Hazards Evaluation and Risk Assessment

1.1. Introduction

PPL would be handling all materials at the proposed plant. The storage of raw material is planned at the site location itself, so, in an unlikely event of release emergencies, there would be a potential risk to life and properties. Hence, the risk assessment study has been conducted for various parameters that include identification of hazards, to calculate consequence distances, to evaluate safety at the plant and to spell out risk mitigation measures to enhance safety at the plant.

1.2. Hazard Identification

Hazard is defined as a chemical or physical conditions those have the potential for causing damage to people, property or the environment. In this chapter the hazards associated with only the proposed expansion project have been discussed.

The primary step of the Hazard identification is the risk analysis and entails the process of collecting information on:

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

1.2.1. Hazardous Materials to be Stored at the Plant

The major hazardous chemical to be stored at the PPL site will be dilute sulphuric acid and Sulphuric Acid 98.5% with specific gravity 1.84,

The acid is stored in two separate tanks, with each tank capacity of 5000 T. Total acid storage capacity will be 10000 MT.

1.2.2. Characteristics of Hazardous Materials

Table 1.1 : Characteristics of Hazardous materials

Material	**Storage Capacity (MT)**	**Remarks**
Ammonia	10000X 5+=50,000	Existing Ammonia Storage Tanks (details in Ch-2)
Sulphuric Acid	4X10000+1X5000=45000 1X10000=10000	Existing Proposed
Phosphoric Acid	6X10000=60000 2X5000=10000	Existing Under commissioning
Nitric Acid (conc.)	5000	
Sulphuric Acid	10000 X 5 + 5000X1	
Ammonium Nitrate	3000	Bagged Storage
HFO /LSHS	18000X2= 36000KL	
HSD	15X1=15KL	
Chlorine Tonners	930X2= 1860 Kg	

LPG	102 153	Industrial Cylinders Domestic Cylinders
Sulphur	45000	

Important characteristics of the hazardous material (i.e. Ammonia, Chorine etc.) has been presented below:

PPL will be using a number of raw materials but only few are stored in bulk and few chemicals 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 below:

Table 1.2 : Environmental Monitoring Program

S. No.	S. No & Threshold Quantity (TQ in MT) as per MSHIC Rules			Chemical Hazards		Remarks
	Schedule-1, Part-II	**Schedule-2, Part-I**	**Schedule-3, Part-I**	**Hazards**	**Toxic**	
1	Ammonia CAS No:7664-41-7 UN No:1005	31	2 TQ-1: 60 MT TQ-2: 600 MT	105 TQ-1: 50 MT TQ-2: 500 MT	Fire Hazards: Mixing of ammonia with several chemicals can cause severe fire hazards and/or explosions. Ammonia in container may explode in heat of fire. Health Hazards: Vapors cause irritation of eyes and respiratory tract. Liquid will burn skin and eyes. Poisonous; may be fatal if inhaled. Contact may cause burns to skin and eyes. Contact with liquid may cause frostbite.	ERPG-1: 25 ppm ERPG-2: 150 ppm ERPG-3: 750 ppm IDLH: 300 ppm
2	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
3	Nitric Acid CAS No: 7697-37-2 Non-flammable Colorless to light yellow.Liquid; **Odor:** Acrid.	423	---	---	Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (irritant,corrosive), of ingestion, . Slightly hazardous in case of inhalation (lung sensitizer). Liquid or spray mist may produce tissue damage particularly on mucous membranes	NFPA: **Health:** 4 **Flammability:** 0 **Reactivity:** 0

S. No.	S. No & Threshold Quantity (TQ in MT) as per MSHIC Rules			Chemical Hazards		Remarks
	Schedule-1, Part-II	**Schedule-2, Part-I**	**Schedule-3, Part-I**	**Hazards**	**Toxic**	
	Disagreeable and choking. (Strong.) BP: 121 C				of eyes, mouth and respiratory tract. Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, 4choking, or s5hortness of breath. Prolonged exposure may result in skin burns and ulcerations. Over-exposure by inhalation may cause respiratory irritation. Severe over-exposure can Result in death.	
4	Phosphoric Acid CAS No.:7664-38-2	497	--	--	Non-flammable viscous colourless, odourless liquid	Oral (LD50): 1530 mg/kg [Rat]. Dermal(LD50): 2740 mg/kg DUST (LC50):;850 mg/m 1 hours
5	Chlorine CAS No:7782-50-5 UN No:1017 A greenish yellow gas with a pungent suffocating odour. Toxic by inhalation.	119	5 TQ-1: 10MT TQ-2: 25 MT	108 TQ-1: 10MT TQ-2: 25 MT	(Gas); Non Combustible; May ignite other combustible materials (wood, paper, oil, etc.). Mixture with fuels may cause explosion. Health Hazards: Poisonous; may be fatal if inhaled. Contact may cause burns to skin and eyes. Bronchitis or chronic lung conditions	ERPG-1: 1.0 ppm ERPG-2: 3.0 ppm ERPG-3: 20 ppm IDLH: 10 ppm

