

CHAPTER – VI

HAZARD ANALYSIS AND RISK ASSESSMENT

6.1 INTRODUCTION

M/s Basis Laboratories deal with materials, some of which are hazardous in nature by virtue of their intrinsic chemical properties or their operating temperatures or pressures or a combination of these. Fire, explosion, toxic release or combinations of these are the hazards associated with industrial plants using hazardous chemicals. More comprehensive, systematic and sophisticated methods of Safety Engineering, such as, Hazard Analysis and Quantitative Risk Assessment have now been developed to improve upon the integrity, reliability and safety of industrial plants. The primary emphasis in safety engineering is to reduce risk to human life, property and environment. Some of the more important methods used to achieve this are: Quantitative Risk Analysis: Provides a relative measure of the likelihood and severity of various possible hazardous events by critically examining the plant process and design. Work Safety Analysis: Safety Audit: Takes a careful look at plant operating conditions, work practices and work.

6.2 RISK ASSESSMENT

A three levels' risk assessment approach has been adopted for the **M/s Basis Laboratories** facilities. The risk assessment levels are generally consistent with the practices encountered through various assignments for medium and large chemical complexes.

The brief outline of the three tier approach is given below:

6.2.1 Level 1 – Risk Screening

This is top-down review of worst- case potential hazards/risks, aimed primarily at identifying plant sites or areas within plant, which pose the highest risk. Various screening factors considered include: Inventory of hazardous materials; Hazardous Materials properties; Storage conditions (e.g. temperature and pressure); Location sensitivity (distance to residential areas / populace).

6.2.2 Level 2 – Major Risk Survey [Semi – Quantitative]

The survey approach combines the site inspection with established risk assessment techniques applied both qualitative as well quantitative mode. The primary objective is to identify and select major risks at a specific location in the plant considering possible soft spots / weak links during operation / maintenance. Aspects covered in the risk usually include: Process Hazards; Security Vulnerability; Impact of hazards consequences (equipment damage, business interruption, injury, fatalities); Qualitative risk identification of scenarios involving hazardous materials; Risk reduction measures. Selection of critical scenarios and their potential of damage provide means of prioritizing. Mitigative measures and allocate the resources to the areas with highest risks.

6.2.3 Level 3 – Quantitative Risk Assessment [Deterministic]

This is the stage of assessment of risks associated with all credible hazards [scenarios] with potential to cause an undesirable outcome such as human injury, fatality or destruction of property. The four basic elements include:

- **Hazards identification** utilizing formal approach [Level 2, HAZOP etc.]
- **Frequency Analysis.** Based on past safety data (incidents / accidents); identifying likely pathway of failures and quantifying the toxic / inflammable material release;
- **Hazards analysis to quantify** the consequences of various hazards scenarios [fire, explosion, BLEVE, toxic vapour release etc.]. Establish minimum value for damage [e.g. IDLH, over pressure, radiation flux] to assess the impact on environment.
- **Risk Quantification:** Quantitative techniques are used considering effect / impact due to weather data, population data, and frequency of occurrences and likely hood of ignition / toxic release. Data are analyzed considering likely damage [in terms of injury / fatality, property damage] each scenario is likely to cause.

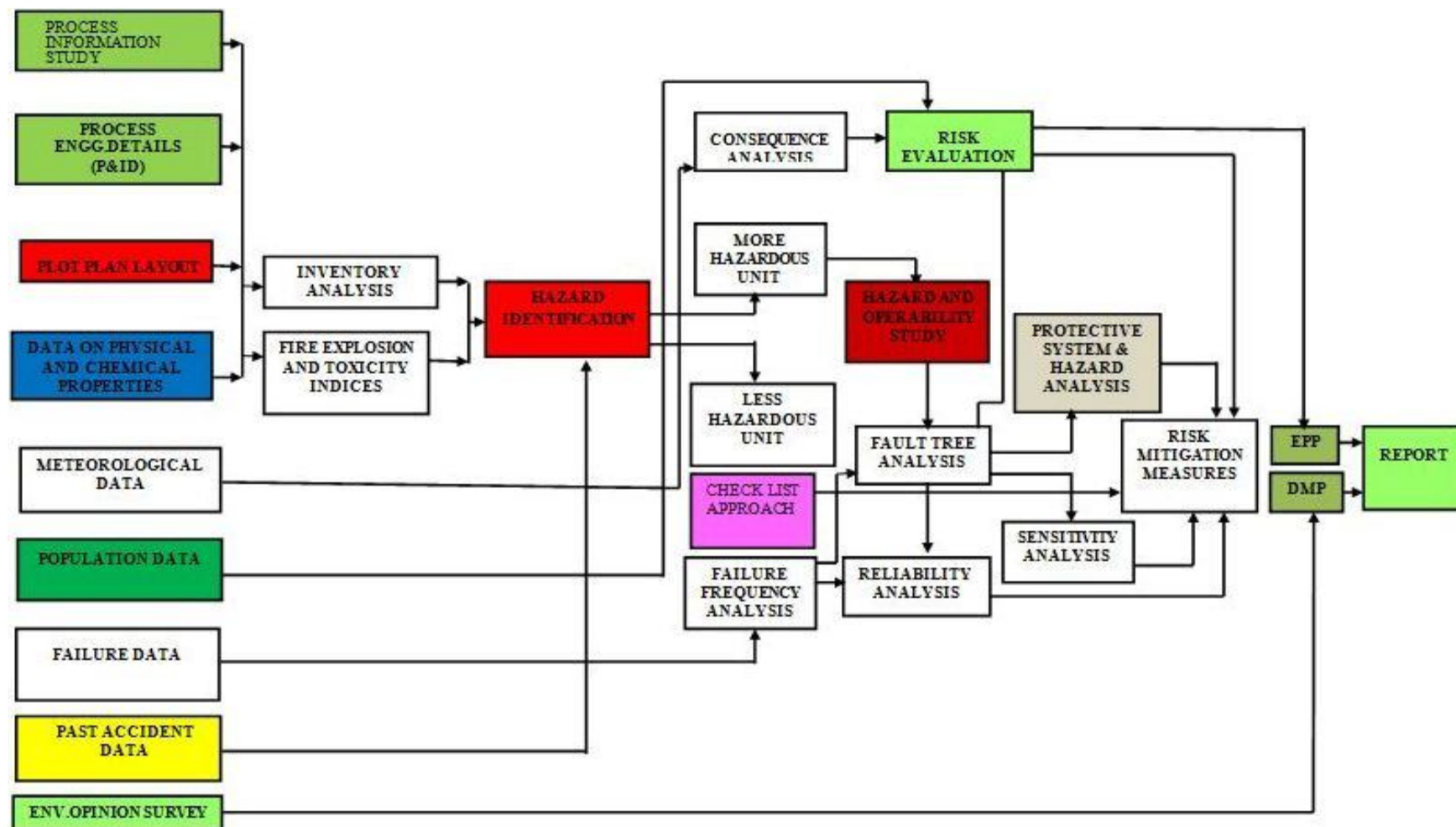
FIGURE 6.1: COMPREHENSIVE RISK ASSESSMENT – AT A GLANCE

TABLE: 6.1. DETAILS OF STORAGE OF RAW / HAZARDOUS MATERIALS AND CONTROL MEASURES

S.NO	NAME OF RAW MATERIAL	PHYSICAL STATE	TYPE OF STORAGE	MAX. QUANTITY OF STORAGE AT ANY POINT OF TIME [Tons]	PLACE OF STORAGE	STATE & OPERATING PRESSURE TEMPERATURE	POSSIBLE TYPE OF HAZARDS	CONTROL MEASURES PROVIDED
1	1,3 – Difluoro benzene	Liquid	HDPE Drums	1.000	Stores	Ambient	Flammable	Stored in well ventilated separate storage room/Storage Shed. Stored on identified suitable drums. Drums are stacked on pallets with proper identification and compatibility.
2	Chloro acetyl chloride	Liquid	HDPE Drums	0.500	Shed	Ambient	Corrosive	
3	Acetic acid	Liquid	HDPE Drums	0.500	Shed	Ambient	Corrosive	
4	Aluminium chloride	Solid	PP Bags	0.500	Stores	Ambient	Corrosive	
5	Potassium hydroxide	Solid	PP bags	0.500	Stores	Ambient	Corrosive	
6	1,2,4 -Triazole	Solid	Fibre Drums	0.500	Stores	Ambient	Harmful	
7	Tri ethyl amine	Liquid	HDPE Drums	1.000	Stores	Ambient	Flammable	
8	TMSI	Solid	Fibre Drums	0.250	Stores	Ambient	Irritant	
9	Potassium carbonate	Liquid	PP Bags	0.250	Stores	Ambient	Corrosive	
10	Hydrochloric acid	Liquid	HDPE Carboys	0.250	Shed	Ambient	Corrosive	
11	Magnesium sulfate	Solid	Fibre Drums	0.250	Stores	Ambient	Harmful	
12	Activated carbon	Solid	PP Bags	0.100	Shed	Ambient	Combustible	
13	L - Menthol	Solid	Fibre Drums	0.500	Stores	Ambient	Irritant	
14	Glyoxalic acid	Solid	Fibre Drums	0.250	Stores	Ambient	Corrosive	
15	Sulphuric acid	Liquid	HDPE Carboys	0.250	Shed	Ambient	corrosive	

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16	Formaldehyde	Liquid	HDPE Drums	0.250	Shed	Ambient	Corrosive	Stored in well ventilated separate storage room/Storage Shed. Stored on identified suitable drums. Drums are stacked on pallets with proper identification and compatibility.
17	1,4 –Dithiane-2,5-diol	Liquid	HDPE Drums	0.250	Shed	Ambient	Flammable	
18	Methyl sulfonic acid	Liquid	HDPE Drums	0.250	Shed	Ambient	Corrosive	
19	Thionyl chloride	Liquid	GI Drums [PP]	0.500	Shed	Ambient	Corrosive	
20	Cytosine	Solid	Fibre Drums	0.250	Stores	Ambient	Harmful	
21	HMDS	Liquid	HDPE Drums	0.250	Shed	Ambient	Flammable	
22	Di potassium hydrogen phosphate	Solid	Fibre Drums	0.250	Stores	Ambient	Harmful	
23	Sodium boro hydride	Solid	MS Drums	0.100	Stores	Ambient	Flammable	
24	Salicylic acid	Solid	Fibre drums	0.250	Stores	Ambient	Corrosive	
25	Sodium hydroxide	Solid	PP bags	0.500	Stores	Ambient	Corrosive	
26	OTBN	Solid	Fibre Drums	0.500	Stores	Ambient	Harmful	
27	Sodium azide	Solid	Fibre Drums	0.150	Stores	Ambient	Flammable	
28	Sodium nitrite	Solid	Fibre Drums	0.150	Shed	Ambient	Harmful	
29	Trityl chloride	Solid	Fibre Drums	0.250	Stores	Ambient	Corrosive	
30	N-Bromo succinimide	Solid	Fibre drums	0.250	Stores	Ambient	Corrosive	
31	SMBS	Solid	Fibre Drums	0.200	Stores	Ambient	Corrosive	
32	BCFI	Solid	Fibre Drums	0.500	Stores	Ambient	Harmful	
33	TBAB	Solid	Fibre Drums	0.150	Stores	Ambient	Corrosive	
34	DMA .HCl	Solid	Fibre Drums	1.500	Stores	Ambient	Corrosive	

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35	N-Cyano guanidine	Solid	Fibre Drums	1.500	Stores	Ambient	Harmful	
36	2- Acetyl phenol	Liquid	HDPE Drums	0.500	Stores	Ambient	Flammable	
37	Benzoyl chloride	Liquid	HDPE Drums	0.500	Stores	Ambient	Corrosive	
38	Sodium carbonate	Solid	PP bags	0.250	Shed	Ambient	Irritant	
39	Bromine	Liquid	Glass Bottles	0.250	Shed	Ambient	Corrosive	
40	MMA [Water]	Liquid	HDPE Drums	0.500	Shed	Ambient	Flammable	
41	Palladium carbon	Solid	MS Drum	0.025	Stores	Ambient	Flammable	
42	Hydrogen	Gas	MS Cylinders	10 No.S	Shed	Ambient	Flammable	
43	L[+] Tartaric Acid	Solid	Fibre Drums	0.500	Stores	Ambient	Corrosive	
44	Di hydroxyl succinate							
45	Liquid Ammonia	Liquid	HDPE Drums	0.250	Shed	Ambient	Corrosive	
46	2,3-Lutidine	Liquid	HDPE Drums	0.500	Shed	Ambient	Flammable	
47	Hydrogen peroxide[50%]	Liquid	HDPE Carboys	0.200	Shed	Ambient	Corrosive	
48	Nitric acid	Liquid	AL.Cans	0.200	Shed	Ambient	Corrosive	
49	3-Methoxy -1-propanol	Liquid	HDPE Drums	0.250	Shed	Ambient	Flammable	
50	2-Mercaptobenzimidazole	Solid	Fibre Drums	0.200	Stores	Ambient	Harmful	
51	Methyl – 4 – (butyramido)-3-methyl-5-nitrobenzene	Solid	Fibre Drums	0.200	Stores	Ambient	Harmful	
52	N-Methylbenzene-1,2-diamine	Liquid	HDPE Drums	0.500	Shed	Ambient	Harmful	

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53	Poly phosphoric acid	Liquid	HDPE Drums	0.200	Shed	Ambient	Corrosive	Stored in well ventilated separate storage room/Storage Shed. Stored on identified suitable drums. Drums are stacked on pallets with proper identification and compatibility.
54	Methyl -4-methyl-1,1-biphenyl-2-carboxylate	Liquid	HDPE Drums	0.250	Shed	Ambient	Corrosive	
55	AIBN	Solid	Fibre Drums	0.025	Stores	Ambient	Harmful	
56	P-formaldehyde	Solid	PP Bags	0.250	Stores	Ambient	Corrosive	
57	Bromo anisole	Liquid	HDPE Drums	1.000	Shed	Ambient	Corrosive	
58	Magnesium	Solid	Fibre Drums	0.150	Stores	Ambient	Combustible	
59	Beta thymidine	Solid	Fibre Drums	0.250	Stores	Ambient	Harmful	
60	Methyl sulfonyl chloride	Liquid	HDPE Carboys	0.250	Shed	Ambient	Corrosive	
61	Ammonium chloride	Solid	PP Bags	0.200	Stores	Ambient	Corrosive	
62	4-Chloro benzhydryl chloride	Liquid	HDPE Carboys	0.500	Stores	Ambient	Corrosive	
63	Piperazine	Solid	Fibre Drums	0.500	Stores	Ambient	Corrosive	
64	2-Chloro ethane	Liquid	HDPE Drums	0.250	Shed	Ambient	Flammable	
65	SMCA	Solid	PP Bags	0.200	Stores	Ambient	Corrosive	
66	Methyl Dopa	Solid	HDPE Drums	0.500	Stores	Ambient	Harmful	
67	Boric acid	Solid	HDPE Drums	0.200	Stores	Ambient	Corrosive	

SOLVENTS

S.NO	NAME OF RAW MATERIAL	PHYSICAL STATE	TYPE OF STORAGE	MAX. QUANTITY OF STORAGE AT ANY POINT OF TIME	PLACE OF STORAGE	STATE & OPERATING PRESSURE TEMPERATURE	POSSIBLE TYPE OF HAZARDS	CONTROL MEASURES PROVIDED
1	MDC	Liquid	MS Drums	4.000	Shed	Ambient	Harmful	Stored in well ventilated separate storage room/Storage Shed. Stored on identified suitable drums. Drums are stacked on pallets with proper identification and compatibility. Bulk Quantities are stored in storage tanks.
2	Ethyl acetate	Liquid	MS Tank	10.000	Open	Ambient	Flammable	
3	Toluene	Liquid	MS Tank	10.000	Open	Ambient	Flammable	
4	IPA	Liquid	MS Tank	10.000	Open	Ambient	Flammable	
5	Acetone	Liquid	MS Tank	10.000	Open	Ambient	Flammable	
6	Tetra hydro furan	Liquid	HDPE Drums	3.000	Shed	Ambient	Flammable	
7	DMF	Liquid	HDPE Drums	3.000	Shed	Ambient	Flammable	
8	Methanol	Liquid	HDPE Drums	3.000	Shed	Ambient	Flammable	
9	MIBK	Liquid	HDPE Drums	3.000	Shed	Ambient	Flammable	
10	1,4-Dioxane	Liquid	HDPE Drums	3.000	Shed	Ambient	Flammable	
11	Cyclohexane	Liquid	HDPE Drums	2.000	Shed	Ambient	Flammable	
12	Ethyl alcohol	Liquid	HDPE Drums	3.000	Shed	Ambient	Flammable	

6.3 SOLVENT STORAGE TANKS /DRUMS HANDLING PRECAUTIONS

Drums

MDC will be transferred to the day tank situated at the production block with the help of AOD pump through pipe lines from the drums. From day tank to reaction vessel unloading by gravity.

