Chapter-7
Additional Studies

A) Risk Assessment

7.1 INTRODUCTION

Industrial plants deal with materials, which are generally 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:** The technique discerns whether the plant layout and operating procedures in practice have any inherent infirmities.
- **Safety Audit:** Takes a careful look at plant operating conditions, work practices and work environments to detect unsafe conditions.

Together, these three broad tools attempt to minimize the chances of accidents occurring. Yet, there always exists, no matter how remote, probability of occurrence of a major accident. If the accident involves highly hazardous chemicals in sufficiently large quantities, the consequences may be serious to the plant, to surrounding areas and the populations residing therein.

7.1.1 Study Objective

The objective of the risk analysis includes the following:

- Identification of hazards
- Selection of credible scenarios

- Consequences analysis of selected accidents scenarios
- Risk mitigation measures

7.1.2 STUDY APPROACH

The risk assessment study broadly comprised of the following steps:

- System Description
- Identification of hazards
- Selection of Credible Accident Scenarios
- Consequence Analysis
- Risk Mitigation Measures

7.1.3 HAZARDOUS IDENTIFICATION

Hazard is defined as a chemical or physical conditions those have the potential for causing damage to people, property or the environment. Hazard identification is the first step in the risk analysis and entails the process of collecting information on:

- The types and quantities of hazardous substances stored and handled,
- The location of storage tanks & other facilities,
- Potential hazards associated with the spillage and release of hazardous chemicals and fuel.

A preliminary hazard analysis is carried out initially to identify the major hazards associated with storages and the processes of the plant. This is followed by consequence analysis to quantify these hazards. Finally the vulnerable zones are plotted for which risk reducing measures are deduced and implemented. The major aspects are described below:

In a resin manufacturing, the main hazards are storage and handling of Formaldehyde solution and Phenol solution. The primary concern has always been fire and Toxic release prevention and control as these are the main hazard posed by such unit. This concern has grown through the loss of life, property and materials experienced after experienced after major disasters, which have occurred over the years.

7.2 RISK ASSESSMENT

A three 'levels' risk assessment approach has been adopted for the M/s Veer Poly Chem proposed to start pesticide, dye & resin production at Plot No. 119 & 120, Ranpur road, GIDC Dhandhuka, Dist: Ahmedabad, Gujarat. 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:

- **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).

  The data/information is obtained from plant. The results provide a relative indication of the extent of hazards and potential for risk exposure.

- **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;
  - Process Safety Management Systems;
  - Fire Protection and Emergency response equipment and programs.
  - 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 prioritising mitigative measures and allocate the resources to the areas with highest risks.

- **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:

i. Hazards identification utilising formal approach (Level 2, HAZOP etc.);
ii. Frequency Analysis. Based on past safety data (incidents / accidents); Identifying likely pathway of failures and quantifying the toxic/ inflammable material release;
iii. 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.
iv. 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 analysed considering likely damage (in terms of injury/ fatality, property damage) each scenarios is likely to cause.

QRA provides a means to determine the relative significance of a number of undesired events, allowing analyst and the team to focus their risk reduction efforts where they will be beneficial most.

- Veer Poly Chem project is hazardous in nature. The QRA for this plant is based on Level 1 and Level 2.
- Table in Chapter 2 gives the list of products (and their monthly production capacity) to be manufactured in the proposed project. **Table 7.1** below gives the bulk storages of liquid and gaseous raw materials and their monthly consumption.

7.3 HAZARDOUS MATERIALS STORAGE

Unit will proposed to start pesticide, dye & resin production. During operation phase, various hazardous chemicals will be handled. As per

Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 and amendment subsequently, chemicals which have potential for creating risk to life and property in an unlikely event of leakage or spillage followed by fire is summarized in below table.

Table 7.1

Bulk Hazardous Materials Storages

Sr. No.	Name of Chemicals	No. of container & size		MOC
1	H_2SO_4	2	20 x 2	MS
2	Hydrochloric Acid	2	20 x 2	MSRL
3	Nitro Benzene	1	20 x 2	MS
4	Formaldehyde (37%)	1	10	SS
5	Aniline Oil	1	20 x 2	MS

7.4 RISK SCREENING APPROACH

Proposed Plant: Risk screening of Veer Poly Chem plant was undertaken through process study and study of data/information provided by Veer Poly Chem. Data of major/bulk storages of raw materials, intermediates and other chemicals were collected. MSDS of hazardous chemicals were studied vis a vis their inventories and mode of storage. Veer Poly Chem plant will be using number of hazardous chemicals and also producing organic chemicals. The chemicals stored in bulk (liquid or gaseous) and defined under MSHIC Rule will be considered for detailed analysis. Many of the RM/Finished products of Veer Poly Chem are hazardous in nature. However, hazards potential (for damage) of products and other materials to plant personnel, environment and off-site area is different for different materials. Veer Poly Chem will be using a number of raw materials but 5 are stored in bulk and all these are listed under "List of hazardous and Toxic Chemicals" category under MSIHC Rules, 1989. The raw materials coming under hazardous category as specified by MSIHC Rules, 1989 (including subsequent amendments) is given in **Table 7.2** below:

Table 7.2: Hazards Analysis - Raw materials (stored in Bulk)

S. No	Raw material	S. No.& Threshold Quantity (TQ in MT) as per MSHIC Rules			Chemicals Hazards Potential		Remarks
		Schedule-1, Part-II	Schedule-2, Part-I	Schedule-3, Part-I	Hazards	Toxic	

1.	Sulphuric Acid CAS No: 7664-93-9 UN No: 1830	591	--	--	Flammability: Will not burn Health Hazard: Extremely hazardous - use full protection; Reactivity: Violent chemical change possible	ERPG-1: 2.0 mg/m^3 ERPG-2: 10 mg/m^3 ERPG-3: 30 mg/m^3 IDLH: 15 mg/m^3	- Toxic by inhalation and if swallowed. - Causes severe burns - Irritating to eyes, respiratory system and skin. -Risk of serious damage to the eyes.
2.	Hydrochloric acid CAS No: 7647-01-0 UN No: 1789	313	--	--	Not Flammable; Inhalation of fumes results in coughing and choking sensation, and irritation of nose and lungs. Liquid causes burns	ERPG-1: 3.0 ppm ERPG-2: 20 ppm ERPG-3: 150 ppm IDLH: ---- ppm	-Causes severe skin burns and eye damage. - May cause respiratory irritation. -Harmful if swallowed. - Very toxic to aquatic life - May be corrosive to metals
3.	Nitro Benzene CAS No: 98-95-3 UN No: 2031	423	--	--	Not Flammable; Very hazardous in case of skin contact Slightly hazardous in case of inhalation (lung sensitizer). Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath.	No ERPG information available IDLH-200	Severe over-exposure can result in death.
4.	Formaldehyde CAS No: 50-00-0 UN No: 2209	295	--	--	Flammable; Toxic if swallowed. Will cause burns to the eyes with effects including: Pain, tearing, conjunctivitis and if duration of exposure is long enough, blindness will occur. Toxic by skin contact.	ERPG-1: 1.2 ppm ERPG-2: 12 ppm IDLH: 20 ppm TWA: 0.75 mg/m^3 STEL: 2.0 mg/m^3	Powerful reducing agent. Reacts with oxidising agents, acids, alkalis, and metal salts.

					Toxic if inhaled.		
5.	Aniline CAS No. 62-53-3 Combustible oily liquid; Auto Igni. Temp.- 615^0C	37	--	--	Stable Product; Reactive with oxidising agents; Products of combustion- CO;CO_2; NOx Ignites on contact with sodium peroxide + water. Aniline ignites spontaneously in presence of red fuming nitric acid. Sodium peroxide etc. When heated to decomposition it emits toxic fumes.	Acute Toxicity oral; (LD_{50}): 250 mg/kg [Rat.]. Dermal (LD_{50}): 820 mg/kg [Rabbit.] Vapor (LC_{50}): 1757 hours [Mouse]	Hazardous in case of skin contact (irritant, permeator), of eye contact (irritant), of ingestion, of inhalation. Severe overexposure can result in death.