S. No.	S. No & Threshold Quantity (TQ in MT) as per MSHIC Rules			Chemical Hazards		Remarks
	Schedule-1, Part-II	**Schedule-2, Part-I**	**Schedule-3, Part-I**	**Hazards**	**Toxic**	
6	Ammonium Nitrate CAS No: 6484-52-2 White odourless prills, with strong disagreeable acrid taste. Ammonium nitrate is not flammable. Gr. 3-Highly Reactive Substance Decomposes from 170 °C before boiling water	33	---	126 TQ-1: 350 MT TQ-2: 2500 MT	Ammonium nitrate is moderately toxic if large amounts are swallowed; Highly Reactive When heated to decomposition (unconfined) ammonium nitrate produces nitrous oxides, white ammonium nitrate fumes. Ammonium nitrate is incompatible with copper, zinc, or their alloys (i.e., bronze, brass, galvanised metals, etc.), aluminium powder and mil	;

The petroleum products used in PPL plant and their hazardous nature are as below:

Table 1.3 : Petroleum Products in PPL and hazardous nature

Item	Physical		Impact on Man, Animal & Eco-System
	Physical	**Chemical**	
HSD UN No.-1202 Flammable Liquid-Class-3 Hazardous Waste ID No.-17 Hazchem Code-3Y* NFPA Hazards Signals Health-0 Flammability-2 Reactivity/ Stabilty-0	BP- 150 – 400°C Vapour Pressure (35°C)- <1 mm at 38°C Specific Gravity-0.81 – 0.91 at 20°C	LEL -0.6% (V/V) UEL – 7.5% (V/V) Flash Point > 32°C Auto ignition Temp.-256°C Stable compound	Entry throughinhalation, ingestion and skin; Inhalation Effects:Dizziness and headache, Aspiration – Rapidly developing, potential fatal chemical pneumonities Ingestion Effect: Nausea and Vomiting; Contact Effects: Irritation, Eyes- Irritation; Dermatitis may develop on prolonged contact.
	Solubility in water-Insoluble	Incompatible with oxidizing agents.	LD_{50} (oral rat)- 2800 mg/kg; LD_{50} - 200;TLV(ACGIH)- 5 mg/kg; STEL- 10 mg/kg
LSHS/FO UN No.-1270 Flammable Liquid-Class-3 Hazardous Waste ID No.-17 Hazchem Code-3Y*E NFPA Hazards Signals Health-0 Flammability-2 Reactivity/ Stabilty-0	BP- 185 – 500^{0}C Vapour Pressure (35^{0}C)- <1 mm at 20^{0}C Specific Gravity-0.8 – 0.9 -- 1.05 at 15.5^{0}C	LEL - 1% (V/V) UEL – 5% (V/V) Flash Point > 66^{0}C Auto ignition Temp.-263^0 C Stable Compound	Entry through inhalation, and skin; Inhalation: Dizziness and headache. Ingestion: Nausea and Vomiting Contact: Irritation, Eyes: Irritation. Dermatitis may result from prolonged contact.
	Solubility in water-Insoluble in water	Incompatible with oxidizing agents.	
	Vapour Density (Air-1)-3 - 5		

1.2.3. Associated Hazards

Hazards associated with the use and storage of hazardous new product namely Ammonium Nitrate has been presented in the following sub sections:

As detailed in the above table out of 6 liquid materials stored in bulk all comes within Schedule I part II (List of Hazardous and Toxic Chemicals) of MSIHC Rules but three materials (Ammonia, Chlorine and Ammonium Nitrate) of them comes under Schedule 3 (list of hazardous chemicals for application of rules 5 and 7 to 15). Total Ammonia stored in PLL is 50,000 Mt, much more than the threshold quantity and such PPL is coming under "major

accident hazards (MAH) installations" as per MSIHC rules. PPL has to follow all norms as stipulated in MSIHC rules for MAH installtions.

Two material (Ammonium Nitrate, Ammonia) and fuel are inflammable. Ammonium Nitrate is explosive also. Eight of these hazardous liquid materials are toxic. Two materials namely Ammonia and Chlorine are toxic.

1.2.3.1 *Ammonium Nitrate*

Ammonium Nitrate is highly reactive substance. Though it has not been put as Explosive substance in MSIHC Rules, it has been used as explosive by terrorist in making bombs. Considering this Government of India has declared this as 'Explosive'. Hazardous nature of Ammonium Nitrate is given below in brief.

