7.2 RISK ASSESSMENT

The proposed expansion through capacity utilization of Bulk Drugs and Intermediate would be undertaken and implemented by the management of **Smruthi Organics Ltd. (SOL)** in their own premises. The risk assessment and hazard management study was done by **Mr. Vinod Sahasrabuddhe** who is the FAE for RH with respect of EEIPL. The proposed expansion project would be formulated in such a fashion and manner, so that utmost care of safety norms and Environment Protection Act shall be taken care of.

7.3. RISK ASSESSMENT REPORT

Under proposed expansion activity bulk drugs will be manufactured by batch production and will be carried out on campaign basis. General production process for proposed expansion products consist of

- Various organic reactions in 2 to 3 stages in various solvent mediums
- Recovery of solvents by batch distillation for recycle and reuse of solvents
- Separation of intermediate products by filtration.
- Layer separations and recovery of crystallized product by centrifuge.
- Drying to get the final product.

➢ **Objectives And Scope of the RH Report:**

- The production of Active Pharmaceutical Ingredients (API`s) involves usage of many chemicals which are both hazardous and non hazardous in nature.

➢ **Objective of the Risk and Hazard analysis is to**

1) Identify hazards and nature of hazard in the process, storage and handling of hazardous chemicals.
2) Carry out Qualitative risk analysis for the process and suggest mitigation measures.
3) Carry out Quantitative risk analysis of the storage of hazardous chemicals and estimate the threat zones for Most Credible and Worst case scenarios
4) Suggest mitigation measures to reduce the risk/probability of the accident to the minimum.
5) Incorporate these measures for ensuring safe operations and safe layout and for effective preparation of On-site and Off-site emergency plans
6) Suggest Guidelines for on-site and off - site emergency plan

7.4. HAZARD IDENTIFICATION

7.4.1 Methodology-

Identify hazards based on

- Processes description received based.
- Identify Hazardous Chemicals handled and stored.
- Inventory of Hazardous chemicals.
- Proposed storage facilities for hazardous chemicals.
- Plant layout

➢ **Hazard Assessment:**

- By Qualitative Risk Assessment

- By Quantitative Risk Assessment by Hazard index calculations and estimate threat zones by using ALOHO

➢ **Recommendations:.**

- Recommend mitigation measures based upon the above
- Recommending guidelines for the preparation of On-site Emergency plan.

7.4.2 Risk Prone Areas in SOL

Based on classification of chemicals, the risk prone areas have been identified as follows-

- Reaction and Separation sections
- Storage of chemicals in respective vessels.
- Handling of the materials or the process equipment by the operator or worker.
- Transportation of the products and raw materials.

7.4.2.1 Reaction and Separation Sections

- In such pharmaceutical API production plants in the reaction section separation sections are the major hazards. The hazards identified are, exposure to hazardous and toxic chemicals during handling, leakage, and fire/explosion depending upon the operating conditions temperature, pressure, and reactions are exothermic.

➢ **For this basic and the most important mitigation measures suggested are:**

- Setting up a SOP after serious considerations.
- Once the SOP has been finalized, strictly following it, 24X7, particularly for batch operations without any change of procedure.
- It is strongly recommended to take all the preventive measures to minimize the probability of the accident to the minimum and make the process and reactor operation as intrinsically safe as possible. Because prediction of realistic estimation of the extent of damage and damage control after the accident is extremely difficult in case of reactor accident.
- Must have system to check that the procedure is not violated at any time, and no short cuts are taken.
- Have following alarm and interlock system (essential for highly exothermic reactions and alarms recommended for all exothermic reactions)
  1. Utility failure alarm
  2. Agitator failure alarm
  3. High temp alarm
  4. High rate of addition alarms
- Raw material addition will be controlled by actuator valve linked with the reaction mass temperature and agitator tripping.
- Chemicals addition will be controlled by mass flow meter.
- Similar safety measures and alarms etc. need to be provided for separation and purification sections of the plant operations.

- In pharmaceutical production plants, the reaction and separation sections are the major hazards. The hazards identified are exposure to hazardous and toxic chemicals during handling, leakage, and fire/explosion depending upon the operating conditions, temperature, pressure and reactions.
- HAZOP studies have been carried out for potentially dangerous and hazardous reactions in the manufacture of products. All safety features have been designed to mitigate the risk and hazard to minimum. Copy of Hazop report may be referred in **Appendix –N**

a) Raw material addition is controlled by actuator valve linked with the reaction mass temperature and agitator tripping.
b) Reactors are interlocked with the temperature sensors, pressure sensors, flow meters and level measurements.

- It is known that highly exothermic reactions and even mildly exothermic reactions can lead to the uncontrollable rise in temperatures and pressures and ultimately to the conditions of run-away reaction, which results in sever explosion and fire.
- The major reason for occurrence of uncontrollable rise in temperature is accumulation of un-reacted reactants. This has to be avoided at any cost.

- **Centrifugation**

Safety measures already adopted in centrifugation areas are as follows-

a. Feeding rate control as per standard operating procedure (SOP).
b. Regular maintenance and inspection
c. Vibration sensors.

- **Other Safety Measures**

1. Eye wash and water shower have been installed on each operating floor of the production.
2. Flow controllers, temperature controllers, pressure controllers are installed as per P&ID diagram.
3. Alarms, sirens and other hazard identification equipments and indication instruments are installed in every risk prone areas.
4. To maintain temperature and pressure, cooling coils for temperature and pressure heads have been provided to respective reaction equipments.

7.4.2.2 Storage of Hazardous Chemicals in Carboys, drums

For the manufacture of above 24 products solvents and hazardous raw materials are used. Out of these hazardous raw materials have been characterized into

1. Flammable solvents
2. Toxic and hazardous chemicals
3. Corrosive chemicals

Products manufacturing under existing and proposed expansion activities involves handling of number of raw materials and hazardous chemicals. Raw materials required in less/ small quantities are stored in drums, bags and carboys. List of raw material handling equipments may be referred in **Appendix-O**

- **Warehouse Storage**

➢ **Hazard Identification**

Major hazards involved in storage of flammable liquids in the containers, like drums are: Fires and vapour explosion due to leakage of liquids coming in contact with ignition source. The extent of a fire or explosion hazard depends on the amount of flammable vapour given off from a liquid which is determined by: the temperature of the liquid; the volatility of the liquid; how much of the surface area is exposed; how long the liquid is exposed for; and the air movement over the surface. Physical properties of the liquid give additional information on how vapour/air mixtures may develop into serious potential hazards. These physical

properties include: flashpoint; auto-ignition temperature lower and upper explosion limits.

