Risk Assessment

Synthetic resins manufacturing industries are generally associated with use of raw materials and chemicals which are hazardous in nature. The process activities of these industries are also associated with certain risks. Prevention of human and property losses is integral to the operation and management of chemical process plants.

HAZOP Analysis

Detailed step-wise HAZOP analysis studies describing process, operation, possible hazard failure and remedial actions for each of the product manufactured is carried out.

Objective and Methodology of Risk Assessment

Objective:
a) Determine possible damage due to major hazards having damage potential to life and property.
b) Identify major risk in manufacture of chemicals, storage of chemicals and provide control though assessment. To prepare onsite, offsite, disaster management plan for control of hazards.

Methodology:
a) Hazard Identification - Identifying sources of process accidents involving release of hazardous material in the atmosphere and the various ways (that is scenarios) they could occur.
b) Consequence Analysis - Estimating the probable zone of impact of accidents as well as the scale and/or probability of damages with respect to human beings and plant equipment and other structures.
c) Accident Frequency Assessment - Computation of the average likelihood of accidents.
d) Risk Estimation - Combining accident consequence and frequency to obtain risk distribution to find out the quantitative Risk Assessment by using software (ALOHA)

Hazard Identification

Hazard is the characteristic of any system or process which has the potential for accident. For hazard identification total quantity of raw material and products to be stored within premises after expansion is taken into consideration.

Details of products storage

Sl No	Products	Physical form	Type of packing/mode of storage	Capacity of storage
1.	Cashew Nut Shell Liquid	Liquid	200 Kg barrel	50 Tons x 3 Nos 70 Tons x 1 No
2.	Cardanol	Liquid	200 Kg barrel	No bulk storage
3.	Recidol	Semi solid	200 Kg barrel	
4.	Liquid Resin	Semi solid	200 Kg barrel	
5.	Paints and varnishes	Liquid	200 Kg barrel	
6.	Phenalkamine	Liquid	200 Kg barrel	
7.	Adducts	Liquid	200 Kg barrel	
8.	Phenolic Resin	Liquid	200 Kg barrel	

Identification of hazardous chemicals handled within premises

Amongst the above described raw materials and products, some chemicals fall into category of hazardous chemicals defined under Manufacture, Storage and Import of Hazardous Chemical Rules, 1989, amended 2000 (MSIHC). Quantity of storage is within the threshold limits stipulated in the MSIHC Rules.

Toxicity and flammable limits of chemicals

Sl No	Chemicals	Toxicity level		Flammable limit		Chemical class (as per MSIHC Rules)
		LD 50 Oral mg/kg	LD 50 dermal mg/kg	FP° C	BP° C	
1.	Phenol	317	669	85	182	Flammable, Toxic, Hazardous
2.	Formaldehyde	100	270	36.5	60	Flammable, Toxic, Hazardous
3.	Xylene	NA	NA	37.8	138.5	Flammable, Toxic, Hazardous
4.	Turpentine oil	5760	29000	35	165	Flammable

Hazards from storage and handling of hazardous materials

Pool fire

A leak or spill of sufficient size of flammable liquid will result in an accumulation of flammable liquid on the ground or in bund or dyke. If ignited, the resulting fire is known as spreading or fixed pool fire. Objects coming in contact with the flame above the pool will be severely damaged or destroyed.

Jet Fire

Jet fire will occur in the event of release of flammable hydrogen gas followed by fire. If released flammable gas/vapours and liquid is ignited immediately, jet fire may take place.

Vapour Cloud Explosion

If released flammable vapours are not ignited immediately, the cloud of vapour will spread in the surrounding area. As long as the concentration of gas/vapour is between the lower and upper flammability limits, the vapour cloud may be set on fire by an ignition source.

Flash Fire

When released quantities of flammable vapours/gas are not ignited immediately, vapour/ cloud of flammable vapours/gas spreads in the surrounding area, some amount of flammable vapours/gas concentration will be between the lower and upper flammable limits, and the vapour cloud may be set on fire by an ignition source in entire length of flammable vapour cloud resulting flash fire. In the event of flash fire, essentially, no over pressure effect is occurred.

