Chapter 7

ADDITIONAL STUDIES

7.1 PUBLIC CONSULTATION

The proposed project site is situated in Chincholi MIDC area. Hence, as per Environmental Impact Assessment (EIA) Notification No.S.O.1533 (E)" dated 14th September 2006; and amendment thereat, the proposed project does not requires conducting of public hearing. The EIA report has been complied by incorporating required information with regards to the project as mentioned in the Terms of Reference (TORs) issued by EAC to **Balaji Specialty Chemicals Pvt. Ltd. (BSCPL)** during 4th EAC meeting held on 11 February 2016.

7.2 RISK ASSESSMENT REPORT

The study of risk assessment report was done by our Functional Area Expert **Mr. Vinod Sahasrabuddhe.**

7.3 BRIEF INFORMATION ABOUT MANUFACTURING PROCESS

Mono Ethanolamine and Ammonia are reacted under hydrogen atmosphere over a catalyst at a pressure of around 150 to 200 Kg/Cm^2 and temperature are preferably between 150 deg and 225 deg Centigrade and continuously converted to a mixture of Ethylene diamine, Diethylene triamine, Piperzine, Amino Ethyl Piperzine, Hydroxyl Ethyl Piperzine and Amino Ethyl Ethanolamine. The reaction mixture obtained from the reactor is then subjected to a series of distillations for recovering of the products and recycling the excess raw materials and by products formed in the reaction. The byproducts are formed are recycled back to the reaction stage for conversion to desired products**.**

7.4 HAZARD IDENTIFICATION

7.4.1 Classification of Chemicals

In a chemical Industry for primary hazard identification, classification of different chemicals to be used based on properties is an important factor. The classification of chemicals to be used by BSCPL is presented below

Table 7.1 Classification of Chemicals

Sr. No.	Group Of Chemicals	Group Members	Handling	Spill	Emergency	Storage
1.	Flammable Liquids	1. Hydrogen Gas 2. Ethylenediamine 3. Monoethanolamine 4. Diethylenetriamine 5. Ammonia	1. Control of electrostatic charges. 2. Non-sparking tools. 3.Containment 4. Inertisation. 5.Spill control material 6.Eye/skin/breathing PPE 7. Fire safety training.	1. Contain spill. 2. Prevent mixing with water sources. 3. Refer TREM card. 4Arrest Leak by closing the valve if is safe to do so. 5.Contact local police/supplier	1.Take vehicle to safe area without endangering life 2. Place warning signs around the vehicle. 3. Prevent crowd approach to the vehicle. 4. Contact local police/supplier 5. Assist	1.Ventilated place 2.Containment 3 Leak detectors 4. Absence of oxidizers 5. Fire protection system 6.Non sparking tools 7. FLP fixtures as per IS 8. Hot work permits system. 9. Spill control material. 10. Flame arrester for storage tanks

Sr. No.	Group Of Chemicals	Group Members	Handling	Spill	Emergency	Storage
					emergency team as per the need.	
2.	Reactive Chemicals	1. Piparzine	1.Refer MSDS before handling 2. Avoid incompatible materials around handling area. 3.Ensure inertisation 4. Make available compatible fire extinguishers. 5.Avoid shocks/drops and rolling while handling containers. 6. Ensure inertisation while charging in to reactors.	1. Contain spill. 2.Prevent mixing with water /moisture 3. Refer TREM card. 4. Arrest leak by closing the valve if is safe to do so. 5. Contact local police/supplier	1.Take vehicle to safe area without endangering life 2. Place warning signs around the vehicle. 3. Prevent crowd approach to the vehicle. 4. Contact local police 5.Assist emergency team as per the need.	1. Refer MSDS for compatibility before storage. 2. Store air reactive materials under nitrogen. 3. Store water reactive materials away from water/moisture/Aqueous solutions. 4. Use visible sign boards for warning about hazards and cautions for responders. 5. Make available compatible fire extinguishers. 6.Do not store the materials in flammables storage area. 7. Avoid shocks/drops and rolling while handling containers. 8. Ensure water layer above Raney/Ni catalyst all the times.
4.	Corrosive Liquids	1. HCl (30%)	1. Wear full gloves, respirator with face shield and body protection while handling. 2. Ensure neutralizing agents nearby.	1. Contain spill. 2.Prevent mixing with flammables /combustibles 3. Refer TREM card. 4. Arrest leak by closing the valve if is safe to do so. 5.Contact local police/supplier 6. Wear all the PPE kept in vehicle before handling	1.Take vehicle to safe area without endangering life 2. Place warning signs around the vehicle. 3. Prevent crowd approach to the vehicle. 4.Contact local police/supplier 5. Assist emergency team as per the need.	1. Consider secondary containment. 2.Store on non-corrosive surface 3.Consider local exhaust system 4. Store away from azides, sulphides, and hydrosulphides and metal powders. 5. Separate Organic acids and In-organic acids. 6. Segregate water reactive corrosive liquids from water moisture and aqueous solutions. 7. Keep neutralizing agents near by. 8. Store containers on sand bed. 9. Display board at the entrance to avoid use of

Sr. No.	Group Of Chemicals	Group Members	Handling	Spill	Emergency	Storage
				spill. 7. Spread neutralizing agent like Calcium oxide/ash liberally on the spill.		water or water based extinguishers during fire fighting.
5	Compressed Gas	1. Hydrogen gas	1. Use cylinder trolleys for moving cylinders. 2. Identify contents by supplier's label. 3.Keep face away while opening the valve. 4. Use non-sparking opener. 5.Wear respiratory and skin protection while handling Ammonia like gases. 6.Indicate FULL/IN USE/EMPTY conditions by label	1. Refer TREM card. 2. Arrest leak by closing the valve if is safe to do so. 3.Contact local police/supplier 4. Wear SCBA while handling gas leak.	1.Take vehicle to safe area without endangering life 2. Place warning signs around the vehicle. 3. Prevent crowd approach to the vehicle. 4.Contact local police/supplier 5. Assist emergency team as per the need.	1. Well ventilated area. Segregate oxidizing and fuel gases 2. Consider sun light protection. 3.Provide chains support Secure valves with valve guard all the time. 4. Store always in upright position. 5. Indicate full/empty cylinders. 6 Display color code chart. 7. Provide leak detectors for fuel gases like Hydrogen/Acetylene/LPG 8. Provide water spray system for Ammonia storage.

7.5 HAZARD PRONE AREAS

During manufacturing of proposed products the major risk is involved during carrying out reaction at high temperature and high pressure between Mono Ethanolamine and Ammonia. However, in light of manufacturing requirements, risk prone areas have been identified which are as follows-

1. Reaction and Separation section
2. Storage and Transportation
3. Utility operations
4. Piping and transfer pumps
5. Boiler operations

7.5.1 Reaction and separation section

Proposed products will be manufactured in a reactor which would be operated automatically without manual interference. All the raw material and utility requirements like steam, pressure would be controlled based on PLC. Mainly the reaction will be carried out with Mono ethanolamine at high temperature and high pressure with continuous conversion. In case recommended operating procedure and conditions are not followed efficiently then it may result in accident of fire or explosion or release of toxic gases leading to serious damage to life and property.

To avoid direct exposure of workers to various hazardous chemicals plant automation plays important role. Here, risk to life is reduced to minimum due to automated systems like Programming Logic Control (PLC) system or similar automation systems. In proposed BSCPL the entire plant would be automated using Distributed Control System (DCS) followed by PLC, from addition of raw material, pumping, reactor control, recovery, recycle till final product formation and storage.

- **Mitigation measures to control risk in reaction and separation section are**

Detailed HAZOP studies would be carried out to make process as intrinsically safe by carrying changes in standard operating procedure, by introducing additional checks, instrumentation and safety alarms and interlocks.

a. Raw material addition will be controlled by actuator valve linked with the reaction mass temperature and agitator tripping.
b. Reactor will be designed at pressure which will be double than operating pressure.
c. Raw material addition like ammonia will be controlled by actuator valve linked with the reactor pressure and temperature.
d. Proper cooling system will be provided in case of uncontrolled temperature rise.
e. Rupture Disc and safety relief valve will be installed on the reactor to control excess pressure.
f. Feeding rate control as per standard operating procedure (SOP) for gases like H_2 will be installed.
g. Regular maintenance and inspection as per SOP.
h. Eye wash and water shower will be installed on each operating floor/ area of the production.
i. Flow controllers, temperature controllers, pressure controllers will be installed as per plant P&ID diagram.
j. Alarms, sirens and other hazard identification equipments and indication instruments will be installed in every hazard prone areas
k. To maintain the temperature and pressure the cooling coils for temperature and pressure heads will be provided to respective reaction equipments.
l. Time to time maintenance will be carried out only when machine out of operation or stand by operation system is there.

7.5.2 Handling of the materials

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

1. **Care in Handling, Use and Storage of Ammonia (raw material)**

- **Hazards Identification-**

Ammonia is very hazardous in case of skin contact (corrosive, irritant, and permeator) , eye contact (irritant), ingestion, Non-corrosive to the eyes. Non-corrosive for lungs. Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract**.**

- **Precautions:**

Handling: Immediately leaks will be reported in case of spills or failures of the safety equipment (e.g. ventilation system). Medical attention will be done for all exposures. Symptoms can be delayed. Accidental contact with incompatible chemicals will be

prevented. Corrosion-resistant tools and equipment will be used. Heat and ignition sources such as sparks, open flames, hot surfaces and static discharge will be avoided. "No Smoking" signs will be posted. Welding operations or other high energy sources will not be used .Heating will be prevented. Pressure regulator appropriate for cylinder pressure and contents will be used. Cylinder in an up-right position will be kept. Cylinders will be kept safe from damage.

- **Protective Equipment:**

Gloves. Full suit. Certified Vapor respirators, Face shield

2. **Care in Handling, Use and Storage of Mono ethanolamine (raw material)**

- **Hazards Identification-**

Very hazardous in case of eye contact (irritant), ingestion, Hazardous in case of skin contact (irritant, permeator), inhalation (lung irritant). Slightly hazardous in case of skin contact (corrosive), of eye contact (corrosive). Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract. Skin contact may produce burns.

- **Precautions:**

Monoethanolamine will be satisfactorily stored in carbon steel, stainless steel, or aluminum tanks using steel pipes and pumps. Caution will be exercised, however, to keep the material in the anhydrous state to prevent severe corrosion to the carbon steel or aluminum tank and related equipment. A drier on the breathing nozzle is recommended to help maintain anhydrous conditions in the storage tank. Solid sediment may form upon standing. There will be circulation in the storage vessel to keep solids suspended. difficult.

- **Steps will be Taken if Material is Released or Spilled**:

If possible spilled material will be contained. The spilled material will be collected in suitable and properly labeled containers. Upwind of spill will be kept. Area of leak or spill will be made ventilated. Only trained and properly protected personnel will be involved in clean-up operations.