Other Solvents will be transferred to the Reaction vessel through pipe lines from the drums with vacuum

Storage Tanks

Solvent will be transferred to the day tank situated at the production block with the help of mechanical seal pump through pipe lines from the tank, from day tank to reaction vessel unloading by gravity.

Tank is connected to chilled water circulated condenser with reflux system

Measures to Avoid Evaporation

Flammables area, keep containers tightly closed.

Keep away from heat, sparks, and flame

Keep away from sources of ignition

Store in a cool, dry, well ventilated area away from incompatible substances

Safety Systems

- Designated areas with proper indication & safety signs
- Double earthing systems
- Flame arrestor to the vent
- Flame proof transferring pumps
- Handling precautions/sop protocol
- Pressure Gauges
- Level indicators
- Flame proof lighting to storage yard

6.4 EFFECT AND CONSEQUENCE ANALYSIS

In a plant handling hazardous chemicals, the main hazard is due to storage, handling and use of these chemicals. If these chemicals are released into the atmosphere, they may cause damage due to resulting fires or vapor clouds. Last over pressures depend upon the reactivity class of material between two explosive limits.

Operating parameters

Potential vapor release for the same material depends significantly on the operating conditions especially for any liquefied gas, operating conditions are very critical to assess the damage potential. If we take up an example of ammonia, if it is stored at ambient temperature say 30°C, and then the vapor release potential of the inventory is much higher as compared to the case if it is stored at 0°C.

Inventory

Inventory analysis is commonly used in understanding the relative hazards and short listing of release scenarios. Inventory plays an important role in regard to the potential hazard. Larger the inventory of a vessel or a system, larger the quantity of potential release. The potential vapor release (source strength) depends upon the quantity of liquid release, the properties of the materials and the operating conditions (pressure, temperature). If all these influencing parameters are combined into a matrix and vapor source strength estimated for each release case, a ranking should become a credible exercise.

Loss of containment

Plant inventory can get discharged to environment due to Loss of Containment. Certain features of materials to be handled at the plant need to be clearly understood to firstly list out all significant release cases and then to short list release scenarios for a detailed examination. Liquid release can be either instantaneous or continuous. Failure of a vessel leading to an instantaneous outflow assumes the sudden appearance of such a major crack that practically all of the contents above the crack shall be released in a very short time. The more likely event is the case of liquid release from a hole in a pipe connected to the vessel. The flow rate will depend on the size of the hole as well as on the pressure, which was present, in front of the hole, prior to the accident. Such pressure is basically dependent on the pressure in the vessel. The vaporization of released liquid depends on the vapor pressure and weather conditions. Such consideration and others have been kept in mind both

during the initial listing as well as during the short listing procedure. In the study, Maximum credible loss accident methodology is to be used, therefore, the largest potential hazard inventories have been considered for consequence estimation.

Damage Criteria

In consequence analysis, use is made of a number of calculation models to estimate the physical effects of an accident (spill of hazardous material) and to predict the damage (lethality, injury, material destruction) of the effects. The calculations can roughly be divided in three major groups.

- Determination of the source strength parameters;
- Determination of the consequential effects;
- Determination of the damage or damage distances.

The basic physical effect models consist of the following.

Source strength parameters

- Calculation of the outflow of liquid, vapor or gas out of a vessel or a pipe, in case of rupture. Also two-phase outflow can be calculated.
- Calculation, in case of liquid outflow, of the instantaneous flash evaporation and of the dimensions of the remaining liquid pool.
- Calculation of the evaporation rate, as a function of volatility of the material, pool dimensions and wind velocity.
- Source strength equals pump capacities, etc. in some cases.

Consequential effects

- Dispersion of gaseous material in the atmosphere as a function of source strength, relative density of the gas, weather conditions and topographical situation of the surrounding area.
- Intensity of heat radiation [in kw/m^2] due to a fire or a BLEVE, as a function of the distance to the source.
- Energy of vapor cloud explosions [in kw/m^2], as a function of the distance to the distance of the exploding cloud.

- Concentration of gaseous material in the atmosphere, due to the dispersion of evaporated chemical. The latter can be either explosive or toxic.

It may be obvious, that the types of models that must be used in a specific risk study strongly depend upon the type of material involved:

- Gas, vapor, liquid, solid
- Inflammable, explosive, toxic, toxic combustion products
- Stored at high/low temperatures or pressure
- Controlled outflow (pump capacity) or catastrophic failure?

Selection of Damage Criteria

- The damage criteria give the relation between extent of the physical effects (exposure) and the percentage of the people that will be killed or injured due to those effects
- The knowledge about these relations depends strongly on the exposure. For instance, much more is known about the damage caused by heat radiation, than about the damage due to toxic exposure, and for these toxic effects, the knowledge differs strongly between different materials.

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

- Heat radiation, from a jet, pool fire, a flash fire or a BLEVE.
- Explosion
- Toxic effect, from toxic materials or toxic combustion products.

Heat Radiation

The consequence caused by exposure to heat radiation is a function of:

- The radiation energy onto the human body [Kw / m²]
- The exposure duration [sec]
- The protection of the skin tissue [clothed or naked body]

The limits for 1% of the exposed people to be killed due to heat radiation, and for second-degree burns are given in below:

DAMAGES TO HUMAN LIFE DUE TO HEAT RADIATION

EXPOSURE DURATION	RADIATION FOR 1% LETHALITY (KW/M ²)	RADIATION FOR 2 ND DEGREE BURNS (KW/M ²)	RADIATION FOR FIRST DEGREE BURNS, (KW/M ²)
10 sec	21.2	16	12.5
30 sec	9.3	7.0	4.0

Since in practical situations, only the own employees will be exposed to heat radiation in case of a fire, it is reasonable to assume the protection by clothing. It can be assumed that people would be able to find a cover or a shield against thermal radiation in 10 sec.time. Furthermore, 100% lethality may be assumed for all people suffering from direct contact with flames, such as the pool fire, a flash fire or a jet flame. The effects due to relatively lesser incident radiation intensity are given in below

EFFECTS DUE TO INCIDENT RADIATION INTENSITY

INCIDENT RADIATION KW/M ²	TYPE OF DAMAGE
0.7	Equivalent to solar radiation
1.6	No discomfort for long exposure
4.0	Sufficient to cause pain within 20 sec. Blistering of skin (first degree burns are likely)
9.5	Pain threshold reached after 8 sec. second degree burns after 20 sec.
12.5	Minimum energy required for piloted ignition of wood, melting plastic tubing etc.

Explosion

In case of vapor cloud explosion, two physical effects may occur:

- A flash fire over the whole length of the explosive gas cloud;
- A blast wave, with typical peak overpressures circular around ignition source.

As explained above, 100% lethality is assumed for all people who are present within the cloud proper.

For the blast wave, the lethality criterion is based on:

- A peak over pressure of 0.1 bars will cause serious damage to 10% of the housing/structures.
- Falling fragments will kill one of each eight persons in the destroyed buildings.

The following damage criteria may be distinguished with respect to the peak overpressures resulting from a blast wave:

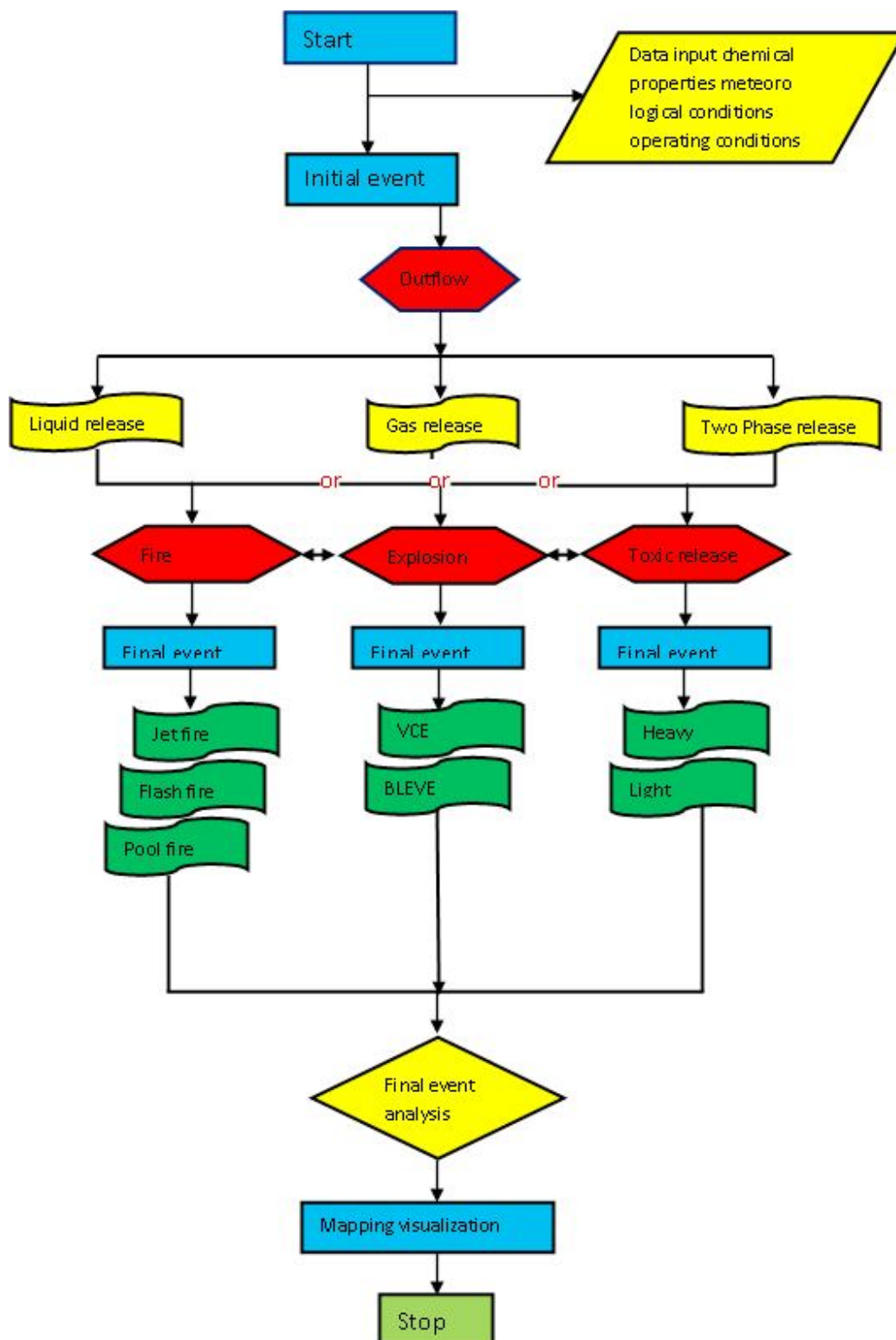
DAMAGE DUE TO OVERPRESSURES

PEAK OVERPRESSURE	DAMAGE TYPE
0.83 bar	Total destruction
0.30 bar	Heavy damage
0.10 bar	Moderate damage
0.03 bar	Significant damage
0.01 bar	Minor damage

From this it may be concluded that $p=0.17 \text{ E}+5 \text{ pa}$ corresponds approximately with 1% lethality. Furthermore it is assumed that everyone inside an area in which the peak overpressure is greater than $0.17 \text{ E}+5 \text{ pas}$ will be wounded by mechanical damage. For the gas cloud explosion this will be inside a circle with the ignition source as its centre.

FOR QUICK REFERENCE THE BEHAVIOR OF RELEASED CHEMICALS CAN
BE TRACED BY USING THE FIGURE.

