vapor Harmful in contact with skin Causes serious eye irritation Harmful if inhaled	Operators Maintenance Technicians	Avoid exposure - obtain special instructions before use. Avoid contact with skin and eyes. Avoid inhalation of vapor or mist. Keep away from sources of ignition - No smoking.Take measures to prevent the buildup of electrostaticcharge. Wear respiratory protection. Avoid breathing vapors', mist or gas. Ensure adequate ventilation.
Methanol	20	NTP	1000	1000	14	Highly flammable liquid and vapor.	Operators Maintenance Technicians	Keep away from heat/sparks/open flames/hot surfaces. Use personal protective equipment. Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Remove all sources of ignition. Evacuate personnel to safe areas.
Dichloromethane	20	NTP	50		13	Limited evidence of a carcinogenic effect.	Operators Maintenance Technicians	Do not breathe gas/fumes/vapor/spray.Avoid contact with skin and eyes Wear suitable protective clothing and gloves.Store in cool place. Keep container tightly closed in a dry and well-ventilated place. Containers which areopened must be carefully resealed and kept upright to prevent leakage.
Toluene	20	NTP	200		4	Highly flammable liquid	Operators	Keep away from

						and vapor. May be fatal if swallowed and enters airways. Causes skin irritation May cause drowsiness or dizziness. May cause damage to organs through prolonged or repeated exposure	Maintenance Technicians	heat/sparks/open flames/hot surfaces. - No smoking. Avoid breathing dust/ fume/ gas/ mist/ vapors/ spray. Use personal protective equipment as required. IF SWALLOWED: Immediately call a POISON CENTER or doctor/ physician.Do NOT induce vomiting. Use personal protective equipment. Avoid breathing vapors, mist or gas. Ensure adequate ventilation

7.8Disaster Management Plan *(Terms of Reference No. 7(xiii))*

7.8.1 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 level, 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 expansion will store fuels, which are flammable in nature, and the storage will be as per the Controller of Explosives and OISD norms. The hierarchy of the employees is yet to be determined 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.

7.8.2 Objectives of Emergency Management Plan (ON-SITE)

(Terms of Reference No. 7(xiii)

ON-SITE EMERGENCY PLAN is a strategy well evolved, organized and rehearsed, to utilize internal resources of the factory with minimal dependence on outside agencies for the following purposes;

1. To rescue causalities
2. To contain the loss and damage to property and environment.
3. To protect the limbs and life of personnel not directly affected by the disaster.
4. To ensure that absolute normal safety and security is achieved within the shortest time.
5. To prevent recurrence of such a disaster.
6. To establish a machinery for review, rectification or modification of the Emergency Plan in the light of actual experience.

Essentials of On-Site Emergency

1. To identify specifically the various emergencies like fire, explosion, leakage, poisoning, risk of life within and without the premises, damage to plant and property within and outside, the factory arising out of abnormalities in operation, maintenance, shutdown, startup, failure or equipment and use of substandard or wrong materials necessitated whether by normal methods of production, or stoppage, or natural disasters or civil and military commotions etc.

2. To describe such emergencies to all the personnel within the factory, to evolve distinct methods of communication to signify different emergencies and emergency plans such as fire and firefighting, fire and evacuation, fire and shutdown of the plant, fire and cut off of power, etc.

3. A procedure to meet such emergencies including evacuation of personnel, removal or salvage of property and hazardous materials.

4. A system of periodic mock demonstration and rehearsal of the Emergency plan to evolve the effectiveness of the plan and also to refresh the personnel to be able to meet the actual situation.

5. A system to draw upon help from outside agencies, private, public and state and to evolve a suitable co-coordinating agency always assuming that such help is not always likely to be available immediately or to the extent required.

A procedure to make available factual information to the mass media and to the statutory authorities.A procedure to simultaneously collect and record as much factual information as possible about the events leading to disaster and the failures in the implementation of the Emergency Plan.

Main elements of the On-Site Emergency Plan are given in the following paragraphs

Identification of Hazard Chart:
Area, place and type of likely hazard are indicated on site plan.

Key Persons:
Site controller, Incident controller, Damage controller Shift In-charge, Communications Officer, Liaison Officer, Plant in-charge, are designated and specific duties for each, in case of emergency are laid out.