Note:

1. **TQ-I: Threshold quantity (for application of rules 4,5,7 to 9 and 13 to 15)**
2. **TQ-II: Threshold quantity (for application of rules 10 to 12)**

S. No.	Toxicity	Oral toxicity LD_{50} (mg/kg)	Dermal toxicity LD_{50} (mg/kg)	Inhalation toxicity LC_{50} (mg/l)
1.	Extremely toxic	>5	<40	<0.5
2.	Highly toxic	>5-50	>40-200	<0.5-2.0
3.	Toxic	>50-200	>200-1000	>2-10

As detailed in the above table, all 5 materials stored in bulk are comes within Schedule I part II (List of Hazardous and Toxic Chemicals) of MSIHC Rules.

Note:

1. Oral Toxicity (OT) in LD_{50} (mg/kg)
2. Dermal Toxicity (DT) in LD_{50} (mg/kg)
3. Inhalation Toxicity in LC_{50} (mg/l) [4 hrs.]

Emergency Response Planning Guidelines (ERPGs)

The 3 ***ERPG*** tiers are defined as follows:

- **ERPG-3** is "the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects."
- **ERPG-2** is "the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action."
- **ERPG-1** is "the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient health effects or perceiving a clearly defined, objectionable odor."
- The *IDLH limit* represents the *concentration* of a chemical in the air to which healthy adult workers could be exposed (if their respirators fail) without suffering permanent or escape-impairing health effects.

7.5 QRA APPROACH

Identification of hazards and likely scenarios (based on Level-1 and Level-2 activities) calls for detailed analysis of each scenario for potential of damage, impact area (may vary with weather conditions/wind direction) and safety system in place. Subsequently each incident is classified according to relative risk classifications provided in Table below as **Table 7.3**:

Table 7.3: Risk Classification

Stage	Description
High (> 10^{-2}/yr)	A failure which could reasonably be expected to occur within the expected life time of the plant. Examples of high failure likelihood are process leaks or single instrument or valve failures or a human error which could result in releases of hazardous materials.
Moderate (10^{-2} --10^{-4}/yr)	A failure or sequence of failures which has a low probability of occurrence within the expected lifetime of the plant. Examples of moderate likelihood are dual instrument or valve failures, combination of instrument failures and human errors, or single failures of small process lines or fittings.
Low (<10^{-4})	A failure or series of failures which have a very low probability of occurrence within the expected lifetime of plant. Examples of 'low' likelihood are multiple

	instruments or valve failures or multiple human errors, or single spontaneous failures of tanks or process vessels.
Minor Incidents	Impact limited to the local area of the event with potent for 'knock – on- events'
Serious Incident	One that could cause: ❖ Any serious injury or fatality on/off site; ❖ Property damage of \$ 1 million offsite or \$ 5 million onsite.
Extensive Incident	One that is five or more times worse than a serious incident.

Assigning a relative risk to each scenario provides a means of prioritising associated risk mitigation measures and planned actions.

7.6 THERMAL HAZARDS

In order to understand the damages produced by various scenarios, it is appropriate to understand the physiological/physical effects of thermal radiation intensities. The thermal radiation due to tank fire usually results in burn on the human body. Furthermore, inanimate objects like equipment, piping, cables, etc. may also be affected and also need to be evaluated for damages. **Table 7.4, Table 7.5** and **Table 7.6** (below), respectively give tolerable intensities of various objects and desirable escape time for thermal radiation. Thermal hazards could be from fires or explosion. Fire releases energy slowly while explosion release energy very rapidly (typically in micro seconds). Explosion is rapid expansion of gases resulting in rapidly moving shock wave. Explosion can be confined (within a vessel or building) or unconfined (due to release of flammable gases).

BLEVE (Boiling Liquid Expanding Vapour Explosion) occurs if a vessel containing a liquid at a temperature above its atmospheric boiling point ruptures. The subsequent BLEVE is the explosive vaporisation of large fraction of its vapour contents; possibly followed by combustion or explosion of the vaporised cloud if it is combustible. Thermal hazards have been considered for various scenarios including Fire in inflammable chemicals storage tanks.

Table 7.4: Effects due to Incident Radiation Intensity

Incident Radiation kW/m^2	Damage Type
0.7	Equivalent to Solar Radiation

1.6	No discomfort on long duration
4.0	Sufficient to cause pain within 20 sec. Blistering of skin (first degree burn are likely).
9.5	Pain threshold reached after 8 sec. Second degree burn after 20 sec.
12.5	Minimum energy required for piloted ignition of wood, melting of plastic tubing etc.
25	Minimum Energy required for piloted ignition of wood, melting, plastic tubing etc.
37.5	Sufficient to cause damage to process equipment.
62.0	Spontaneous ignition of wood.

Table 7.5: Thermal Radiation Impact to Human

Exposure Duration	Radiation Energy {1% lethality; kW/m^2}	Radiation Energy for 2nd degree burns; kW/m^2	Radiation Energy for 1st degree burns; kW/m^2
10 sec	21.2	16	12.5
30	9.3	7.0	4.0

Table 7.6: Tolerable Intensities for Various Objects

Sl. No.	Objects	Tolerable Intensities (kw/m^2)
1	Drenched Tank	38
2	Special Buildings (No window, fire proof doors)	25
3	Normal Buildings	14
4	Vegetation	10-12
5	Escape Route	6 (up to 30 secs.)
6	Personnel in Emergencies	3 (up to 30 secs.)
7	Plastic Cables	2
8	Stationary Personnel	1.5

7.7 Damage due to Explosion

The explosion of a dust or gas (either as a deflagration or detonation) results in a reaction front moving outwards from the ignition source preceded by a shock wave or pressure front. After the combustible material is consumed the reaction front terminates but the pressure wave continues its outward movement. Blast damage is based on the determination of the peak overpressure resulting from the pressure wave impacting on the object or structure. Damage estimates based on overpressure are given in **Table 7.7** below:

Table 7.7: Damage due to Overpressure

Sl. No.	Overpressure (psig/bar)	Damage
1.	0.04	Loud Noise/sonic boom glass failure
2.	0.15	Typical pressure for glass failure
3.	0.5-1	Large and small windows usually shattered
4.	0.7	Minor damage to house structure
5.	1	Partial demolition of houses, made uninhabitable
6.	2.3	Lower limit of serious structure damage
7.	5 – 7	Nearly complete destruction of houses
8.	9	Loaded train box wagons completely demolished
9.	10	Probable total destruction of houses
10.	200	Limits of crater lip

7.8 TOXIC RELEASE

Damage criteria: For toxic release the damage criteria considered is IDLH concentration (if data are available). In the absence of non-availability of IDLH, 'Inhalation Toxicity (AEGL) data are considered. 'AEGL' norms are used for chemicals, as IDLH are not available for these chemicals.

7.8.1 Acid/Alkali Hazards

Various hazards that can occur due to the acid and alkali incidents are-

- Skin irritation and corrosive effects after spillage
- Spill pool evaporation of sulphuric storage tanks catastrophic failure are limited only
- Catastrophic failure giving rise to spill pool evaporation dispersion up to LC_{50}, IDLH and TLV level

The more hazardous scenario likely is if spilled acid comes in contact with metal and hydrogen is generated resulting in fire/explosion hazards.

Based on the outcome of the risk assessment, following recommendation has been made to avoid any risk associated with the storage and use of sulphuric/Hydrochloric acid in the plant:

- Double drain valve will be provided to sulphuric acid storage tank.
- Full body protection will be provided to operator.
- Caution note and emergency first aid will be displayed
- All employees will be trained for use of emergency first aid.
- Safety shower and eye wash will be provided in storage tank area and plant area.
- Total close process will be adopted for Sulphuric acid handling.
- Dyke wall will be provided to storage tank
- Tanker unloading procedure will be prepared.
- SOP will be prepared for sulphuric acid handling.
- Training programme will be conducted for safe handling and emergency handling of Sulphuric Acid
- In Storage Tank Area, reaction with water generating fumes should be displayed and avoided
- Suitable extinguishing media-Extinguish with dry powder/sand. DO NOT USE WATER.