Process Hazards and Control Measures

Name of hazardous process	Type of hazards possible	Control measure provided
Thermic fluid heater	• Flash point variation of thermal fluid/oil over a period of time • Mist Formation around leak points such as flagged joints, around valves and connection points in the pipe line. These may create explosive atmospheres • Lagging Fire – leak and dispersion of oil within insulation leads to fire	• Annual inspections • Safety interlocks to be provided • Safety and pressure gauge valves to be fitted • Properly supported and protected against corrosion • Testing of joints of tubes regularly
Reactor vessel	• Release of Heat and Flammable gases • Fire, Toxic gas release and Explosion	• Raw Materials quantity must be controlled either volumetrically or gravimetrically. • Process control devices installed must include the use of sensors or alarms that take automatic action to prevent the conditions of uncontrolled reactions • Auto cut off system must be provided after reaching of predetermined maximum safe temperature • Safety Control valve must be provided • Use of skilled workers • Proper selection of material of construction • Mechanical seal in all pumps and reactors

General Hazards and Control Measures

Type of emergency	Identification area	Possible causes	Preventive measures
Fire	Resins storage area	• Fire due to bottom nozzle failure • Damage of diesel storage tank pump discharge nozzle failure • Unloading tanker hose rupture	• Flame proof fittings and Earthling while unloading. • No electrical junction box close to storage materials. • Hot work should be avoided near the storage area
Explosion	Material handling areas	• Vapour explosion due to contact of spark to accumulated flammable vapour in confined area • Spillage and overflow	• Flameproof electric installations • Isolated storage of flammable material drums • Hot work should be avoided near the storage area • Good ventilation for flammable material storage • Necessary fire hydrant systems should be in place
Material handling and charging	Within the plant	Fire and health hazards	• Trained employees • Required PPE and Fire Protective equipments to be provided • Good engineering practice

Consequence Analysis

The objectives of the consequence analysis are to:

- Determine relevant toxic and flammable inventories
- Analyse a representative set of spill or loss of containment cases
- Determine the consequences of each spill with regards to the potential of fire and explosion and off site impact to people, environment and properties.

Selected Scenarios for Consequence Analysis

Among the various hazardous chemicals to be stored after expansion within the premises of M/s. Adarsh Industrial Chemicals following chemicals are considered for catastrophic failure of storage tanks/barrels/drums.

1. Phenol
2. Formaldehyde
3. Ethylene diamine

Model used for Consequence analysis

ALOHA (Areal locations of Hazardous Atmosphere) is an air dispersion model, used as a tool for predicting the movement and dispersion of gases. It predicts pollutant concentrations downwind from the sources of a spill, taking into consideration the physical characteristics of the spilled material. ALOHA also accounts for some of the physical characteristics of the release site, weather conditions, and the circumstances of the release. ALOHA provides output as amount of chemical discharged from the source as well as its concentration in air it takes in to account different levels of concentrations for a specified chemical. ALOHA version 5.4.7 is used for consequence analysis.

A Thermal Radiation Level of Concern (LOC) is a threshold level of thermal radiation, usually the level above which a hazard may exist.

ALOHA uses three threshold values (measured in kilowatts per square meter) to create the default threat zones:

- Red: 10 kW/(sq m) -- potentially lethal within 60 sec
- Orange: 5 kW/(sq m) -- second-degree burns within 60 sec
- Yellow: 2 kW/ (sq m) -- pain within 60 sec

The thermal radiation affects the people depending upon the length of time they are exposed to a specific radiation level. Longer exposure durations, even at a lower thermal radiation level, can produce serious physiological effects.

Toxic release

For toxic release, there are several hazard classification systems in use. ALOHA determines its default toxic Level of Concern (LOC) values based on the following:

- AEGL (Actual exposure guideline levels)
- ERPG (Emergency Response Planning Guidelines)
- TEEL

- IDLH (Immediately Dangerous to Life or Health)

Note: For AEGLs, ERPGs and TEELs, the rank number increase with the hazard level, so that AEGL-3 is more hazardous than AEGL-1. Typically, the "3" values are used for the most hazardous (red) threat zones because they represent the threshold concentration above which health effects may be life threatening.