Emergency Control Centre:
The present Duty Security Office is considered as, Emergency Control Centre and marked on the site plan. The control centre is the focal point in case of an emergency from where the operations to handle the emergency are directed and coordinated. It contains site plan, external & internal telephone connections loud speaker, torches, list of essential telephone

numbers, list of key persons and their addresses, a copy of the chemicals Data sheet for the factory.

Assembly Points:

Assembly points are set up as given on the site plan farthest from the location of likely hazardous events, where predestinated persons from the works, contractors and visitors would assemble in case of emergency. Up to date lists are available at these points so that roll call could be taken. Pre-designated persons would take charge of these points and mark presence as the people come into it.

Procedure to meet emergency:

The responsibilities of management and staff and the action to be taken in an emergency situation is given in the following paragraphs.

Communication System:

During an emergency involving total electricity failure the telephone & intercom system may not work hence **Communication Officer** should appoint runner / messengers detailed for specific jobs.

EMERGENCY ALARM - An audible emergency alarm system will be given by actuating **wailing alarms 30 seconds on, 5 seconds off continuously for 3 min**. The Alarm signifies that it is an emergency and emergency services should be put into operation. On hearing the alarm, the Incident Controller will communicate through the Telephone Operator with the staff about the nature of emergency and give specific instructions for evacuation, etc. either for localized evacuation or for few Departments or for all the Departments.

Service and Control:

i) EMERGENCY SERVICES The facilities of firefighting, first aid and rescue, power supply for operating the pumps, security services are considered as emergency services.

ii) CONTROL CENTRE - 'Security Officer's room contains.

1. External and Internal Telephones
2. A plan of the works to illustrate

a. Areas where there are large inventories of hazardous materials.

b. Sources of safety equipment

c. Fire hydrant system and alternator supply source

d. Stock of other fire-fighting materials

e. Works entrance and road system, update

f. Assembly points, first-aid centre.

3. Additional plans on which may be illustrated during emergency.

a. Areas affected / endangered

b. Development of emergency vehicles and personnel

c. Areas where particular problems arise, e.g. fractured pipe-lines.

d. Areas evacuated.

4. Nominal Roll of Employees.
5. List of key persons and their addresses with telephone numbers.
6. Note pads, pencils, etc., to record messages received and any instruction to be passed on through runners.

6. Roll Call - Boards, listing the names of all person's department wise and shift wise should be placed in the allocated places called assembly points. All personnel including visitors & contractor's men, except those who are detailed to fight emergency or to man such services, shall proceed to such allocated points as soon as an evacuation is ordered orally by the section in charge and roll call taken. The assembly point in charge shall report to control room immediately any absentee unaccounted-for persons. He will also keep the group until advised to move or return on work by the Site Controller or any other person pre-nominated by him.