- **Protective Equipment:**

Gloves. Synthetic apron. Vapor respirator. Splash goggles. Will be provided

3. **Care in Handling and Use of Hydrogen gas (Raw material)**

Hydrogen will be manufactured using methanol / ammonia in hydrogen generator. Further, the same without any intermittent storage would be directly feed to reactor. The quantity required for reaction will be 175 Kg/day

- **Hazards Identification-**

It is a extremely flammable gas. When stored under pressure, and heated may explode. It may displace oxygen and cause rapid suffocation. May form explosive mixtures with air - burns with invisible flame.

- **Precautions:**

Safety precautions will be read and understood. It will be kept away from heat, open flames, sparks, and hot surfaces. Smoking would be avoided in industry. In case of

leaking gas fire, all ignition sources will be eliminated with back flow preventive device in the piping. Valve will not be opened until connected to equipment prepared for use. Valve will be closed after each use and when empty

- **Storage:**
  The Hydrogen gas generated from generator would directly feed to the reactor without intermediate storage.

- **Protective Equipment:**
  An air-supplied respirator will be used while working with this product in confined spaces. Safety shoes while handling containers.

4. Care in Handling, Use and storage of Peprizine (Byproduct)

- **Hazards Identification-**

  Hazardous in case of skin contact (irritant, permeator), eye contact (irritant), ingestion, of inhalation**.** Flammable liquid

- **Precautions:**

  Neoprene gloves and boots and safety goggles will be worn when handling piperazine. If leather articles (shoes, belts, watch straps, etc.) are contaminated, they will be taken off and destroyed, since piperazine will be absorbed by the leather and cannot be removed. If contaminated items continue to be worn there is a real risk of skin burns. Approved respirators will be worn when piperazine is present in the air at more than 1 part per million. Self contained or supplied air respiratory equipment may also be worn.

  • **Large spills**: Contain with a dike and pump into suitable, properly labelled containers for reuse or disposal.
  • **Moderate spills**: Absorb with sand and put into a suitable and properly labelled container for disposal. Flush the remainder with plenty of water.
  • **Small spills:** Flush with large amounts of water.

  Copies of MSDS are appended at **Appendix - I**

7.5.3 Storage and transportation

Ammonia and Mono Ethanolamine are main raw materials required for manufacturing of proposed products and products will be drawn continuously. Areas allotted for the storage of raw materials and products are as follows -

1. Ammonia storage tanks -660 m^2
2. Mono ethanolamine storage tanks-875 m^2
3. EDA Storage tanks -875 m^2

The storage capacities are given as follows-

Table 7.2 Storage Tank Details of Products and Raw Materials

Sr. No.	Name of the Chemical	Storage Capacity	Storage Conditions	Note
1	Ammonia	70 KL	Closed Pressure Vessels	As per Explosive Act, distance will be kept **30 M** form each side of the area allocated for

Sr. No.	Name of the Chemical	Storage Capacity	Storage Conditions	Note
				storage.
2	Mono Ethanolamine	1800 KL	Closed Vessels	----
3	Ethylene Diamine	1800 KL	Closed Vessels	----
4	HCL (30%)	20 KL	Closed Vessels	----
5	Piperzine	50 KL	Closed Vessels	----
6.	Di Ethylenetetramine	50 KL	Closed Vessels	----
7	AEP	50 KL	Closed Vessels	----
8.	HEPP	50 KL	Closed Vessels	----
9.	AEEA	50	Closed Vessels	----
10.	All other materials	100 M.T	Stored in Godown	----

Table 7.3 Details of storage tanks with dyke wall dimensions

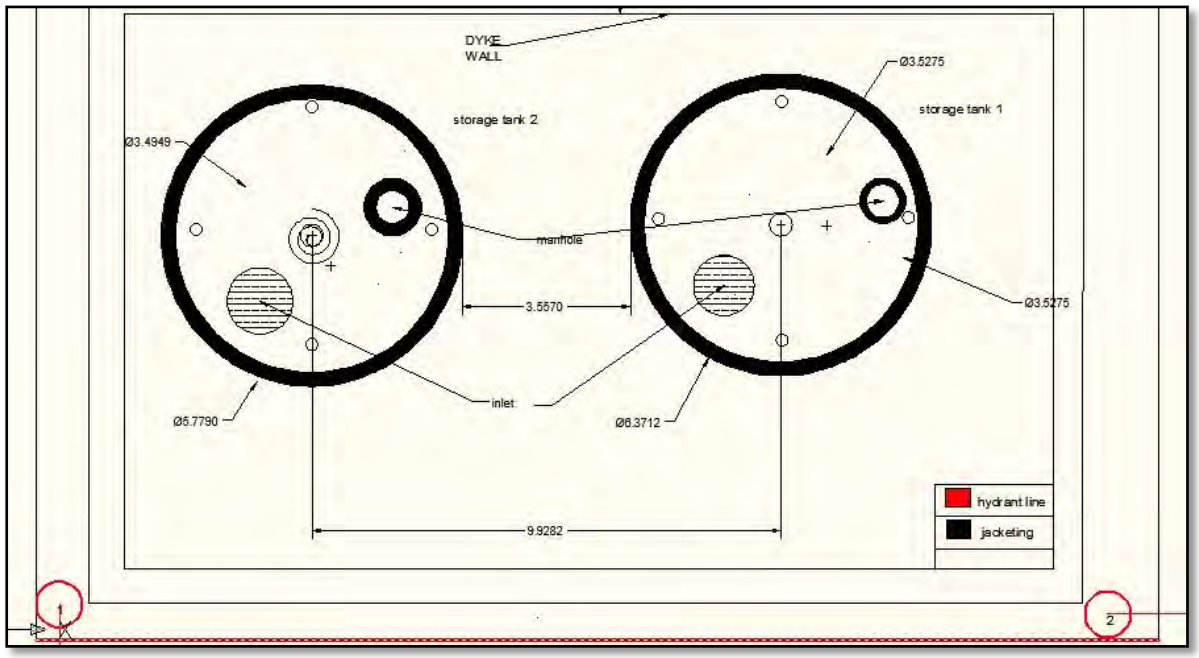
Sr. No.	Equipment Details	Dimensions of Tank(Meter)	Capacity (KL)	Dyke Wall Dimensions(MTR)	MOC of Tank
1	Ammonia Tanks (6 NOS)	3 Diameter x 10.5 Length	80	34X20	SA 516 Gr 70
2	Mono Ethanol Amines Bulk Tanks (6 NOS)	7.5 x 7.5	331	36X25	SS 316
3	Ethylene Di Amine Bulk Storage Tanks (6 NOS)	7.5 x7.5	331	36X25	SS 316
4	Di Ethylene Tri Amine Tanks (2 NOS)	5 x 5.5	100	24X12	SS 316

7.5.3.1 Safety Measures for Storage tanks

a. The storage tanks will be provided with dyke wall. Dyke walls as mentioned in above **Table No.7.3**
b. Tanks will be segregated based on contents, solvents, acids and would be located in separate dyke walls.
c. All the tanks would be provided with breather valves and flame arresters.
d. Nitrogen Blanketing would be provided to respective tanks.
e. Non -contact level indicator will be provided.
f. Enclosed dispensing system will be practiced.
g. Pumps with double mechanical seal will be provided.
h. All the tanks shall be made earthed sufficiently and static electricity discharging facility shall be provided.
i. All the vehicles at the entry of the factory shall be provided with spark arrestors and at the point of unloading, earthling clips will be hooked before unloading of tankers.
j. Fire fighting hydrant system, hydrant layout, dedicated water storage tanks for fire fighting, fire fighting pumps will be designed and installed as per IS code 13039 and IS 9668 and other applicable codes.
k. As per the code adequate portable fire extinguishers will be installed around tank area, plant, and offices.
l. Loading and unloading procedure for solvents under pressure and other solvents will be prominently displayed near the tanks.

m. Safe clear distances between the tanks will be maintained as per the petroleum storage rules applicable to class A and class B solvents.
n. Fire fighting pumps and jokey pumps will be provided with alternate power supply.
o. All drivers and employees shall be trained to identify hazard communication information on containers and to interpret information on TREM card.
p. Received material will be unloaded at storage area manually with the help of pallet trolley. All material will be securely palletized on racks by forklift. Hazardous material will be placed away from other incompatible materials.

Figure 7.1 Tank Representation



▸ Warehouse safety

Raw materials required in smaller quantities are mainly in form of solid as well as liquids would be stored in the warehouse. These chemicals would be stored in drums as well as bags. The warehouse provides safety from sunlight; air and humidification which help retain the original properties of raw material. This enhances the reactivity and performance of the products as well as reactants. In warehouse, fire hazards could occur if there are spillages/ leakages. Safety measures to be adopted in warehouse areas are as follows-

i) Piparazine in powder form would be stored in bags of 25 kg. These bags would be further stored in warehouse. Also Drums will be stored in warehouse with specific segregation.
ii) Material Safety Data Sheet (MSDS) would be maintained for each chemical for which workers are exposed in the facility;
iii) Instructions would be followed as per the MSDS for handling chemical products.
iv) Employees will be trained for handing risks of each chemical being stored.
v) Spill cleanup kits would be provided in all areas where chemicals would be stored.
vi) A written down procedure would be formulated and training would be imparted to employee for spill control and cleaning.
vii) Adequate and proper personal protective equipment would be provided and enforced to use while working.
viii) All chemicals would be stored safely and securely.
ix) Chemicals would be stored away from forklift traffic areas.

x) Drums/ carboys of chemicals would be stored in designated place in warehouse, separated by at least 1 meter and will be arranged based upon the compatibility/non compatibility properties. Provision of two gates for the warehouse shall be made.
xi) The static discharge boards shall be provided before entry into the warehouse to discharge the static electricity of the personnel.
xii) Sufficient fire extinguishers DCP type, CO_2 type and Foam type will be provided inside the warehouse & at the entry.
xiii) No dispensing in storage area shall be allowed.
xiv) Organic vapor detectors shall be provided.
Actions to be taken in case of spillage of toxic and hazardous chemicals, exposure shall be prominently displayed inside the warehouse.

7.5.4 Utility operations

Utility operations are the heart of the production process. The BSCPL is producing specialty chemicals which involves number of utility operations as boiler operations, distillation etc. it is necessary to look out hazard if the utility failure occurs.

As mentioned, plant utility systems are used to enhance chemical processes. Plant operation, not only includes production considerations, but also involves safety aspects to control failure that could lead to a catastrophic release (e.g., a flexible hose connection, pump seals, vessel/tank welds);

Mitigation Measures for Utility operations

- Operations will be made end to end automated and well equipped with utility failure prevention system.
- Distillation columns will be automatically operated and connected with PLC or SCADA system.
- Reactors will be interlocked with actuator valves and control panels

7.6 NFPA RATING

Table 7.4 NFPA Ratings of Raw Material and Products.