Chemical raw materials and solvents are stored in tanks above-ground

Solvent/chemical	Dia m	Height m	Volume cum	Quantity stored/month
Phenol	0.6	0.9	0.25	25 ton
Ethylene diamine	0.6	0.9	0.25	15 ton
Xylene	0.6	0.9	0.25	3 KL

PHENOL

Site Data

- Location: KARKALA, UDUPI, KARNATAKA, INDIA
- Building Air Exchanges Per Hour: 0.62 (sheltered single storied)
- Time: April 9, 2019 1548 hours ST (using computer's clock)

Chemical Data

- Chemical Name: PHENOL
- Molecular Weight: 94.11 g/mol
- AEGL-1 (60 min): 15 ppm
- AEGL-2 (60 min): 23 ppm
- AEGL-3 (60 min): N/A
- Ambient Boiling Point: 340.7° F
- Vapor Pressure at Ambient Temperature: 0.0045 atm
- Ambient Saturation Concentration: 4,578 ppm or 0.46%

Atmospheric Data: (Manual Input of Data)

- Wind: 2.58 meters/second from E at 3 meters
- Ground Roughness: open country Cloud Cover: 5 tenths
- Air Temperature: 30° C Stability Class: C
- No Inversion Height Relative Humidity: 50%

Source Strength

- Leak from hole in horizontal cylindrical tank
- Flammable chemical escaping from tank (not burning)
- Tank Diameter: 0.6 meters
- Tank Length: 0.9 meters

- Tank Volume: 0.25 cubic meters
- Tank contains liquid
- Internal Temperature: 41° C
- Chemical Mass in Tank: 0.19 tons Tank is 58% full
- Circular Opening Diameter: 5 centimeters
- Opening is 0.18 meters from tank bottom
- Ground Type: Default soil
- Ground Temperature: equal to ambient
- Max Puddle Diameter: Unknown
- Release Duration: ALOHA limited the duration to 1 hour
- Max Average Sustained Release Rate: 0.207 pounds/min
- (averaged over a minute or more)
- Total Amount Released: 12.2 pounds
- Note: The chemical escaped as a liquid and formed an evaporating puddle.
- The puddle spread to a diameter of 5.0 yards.

1) Toxic area of vapour cloud

Threat zone: Model Run: Gaussian

- Red : no recommended LOC value --- (N/A = AEGL-3 [60 min])
- Orange: 14 yards --- (23 ppm = AEGL-2 [60 min])
- Note: Threat zone was not drawn because effects of near-field patchiness make dispersion predictions less reliable for short distances.
- Yellow: 18 yards --- (15 ppm = AEGL-1 [60 min])
- Note: Threat zone was not drawn because effects of near-field patchiness make dispersion predictions less reliable for short distances.

2) Flammable area of vapour cloud

Threat Modelled: Thermal radiation from pool fire

- Red : less than 10 meters(10.9 yards) --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
- Orange: less than 10 meters(10.9 yards) --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
- Yellow: less than 10 meters(10.9 yards) --- (2.0 kW/(sq m) = pain within 60 sec)

3) Blast area of vapour cloud explosion

Threat Modelled: Thermal radiation from fireball

- Red : LOC was never exceeded --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
- Orange: LOC was never exceeded --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
- Yellow: LOC was never exceeded --- (2.0 kW/(sq m) = pain within 60 sec)

ETHYLENE DIAMINE

- Chemical Name: ETHYLENE DIAMINE
- CAS Number: 107-15-3
- Molecular Weight: 60.10 g/mol
- AEGL-1 (60 min): N/A
- AEGL-2 (60 min): 9.7 ppm
- AEGL-3 (60 min): 20 ppm
- IDLH: 1000 ppm LEL: 25000 ppm , UEL: 120000 ppm
- Ambient Boiling Point: 242.2° F
- Vapor Pressure at Ambient Temperature: 0.024 atm
- Ambient Saturation Concentration: 24,625 ppm or 2.46%

Atmospheric Data: (Manual Input of Data)

- Wind: 2.58 meters/second from E at 3 meters
- Ground Roughness: urban or forest Cloud Cover: 3 tenths
- Air Temperature: 31.58° C Stability Class: C
- No Inversion Height Relative Humidity: 75%

Source strength:

- Leak from hole in vertical cylindrical tank
- Flammable chemical escaping from tank (not burning)
- Tank Diameter: 0.6 meters
- Tank Length: 0.9 meters
- Tank Volume: 0.25 cubic meters
- Tank contains liquid
- Internal Temperature: 31.58° C
- Chemical Mass in Tank: 0.17 tons and Tank is 70% full
- Circular Opening Diameter: 8 centimetres
- Opening is 0.45 meters from tank bottom
- Ground Type: Default soil
- Ground Temperature: equal to ambient
- Max Puddle Diameter: Unknown
- Release Duration: ALOHA limited the duration to 1 hour
- Max Average Sustained Release Rate: 0.499 pounds/min
- (averaged over a minute or more)
- Total Amount Released: 29.5 pounds
- Note: The chemical escaped as a liquid and formed an evaporating puddle.
- The puddle spread to a diameter of 3.8 yards.