BEHAVIOUR OF RELEASED CHEMICALS



OVERLAYS OF THE HAZARDS ZONES

- The overlays damage distances for following scenarios should be developed by using either mathematical calculations or by available computer models for consequence analysis:-



FIRE



EXPLOSION

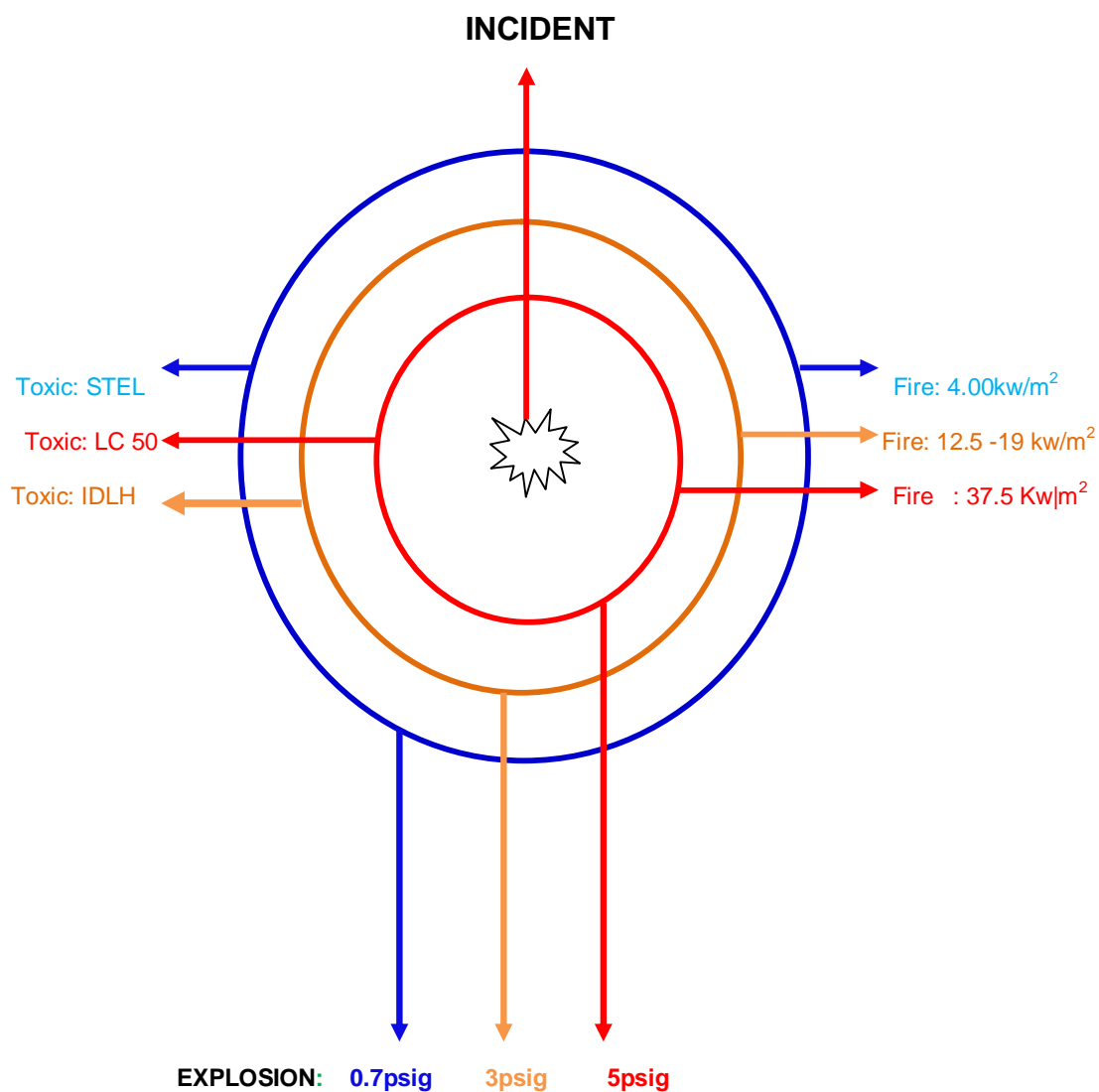


TOXIC

The overlays will have consequence maps will be shown in fig. with various color demarcations. Three colors should be used for the vulnerability mapping and people should be made aware by giving proper training on awareness programs.

RED ZONE	ORANGE ZONE	BLUE ZONE
Fire : 37.5 Kw/m ²	Fire: 12.5 -19 kw/m ²	Fire: 4.00kw/m ²
Explosion: 5Psig	Explosion: 3Psig	Explosion:0.7Psig
Toxic: LC 50	Toxic: IDLH	Toxic: STEL

The above zones for Fire, Explosion and Toxic concentration/zones should be used in Red, Orange and Blue color for the benefit of the responders within the plant and outside the plant



6.5 INCIDENTS IMPACT

The identified failure scenarios in plant have been analyzed for the impact zones considering damage due to thermal, explosive and toxic impacts. Each incident will have Impact on the surrounding environment which in extreme case may cross plant boundary.

6.6 SAFETY AT THE PROPOSED PLANT

6.6.1 System Specific Measures

The proposed plant will adopt various safety measures for handling and storage of hazardous materials.

Safety initiatives to be adopted at the proposed plant have been described below:

6.6.2 Occupational Health, Environment and Safety Policy

The plant will prepare Occupational Health, Environment and Safety Policy. The Occupational Health, Environment and Safety Policy will be displayed at locations prominently within the plant and will be circulated to all employees.

6.6.3 Environment, Health & Safety Organization

The HSE department will be managed by qualified, experienced and competent personnel and strict controls will be enforced for each hazardous activity

6.7 ACCIDENT REPORTING, INVESTIGATION AND ANALYSIS

A record for near-miss, incidents and accidents is and will be maintained and analyzed to take precautionary measures (Ref. Annexure - VII). All near-miss incidents and accidents will be reported and investigated to take corrective measures. The accident statistics and data will be maintained by Environment, Health & Safety Department. Accident statistics and data will be reviewed regularly by senior management to take corrective measures.

6.8 SAFETY INSPECTIONS AND INTERNAL AUDIT

General safety inspections will be carried out regularly at the proposed plant. Internal safety audit will also be conducted frequently.

6.8.1 Safety Education and Training

A. Safety Training

There will be provision at the plant for induction training for new workers. The assessment of the trainee will be done to ensure the effectiveness of training.

B. Periodic Training / Reporting

The workers will be trained as per need of training.

C. Safety Communication / Motivation / Promotion

The system for safety suggestion schemes will be implemented at the plant. There will be provision at the plant for the safety contests for motivation of safety at the plant.

6.8.2 First Aid

First aid boxes are and will be available within various departments. The first-aid room will be available and trained first aid will be available in each shift at the plant.

6.9 OCCUPATIONAL HEALTH

6.9.1 Occupational Health

Hazardous and toxic substances are defined as those chemicals present in the work place which are capable of causing harm.

[In this definition the term chemicals include dust, mixtures and common materials-solvents.]

- For handling hazardous chemicals and to take care of employee's health, and predictive maintenance looking to the nature of hazardous chemicals being handled/processed. All the equipments in the plant areas shall be inspected/tested by an outside agency.
- The various safety equipments like breathing apparatus and critical instrumentation provided on various equipments are inspected and tested frequently to ensure their operability all the time. Besides, all the first aid, fire fighting devices are also being inspected, tested and maintained by a competent third party and kept all the time in ready to use condition.
- Health of all the employees in plant area is regularly monitored by outside physician. If any abnormality is found necessary treatment is also being given time to time. Necessary history cards, records are also be maintained which is up-dated time to time.

6.9.2 Common Hazards

- Physical such as ventilation, poor illumination, noise, extreme temperature, humidity and radiation.
- Biological such as variety of pathogenic bacteria and parasites.
- Chemical due to hazardous gases and dusts.
- Ergonomic.

6.9.3 Industrial Hygiene Monitoring

- Industrial hygiene monitoring is to located and identify source of exposure in the workplace so that they can be corrected and to quantify the exposure of employees to chemicals in the air.
- Air monitoring is conducted by industrial hygienists or other person with specialized training he hygienist first record relevant data such as the process or activity sources of contamination and ventilation conditions then he or she uses special equipment to measure the levels of substance present in the workplace employees should be informed have a right to obtain monitoring results under the OSHA regulation.

6.9.4 Occupational Health Monitoring System

A. Air samples

Locations of samples – air samples are generally collected in one or three locations:

- At the breathing zone of the worker [Personal sample]
- In the general room air [Area sample]
- At the operation which is generating the hazardous substance [Area sample]

Lengths of samples – Air samples are generally collected for two lengths of time.

- Grab samples [instantaneous] measure conditions at one moment in time and can be likened to a still photograph. They give only a picture of conditions at one place at one instant in time.
- Continuous Samples [range from twenty minutes to 8 – 10 Hours]. These is used to evaluate all day exposure by a series of continuous samples. Continuous samples may be thought of as like a motion picture since they record activity taking place in various places over a period of time. They provide an average of conditions over a period samples.

B. Other sampling methods

Bulk samples

Bulk samples are collected from settled dust in the work place or from drums or bags of chemicals. Their purpose is to analyze and identify the substances present. For example, bulk samples are used to analyze the percent of asbestos in insulation or dust. Usually, a substance which is greater than one percent of bulk sample is considered a concern.

Wipe Samples

Wipe samples are used when skin absorption or ingestion is a suspected route of exposure. The purpose is to show whether skin, respirators, clothing, lunch rooms, lockers, etc. are contaminated.

It can show which surfaces are clean and which are contaminated. It can also show if some surfaces are more contaminated than others.

Sampling Devices

The general principle of sampling is to collect an amount of a contaminant onto a medium from a known quantity of air.

Air samples are collected using small pumps to suck air from the workroom. The pump is attached by tubing to a sampling device which contains the sampling medium; for example a glass tube containing charcoal.

The sampling method used depends on the physical form of the substance:

- DUSTS –The sampling device is a filter of plastic or paper in a holder:
- VAPORS –The sampling device is a glass tube containing activated charcoal as a medium.
- GASES –The sampling device is a bubbler containing a fluid medium to dissolve or react with the gas.

The collected sample are sent to a laboratory where the amount of the substance on the sampling medium [filter, tube, etc.] is measured.

In some cases air monitoring is conducted by using direct reading instrument such as a monitoring for carbon monoxide these instruments can measure the amount of a contaminant in the air immediately without being sent to a laboratory.

- **PELs [Permissible Exposure Limits]** – these are legal's limits which have been established by OSHA.
- **Recommended PELs** – also reference to as **RELs [Recommended Exposure Limits]** often these values are based on more recent scientific information than the legal PELs enforced by OSHA.
- **TLVs [Threshold Limit Values]** – These are exposure limits put out by a nongovernmental group, the **ACGIH [American Conference of Governmental Industrial Hygienists]**. Many of these were adopted as legal requirements. Revised TLVs are often based on the most recent and accurate scientific information.
- **Permissible Exposure Limits by OSHA [Occupational Safety and Health Administration]** when it started back in 1970.
- **IDLH [Immediate Dangerous to Life or Health]** limits are prescribed by **NIOSH [National Institute of Occupational Safety and Health]**

CHEMICAL EXPOSURE CONTROLS / PERSONAL PROTECTION

S. No	SOLVENT NAME	Exposure Standards			PROTECTION
		ACGIH [TLV]	OSHA [PEL]	NIOSH [IDLH]	
1	Acetic anhydride	5	5	200	Engineering controls, Ventilation and PPEs
2	Sodium hydroxide	2	2	10	Engineering controls, Ventilation and PPEs
3	Sulphuric acid	1	1	15	Engineering controls, Ventilation and PPEs
4	Formaldehyde	0.75	0.75	20	Engineering controls, Ventilation and PPEs
5	Hydrochloric acid	5	5	50	Engineering controls, Ventilation and PPEs
6	Liq.Ammonia	25	50	300	Engineering controls, Ventilation and PPEs
7	Hydrobromic acid	3	3	30	Engineering controls, Ventilation and PPEs
8	Hydrogen peroxide	1	1	75	Engineering controls, Ventilation and PPEs
9	Mono methyl amine	5	10	100	Engineering controls, Ventilation and PPEs
10	Bromine	0.1	0.1	10	Engineering controls, Ventilation and PPEs
11	Thionyl chloride	2	2	100	Engineering controls, Ventilation and PPEs

SOLVENTS

S. No	SOLVENT NAME	Exposure Standards			PROTECTION
		ACGIH [TLV]	OSHA [PEL]	NIOSH [IDLH]	
1	Methanol	200	200	6000	Engineering controls, Ventilation and PPEs
2	Toluene	50	100	500	Engineering controls, Ventilation and PPEs
3	Acetone	750	750	2500	Engineering controls, Ventilation and PPEs
4	Ethyl acetate	250	250	2000	Engineering controls, Ventilation and PPEs
5	MDC	25	125	2000	Engineering controls, Ventilation and PPEs
6	IPA	400	400	2000	Engineering controls, Ventilation and PPEs

Notes:

- All the above Values are in **ppm**

- Engineering Control means provision of Exhaust Fans, Fume Hoods, Fume Ducts etc.,
- Ventilation means Good Lighting, Air Circulation etc.,
- PPE Means Personal Protective Equipment like Helmets, Safety Google, Breathing apparatus, Nose Masks, Gloves, Gum Shoes etc.,

6.9.5 Medical Surveillance

Employees are under gone for medical checkup periodically in industry.[Once in six months or depends on severity]

There are basically two types of job – related medical tests:

- Disease monitoring tests look for evidence that an employee has developed an occupation disease these include chest X-rays lung function tests blood or urine tests for kidney or liver function and ECG's to check the heart.
- Tests for toxic substances in our blood, breathe, urine. Hair or other part of our body, such tests known as biological monitoring.

Conclusion

Exposure to occupational hazardous increases the risk for morbidity and mortality.

The most prevalent occupation practices that increase the risks for morbidity and mortality are lack of training in occupation health safety lack of PPE's inadequate training in the proper use of machinery and long hours of work the situation is further compounded by overcrowding and poor sanitary conditions.

There is an urgent need to introduce safe industrial hygiene practices based on accurate knowledge of existing hazards and job exposure matrix for reducing the risks associated with occupational hazards.

6.10 HAZARD CONTROL MEASURES

- Procedures and actions will be well defined and known to all operating personnel's for safe shut down of plant in case of failure of any power, instrumentation, cooling water, air, etc.
- All the vessels and tanks will be provided with temperature indicator, pressure gauge and safety valves as depending upon the process and operating parameters.
- Plant specific HAZOP studies will be carried out using P & IDs for identification of hazards during operation considering deviation of

operational parameters, their possible cause and consequence and safe guards.

- Interlocks and DCS control will be provided during reaction process.
- All the motors and other rotating equipment machines will be provided with suitable safety guards.
- Fire extinguishers will also be installed in the plant area.
- Flame arrestors will be provided at all vent lines at solvent tanks.
- Suitable first aid fire extinguishers, such as, DCP, CO₂ & foam type will be kept in every plant area at easily approachable spots and in sufficient numbers.
- Fire hydrant points with sufficient length of hose reel will be provided at major emergency spots.
- Bound walls, bonded wire fencing, detached storage area will be kept away from probable ignition sources;
- Safety shower and eye washer will be installed at crucial places.
- Sufficient space will be provided for free movement in the plant area.
- Safe distances have been considered in designing of plant lay out.
- Regarding all components of the plant proper certificate will be taken.
- Also testing and inspection will not be compromised before deliveries. Certificate of structure stability will be taken from competent person.
- Insulation of piping will be provided as per requirement.
- All elevated structures will be provided with lightening arrestors.
- All exposed parts of moving machineries will be provided with suitable guards for personnel safety.
- All piping and equipment will be provided with earthing connection and it will be tested regularly.
- Safety valves & rupture disc will be provided to prevent over pressurization of vessels and reactors.
- SOP will be available of safe shut-down of plant during any emergency situation.