7.8.2 Likely Failure Scenarios

Few likely failure scenarios have been selected after critical appraisal of raw materials and storage inventories. Failure scenarios selected are as given in **Table 7.8** below:

Table 7.8: Different Failure Scenarios

S. No.	Scenario	Remark
Raw materials		
RM-1	H_2SO_4	Toxic/Corrosive
RM-2	Nitro Benzene	Toxic/Flammable
RM-3	Formaldehyde (37%)	Toxic/Flammable
RM-4	Aniline Oil	Toxic/Flammable

7.9 QUANTITATIVE RISK ASSESSMENT & CONSEQUENCE ANALYSIS

In the previous part, we have carried out the hazards analysis of the Veer Poly Chem complex considering various aspects including bulk storages of hazardous chemicals, plant process system, plant incidents/accidents records, critical appraisal and discussion at site for soft spots in the plant etc. Based on the hazards analysis critical scenarios have been selected for QRA and consequence analysis. QRA quantifies vulnerable zones for a conceived incident with various levels of severity. Consequence calculations for risk assessment are invariably in terms of percentage of fatalities. The injury criteria have to be agreed in terms of thermal load or toxic concentration versus exposure duration in the first instance.

In consequence calculation, 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, and other property damage). The risk assessment modelling can be roughly divided into three groups:

- Determination of source strength parameters;
- Determination of consequential effects;
- Determination of damage or damage distances (with specific severity rates)

7.9.1 Weather Effect

The effect of ambient conditions on the impact of fire/heat radiation and GLC of hazardous/toxic material can be beneficial as well as harmful. A high wind (turbulence) can dilute the toxic material while stable environment can extend the reach of IDLH or IT (inhalation LC_{50} rats for products) or AEGL (in absence of IDLH data) concentration to long distance. Any inflammable gas/vapour release in turbulent weather will soon dilute the hazardous gases below LEL and thus save the disaster.

7.9.2 Incidents Impacts

The identified failure scenarios (**Table 7.8**) have been analysed (Using ALOHA and EFFECT Modules) for the impact zones considering damage due to thermal and toxic impacts. Each incident will have Impact on the surrounding environment which in extreme case may cross plant boundary. The impact zones for various scenarios are given in **Table 7.9.**

Table 7.9: Hazards Scenario Impact

Scenario No.	Scenario	Impact Zone (m)	Remarks
Scenario Raw Material			
RM-1	Sulphuric Acid	❖ AEGL 3~ 3100	Stability Class D **Figure 7.1**
RM-2	Nitro Benzene	❖ 16	1^{st} degree burn

Scenario No.	Scenario	Impact Zone (m)	Remarks
			Figure 7.2
RM-3	Formaldehyde (37%)	❖ AEGL 3~ 6500	Stability Class D **Figure-7.3**
RM-4	Aniline Oil	❖ 14	1st degree burn **Figure 7.3**