- **Reasons**

Main reasons for fire are, lack of awareness of the properties of flammable liquids; operator error, due to lack of training; inadequate or poor storage facilities; hot work on or close to flammable liquid; exposure to heat from a nearby fire; decanting flammable liquids in unsuitable storage and dismantling or disposing of containers containing flammable.

In warehouse fire hazards could occur if there are spillages/ leakages. Safety measures adopted in warehouse areas are as follows-

1. Proper and adequate training to the operators, contract works on the hazards and precautions SOP they must follow while handling and transferring flammable liquids. Making sure that they don't lose the fear of hazards involved in handling of flammable solvents and toxic chemicals and consequence of the accident.
2. Must have standard work permit system for carrying about any maintenance work, hot or cold near the storage of flammable liquids. Ensuring that this is implemented always and strictly.
3. In the design of storage of warehouse ensuring implementation of following 5 principles will reduce the possibility of accidents to the minimum.
4. Ventilation: Good ventilation means vapours given off from a spill, leak, or release, will be rapidly dispersed.
5. A good standard of ventilation is required in buildings or rooms used for storing flammable liquids, to disperse the vapours from any small releases. The ventilation arrangements need to take into account the heavy nature of the vapours and to ensure adequate air movement at high and low levels.
6. Five air changes per hour are normally sufficient to ensure vapour levels in the store are kept to a low level. For small buildings, the simplest method of ensuring adequate ventilation is to provide fixed, permanent openings.
7. Ignition: Have all ignition sources been removed from the storage area, by FLP electrical fittings, no sparking by ensuring permit system during maintenance work, Declaring this as NO Smoking and No Naked flame area.
8. Containment: Use of proper containers, providing spill kit, proper drainage of spillage to safe place, collection and recycle, Containers should be stored in at ground level (singly or in stacks). This enables leaks or releases to be quickly seen, and allows for any vapours to be dispersed effectively by natural ventilation.
9. Exchange: Substituting with less flammable liquid.
10. Separation: flammable liquids should be stored well away from other processes and general storage areas. If necessary the storage should be separated by a physical barrier, wall or partition.
11. Material Safety Data Sheet (MSDS) is maintained for each chemical to which workers are exposed in the facility;
12. Instructions have been followed as per the MSDS for handling chemical and products.
13. Employees are trained for handing risks of each chemical being stored.
14. Spill cleanup kits have been provided in all areas where chemicals would be stored.
15. A written down procedure have been formulated and training imparted to employee for spill control and cleaning.
16. Adequate and proper personal protective equipment have been provided and enforce to use while working.
17. All chemicals are stored safely and securely.
18. Chemicals have been stored away from forklift traffic areas.

19. Drums / carboys of chemicals are stored in designated place in warehouse, separated by at least 1 meter and have been arranged based upon the compatibility/non compatibility properties. Provision of two gates for the warehouse is applied.
20. Sufficient fire extinguishers DCP Type & CO2 Type & Foam Type have been provided inside the warehouse & at the entry.
21. No dispensing in storage area is allowed.

- **Warehouse Design Considerations For Project**

1. Roadways around warehouse should be min 5 meters wide and compound gates min 4.5M wide.
2. Floor areas: WH should be divided to have max 750 sq m area by separating walls. Dimensions LXW not exceeding 40 meter.
3. Floors should have 2 hrs fire resistances.
4. Buildings used for storage of hazardous and extra-hazardous goods should be preferably of single storied structure and in no case should exceed 2 stories in height.
5. In no case should a storage building exceed 1S m in height.
6. Floor drainage : the floors should be of watertight construction and scuppers of not less than 20 cm sq cross sectional area should be provided at no more than 6·0 m intervals or as required to take care of maximum water discharge from hydrant/sprinkler system.
7. External drainage external drains of not less than 25 cm width and 30 cm depth should be provided along the side of each building and so constructed that any flow of water from the building be directed to a suitable ground tank or reservoir or public drainage system in the vicinity not leading to a natural water source. No external drainage of warehouses storing hazardous goods should be connected to public drainage system which leads directly to a natural water source.
8. Every storage/warehouse building should have a minimum of two exit doorways, and at the rate of one exit doorway per every 30 m length of the external walls of the building.
9. The means of exit as well as the exit ways, travel distances, etc, should be as per the guidelines given in IS 1641: 1988. If used for storage of hazardous goods, it should conform to Type I of IS 1642 : 1989.

- **Measures Suggested for Improvement in the Design of Warehouse:**

1. Dividing warehouse into fire compartments, by suitably designed firewalls, to limit the spread of fire.
2. Limiting the quantity of hazardous chemicals stored.
3. Thyonil Chloride should be stored in a separate area, away from flammable chemicals where there will be no water sprinklers.
4. It is safe practice to store explosive, self igniting, oxidizing and organic peroxides separately, preferably in different compartments.
5. Storage of chemicals should be planned by categorizing these based on their hazardous properties, like toxicity, flammability, explosibility, for which MSDS needs to be critically studied.
6. Based on the above, proper segregation of materials should be achieved.
7. Installation of smoke, fire and toxic gas leak detectors.
8. It should be easily possible to reach and attend toxic chemical leakage.
9. There should be enough space, and pathways for easy approach and escape.
10. Having all flameproof fittings inside the warehouse.

11. Installing sprinkler system where flammable chemicals are stored and ensuring that these are not installed in the area where water reactive chemicals are stored.

