CHAPTER 7. ADDITIONAL STUDIES

7.1. General

Industrial plants deal with materials, which are generally hazardous in nature by virtue of their intrinsic chemical properties or their operating conditions. 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 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:** Is a formal and systematic risk analysis approach to estimating the likelihood and consequences of hazardous events and expressing the results quantitatively as risk to people, the environment or business.
- **Work Safety Analysis:** Is a procedure which helps integrate accepted safety and health principles and practices into a particular task or job. Each basic step of the job is analysed to identify potential hazards and recommend the safe way to perform the job.

7.2. Risk Assessment

A three 'levels' risk assessment approach has been adopted for the Ambey proposed expansion project to be set up at its existing plant at RIICO Industrial Area, Sotanala. 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 above data / information are 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 in both qualitative and 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
- Security Vulnerability;
- Impact of hazard 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 prioritizing 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:

- Hazards identification utilizing formal approach (Level 2, HAZOP etc.);
- Frequency Analysis. Based on past safety data (incidents / accidents); Identifying likely pathway of failures and quantifying the toxic / inflammable material release;
- 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.
- Risk Quantification: Quantitative techniques are used considering effect / impact taking into consideration weather data, population data, and frequency of occurrences and likelihood. Data are analyzed considering likely damage (in terms of injury / fatality, property damage) each scenario 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.

Table in Chapter 2 gives raw material details of the Ambey Plant. Table 2.10 provides details of the Bulk Storages in Ambey plant. (Given below):

Table 7.1. : Bulk Storages of Chemicals & Raw Materials

S. No.	Name of Chemicals	State	Storage capacity (KL)		Remarks
			Existing	Proposed	
1.	Phenol	Liquid	40	40	4X10 KL each= 40KL
2.	Chlorine	Gas/MT	43.2	86.4	86.4 MT (0.9 t tonner)
3.	Sodium hydroxide (Caustic Soda)	Liquid	-	65	4X16 KL=65 KL
4.	Hydrochloric Acid	Liquid	-	50	5X10 KL each= 50KL
5.	Dimethyl Amine	Liquid	-	32	2X16 KL each= 32KL
6.	Sulphuric Acid	Liquid	-	20	1X20 KL each= 20KL
7.	Ethanol	Liquid	-	28	28 KL underground Tank
8.	Toluene	Liquid	-	28	28 KL underground Tank
9.	Methanol	Liquid	-	28	28 KL underground Tank
10.	Hexane	Liquid	-	28	28 KL underground Tank
11.	Isobutylene	Gas	-	10	10 MT Bullet
12.	Trifluro Acetic Acid	Liquid	-	10	1X10 KL each= 10KL
13.	Dichloromethane	Liquid	-	10	1X10 KL each= 10KL
14.	Bromine	Liquid/gas	-	1 MT	Bottles of 5 kg each
15.	MEG (107-21-1)	Liquid	-	10 KL	Storage Tank – No 3
16.	Di Chloro Methane (75-09-2)	Liquid	-	10	Storage Tank – No 2
	Formulations				
1.	Aromax	Liquid	-	25	Storage Tank
2.	C-9	Liquid	-	25	Storage Tank
3.	Cyclohexane	Liquid	-	25	Storage Tank
4.	KESOL 100	Liquid	-	25	Storage Tank
5.	Xylene	Liquid	-	25	Storage Tank

7.3. Quantitative Risk Analysis Study (QRA)

Quantitative Risk Analysis is proven as a valuable management tool in assessing the overall safety performance of a Chemical Process Industry.

7.4. Risk Screening Approach:

Proposed Plant: Risk screening of the proposed project was undertaken using data / information provided by Ambey. 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. Ambey plant will be using a number of hazardous chemicals and also producing hazardous pesticides products. The chemicals stored in bulk (liquid) and defined under MSHIC Rule will be considered for detailed analysis.