Government Notification New Delhi: Concerned over the increased use of ammonium nitrate by terror groups in making bombs, the government has finally declared the chemical as an "explosive". But given the widespread use of the mixture as fertilizer, the government notification came with a rider that its possession and use would invoke penal action only if the composition had 45% or more ammonium nitrate content.

"The central government hereby declares that ammonium nitrate or any combination containing more than 45% of ammonium nitrate by weight including emulsions, suspensions, melts or gels shall be deemed to be an explosive," the commerce and industry ministry said in a notification issued last week.

Hazardous Nature: Ammonium nitrate is not flammable under normal applications and is not considered a fire risk, but will support combustion in an existing fire by liberating oxygen – even if smothered. It is for this reason that fires involving ammonium nitrate cannot be extinguished by the prevention or air ingress

Ammonium nitrate has a melting point of 170^0C and decomposes from 170 °C before boiling.. It is not in itself combustible but, as it is an oxidising agent, it can assist other materials to burn, even if air is excluded.

Ammonium nitrate will not explode due to the friction and impact found in normal handling, but it can be detonated under heat and confinement or severe shock. For example, in a fire, pools of molten ammonium nitrate may be formed and if the molten mass becomes confined (e.g. in drains, pipes, plant or machinery) it could explode, particularly if it becomes contaminated.

In a fire, all types of ammonium nitrate may melt and decompose with the release of toxic fumes (mainly oxides of nitrogen) which may be yellow or brown. Most types do not continue to decompose once the fire has been extinguished. However, when some types of ammonium nitrate fertilizers (cigar burners) are heated they undergo a smouldering (self-sustaining) decomposition that can spread throughout the mass to give substantial toxic fumes, even when the initial heat source is removed. The risk of fire or explosion is greatly increased if ammonium nitrate is mixed with combustible or incompatible materials, such as

powdered metals, alkali metals, urea, chromium or copper salts, organic and carbonaceous materials, sulphur, nitrites, alkalis, acids, chlorates and reducing agents (consult data sheets to establish if a substance has reducing properties).

The risk of an explosion is increased by a combination of the following:

- Heating ammonium nitrate (e.g. in a fire);
- Contamination;
- Serious confinement (e.g. in drains or enclosed parts of equipment).

To minimise the risk of explosion it is therefore important to take precautions against each of these situations.

1.3. Effect & Consequence Analysis

As a part of risk assessment study, maximum credible accident analysis (MCA) is carried out to determine the maximum loss scenario from this analysis. It is an eventuality, which is possible and will have maximum consequential distances for the particular hazardous chemicals under evaluation.

The selection of the accident scenarios is based on the engineering and professional judgment, accident descriptions of the past in similar type of plants & the expertise in risk analysis studies.

1.3.1. Likely Scenarios

Few likely failure scenarios have been selected after critical appraisal of raw materials and products properties and storage inventories. Failure scenarios selected are as given in Table 6.4 below:

Table 1.4 : Different Failure Scenarios

S. No.	Scenario	Remark
Scenario – 1	Ammonia Tank [200 m Puddle]	
Scenario -2	Heavy Ammonia Leakage and Spillage	
Scenario -3	Nitric (conc.) Acid Tank	
Scenario – 4	Chlorine Cylinder/Pipe Line Leakage	

1.3.2. Weather Effect

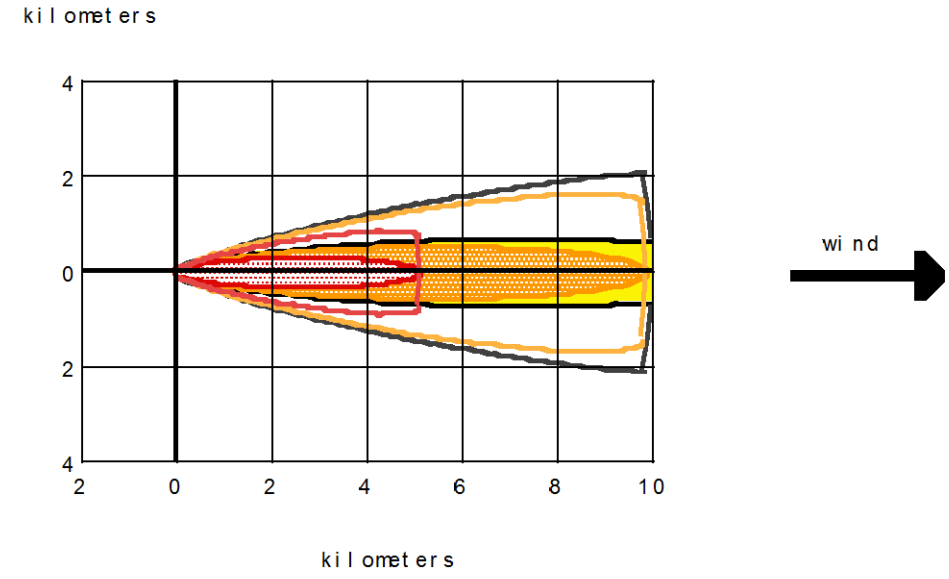
The effect of ambient conditions on the impact of fire / heat radiation and GLC of hazardous / toxic material can be beneficial as well as harmful. A high wind (turbulence) can dilute the toxic material while stable environment can extend the reach of IDLH or IT (inhalation LC50 rats for products) or 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.