6.11 OPERATIONAL SAFETY

- All operators & maintenance personnel's concerned with the plant will be given data sheets for hazardous chemicals and to be trained to combat any leakage spillage, etc.
- Interlocks and DCS control will be provided during reaction process.
- Instrumentation provided will be calibrated at regular intervals.
- Detections and sensors for smoke, heat, ammonia, chlorine, etc. will be provided with alarm at strategic locations at the plant.
- Non-destructive thickness measurements will be carried out regularly to prevent sudden bursting by thinning out of metal by erosion or corrosion through competent person.
- Safety appliances like PVC suit, hand gloves, safety goggles, helmets etc. will be used during material handling. Also SCBA/emergency air masks will be kept available all the time.
- Emergency First Aid kits will be kept available in all departments.
- Preventive maintenance will be carrying out as per schedule to avoid failure.
- Internal and external inspection of vessel, tanks, piping, thickness measurement of piping, inspection and testing of lifting tackles, etc, will be carried out as per schedule.

6.12 TOXIC RELEASES

Controls

Small quantities - say leakage from piping, valves, pin holes etc. will be easily controlled by isolating the equipment/piping etc. & using personal protective equipment like helmet, shoes, hand gloves, air line respirator, breathing apparatus (SCBA), apron, etc. Toxic gases / vapour -chlorine detectors will be provided at the strategic locations.

6.13 SPILLAGES, LEAKAGES

Controls

Depending on the leaking rate/source the following actions will be taken. Isolation/cutting of supply at the leaking point, transfer to some other vessel/equipment, and using protective appliances like hand gloves, helmets, PVC suits etc. Efforts will be made, to prevent the spread of spillage by neutralization/

earth barriers. Outgoing effluents will have to be blocked and taken to effluent pit. It will be discharged after treatment only. Continuous neutralization will also be arranged.

6.14 HAZARDS IN TRANSPORTATION

Controls

Highly inflammable chemicals will be transported by road. Therefore, adequate safety precautions for transportation are followed. During transportation of hazardous chemicals, MSDS & TREM card will be provided to driver. As per Motor Vehicle Rules, PESO rules and Factory Rules all safety precautions will be followed during transportation of hazardous chemicals.

The following safety precautions are suggested during transportation of toxic, inflammable and corrosive chemicals in tankers, while loading and unloading, transportation and meeting the emergencies arising out of leakages and spillages of hazardous materials:

- Park the vehicle at designated place.
- Stop the engine.
- Check-up spark arrester.
- Provide earthing to tanker securely.
- Ensure that fireman is available near the place with proper equipment's.
- Connect the piping properly
- Before start unloading, check that, there should not be any leakage.
- In case of leakage, immediately attend the leakages & rectify it.
- After unloading is over, close the lid properly.
- Vehicle to be started only after removal of all pipelines connected with tanker.

6.15 SAFETY INSTRUCTIONS FOR TRANSPORTATION OF HAZARDOUS MATERIALS

- The name of the chemical along with pictorial sign denoting the dangerous goods should be marked on the vehicle and the packing material.
- The name of the transporter, his address and telephone number should be clearly written on the road tanker and on the vehicle.

- The important safety precautions should be mentioned on the tanker as a warning label.
- The tanker or vehicle should not be used to transport any material other than what is written on it.
- Only trained drivers and cleaners should transport hazardous chemicals.
- The transporter and the manufacturer must ensure the safe transportation of the material.
- The tanker should be checked for its fitness and safe condition before loading.
- During loading and unloading, the tanker should be braked and Isolated against any movement, while loading/unloading, use safety appliances.
- The tanker should not be overloaded beyond the weight permitted by R.T.O.
- Check for leakages from the line connections before starting and Stopping the filling operations.
- Drive the vehicles carefully, especially in crowded localities and on Bumpy roads.
- Do not apply sudden break.
- The tanker should not be parked for long time on the way and especially in crowded places. Park the vehicle away from residential areas.

6.16 OTHER HAZARDS

Controls

In addition to the storage hazards, process hazards and vessel hazards, there are other hazards as given below:

- Boiler failure hazards.
- Non-Chemical vessels failure hazards
- Maintenance Hazards
- Hazards due to failure of electrical installations.
- Physical injuries.

6.17 MAINTENANCE HAZARDS

- Safety permit system will be followed like hot work, cold work, confined space entry,

- Preventive maintenance will be carried out.
- Adequate inventory of spare parts will be maintained.
- Scaffoldings/Ladders will be used.
- Protective appliances will be utilized for protection against fall, hand injury, head injury etc.
- Positive insulations will be made.
- Maintenance procedures will be developed and followed.
- All physical hazards will be eliminated.
- Lifting tackles will be maintained and examined periodically as per rules & regulation.
- Hand tools/power tools will be used with approved types and of good quality.

6.18 RISK REDUCTION MEASURES

Based on hazard identification, consequence analysis and safety measures to be adopted at the plant, following suggestions for improvement of safety at the plant are emerged.

6.18.1 Risk Mitigation/Reduction Measures

For risk mitigation/reduction, attempts should be made to either reduce inventories that could get released in the event of loss of containment or failure likelihood's or both as feasible. Risk analysis identifies the major risk contributors, which enables prioritization of the plant that deserve special attention in terms of inspection and maintenance in Particular and over all safety management as a whole.

For the risk reduction at the proposed plant, the following salient suggestions and Recommendations are made:

- A written process safety information document may be compiled for general use.
- Personnel especially contractor workers at the plant should be made aware about the hazardous substance stored at the plant and risk associated with them.
- The process design information in the process safety information compilation must include P&IDs/PFDs; process chemistry; maximum intended inventory; acceptable upper and lower limits, pressures, flows and compositions and process design and energy balances.

- The document compilation should include an assessment of the hazards presented including
 - Toxicity information
 - Permissible exposure limits.
 - Physical data
 - Thermal and chemical stability data
 - Reactivity data
 - Corrosivity data
 - Information on process and mechanical design.
- The adequate numbers of heat, smoke, ammonia, detectors may be provided at strategic locations in the plant and indication of detectors/sensors should be provided in main control room.
- Predictive and preventive maintenance schedule should be prepared for equipment, piping, pumps, etc. and thickness survey should be done periodically as per standard practices.
- Safety measures in the form of DO and Don't Do should be displayed at strategic locations especially in Telugu and English language.
- Safe work practices should be developed to provide for the control of hazards during operation and maintenance.
- Personnel engaged in handling of hazardous chemicals should be trained to respond in an unlikely event of emergencies.
- The plant should check and ensure that all instruments provided in the plant are in good condition and documented.

6.19 PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment (PPEs) is devices that are fitted and issued to each worker personally for his or her exclusive use. They are intended for temporary use and emergency response action only. If a worker must enter a contaminated area, he must wear adequate protective equipment. Employees should be taught when and how to use respiratory apparatus (SCBA) provided, and how to recognize defects in the equipment. Without SCBA entry into the contaminated area should not be attempted.

- Keep personal protective equipment where it can be accessed quickly, outside the hazardous material storage area and away from areas of likely contamination.
- Each employee should maintain his personal protective equipment in clean, working condition at all times.
- All equipment should be used and maintained in accordance with the manufacturer's instructions.
- Equipment installed for body and eye wash should be checked properly for round the clock operation.

6.20 IMPORTANT RISK MITIGATION MEASURES

- Safe Operating Procedures will be made for all processes & operations and these are being operated according to Safe Operating Procedures. Staffs are also trained for the same.
- Hazardous chemicals will be stored in separate storage along with all safety measures.
- Gas detectors will be installed and emergency gas leakage handling kits and scrubbing arrangements will be provided for handling emergency, at the chlorine station.
- Hazardous operations will be carried out by trained person & under supervision.
- Hazardous chemicals will be handling in close circuit.
- Enclosures will be provided with vent connected to scrubber
- Nitrogen blanketing will be done for storage & process of highly flammable liquids.
- Safety fittings like Safety valve, Pressure reducing valve, vent, flame arrestor, pressure / temperature indicators, level indicators, rupture discs etc. will be provided to the concern equipment.
- Periodical testing will be carried out by competent person for Pressure vessels and Lifting tackles.
- Preventive maintenance will be done periodically for all concern equipment.
- Calibration of all instruments in the plant will be carried out periodically.
- Interlocks will be provided as & where required, in manufacturing processes.

- Loading / Unloading will be ensured with earthing & bonding for flammable chemicals.
- Flameproof fitting, Earthing & Bonding of equipment & pipelines will be provided.
- Work permit system will be followed strictly.
- Periodic on site emergency Mock drills will be arranged.
- Work area monitoring will be done periodically.
- Safety training's will be given to the employees for handling of hazardous chemicals. First aid treatment will be provided through well-equipped first aid box & Occupational Health Centre. Trained first aid persons will be available in each shift. Pre-employment & periodic medical examination is done.
- Monthly Cholinesterase enzyme test will be done for those employees who are working in manufacturing process.
- Washing and Bathing facilities will be provided
- Well-maintained SCBA set & Emergency Airline respirators will be installed at conspicuous places.
- Protective clothing will be provided to all employees & casual workers and these are regularly washed properly.
- Necessary PPE's will be readily available. Jobs are accomplished using relevant PPEs
- Deployment of competent supervisors for supervising hazardous activities.
- Necessary cautionary placards will be displayed at conspicuous places in company.
- Eating & Chewing will be prohibited in manufacturing area.
- Vehicle and strangers movements will be regulated.

6.21 SPILL CONTROL

- For all plants spill control procedures will be displayed. Spillage shall be controlled as per concerned spill control procedure.
- Unprotected personnel up wind will be kept up wind.
- Like any spilled materials to contain. Absorb spilled liquid by dry absorbent clay or sawdust.

- Collect most of the contaminated absorbent with shovel for further disposal/incineration.
- If spill of material directly on the ground, dig up and remove saturated soil for disposal/incineration.
- Inactivate poisonous chemical with suitable method.

6.22 HANDLING OF HAZARDOUS MATERIALS

- Personal protective equipment used by the workers during handling of hazardous chemicals, should be replaced after certain time.
- If any spillage of hazardous chemicals, it should be cleaned and disposed as per standard practiced.
- Empty drums of hazardous chemicals should neutralize immediately.
- Workers engaged in handling of hazardous chemicals should be made aware of properties of hazardous chemicals.
- General Working Conditions at the Proposed Plant
12.36) House Keeping
- All the passages, floors and stairways should be maintained in good conditions.
- The system should be available to deal with any spillage of dry or liquid chemical at the plant.
- Walkways should be always kept free from obstructions.
- In the plant, precaution, instructions and DO and Don't Do should be displayed at strategic locations in Telugu and English Languages.
- All pits, sumps should be properly covered or securely fenced.

6.23 VENTILATION

- Adequate ventilation should be provided in the work floor environment.
- The work environment should be assessed and monitored regularly as local ventilation is most effective method for controlling dust and gaseous emissions at work floor.

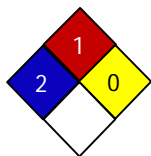
6.24 SAFE OPERATING PROCEDURES

- Safe operating procedures will be available for mostly all materials, operations and equipment.
- The workers will be informed of consequences of failure to observe the safe operating procedures. Some of the SOPs are as follows:

METHYLENE DICHLORIDE - HANDLING PRECAUTIONS

NFPA Rating

HAZARDOUS NATURE



- **Harmful**

Description:

Methylene dichloride, also called Methylene chloride, is colorless liquid with a density heavier than water. At room temperature, Methylene chloride is volatile, has a chloroform-like odor but it is not flammable. Methylene chloride is used as a solvent.

WARNING:

1. OSHA considers MDC to be a potential carcinogen
2. Short term exposure to high concentrations may cause mental confusion.

Permissible exposure:

Exposure may not exceed 25 parts MC per million parts of air (25 ppm) as an eight-hour time weighted average (8-hour TWA PEL) or 125 parts of MC per million parts of air (125 ppm) averaged over a 15-minute period (STEL)

Health hazard data:

A. MC can affect the body if it is inhaled or if the liquid comes in contact with the eyes or skin. It can also affect the body if it is swallowed.

B. Effects of overexposure:

1. Short-term exposure:

MC is an anesthetic. Inhaling the vapor may cause mental confusion, light-headedness, nausea, vomiting, and headache. Continued exposure may cause increased light-headedness, staggering, unconsciousness and even death. High vapor concentrations may also cause irritation of the eyes and respiratory tract. Exposure to MC may make the symptoms of angina (chest pains) worse. Skin exposure to liquid MC may cause irritation. If liquid MC remains on the skin, it may cause skin burns. Splashes of the liquid the eyes may cause irritation.

2. Long-term (chronic) exposure:

The best evidence that MC causes cancer is from laboratory studies in which rats, mice and hamsters inhaled MC 6hours per day,5 days per week for 2 years.MC exposure produced lung and liver tumors in mice and mammary tumors in rats. No carcinogenic effects of MC were found in hamsters.

There are also some human epidemiological studies which show an association between occupational exposure to MC and increases in biliary (bile duct) cancer and type of brain cancer. Other epidemiological studies have not observed between MC exposure and cancer.OSHA interprets these results to mean that there is suggestive (but not absolute) evidence that MC is a human carcinogen

C.Reporting signs and symptoms

You should inform your employer if you develop any signs or symptoms and suspect that are caused by exposure to MC.

a) Emergency first aid procedures

In the event of emergency, institute first aid procedures and send for first aid or medical assistance. Eye and skin exposures: If there is a potential for liquid M to come in contact in with eye or skin, face shields and skin protective equipment must be provided and used. If liquid MC comes in contact with the eye, get medical attention. Contact lenses should not be worn when working with this chemical.

b) Breathing:

If a person breathes in large amounts of MC, move the exposed person to fresh air at once. If breathing has stopped, perform cardiopulmonary resuscitation. Keep the affected person warm and at rest. Get medical attention as soon as possible.

- c) Rescue Move the affected person from the hazardous exposure immediately. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises. Do not become a casualty yourself

Respirators, protective clothing, and eye protection

Respirators: Good industrial hygiene practices recommend that engineering controls is used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not feasible, when such controls are in the process of being installed, or when these controls fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations.

If the use of respirators is necessary, the only respirators permitted are those that have been approved by the mine safety and health administration (MSHA) or the national institute for occupational safety and health (NIOSH). Supplied air respirators are required because air purifying respirators do not provide adequate respiratory protection against MC. In addition to respirator selection, a complete written respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning and evaluation. If you can smell MC while wearing a respirator, proceed immediately to fresh air. If you experience difficulty in breathing while wearing a respirator, tell your employer.

Protective clothing: Employees must be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquid MC or contact with vessels containing liquid MC should be removed immediately and not reworn until the employer has ensured that the protective clothing is fit for reuse. Contaminated protective clothing should be placed in a regulated area designated by the employer for removal. Of MC before the clothing is laundered or disposed of. Clothing and equipment should then be laundered or disposed of as appropriate.