Sr no.	Name of Chemical	NH	NF	NR	Special	TLV Values
1	Piperazine	3	2	1	Poisonous	TLV-TWA : 0.03ppm(IFV)
2	Ammonia	2	0	0	---	TLV-TWA 25ppm TLV-STEL 35ppm
3	Diethylenetriamine	3	1	0	Hazardous in skin contact	TLV-TWA 1ppm
4	Ethylenediamine	3	3	0	Extremely hazardous in case of skin contact, Corrosive	TLV-TWA: 10 ppm
5	Hydrogen Gas	0	4	0	Extremely flammable gas.	Simple asphyxiate Due to Minimal Oxygen content

Sr no.	Name of Chemical	NH	NF	NR	Special	TLV Values
6	Monoethanolamine	3	2	0	Very hazardous in case of eye contact	TLV-TWA: 3ppm TLV-STEL: 5 ppm
7	HCL (30%)	3	0	1	Extremely hazardous in case of skin contact,	TLV-TWA: 1 ppm TLV-STEL: 5 ppm

7.7 QUANTITATIVE RISK ANALYSIS

The chemicals are quantified on the basis of ALOHA software and toxic threat zones have been carried out as follows. HAZOP studies will be carried out for highly hazardous chemicals.

Table 7.5 Worst Case Scenario

Sr. No.	Raw Material	Scenario of Spillage/ Leakage	Area of Spread	Mitigation Measures
1.	Ammonia	Leak from hole in Horizontal cylindrical tank Non-flammable chemical is escaping from tank	Red : 1.8 kilometers --- (1100 ppm = AEGL-3 [60 min]) Orange: 4.8 kilometers --- (160 ppm = AEGL-2 [60 min]) Yellow: greater than 10 kilometers --- (25 ppm)	**Small Spill:** Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. If Necessary: Neutralize the residue with a dilute solution of acetic acid. **Large Spill:** Corrosive liquid. Poisonous liquid. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Do not touch spilled material. Use water spray curtain to divert vapor drift. Use water spray to reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Neutralize the residue with a dilute solution of acetic acid. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.
		Flammable gas escaping from pipe (not burning)	Red : 37 meters --- (1100 ppm = AEGL-3 [60 min]) Orange: 97 meters --- (160 ppm = AEGL-2 [60 min]) Yellow: 246 meters --- (25 ppm)	
2.	Ethanolamine	Leak from hole in horizontal cylindrical tank Flammable	Red : 20 meters --- (1000 ppm = PAC-3) Orange: 41 meters --- (6 ppm = PAC-2)	**Small Spill**: Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. **Large Spill**: Flammable liquid.

Sr. No.	Raw Material	Scenario of Spillage/ Leakage	Area of Spread	Mitigation Measures
		chemical escaping from tank (not burning)	Yellow: 74 meters --- (3 ppm)	Corrosive liquid. Keep away from heat. Keep away from sources of ignition. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Do not touch spilled material. Use water spray curtain to divert vapor drift. Prevent entry into sewers, basements or confined areas; dike if needed. Eliminate all ignition sources. Call for assistance on disposal. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.
3.	Ethylenamine	Leak from hole in horizontal cylindrical tank Flammable chemical escaping from tank (not burning)	Red : 1.6 kilometers --- (9.9 ppm = AEGL-3 [60 min]) Orange: 2.4 kilometers --- (4.6 ppm = AEGL-2 [60 min]) Yellow: 1.6 kilometers --- (10 ppm)	**Small Spill:** Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. **Large Spill:** Flammable liquid. Corrosive liquid. Keep away from heat. Keep away from sources of ignition. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Do not touch spilled material. Use water spray curtain to divert vapor drift. Prevent entry into sewers, basements or confined areas; dike if needed. Eliminate all ignition sources. Call for assistance on disposal. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

7.7.1 Colour Coding For Safety during In-House Material Transfer

Following color coding will be implemented on site for pipes carrying materials in Industrial premises.

Table 7.6 Colour Coding For BSCPL Plant

Substance	Colour
Water	
Steam	
Acid &alkali	
Air	
Other liquid	
Gaseous	

7.8 FIRE FIGHTING ARRANGEMENTS

- Guidelines in OISD 117 will be followed, while designing firefighting system around the tanks
- The main components of the fire system are Fire Water Storage, Fire Water Pumps and Distribution Piping Network.
- The fire water system installation will be designed to meet the fire water flow requirement to fight single largest risk at a time.
- Fire water flow rate for a tank farm will be aggregate as following :-
- Water flow calculated for cooling a tank on fire at a rate of 3 lpm/m² of tank shell area.
- Water flow calculated for exposure protection for all other tanks falling within a radius of (R +30) meters from centre of the tank on fire (R-Radius of tank on fire) and situated in the same dyke at a rate of 3 lpm/m² of tank shell area.
- Water flow calculated for exposure protection for all other tanks falling outside a radius of (R+30) m from centre of the tank on fire and situated in the same dyke at a rate of 1 lpm/m2 of tank shell area.
- Foam water requirement will be calculated based on 5lpm/m2 of tank area.
- For water flow calculations, all tanks farms having class A or B petroleum storage will be considered irrespective of diameter of tanks and whether fixed water spray system is provided or not.
- Water flow required for applying foam on a single largest tank by way of fixed foam system, where provided, or by use of water/foam monitors.
- Various combinations will be considered in the tank farm for arriving at different fire water flow rate and the largest rate to be considered for design.
- Fire water flow rate for supplementary streams will be based on using 4 single hydrant outlets and 1 monitor simultaneously.
- Capacity of each hydrant outlet as 36 m^3/hr and each monitor as 144 m^3/hr minimum may be considered at a pressure of 7 kg/cm^2g.
- Distance between two tanks must be half of the dimension of the tank or the largest tank dimension in the tank farm.
- Smoke detectors will be installed in the warehouse area.

7.9 OCCUPATIONAL HEALTH CENTER (OHS)

Company will define the specific information for the workers and will plan a well equipped health center. OHC will be provided as per factories act. Health checkup of all employees and contract labors will be carried out before employment and at regular intervals and record for the same will be maintained.

Table 7.7 Details of Occupational Health Monitoring

No	Solvent	Target organs	Parameters for occupational Health monitoring	Frequency
1	Hydrochloric acid	Skin Respiratory system.	Pre-placement medical check-up Function and integrity of eyes, skin and lungs.	Pre-placement Annual
2	Ammonia	Skin ,eye respiratory	Pre-placement medical check-up Function and integrity of eyes, skin and lungs.	Pre-placement Annual
3	Diethylenetriamine	Very hazardous in case of skin contact (irritant, permeator), of eye contact	Pre-placement medical check-up	Pre-placement Annual
4	Ethylenediamine	Very hazardous in case of skin contact ,eye contact (irritant, corrosive), of ingestion lung irritant	Pre-placement medical check-up	Pre-placement Annual
5	Methanol	Skin-dermatitis Liver Optic atrophy Blindness	Pre-placement medical check-up	Pre-placement Annual
6	Piperazine	eye contact (irritant), redness, watering, and itching. skin ,	Pre-placement medical check-up	Pre-placement Annual
7	Monoethanolamine	Very hazardous in case of skin contact ,eye contact (irritant, corrosive), of ingestion lung irritant	Pre-placement medical check-up	Pre-placement Annual
8	Hydrogen gas	eye respiratory	Pre-placement medical check-up	Pre-placement Annual

7.10 SAFETY HEALTH AND ENVIRONMENT POLICY

The company has defined Safety Health Environment and Risk policy. The content of same are presented as follows-

- The safety committee will be an advisory body for recommending measures to management for Improvement of safety, safer working conditions and ensuring implementation of safety measures decided upon.
- The committee will be constituted consisting of Production Manager as chairman and Four other members. From the management, the Administration Officer and one Production Supervisor will be nominated as members and there will be two worker members. The Administration Officer will function as the Secretary of the Committee.
- The members will have a term of 2 years and are eligible for re-nomination at the end of the term.
- The function of the Committee will be to:
  a. Assess safety requirements on machines, jobs, work places, work rooms and other places in the company and assess safety equipment like Appliances, devises, apparel etc. to prevent accidents. Also standardize appliances, apparel etc. required for more than one job.
  b. Assess jobs in the company to avoid hazards to health.
  c. Decide upon and implement safety campaigns and programs within the company.
- To avoid accidents and damages to health of all employees.
- To integrate safety practices completely with production and operation requirement.
- To ensure that the safety measures in force are fully complied with and by all employees.
- To maintain neat, clean, safe, attractive& healthy working conditions.
- To comply with all statutory & legal requirement pertaining to accident, prevention, pollution control, improvement in working conditions & prevention of fire & explosion hazards.

7.11 OBJECTIVES OF THE DISASTER MANAGEMENT PLAN (DMP)

Disaster occurring at any industry or installation may cause injuries or loss of life or damage to the property or disruption inside as well as outside the premises. The disaster could be a result of abnormal functioning within the facility or caused by third parties or by natural factors. If an emergency becomes uncontrollable and leads to damage to life and property in the industry and it's neighborhood, it may be defined as the disaster.

The objectives of disaster management plan are as follow

Controlling the disaster, localizing the disaster and eliminating the hazard.

- Welfare of person managing the disaster.
- Head count and rescue operations.
- Treatment of injured.
- Safeguarding others by timely evacuation.
- Minimizing damage to property and environment.
- Informing and assisting relatives.
- Informing and collaborating with statutory authorities.
- Informing the news media.
- Preserving records and organizing investigations.
- Ensuring safety of the works before personnel reenters and resumes work.
- Investigating and taking steps to prevent recurrence.
- Resorting normalcy.

The prerequisites for a good disaster management plan have been given below:

- Management's commitment to safety.
- Emergency organization.
- A good Public Address System in the complex with one or two jeeps with PA system for use in surrounding areas also.
- "Duty Team" for silent-hour coverage, approved emergency control centers and assembly points.
- Written guidelines for the duty team members.
- List of key personnel, experts, doctors, village leaders, authorities with their locations and telephone numbers (both office and residence).
- Clear-cut definition of role of individuals.
- Adequate means of communication with good back-up facility for telephone system. Also, alternative methods of communication like wireless, messengers etc. should be available
- Training, Regular rehearsals including alarms at least once / quarter.
- Fire and safety manuals (Both common and plant wise).
- Operating and Maintenance Manuals.
- Strong conviction that “the prevention is better than cure”. Therefore, more emphasis should be made to prevent disasters.
- Warehouse safety manual.
- Chemical Information Sheets (CIS) or Material Safety Data Sheets (MSDS) or Work Practice Data Sheet (WPDS) for all the hazardous substances handled.
- Transport emergency cards (Trim cards) for the products transported by road.
- Disaster Management Plan (both On-site and Off-site)
- Rehearsals of the disaster management plan (disaster control plan) and modifying / updating the same, if necessary. The timing of events, communication failures etc. should be noted and analyzed for improvement. The plan may therefore, have to be regularly discussed and updated.
- Division of each large factory into 'Safety Districts' for better safety management.
- Availability of emergency 'Instalite' (emergency light) to take care of power failures.
- Mutual aid scheme, if feasible.
- Provision of antidotes, emergency medicines and beds in nearby hospitals.
- Liaison with outside agencies and civic and government authorities for mitigation of the effects of a disaster.
- Round- the- clock availability of trained first-aid personnel.
- Standby communication system in case the telephone system is affected, e.g. Walkie-talkie, radio telephone, mobile phone etc.