Incidents Impacts

The identified failure scenarios (Table 6.4) have been analysed (Using ALOHA Module) 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 6.5.

Table 1.5 : Hazards Scenario Impact

Scenario No.	**Scenario**	**Impact Zone (m)**	**Remarks**
Material			
enario-1	Ammonia Tank [200 m Puddle]	IDLH~>10000 IDLH~>10000	Stability Class D Template 1 Stability Class F Template 2
enario-2	Heavy Ammonia Leakage and Spillage	IDLH>10000 IDLH>10000	Stability Class D Template 3 Stability Class F Template 4
enario-3	Nitric (conc.) Acid Tank Leakage	IDLH ~ 188	Stability Class D Template 5
enario-4	Chlorine Cylinder/Pipe Line Leakage	IDLH ~ 75 IDLH ~159	Stability Class D Template 6 Stability Class F Template 7



greater than 1100 ppm (AEGL-3 [60 min])

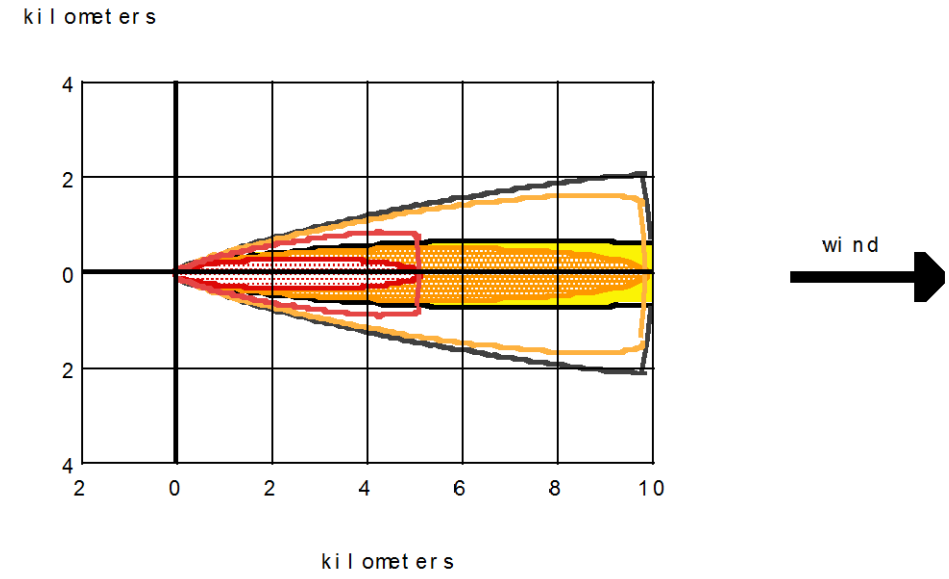
greater than 300 ppm (IDLH)

greater than 160 ppm (AEGL-2 [60 min])

wind direction confidence lines

Note: Threat zone picture is truncated at the 10 km limit.

Figure 1.1 : Ammonia Tank [200 m Puddle]



greater than 1100 ppm (AEGL-3 [60 min])

greater than 300 ppm (IDLH)

greater than 160 ppm (AEGL-2 [60 min])

wind direction confidence lines

Note: Threat zone picture is truncated at the 10 km limit.