Eye protection:

Employees should be provided with and required to use splash-proof safety goggles where liquid MC may contact the eyes

Precautions for safe use, Handling and storage

Fire and explosion hazards:

MC has no flash point in a closed tester, but it forms flammable vapor air mixtures at approximately 100 deg.C, or higher. It has a lower explosion limit of 12% and an upper explosion limit of 19% in air. It has an auto ignition temperature of 556.1 deg.C (1033 deg.F), and a boiling point of 39.8 deg.C (104 deg.F) it is heavier than water with a specific gravity of 1.3. It is slightly soluble in water.

Reactivity hazards: Conditions contributing to the instability of MC are heat and moisture. Contact with strong oxidizers, caustics, and chemically active metals such as aluminum or magnesium powder, sodium and potassium may cause fires and explosions. Special precautions liquid MC will attack some forms of plastics, rubber, and coating.

Toxicity Liquid MC is painful and irritating if splashed in the eyes or if confined on the skin gloves, or shoes. Vapors in high concentrations may cause narcosis and death prolonged exposure to vapors may cause cancer or exacerbate cardiac disease.

Storage: Protect against physical damage. Because of its corrosive properties, and its high vapor pressure, MC should be stored in plain, galvanized or lead lined mild steel containers in a cool, dry, well ventilated area away from direct sunlight, heat source and acute fire hazards.

Piping material: All piping and valves at the loading or unloading station should be of material that is resistant to MC and should be carefully inspected prior to connection to the transport vehicle and periodically during the operation.

Fire fighting: When involved in fire, MC emits highly toxic and irritating fumes such as phosgene, hydrogen chloride and carbon dioxide. Wear breathing apparatus and use water spray to keep fire-exposed containers cool. Water spray may be used to flush spills away from exposures. Extinguishing media are dry chemical. Carbon dioxide, foam. For purposes of compliance with 29 CFR 1910.307, locations classified as hazardous due to the presence of MC shall be class I.

Spills and leaks: Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed. If MC has spilled or leaked, the following steps should be taken

1. Remove all ignition sources
2. Ventilate area of spill or leak
3. Collect for reclamation or absorb in b vermiculite, dry sand, earth, or a similar material

Methods of waste disposal

- Small spills should be absorbed onto sand and taken to safe area for atmospheric evaporation. Inclination is the preferred method for disposal of large quantities by mixing with a combustible solvent and spraying into an incinerator equipped with acid scrubbers to remove hydrogen chloride gases formed. Complete combustion will convert carbon monoxide to carbon dioxide. Care should be taken for the presence of phosgene.
- You should not keep food, beverage, or smoking materials, or eat or smoke in regulated areas where MC concentrations are above the permissible exposure limits.
- Portable heating units should not be used in confined areas where MC is used.

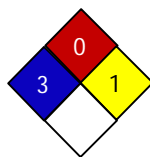
Monitoring and measurement procedures

A. Exposure above the permissible exposure limit

1. Eight hour exposure evaluation measurements taken for the purpose of determining employee exposure under this section are best taken with consecutive samples covering the full shift. Air samples must be taken in the employees breathing zone.
2. Monitoring techniques The sampling and analysis under this section may be performed by collection of the MC vapor on two charcoal adsorption tubes in series or other composition adsorption tubes, with subsequent chemical analysis. Sampling

and analysis may also be performed by instruments such as real time continuous monitoring systems, portable direct reading instruments, or passive dosimeters as long as measurements taken using these methods accurately evaluate the concentration of MC in employees breathing zones, OSHA method 80 is an example of a validated method of sampling and analysis of MC. Copies of this method are available from OSHA the employer has the obligation of selecting a monitoring method which meets the accuracy and precision requirements of the standard under his or her unique field conditions. The standard requires that the method monitoring must be accurate, to a 95 percent confidence level, to plus or minus 25% for concentrations of MC at or above 25 ppm, and to plus or minus 35% for concentrations at or below 25 ppm. In addition to OSHA method 80, there are numerous other methods available for MC in the workplace.

B. Since many of the duties relating to employee exposure are dependent on the results of measurement procedures, employers must assure that the evaluation of employee exposure is performed by a technically qualified person.

SODIUM HYDROXIDE- HANDLING PRECAUTIONS**NFPA RATING****HAZARDOUS NATURE**

- Corrosive
- oxidizer

Sodium hydroxide: LD50: Not available. LC50: Not available

HAZARDS IDENTIFICATION

Potential Acute Health Effects: Very hazardous in case of skin contact (irritant), of eye contact (irritant). Hazardous in case of skin contact (corrosive), of eye contact (corrosive), of ingestion, Slightly hazardous in case of inhalation (lung sensitizer). Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract. Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath. Prolonged exposure may result in skin burns and ulcerations. Over-exposure by inhalation may cause respiratory irritation. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential chronic health effects:

Carcinogenic: NA

Mutagenic: Mutagenic for mammalian somatic cells.

Tetrogenic: NA

Developmental toxicity: Not available. The substance may be toxic to mucous membranes, upper respiratory tract, skin, eyes. Repeated or prolonged exposure to the substance can produce target organs damage. Repeated exposure of the eyes to a low level of dust can produce eye irritation. Repeated skin exposure can produce local skin destruction, or dermatitis. Repeated inhalation of dust can produce varying degree of respiratory irritation or lung damage

FIRST AID MEASURES

Eye Contact: Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately.

Skin Contact: In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Serious Skin Contact: Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Serious Ingestion: Not available. Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.

Ingestion: Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

FIRE AND EXPLOSION

Flammability of the Product: Non-flammable.

Auto-Ignition Temperature: Not applicable.

Flash Points: Not applicable.

Flammable Limits: Not applicable.

Products of Combustion: Not available

Explosion Hazards in Presence of Various Substances: Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available. Slightly explosive in presence of heat.

ACCIDENTAL RELEASE MEASURES

Small Spill: Use appropriate tools to put the spilled solid in a convenient waste disposal container. If necessary: Neutralize the residue with dilute solution of acetic acid.

Large Spill: Corrosive solid. Stop leak if without risk. Do not get water inside container. Do not touch spilled material. Use water spray to reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Neutralize the residue with a dilute solution of acetic acid. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

HANDLING STORAGE

Precautions: Keep container dry. Do not breathe dust. Never add water to this product. In case of insufficient ventilation, wear suitable respiratory equipment. If you feel unwell, seek medical attention and show the label when possible. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, reducing agents, metals, acids, alkalis, moisture

Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area. Hygroscopic. Deliquescent

EXPOSURE CONTROL /PERSONAL PROTECTION

Engineering Controls: Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

Personal Protection: Face shield, Full suit, Vapor respirator be sure to use an approved/certified respirator or equivalent, Gloves, Boots.

Exposure Limits: STEL: 2 (mg/m³) from ACGIH (TLV) [United States] TWA: 2 CEIL: 2 (mg/m³) from OSHA (PEL) [United States] CEIL: 2 (mg/m³) from NIOSH Consult local authorities for acceptable exposure limits.

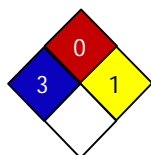
STABILITY AND REACTIVITY

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Incompatible materials, moisture, moist air

Incompatibility with various substances: Highly reactive with metals. Reactive with oxidizing agents, reducing agents, acids, alkalis, moisture.

HYDROCHLORIC ACID- HANDLING PRECAUTIONS**NFPA RATING****HAZARDOUS NATURE**

- Corrosive
- Oxidizer

Hydrochloric acid: GAS (LC50): Acute: 4701 ppm 0.5 hours [Rat].

HAZARDS IDENTIFICATION

Potential Acute Health Effects:

Very hazardous in case of skin contact (irritant), of eye contact (irritant). Hazardous in case of skin contact (corrosive), of eye contact (corrosive), of ingestion, . Slightly hazardous in case of inhalation (lung sensitizer). Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract. Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath. Prolonged exposure may result in skin burns and ulcerations. Over-exposure by inhalation may cause respiratory irritation. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential chronic health effects:

Carcinogenic: Classified 3 (Not classifiable for human.) by IARC [Hydrochloric acid]

Mutagenic: NA

Tetrogenic: NA

Developmental toxicity: Not available. The substance may be toxic to kidneys, liver, mucous membranes, upper respiratory tract, skin, eyes, Circulatory System, teeth. Repeated or prolonged exposure to the substance can produce target. 2organs damage. Repeated or prolonged contact with spray mist may produce chronic eye irritation and severe skin irritation. Repeated or prolonged exposure to spray mist may produce respiratory tract irritation leading to frequent attacks of bronchial infection. Repeated exposure to a highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.

FIRST AID MEASURES

Eye Contact: Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately.

Skin Contact: In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Serious Skin Contact: Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Serious Ingestion: Not available. Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.

Ingestion: Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

FIRE AND EXPLOSION

Flammability of the Product: Non-flammable.

Auto-Ignition Temperature: Not applicable.

Flash Points: Not applicable.

Flammable Limits: Not applicable.

Products of Combustion: Not available

Explosion Hazards in Presence of Various Substances: Non-explosive in presence of open flames and sparks, of shocks.

ACCIDENTAL RELEASE MEASURES

Small Spill: Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. If necessary: Neutralize the residue with a dilute solution of sodium carbonate

Large Spill: Corrosive solid. Stop leak if without risk. Do not get water inside container. Do not touch spilled material. Use water spray to reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Neutralize the residue with a dilute solution of acetic acid. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

HANDLING & STORAGE

Precautions: Keep locked up.. Keep container dry. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Never add water to this product. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, organic materials, metals, alkalis, moisture. May corrode metallic surfaces. Store in a metallic or coated fiberboard drum using a strong polyethylene inner package.

Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area

EXPOSURE CONTROL /PERSONAL PROTECTION

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

Personal Protection: Face shield, Full suit, Vapor respirator be sure to use an approved/certified respirator or equivalent, Gloves, Boots.

Exposure Limits: CEIL: 5 (ppm) from OSHA (PEL) [United States] CEIL: 7 (mg/m³) from OSHA (PEL) [United States] CEIL: 5 from NIOSH CEIL: 7 (mg/m³) from NIOSH TWA: 1 STEL: 5 (ppm) [United Kingdom (UK)] TWA: 2 STEL: 8 (mg/m³) [United Kingdom(UK)] Consult local authorities for acceptable exposure limits.

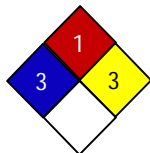
STABILITY AND REACTIVITY

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Incompatible materials, moisture, moist air

Incompatibility with various substances: Highly reactive with metals. Reactive with oxidizing agents, organic materials, alkalis, water .

SODIUM AZIDE - HANDLING PRECAUTIONS**NFPA RATING****HAZARDOUS NATURE**

- Poison
- Flammable

Sodium Azide: Sodium azide: ORAL (LD50): Acute: 27 mg/kg [Rat]. 27 mg/kg [Mouse]. DERMAL

(LD50): Acute: 20 mg/kg [Rabbit].

HAZARDS IDENTIFICATION

Potential Acute Health Effects:

Very hazardous in case of skin contact (irritant), of eye contact (irritant).

Hazardous in case of ingestion, of inhalation.

Slightly hazardous in case of skin contact (permeator). Severe over-exposure can result in death.

Inflammation of the eye is characterized by redness, watering, and itching.

Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential chronic health effects:

Carcinogenic:

NA

Mutagenic:

NA

Tetrogenic:

NA

Developmental toxicity:

Not available. Repeated exposure to an highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.

FIRST AID MEASURES**Eye Contact:**

Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Cold water may be used. Get medical attention.

Skin Contact:

In case of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

Serious Skin Contact:

Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention.

Inhalation:

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention if symptoms appear.

Serious Inhalation:

Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.

Ingestion:

Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

FIRE AND EXPLOSION**Flammability of the Product:**

May be combustible at high temperature.

Auto-Ignition Temperature:

Not available.

Flash Points:

Not available.

Flammable Limits:

Not available.

Products of Combustion:

Some metallic oxides

Explosion Hazards in Presence of Various Substances:

Risks of explosion of the product in presence of static discharge: Not available.

Highly explosive in presence of shocks, of metals.

ACCIDENTAL RELEASE MEASURES

Small Spill:

Use appropriate tools to put the spilled solid in a convenient waste disposal container.

Large Spill:

Use a shovel to put the material into a convenient waste disposal container. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

HANDLING & STORAGE

Precautions:

Keep locked up. Keep away from heat. Keep away from sources of ignition. Ground all equipment containing material. Do not ingest. Do not breathe gas/fumes/vapor/spray. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, reducing agents, acids, alkalis.

Storage:

Store in a segregated and approved area (flammables area). Keep container in a cool, well-ventilated area. Keep container tightly closed and sealed until ready for use. Keep away from direct sunlight and heat and avoid all possible sources of ignition (spark or flame).

EXPOSURE CONTROL /PERSONAL PROTECTION**Engineering Controls:**

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

Personal Protection:

Splash goggles, Lab coat, Vapor respirator be sure to use an approved/certified respirator or equivalent, Gloves.

Exposure Limits:

TWA: 0.29 (mg/m³) from ACGIH Consult local authorities for acceptable exposure limits

STABILITY AND REACTIVITY**Stability:**

Unstable.

Instability Temperature:

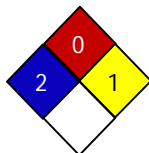
Not available.

Conditions of Instability:

Not available.

Incompatibility with various substances:

Extremely reactive or incompatible with metals.

HYDROGEN PEROXIDE - HANDLING PRECAUTIONS**NFPA RATING****HAZARDOUS NATURE**

- Corrosive
- oxidizer

Hydrogen Peroxide: ORAL (LD50): Acute: 2000 mg/kg [Mouse]. DERMAL (LD50): Acute: 4060 mg/kg [Rat]. 2000 mg/kg [pig]. VAPOR (LC50): Acute: 2000 mg/m 4 hours [Rat].S

HAZARDS IDENTIFICATION**Potential Acute Health Effects:**

Very hazardous in case of skin contact (irritant), of eye contact (irritant). Hazardous in case of skin contact (corrosive), of eye contact (corrosive), of ingestion, slightly hazardous in case of inhalation (lung sensitizer).

Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract.

Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath. Prolonged exposure may result in skin burns and ulcerations.

Over-exposure by inhalation may cause respiratory irritation.

Inflammation of the eye is characterized by redness, watering, and itching.

Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential chronic health effects:

Carcinogenic: NA

Mutagenic: NA

Tetrogenic: NA

Developmental toxicity:

Not available. The substance is toxic to lungs, mucous membranes. Repeated or prolonged exposure to the substance can produce target organs damage.

FIRST AID MEASURES

Eye Contact:

Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately.

Skin Contact:

In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Serious Skin Contact:

Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation:

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately. Serious Inhalation: Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.

Ingestion: Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion:

Not available. Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.

Ingestion:

Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

FIRE AND EXPLOSION

Flammability of the Product:

Non-flammable.