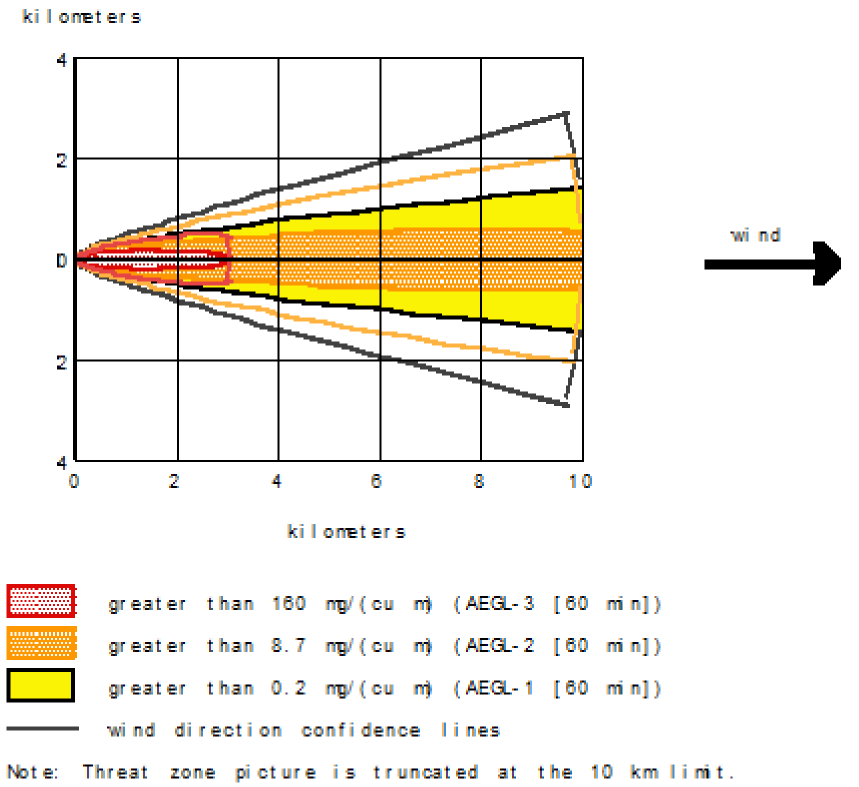

Figure 7.1: Sulphuric Acid Spillage-SO_2 release

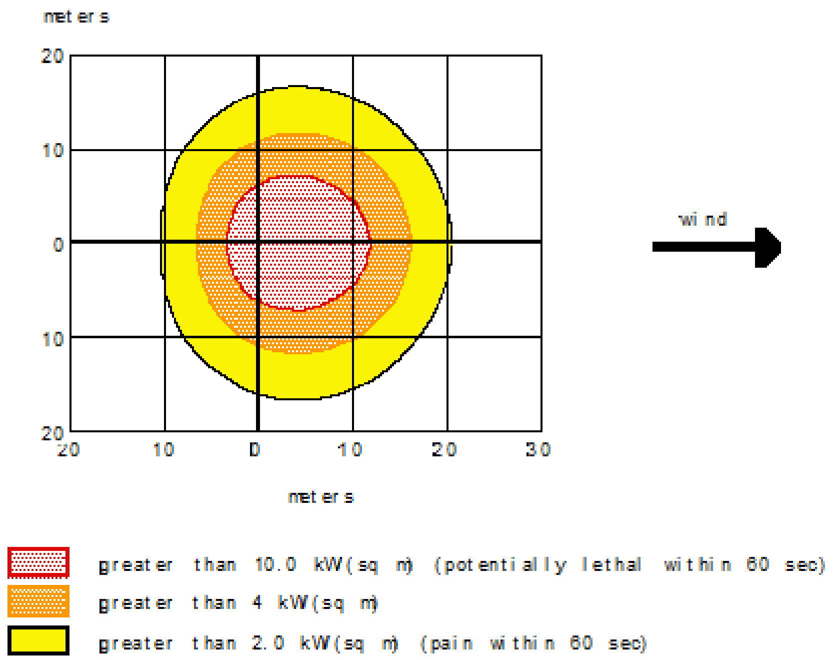

Figure 7.2 Nitro Benzene Spillage & Pool Fire

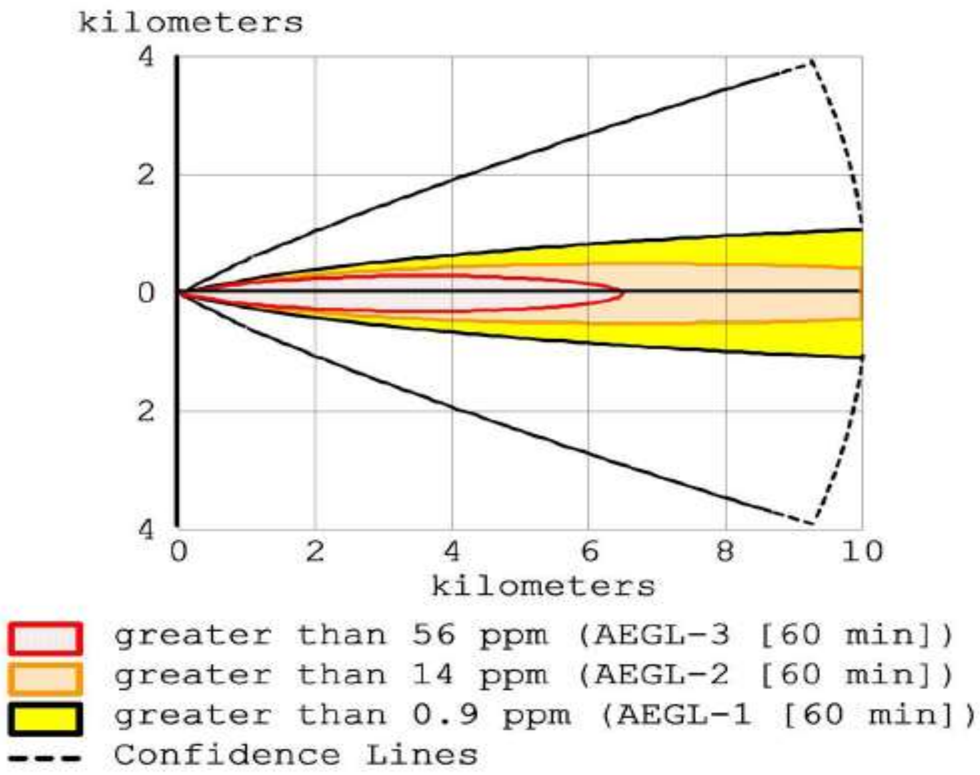

Figure 7.3: Formaldehyde release

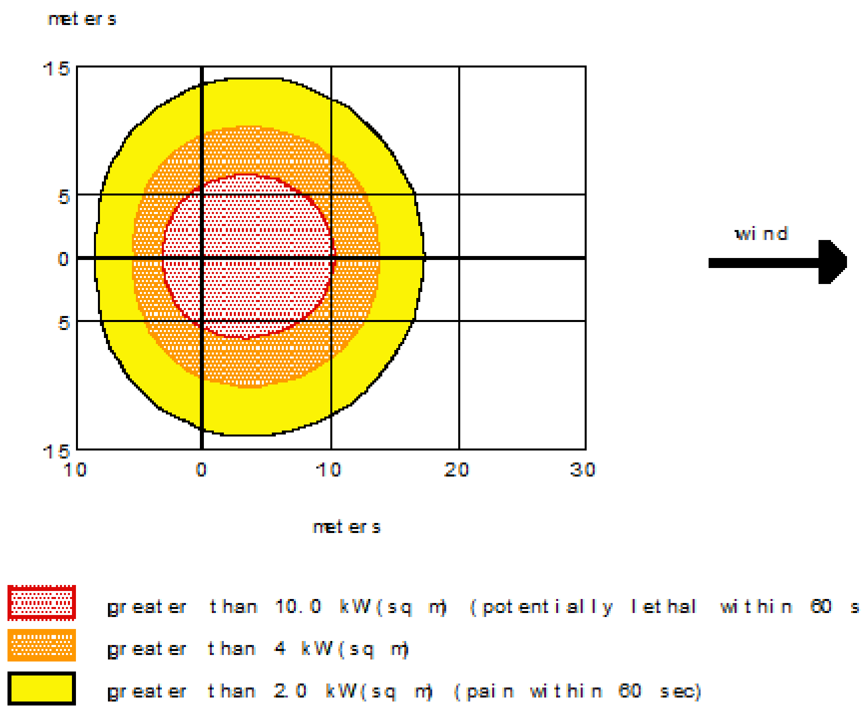

Figure 7.4: Aniline Oil; Tank Failure & Pool Fire

7.9.3 Consequential Impacts

The consequential impacts from each incident scenarios can be though thermal, over pressure wave and toxic route. The damage can be on plant personnel (and neighbouring industry/ residents in case incident crosses boundary), property and also loss in production.

7.9.4 Toxic Hazards

Toxic hazards are mainly due to SO_2 release and other chemicals leakage and their impact can cross the plant boundary (if not controlled in time). The impact due to SO_2 release (due to H_2SO_4 leakage) and other toxic material leakages/ spillages may go up to ~ 3100 m i.e. it may cross plant area /storage area. Sulphuric Acid release will have adverse impact outside the plant battery limit and may involve district authorities to contain the damage.

7.9.5 Other Hazards

The other hazards in the plant include (but not limited to):

- Other toxic hazards due to acids/other toxic spillages (mainly limited to spillage area only).
- Mechanical hazards due to machines/equipment.
- Hazards due to individual soft spots like walking casually and noticing a pit and falling or colliding/ stumbling or slipping (not noticing a wet place etc.).

7.9.6 Other Toxic Hazards

Acid spillage-its impact will be limited to spillage area. The spillage if comes in contact with metal parts will produce hydrogen which is highly flammable gas. Any person moving in area and getting splash will get the injury. In addition the spillage will cause pollution problem. The spillage is to be collected and neutralized for toxic contents before disposal.

7.10 OCCUPATIONAL HEALTH

Veer Poly Chem will have a well-equipped first aid post. It will also have staff personnel trained in first aid. Injured personnel will be immediately rushed to hospital after giving first aid. All employees will have regular medical checkup as per norms. An emergency vehicle/ambulance will always (round the clock) available for meeting any eventuality.

7.10.1 Treatment of workers affected by accidental spillage of chemicals

There is a wide range of chemicals present in the Chemical plants. The safe clean-up of a chemical spill requires some knowledge of the properties and hazards posed by the chemical, and any added dangers posed by the location of the spill.

Treatment of workers affected by accidental spillage of chemicals

Employees must notify their immediate supervisor of injury by spillage of chemicals or exposure to hazardous materials. All injuries that may be work related must be reported. Supervisor is responsible for reporting any injuries or occupational illnesses to the management. Following steps will be immediate taken by the supervisor.

- **Identify spillage/leakages of hazardous chemicals**
- **Chemical Exposure to Skin:**

  Immediately flush with cool water for at least 15 minutes. If there are no visible burns, remove the cloth from burning part of body. Seek medical attention if exposure/spillages occur major possible problems.
- **Chemical Exposure to Skin – Serious:**

  Remove all contaminated clothing. Locate the nearest emergency shower and soak for at least 15 minutes. Have someone contact the Hospital for immediate medical attention.
- **Chemicals in Eyes:**

  Irrigate eyes for at least 15 minutes with tempered water from emergency eyewash station. Remove contact lenses if there is. Notify the management and immediate medical attention.
- **Acid Fumes:**

  Anyone overcome by fumes should be removed by fresh air. Never attempt to enter a location where potentially dangerous fumes might place you at risk. If someone is down, contact emergency personnel and let them enter. Self-breathing apparatus is requiring to whom enter in the acidic fumes area. Seek medical attention for exposure as soon as possible.

- **Chemical Spills**

There is an HCl, H_2SO_4 present in the chemical plant. The safe clean-up of an acid spill requires some knowledge of the properties and hazards posed by the acid and any added dangers posed by the location of the spill. If you believe a spill is beyond your capacity to clean up, do not attempt to do so by your own, immediately contact to nearest fire/emergency station. Spill kits with instructions, absorbents, neutralizing agents if applicable, protective equipment, and sealable waste buckets should be present in plant area.

Following steps to be taken for ensuring health and safety of workers engaged in handling of toxic materials

- Identify chemicals to be used, amounts required, condition followed as per the MSDS guideline.
- Evaluate the hazards posed by the chemicals and the process conditions. The evaluation should cover toxic, physical, reactive, flammable, explosive as well as any other potential hazards posed by the respective chemicals.
- Select appropriate controls to minimize risk, including use of engineering controls, administrative controls, and personal protective equipment (PPE) to protect workers from hazards. The controls must ensure that OSHA's Permissible Exposure Limits (PELs).
- Avoid Underestimation of Risk of handling and its reaction.
- Before working with chemicals, know the facility's policies and procedures for how to handle an accidental spill or fire. Emergency telephone numbers should be posted in a prominent area. Know the location of all safety equipment, nearest fire alarm & telephone.
- Provide popper Ventilation in the plant/process area.
- Toxic or corrosive chemicals that require vented storage should be stored in vented cabinets instead of in a chemical hood.
- Local exhaust ventilation devices should be appropriate to the operations in the plant.
- Chemicals should be separated and stored according to hazard category and compatibility.