Hazardous materials have been defined under MSIHC Rules (1989) - 2 (e) which means.

(i) Any chemical which satisfies any of the criteria laid down in Part I of Schedule I and is listed in Column 2 of Part II of this Schedule;

Toxic Chemicals: Chemicals having the following values of acute toxicity and which owing to their physical and chemical properties are capable of producing major accident hazards:

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	> 20 – 200	< 0.5 – 2.0
3.	Toxic	>50 - 200	> 200 - 1000	> 2 – 10

Flammable Chemicals:

(i) **Flammable gases**; 20 ^{0}C and at standard pressure of 101.3 KPa are:

- Ignitable when in a mixture of 13% or less by volume with air, or;
- Have a flammable range with air of at least 12% points regardless of the lower flammable limits.

(ii) **Extremely Flammable Liquids**: chemicals which have a flash point lower than or equal to 23 ^{0}C and the boiling point less than 35 ^{0}C;

(iii) **Very Highly Flammable Liquids**: chemicals which have a flash point lower than or equal to 23 ^{0}C and the boiling point higher than 35 ^{0}C;

(iv) **Highly Flammable Liquid**: Chemicals, which have a flash point lower than or equal to 60 ^{0}C but higher than 23 ^{0}C.

(v) **Flammable Liquids**: chemicals, which have a flash point higher than 60 ^{0}C but lower than 90 ^{0}C.

Explosives: Explosive means a solid or liquid or pyrotechnics substance (or a mixture of substances) or an article.

a) Which is in itself capable by chemical reaction of producing gas at such a temperature and pressure and at such a speed as to cause damage to surroundings;

b) Which is designed to produce an effect by heat, light, sound, gas or smoke or a combination of these as the result of non-detonative self-sustaining exothermic chemical reaction.

I. any chemical listed in Column 2 of Schedule 2;

II. any chemical listed in Column 2 of Schedule 3;

Table 7.2. : Hazardous Analysis of Products

S. No.	Product/ Formula / [Active Ingredient (AG) % + Others%]/ CAS / UN No	S. No & Threshold Quantity (TQ in MT) as per MSHIC Rules			Properties	Toxicity Potential	Remarks / Hazards
		Schedule- 1, Part-II	Schedule-2, Part-I	Schedule-3, Part-I			
1.	2,4-D Sodium Salt (95% SP) (Monohydrous sodium salt of 2,4 Dichlorophenoxyacetic acid) C8H5Cl2NaO3 · H2O CAS No: 2702-72-9 Class: 9 Solid Powder	---	---	---	May be harmful if inhaled. May cause respiratory tract irritation. Harmful if swallowed. May be harmful if absorbed through skin. May cause skin irritation. Causes eye burns. Hazardous decomposition products formed under fire conditions. - Carbon oxides, HCl gas, Sodium oxides	No data available TLV – TWA 7mg/m³ ORAL LD50 (Rat) : = 552mg/kg b.w. DERMAL LD50 (Rat) :>5000mg/kg b.w.	Limited Data
2.	2,4-D Acid Technical C8H6Cl2O3 CAS No: 94-75-7 White to browncrystalline Solid; MP: 138^{0}C	---	---	---	Extremely hazardous in case of eye contact (irritant). Slightly hazardous in case of skin contact (irritant), of eye contact (Corrosive). Non-corrosive for skin. Severe over-exposure can result in death. Inflammation of the eye is characterized by Redness, watering, and itching.	ORAL (LD50): Acute: 375 mg/kg [Rat]. 347 mg/kg [Mouse]. 100 mg/kg [Dog]. DERMAL (LD50): Acute: 1400 mg/kg [Rabbit].	Limited Data
3.	2,4-D Ethyl Ester Technical CAS No: 533-23-3 Colourless to amber liquid; does not mix with water	---	---	---	Accidental ingestion of the material may be harmful; animal experiments indicate that ingestion of less than 150 gram may be fatal. f applied to the eyes, this material causes severe eye damage.; Inhalation of	Oral (rat) LD50: 500 mg/kg *	Limited Data