Auto-Ignition Temperature:

Not applicable.

Flash Points:

Not applicable.

Flammable Limits:

Not applicable.

Products of Combustion:

Not available

Explosion Hazards in Presence of Various Substances:

Slightly explosive in presence of open flames and sparks, of heat, of organic materials, of metals, of acids.

ACCIDENTAL RELEASE MEASURES

Small Spill:

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

Large Spill:

Corrosive liquid, oxidizing material. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Avoid contact with a combustible material (wood, paper, oil, clothing...). Keep substances damp using water spray. Do not touch spilled material. Use water spray curtain to divert vapor drift. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

HANDLING & STORAGE

Precautions:

Keep locked up. Keep container dry. Keep away from heat. Keep away from sources of ignition. Keep away from combustible material.. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Never add water to this product. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, reducing agents, combustible materials, organic materials, metals, acids, alkalis.

Storage:

Keep container tightly closed. Keep container in a cool, well-ventilated area. Separate from acids, alkalis, reducing agents and combustibles. See NFPA 43A, Code for the Storage of Liquid and Solid Oxidizers. Do not store above 8°C (46.4°F). refrigerate Sensitive to light. Store in light-resistant containers.

EXPOSURE CONTROL /PERSONAL PROTECTION

Engineering Controls:

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

Personal Protection: Face shield. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves. Boots.

Exposure Limits:

TWA: Hydrogen Peroxide TWA: 1 (ppm) from ACGIH (TLV) [United States] TWA: 1 (ppm) from OSHA (PEL) [United States] TWA: 1 STEL: 2 [Canada] TWA: 1.4 (mg/m3) from NIOSH TWA: 1.4 (mg/m3) from OSHA (PEL) [United States] TWA: 1 (ppm) [United Kingdom (UK)] TWA: 1.4 (mg/m3) [United Kingdom (UK)] Consult local authorities for acceptable exposure limits

STABILITY AND REACTIVITY

Stability:

The product is stable. It contains a stabilizer.

Instability Temperature:

Not available.

Conditions of Instability:

Excess heat, incompatible materials

Incompatibility with various substances:

Reactive with reducing agents, combustible materials, organic materials, metals, acids, alkalis.

SULFURIC ACID- HANDLING PRECAUTIONS**NFPA RATING****HAZARDOUS NATURE**

- **Corrosive**

Sulfuric acid: ORAL (LD50): Acute: 2140 mg/kg [Rat.]. VAPOR (LC50): Acute: 510 mg/m² hours [Rat]. 320 mg/m² hours [Mouse].

HAZARDS IDENTIFICATION**Potential Acute Health Effects:**

Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (irritant, corrosive), of ingestion, of inhalation.

Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract.

Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath. Severe over-exposure can result in death.

Inflammation of the eye is characterized by redness, watering, and itching.

Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential chronic health effects:**Carcinogenic:**

Classified 1 (Proven for human.) by IARC, + (Proven.) by OSHA. Classified A2 (Suspected for human.) by ACGIH.

Mutagenic:

NA

Tetrogenic:

NA

Developmental toxicity:

Not available. The substance may be toxic to kidneys, lungs, heart, cardiovascular system, upper respiratory tract, eyes, and teeth. Repeated or prolonged exposure to the substance can produce target organs damage. Repeated or prolonged contact with spray mist may produce chronic eye irritation and severe skin irritation. Repeated or prolonged exposure to spray

Mist may produce respiratory tract irritation leading to frequent attacks of bronchial infection. Repeated exposure to a highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.

FIRST AID MEASURES

Eye Contact:

Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately

Skin Contact:

In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Serious Skin Contact:

Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention

Inhalation:

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical Attention immediately.

Serious Inhalation:

Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.

Ingestion:

Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion:

Not available.

FIRE AND EXPLOSION

Flammability of the Product:

Non-flammable.

Auto-Ignition Temperature:

Not applicable.

Flash Points:

Not applicable.

Flammable Limits:

Not applicable.

Products of Combustion:

Products of combustion are not available since material is non-flammable. However, products of decomposition include fumes of oxides of sulfur. Will react with water or steam to produce toxic and corrosive fumes. Reacts with carbonates to generate carbon dioxide gas. Reacts with cyanides and sulfides to form poisonous hydrogen cyanide and hydrogen sulfide respectively.

Explosion Hazards in Presence of Various Substances:

Risks of explosion of the product in presence of mechanical impact: Not available.

Risks of explosion of the product in presence of static discharge: Not available.

Slightly explosive in presence of oxidizing materials.

ACCIDENTAL RELEASE MEASURES

Small Spill:

Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. If necessary: Neutralize the residue with a dilute solution of sodium carbonate.

Large Spill:

Corrosive liquid, Oxidizing material. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Avoid contact with a combustible material (wood, paper, oil, clothing...). Keep substances

damp using water spray. Do not touch spilled material. Use water spray curtain to divert vapor drift. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

HANDLING & STORAGE

Precautions:

Keep locked up.. Keep container dry. Do not ingest. Do not breathe gas/fumes/vapor/spray. Never add water to this product. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, reducing agents, combustible materials, organic materials, metals, acids, alkalis, moisture. May corrode metallic surfaces. Store in a metallic or coated fiberboard drum using a strong polyethylene inner package.

Storage:

Hygroscopic, Reacts violently with water. Keep container tightly closed. Keep container in a cool, well-ventilated area. Do not store above 23°C (73.4°F).

EXPOSURE CONTROL /PERSONAL PROTECTION

Engineering Controls:

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

Personal Protection:

Face shield, Full suit, Vapor respirator be sure to use an approved/certified respirator or equivalent, Gloves, Boots.

Exposure Limits:

TWA: 1 STEL: 3 (mg/m³) [Australia] Inhalation TWA: 1 (mg/m³) from OSHA (PEL) [United States] Inhalation TWA: 1 STEL: 3(mg/m³) from ACGIH (TLV) [United States] [1999] Inhalation TWA: 1 (mg/m³) from NIOSH [United States] Inhalation TWA: 1(mg/m³) [United Kingdom (UK)] Consult local authorities for acceptable exposure limits.

STABILITY AND REACTIVITY

Stability:

The product is stable.

Instability Temperature:

Not available.

Conditions of Instability:

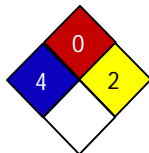
Conditions to Avoid: Incompatible materials, excess heat, combustible material materials, organic materials, exposure to moist air or water, oxidizers, amines, bases. Always add the acid to water, never the reverse.

Incompatibility with various substances:

Reactive with oxidizing agents, reducing agents, combustible materials, organic materials, metals, acids, alkalis, moisture.

THIONYL CHLORIDE- HANDLING PRECAUTIONS**NFPA RATING****HAZARDOUS NATURE**

- **Corrosive**



Thionyl chloride: VAPOR (LC50): Acute: 500 ppm 1 hours [Rat].

HAZARDS IDENTIFICATION

Potential Acute Health Effects:

Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (irritant, corrosive), of ingestion, of inhalation.

Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract.

Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath. Severe over-exposure can result in death.

Inflammation of the eye is characterized by redness, watering, and itching.

Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential chronic health effects:

Carcinogenic:

Classified 1 (Proven for human.) by IARC, + (Proven.) by OSHA. Classified A2 (Suspected for human.) by ACGIH.

Mutagenic: NA

Tetrogenic: NA

Developmental toxicity:

Not available.

The substance may be toxic to kidneys, lungs, heart, cardiovascular system, upper respiratory tract, eyes, and teeth. Repeated or prolonged exposure to the substance can produce target organs damage. Repeated or prolonged contact with spray mist may produce chronic eye irritation and severe skin irritation. Repeated or prolonged exposure to spray

Mist may produce respiratory tract irritation leading to frequent attacks of bronchial infection. Repeated exposure to a highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.

FIRST AID MEASURES

Eye Contact:

Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately

Skin Contact:

In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Serious Skin Contact:

Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention

Inhalation:

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Serious Inhalation:

Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. **WARNING:** It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.

Ingestion:

Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband.

Serious Ingestion:

Not available.

FIRE AND EXPLOSION

Flammability of the Product:

Non-flammable.

Auto-Ignition Temperature:

Not applicable.

Flash Points:

Not applicable.

Flammable Limits:

Not applicable.

Products of Combustion:

Not applicable.

Explosion Hazards in Presence of Various Substances:

Risks of explosion of the product in presence of mechanical impact: Not available.

Risks of explosion of the product in presence of static discharge: Not available

ACCIDENTAL RELEASE MEASURES

Small Spill:

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

Large Spill:

Corrosive liquid. Oxidizing material. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Avoid contact with a combustible material (wood, paper, oil, clothing...). Keep substances damp using water spray. Do not touch spilled material. Use water spray curtain to divert vapor drift. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

HANDLING & STORAGE

Precautions:

Keep locked up. Keep container dry. Do not ingest. Do not breathe gas/fumes/vapor/spray. Never add water to this product. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, reducing agents, combustible materials, organic materials, metals, acids, alkalis, moisture.

Storage:

Keep container tightly closed. Keep container in a cool, well-ventilated area.

EXPOSURE CONTROL /PERSONAL PROTECTION

Engineering Controls:

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

Personal Protection:

Face shield, Full suit, Vapor respirator, be sure to use an approved/certified respirator or equivalent, Gloves, Boots.

Exposure Limits: CEIL: 1 (ppm) from OSHA (PEL) [United States] CEIL: 1 from ACGIH (TLV) [United States] CEIL: 1 (ppm) from NIOSH [United States] TWA: 1 (ppm) [Denmark] STEL: 1 (ppm) [Belgium] STEL: 1 (ppm) [United Kingdom (UK)] Consult local authorities for acceptable exposure limits.

STABILITY AND REACTIVITY

Stability:

The product is stable.

Instability Temperature:

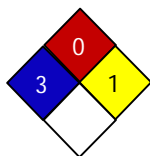
Not available.

Conditions of Instability:

Incompatible materials, moisture/moist air, temperatures above 140 deg. C

Incompatibility with various substances:

Reactive with metals, acids, alkalis, moisture. The product may undergo hazardous decomposition, condensation or polymerization, it may react violently with water to emit toxic gases or it may become self-reactive under conditions of shock or increase in temperature or pressure.

POTASSIUM HYDROXIDE- HANDLING PRECAUTIONS**NFPA RATING****HAZARDOUS NATURE**

- Corrosive

Potassium hydroxide: ORAL (LD50): Acute: 273 mg/kg [Rat].

HAZARDS IDENTIFICATION**Potential Acute Health Effects:**

Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (irritant, corrosive), of ingestion, of inhalation.

Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract.

Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath. Severe over-exposure can result in death.

Inflammation of the eye is characterized by redness, watering, and itching.

Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential chronic health effects:

Carcinogenic: Classified 1 (Proven for human.) by IARC, + (Proven.) by OSHA.

Classified A2 (Suspected for human.) by ACGIH.

Mutagenic: NA

Tetrogenic: NA

Developmental toxicity: Not available. The substance may be toxic to upper respiratory tract, skin, and eyes. Repeated or prolonged exposure to the substance can produce target organs damage. Repeated exposure of the eyes to a low level of dust can produce eye irritation. Repeated skin exposure can produce local skin destruction, or dermatitis. Repeated inhalation of dust can produce varying degree of respiratory irritation or lung damage

FIRST AID MEASURES**Eye Contact:**

Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately.

Skin Contact:

In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Serious Skin Contact:

Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation:

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Serious Inhalation:

Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. **WARNING:** It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.

Ingestion:

Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband.

Serious Ingestion:

Not available.

FIRE AND EXPLOSION**Flammability of the Product:**

Non-flammable.

Auto-Ignition Temperature:

Not applicable.

Flash Points:

Not applicable.

Flammable Limits:

Not applicable.

Products of Combustion:

Not applicable.

Explosion Hazards in Presence of Various Substances:

Risks of explosion of the product in presence of mechanical impact: Not available.

Risks of explosion of the product in presence of static discharge: Not available

ACCIDENTAL RELEASE MEASURES

Small Spill: Use appropriate tools to put the spilled solid in a convenient waste disposal container. If necessary: Neutralize the residue with a dilute solution of acetic acid..

Large Spill: Corrosive liquid. Oxidizing material. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Avoid contact with a combustible material (wood, paper, oil, clothing...). Keep substances damp using water spray. Do not touch spilled material. Use water spray curtain to divert vapor drift. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

HANDLING STORAGE

Precautions:

Keep container dry. Do not ingest. Do not breathe dust. Never add water to this product. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as organic materials, metals, acids, moisture.

Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area. Do not store above 23°C (73.4°F).

EXPOSURE CONTROL /PERSONAL PROTECTION

Engineering Controls: Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits.

If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

Personal Protection:

Face shield, Full suit, Vapor respirator, be sure to use an approved/certified respirator or equivalent, Gloves, Boots.

Exposure Limits:

CEIL: 1 (ppm) from OSHA (PEL) [United States] CEIL: 1 from ACGIH (TLV) [United States] CEIL: 1 (ppm) from NIOSH [United States] TWA: 1 (ppm) [Denmark] STEL: 1 (ppm) [Belgium] STEL: 1 (ppm) [United Kingdom (UK)] Consult local authorities for acceptable exposure limits.

STABILITY AND REACTIVITY

Stability:

The product is stable.

Instability Temperature:

Not available.

Conditions of Instability:

Incompatible materials, dust generation, exposure to moist air or water.

Incompatibility with various substances:

Highly reactive with acids. Reactive with organic materials, metals, moisture.

6.25 FIRE PROTECTION

- Well-designed pressured hydrant system comprising with jockey pump, electrical & diesel pumps, hydrant, monitor etc. will be installed at the plant.
- The fire fighting system and equipment will be tested and maintained as per relevant standards.
- Heat and smoke detectors will be provided at the plant and shall be calibrated and maintained properly.

6.26 STATIC ELECTRICITY

- All equipment and storage tanks/containers of flammable chemicals shall be bounded and earthed properly.
- Electrical pits shall be maintained clean and covered.
- Electrical continuity for earthing circuits shall be maintained.

- Periodic inspections shall be done for earth pits and record shall be maintained.

6.27 COMMUNICATION SYSTEM

Communication facilities shall be checked periodically for its proper functioning.

6.28 SAFETY INSPECTIONS

The system shall be initiated for checklist based routine safety inspection and internal audit of the plant. Safety inspection team shall be formed from various disciplines and departments.

6.29 SAFE OPERATING PROCEDURES

- Safe operating procedures should be formulated and updated, specific to process & equipment and distributed to concerned plant personnel.
- Safety procedure near anhydrous Ammonia tanks and Ammonia Cylinders shall be prepared and displayed meticulously in Telugu and English languages.

6.30 PREDICTIVE AND PREVENTIVE MAINTENANCE

Predictive and preventive maintenance schedule shall be followed in religious manner.