1) Toxic area of vapour cloud

Model Run: Gaussian

- Red : 21 yards --- (20 ppm = AEGL-3 [60 min])
- Note: Threat zone was not drawn because effects of near-field patchiness make dispersion predictions less reliable for short distances.
- Orange: 32 yards --- (9.7 ppm = AEGL-2 [60 min])
- Note: Threat zone was not drawn because effects of near-field patchiness make dispersion predictions less reliable for short distances.
- Yellow: no recommended LOC value --- (N/A = AEGL-1 [60 min])

2) Flammable area of vapour cloud

- Model Run: Gaussian
- Red : less than 10 meters(10.9 yards) --- (15000 ppm = 60% LEL = Flame Pockets)
- Note: Threat zone was not drawn because effects of near-field patchiness make dispersion predictions less reliable for short distances.
- Yellow: less than 10 meters(10.9 yards) --- (2500 ppm = 10% LEL)
- Note: Threat zone was not drawn because effects of near-field patchiness make dispersion predictions less reliable for short distances.

3) Blast area of vapour cloud explosion

- Threat Modeled: Overpressure (blast force) from vapor cloud explosion
- Type of Ignition: ignited by spark or flame
- Level of Congestion: uncongested
- Model Run: Gaussian
- No explosion: no part of the cloud is above the LEL at any time

XYLENE

- Chemical Name: XYLENE
- CAS Number: 95-47-6
- Molecular Weight: 106.17 g/mol
- IDLH: 900 ppm
- LEL: 11000 ppm
- UEL: 64000 ppm
- Ambient Boiling Point: 290.9° F
- Vapor Pressure at Ambient Temperature: 0.013 atm
- Ambient Saturation Concentration: 12,907 ppm or 1.29%

<u>Atmospheric Data: (Manual Input of Data)</u>

- Wind: 2.58 meters/second from E at 3 meters

- Ground Roughness: urban or forest Cloud Cover: 3 tenths
- Air Temperature: 31.58° C Stability Class: C
- No Inversion Height Relative Humidity: 75%

Source strength:

- Leak from hole in vertical cylindrical tank
- Flammable chemical escaping from tank (not burning)
- Tank Diameter: 0.6 meters
- Tank Length: 0.9 meters
- Tank Volume: 0.25 cubic meters
- Tank contains liquid and Internal Temperature: 31.58° C
- Chemical Mass in Tank: 0.17 tons Tank is 70% full
- Circular Opening Diameter: 8 centimeters
- Opening is 0.45 meters from tank bottom
- Ground Type: Default soil
- Ground Temperature: equal to ambient
- Max Puddle Diameter: Unknown
- Release Duration: ALOHA limited the duration to 1 hour
- Max Average Sustained Release Rate: 0.487 pounds/min
- (averaged over a minute or more)
- Total Amount Released: 28.4 pounds
- Note: The chemical escaped as a liquid and formed an evaporating puddle.
- The puddle spread to a diameter of 3.9 yards.

1) Toxic area of vapour cloud

- Model Run: Gaussian
- Red : less than 10 meters(10.9 yards) --- (900 ppm = IDLH)
- Note: Threat zone was not drawn because effects of near-field patchiness make dispersion predictions less reliable for short distances.

2) Flammable area of vapour cloud

- Threat Modelled: Flammable Area of Vapor Cloud
- Model Run: Gaussian
- Red : less than 10 meters(10.9 yards) --- (6600 ppm = 60% LEL = Flame Pockets)
- Note: Threat zone was not drawn because effects of near-field patchiness make dispersion predictions less reliable for short distances.
- Yellow: less than 10 meters(10.9 yards) --- (1100 ppm = 10% LEL)
- Note: Threat zone was not drawn because effects of near-field patchiness make dispersion predictions less reliable for short distances.

3) Blast area of vapour cloud explosion

- Threat Modelled: Overpressure (blast force) from vapor cloud explosion
- Type of Ignition: ignited by spark or flame
- Level of Congestion: uncongested
- Model Run: Gaussian
- No explosion: no part of the cloud is above the LEL at any time

Occupational Health Surveillance Programme

Occupational Health Surveillance (also termed as medical surveillance for workers) constitutes an important component in efforts to protect and improve worker's health. It is the systematic collection, analysis of disease data on groups of workers and is designed to detect early signs of work-related illness.