Table 7.1 Quantified Action Plan for Warehouse Safety

Ref No.	Location	Hazard Review	Controls	Risk Level			Suggested Action Plan
				Low	Medium	High	
1.	Dispensing room Ground floor, ware House	Fire Exposure to chemicals	SOP FLP fittings PPE	X			FLP maintenance as per IS-SOP to be reviewed Policy to prevent dispensing of highly reactive materials having rating of NR 3,4 NF 3,4 Oxidizing and water reactive materials. Smoke detectors, Non-sparking tools.
2.	Charcoal store. ware house Ground floor,	Dust explosion Self heating.	FLP fittings. SOP PPE	X			FLP fittings would be dust tight. Heat detectors. Respirators.
3.	Ground floor, Hazardous material store Warehouse	Fire Explosion.	SOP RCC room			X	Humidity control to maintain dry air. Gas detector detectors Special DCP extinguishers. Double door opening. Non-sparking tools.
4.	Sampling room	Fire Toxic release.	SOP FLP fittings PPE	X			FLP maintenance as per IS-SOP to be reviewed Policy to prevent sampling of highly reactive materials having rating of NR 3,4 NF 3,4 Oxidizing and water reactive materials. Smoke detectors. Non-sparking tools.
5.	Packing materials. Ware house	Fire	Proper segregation	X			Provide smoke detectors.
6.	Solvent tanks. Tank Farm	Fire Explosion.	Double earthing Flame arrester. Loading unloading SOP FLP fixtures. Fire extinguishers Fire Hydrant		X		Sprinklers for tanker. Static discharge interlock system Non-sparking tools.
7.	Acids storage Shed	Exposure to vapors. Liquid contact.	Long sleeved gloves. Chemical		X		Supplied air mask. Chemical clothing should be based on permeability.

Ref No.	Location	Hazard Review	Controls	Risk Level			Suggested Action Plan
				Low	Medium	High	
			suit. Face shield Canister mask.				

*FLP -Flame proof Fitting

Warehouse is provided with alarm systems and sprinklers to mitigate fire hazard. Refer photographs of same appended **at Appendix-P**

7.4.2.3 Bulk Storage of Hazardous Reactants

Solvents namely Methanol, Hydrochloric Acid, Acetic Acid, Toluene, Xylene and Sulphuric acid are stored in tanks of respective capacity. These tanks are placed above ground. Maximum Storage of these chemical would be 65 KL at a time. The area allocated for tanks is 683.5 Sq. M. Major hazard in this area is of leakage of tank leading to pool fire, BLEVE. Major hazard identified is leakage of solvents which may lead to fire (pool-fire) and rarely to vapour cloud explosion, if there is ignition source when the concentration of solvent is in the explosive range.

Safety measures adopted in bulk storage area is as follows-

The storage tanks are provided with dyke wall. Tanks are segregated based on contents, solvents, acids –

a. The tanks will be kept above ground level and painted with anti corrosive paint. The tanks will be placed on the PCC platform.
b. Clear distance between each tank will be minimum half the tank diameter.
c. Tanks are located in the dyke and dyke wall dimensions are 50 feet by 60 feet by 3 feet height have been provided.
d. Double valve will be provided for dispensing of material.
e. Drainage arrangement inside the dyke will be designed for collection of leakage and recycle to the tanks or manually collecting in drums.
f. The tank farm layout and tank farm location will follow the rules of Petroleum Act 2003.
g. All the necessary statutory licenses and approvals needed for the Class A flammable liquids will be obtained.
h. Stainless steel pump with mechanical seal will be provided to the tank for transfer of solvents. Dedicate transfer line from storage tank to the day tank are provided to the pump with pressure gauze.
i. The tanks will be provided with flame arrestor and breathing valve and vent condenser wherever necessary.
j. Automatic sprinkler system will be installed on each tank for cooling the tanks externally and eliminate the possibility of further aggravation of the situation.
k. Provisions will be made to the facility for earthing the static charge generation during loading and unloading of tankers.
l. Metal wire Jump-over connections will be provided on transfer lines for flange connections.
m. The tanks will be properly connected to the earth pit.
n. The area will marked with sign boards.

o. Day tanks will be provided in the manufacturing plants to keep the inventory to the minimum required and thus reduce potential risk.
p. As per the factories act, the tanks will be frequently tested to its thickness and integrity by competent person.
q. Fire hydrant piping will be laid around the tank farm and will be designed as per the IS and other applicable standards.
r. Trained fire fighters shall be provided for the site.
s. The area will be marked with red zone where necked flames, hot work will be strictly avoided.
t. Work permit system will be implemented for carrying out any hot or cold work near the tank storage area, as well as all over the factory.
u. Spill kits, sand buckets shall be provided. Spillage control procedure will be provided to the site.
v. The area will provided with 24 hrs security and kept in lock and key. Eye and body shower will be provided just outside the storage.
w. All the tanks will be designed and fabricated as per the relevant Indian and international applicable codes.
x. The tank layout and tank-farm layout vis-vis factory layout will be as per the applicable Petroleum Rules 2003, for the storage of Class A Flammable chemicals.
y. The necessary approvals from the CCE will be/have been obtained.
z. Foam base system is available on site for flammable liquids. Refer photographs of same appended at **Appendix-P.**

Fire hydrant layout is appended at **Appendix – Q**

Table 7.2 Details of Storage of Solvents

Sr. No	Tank ID	Material in Tank	Height	Diameter	Max. Storage At a Time at Site (MT) or KL
1	J/ST/001	Methanol Tank No.1	3.75	2.4	65 KL
2	J/ST/002	Methanol Tank No. 2	5.08	2	65 KL
3	J/ST/003	Toluene Tank No. 1	5.08	2	25 KL
4	J/ST/004	Toluene Tank No.2	3.82	1.8	25 KL
5	J/ST/005	Ethyl Acetate tank No.1	3	2.5	12KL
6	J/ST/015	Ethyl Acetate tank No.2	3	2	12KL
7	J/ST/021	Methanol Tank No. 3	4.54	2.4	65 KL
8	J/ST/022	Xylene	3.6	2.4	10 KL

7.4.2.4 Storage of Acids and Alkali in Tanks:

It is proposed to store, 30-36% HCL solution in 10 Cu.m and 98 % Sulphuric Acid in 5 Cu. M and Acetic Acid in 10 Cu. M and Caustic lye I 15 Cu.M tanks.

- **Hazard Identification**:

Leakage HCL storage tank particularly will cause serious environment pollution problem and may harm the workers in the factory, as TLV for HCL gas is = 3-5 ppm only.

- **Mitigation Measures:**

Following mitigation measures are suggested to minimize possibility of major leak from HCL tank and air pollution in particular. But these are applicable and relevant for all acid storage tanks.