Elements and Essentials of Disaster Management Plan-

- Vulnerable areas of the plant where disasters are likely to originate should be identified and planned measures to deal with the same should be decided.
- Organization, i.e. appointment of key personnel with their duties and responsibilities should be done. This should cover personnel by their designation and it should not only consider the normal working but shifts and holiday work also.
- Communication mechanism for raising the alarm as well as that for the interaction within and outside works should be provided.
- Roles and responsibilities of other individuals, as mentioned below, need to be defined clearly.

a) Fire fighting
b) Medical
c) Rescue
d) Engineering support

- All others, not taking part in emergency handling operations.
- Location of emergency control center and assembly points should be precisely and carefully planned.
- Check -list for sequence of operations to be followed should be prepared.

7.11.1 Identification / Assessment of Situation

It is essential that the situation is identified at the earliest possible time and judged correctly and if necessary, the emergency is to be declared.
The Shift In-charge, who is at all times in the industry, shall identify situation of the hazard or calamity and report immediately the same to Managing Director and shall also sound the alarm bell provided in each of the sections.
Under this plan, the Managing Director will take charge of the situation. No sooner, he gets the information from shift in-charge, he shall move to the place of hazard / calamity. He would assess the situation and decide to declare emergency either in that particular section or the entire plant and sound alarm bells accordingly.
If the emergency is to be declared only in one plant, the other plants will work normally. He will take immediate steps to control the situation.

7.11.1.1 Action Plan

BSCPL have prepared an action plan for the proposed unit which is stated as follows and the same will be followed for the expansion products

- **Action To Be Taken By Any Employee Seeing An Emergency**

1. Any employee seeing an emergency situation should inform to the plant control room no. 3, indicating the nature and location of emergency.
2. The shift in charge / panel operator should put on the siren.
3. On hearing the siren, the chief controller should go to control room and the incident controller should reach the site of incidence after confirming the nature and location of emergency from the control room no. 3
4. The emergency squad members (fire team and first aid team) should reach the site of incidence after confirming the nature and location of emergency from the control room no. 3
5. After confirming the emergency location, security should rush towards the point with emergency vehicle. And other security should stay on the gate.
6. Other employees / contract workmen / visitors should reach the assembly points.

- **Action Plan For Electrical Fire**

a) Disconnection of the electric supply of the affected area.
b) Attempt to extinguish the fire with the help of CO_2 fire extinguishers.
c) If the fire still persists, ensure complete isolation of electric supply of that area and use water.

- **Action Plan For Office Fire**

a) Disconnection the electric supply of the affected area.
b) Attempt to extinguish the fire with the help of CO2 / DCP fire extinguishers.

c) Save all records from fire.

- **Action Plan For Person Aflame**

a) Bring the water gel blanket
b) Open the bag inside the container to remove blanket. If the bag is already open such blanket should not be used for burn victims.
c) The blanket can be held as a screen between the victim and the fire.
d) If possible lay down the victim and wrap the blanket around the victim. Leave the victim wrapped in blanket and seek medical help.

- **Action Plan For Food / Water Poisoning**

a) Persons observing the symptom should inform the location in change for assessing the situation.
b) Safety officer should announce instruction of the location in charge to all employees.
c) Shift in charge should call the doctor and ambulances and also alert all hospitals to meet any exigencies.
d) To render first aid and induce vomiting to the affected persons.
e) The ambulances and vehicles available should be mobilized to be in readiness to transport large number of people if required.
f) Safety officer report to location in charge for required sanitation and medical assistance.

- **Action Plan For Electric Shock Casualties**

Electric shock results in irreversible damage to brain cells followed by deterioration of other organs.
Rescue and first aid –
Do first thing first, quickly and without fuss of panic.
Switch off the supply if this can be done at once. If not possible, use a dry stick, dry cloth or other non conductor to separate the victim of electrical contact. The rescuer must avoid receiving shock himself by wearing gloves or using a jacket to pull the victim. Always keep in mind that delay in rescue and resuscitation may be fatal. Every second counts.

- **Artificial respiration**

a) Mouth to mouth method
b) Silverster Brosch Method
Give artificial respiration, if breathing has stopped. There are several methods of artificial respiration. If the
Victim is not injured over the face, try mouth to mouth. If the victim is injured over the face, use Silverstar Brosch method.

- **Emergency Procedure For Handling Coal Stack Yard Fires:**

Coal stack of full height (eight meters) and a length of 10 m on fire or smoldering below the surface on the entire length shall be considered as an emergency. (The dimensions mentioned above are indicative only. Uncontrolled fire in a portion of coal stack yard shall be treated an emergency).

a) Availability of fire hydrant and spray system around the stack yard
b) Trained fire fighting personnel
c) Earth moving equipment (2 nos. dozers & one pay loader).

Procedure

1) On observation of emergency fire situation in coal stack yard CHP operation engineer shall immediately report to CHIEF CONTROLLER (CC)
2) On receipt of communication from CC all key personnel shall reach to designated emergency control centre.
3) Work incident controller shall ensure containing of the fire affected stack yard by cutting of coal on either side of coal stack by means of available machinery viz., dozers, re-claimers.
4) The coal so removed shall transport to the unaffected portion of the stack yard or adjacent stack yard.
5) After ensuring complete isolation of the affected portion of stack yard, press spray of water from water hydrant from all possible directions along with tenders. Ensure quenching of flames and smoldering coal. Spontaneous hibernation of steam from the quenched coal stack should boot be a cause of worry, however care to be exercised that persons involved in tackling the emergency does not get hurt by the steam burst.
6) Excess fire fighting water going through the drain shall be contained in the holding pond and shall be released only after complete setting of coal in the holding pond.
7) After containing the fire completely, press dozers in service and compact the coal further.
8) Reclaim the partially burnt coal at the earliest opportunity for bunker.

- **Action Plan For Fire Emergency In Cone Roof Tank**

Class B/C products are normally stored in cone roof tanks. Chances of fire generally in cone roof tanks storing petroleum liquids having flash point more than 23^0c are less. However due to explosion there is every possibility of roof blowing off and tank catching fire. The following steps are to be taken:

1) Assess the situation
2) Approach the tank and start cooling operation
3) Start cooling operation of nearby tank
4) Isolate the lines leading to the tank on fire
5) Assess the foam requirement and check the stock availability prior to foam application.
6) Arrange and position the foam monitors for foam application of the tank top
7) Apply foam on adjoining pipe track area to avoid spilled oil catching fire and to avoid spreading of fire in pipe track area.
8) Arrange for sufficient numbers of sand bags for stopping of oil spreading into other areas.
9) Arrange for dewatering pumps for removing water from tank dyke area.
10) Arrange for foam application for minimum two hours.

- **Action Plan For Cone Roof Tank Vent Fires**

1^{ST} Case

Fire at a tank vent that is burning with a yellow orange flame emitting black smoke indicates a vapour rich condition within the tank that is above the flammable or explosive limits.

2^{nd} Case

Fire at a tank vent that burns with a snapping blue-red nearly smokeless flame indicates a vapour air mixture within the tank that is within the flammable range. There is danger of an explosion should the flame reach the inside of the tank. In this case no one should approach the vent for putting off fire.

- **Precautions to be taken while fighting tank fires.**

a) Fire fighting personnel should not go down on the floating roof of the tank unless in extreme necessity.
b) In case of above requirement, proper safety equipments should be used and back up for firefighting/rescuing team to be provided.
c) Keep constant vigil on that particular tank and as well as on the neighboring tanks
d) Avoid directing heavy stream of water on the roof to avoid water stagnation.
e) Follow the instruction of Man-in-charge during the entire fire fighting exercise.

- **General Considerations**

- To ensure sufficient supply of foam compound
- Additional manpower
- Assistance from other agencies

- **Action Plan For Tank Dyke Fire**

- In case fire occurs in the dyke area due to flange leak in manifold area, the fire is to be extinguished with the help of foam.
- Operate water sprays system of the tank for cooling the tank shell.
- Use DCP if the fire is small; otherwise use water spray of foam.
- Cooling of lines / flanges is to be continued till Man-in-Charge gives the instruction to Stop

If tank collapses and product is spread in the dyke area with fire.

- Withdraw manpower in and around the tank dyke area
- Use foam monitors of vehicles to spray and spread foam in the affected dyke area.

- **Action Plan For Fire In Pipe Rack**

Fire in pipe track can be due to leak from the flanges, valves, holes in pipelines, rupture in pipeline or failure of the vent bleeder or drain etc.
Fire fighting strategy –

a) Ensure the isolation of pipelines
b) In case of small fire the fire can be extinguished with the help of DCP followed by water to prevent re-ignition.
c) It is a major fire due to leak or rupture of pipeline then foam should be sprayed using foam tender or foam trolleys.
d) Cordon the area and do not allow any unauthorized entry.
e) Keep a safe distance if there is any possibility of explosion.
f) Lighter hydrocarbon fires may be effectively put off by using DCP from DCP tender and followed by water.
g) In the event of any threat to the neighboring industries and residents, besides alerting them on the incident ensure that necessary precaution have been taken by them with the help of Civil Administration Authorities.
h) Mutual aid to be activated and district authorities shall be contacted for activating off-site emergency preparedness.

- **Action Plan For Fire In Process Units**

Fire in process unit can be due to leak from flanges, valves pipeline etc. It may be at ground level or over ground.

It can be a minor fire due to leak or a major fire due to rupture and formation of pool of flammable material. Before attacking the fire, details of the source of fuel, isolation of the source and adjoining equipments to be essentially obtained from the incident controller. If the fire is minor, it can be attacked with DCP extinguisher or fire spray of water using spray nozzles. However, DCP attack should be backed with water spray to prevent re-ignition.

Simultaneously isolation of the source of fuel to be carried out flowed by isolation of adjacent equipment, stoppage of rotary equipment, (from substation), shutdown fired equipment shutdown of entire unit, isolation of power to unit etc. as required by the unit personnel as per the instructions of the incident controller.

Water spray protection may be provided to the operation staff to approach and close the valve for isolation of fuel if isolation valve is on fire. The fire at a height can be fought with water spray monitor. In the event of any threat to the neighboring industries and residents, besides alerting them on the incident ensure that necessary precautions have been taken by them with the help of Civil Administration.

Mutual aid to be activated and district authorities shall be contacted for activating offsite emergency preparedness.

- **Action Plan for Hydrogen Leakage / Fire (Generally Hydrogen Flame Will Not Be Visible)**

- Identify the source of leakage /equipment and isolate the same
- Clean the roads in the vicinity for traffic movement and eliminate all sources of ignition
- Seek the information from the process personnel about the leakage / hot spot, as fire will not be visible
- Wind direction to be assessed and approach to be made from crosswind direction, position the fire vehicles accordingly
- Check the area with the explosive meter for explosive atmosphere.
- Don’t allow person to enter in hydrogen leak (highly concentration) area
- Keep surrounding area cool by spraying water. Fire can be extinguished at low pressure gas only.