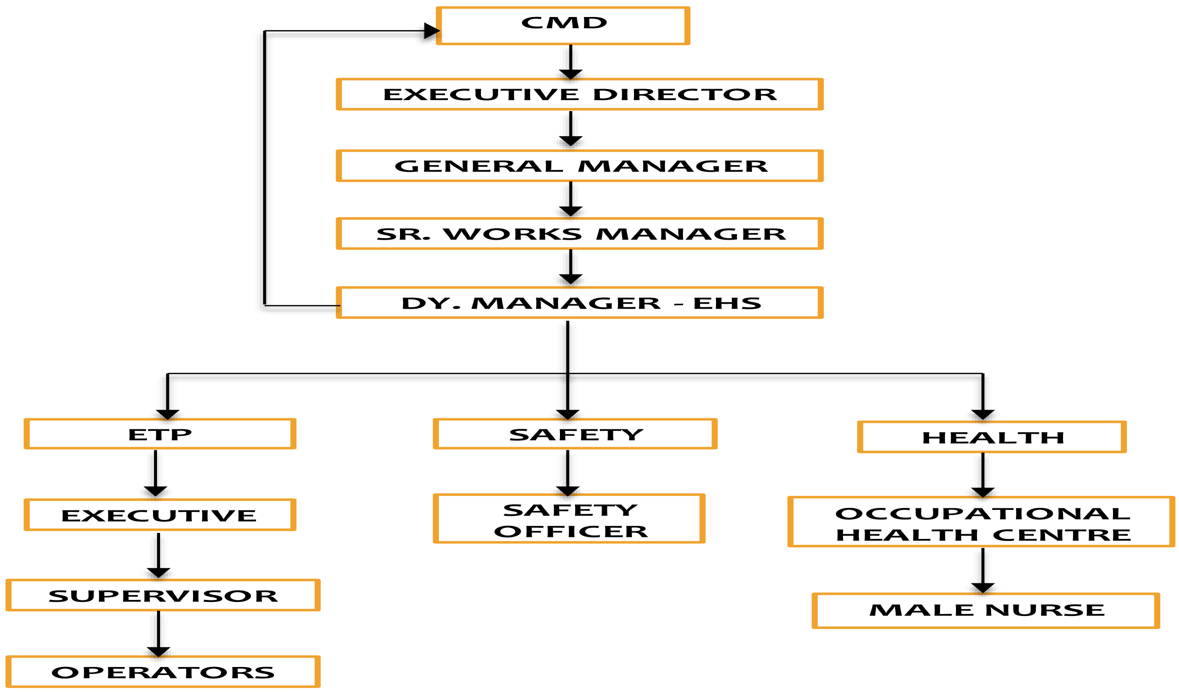

Fig 7.7 Organ gram of the Environment Management Cell

7.8.2.1 Emergency Squad Members

I.RESPONSIBILITIES DURING GENERAL DUTY HOURS.

1.Senior Works Manager: Site Controller

Sr. Works Manager or in his absence Production Manager, will retain overall responsibility for the factory and its personnel. As soon as he is informed of the emergency he shall proceed to the site and thereon to Emergency Control Room. His duties shall be;

i. Assess the magnitude of the situation and decide if staff needs to be evacuated from their assembly points.

ii. Exercise direct operational control over areas other than those affected.

iii. Maintain a continuous review of possible development and assess in consultation with Incident Controller and other key personnel as to whether shutting down of the plant or any section of the plant and evacuation of persons is required.

iv. Control rehabilitation of affected areas on discontinuation of emergency.

v. Issue authorized statements to news media and ensures that evidence is preserved for enquiries to be conducted by statutory authorities.

i. Is required to report to Managing Director appropriately.

Location of Operation: Emergency Control Room.

2.Production Manager: Incident Controller

Production Manager or in his absence Plant Manager In Charge will act as Incident Controller. On hearing of an emergency, he will rush to the scene of the occurrence and take overall charge and report to Site Controller. On arrival he will assess the scale of emergency and decide if major emergency exists or is likely to arise and inform the Communication Officer accordingly. He will –

i Direct all operations within the affected areas with the priorities for safety of personnel, minimize damage to the plant, property and environment and minimize loss of materials

ii Pending arrival of Site Controller, assume the duties of his post and in particular

  a Direct the shutting down and evacuation of plant and areas likely to be adversely affected by the emergency

  b Ensure that all key personnel and outside help is called in

iii Provide advice and information to the local Fire Service as and when they arrive.

iv Ensure that all non-essential workers / staff of the areas affected are evacuated to the appropriate assembly points, and the areas are searched for casualties

v In the event of failure of electric supply and internal telephones, set up communication point and establish contact with Emergency Control Centre

vi Report on all significant developments to the Communication Officer

vii Have regard to the need for preservation of evidence so as to facilitate any enquiry into the causes and circumstances which caused or escalated the emergency

3.Manager Administration: Liaison Officer

Has specific responsibility for all matters associated with Personnel Security and Communications where it involves telephones or fax machines, and has managers reporting to him on each of these disciplines.

He reports directly to the Site Controller) and is required and authorized to implement his decisions as well as any of his own which reflect the overall Onsite Emergency Plan.

He will work as Liaison Officer and will be stationed at the Main Entrance (Gate House) during the emergency. He will under the direction of the Site Controller handle police, press and other enquiries, receive reports from roll-call leaders from assembly points and pass on the absentee information to the Incident Controller. His responsibilities shall include:

i. Ensuring that casualties receive adequate attention, to arrange additional help if required and inform relative(s).
ii. Controlling traffic movements into the factory with the help of MaterialsDepartment and ensuring that alternate transport is available when the need arises.
iii. When emergency is prolonged, arrange for the relief of personnel and organize refreshments / catering facility.