					vapours or aerosols (mists, fumes), may be harmful.		
4.	2,4-D Amine Salt C10H13Cl2NO3 CAS No: 2008-39-1 UN No: 3082 Clear dark/brown viscous liquid with Mild phenolic odour	---	---	---	Very irritating to eyes. Skin contact: Not irritating to skin. Ingestion: Harmful if large amounts are swallowed. Inhalation: Moderately irritating to respiratory tract.	Acute oral LD50:600. 5 mg/kg in rats. Acute dermal LD50: > 4 347, 73 mg/kg in male rats. Acute inhalation LC50(4h) : 1.60 mg/l [HT]	Limited Data
	New Products Proposed						
5.	ClodinofopPropergyl $C_{17}H_{13}ClFNO_4$ AG-22.3 % CAS No:105512-06-9	---	---	---	Light to dark brown liquid. With aromatic odour. Dangerous products Flash Point: 143.5^{0}F of decomposition at high temperature – Toxic gases Nitrogen oxides (NOx)	DT-4000; OT-2276 IT-3.5; [T] (Rats) NFPA- H-2;F-2;I-0	Causes eye, skin and respiratory passage irritation. May cause sensitation of skin. Exposure to high vapour level may cause dizziness, headache or affect nervous system.
6.	Hexaconazol C14H17Cl2N3O AG-4.96%; CAS No:79983-71-4 UN No:2903	---	---	---	White crystalline odourless solid Combustion Products-Sulphur / phosphorus compounds etc.	DT-> 2000; OT-2189; IT->5.98;[T] (Rats)	Eyes &Skin:Can cause mild irritation; Ingestion may result nausea. Cramps and vomiting; Non Carcinogenic
7.	Atrazine CAS No: 1912-24-9	---	---	---	Active Ingredient: 25% Ethylene Glycol –6%	DT-3100mg/Kg	

					Balance Formulation Aids White coloured liquid; BP-103 ^{0}C	(Rabbit) OT-4346; ()Rat IT-NE (Rats)	
8.	Buprfezine CAS No: 69327-76-0	---	---	---	Active Ingredient: 43% Ethylene Glycol –6% Balance Formulation Aids Solid	DT->5000mg/Kg (Rat) OT-2198; (Rat) IT-NE (Rats)	Skin irritation in rabbits: the product is considered none irritating. Eye irritation rabbits: the product is considered none Irritating the product is considered none sensitizing.
9.	Lambda-Cyhalothrin C23H19ClF3NO3 C23H19ClF3NO3 AG: 97% CAS No:91465-08-6	---	---	---	Dark brown/green solid FP: 185^{0}C	DT- 696; OT-79; IT-0.06 [ET]; (Rats)	Mild eye irritant; Not skin irritant; Symptoms that may arise if the product is mishandled and overexposure occurs are nausea, vomiting, diarrhoea, abdominal pain, ataxia, unsteady gait, hyper excitability, salivation, tremors and incontinence
10.	Cypermethrin AG-97% C22H19Cl2NO3	168	---	---	Appearance:yellow-brown viscous semi-solid at ambient temperatures	DT->4920; OT-187-326; IT-2.5; [T]	Skin Hazards – temporary (~ 24 hrs); Ingestion-affects gastrointestinal