- HCL storage tank leakage can create serious risks, not only to people on-site, but also to the emergency services, to the general public off-site and to the environment. The greatest risk of significant harm is a large spill or leak from tanks or pipe work or associated plant.
- The main causes of such incidents include:
  a) Failure to detect corrosion and replace corroded components;
  b) Damage caused by the impact of vehicles or other objects;
  c) Overfilling
  d) Small spills and leaks can produce serious injuries if people come into contact with the liquid or inhale the fumes. Minor incidents can develop into major incidents if prompt emergency action is not taken.
  e) The basic aim to suggest mitigation measures is to minimize the likelihood of a spillage; reduce the consequences of such an incident, particularly with regard to people and the environment.

- **Location of the Tank:**

1. When selecting the location of acid storage tanks, the consideration should be given to the distance of the proposed tank farm from:
2. Site boundary
3. Roadways and site thoroughfares
4. Occupied buildings
5. Storage or processing of other dangerous substances particularly incompatible substances such as strong alkalis and oxidising agents; water courses and boreholes.
6. The tanks are aboveground and must be installed on the foundation (and the supports for horizontal tanks). These should normally be of concrete with the required load bearing strength and thickness.

- **Dyke Walls**

a. The tanks must be covered with the dykewalls. The purpose of the dyke wall is to:
b. Prevent the liquid entering drainage or other water systems.
c. Prevent the spread of the liquid which could present a hazard to other plant or personnel both on and offsite.
d. Prevent contamination of land.
e. Allow the controlled recovery or treatment of the spilled material.
f. The dyke walls and floor should be constructed of materials resistant to the acid being stored. Acid resistant tiles are available and bricks and cement can be faced with acid resistant coatings. Coatings will require maintenance and regular renewal. The choice of materials will depend on the acid itself, its concentration and temperature.
g. The bund should have sufficient capacity to contain the largest predictable spillage. A bund capacity of 110% of the capacity of the largest storage vessel within the bund will normally be sufficient. Consideration should be given to the provision of individual dyke walls for each acid tank to prevent damage to other tanks if a leak occurs. Chemicals which react with the acid should not share the same bund.
h. The dyke walls should have sufficient strength to contain an acid spill.
i. Rainwater should not be allowed to accumulate in the bund.

j. Provision must be made for the removal of bund contents (e.g acid spills or rainwater).
k. These can be, providing a sump and a manually controlled sump pump, should be provided.
l. Bund liquids should be analyzed as necessary before removal or disposal to prevent contamination of drainage systems.
m. If a drain valve is used it should be kept locked in the closed position and only used by authorized personnel. The drain valve and any associated piping should be made of materials compatible with the acid stored.

- **Vents and Overflow lines of the storage tank:**

a. Atmospheric tanks should have separate vent and overflow lines. The overflow should be sized to prevent any pressure build up within the tank in the event of an overfill. The overflow diameter should be equal to or greater than the inlet diameter. Normally, the overflow is at least 100 mm (4 inches) in diameter and at least 350 mm below the vent base. It should terminate as close to the ground as possible within the bund or other contained area. To prevent fuming, a dip leg and small water lute can be used.
b. To prevent release of fumes into the atmosphere, vent lines of bulk acid tanks should feed into a scrubber unit. The scrubber should be designed to cope with the fumes given off and the pressures generated during the filling of the tank. The scrubber should be so designed that HCL fumes escaping should be within the norms set by the statutory authorities.
c. Water, sodium hydroxide solution or dilute acid solution can be used as the scrubbing medium. Provision should be made to monitor the pH of the scrubbing solutions.
d. **Piping:** While designing the piping and piping routing it is advisable to have minimum flange joints. The line should be so routed to avoid walkways and joints over the walk ways.
e. All pipe lines of acid, being of HDPE MOC, should be protected against foreseeable impact from vehicles or mobile plant.

- **Measures for Coal Storage**

1) Fire hydrant lines (self auto-mode fire fighting) will be laid around these areas.
2) No hot work is permitted in this area without safety permit.
3) All useful material is stored far away from storage of bagasse and coal area.
4) Proper supervision staff with necessary communication facility is deployed.
5) Training will be arranged for all the staff in normal & emergency operating system.
6) Proper training is imparted for creating awareness among workers about sudden bagasse and coal fire and emergency action plan. This is part of On-site-emergency plan.

7.4.2.5 Handling of the Materials / Process Equipment

List of equipments may be referred in **Appendix-D**

Safety measures adopted during handling of hazardous chemicals/ equipments are as follows-

A. Care during Handling, Use and Storage of Thyonil Chloride-

With respect to Thyonil Chloride following precautions are special because of peculiar dangers for man and environmental. It reacts violently with water. Contact with water liberates toxic gas. Hence the drums of Thyonil Chloride are separately stored in a separate area which is not covered with sprinkler system and in water tight containers. Spill Kit and absorbing material used for removing the spill will be readily available in ample quantity. Workers controlling the spill wear proper PPE to strictly avoid contact with skin, as this is

very corrosive chemical. All other workers will evacuate the warehouse and /or area where the spill has occurred. Siren will be sounded and higher authorities will be informed to take necessary action. Actions to be taken in case of spill will form an important part of Onsite Emergency Plan and mock drill.

- **Mitigation Measures**

a) Thionyl Chloride reacts with water violently releasing toxic gases like SO_2. Hence drums will be stored in dry place and ensure that there is no water seepage or leakage etc in the area where drums are stored.
b) Operator vigilance and frequent checking of drum quality and condition and installation of leak detectors is highly recommended.
c) Spill kits, recommended PPEs will be available all the time in sufficient quantities and in an easily accessible place. Only trained operators will deal with leakages and alert authorities.
d) No manual handling of even small quantities is recommended. If and when unavoidable, it will be ensured that all the precautions necessary against sudden failure of the container have been taken.
e) All necessary PPE's will be used while manually transferring of handling Thionyl Chloride.
f) Use local ventilation exhausts conditions, if not possible use breathing apparatus, recommended PPEs.
g) Workers need to be properly informed and trained to handle this.
h) As far as possible use suitable air operated pump to transfer TC from the work place to the user end.
i) Eye and shower facilities should be installed at the nearest possible position and it should be ensured that it is always in working condition.
j) Spill kit must be kept handy to absorb small leaks and disposal.

B. Care during Handling, Use and Storage of Chloroform

Chloroform is a suspected human carcinogen and reproductive toxin. It is commonly used as a solvent in the laboratory as a reagent in organic synthesis. Clear, colorless, volatile liquid with pleasant sweet odour affects CNS.