4. **Manager (SHE)**: **Damage Controller:** Will act as Damage controller and will ensure all safety & fire equipment are available

5. Accountant: Has specific responsibilities for matters associated with Finance and Management Systems (Computers) and has Managers reporting to him on each of these disciplines.

6. Security Officer: On hearing the emergency intimation from any Department she will immediately contact Site Controller and on the advice call the local fire-brigade. In case, internal / external telephone system becomes in-operative she shall inform the Security Officer through a messenger / runner. In case fire is discovered but no alarm is sounded she shall receive information about location from the person discovering the fire and thereafter immediately consult the Site Incident Controller and make announcement through telephone telling the staff about location of the incident and to evacuate to their assembly points. She will continue to operate the switch board advising the callers that staff are not available and pass all calls connected with the incident to the Communications Officer.

Security Officer will act will be responsible for firefighting / rescue operations. On hearing the fire alarm, he will reach the fire station immediately and advise security staff in the factory of the incident zone and cancel the alarm. He will open the gates nearest to the incident and standby to direct the emergency services. He shall inform the Incident Controller by telephone and stand by the telephone to receive further messages. He will also liaise with Senior Officials of Police, Fire Brigade, Factory Inspectorate, provide advice on possible effect on areas outside the factory premises. He will also -

i) Advise the Site Controller of the situation and recommend (if necessary) evacuation of staff from assembly points.

ii) Recruit suitable staff to act as runners between the Incident Controller and himself if the telephone and other system of communication fails due to whatsoever reasons.

iii) Maintain prior agreed inventory in the control center.

iv) Maintain a log of the incidents.

v) In case of prolonged emergency involving risk to outside areas by wind-blown materials - contact local Meteorological Office to receive early notification of changes in weather conditions.

II. RESPONSIBILITIES DURING SHIFT HOURS

A. SHIFT INCHARGE / NIGHT DUTY OFFICER

1. Immediately he becomes aware of the emergency and its location he will proceed to the scene. On arrival he shall assess the scale of the incident and direct all operations within the affected areas with the following priorities:
   i) Secure the safety of persons, which may require evacuation to the assembly points.
   ii) Minimize damage to plant, property and the environment.
   iii) Minimize loss of materials.
   iv) Have regard to the need for preserving evidence that would facilitate subsequent enquiry.
2. Inform shift engineer in-charge as to what service are/not required.
3. Hand over charge of operations to the Incident Controller when he arrives on the scene.

4. Advise the Security Office at Gate House whether to make an announcement and if he considers necessary to call the TOTAL EMERGENCY SQUAD to the Factory.

B. SECURITY OFFICER / SUPERVISOR

On hearing the alarm, he shall rush to the Gate House and advise the security staff in the factory of the incident zone. He shall cancel the Emergency alarm and on advise of shift In-charge inform the local fire brigade.

1) Announce over Internal Telephone in which zone the incident has occurred, and on the advise of the Shift In-charge, tell the staff to evacuate the assembly points.
2) Open the gates nearest to the incident and standby to direct the emergency services.
3) If told of a large escape of gas, inform the Shift In-charge.
4) Call out in the following order :-
   i) Incident Controller or his nominated deputy.
   ii) Plant Operations Incharge
   iii) Liaison Manager

C. Liaison Manager

On his arrival he will keep roll call lists for the fire and first-aid teams on duty. Roll call leaders and first-aiders are appointed by each Departmental Head for his shift-team. Roll call leaders shall check their rolls as members of the services report for emergency duty. Names of any unaccounted for absentees will be informed to the Security Officer.

D. First Aiders

Members of First-Aid Teams will report to the Shift Incharge/Incident Controller on hearing of the alarm. The Ambulance driver, if safe to do so, shall collect the ambulance and park nearest of the scene of the accident. Should it become necessary for the ambulance to leave the site, the first aiders in inform incident controllers Shift-In-charge (if incident controller has not arrived till then) that the ambulance is leaving the site, giving the name of the patient and destination i.e. hospital or doctor's room and advising them about the casualities reaching there.