Figure 1.2 : Ammonia Tank [200 m Puddle]

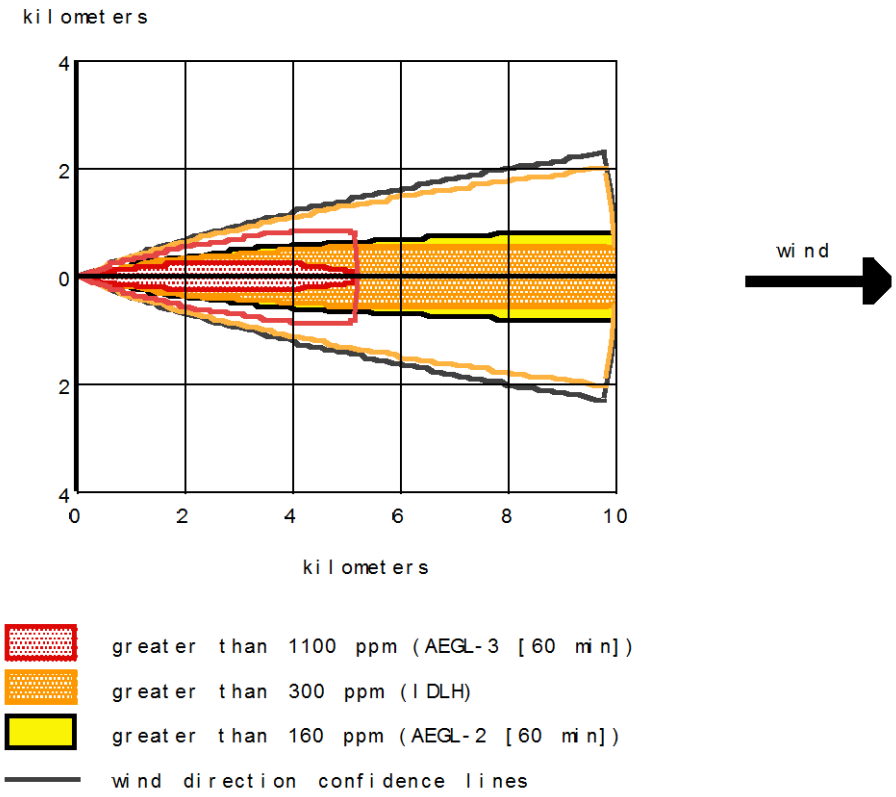


Figure 1.3 : Heavy Ammonia Leakage and Spillage

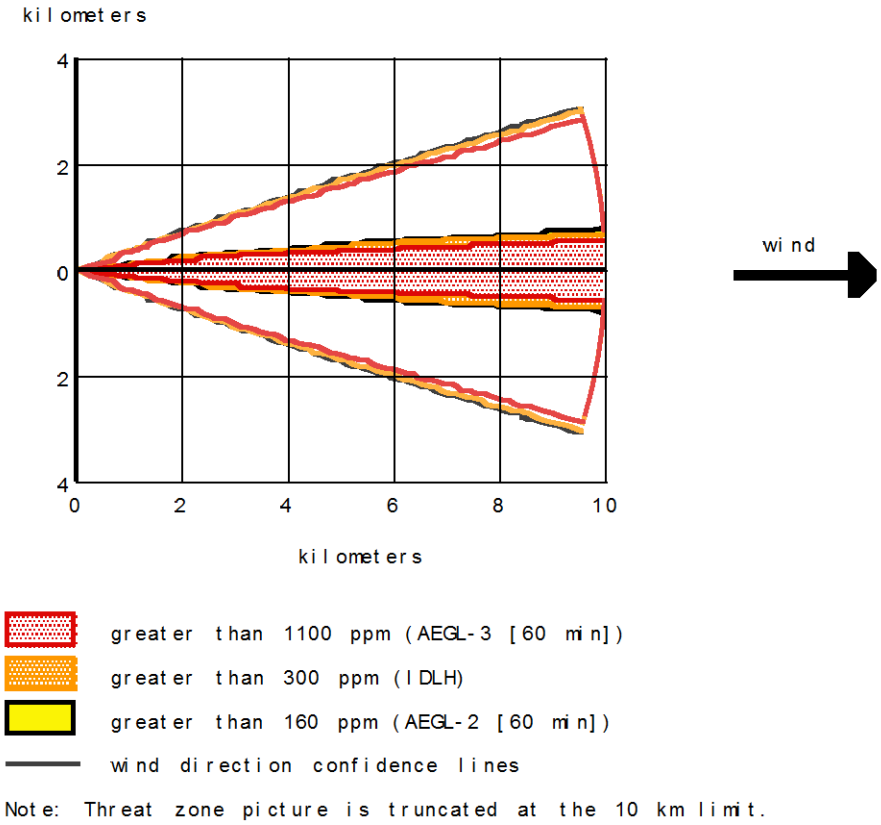


Figure 1.4 : Heavy Ammonia Leakage and Spillage

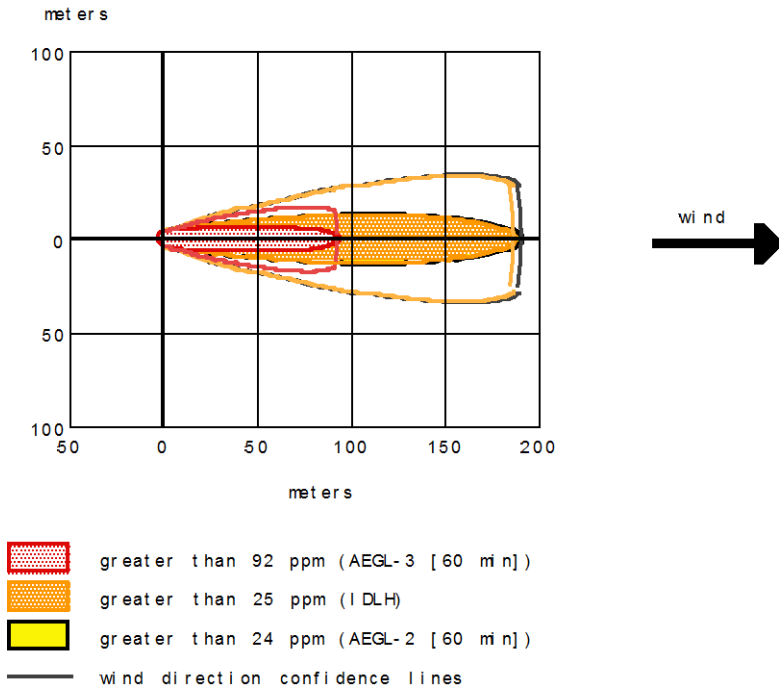


Figure 1.5 : Nitric (conc.) Acid Tank Leakage

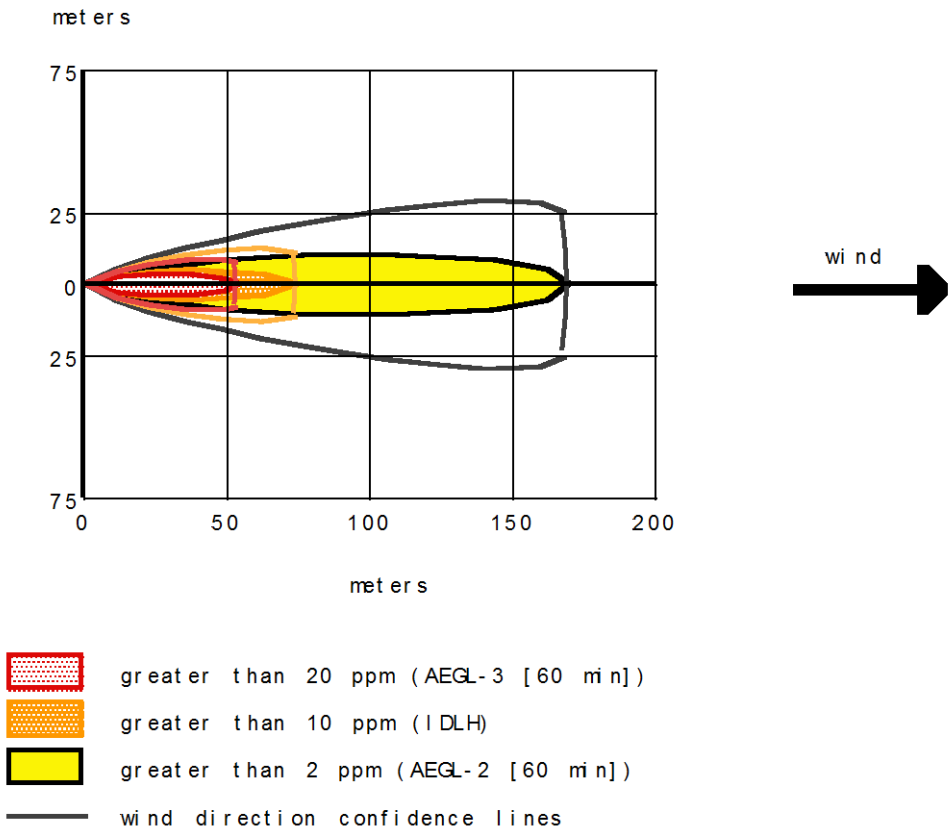


Figure 1.6 : Chlorine Cylinder/Pipe Line Leakage

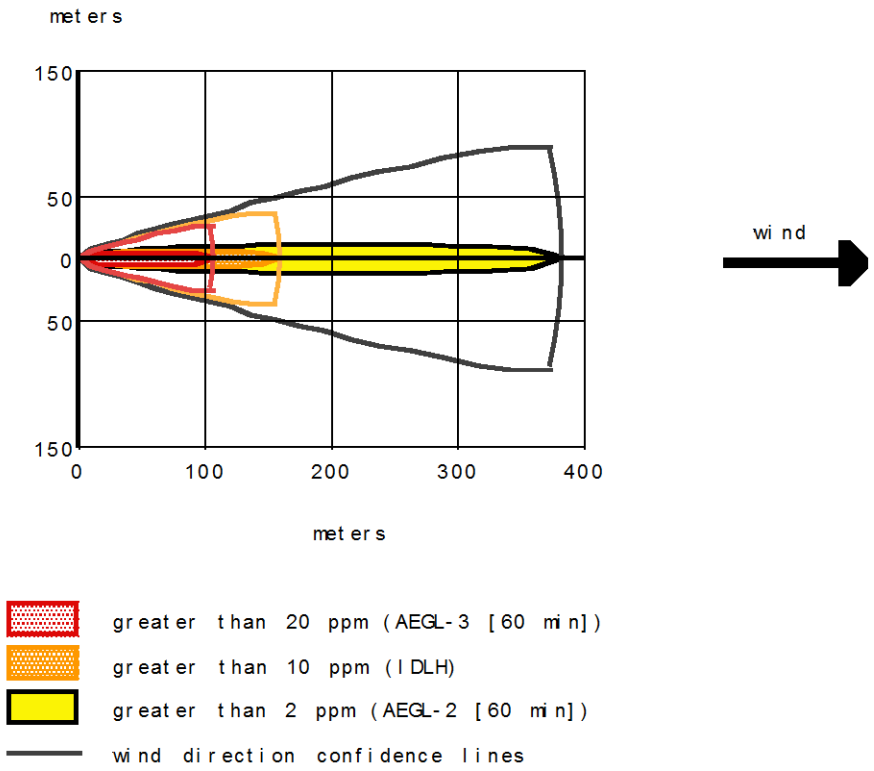


Figure 1.7 : Chlorine Cylinder/Pipe Line Leakage

1.3.3. Consequence Analysis

1.3.3.1 *Toxic Hazards*

Toxic hazards are mainly due to Ammonia, chlorine gases and Nitric Acid leakage. Ammonia leakage impact can cross the plant boundary (> 10 km; if not controlled in time). The impact due to chlorine and Nitric Acid is limited to 159 / 188 m (within plant only.) products will go up to 7.7 km in worst case (Scenario 1).

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's.

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.).

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**.**

1.3.3.2 ***Fire Hazards***

Fire hazards in the proposed expansion project are much less (Fuels-coal, FO/LSHS, HSD (limited storage only)). These fuels are not highly combustible and their impacts are limited only (within short distance). However process has fire hazards due to hydrogen.