- **Route of Exposures**: Through Skin, inhalation, ingestion, injection
- **Handling Instructions:**

Employees will be trained to handle the material. Personal will use 70% ethanol to decontaminate work surfaces after use.

- **Storage :**

Chloroform will be protected from heat sources, direct sunlight and moisture. Chemicals will never be stored above eye level. Chemical containers will be closed and labeled.

- **PPE Requirement:** Lab coat, face shield, goggles, respirator, nitrile gloves etc. will be used.

- **Description:** Clear, colourless, volatile liquid with pleasant sweet odour affects CNS

Route of Exposures: Through Skin, inhalation, ingestion, injection.

- **Handling Instructions:** Employees must be trained to handle the material. Personal should use 70% ethanol to decontaminate work surfaces after use.

- **PPE Requirement:** Lab coat, face shield, goggles, Respirator, nitrile gloves etc.
- **First Aid:** Wash skin with plenty of water and remove contaminated clothing

Disposal Proced1ure / Recovery: All unused chloroform and By -product will be collected in appropriate specifically labeled, leak-proof container and send back to the supplier/ original manufacturer.

- **Air emission control**: Effective two stage scrubbing system will be provided.

C. Care during Handling, Use and Storage of Ammonia Gas

All the precautions have been taken while handling Ammonia cylinders and safe working with ammonia as per IS 4244 -2000 standards.

- **Mitigation Measures for Ammonia**

Ammonia Cylinders:

Hazard: Damage to cylinder valve or leakage from the connector to gas manifold or from pipeline. Ammonia is classified as Class 2.3 Toxic gas.

Table 7.3 Toxic Properties of Ammonia

Vapour Concentration(ppm)	General Effect	Exposure Period
1-5	Odour detectable by most person	Prolonged repeated exposure produces no injury
25	No adverse effect for average worker	Maximum allowable concentration for 8 hour working exposure
35	No adverse effect for average worker	Exposure should not be longer than 15 minutes and should not occur more than four times per day.
400 to 700	Nose and throat irritation Eye irritation with tearing	Infrequent short (1/2 hour) exposure ordinarily produces no serious effect.
2 000 to 3 000	Convulsive coughing Severe eye irritation	No permissible exposure. May be fatal after short exposure.
5 000 to 10 000	Respirator spasm. Rapid asphyxia	No permissible exposure. Rapidly fatal.

- **Basic Safety measures for dealing with Ammonia leak:**
  a. Ammonia gas sensors should be installed at selected location with alarm system.
  b. Adequate number of eye washes should be installed wherever ammonia is used and handled.
  c. Ensure that approved, self-contained breathing apparatus are always available and personnel are properly trained for its use.
  d. Safety equipment should be inspected and maintained in accordance with the manufacturer’s instructions.

e. Emergency kits are available that can seal off most leaking areas of ammonia containers. Only trained personnel familiar with this equipment should use these kits. If a ton container is leaking it is good practice to orient the container so that only gas is escaping.
f. Ammonia leaks never get better, they should be responded to immediately.
g. Never use water on a leaking ammonia container; this can cause rapid corrosion of the metals making the leak worse or increase the leak rate if the water temperature is hotter than the gas

- **Safety measures for safe handling of cylinders:**

➢ Ammonia cylinder pressure is 7.77 bar at 21 deg C and 10 bar at 30 deg C. Maximum withdrawal rate recommended is 1.3 lbs/hr
➢ The markings on cylinders that identify the contents, and mark the full/empty status on cylinders. Manufacturers paint gas cylinders using a colour coded system that is useful for identification. Never alter markings, labelling or colour coding of gas cylinders supplied. They are a rented item and should be treated as such. The integrity and compliance of the gas cylinder is the supplier's responsibility.
➢ **Regulators:** The regulator is the next most important safety device to be fitted to a gas cylinder before operation/use. It allows for the high pressure of the cylinder contents to be brought down to a usable working pressure. Regulators come as single stage for short term applications and two stages for long term applications. Regulators are also constructed from different materials, mainly brass or stainless steel.
➢ Bulk cylinder storage gas stores should be located outdoors, preferably in a secure, cage protected from sunlight.
➢ Storage indoors is not recommended unless the building has been designed for that purpose with appropriate fire rated walls and ventilation. Where gases are stored indoors, additional safety considerations and control measures need to be given consideration.
➢ Store cylinders in an upright position.
➢ Secure cylinders using a purpose built non-abrasive coated chain, strap or cable that will not scratch the cylinder markings and paint work or a racking system.
➢ Store cylinders in a dry, well-ventilated area. Place them in a location where they will not be subject to mechanical or physical damage, heat, or electrical circuits to prevent possible explosion or fire. Keep cylinders away from pedestrian traffic.
➢ Full and empty cylinders should be stored separately in clearly marked areas.
➢ Gas cylinders should not be located where they may block stairs, exits, and ladders or walk ways. Ensure an up to date and accurate inventory is kept. Keep inventory quantities as low as possible.
➢ Class 2.3 "Toxic gas" and corrosive gases are stored away from all other gas cylinders.
➢ Do not use oil or grease on the valve of a cylinders or regulators/gauges, particularly those containing oxygen or oxidizing agents, to avoid fire or explosion. Store cylinders in cool areas away from sources of radiant heat (e.g. boilers, hot surfaces, and internal combustion engines).Where possible, store cylinders in the shade to avoid exposing cylinders to direct sunlight.

- **Transport with Vehicles:**

➢ It should be ensured to have your gas supplier deliver the cylinders directly to the field site.
➢ If a vehicle is required to transport cylinders, then it shall be done as follows:
➢ Gas cylinders shall only be transported on an open back truck.
➢ Ideally cylinders should be transported standing up and firmly secured.

- If cylinders are transported lying down than suitable support devices are required to prevent the cylinders from rolling.
- Remove the gas cylinder(s) from the vehicle immediately on arrival to destination. Unload them safely. Don't follow the wrong procedure of unloading the cylinder by rolling them on the tyres.
- It is prohibited to carry gas cylinders of any kind in the passenger compartment of a vehicle.