- A risk assessment should be conducted prior to beginning work with any hazardous chemical for the first time.

7.11 ACTION PLAN FOR HANDLING & SAFETY SYSTEM

HCl, H_2SO_4, Formaldehyde, Aniline are major raw materials to be utilized for proposed project, classified as flammable and corrosive chemicals. Flammable chemicals will be stored in open area outside the process plant with all the safety measures. Hazardous chemicals bags/ barrels/ drums will be stored and handle in dispensing room for taking out sample from the container for quality check-up purpose or for the partial use. This activity for hazardous material handling will be carried out by using all PPEs with proper ventilation & under supervision.

7.11.1 Safety Measures for Storage/Handling of Hazardous Chemicals

All hazardous and flammable chemicals will store separately and away from the strong oxidant & kept it in well ventilated room. Adequate fire-fighting system will be installed. Safety shower and eye washer will be installed near storage area. Flame proof light fitting will be provided at storage area. Sprinkler system will be installed near storage area. Safety permit system will be followed for loading and unloading. Isolate storage will be provided with wire fencing under lock and key. Caution note, hazardous identification board will be provided. Only authorized person will be permitted in storage area and register will be maintained. "NO SMOKING" board will be displayed and wind Indicator and siren will be provided.

7.11.2 Safety Measures for transportation & unloading of Hazardous Chemicals

- Solvent unloading standard procedure will in place and will be implemented for safe unloading of road tanker.
- Static earthing provision will be made for tanker unloading.
- Drum handling trolleys will be used for transportation of drums up to plant and internal handling from storage to process area.
- Display Boards will be provided on all storage tanks which include the name of the chemicals and its major hazardous characteristics.
- Fire extinguishers will be provided as required.

- First aid boxes will also be provided at different places wherever required.
- Water showering system will be provided to the flammable chemicals storage area.
- Area will be declared as “NO SMOKE ZONE”.

7.11.3 Safety measures for process units

Safety measures are the most important aspect of selection of process technology to ensure safety in production unit. For the safety in production area some important critical safety measures will be provided within the process technology/equipment itself & will put continue efforts for developing new technology/equipment. Company will ensure such provision at time of purchase. The details of the critical safety measures for process unit are as below; any reaction upsets will be confined to the reaction vessel itself as defined quantity of raw materials will be issued to the reaction vessel by metering pumps/load cells. Process parameters control will be provided as per SOP - Standard Operating Procedures. Materials will be transferred by pumping through pipeline or by vacuum from drums. All reaction vents will be connected to vapor condensers system. Hazardous materials will be transferred by pipelines and in control manners. Trained person will be engaged for handling of hazardous materials. Proper safety precautions will be taken during handling of hazardous materials.

All solvents and flammable material with required quantity will be charge in reactor by pump or by gravity. All the vessels will be examined periodically by a recognized competent person. All the vessels and equipments will be well earthed appropriately and well protected against Static Electricity. Temperature indicators will be provided near all reactor and distillation systems. Flame proof light fittings will be installed in the plant. All the Plant Personnel will be provided with Personal Protection Equipments to protect against any adverse health effect during operations, leakage, spillages or splash. PPEs like Helmets, Safety Shoes and Safety Glasses will be provided to the employees.

7.11.4 Hazardous Waste Transport

The occupier of hazardous substance shall prepare seven copies of the manifest (transporting documents) in Form 10(rule 19 (1)) comprising of colour code indicated below (all six copies to be signed by the transporter):

Copy 1 (white): To be forwarded by the sender to the State Pollution Control Board after signing all the seven copies.

Copy 2 (yellow): To be retained by the sender after taking signature on it from the transporter and the rest of the five signed copies to be carried by the transporter.

Copy 3 (pink): To be retained by the receiver (actual user or treatment storage and disposal facility operator) after receiving the waste and the remaining four copies are to be duly signed by the receiver.

Copy 4 (orange): To be handed over to the transporter by the receiver after accepting waste.

Copy 5 (green): To be sent by the receiver to the State Pollution Control Board.

Copy 6 (blue): To be sent by the receiver to the sender.

Copy 7 (Grey): To be sent by the receiver to the State Pollution Control Board of the sender in case the sender is in another State.

The sender shall forward copy 1 (white) to the State Pollution Control Board, and in case the hazardous or other wastes is likely to be transported through any transit State, the sender shall intimate State Pollution Control Boards of transit States about the movement of the waste. No transporter shall accept waste from the sender for transport unless it is accompanied by signed copies 3 to 7 of the manifest.

The transporter shall submit copies 3 to 7 of the manifest duly signed with date to the receiver along with the waste consignment.

The receiver after acceptance of the waste shall hand over copy 4 (orange) to the transporter and send copy 5 (green) to his State Pollution Control Board and send copy 6 (blue) to the sender and the copy 3 (pink) shall be retained by the receiver.

The copy 7 (grey) shall only be sent to the State Pollution Control Board of the sender, if the sender is in another State.

7.11.5 Personnel Safety

- Special clothing and personal protective equipment necessary for entry.
- Protective equipment should be inspected frequently to ensure that it is in good condition. Frequency of checking can be decided depending upon the usage.
- After the use of protective equipment, it should be cleaned and disinfected before being issued to another person.
- Glove materials must resist the product's active ingredients and its solvents. It should allow adequate grip so that applicators can safely carry out their jobs (e.g. change nozzles and screens).
- For protection of eyes always use goggles, polycarbonate lenses are preferred to protect eyes from flying objects. Face shields are secondary means of eye protection and are designed to be worn over safety spectacles or goggles for full face protection.
- When purchasing eye protection, make sure it complies with ANSI Z87 for occupational and educational eye and face protection.
- Sleeve guards should be use when handling hazardous materials to avoid the splashing effect of material.
- Wash contaminated clothing and other PPE daily, as soon as possible after wearing. Delay in laundering will reduce the likelihood of total residual removal.
- Follow the work instruction/checklist.
- Know about MSDS of hazardous chemicals used.
- A person not-familiar with MSDS and trained in use of appropriate shall not commence any work with hazardous chemicals.
- Frequently refer to the MSDS and use of appropriate PPE.
- Display prominently requisite information on MSDS and use of PPE through illustrations.
- It is essential that right type of PPE and in sound condition be used.
- All stocks of PPEs should be periodically inspected, serviced and maintained and unusable ones removed from stock of usable PPEs and sent for disposal.

- All PPEs should be cleaned for personal hygiene and kept packed in poly bags.
- All PPEs should be inspected before and after each use.

7.11.6 Safety Measures for Preventive Maintenance

The safety measures in form of the general Do's & Don'ts for safety in process & other plant area are as below:

- Do not work on equipments without permission from plant head and maintenance head.
- Make sure equipment is empty and fluxed with nitrogen and air.
- Check VOC content for flammable and make sure that no flammable vapour contents.
- Keep proper and adequate fire extinguisher near work area.
- Use proper PPE.
- Do not allow any employment without pre-medical check-up or without checking fitness.
- Check all motors are disconnected and fuse pulled out before maintenance.
- Work in any equipment must be conducted in presence of supervisor.
- Make sure all process lines are disconnected.
- Additional safety measures in form of the checklist covering Do's & Don'ts of preventive maintenance, strengthening of HSE, manufacturing utility staff for safety related measures will be updated timely and will be made available to all concern department & personnel.

7.11.7 Safety measures to prevent spillage/leakage of toxic chemicals

The preventive maintenance will be planned and carried out as per plan to avoid the failure of valve, pipe lines and other component of transferring line. The spillage will be confined to the dyke area underneath the vessel. The resultant splash of such chemicals will result in exposure of toxic chemicals to employees. Decontamination facilities (Safety shower and eye wash fountains) will be provided in the plant area, which can be used to decontaminate the affected employees.