- Pre-placement examination and periodic examination must be carried out at workplace
- Emergency/exposure examination and test should be carried out
- Maintain the work profile and medical history of employee/workers
- Pulmonary function test must be carried out in case handling of formaldehyde
- Written medical opinion must be maintained by industry

A medical program has been developed for M/s.Adarsh Industrial Chemicals., based on site specific needs and potential exposures of employees and workers to the various chemicals handled at the site.
A site medical program consists of the following components:

A. Surveillance:

- Pre-employment screening
- Periodic medical examinations (and follow-up examinations when appropriate)

B. Treatment:

- Emergency
- Non-emergency (on a case-by-case basis)

C. Record-keeping
D. Program review

Plan and Fund allocation for Occupational Health & Safety Programme

Component	Recommendation	Fund allocation
Pre-Employment Screening	• Occupational history • Physical examination • Determination of fitness to work wearing protective equipment	-
Periodic Medical Examinations	• Yearly update of medical and occupational history • Yearly physical examination and testing	Rs. 30,000/ year
Emergency treatment	• Provide emergency first aid on site • Develop liaison with local hospital and medical specialists • Give details of incident and medical history to next care provider	Rs. 15,000 / year (in case of emergency)
Record keeping and review	• Maintain and provide access to medical • Report and record occupational injuries and illnesses • Review program periodically • Focus on current site hazards, exposures, and industrial hygiene standards.	-

Workers can be directly or indirectly exposed to chemicals like Phenol, Formalin, Caustic Soda, Para Formaldehyde, xylene etc., during process or material handling.

Following actions will be taken to keep the chemicals within Permissible Exposure Limit (PEL)/ Threshold Limit Value (TLV).

- Process will be carried out in closed system
- Exhaust ventilation system will be provided
- Chemicals will be handled by competent person
- MSDS of all the chemicals will be maintained by company
- Flame proof electrical fittings should be provided
- Safety devices like temperature control and pressure control must be provided to vessel
- Labelling and sign board should be provided
- Firefighting and emergency exit should be provided
- PPE must be used during handling of chemicals

Evaluation of Exposure of Chemical during Pre-Placement and Periodical Medical Monitoring

- Emergency /exposure examination and test should be carried out. Examination is based on irritation, sensitization of skin, respiratory system, eye, shortness of breath.
- Test must be carried out as per handling of chemicals as per OSHA guideline.
- Previous medical opinion of workers/employees must be taken into account during pre-placement and periodical medical monitoring period

Treatment of workers affected by accidental spillage of chemicals

Hazards with Acute and chronic Exposure

- Contact with skin may cause severe burns
- Systemic effects may occur from any route of exposure, especially after skin absorption
- Repeated or prolonged exposure may harm the respiratory system
- Methanol affects the central nervous system, liver, and kidneys

Precautions

- Prevent contact with skin by wearing gloves and lab coat
- Wear safety glasses or a face shield if splashing may occur
- Store in a cool, dry, well-ventilated area, away from heated surfaces or ignition sources
- Remove contaminated clothing
- Skin contact requires immediate flushing of the contaminated area with water at a sink or shower. In case of eye contact, promptly flush the eyes with ample amounts of water and obtain medical attention.

Risk Mitigation Measures for Phenol

Phenol can pose a severe health hazard and should be handled with extreme caution. Phenol is highly corrosive to the skin and readily absorbed through it, where upon it can affect the central nervous system and cause damage to the liver and kidneys.

- Phenol handling should be done only in presence of collection system especially when heating it

- Prevent phenol from contacting skin by wearing gloves. Wear chemical goggles to protect the eyes.
- Review a phenol Material Safety Data Sheet (MSDS) before handling the material.
- As with any chemical, do not eat, drink, or smoke where phenol is handled, processed, or stored, since the chemical could be ingested.
- Store phenol in a cool, dry, well-ventilated area, away from heated surfaces or ignition sources.

Risk Mitigation Measures for Formaldehyde

- Standard Operating Procedures (SOP) need to be developed for the use of formalin / formaldehyde.
- Employees who handle formaldehyde must be trained on the hazards of formaldehyde and informed about the measures to be taken during exposure or spill.
- It should be ensured that workers are not over-exposed
- Formaldehyde should be used with adequate ventilation, away from ignition sources preferably in a fume hood, to minimize inhalation of formaldehyde vapour.

Risk Mitigation Measures for Spills

In all chemical and hazardous material emergency situations, the primary concern is the protection of personnel. The secondary concern is to confine the contamination. The release or spill of hazardous material will require a prompt response including the amount, type and location of the spill.
Hazardous materials spills can occur during storage, handling or charging on reactor.