Transportation Of Chemicals

Chemicals like N7-Quinolinic acid and N7-Quinolinic acid dry are transported by tanker and Handling procedure may be referred at **Appendix- R**

A. Class A Solvents transport:

- Rules to be followed and precautions to be taken:

1) The Petroleum Act and the Petroleum rules 2002 clearly specify in PART IV "TRANSPORT ON LAND BY VEHILES" UNDER RULES 62 TO 86 mandatory for the transportation of Class A chemicals**.**

B. Few important being cited below:

a) No 63 CCE Approval required for tank and vehicle used for transportation.
b) No 64 deals with tank capacity limits and solvent filling limits in the tank.
c) No 65 clearly specifies that the vehicle approved for Class A solvent will not be used for transportation of any other purpose.
d) No 69: No other article can be transported in the vehicle transporting Class A chemical.
e) No 70 makes it mandatory to have spark arrestor fitted to the exhaust pipe of the vehicle and engine air intake fitted with effective flame-arrestor.
f) No 71 specifies Electrical installation requirement for the tanker.
g) No 72 specifies that it is mandatory to carry Fire Extinguisher of minimum 10 kg capacity.
h) No 73 specifies that it is mandatory to have at least one person with knowledge attending the vehicle 24X7 during parking.
i) No 74 specifies rules regarding parking of vehicle in the public place.
j) No 76 specifies rules for loading and unloading of the tanker.
k) No 73 specifies precautions against static charge, the most important being (7) of the same.
l) No 73 specifies precautions against electrical hazard: No loading or unloading unless the engine is switched off.
m) No 83 specifies tanker loading and unloading to be restricted between sunrise and sunset.
n) No 84 prohibits smoking /open flame etc.

C. Sulfuric Acid Transport and Handling:

- Guidelines for transportation:

i. It will be ensured that during the transportation contents are not spilled.
ii. Personnel, including the driver and cleaner are properly trained about the hazardous properties of the material being carried and for transport of hazardous material, in general, and Sulphuric Acid in particular.
iii. Tanker must be RTO approved and tested frequently tested for integrity. Certificate must be available.
iv. Vehicle must have safety equipment/PPEs, and antidote if necessary.
v. It is mandatory that driver possess a valid driver's license.

vi. The maximum speed limit is prescribed.
vii. Driver will be instructed to park the tanker at safe place and they should be available in the near vicinity.
viii. TREM (Transport Emergency) cards are to be provided to the drivers.

7.5 QUANTITATIVE RISK ANALYSIS

7.5.1 NFPA Rating

NFPA rating for hazardous chemicals stored on site are summarized following in table.

Table 7.4 NFPA Rating for Hazardous Chemicals

No.	Name of Raw Material	NH	NF	NR	TLV Values
1	Acetic acid	3	2	0	TLV-TWA : 25 ppm
2	Acetic anhydride	3	2	1	TLV-TWA : 1 ppm, TLV-STEL: 3ppm
3	Ethyl acetate	1	3	0	TLV-TWA : 5ppm, TLV-STEL: 15ppm
4	Hydrochloric acid	3	0	1	TLV Celling- 1.22ppm
5	Ammonia	3	1	0	TLV-TWA : 25 ppm, TLV-STEL: 35 ppm
6	Xylene	2	3	0	TLV-TWA : 100ppm, TLV-STEL: 150 ppm
7	Toluene	3	1	0	TLV-TWA : 25 ppm, TLV-STEL: 35 ppm
8	Phthalic anhydride	3	1	0	TLV-TWA : 1ppm
9	2-Amino ethanol	3	2	0	TLV-TWA : 3 ppm, TLV-STEL: 6 ppm
10	Furfuraldehyde	3	2	0	TLV-TWA : 10ppm, TLV - STEL: 15ppm
11	Sodium hypochlorite	3	0	0	TLV-TWA : 0.5 ppm,
12	Dimethyl sulphoxide (DMSO)	1	1	0	TLV-TWA : 250 ppm,
13	Potassium tertiry butoxide	3	1	0	-------
14	Acetone	1	3	0	TLV-TWA : 250 ppm, TLVSTEL: 500 ppm
15	Potassium Hydroxide	3	0	1	TLV-TWA : 0.87ppm
16	Methanol	3	1	0	TLV-TWA : 200 ppm, TLVSTEL: 250ppm
17	Maleic acid	3	0	1	----
18	Piperazine	3	1	0	TLV-TWA :0.03ppm,
19	Potassium carbonate	2	0	0	TLV-TWA :3.46ppm,
20	n-Butanol	1	3	0	TLV-TWA :20ppm,
21	NMP	2	1	0	TWA: 25 ppm STEL: 75 (ppm)

No.	Name of Raw Material	NH	NF	NR	TLV Values
22	NEP	3	2	0	----
23	Benzene	2	3	0	TWA:0.5 STEL: 2.5 (ppm)
24	Carbon	1	3	0	TLV-TWA : 6.11ppm
25	Mono methyl amine	4	4	0	TWA -5 ppm STEL-15 ppm
26	2-amino methanol	2	2	0	TWA:200 STEL: 250 (ppm)
27	Sodium hydried	3	0	1	TLV-TWA : 2.04ppm
28	Morpholine	3	3	3	TLV-TWA : 20ppm
29	Methyl carbonate	1	3	0	-----
30	Thionyl Chloride	4	0	2	TLV-STEL: C 0.2 ppm

Appendix – M may be referred for MSDS of most hazardous chemical.

7.5.2 Quantification of Hazards due to Storage of Hazardous Materials

Worst case scenarios for leakage / spillage of hazardous raw materials using ALOHA software are done. This is summarized in following table:

Table 7.5 Risk Assessment - Worst Case Scenarios and Mitigation Measures

No.	Raw Material	Scenario of Spillage/Leakage	Area of Spread	Mitigation Measures
1	**Methanol**	Pool Fire	**Threat zone in case of 5 mm hole:** **Red : =** (10.0 kW/(sq m) = potentially lethal within 60 sec)= < 10 meters Orange: = (5.0 kW/(sq m) = 2nd degree burns within 60 sec)= <10 M **Yellow:** (2.0 kW/ (sq m) = pain within 60 sec) =<10M **Threat zone in case of 20 mm hole:** Red : = (10.0 kW/(sq m) = potentially lethal within 60 sec)= < 10 meters **Orange**: = .0 kW/(sq m) = 2nd degree burns within 60 sec)= <10 meters **Yellow:** (2.0 kW/(sq m) = pain within 60 sec) = 12M. **Threat zone for 50 mm hole:** **Red** : = (10.0 kW/(sq m) = potentially lethal within 60 sec)= 16 meters **Orange:** = (5.0 kW/(sq m) = 2nd degree burns within 60 sec)= 20 meters	**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:** Flammable liquid. Poisonous liquid. Keep away from heat. Keep away from sources of ignition. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. 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. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