1.4. Recommendations

Based on the outcome of the risk assessment, following recommendation has been made to avoid any risk associated with the storage and use of acids and other liquid materials in the plant:

1.4.1. LDAR program :--

Chemicals are manufactured in multi-stages in batch/continuous mode. In the manufacture of chemicals, various unit processes/operations/equipment are used in industries.

The chemical industries are using pipelines, pumps, valves/ vessels and other fittings in the transfer of materials from reactors and other ancillary facilities to other equipment. To reduce fugitive emissions in the plant, proper Leak Detection &Repair (LDAR) program is required in the industry.

The proposed LDAR program is as follows :--

- Identification of sources: Valves, pipes, joints, pump seals, flanges etc.
- Monitoring of gases/fluids is to be carried out regularly. Monitoring frequency should be once in a quarter is required.
- The industries handling small/large quantities of hazardous chemicals like chlorine, SOx/NOx/Hydrogen (process) etc. can use simpler methods like gas/vapour sensors.
- Focus should be for prevention of fugitive emissions by having preventive maintenance of pumps, valves, pipelines etc. A preventive maintenance schedule should be prepared and it should be strictly adhered to

When monitoring results indicate hazardous gases/vapors/VOC above permissible limit repairing should be done immediately. The repair should be conducted in such a way that there is no fugitive emission from the particular component.

1.4.2. Fugitive Emission Control Guidelines :--

The following guidelines will be strictlyfollowed :--

- Fugitive emissions over reactors, formulation areas, rotory machines, chemical loading, transfer areas etc. will be collected through hoods and ducts by induced draft and controlled by scrubber/ dust collector.
- Scrubbers installed for channelized emissions are used for fugitive emissions control also and sometimes dedicated scrubbers will be used.

- Hazardous gaseous emissions (toxic and odorous) will be routed to activated carbon beds or to incinerator, and for dust emissions cyclones/bag filters will be provided.
- Enclosures to chemical storage area, collection of emissions from loading of raw materials, in particular, solvents through hoods and ducts by induced draft, and control by scrubber/ dust collector will be ensured.
- Vapour balancing, nitrogen blanketing, iso tanks etc, will be provided. Special care will be taken for odorous chemicals.