7.12 ONSITE EMERGENCY PLAN

Onsite and off-site Emergency Plan would be prepared as per Factories act/rules in consultation with local authorities, hospitals, MIDC authorities. These can be prepared as per the general guidelines given below:

7.12.1 Guidelines for Preparing Emergency Plans

Objectives of Onsite Emergency Plan will be

a) To control emergency situation arising out of possible hazards identified in the factory fire, explosion, and toxic leakage.
b) To identify all possible hazards, its consequence, areas affected.
c) To estimate areas affected.
d) Define actions to be taken in case of emergency.
e) Identify persons responsible to take necessary actions to deal with situation.

f) To localize emergency and if possible eliminate it.
g) To avoid confusion, panic and handle the emergency in a planed manner.
h) To minimize loss of life and property to the plant as well as to the neighborhood.
i) To carry out rescue operations
j) To treat injured persons and transfer to the nearest hospital for treatment.
k) To restore normalcy.

- It will specify names of key personnel as

1. Chief Controller (Generally he is Factory Chief)
2. Incidence Controller (Generally he is plant in charge where emergency has occurred or shift in charge after General Shift)
3. Under Chief Controller, three teams are formed
   a. RESCUE TEAM
   b. SERVICE TEAM
   c. WELFARE TEAM
4. Liaison Officer

The nature of responsibilities of these key personal & teams would be clearly defined.
Reporting chain of command will be clearly defined. Following documents will be required and will form essential part of the Onsite and offsite emergency plan

1. Factory layout showing location of all plants, location of hazardous storage, location of Emergency control center.
2. Factory layout showing designated assembly areas
3. Block diagram of manufacturing processes.
4. List of hazardous chemicals stored.
5. MSDS of all hazardous chemicals
6. List of Antidotes
7. List of key factory personnel with contact numbers and addresses.
8. List of employees trained in fire fighting with contact numbers
9. List of employees trained in first-aid and rescue operations
10. List of telephone numbers and addresses of outside government and other agencies mainly
    - Nearest Police station
    - Nearest Fire Brigade Station
    - Ambulance services
    - Nearest Government and other Hospitals
    - Blood Bank
    - MSEB
    - MPCB
11. Emergency action plan in case of all possible hazards identified.
12. Procedure for reporting emergency will be clearly defined.
13. Actions taken by personnel where emergency has occurred and
14. Actions taken by personnel at other location will be clearly defined..

7.13 OFF SITE DISASTER CONTROL PLAN

The Factory is situated in the state owned Industrial Estate for the chemical industries. There are about 50 industries in the area. A station is also situated in the Industrial Estate. Neighboring industries are mutually extending the co operation in case of emergency.

Table 7.8 Details of emergency telephone numbers

Neighboring Industries	STD CODE	TELEPHONE
AVON ORGANICS	0217	2357338,2357739
VAMSI LABS LTD	0217	2357152, 2357132, 2357133
SMUTHI ORGANICS	0217	2357772, 2357775
VENKIES INDIA LTD	0217	2357179
LAXMI HYDROLICS	0217	2357001,002,003,004,005,006
LOKMANGAL BIOTECH LTD	0217	2357285
SURJAN FOODS PVT LTD	0217	2357571,72,73,74

However, District authorities whose telephone numbers are given below must be contacted in the event of any emergency which, in the opinion of the Emergency Controller, is of severe nature and is not controllable with the in-house facilities of the industry.

7.13.1 Training and Mock Drill

It is absolutely necessary to train & carryout mock drills for success of emergency plan during actual emergency. Emergency procedures would be laid down clearly and convincingly to everyone on site, particularly the Key Personnel & Essential Workers.

Table 7.9 Worst case Scenarios for Hazardous Raw Materials

Sr. No	Name of chemical	Source of chemical	Site data	Atmospheric data	Chemical data	Source strength	Threat zone
1	**Ammonia**	Leak from hole in horizontal cylindrical tan Flammable chemical escaping from tank (not burning)	Location: BALAJI SPECIALITY CHEMICALS, INDIA Building Air Exchanges Per Hour: 0.37	• Wind: 1.5 meters/second from NE at 10 meters • Ground Roughness: open country Cloud Cover: 0 tenths • Air Temperature : 26° C Stability Class: A • No Inversion Height Relative Humidity: 5%	▪ Molecular Weight: 17.03 g/mol ▪ AEGL-1 (60 min): 30 ppm AEGL-2 (60 min): 160 ppm AEGL-3 (60 min): 1100 ppm IDLH: 300 ppm ▪ LEL:150000 ppm UEL:280000 ppm ▪ Ambient Boiling Point: -34.5° C ▪ Vapor Pressure at Ambient Temperature: greater than 1 atm ▪ Ambient Saturation Concentration: 1,000,000 ppm or 100.0%	▪ Tank Diameter: 3meter ▪ Tank Length: 10.5 meters ▪ Tank Volume: 74.2 cubic meters ▪ Tank contains liquid Internal Temperature: 26° C ▪ Chemical Mass in ▪ Tank: 37.0 tons Tank is 75% full ▪ Circular Opening Diameter: 5 centimeters ▪ Opening is 0.90 meters from tank bottom	▪ Red : 1.8 kilometers --- (1100 ppm = AEGL-3 [60 min]) ▪ Orange: 4.8 kilometers --- (160 ppm = AEGL-2 [60 min]) ▪ Yellow: greater than 10 kilometers --- (25 ppm)

Sr. No	Name of chemical	Source of chemical	Site data	Atmospheric data	Chemical data	Source strength	Threat zone
		Flammable gas escaping from pipe (not burning)					▪ Red : 37 meters --- (1100 ppm = AEGL-3 [60 min]) ▪ Orange: 97meters --- (160 ppm = AEGL-2 [60 min]) ▪ Yellow: 246 meters --- (25 ppm)