Spill control and management

The following measures will be taken in the event of spills:

- Notify such area immediately
- Limit access, prevent contamination spread
- Survey personnel before exiting
- Cover spill with absorbent materials (unless liquid is flammable or oxidizing)
- Remove contaminated clothing and footwear
- Record spill details and contamination monitoring results
- Persons involved in the spill should leave the area immediately
- Close off and secure the spill area to prevent entry

- Warning signs will be posted
- Select the appropriate PPE, shielding and absorbent spill materials like absorbent paper or spill pillows if the liquid is not a flammable or oxidizing agent.

Personal Protective Equipments

Personal protective equipments (PPEs) are devices issued to each worker personally for their 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. Protective equipments like helmets, goggles, aprons, gloves etc., based on the area of work to ensure safety.

- Employees will be taught when and how to use equipments and how to recognize defects in the equipment.
- Personal protective equipment should be kept where it can be accessed quickly, outside the hazardous material storage area and away from areas of likely contamination.
- Employees are instructed to maintain the personal protective equipments in clean, working condition at all times.

Mock drills: Safety mock drills will be held by annually before the regulatory authorities for prompt and safe response during emergencies.

Training: Safety training for the employees on need basis depending on the work area is given at regular intervals to ensure development and maintenance of safety mind-set amongst the employees.

Safe Practice for Handling, Storage, Transportation and Unloading of Hazardous Chemicals

For Storage and Handling

- Keep solvents in well ventilated room
- Fire hydrant system shall be installed
- Flame proof light fitting shall be provided at flammable storage area
- Proper selection of MoC for chemicals storage tank
- Earthing/bonding shall be provided for static charges
- Hazardous material should be stored away from the plant and safe distance shall be maintained
- Caution note, hazardous identification board should be provided
- Only authorized person shall be permitted in storage tank area

For Transportation & Unloading

- Solvent shall be received by road tanker and stored in above ground storage tanks
- Loading and unloading procedure shall be carried out very carefully
- Fixed pipeline with pumps shall be provided for transfer to vessel.
- Transporters shall be trained for transportation of hazardous chemicals.
- Personal Protective Equipment (safety goggles, hand gloves, apron, masks, gum boots etc.) shall be provided.

General Risk Reduction Measures in View of Safety Consideration

- Storage tank of Formaldehyde, Phenol and Xylene should be installed as away as possible from the plant area
- Proper sloping and collection sumps should be provided so that any spillages in the bulk storage and other handling areas shall not stagnate and shall be quickly lead away to a safe distance from the source of leakage.
- Inspection of the storage tanks as per inspection schedule for thickness measurement, joint and weld efficiency etc.
- Provision of flameproof electrical fittings / equipment's.
- Strict enforcement of no smoking.
- Periodic training and refresher courses to train the staff in safety firefighting.
- Emergency drills should be carried out periodically to ensure preparedness for emergency situations
- Many of the raw materials used for resin are either toxic or flammable. It is therefore important to ensure that these materials are stored in closed, well ventilated totally safe areas.
- All personnel should be trained in handling emergency situations
- Adequate number of caution boards highlighting the hazards of chemicals should be provided at critical locations.
- Prepare & display the safe operating procedure for hazardous chemicals storage, handling & transporting or using.
- Reduce the level of physical activity by sharing workload with other or by using mechanical means.

Firefighting Facilities

A. **Fire Extinguishers**
   Portable fire extinguishers/ sand buckets are provided in the industry depending upon the specific needs of the area.

- Cease fire cylinders 15 kgs – 10 numbers
- Carbon dioxide cylinders 15 kgs – 10 Numbers
- Carbon dioxide cylinders 10 kgs – 10 Numbers
- Sand buckets – 5 nos

Some spare equipments will also be maintained in the inventory at an identified fire & safety equipment store.

B. Fire Alarm Sirens

Sirens are provided to alert all the employees inside the premises about the situation of an emergency.

C. Safety Equipments

All types of personnel protective safety equipments required for handling the emergency are to be arranged at the site after making necessary upgradation for proposed expansion.

In addition, the necessary safety documents like Material Safety Data Sheets (MSDS), risk assessment study report, HAZOP study report, on-site emergency plan shall be prepared and made readily available to the concerned persons in case of emergency. Contact numbers of concerned in case of emergencies will be displayed at prominent locations