1.4.3. Acid Spillage

- 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.
- Fire and explosion hazards-Not flammable. May evolve toxic fumes in fire (sulphur oxides).
- Personal protective equipment-Fire fighter must use fresh-air helmet and chemical protection suit
- Personal protection: complete protective clothing including self-contained breathing apparatus. Do Not let this chemical enter the environment.
- Evacuate danger area do not absorb in saw-dust or other combustible absorbents.

1.5. Occupational Exposure Mitigation Planning

To control any occupational health and safety impact a detailed planning for mitigation measures has been done in the design stage of the project. Apart from the occupational exposure mitigation plans for various activities and work areas of hazards, following administrative control measures will be followed:

- All the employees will be trained for EHS policies.
- Health check-up for OSHA– Yearly
- Health check-up for Employees- Yearly

- All the OSHA peoples have been trained for Basic life support, first aid, Basic fire safety and emergency preparedness.
- Ambient air quality monitoring in every month at 3 locations
- Monthly monitoring of environmental parameters.
- Safety display boards provided throughout the plant.
- Monthly fire extinguisher audit.
- Work permit system
- PPE adherence
- Waste management and hazardous waste handling
- Safe lifting operation
- Industrial hygiene

1.6. Other Recommended Measures for Safe Operation of the Plant

In addition to the specific recommendations made in the above section for storage and handling of sulphuric acid within the plant premises, for safe operation of the plant and risk reduction, following suggestions and recommendations are made:

- Personnel especially contractor workers at the plant should be made aware about the hazardous substance stored at the plant and risk associated with them.
- A written process safety information document may be compiled for general use.
- The document compilation should include an assessment of the hazards presented including (i) toxicity information (ii) permissible exposure limits. (iii) physical data (iv) thermal and chemical stability data (v) reactivity data (vi) corrosivity data (vii) information on process and mechanical design.
- The process design information in the process safety information compilation must include P&IDs/PFDs; process chemistry; maximum intended inventory; acceptable upper and lower limits, pressures, flows and compositions and process design and energy balances.
- The adequate numbers of heat, smoke, detectors may be provided at strategic locations in the plant and indication of detectors/sensors should be provided in main control room.
- Predictive and preventive maintenance schedule should be prepared for equipment, piping, pumps, etc. and thickness survey should be done periodically as per standard practices.
- Safe work practices should be developed to provide for the control of hazards during operation and maintenance.
- Personnel engaged in handling of hazardous chemicals should be trained to respond in an unlikely event of emergencies.
- The plant should check and ensure that all instruments provided in the plant are in good condition and documented.
- Safety measures in the form of DO and Don’t Do should be displayed at strategic locations especially in Hindi and English language.

- The present DO's and DON'T's followed in their other units/ factories is checklist in the form of do's and don'ts of preventive maintenance, strengthening of HSE, manufacturing utility staff for safety related measures.

1.6.1. Personal Protective Equipment

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

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

1.6.1.1 *Handling of Hazards*

Some of the measures employed in handling of hazards:

- Personal protective equipment used by the workers during handling of hazardous chemicals, should be replaced after getting defective.
- If any spillage of hazardous chemicals, it should be cleaned and disposed as per standard practiced.
- Empty drums of hazardous chemicals should neutralize immediate.
- Workers engaged in handling of hazardous chemicals should be made aware of properties of hazardous chemicals.

1.6.1.2 *General Working Conditions at the Proposed Plant*

House Keeping

The House Keeping practices employed would be:

- All the passages, floors and stairways should be maintained in good conditions.
- The system should be available to deal with any spillage of dry or liquid chemical at the plant.
- Walkways should be always kept free from obstructions.
- In the plant, precaution and instructions should be displayed at strategic locations in Hindi and English Languages.
- All pits, sumps should be properly covered or securely fenced.

Ventilation

The Ventilation measures that would be employed:

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

Safe Operating Procedures

Other operation procedures followed would be:

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

Work Permit System

Work permit system will be followed at the plant during maintenance.

Fire Protection

For fire protection the measures taken are:

- The fire fighting system and equipment will be tested and maintained as per relevant standards.
- Smoke detectors will be provided at the plant and shall be calibrated and maintained properly.

Static Electricity

The general instructions for working with static electric are:

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

Material Handling

For material handling the regulatory measures that are taken for workers handling various materials would include:

- The workers shall be made aware about the hazards associated with manual material handling.

- The workers shall be made aware and trained about the use of personal protective equipment (PPE) while handling hazardous chemicals.

Communication System

Communication facilities shall be checked periodically for its proper functioning.

Safety Inspections

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

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

Electrical Safety

For electric safety provisions to be taken care of are:

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

Colour Coding System

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