	CAS No:52315-07-8 UN No:3349					(Rats)	tract;
11.	Alphamethrin C25H20Cl2NO3 CAS No: 67375-30-8	---	---	---	Active ingredient~ 12 to 15% Rest Aromatic hydrocarbon Appearance: yellow-colour liquid with mild odour at ambient temperatures Inflammable- FP- >62 ^{0}C	DT- ---; OT-79 mg/Kg (Rat); IT-2.5; [T] (Rats)	Skin Hazards – temporary (~ 24 hrs); Ingestion-affects gastrointestinal tract;
12.	Deltamethrin $C_{22}H_{19}Br_2NO_3$ AG-98% CAS No:52918-63-5 UN No:3349	---	---	---	Colourless and odourless solid	DT->2000; OT-135 - >5000; IT----- NFPA- H-2;F-0;I-0	Toxic by inhalation and if swallowed and breathe dust.
13.	Cypermethrin Acid Chloride AG: 98.5% CASNo: 52314- 67-7	---	---	---	Yellow Colour Liquid with aromatic odour; React violently with water with evolution of HCl	-------	Can cause temporary irritation, tearing and blurred vision Can cause a slight irritation on more sensitive areas [face, eyes, mouth] Can cause stomach irritation resulting in nausea, cramps and vomiting. Excessive inhalation can cause nasal and respiratory irritation

14.	Meta PhenoxyBeenzaldehyde AG: 98% CAS No: 39515-51-0	---	---	---	Clear light amber liquid; BP: 140 ^{0}C Inflammable FP: 112 ^{0} C	Not available	Causes eye irritation. May cause chemical conjunctivitis. Skin: Causes skin irritation. Ingestion: May cause gastrointestinal irritation with nausea, vomiting and diarrhea. Inhalation: Causes respiratory tract irritation.. Can produce delayed pulmonary edema. Chronic: Effects may be delayed.
15.	Fipronil CAS No: 1200068-37-3	---	---	---	Appearance: grey to tan granules Odor: slight musty odor Not inflammable	DT-2000 (Rabbit); OT- > 5000 mg/Kg (Rat) IT- 5.16; mg/L (4 hrs.)(Rats) [T] NFPA- H-1;F-1;R-0	Eye: May causes redness, irritation, tearing. Skin: Harmful if absorbed through skin. May produce symptoms similar to those from ingestion. May cause irritation, redness, swelling. Ingestion: Harmful if ingested. May cause drowsiness, involuntary shaking, shortness of breath, convulsions,

							excitement.
16.	Glyphosate CAS No: 38641-94-0	---	---	---	AG: 53.8% Pale yellow viscous liquid with amine odour POTENTIAL PHYSICAL HAZARDS: May react with metals such as galvanized or mild steel to produce hydrogen gas, potentially forming a highly combustible gas mixture	DT-5000 (Rat); OT- > 5000 mg/Kg (Rat) IT- >7.03; mg/L (4 hrs.)(Rats) [T]	EYE – Slight eye irritant. Undiluted product may cause pain, redness and tearing. SKIN - May be slightly irritating to the skin. INGESTION - No more than slightly toxic and no significant adverse health effects are expected to develop if a small amount (less than a mouthful) is swallowed.
	Additional Products as per TOR Amendment						
17.	Glufosinate Ammonium C5H11NO4P • NH4 CAS No: 77182-82-2 Crystalline solid	---	---	---	Harmful if inhaled. : Harmful if swallowed. Harmful in contact with skin. : May damage fertility or the unborn child. : May cause damage to organs through prolonged or repeated exposure	DT-----; OT-475.7 mg/Kg (man) IT----	
18.	Metribuzin CAS NO:99129-21-2 UN No:3077	---	---	---	White Powder with slight sulphurousodour; Harmful if swallowed; Not harmful in eyes and skin and if inhaled	DT-20000; OT-320--510 IT-0.65; **[HT]** (Rats)	