No.	Raw Material	Scenario of Spillage/Leakage	Area of Spread	Mitigation Measures
			Yellow: (2.0 kW/(sq m) = pain within 60 sec) = 27M	
2	**Toluene**	Pool Fire	**Threat zone in case of 5 mm hole-** **Red :** = (10.0 kW/(sq m) = potentially lethal within 60 sec)= < 10 meters **Orange:** = (5.0 kW/(sq m) = 2nd degree burns within 60 sec)= <10 meters **Yellow:** (2.0 kW/ (sq m) = pain within 60 sec) =<10M **Threat zone in case of 20 mm hole:** **Red :** = (10.0 kW/(sq m) = potentially lethal within 60 sec)= < 10 M **Orange:** = (5.0 kW/(sq m) = 2nd degree burns within 60 sec)= <10 M **Yellow:** (2.0 kW/(sq m) = pain within 60 sec) = 12 M **Threat zone for 50 mm hole:** **Red :** = (10.0 kW/(sq m) = potentially lethal within 60 sec)= 16 M **Orange**: = (5.0 kW/(sq m) = 2nd degree burns within 60 sec)= 20 meters **Yellow:** (2.0 kW/(sq m) = pain within 60 sec) = 27 M	**Small Spill:** Absorb with an inert material and put the spilled material in an appropriate waste disposal. **Large Spill:** Toxic flammable liquid, insoluble or very slightly soluble in water. Keep away from heat. Keep away from sources of ignition. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Do not touch spilled material. 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.
3	**Thionyl chloride**	Leak from hole in vertical cylindrical tank	**For 2 mm hole:** Model Run: Heavy Gas **Red :**25 meters --- (14 ppm = PAC-3) **Orange:** 61 meters ---(2.4 ppm = PAC-2) **Yellow:** 223 meters --- (0.2 ppm = PAC-1) **For 5 mm hole:** **Red :**63 M --- (14 ppm = PAC-3) **Orange:** 157 meters ---(2.4 ppm = PAC-2) **Yellow:** 612 M --- (0.2 ppm = PAC-1) **Sudden release of 2 Liters** **Red** : 130 M (PAC 3= 14	**Small Spill:** Absorb with an inert material and put the spilled material in an appropriate waste disposal. **Large Spill:** Corrosive liquid. Poisonous liquid. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Do not touch spilled material. Use water spray curtain to divert vapor drift. Use water spray to reduce vapors. Prevent entry

No.	Raw Material	Scenario of Spillage/Leakage	Area of Spread	Mitigation Measures
			ppm) **Orange:** 322 M --- (PAC 2= 2.4 ppm) **Yellow:** 1100 M --- (PAC 1= 0.2 ppm)	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.
4	Chloroform		**For 2 mm hole:** Model Run: Heavy Gas **Red** :less than 10 Meter IDLH=500 ppm **Orange:** 22 M ---(PAC 2= 64 ppm **Yellow:** 223 M --- PAC 1= 2 ppm **For 5 mm hole:** Model Run: Heavy Gas **Red** :less than 10 M IDLH=500 ppm **Orange:** 25 M ---(PAC 2= 64 ppm **Yellow:** 146 M --- PAC 1= 2 ppm **Sudden release of 15 Liters-** **Red** : 66 M IDLH=500 ppm **Orange:** 196 M--- (PAC 2= 64 ppm) **Yellow:** 1100 M--- PAC 1= 2 ppm	**Small Spill:** Absorb with an inert material and put the spilled material in an appropriate waste disposal**.** **Large Spill:** Absorb with an inert material and put the spilled material in an appropriate waste disposal. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Appendix S may be referred for severity mapping done for hazardous chemicals.

- **Conclusions and Recommendations from QRA results**

Many of the following mitigation/safety measures are already been installed and are in place as plant is operational, the rest will be adopted –

1. QRA results of pool fire in case of both the cases, i.e. in the case of flammable solvents stored in the tank and flammable solvents stored in drums, The threat zones estimated for the radiation effects are within or less than 10 meters in all the scenarios considered. Because of less quantity stored.
2. However flame lengths estimated are in the range of 1.5 to 3 meters, which can cause escalate the fire situations because of heating of the nearest tank.
3. Automatic Sprinkler system will be provided to counter this effect.
4. Tanks will be placed within the well designed dyke wall of 6 m by 12 meters to contain and recover the spillage.
5. QRA results for toxic chemicals indicate that the threat zones as estimated based on PAC values and other recommended values, workers inside the warehouse and factory

will be affected and on-site emergency plan will have to be put in action and if necessary also Off site emergency plan will have to be activated, if the leakage gets unnoticed for a long period of time like 30 to 45 minutes.

6. It is recommended to provide close watch on all the toxic chemicals stored for leak detection by the alert staff.
7. Adequate training and retraining needs to be provided for the workers, including contract workers.
8. Along with smoke detectors, adequate number of toxic gas leak detectors should be installed inside the warehouse.
9. All manual handling of drums should be avoided.
10. Special and all recommended PPEs should be used while handling of toxic chemicals, particularly suspect and confirmed carcinogenic chemicals.
11. Adequate spill kits in adequate quantities must be readily available inside the warehouse and plant to deal effectively with spillages.
12. Boards in local language should be displayed instructing workers to effectively deal with spillages and leakages.