6.31 ELECTRICAL SAFETY

- Insulation pad at HT panels shall be replaced at regular interval.
- Housekeeping in MCC room shall be kept proper for safe working conditions.

6.32 COLOUR CODING SYSTEM

Colour coding for piping and utility lines shall be followed in accordance with IS: 2379:1990.

6.33. MAXIMUM CREDIBLE LOSS ACCIDENT SCENARIOS

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

of the study, weather conditions having an average wind speed of 2.46 m/s have been chosen.

The maximum credible loss (MCL) scenarios have been developed for the facility. The MCL case considered, attempt to include the worst “credible” incidents-what constitutes a credible incident is always subjective. Nevertheless, guidelines have evolved over the years and based on basic engineering judgment, the cases have been found to be credible and modeling for assessing vulnerability zones is prepared accordingly. Only catastrophic cases have been considered and not partial or small failures (as is the case in quantitative risk assessment where contributions from low frequency-high outcome effect as well as high frequency-low outcome events are distinguished). The objective of the study is emergency planning, hence only holistic & conservative assumptions are used for obvious reasons. Hence though the outcomes may look pessimistic, the planning for emergency concept should be borne in mind whilst interpreting the results.

3.34 CONSEQUENCE ANALYSIS CALCULATIONS

The consequence analysis has been done for selected scenarios. This has been done for weather conditions having wind speed 2.46 m/s. in consequence analysis, geographical location of the source of potential release plays an important role. Consideration of a large number of scenarios in the same geographical location serves little purpose if the dominant scenario has been, identified and duly considered.

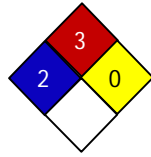
SCENARIO

TABLE - 6.2: POSSIBLE ACCIDENT SCENARIO

SCENARIO	MCL SCENARIO	PRESSURE & TEMP.	QUANTITY
1	Pool fire due to release of - METHANOL	Ambient	10 KL

DETAILED SUMMARY OF RESULTS

Pool fire due to release of **TOLUENE**



A release from the Toluene storage Tank;

- Pressure & Temperature - Ambient
- Quantity Stored - 10KL

Results indicate:

- Effective diameter of the pool - 3.0 m
[100% fatality with in the pool area]
- Fatality Zone radius - 11m
- Injury Zone radius - 16 m
[First degree burns]

Preventive Measures:

Storage:

- Keep away from heat, sparks, and flame
- Keep away from sources of ignition
- Store in a cool,dry,well-ventilated area away from incompatible substances
- Flammables area- Keep containers tightly closed

Handling:

- Wash thoroughly after handling
- Remove contaminated clothing and wash before reuse
- Use only in a well ventilated area
- Ground and bond containers when transferring material.
- Use spark- proof tools and explosion proof equipment
- Avoid contact with skin and eyes
- Do not get in eyes, on skin, or on clothing
- Do not ingest or inhale
- Empty containers retain product residue [liquid and/or vapor],and can be dangerous
- Avoid ingestion and inhalation
- Do not pressurize,cut,weld,braze,solder,drill,grind,or expose empty containers to heat, sparks or flame

Protection:

Eyes: Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN 166.

Skin: Wear appropriate protective gloves to prevent skin exposure

Clothing: Wear appropriate protective clothing to prevent skin exposure

Small spills/leaks:

- Scoop up with a no sparking tool, then place into a suitable container for disposal
- Use water spray to disperse the gas/vapor.
- Remove all sources of ignition
- Absorb spill using an absorbent, non-combustible material such as earth, sand, or vermiculite
- Provide ventilation
- A vapor suppressing foam may be used to reduce vapors

Hazards:

- Vapors may form explosive mixtures with air
- Vapors may travel to sources of ignition and flash back
- Most vapors are heavier than air. They will spread along ground and collect in low or confined areas [sewers, basements, tanks]
- Vapor explosion and poison hazard indoors, outdoors or in sewers

6.35 DISASTER MANAGEMENT PLAN

Level of emergency can be classified in three categories.

LEVEL-1

The leakage or emergency, which is confinable the plant, premises. It may be due to-

- Small fire in the plant
- Low toxic gas release for short duration.
- Collapsing of equipment that do not affect outside premises.

LEVEL-2

The emergency, which is confinable within the factory premises. It may arise due to-

- Major fire inside the factory premises.
- Medium scale explosion confined to the factory premises.
- Heavy toxic/flammable gas leakage for short duration.

LEVEL-3

The emergency, which is not confinable within the factory premises and general public in the vicinity likely to be affected. It may arise due to-

- Explosion of high magnitude affecting the adjacent area
- Heavy/profuse leakage of toxic/flammable gases for a long duration.

6.36 OBSERVER

Any person noticing a fire, leakage of chemicals or an unusual occurrence will contact the security personnel a main gate and plant supervisor by:

- Giving a telephone message
- Sending message through a messenger
- Rush personally

While giving the message, he will:

- Identity himself
- State briefly type of emergency
- Location of incident/accident
- Severity of emergency

After giving message, he will return to the scene/area of emergency by taking all personnel protection measures, if possible and awaits instructions from plant supervisor (incident controller).

6.37 ROLE OF CHIEF EMERGENCY CONTROLLER

He will be chief manager in his absence, the plant supervisor will be the chief controller till any one of the designated manager arrives at site and assumes overall charge of the situation. His task will be to co-ordinate all internal and external activities from the emergency control centre at main security gate from where all operations will be directed. He shall:

- Immediately on being informed of the emergency and its location, will arrive at the scene and handle the situation.
- Relieve the incident controller from responsible of the main controller
- Co-ordinate to avail services from external agencies like fire brigade, hospitals etc.is called for, following the declaration of major emergency. If necessary, major installations in the vicinity may also be informed of the situation.
- Exercise direct operational control of the unaffected section of the plant.
- In consultation with the advisory team, expedite the shutting down of loading/unloading operations of tankers and if necessary, instruct the supervisor/security/personnel to evacuate tankers.
- Ensure that all employees are evacuated from the affected area and the casualties, if any, are given necessary medical attention. Instruct P&A Assistant/security for rushing casualties to hospitals if required.
- Liaise with fire and police officials, pollution control board officials and other statutory bodies and advise them of all possible consequence effects outside the premises.
- Arrange for relief of personnel when emergency is prolonged
- Issue authorized statement or press release to the news –media
- Ensure preservation of evidence for enquiries to be conducted by statutory authorities.
- Authorize the sounding of “**All Clear**” and “**Evacuation Siren**”
- Arrange for obtaining the head-count of all personnel within the premises and cross-checking with the data from records available for no. of persons within the premise.

DETAILS OF SITE MAIN AND ALTERNATIVE CONTROLLER**TABLE - 6.3 – (A) SITE MAIN CONTROLLER**

NAME	DESIGNATION	QUALIFICATION	PLACE OF AVAILABLE & CONTACT NUMBERS	
			FACTORY	RESIDENCE

TABLE - 6.3 – (B) ALTERNATIVE CONTROLLER

NAME	DESIGNATION	QUALIFICATION	PLACE OF AVAILABLE & CONTACT NUMBERS	
			FACTORY	RESIDENCE

6.38 INCIDENT CONTROLLER

Role of Incident Controller [Plant Manager/Shift in Charge]. He is the shift supervisor of the plant. Assume the role of the incident controller and take charge of the situation. Keep the chief controller informed of the situation from time to time.

1. Proceed to the scene of emergency and assess the situation
2. Direct all operation within the affected area with the following priorities
 - Safety of personnel
 - Minimize damage to property and loss of material
 - Arrange for rescue of trapped workers and those in a state of shock
 - Get all non-essential persons safely evacuated after stopping all the engineering/hot jobs.
 - Set up a communication system with the main control center at the main security gate through telephone or messenger system.
 - Pending arrival of the main controller, direct the shutting down and evacuation of the site

- Report all developments to the main controller
- Preserve all evidence for use in the subsequent enquiry.
- Intimate to the Emergency Control Center (Main Security Gate) the head count of plant.

INCIDENT CONTROLLERS / RUNNERS**TABLE-6.4 – (A) INCIDENT CONTROLLERS - 3 SHIFTS**

S.NO	NAME	DESIGNATION	QUALIFICATION	PLACE OF AVAILABLE & CONTACT NUMBERS	
				FACTORY	RESIDENCE

RUNNERS - 3 SHIFTS**TABLE - 6.4 - B**

S. No	NAME	DESIGNATION	QUALIFICATION	PLACE OF AVAILABLE & CONTACT NUMBERS	
				FACTORY	RESIDENCE

6.39 FIRE SERVICES

Fire Fighting, Gas leak Control and Rescue operation

A] Role of Manager (Fire and Safety/shift in-charge [Fire and Safety]:

- Manager [EHS] shift in-charge [EHS] will be the only person to direct the fire fighting and emergency operation.
- Keep the constant touch with the chief emergency controller.
- Direct the crew members to the scene of emergency and arrange replenishment of man power/equipment/extinguishing media etc.

B] Fire and Safety officer. [EHS Officer]:

- On being notified about the location of fire/gas leakage immediately proceed to the scene of incident with fire tender and crew.
- Position the fire tender in upwind direction.
- Decide his line of action in consultation with incident controller and take appropriate measures to handle the emergency.
- Assessing the severity of the incident immediately report to emergency controller about the gravity of the situation.
- He will assess the extra requirement required if any from the neighboring industry.

C] Fire Crew Members:

- On hearing fire alarm, emergency siren they shall immediately report to control room and proceed to the scene of emergency and work under the direction of shift fire & safety officer.
- The personal availability at the scene of incident to be made optimize.

6.40 PLANT OPERATIONS

1. Role of HOD:

He will take plant related decisions, which will facilitate the fire fighting operation.

2. Plant Employees:

They shall:

- On hearing the siren, report to plant supervisor
- Do as directed by plant supervisor
- Stop all hot works
- Remove unwanted persons from the affected area to the “Assembly Point” near main security gate viz visitors, guests
- Stop all non-essential operations

3. Non-plant Employees:

On hearing the siren, shall stop their work assemble at “Assembly Point” near main security gate along with guests and visitors.

6.41 MEDICAL SERVICES

A] Role of Chief Medical Officer/Medical Officer (Medical Assistance):

- He will contact immediately to chief emergency controller
- He will render necessary treatment as first aid center and hospital.
- He will arrange for hospitalization and treatment at outside hospitals if required.
- He will mobilize extra medical assistance from outside if necessary.
- He will make arrangement for treating public if necessary.

B] ROLE OF OTHER MEDICAL STAFF:

As directed by medical officers.

6.42 ADMINISTRATIVE SERVICES

A] ROLE OF Dy.MGR (HR):

- He will contact chief emergency controller immediately and keep in touch with local authorities and nearby fire services for their help.
- He will inform Collector, Inspector of Factories and Police department as per the legal requirements.
- Ensure that press does not publish inauthentic news.
- Coordinate to inform relative of affected persons.

- Depute one person each at assembly points to record all personnel arriving there and pass information to chief emergency controller.
- Arrange for round of the clock persons at hospitals to look after the need of the affected personnel.
- Prepare record of affected personnel with local and permanent address.

B] ROLE OF TELEPHONE OPERATOR:

- Ensure that telephone operator keeps the board free to the extent possible for incoming calls.
- He should immediately convey message to key person's operation director, all H.O.D.'s, and all concerns as directed by the chief emergency controller.

TABLE 6.5: MEDICAL ARRANGEMENTS

S.NO	NAME & LOCATION	TELEPHONE NOS.	IN-CHARGE PERSON NAME & DESIGNATION	RESIDENCE ADDRESS	FACILITIES & EQUIPMENT'S	ANTIDOTES AVAILABLE	FIRST AID AVAILABLE	ACCOMMODATION
AMBULANCE VAN OR ALTERNATE ARRANGEMENT								
S.NO	PLACE OF AVAILABILITY	CAPACITY	FACILITIES AVAILABLE IN THE VAN	DRIVER'S NAME AND ADDRESS	DOCTORS NEARBY NAME AND ADDRESS, TELEPHONE NO.	OTHER MEDICAL STAFF NAME & ADDRESS TELEPHONE NO.	RESIDENCE ADDRESS TELEPHONE NO.	MUTUAL AID ARRANGEMENT

6.43 SECURITY SERVICES

Role of H.O.D. (Security) / Security Officers.

- Receive message from the observer
- Initiate the emergency siren to declare the emergency
- Announce on the public address system
- Arrange to close all the gates and stop traffic
- Keep vehicle/ambulance ready and keep track of casualty sent to hospital during off hours
- Ensure that unauthorized persons/vehicles do not enter the premises\
- Organize the positioning and transport of vehicles near the main gate
- Depute security guard for controlling traffic at the scene of emergency
- Call up for additional help from the outside agency like fire brigade, hospitals during off hours

6.43.1 ROLE OF SECURITY GUARD

On hearing emergency siren contact security officer and work under his directions.

MUTUAL AID:

Role played by members of mutual aid scheme

- On receiving the call they shall proceed immediately with fire crew and fire tender.
- The place of incident will be guided by the main gate security guard.
- Fire crew in-charge will report to the fire officer of the unit in which incident has occurred and assist the emergency operation as guided by him.
- In-charge of assisting fire brigades ensures safety of their crew members involved in emergency operation.

6.44 EMERGENCY RESPONSE

Concept of operations deals with the possible steps associated with an emergency response assuming the most severe emergency scenario. This includes:

- Accident initiation and rising of alarm
- Accident evaluation and emergency declaration
- Off site and external agency notification

- Implementation of onsite response actions
- Implementation of protective actions and evacuations
- Co-ordination of response action with external agencies
- Management of emergency resources
- Recovery and facilitate re-entry procedures

6.45 EMERGENCY CAPABILITIES

The primary emergency response facilities comprise with emergency control center upon declaration of emergency, the main security gate office will become the emergency control center [ECC]. The ECC is located in a low /minimal risk zone of the plant. It is manned round

6.45.1 EMERGENCY HANDLING PROCEDURES

Action plan:

- On hearing emergency declaration siren and announcement on public address system, all key persons will rush to their nominated location and start actions.
- The main controller will continuously assess the situation by taking feedback from the incident controller. He will consult the advisory team members to get essential information if required but if does not required to take help from advisory team; he can assign other jobs to advisory team.
- Once the emergency is brought under control, Main Controller will inform to security to give **“ALL CLEAR”** siren and announce on Public Address System about termination of emergency.

In the case the emergency assumes off site dimensions and cannot be controlled, then if the chief controller with his advisory team decides to evacuate the plant, he will instruct the security to sound **“EVACUATION SIREN”**

Procedure in case emergency tends to have off site implications

- As per the sire plan and wind direction at the time of emergency, the likely affected area will be identified and population within will estimated.