19.	Pendimethalin Technical CAS No: 40487-42-1 Black colour liquid with orange tinge; solvent odour; Combustible	---	---	---	Irritating to eyes;May cause sensitization to eyes; Harmful if swallowed; Vapours may cause drowsiness/dizziness.	DT->----; OT->---- IT- 320; (Rats)	Product is considered stable in ambient conditions for a period of at least 2 years after manufacture. **Conditions to avoid:** Do not store for prolonged periods in direct sunlight. Some crystallization may occur below 5ºC.
20.	Mancozeb AG-80%; Balance-20% (Calcium Lignosulfonate; Ethylene Thiourea; HexamethyleneTetramine) CAS No:8018-01-7 UN No: 3077	---	---	---	Blue to green powder with musty odour /Nonflammable Thermal decomposition products include carbon disulfide and Hydrogen sulfide.	DT->5000; OT-8000; IT-5.14; **[T]** (Rats)	Harmful if swallowed. May cause sensitisation by skin contact May cause severe eye irritation
21.	Azoxystrobin $C_{22}H_{17}N_3O_5$ CAS No: 131860-33-8	---	---	---	Purple Powder Can decompose at high temperature releasing toxic gases	DT->5000; OT->5000; IT->5.37; **[T]** (Rats)	May be harmful by inhalation, ingestion, or skin absorption. May cause eye irritation. May cause skin irritation. Not Carcinogen
22.	Ziram AG-85% CAS No:137-30-4	---	---	---	Off-white to brown-colored granular solid with negligible odor Decomposed by excessive heat and acids. Thermal decomposition will generate oxides of carbon, oxides	DT->6000; OT-1400; IT—0.14;**[ET]** (Rats) NFPA- H-3;F-1;I-0	Ziram can cause skin and mucous membrane irritation. Humans with prolonged inhalation exposure to ziram have developed nerve and visual

					of nitrogen, and sulfur.		disturbances. Ziram is corrosive to eyes and may cause irreversible eye damage. .
23.	Thiram AG-98%; $C_6H_{12}N_2S_4$. CAS No:137-26-8 UN No: 3077	---	---	---	Granular solid ColorLight brown OdorCaramel-like Thermal decomposition may produce: Carbon disulfide Oxides of carbon. Oxides of nitrogen. Oxides of sulfur.	DT->2400; OT-1080; IT-4.42;**[T]** (Rats)	May be irritating to respiratory system, skin and eyes. May cause skin sensitization. May be harmful if inhaled, swallowed, or absorbed through skin.
24.	Propineb (C5H8N2S4Zn) x Form: Solid Color: White/ slight yellow Odor: Slight Characteristic CAS No.: 9016-71-2	---	---	---	May cause sensitization by skin contact. Harmful: dangerous of serious damage to health by prolonged exposure if swallowed	DT- >5000; OT-3708; IT (4 hrs)----- 5.04 **[T]** (Rats)	
25.	Ethion $C_9H_{22}O_4P_2S_4$ AG-88% CAS No: 563-12-2 UN No: 2903	245		38 TQ-1 (100 kg)	Clear yellow liquid withmercaptain like odour Flash Point >27 ^{0}C/ May decompose rapidly & violently at temp~ 150^{0}C Combustion Products- Sulphur / phosphorus compounds etc.	DT-1084; OT-47 IT-0.45 ;**[ET]** (Rats)	Highly toxic if swallowed; Moderately toxic if inhaled or absorbe by skin.
26.	Ethepon (75% minm).	---	---	---	Causes burns. Harmful by inhalation and in contact with skin. harmful to aquatic	DT: rabbit: LD50 = 5730 mg/kg;	