Figure 7.2 Toxic Threat zone

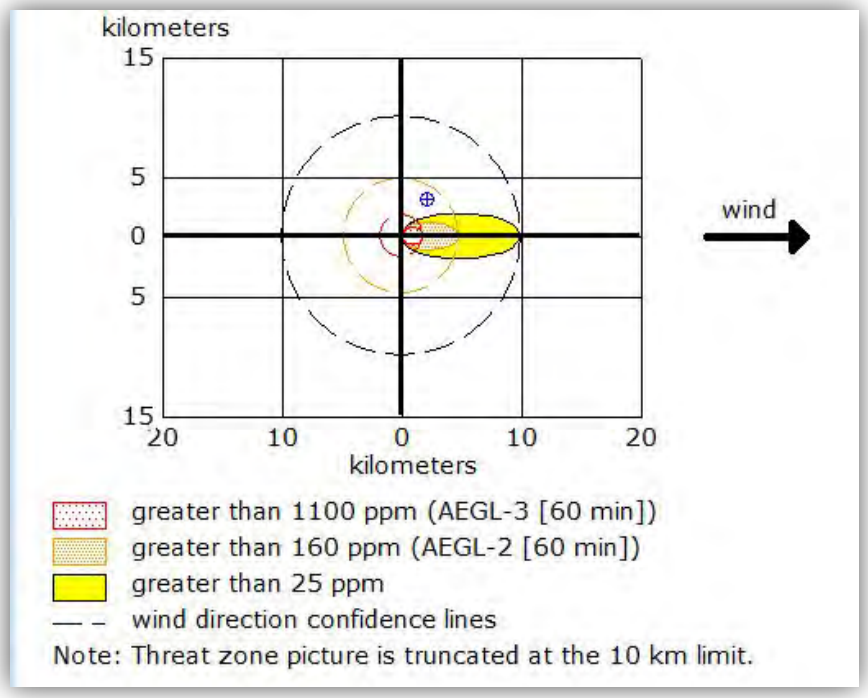


Figure 7.3 Toxic Threat zone at point 1

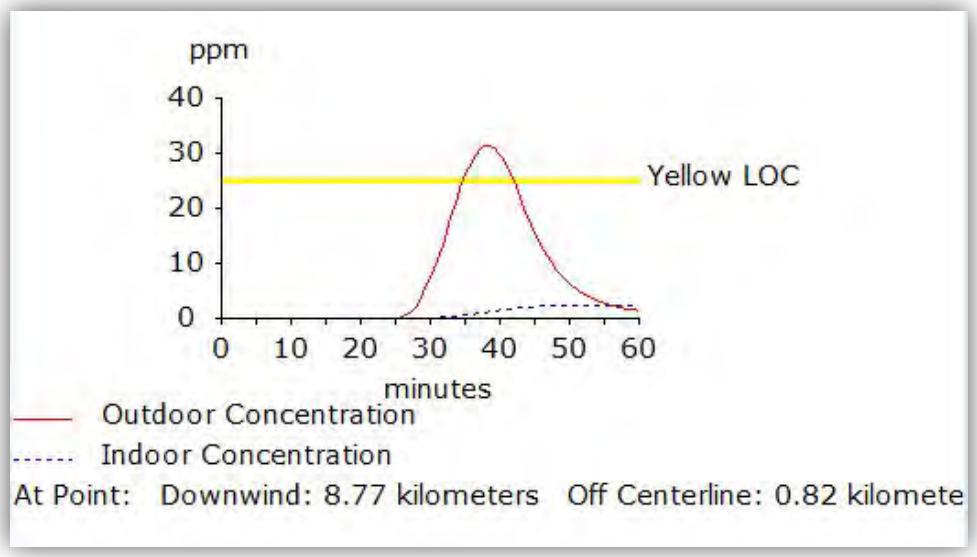


Figure 7.4 Toxic Threat zone at point 2

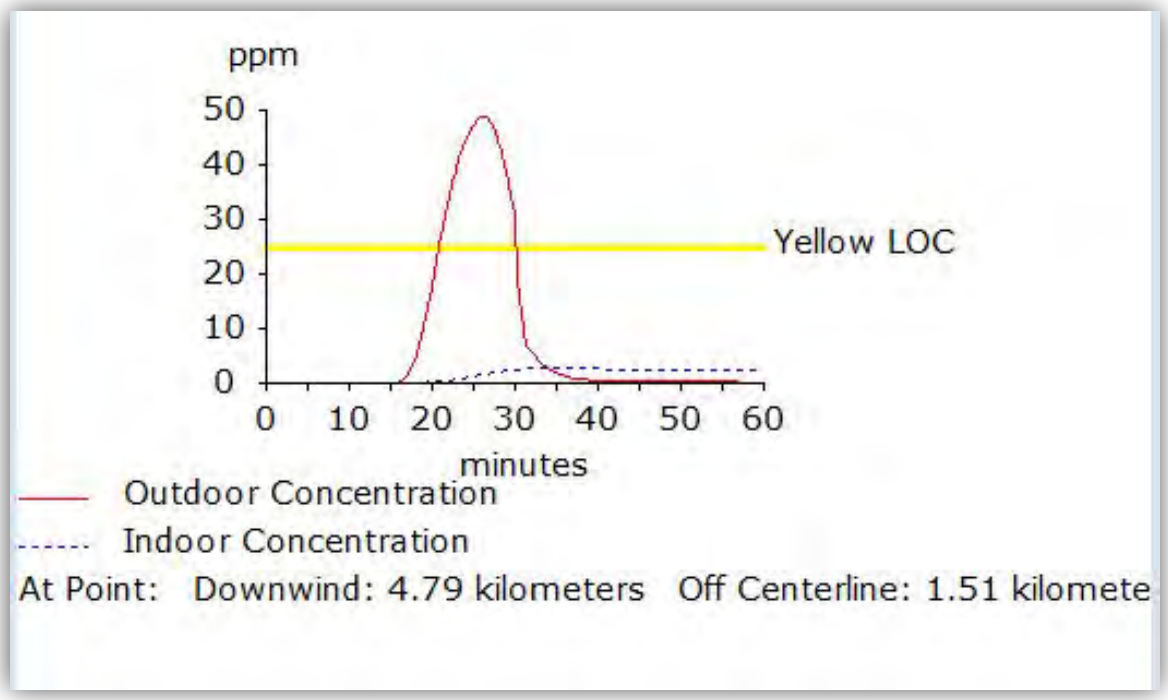


Figure 7.5 Toxic Threat zone at point 3

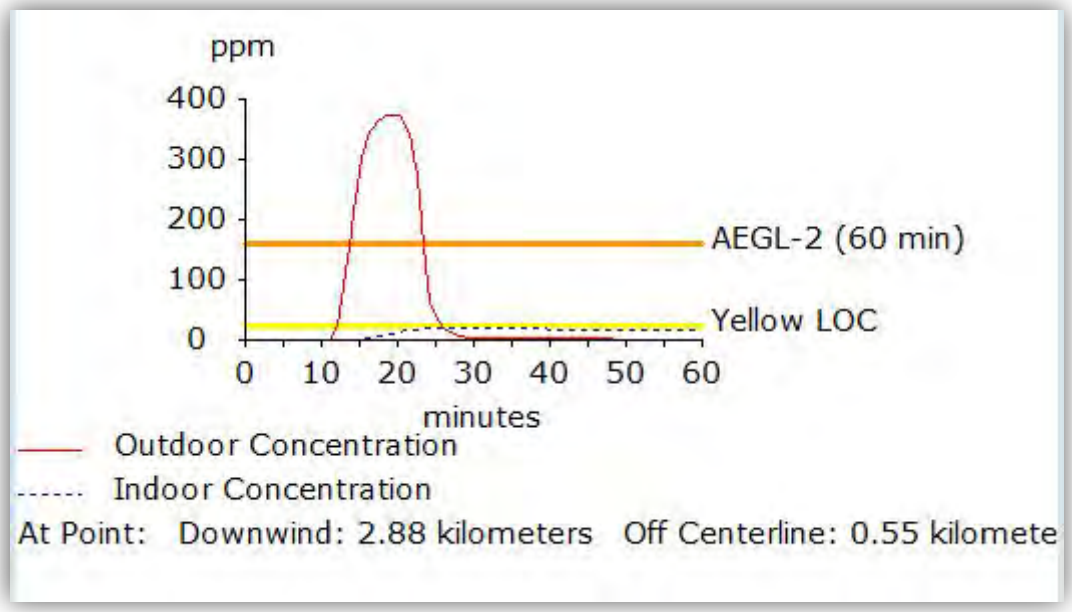
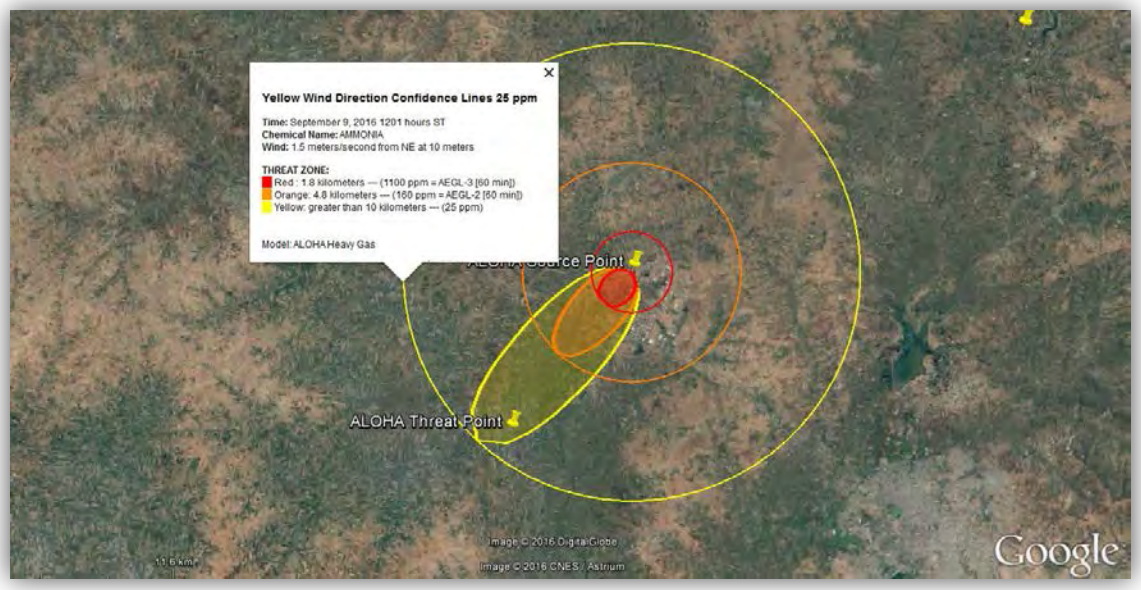