7.5.3 Fire Protection

The hazard of fire is very essential to identify because the direct impact of fire or explosion is on the worker or the operator who is actually operating in the accident areas. So to prevent the fire, number of fire extinguishers, smoke detectors have already been implemented in respective unit areas. Details of same are as follows-

Table 7.6 Details of Fire Extinguishers

Sr. No.	Type of Extinguisher							
	DCP -2kg	**DCP – 10 kg**	**DCP – 22.5 kg**	**DCP – 50 kg**	**CO_2- 2kg**	**CO_2- 4.5kg**	**CO_2- 9.8 kg**	**M-Foam 50 lts**
A-Block	**0**	**9**	**0**	**1**	**0**	**5**	**0**	**2**
B-Block	0	6	0	0	0	0	0	2
C-Block	0	9	1	0	1	1	1	3
D-Block	0	9	0	0	0	0	0	3
E-Block	0	7	0	0	0	1	1	3
G-Block	0	2	0	0	1	1	0	2
RM Stores	0	9	0	0	0	0	0	2
GM Store	0	0	0	0	1	1	0	0
QCD	2	0	0	0	0	0	0	0
R&D	1	1	0	0	0	0	0	0
Drum Yard	0	2	0	0	0	0	0	1
Total	**3**	**54**	**1**	**1**	**8**	**9**	**2**	**18**

Manually Operated 'Fire Alarm System' & Automatic 'Smoke Detection System' have been installed in various zones as follows-

Table 7.7 Details of Fire Alarm System and Automatic Smoke Detector System

Sr. No.	Zone	Locations	Manual Call Points	Smoke Detectors
1	Zone:1	Office Building Area	MCP : 03	19 Nos.
2	Zone:2	Right Side Of Plant (Entry)	MCP : 04	N.A.
3	Zone:3	Back Side Of Plant (ETP Plant)	MCP : 02	01 Nos.
4	Zone:4	Left Side Of Plant (DG Side)	MCP : 04	02 Nos.
5	Zone:5	Block -'A' Concrete Staircase	MCP : 03	02 Nos.
6	Zone:6	Block -'A' Steel Staircase	MCP : 03	N.A.
7	Zone:7	Block- 'B' Concrete Staircase	MCP : 03	02 Nos.
8	Zone:8	Block- 'B' Steel Staircase	MCP : 03	N.A.
9	Zone:9	Utility -Elect Panel Room	N.A.	04 Nos.

Table 7.8 Siren and Hooter System Installed in SOL

Sr. No	Locations	Preventive system	No.
1.	Near Utility:	Sounder	1nos.
2.	RM Store	Sounder	1nos.
3.	Office	Strober Hooter	1nos.
4.	Security Cabin	Strober Hooter	1nos.
5	Back side of the office	Siren	1nos.

List of Eye wash and of PPE may be referred at **Appendix –P**

7.6 Colour Coding for Safety during In-house Material Transfer

Following color coding have been implemented on site for pipes carrying materials in Industrial premises.

Table 7.9 Standard Colour Coding for Pipes

Substance	Colour
Water	
steam	
Acid &alkali	
Air	
Other liquid	
Gaseous	

Table 7.10 Colour Coding Implemented for Pipes in SOL

Substance	Colour
RT	
steam	
Vacuum	
Brine solution	
Air	

To avoid direct exposure of workers to various hazardous chemicals plant automation plays important role. Here, risk to life is reduced to minimum. Programming logic control system is allotted on plant site to control hazard automatically.

7.7 HEALTH CENTER

OHC has been provided as per factories act. Health checkup of all employees and contract labours have been carried out before employment and at regular intervals and record for the same are maintained. It is ensured that adequate stock of critical anti-dote for toxic chemicals are always kept in the OHC.

Company has prepared well designed health check up plan for its employees and contract workers. Health check-up parameters have been identified based upon the chemicals to which workers are likely to be exposed. Some of the parameters are given below:

Table 7.11 Details of Occupational Health Monitoring

No.	Solvent	Target organs	Parameters for occupational Health monitoring	Frequency
1.	Thyonil Chloride	Skin sensitization. CNS Peripheral Nervous system, Decreased muscle strength	Pre placement medical condition. Skin condition. Urine samples for testing presence of hexanedione. Exhaled air sampling.	Pre-placement Annual
2.	Ammonia	Respiratory system	LFT and lung damage test.	Pre-placement Annual
3	Methanol	Skin-dermatitis Liver Optic atrophy Blindness	Integrity of skin Profile of liver Integrity of eyes for pre existence of eye disease.	Pre-placement Annual
4.	Hydrochloric Acid	Kidney, Liver Lungs-Bronchitis	Pre-placement medical check-up Liver function test. Urinalysis for presence of Acid.	Pre-placement Annual
5.	Ethyl acetate	Irritation of the eyes, nose and throat, followed by headache, nausea, vomiting, sleepiness, and unconsciousness.	Pre-placement medical check-up Of eyes, nose, throat,	Pre-placement Annual
6	N-Hexane	Dizziness, confusion, nausea, headache, and irritation of the eyes, nose, throat, and skin	Pre-placement medical check-up Of eyes, nose, throat,	Pre-placement Annual
7	Toluene	If inhaled or swallowed and is a central nervous system depression. Skin and eye irritation.	Pre-placement medical check-up Of eyes, nose, throat,	Pre-placement Annual

Note: Antidote for the chemicals can be suggested by the health officer and appropriate actions shall be taken

Detailed Health plan and health check up report may be referred in **Appendix-T**

7.8 SAFETY HEALTH AND ENVIRONMENT POLICY

The functions of the Secretary will be to:

a) Receive recommendations from the Safety Committee and evaluate them for

implementation.

b) Inspect the scene of accidents and investigate cases thereof.
c) Present reports to the Safety Committee of safety activities.
d) Study reports and recommendation from the Factory Inspector and implement recommendation.
e) Organize safety captions; arrange safety posters and the display thereof.
f) Arrange and distribute safety literature with a view to promote safety consciousness.
g) Liaison with labour institutions, Factory Inspector and other bodies. Promote safety measures with a view to improve methods, appliances, apparel etc.
h) Ensure that the contractor and his employees working in the premises of the company observe safe method of work.
i) Maintain a register recording minutes of committee Meeting and show the register to Factory Inspector during his visit to the Factory.

7.9 ONSITE EMERGENCY & DISASTER MANAGEMENT PLAN

The company has 180 skilled and 180 unskilled workers presently employed. There is OHC center at the site fulfilling all the requirements of the factory act, based upon the number of workers employed. The same facilities will be expanded for additional workers, likely to be employed after expansion. Special medical tests need to be included in the pre employment and six monthly and annual medical checkups of the workers, as numbers of toxic chemicals as well as suspect and confirmed carcinogenic chemicals are handled. This has to done in consultations with the experienced and professional doctor and it has to be ensured that stock of necessary anti-dote for toxic chemicals will be always available at OHC It will be ensured that adequate stock of critical anti-dote for toxic chemicals will be always kept in the OHC.

Onsite Emergency Plan has already been incorporated for existing plant please refer **Appendix-U**

7.10 OFF SITE DISASTER CONTROL PLAN

Off-site management plan is incorporated in **Appendix-V**