Suitable decontamination procedure will be used to decontaminate the spilled or leaked material. The SOP for decontamination will be reared with all related department.

7.12 ARRANGEMENTS FOR ENSURING HEALTH AND SAFETY OF WORKERS ENGAGED IN HANDLING OF TOXIC MATERIALS

The significance of Safety & Health in chemical industries has been a vital issue in achieving productivity and quality standard. Following is an effort for safety and Health of workers working in chemical plant.

Numbers of chemicals are used in plant have specific health hazards in nature. Following are basic fundamental principles properly underlie all the workers working in the plant. Occupational health and safety is about preventing people from being harmed by work or becoming ill from work by taking adequate precautions and providing a safe and healthy work environment. Consideration of each should be encouraged before beginning work as part of the culture of safety within the plant.

- **Plan ahead.** Determine the potential hazards associated with production.
- **Minimize exposure to chemicals.** Do not allow toxic chemicals to come in contact with skin. Provide proper ventilation devices to prevent/minimize airborne.
- **Do not underestimate hazards or risks.** Assume that any mixture of chemicals will be more toxic than its most toxic component. Treat all the chemicals as toxic substances.
- **Be prepared for accidents.** Before beginning of any batch reaction, know what specific steps to take which cause to accident if any hazardous substance release accidently. Proper follow SOP- Standard Operating procedure to take batch reaction.

Unit will assess is careful examination of what, at work, could cause harm to workers. Accidents and ill health. All risks in the workplace must be identified and assessed for control measures to be put in place.

Follow the five steps of hazard identification will be taken by unit namely;

- Identify the hazards
- Decide who might be harmed and how
- Evaluate the risks and decide on precaution

- Record your findings and implement them
- Review your assessment and update if necessary

Following Information workers should know regarding hazardous chemicals

We shall ensure that the employee is adequately trained with regard to:

- The contents of the hazardous chemical substances
- Potential source exposure to chemicals
- Potential risks to health caused by exposure
- Measures taken by the employer to protect employees against any risk from exposure
- Precautions to be taken by an employee to protect himself against the health risks associated exposure
- Correct use, maintenance of safety equipment, facilities and engineering controls
- Importance of good housekeeping at the workplace and personal hygiene
- Safe working procedures
- Procedures to be followed in the event of spillages or leakages.

7.13 DISASTER MANAGEMENT PLAN

7.13.1 Introduction

Disaster Management Plan (DMP) is proposed to meet the extremely adverse situations caused by the various hazardous accident scenarios. A sample Disaster Management Plan is attached to develop the DMP for the plant and submit to Factory inspector for approval. Mock drills are to be carried out in association with district authorities. Any weak points observed during the mock drills are to be strengthened.

Disaster/Emergency Management Plan is essential for a chemical plant as the processes adopted for manufacturing are classified under Factory Act as Hazardous due to handling and storage of toxic, flammable and explosive hazardous materials. Over the years, the chemical process plant has created adequate infrastructure and adopted risk mitigation measures to tackle any emergency that may arise during the manufacturing process. The important aspect in emergency planning is to control an emergency by technical and organizational means, minimize accidents and consequent losses. Emergency planning also brings to light deficiencies, such as, lack of resources necessary for effective emergency response. It also demonstrates the organization's commitment to safety of employees and physical property as well as increases the awareness among management and employees.

Disaster Management Plan for the plant is necessarily a combination of various actions which are to be taken in a very short time but in a pre-set sequence to deal effectively and efficiently with any disaster, emergency or major accident with an aim to keep the loss of men, material, plant/machinery etc. to the minimum.

A major emergency in a plant is one, which has the potential to cause serious injury or loss of life. It may cause extensive damage to property and serious disruption of both inside and outside the plant. Sometimes, it would require the assistance of outside emergency services to handle it effectively. Although the emergency at the plant may be caused by a number of different factors, e.g. leakage of toxic and flammable materials from piping/tanks, total/partial power failure, earthquake or sabotage, it will normally manifest itself in fire/toxic release.

Primarily, DMP is prepared to furnish details which may require at the time of the emergency, to delegate responsibility, to estimate the consequences in advance and to prepare ourselves to control any type of emergency. The plan explains basic requirements as follows:

- Definition,
- Objectives,
- Organization set up,
- Communication System,
- Action on site,
- Link with Off-site Emergency Plan,
- Training rehearsal and record aspect

7.13.2 Definitions

Various definitions on different analogy used on On-site & Off-site Emergency Plan are as follows:

- **Accident:** An accident may be defined as "an undesirable and unplanned event with or without or major damage consequence of life and /or property.
- **Major Accident:** It is a sudden, unexpected, unplanned event resulting from uncontrolled developments during an industrial activity, which causes or has the potential to cause, death or hospitalization to a number of people, damage to environment, evacuation of local population or any combination of above effects.
- **Emergency:** This can be defined as any situation, which presents a threat to safety of person's or/and property. It may require outside help also.
- **Major Emergency:** Occurring at a work is one that may affect several departments within and/or may cause serious injuries, loss of life, extensive damage to properly or serious disruption outside the works. It will require the use of outside resources to handle it effectively.
- **Disaster:** Disaster is a sudden calamitous event, bringing great damage, loss or destruction.
- **Hazards:** Hazard may be defined as "the potential of an accident". Hazard exists in man and the system of materials and machines.
- **Chemical Hazards:** It is a hazard due to chemical(s) (including its storage, process, handling, etc.) and it is realized by fire, explosion, toxicity, corrosively, radiation, etc.
- **Risk:** Risk may be defined as the combination of consequence and probability or likelihood of an accident being caused in a given man-material – machine system.
- **On-Site Emergency plan:** It deals with measures to prevent and control emergencies within the factory and not affecting outside public or environment.
- **Off-Site Emergency plan:** It deals with measures to prevent and control emergencies affecting public and the environment outside the premises.

7.13.3 Objective of the Disaster Management Plan

The primary purpose of this Disaster Management Plan is to equip the Plant with required resources and information for prompt implementation of the set of actions to be undertaken in the event of an accident posing hazards to the people and community after commissioning of the plant.

The objective of Disaster Management Plan (DMP), for the plant is to be in a state of perceptual readiness through training, development and mock drills, to immediately control and arrest any emergency situation so as to avert a full fledge disaster and the consequence of human and property damage and in the event of a disaster still occurring, to manage the same to that the risk of the damage consequences to life and property are minimized and thereafter, proper rehabilitation, review and revisions of the DMP to overcome the shortcomings noticed are undertaken. The DMP document is prepared keeping in view and to conform the requirements of the provisions of The Factories Act 1948 under section 41 B (4), Guidelines issued by the Ministry of Environment and Forests, Govt. of India and Manufacture, Import and Storage of Hazardous Chemicals Rules, 1989 amended in 2000, Schedule 11 under Environmental Protection Act 1986.

Following are the main objectives of the plan to:

- Defined and assess emergencies, including hazards and risk
- Control and contain incidents.
- Safeguard employees and people in vicinity.
- Minimize damage to property and/or the environment.
- Minimization of risk and impact of event accident.
- Preparation of action plan to handle disasters and to contain damage.
- Inform employees, the general public and the authority about the hazards/risk assessed and to provide safeguard, and the role to be played by them in the event of emergency.
- Be ready for 'mutual aid' if need arises to help neighbouring unit.
- Inform authorities and mutual aid centres to come for help.
- Effect rescue and treatment of casualties.
- Effective rehabilitation of the affected persons and prevention of damage to the property.
- Identify and list any fatalities.
- Inform and help relatives.

- Secure the safe rehabilitation of affected areas and to restore normalcy.
- Provide authoritative information to the news media.