E. Factory Fire Brigade

The duty Security Guards under the command of the Security Officer shall be responsible for fire fighting and rescue. On hearing the alarm they shall proceed to the place of incident, if known, otherwise to the Fire Station. The men at Fire-Station shall find out the location of the emergency, man the equipment and proceed to the site of occurrence. At the incident scene squad members will respond to the advice and information given by the Incident Controller (shift In-charge if Incident Controller has not arrived till then). On arrival of the local fire brigade, they will also assist in fire-fighting work with the advice of the Incident Controller.

The designated officials will carry out the emergency function till the arrival of Site Controller and Incident Controller, in the event of the emergency going out of control.

III.POST- EMERGENCY OPERATION

A. ALL CLEAR SIGNAL

In the event of the emergency brought under control and if in the opinion of Site Controller that everything is safe, he will instruct for 'All Clear' Signal indicated by continuous alarm for 2 minutes.

B. Salvage Operations: Upon declaring All Clear Signal, the following actions will be carried out by Site Emergency Team.

C. Affected Area: Will not be tampered with until investigation is carried out by Plant In Charge) or Committee formed by the Management. Damaged material will not be handled by anybody, unless it is certified by the Emergengy Squad to be safe to remove after analyzing the hazardous nature and after confirming the compliance of any statutory requirements.

D. Liaison Manager: He will carry out attendance particulars from the respective Departments with the assistance of Department Heads co-related with those available at Assembly points.

All the necessary written official intimation will be carried out within the stipulated timings. Any official declarations to Press, Radio and other PR Agencies will be released by him.

E. Accountant: He will immediately communicate to Insurance Authorities to take stock of the situation and take necessary photos to facilitate other formalities as required for settlement of claims.He will also submit necessary reports as required by Finance Department for expediting damage claims

H. Security Officer: He will ensure that all the affected area/areas concerned are kept off till a clearance is given by General Manager for normal Operation or rectification work.

I Firefighting Facilities

Table 7.21 List of Fire Extinguishers

S.No	Description of Item	Quantity
1.	6 KGS ABC Fire Extinguishers	75 Nos.
2.	50 KGS Foam Fire Extinguishers	2 Nos.
3.	25KGS DCP Fire Extinguishers	2Nos.
4.	6.5KGS CO2 Fire Extinguishers	5 Nos.
5.	Foam Containers	1000 Nos.

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 charge of security coordinator.

7.8.2.2 Emergency Procedures

a) Procedure for Raising Emergency alarm

Whenever and whoever notices an emergency or a situation with a potential emergency should forthwith 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.

b) 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 who ever are available in the shift.

c) 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.

d) 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 wailing for 3 minutes. When the emergency has been brought under control, the Emergency controller will direct plant control staff giving an 'all clear signal', by way of normal siren (continuously for 3 minutes).

7.8.2.3 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.

a) 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.

b) 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 shut down, firefighting 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.

c) 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 coordinator initiates and authorizes such review as and when required, and the changes if any will be duly informed to all the employees concerned.

EMERGENCY RESPONSE TEAM

ANNEXURE – I

Name of the Member		**Designation**
01) Mr.P.DIGAMBER	-	Works Manager – **Site Controller**
02) Mr. M.C. Roy	-	Production Manager - **Incident Controller**
03) Mr.K.RameshBabu	-	Manager - Admin – **Liaison Officer**
04) Mr.G.Ganesh Kumar	-	Dy.Manager - (EHS) - **Damage Controller**
05) Mr. K. Srinivas	-	Manager Maintenance-**Communication Officer**

Members

06) B. Ramesh	-	Manager - Electrical
07) P. Krishnam raju	-	Manager Stores
08) Kutumba Rao	-	Supervisor Electrical
09) Parameswara Rao	-	Asst.manager QA
10) Durga Rao	-	Sr.Chemist- QA
11) Srisailam	-	Operator Plant IV
12) S.A.Khan	-	Security Supervisor
13) J. Ramarao	-	Supervisor (EHS)
14) M.Peddi Raju	-	Executive (QMS)

15) Duty Security Officer

16) Shift Incharge

17) Fire Fighting Team (Trained Security Guards)

18) First Aiders (Trained Employees)

19) Telephone Operator