Figure 7.6 Google Image



For Pipe line leak -

Figure 7.7 Toxic Threat Zone

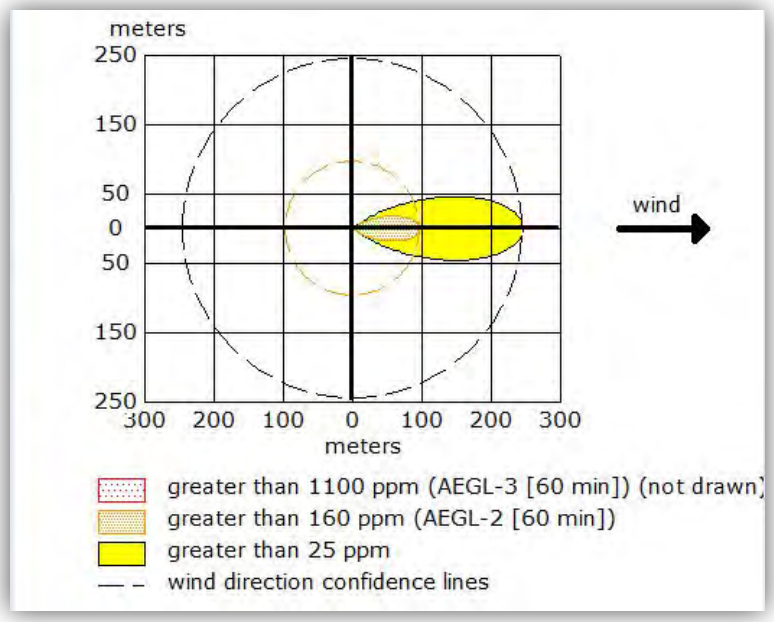


Figure 7.8 Toxic Threat Zone at point 1

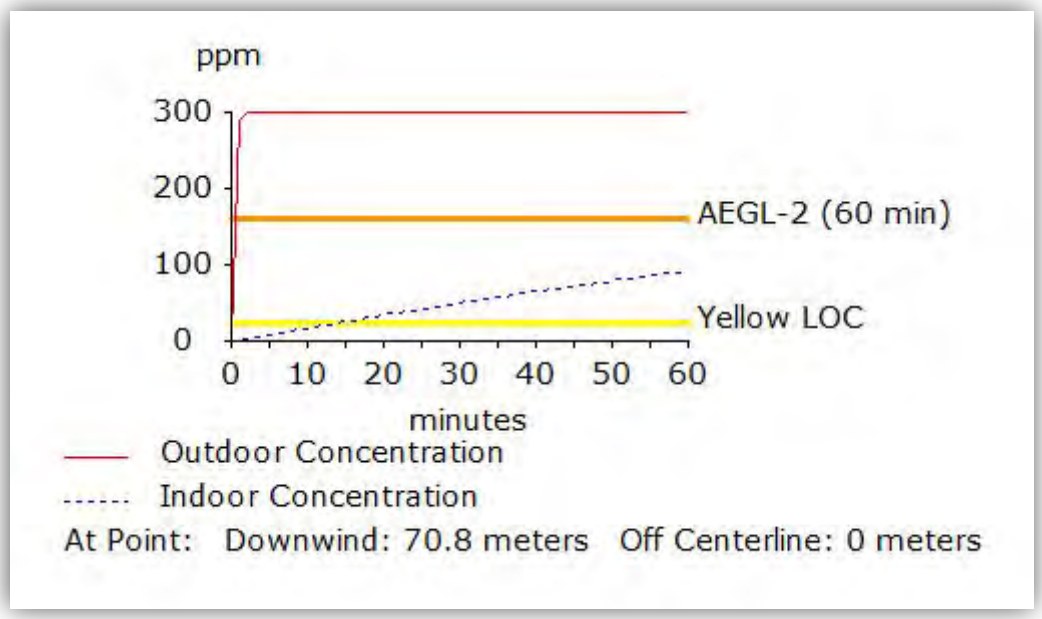


Figure 7.9 Toxic Threat Zone at point 2

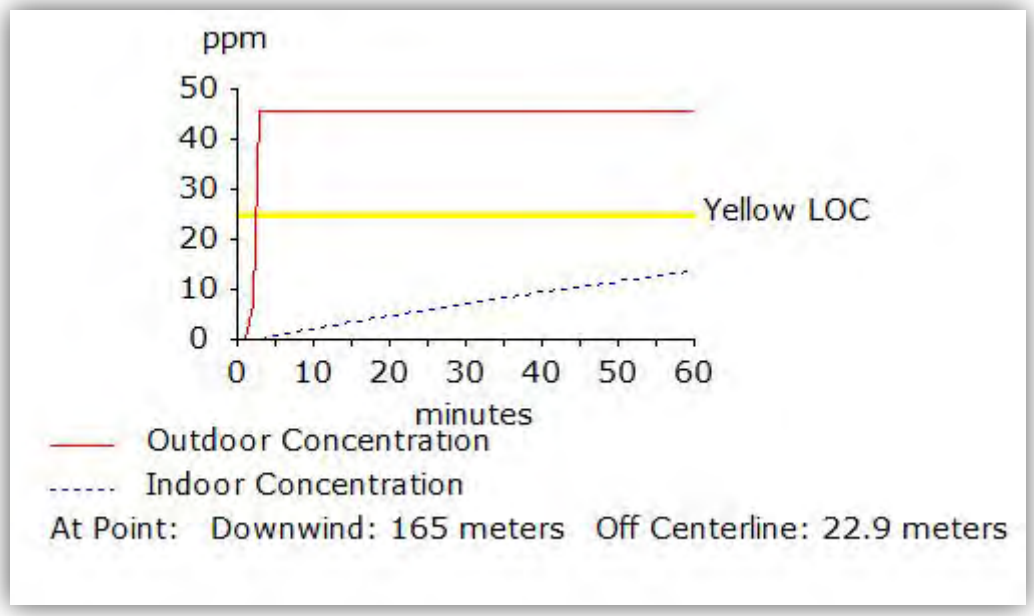
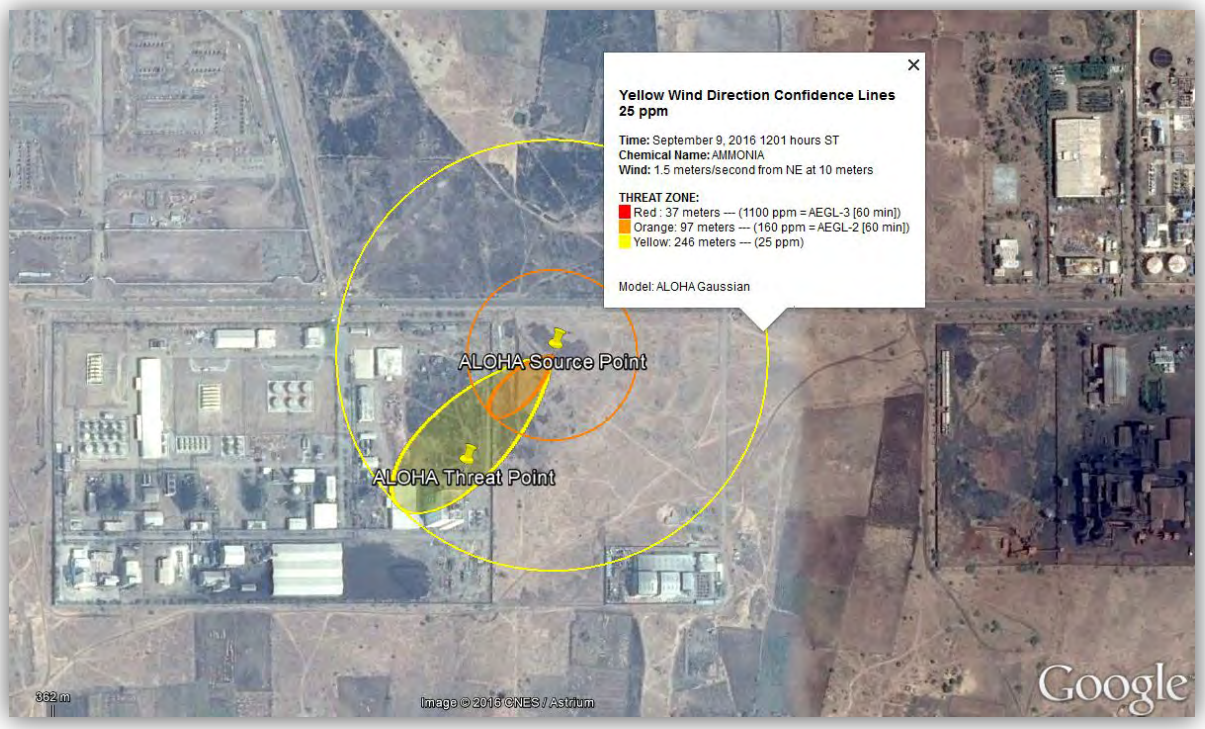


Figure 7.10 Google Image



Sr. No	Name of chemical	Source of chemical	Site data	Atmospheric data	Chemical data	Source strength	Threat zone
2	Ethanlodiamine	Leak from hole in horizontal cylindrical tan Flammable chemical escaping from tank (not burning)	Location: BALAJI SPECIALITY CHEMICALS, INDIA Building Air Exchanges Per Hour: 0.37	• Wind: 1.5 meters/second from NE at 10 meters • Ground Roughness: open country Cloud Cover: 0 tenths • Air Temperature: 26° C Stability Class: A • No Inversion Height Relative Humidity: 5%	▪ Molecular Weight: 61.08 g/mol ▪ PAC-1:6 ppm PAC-2: 6 ppm PAC-3: 1000 ppm ▪ IDLH: 30 ppm ▪ LEL: 30000 ppm ▪ UEL: 131000 ppm ▪ Ambient Boiling Point: 167.8° C ▪ Vapor Pressure at Ambient Temperature: 5.30e-004 atm	▪ Tank Diameter: 7.5 meters Tank Length: 7.5 meters ▪ Tank Volume: 331 cubic meters ▪ Tank contains liquid Internal Temperature: 35° C ▪ Chemical Mass in Tank: 128 tons Tank is 35% full ▪ Circular Opening Diameter: 5.3 centimeters Opening is 1.13 meters from tank bottom ▪ Ground Type: Concrete Ground Temperature: 30° C	▪ Red : 1.8 kilometers --- (1100 ppm = AEGL-3 [60 min]) ▪ Orange: 4.8 kilometers --- (160 ppm = AEGL-2 [60 min]) ▪ Yellow: greater than 10 kilometers --- (25 ppm)