- The police will be informed so that in-coming traffic on highway can be controlled from both the ends. The police force will be helpful in evacuation of villages, factories or other public places in the vicinity
- The fire brigade will be informed and ambulance will be called and kept ready to meet any eventuality.
- Neighboring factories will be communicated for sending help.
- Statutory authorities such as factory inspector, district collector and others concerned to be intimated.

Procedure for salvage operations

- The salvage operation will be carried out under the guidance of the main controller, his advisory team and incident controller.

They will conduct accident investigation; assess the damages-the clock by security supervisors.

During emergency, the main controller and his advisory-team will confirm

- Master plan of facility and 5kms surrounding area-displayed on wall
- Layout of facility, equipment and storages, displayed on table and wall
- Availability and location of personal protective equipment
- Self-contained breathing apparatus sets and the spare cylinders
- External telephone with direct dialing and STD facilities
- Internal telephone
- List of important internal and external telephone numbers displayed on table and wall.
- Transport facility
- Extra copies of plant layout for marking during emergency
- Telephone directory both local and surrounding district
- General stationary like paper, pencil etc.
- Nominal roll and address of all employees with contract telephone no's and blood group
- List of first aiders and emergency squad members
- Details of all contractors and their employees.

- Details of meteorological information during different seasons such as wind speed, direction, temperature, humidity etc.

The location of ECC, Assembly points, availability of first aid boxes, fire extinguishers, PPE should be marked onsite.

6.46 MITIGATION OF ENVIRONMENTAL IMPACT DURING FIRE EMERGENCY

- In case of fire, cut of contact of fire with flammable material or prevent of fire by other means
- Use water or suitable fire extinguisher to extinguish fire
- Contain the contaminated water or any other liquid to prevent it going to soil or drain and divert it to ETP storage tank. If required treat it before sending to ETP tank.
- Any solid waste generated should be collected, stored and send to TSDF site.
- During fire emergency use necessary PPE.
- Bottom valve failure: mitigation of environment impact during failure of between valves or tank failure.
- In case of material coming out of the bottom valve shall be contained inside the dyke wall and will be transferred to HDPE plastic drum by help of pump/piping.
- In case of acid spillage after pumping shall be neutralized and waste shall be cleaned with help of water and send the water to ETP.
- The failed bottom valve shall be replaced or repaired and restart. After tank is empty valve will be repaired, or replaced. In case of leakage form tank body tank will be repaired.
- Preventions of failure: preventive maintenance of bottom value shall be carried out as per schedule. To prevent any leakage from tank body, thickness checking shall be same as per schedule.
- In case of bottom value failure or heavy leakages from tank body material from caustic of aniline in the tank shall be transferred to the HDPE drums, by running the pump.

- Preventions of failure: preventive maintenance of bottom valve shall be carried out as per schedule. To prevent any leakage from tank body, thickness checking shall be same as per schedule.
- In case of any material leaching the soil it shall be neutralized and washed with water.

TABLE- 6.6: KEY PERSONNEL

KEY PERSONS						
S. No	NAME	QUALIFICATION	DESIGNATION	ADDRESS	PLACE OF AVAILABLE & CONTACT PHONE NUMBERS	
					FACTORY	RESIDENCE
ALTERNATIVE KEY PERSONS						

6.47 EXTERNAL AND INTERNAL EMERGENCY TELEPHONE NO.S**TABLE- 6.7: EXTERNAL EMERGENCY TELEPHONE NO.S**

S. NO	NAME	PLACE	OFFICE

TABLE- 6.8 INTERNAL TELEPHONE NO.S

S. NO	NAME & LOCATION OF THE PLANT, DEPARTMENT OR AREA	TELEPHONE NUMBERS

6.48 ESSENTIAL WORKERS

A task force of essential trained workers [expert's team] is available to get the work done by the incident controller and the site main controller. Such work will include: Fire fighting and spill control till a fire brigade takes the charge.

- To help the fire brigade and mutual aid teams, if it is so required.
- Shutting down plant and making it safe.
- Emergency engineering work e.g. isolating equipment, material process, providing temporary by-pass lines, safe transfer of materials, urgent repairing or replacement, electrical work, etc.
- Provision of emergency power, water, lighting, instruments, equipments, materials, etc.
- Movement of equipment, special vehicle and transport to or from the scene of the accident.
- Search, evacuation, rescue and welfare.
- The injured is given first aid.
- Moving tankers or other vehicles from area of risk.
- Carrying out atmospheric test and pollution control.
- Manning of assembly points to record the arrival of evacuated personnel. Manning for outside shelters and welfare of evacuated persons there.
- Assistance at casualties reception areas to record details of casualties.
- Assistance at communication centers to handle outgoing and incoming calls and to act as messengers if necessary.
- Manning of works entrances in liaison with the police to direct emergency vehicles entering the work, to control traffic leaving the works and to turn away or make alternative safe arrangements for visitors, contractors and other traffic arriving at the works.
- Informing surrounding factories and the public as well as directed by the site main controller.
- Any special help required.

TABLE- 6.9: ESSENTIAL WORKERS

S. NO	NAME	DESIGNATION	RESIDENCE ADDRESS & CONTACT PHONE NUMBERS	TRAINED FOR WORK

6.49 ASSEMBLY POINTS

At the time of emergency, on-essential workers, casual workers, visitors and others are to be replaced to assembly points and separate in charge are nominated.

TABLE- 6.10: LIST OF ASSEMBLY POINTS

S. NO.	LOCATION	ACCOMMODATION CAPACITY	AT THE TIME OF EMERGENCY			NEAREST TEL. NO.
			PERSON IN-CHARGE	PLACE OF AVAILABLE & TELEPHONE NO.		
				FACTORY	OFFICE	

6.50 EMERGENCY CONTROL CENTRE

ECC means the place from where the emergency may be controlled by ECC controller and other key personnel. Location of the centre **SECURITY CABIN.**

TABLE - 6.11: FIRE AND TOXICITY CONTROL ARRANGEMENTS

S.NO	ITEM TO BE KEPT IN THE CENTER	QUANTITY	PERSONS WHO WILL HANDLE OR OPERATE THIS ITEM	ITS PERIOD OF OPERATION	NOTES
1	Safety Helmets		Plant employees including security personnel are trained in the use & upkeep of all the personal protective equipments available in the factory. They will operate & use these equipments & tackle emergency situation. Separate persons are trained for fire and toxic gas control. They are also trained personnel protective equipment.	The equipments kept in ECC are being used regularly & all the time kept in ready to use condition. Whenever they are being used if required they are being cleaned /maintained or being replenished immediately.	<p>The safety equipments kept in the ECC have 24 hrs.access to all employees.</p> <p>Outside aid agency likes fire brigade, medical etc.will go to the factory premises via the emergency control centre</p> <p>Besides at plant/shop floor level various types of personal protective equipments are kept for the use of plant employees in emergency</p> <p>Plant employees are being trained on the use & upkeep of all safety Equipments.</p>
2	Safety Hand Gloves <ul style="list-style-type: none"> • PVC • Rubber • Cotton Cum • Leather • Asbestos 				
3	Safety Goggles <ul style="list-style-type: none"> • Spectacle Type • Panoramic Type 				
4	Face Shield				
5	Aprons <ul style="list-style-type: none"> • PVC • Cotton 				

S.NO	ITEM TO BE KEPT IN THE CENTER	QUANTITY	PERSONS WHO WILL HANDLE OR OPERATE THIS ITEM	ITS PERIOD OF OPERATION	NOTES
6	PVC Suits		Plant employees including security personnel are trained in the use & upkeep of all the personal protective equipments available in the factory. They will operate & use these equipments & tackle emergency situation. Separate persons are trained for fire and toxic gas control. They are also trained personnel protective equipment.	The equipments kept in ECC are being used regularly & all the time kept in ready to use condition. Whenever they are being used if required they are being cleaned /maintained or being replenished immediately	<p>The safety equipments kept in the ECC have 24 hrs. access to all employees.</p> <p>Outside aid agency likes fire brigade, medical etc. will go to the factory premises via the emergency control centre</p> <p>Besides at plant/shop floor level various types of personal protective equipments are kept for the use of plant employees in emergency</p> <p>Plant employees are being trained on the use & upkeep of all safety Equipments.</p>
7	Safety Gum Boots				
8	Self Contained Breathing Apparatus				
9	Gas mask with canister				
10	Safety emergency				
11	Fire extinguishers <ul style="list-style-type: none"> • DCP[10kg.cap] • Co2[3.2kg.cap] • Soda acid[9lit.cap] • Foam [10lit.cap] 				
12	Fire hoses with branches				
13	Explosive meter				
14	Gas detection devices				
15	Resuscitator				
16	Portable mike				

S.NO	ITEM TO BE KEPT IN THE CENTER	QUANTITY	PERSONS WHO WILL HANDLE OR OPERATE THIS ITEM	ITS PERIOD OF OPERATION	NOTES
17	Telephone- P&T intercom		Plant employees including security personnel are trained in the use & upkeep of all the personal protective equipments available in the factory. They will operate & use these equipments & tackle emergency situation. Separate persons are trained for fire and toxic gas control. They are also trained personnel protective equipment.	The equipments kept in ECC are being used regularly & all the time kept in ready to use condition. Whenever they are being used if required they are being cleaned /maintained or being replenished immediately	The safety equipments kept in the ECC have 24 hrs.access to all employees.
18	Emergency siren switch				Outside aid agency likes fire brigade, medical etc.will go to the factory premises via the emergency control centre
19	First aid box				Besides at plant/shop floor level various types of personal protective equipments are kept for the use of plant employees in emergency. Plant employees are being trained on the use & upkeep of all safety Equipments.

6.51 RAISING THE ALARM

- Emergency alarm should be raised in the event of an emergency.
- Any person noticing an unusual occurrence, fire, chlorine leakage, toxic or corrosive substance leakage etc. should inform the concerned department/section head/shift in charge immediately and try to control/contain the incident.
- Departmental head/shift in charge will immediately go to the site of incident, assess the situation and initiate the action to “blow the emergency Alarm” by telephoning the main gate to security officer/Asst, security officer/Security supervisor.
- In case of telephone failure a messenger should be sent running to main gate to inform.

Details of siren are given below

Siren codes

- Declaration of emergency:-A long short wailing siren for one minute will mean that there is an emergency within the premises.
- All clear siren: - A long siren for one minute will mean that the emergency declared is under control, i.e. all clear. This siren code will mean All clear, normal condition.
- Evacuation siren:-A long short wailing siren for 3 [three] minutes, will mean that emergency declared cannot be controlled. Hence all persons in the premises will evacuate as per the plan.

TABLE- 6.12: DETAILS OF ALARMS AND SIRENS

S. NO	TYPE OF EMERGENCY	TYPE OF SIREN /ALARM	DURATION OF SOUNDING	TYPE OF SOUND
1	Fire & explosion	Electrical operated siren	1 Minute	Continuous
2				
3				

6.52 DECLARING MAJOR EMERGENCY

Major emergency may be declared after sufficient thought because it activates many agencies. The nominated persons to declare major emergencies are given.

TABLE- 6.13: NOMINATED PERSONS TO DECLARE MAJOR EMERGENCY

S. NO.	NAME OF PLANT/DEPT./LOCATION	NAME & DESIGNATION OF THE PERSONS NOMINATED TO DECLARE THE EMERGENCY	DUTY OR DESIGNATION GIVEN UNDER THE ON-SITE/OFF-SITE EMERGENCY PLAN	TELEPHONE NO.	RESIDENCE ADDRESS AND TELEPHONE NO.

6.53 TRANSPORT AND EVACUATION ARRANGEMENTS

Following arrangements shall be made for the transport and evacuation of persons in case of any emergency situation arises in the factory.

Those employees who have own vehicles will make arrangements to shift the injured.

TABLE- 6.14: TRANSPORT AND EVACUATION ARRANGEMENTS

NAME & LOCATION	TELEPHONE NO.	IN CHARGE PERSON		OWN VEHICLES		
		NAME & DESIGNATION	RESIDENCE ADDRESS & TELEPHONE NOS.	TYPE & NOS.	CAPACITY	DRIVER'S NAME &ADDRESS

6.53.1 TELEPHONE MESSAGES

Telephone operator has to play vital role in case of emergency. After hearing the siren/hooter, he/she should inform to all key personnel immediately on phone. He/she should be very sharp, precise, attentive and quick in & noticing the message.

TABLE- 6.15: FORMAT TO RECORD EMERGENCY CALL

PART - A ESSENTIAL INFORMATION		
DETAILS OF CALL AS REPORTED		
CALLER'S NAME & DESIGNATION PHONE NO.	DATE:	TIME:
PURPOSE: OF CALL IS ANY PARTICULAR ADVICE REQUIRED IMMEDIATELY?		
NAME OF CHEMICALS TO BE SPELT OUT CLEARLY BRIEF DESCRIPTION OF INCIDENT. FIRE/EXPLOSIVE/LIQUID SPILL/GAS RELEASE QUANTITY INVOLVED PACKING/STORING/HANDLING/USING DETAILS LOCATION OF INCIDENT CAUSE, IF KNOWN, IN BRIEF		

PART- B INFORMATION TO BE OBTAINED IF READILY AVAILABLE		
HAS ANY ONE BEEN INJURED	YES / NO	
IF YES, HOW MANY AFFECTED BY CHEMICALS	YES / NO	IF YES,
HOW		
WHAT FIRST-AID HAS BEEN GIVEN	YES / NO	
IF YES, ADDRESS OF THE HOSPITAL.		
IS THE ROAD BLOCKED	YES / NO	
CLOSED TO TRAFFIC	YES / NO	
WHO OWNS THE CHEMICALS		
HAS THE OWNER BEEN INFORMED	YES / NO	
IF CAUSED BY VEHICLE		
VEHICLE NUMBER AND NAME & ADDRESS OF THE OWNER		
HAS THE OWNER BEEN INFORMED	YES / NO	
TO WHOM WAS THE LOAD CONSIGNED		

6.54 MUTUAL AID

In emergency situations, resources over and above those available at the works may be needed. Emergency Coordinator would be contacting neighboring factories for help. A survey of industries who can come to help and also the help, they can extend is done as mentioned below.

- The help would be in the form of technical manpower, medical aid, transport for rescue and Rehabilitation, fire fighting, additional special protective wear or any other help as the case may be.
- Manager – Safety who is Emergency Coordinator is assigned with this responsibility and he would maintain liaison during non-emergency period and ensure co-operation
- Similarly, the help required from civil administration, in respect of medical aid, transport, law and order, rehabilitation etc. are identified and liaison is established with Mandan Revenue Officer and Police Officials.

6.55 MOCK DRILL

Mock Drills would be organized once in six months to evaluate the Preparedness and functioning of OSEP.

- It is also planned to undertake few informed and uniformed mock drills [or rehearsals] for meeting emergencies.
- Such rehearsals would be carefully analyzed and shortcomings would be identified and necessary corrections would be taken up.
- Site Controller is responsible for planning and execution and evaluation of mock drills. Also information would be given to statutory authorities.