7.14 ON-SITE EMERGENCY PLAN

7.14.1 General

The emergency is an undesirable occurrence of events of such magnitude and nature that adversely affect business, cause loss of human lives and property as well as damage to the environment. Industrial units are vulnerable to various kinds of natural and man-made emergencies. Examples of Natural disasters are flood, cyclone, earthquake, lightening etc. and manmade disasters are major fire, explosion, sudden heavy leakage of toxic/flammable gases, building collapse, human errors, vehicle crash, sabotage, etc. It is impossible to forecast the time and nature of emergency, which might strike the unit. In spite of the fact that every industry is expected to take steps to assess, minimize and, wherever feasible, eliminate risks, accidents may still occur. Risks can only be minimized; it can never be totally eliminated. However, an effective emergency plan helps to minimize the losses in terms of human lives, plant assets and environmental damage and to resume the working condition as soon as possible. In all these steps speed is the essence.

Controlling the emergency will require prompt action by the operating staff, the staff of various agencies, emergency teams and the outsiders when called for. Minimizing the effect on people may be achieved by prompt communication, rescue, evacuation etc., if the situation so warrant.

7.14.2 Statutory Requirement

The provisions for preparing the on-site emergency plan are explained below:

The Factories Act, 1948:

Rules 68J(12), Schedule 8 A of the Gujarat Factories Rules 1963 (Amended 1995) providing that the every occupier, who has control of an industrial activity pertaining to hazardous chemicals shall furnish the On-Site Emergency Plan detailing how major accidents shall be dealt with along with explaining specific responsibilities and actions by various persons.

The Environment (Protection) Act-1986:

Rule 13(1) under the Manufacture, Storage and Import of Hazardous Chemicals Rule 1989 (amended 1994), rules framed under The Environment (protection) Act-1986, indicates that the occupier shall prepare and keep up-to-date an on-site emergency plan containing details specified in schedule II and detailing responsibilities and actions by different person and agencies.

Chemical Accidents (Emergency Planning, Preparedness and Response) Rule 1996.

Under these rules, framed under The Environment (Protection) Act-1986, the state government has constituted a Local Crisis Group & District Crisis Group to deal with major chemical accidents and to provide expert guidance for handling chemical accidents. Further provision is made that the Major Accident Hazard units have to prepare the on-site emergency plan and submit the plan to the crisis groups. The local emergency plan will dovetail with the District off-site emergency plan.

7.14.3 Preparedness of On–Site Emergency Plan

The On-site Emergency Plan describes planning, preparation and training for on-site action in the event of emergency.

For On-Site Emergency Plan Advance planning and proper training of each employee’s into the emergency function is very essential to make emergency control measure more effective. It is not possible to eliminate emergency but is definitely possible to control them. The scope of onsite emergency plan is to prepare for activate the emergency time activities, to controlled and contained within the shortest time if emergency arise after failure of our pre-emergency control measures. Following stage activities are consider for the purpose, as they are co-related and provide better points for emergency preparedness.

7.14.4 Emergency Time Activities

It is not possible to include and discuss every action, which should be taken first during emergency. It is also not possible to describe entire actions on emergency situation. The basic principle of handling emergency, that may be relied upon, who have the knowledge and experience to assess the situation and give direction as per the objectives as quickly as possible. However, the aim is to control the situation by safest way in a limited time within existing available resources. Further, it should be handle with such a care that minimum loss of life, property and environment. In short, the objective of the plan should be successfully complied with.

7.14.5 Sequential actions during emergency

7.14.5.1 Incident

There are possibilities of occurrences of various types of the accidents or mishaps in the factory premises or around the factory. Most of the occurrences will be of minor nature, while few occurrences may be of major type. If the factory is fortunate enough, there may not be a single incident or mishap during its lifespan. However, when any incident occurs, it cannot be distinguished immediately whether it is minor or major, the subsequent development, or gravity of situation, or seriousness of such occurrence is required safe handling irrespective of its nature, if it cannot be controlled. It should be general practice that whenever any person notices the accident/fire/explosion/mishap at the site, he should immediately shout "FIRE", "FIRE" or "HELP", "HELP" and such message should reach to the Supervisor/Shift Officer/Senior Person of the unit.

7.14.5.2 Responding Actions

The root cause of occurrence should be removed immediately if possible. Similarly, if any incident takes place in the premises, using available resources, within the factory as well as nearby, to their optimum, it should be so responded that the incident is contained immediately before spreading. If the incident looks severe and could not be controlled by simple efforts, the Shift Officer or Senior Personnel should rush to the place and make every effort to control the incident using various resources at the site. Further, if the incident is uncontrollable even using own resources, he should immediately call for additional helps form outside resources such as Mutual Aiders, Fire Brigade, etc. He should act the Incident Controller and immediately start the following actions:

- Sound the siren or ring the emergency bell.
- Take continuous responding actions with the use of other helps.
- Call the higher authorities and Site Main Controller.

7.14.5.3 Site Crisis

On arrival, the Site Main Controller (Factory Manager) will take the charge of Incident site. He will immediately assess the situation and manage the Situation as site crisis. The incident can be said as on-site-emergency.

- Activate the emergency teams like fire team, first aid team, communication.
- Team, rescue team, essential workers, key personnel, etc.
- The Emergency control room will communicate the messages regarding
- Prevailing situation to requisite authorities, outside resources, agencies, neighbors, etc.
- Non-essential person will rush to safe shelter and roll call will be taken.
- He will order to shut down the plant, if situation so warrants.
- Now, if the situation is uncontrollable by the management of the unit, he will immediately call for the local crisis group to handle the situation.

7.14.5.4 Messages

While conveying the messages regarding the incident, the following details should be incorporated.

- Brief description of incident
- Type of help required & direction
- Chemical involved & Quantity
- Action immediately taken
- Development of the incident

7.14.5.5 Discipline

The plan assuming certain discipline at site during emergency, as follows;

- Do not get panicky.
- Do not approach the site of incident as an observer.
- Do not engage telephone unnecessary.

- Do not move about unnecessary.
- Do not approach unnecessarily for information or more inquiry.
- Arrange medical first aid care to the injured.
- Do not allow unnecessary crowd nearby incident.

7.14.5.6 Emergency Actions

- On receiving information, the Emergency Control Centre will activate and urgently establish the contact with the required persons, agencies and authorities.
- The essential workers, responsible to carry out certain specific functions, will have to start work immediately.
- The non-essential workers should go to the assembly center.
- The cordoning the incident area will be ensured.
- The water should be sprayed on the flammable storage tank, even if not caught under fire.
- The experts for the responding to emergency situation will be consulted, if required. Authentic information for incident will be provided to Press/Public by the authorized officer only.
- Removal of the flammable, dangerous material, cylinders, etc. should be arranged along with isolation from fire.
- The trapped personnel, if any, in incident will be rescued.
- All assistance will be provided to the Fire Brigade to control spreading of fire.

7.14.6 Shut Down Procedure

It is advisable to shut down the plant for safety, if situation so warrants. The safe shut down procedure should be adopted during such eventualities. First of all, main electrical supply should be cut-off/switch-off. Similarly, the pipelines supplying flammable gas, liquid or chemicals should be immediately shut-off by valves and should be isolated from the process line. The water shower on flammable storage tank, if installed, to be started to keep it in cool condition, if tank is in vicinity of fire. The shutdown procedure should be laid down in the process manual, which will be useful during such emergency.

7.14.7 Post Emergency Activities

Post emergency activities comprise of step taken after the emergency is over. To Find out the reason of emergency after the investigation and suggest the preventive measure. For the investigation different level personnel from different dept., are selected and an investigation team is formed. The following steps are taken after the emergency is over.