Figure 7.11 Toxic Threat Zone

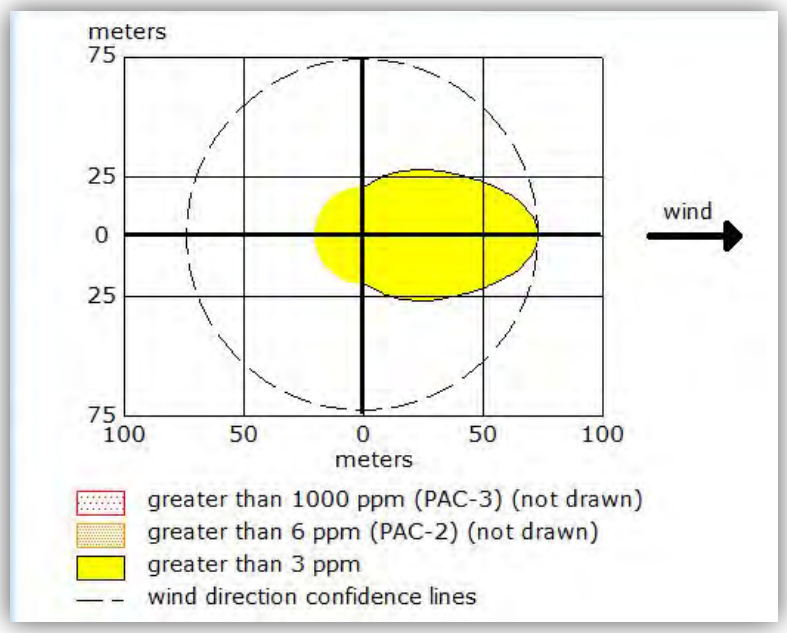


Figure 7.12 Toxic Threat Zone at point 1

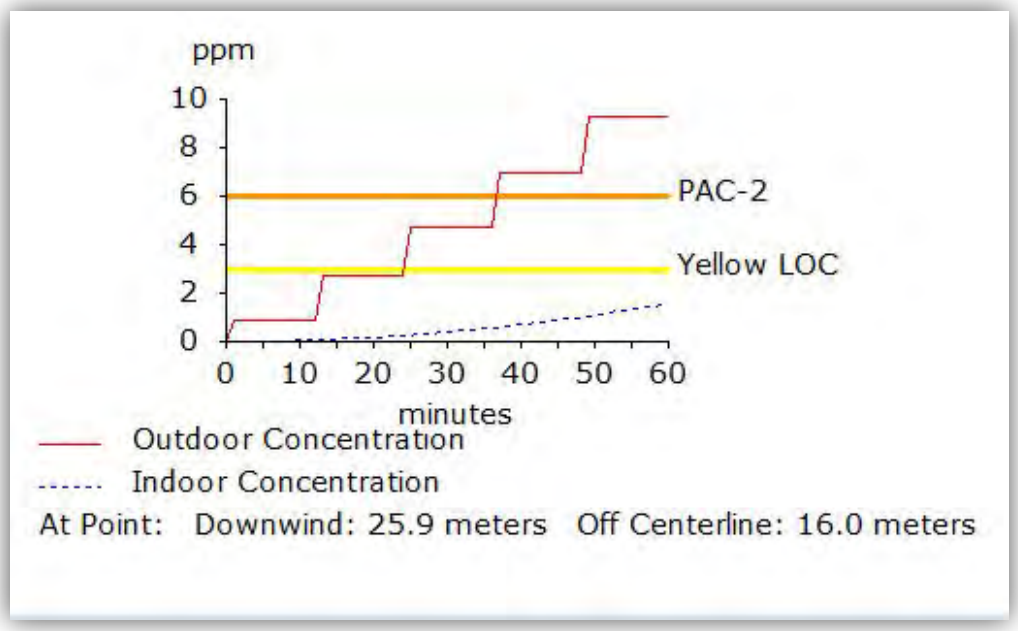


Figure 7.13 Source Strength

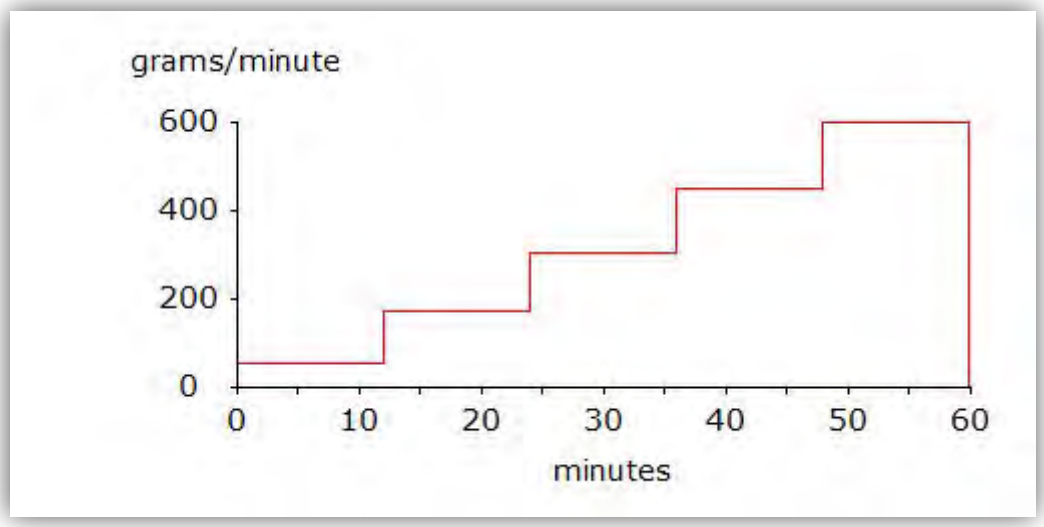
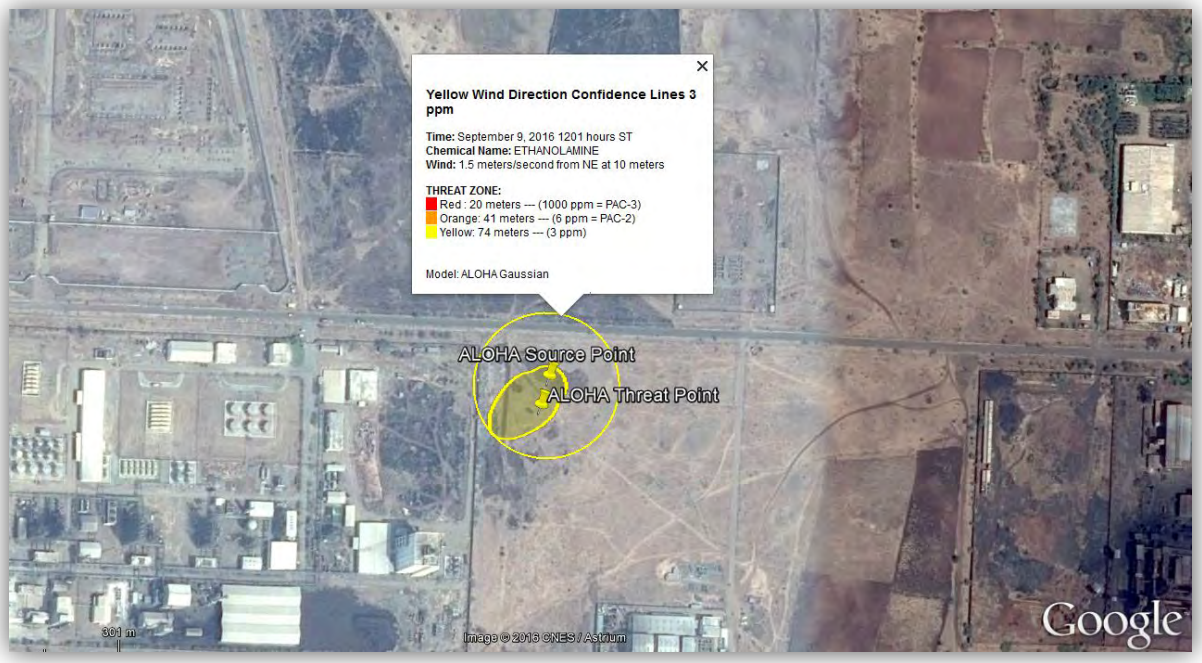


Figure 7.14 Google Image



Sr. No	Name of chemical	Source of chemical	Site data	Atmospheric data	Chemical data	Source strength	Threat zone
3	Ethylenediamine	Leak from hole in horizontal cylindrical tan Flammable chemical escaping from tank (not burning)	Location: BALAJI SPECIALITY CHEMICALS, INDIA Building Air Exchanges Per Hour: 0.37	• Wind: 1.5 meters/second from NE at 10 meters • Ground Roughness: open country Cloud Cover: 0 tenths • Air Temperature: 26° C Stability Class: A • No Inversion Height Relative Humidity: 5%	▪ Molecular Weight: 43.07 g/mol ▪ AEGL-1 (60 min): N/A AEGL-2 (60 min): 4.6 ppm AEGL-3 (60 min): 9.9 ppm ▪ IDLH: 100 ppm LEL: 36000 ppm UEL: 460000 ppm ▪ Ambient ▪ Boiling Point: 54.5° C ▪ Vapor Pressure at Ambient Temperature: 0.29 atm ▪ Ambient Saturation Concentration: 307,890 ppm or 30.8%	▪ Tank Diameter: 7.5 meters Tank Length: 7.5 meters ▪ Tank Volume: 331 cubic meters ▪ Tank contains liquid Internal Temperature: 35° C ▪ Chemical Mass in Tank: 225 tons Tank is 75% full ▪ Circular Opening Diameter: 4.5 centimeters ▪ Opening is 3.00 meters from tank bottom ▪ Ground Type: Concrete Ground Temperature: 30°	▪ Red : 1.6 kilometers --- (9.9 ppm = AEGL-3 [60 min]) ▪ Orange: 2.4 kilometers --- (4.6 ppm = AEGL-2 [60 min]) ▪ Yellow: 1.6 kilometers (10ppm)

Figure 7.15 Threat Zone

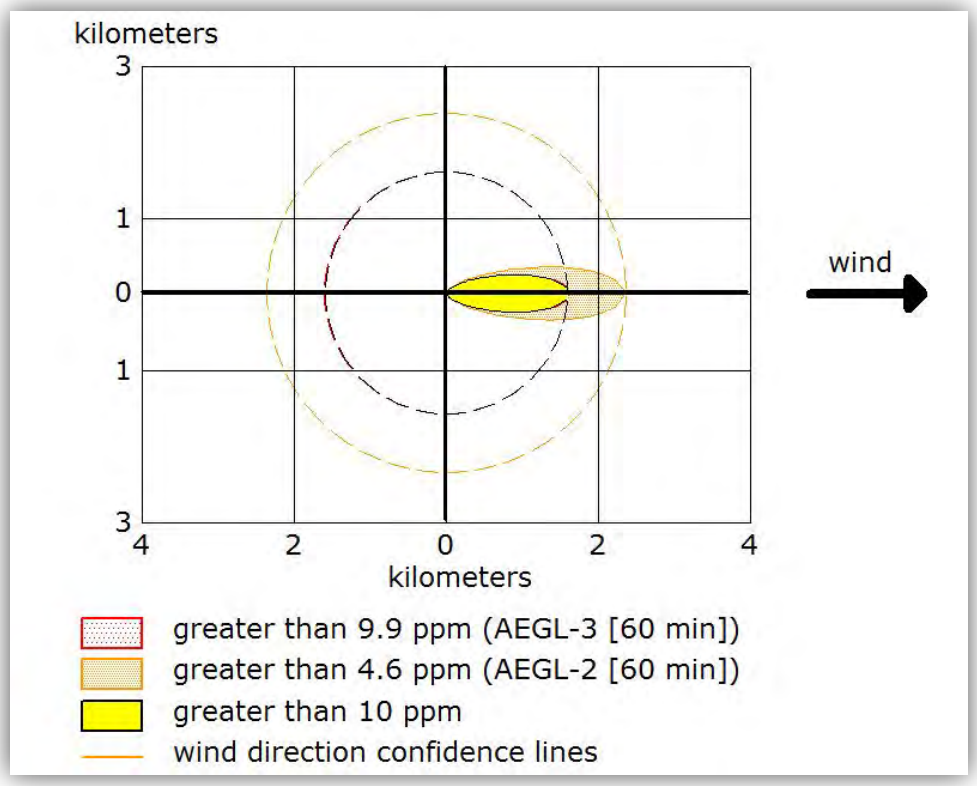


Figure 7.16 Threat Zone at point 1

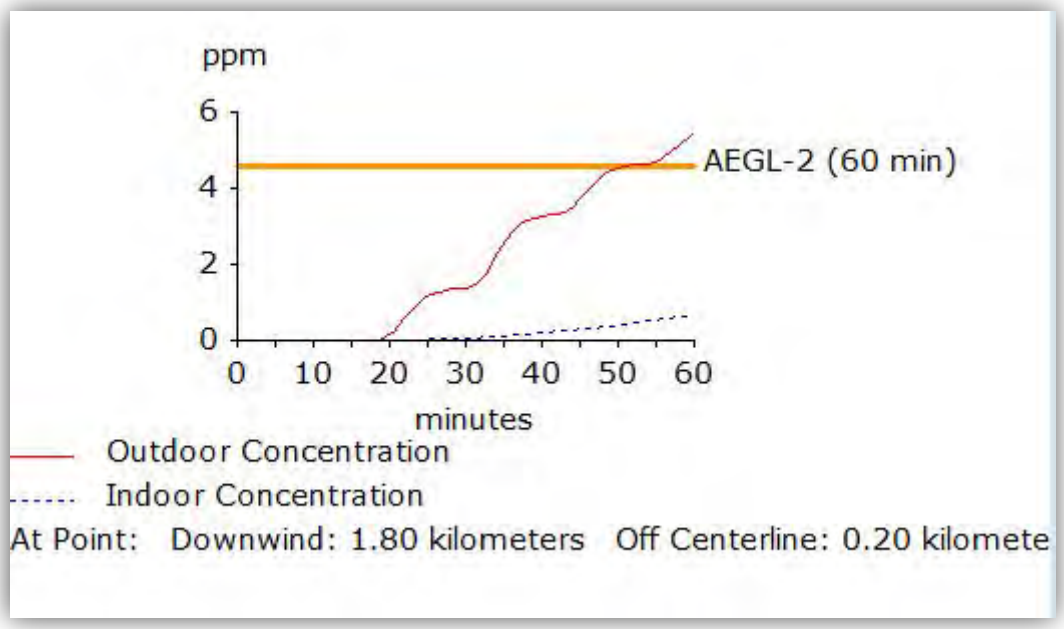


Figure 7.17 Threat Zone at point 2

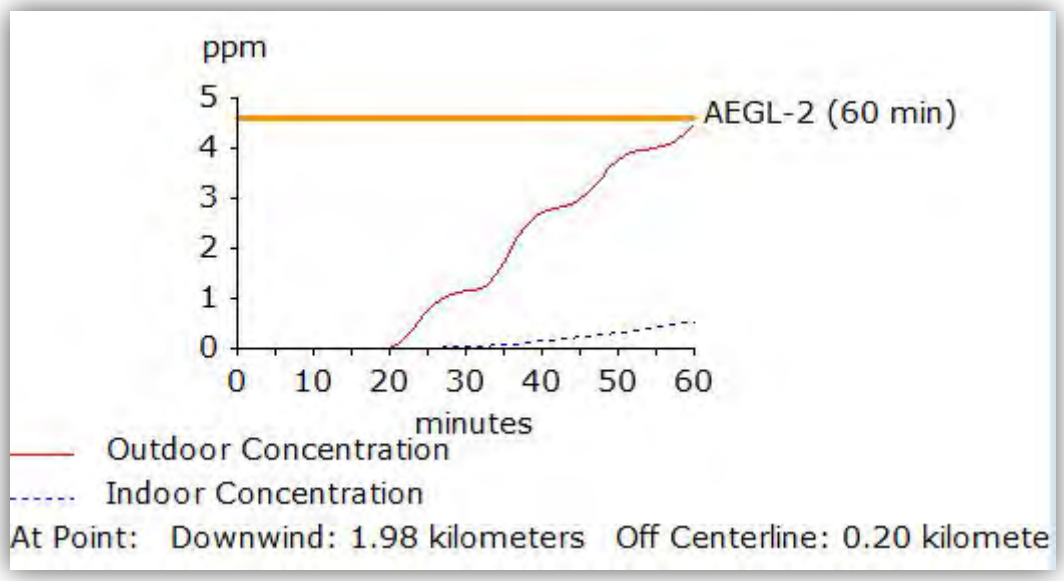


Figure 7.18 Google Image