- Collection of record
- Conducting the investigation/inquiry committee with the suggestion for preventive measure
- Making the insurance claim and necessary procedure
- Implementation of the recommendation of inquiry reports
- Rehabilitation of the affected persons within the plant and outside the plant. They are in continuous touch with the hospitalized person and give status report of them to the top management
- Restart the plant if shut down happened

7.14.8 Training, rehearsal and records

7.14.8.1 Need of Training & Rehearsal

Extensive experience in the chemical industry with on-site emergency planning has proved the need and value of rehearsal of emergency procedures. When finalized, the major emergency procedure should be set down in clear, concise terms and everyone on-site made aware of them, particularly the key personnel and essential workers. They should then be put to the test. This may best be done by arranging a series of preliminary exercises to test certain system, including the alternative arrangements in cases of failure. The speed of Mobilization of the factory emergency teams, search & rescue and treatment of casualties, emergency isolation and shut down procedures. These exercises will help to define the procedures by identifying deficiencies and difficulties. At this stage, more exercises that are elaborate can be planned to involve the outside services who should be closely involved at the planning stage. Each exercise should at various positions, e.g. at the scene, the emergency control center, work entrance; assemble points or casualty reception area. A following round-the-table discussion between managers, senior officers of the emergency services, factory inspectorate and observers will further assist to develop practical and effective procedures. It is recommended that a major emergency exercises should be conducted at regular intervals with arrangement with the outside agencies. There is much practical advantage to be gained in situations where people required working together in handling emergencies are already known to each other. Close local liaison and combined exercises are invaluable in this respect. At the same time, familiarization visits to works especially of the fire service personnel, will help enormously to acquaint with the works layout and the nature of potential hazards. Emergency plans need to be tested when first devised and thereafter to be rehearsed at suitable intervals. Their normal training and experience in day-to-day operation will generally qualify individual personnel with duties under the plans. Some duties, however, such as firefighting for the works fire team are not routine and special training will be needed. In addition, key personnel will need training in their emergency roles both individually and as a team. For the professional emergency services the general training may be taken for granted. Rehearsals or exercises are important for all personnel likely to be involved in an incident on or off-site because, for example:

- They familiarize on-site personnel with their roles, equipment and the details of the plans.
- They allow the professional emergency services to test their parts of the plan and the co-ordination of all the different organizations. They also familiarize them with the special hazards.
- They prove the current accuracy of the details of the plan [phone no., etc.] and the availability of special equipment.
- They give experience and build confidence in the team members. In the initial shock and confusion of a real incident, ability to fall back on established initial actions is invaluable.

Employers should ensure that the on-site emergency procedures for such process plants, storage facility, etc. are tested regularly and that all employees receive initial and refresher training. Exercises should be arranged to test each part of the emergency plan on each plant, state by state, starting with first immediate action. Emergency isolation and shut down should be rehearsed from the emergency services, the emergency planning officer [EPO] should be invited to attend on-site exercise, and familiarization visits should be encouraged. The complete plan for each site including both on-site and off-site components should be tested. Many organizations now use tabletop exercises to test emergency plans. These are very cost effective because they do not interrupt the day-to-day running of the plant and because many events can be catered for in one session. However, they are theoretical in nature and should be communications and key personnel working from the locations they would use in an emergency. It is, of course, essential that the exercises be carefully prepared, the results analyzed and the lessons learned, circulated and discussed. Full-scale practices involving all concerned that all reasonably practicable measures have been taken. After each rehearsal of practice, the plan should be reviewed to take account of any shortcomings highlighted by the exercise. In addition, its effectiveness should be reviewed every time it is used to with a real emergency. Fix your periodicity to carry out table tope exercises and real rehearsal of this on-site and off-site emergency plan, including mutual aid agencies and mention here in this chapter.

7.15 OFF-SITE EMERGENCY PLAN

7.15.1 Need of the Site Emergency Plan

Depending upon the wind direction and velocity of the effects of accident in factory may spread to outside its premises. To avert major disaster it is essential to seek guidance/assistance of statutory authorities, police and health department. The movement of traffic may have to be restricted. Required information will be given to the authority and consultation will be sought for remedial measures.

A purpose of the off-site emergency plan is:

- To provide the local/district authorities, police, fire, brigade, doctors, surrounding industries and public the basic information of risk and environmental impact assessment and appraise them of the consequences and the protection/prevention measures and to seek their help to communicate with public in case of major emergency.

- To assist district authorities for preparing the off-site emergency plan for district or particular area and to organize rehearsals from time to time and initiate corrective actions on experience.

7.15.2 Structure of the Off-Site Emergency Plan

Available with concerned authorities.

7.15.3 Role of the Factory Management

The site main controller will provide a copy of action plan to the statutory authorities in order to facilitate preparedness of district/area off-site emergency plan.

7.15.4 Role of Emergency Co-ordination Office (ECO):

He will be a senior police or fire officer co-ordination with site main controller. He will utilize emergency control center.

7.15.5 Role of Local Authority

Preparation of Off Site Plan lies with local authorities. An emergency-planning officer (EPO) works to obtain relevant information for preparing basis for the plan and ensures that all those organization involved in offsite emergency and to know their role and responsibilities.

7.15.6 Role of Fire Authorities:

The fire authorities will take over the site responsibility from incident controller after arrival. They will be familiarized with site of flammable materials, water and foam applies points, fire-fighting equipment.

7.15.7 Role of the Police and Evacuation Authorities:

Senior Police Officer designed, as emergency co-ordination officer shall take over all control of an emergency. The duties include protection of life, property and control of traffic movement.

Their functions include controlling standards, evacuating public and identifying dead and dealing with casualties and informing relatives of dead or injured. There may be separate authorities/agencies to carry out evacuation and transportation work. Evacuation depends upon the nature of accident, in case of fire only neighboring localities shall be alerted. Whole areas have to be evacuated in case of toxic release.

7.15.8 Role of Health Authorities

After assessing the extent of effect caused to a person the health authorities will treat them.

7.15.9 Role of Mutual Aid Agencies

Various types of mutual aid available from the surrounding factories and other agencies will be utilized.

7.15.10 Role of Factory Inspectorate

In the event of an accident, the Factory Inspector will assist the District Emergency Authority for information and helping in getting Neighboring Industries/mutual aid from surrounding factories.

In the aftermath, Factory Inspector may wish to ensure that the affected areas are rehabilitated safely.

7.16 Training Rehearsal and Records

7.16.1 Need of Rehearsal & Training

Regular training and rehearsal program of emergency procedures shall be conducted with elaborate discussions and testing of action plan with mock drill. If necessary, the co-operation/guidance of outside agencies will be sought.

7.16.2 Some Check Points

- The extent of realistic nature of incidents.
- Adequate assessment of consequences of various incidents.
- Availability of sufficient resources such as water, fire fighting aids, personnel.
- The assessment of time scales.
- Logical sequences of actions.
- The involvement of key personnel in the preparation of plan.
- At least 24 hour’s covers to take account of absences due to sickness and holiday, minimum shift manning.
- Satisfactory co-operation with local emergency services and district or regional emergency planning offices.
- Adequacy of site.

7.16.3 Records and Updating the Plan

All records of various on-site and off-site emergency plans of the factory will be useful alone with those of the factors by which statutory authorities draw a detailed plan for the whole area/district. The records of the activity will be updated regularly.

B) Social Impact Assessment

Proposed unit will be developed in GIDC Dhandhuka. There will be no R & R due to proposed activities. Not any negative Social Impact envisaged from the proposed project activities. Infact positive Social impact was prevail during the study of Sociological data because, necessity for unskilled and skilled person will increase for proposed activities and unit will accord opportunity first prior to the local people.

C) Public Consultation

The public hearing was held on 11.07.2017 on the basis of the draft EIA/EMP incorporating the Terms of References. Comments and suggestions of the public during public hearing are given below.

Issues/objections raised by the participants and responded to by the representative of the applicant during the Public Hearing:			
Sr. No.	**Name and Address**	**Issue raised**	**Reply from Project Proponent / Other**
1	Name: Govindbhai Palabhai Village: Kotda	• How much employment opportunity is generated for surrounding villages due to this project? • How many of them are Technical staff and non-technical staff?	• 25 to 30 people will get direct employment from this unit and indirect employment like transportation will also generate. • In this unit, 3 to 4 will be technical staff and rest non-technical staff will include 2 to 3 skilled persons and others will be unskilled.
2	Name: Laxmanbhai Thumar Village: Dhandhuka	• What is the water supply system of the unit?	• Water requirement of the unit will be satisfied through GIDC water supply. • W/w will be treated in ETP and evaporate in evaporator and condensate will be reused. Hence, unit will achieve zero liquid discharge.