	C2H6ClO3P CAS No:16672-87-0 Clear slight brown liquid				organisms, may cause long- term adverse effects to the aquatic environment	OT: rat: LD50 = 3400 mg/kg; IT: rat: LC50 = 90 mg/m 3/4H;	
27.	Propargite CAS No:2312-35-8 Dark brown liquid. Mild, solvent odour	---	---	---	Data suggests that this product is harmful if swallowed; Mildly irritating to skin; Data indicates that this product may be irritating if inhaled. May lead to minor discomfort which shouldquickly disappear once exposure has ceased.	DT- >4500; OT-960; IT-685 (Rats)	
28.	Imazethapyr Technical CAS No: 81335-77-5 Light brown to yellow crystals	---	---	---	Effects from overexposure result from coming into contact with the skin and eyes. Symptoms of overexposure include nasal discharge	DT->5000; OT->5000 IT- 3.27; **[T]** (Rats)	Thermal decomposition and burning may form toxic by-products
29.	Propizonazole C15H17Cl2N3O2 CAS-No. : 60207-90-1 Yellow colour liquid	---	---	---	Harmful if swallowed. May cause sensitization by skin contact. Very toxic to aquatic organisms,	LD50 Oral - rat - 1.517 mg/kg LC50 Inhalation - rat - 4 h - 1.264 mg/m3 LD50 Dermal - rat - > 4.000 mg/kg	
30.	Tebuconazole C16H22ClN3O AG-96% Balance - inerts CAS No:107534-96-3 UN No: 2491	---	---	---	Slight Brown Powder with mild ammonia like odour	DT-> 5000; OT-1700;(femal e rats) IT-0.37 (air);**[ET]** > 5.1	Harmful if swallowed, inhaled or absorbed through the skin. Chemical Interactions: No known

						(dust)[T] (Rats) NFPA- H-1;F-1;I-1	interactions Medical Conditions Aggravated: Pre-existing liver diseases, Pre-existing kidney disease
31.	Bispyribac Sodium C19H17N4NaO8 Form:Whiteodourless solid CAS No.: 125401-92-5	---	---	---	Never faced the poisoning problem attributed to bispyribac-sodium technical on laboratory researchers, factory workers and users,	DT- >2000; OT-> 4111; IT (4 hrs)----- 4.48 [T] (Rats)	However on animals bispyribac-sodium technical may cause hypoactivity, abnormal walking and prostration.
32.	Metalaxyl Technical C15H21NO4 CAS No:57837-19-1 UN No:2588 Dark red liquid. With Slight paint odour	---	---	---	Contact with the skin: Irritive to skin Contact with the eyes: Eyes become red Inhalation: Irritative to respiratory tract Ingestion: nausea, vomiting and breathing difficulty	------	
33.	Carbendazim CAS No:10605-21-7 White to light grey crystalline solid; does not mix with water	---	---	---	Harmful in contact with skin. May cause heritable genetic damage. May impair fertility. May cause harm to the unborn child. Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment	DT(rat): LD 50: 2000 mg/Kg (rat) OT (rat): LD 50: 6400 mg/Kg	
34.	Diafenaconazole C19-H17-Cl2-N3-O3,	---	---	---	Harmful if swallowed. Toxic to aquatic organisms, may cause long-term adverse	DT(rabbit): LD 50: 2010 mg/Kg (rat) OT (rat): LD	

	CAS No119446-68-3: White to light beige crystalline solid; does not mix well with water				effects in the aquatic environment	50: 1453 mg/Kg	
35.	Quizalofop Ethyl (92%) $C_{19}H_{17}ClN_2O_4$ CAS No: 100646-51-3 white to pale yellow fine crystalline solid	---	---	---	Causes irreversible eye damage. Harmful if swallowed, inhaled, or absorbed through the skin. Avoid contact with eyes, skin, or clothing. Avoid breathing vapor or spray mist.	Acute Oral LD_{50}: 1210 mg/kg (male); 1182 mg/kg (female) **Inhalation 4 hour LC_{50}:** 2.6 mg/L (rats, male); 4.4 mg/L **[T]** (rats,female) ; 3.5 mg/L (rats combined)	
36.	Acephate AG-98% CAS NO:30560-19-1				White coloured free flowing granules; strong mercaptanodour	DT-2000; OT-846 IT-2.13; **[T]** (Rats) NFPA- H-1;F-1;I-1	Causes Eye irritation; harmful if swallowed; Avoid breathing dust or spray mist; Avoid contact with eyes, skin or clothing; Keep out reach of Children.Not Carcinogen

Table 7.3. Hazards Analysis of Raw Materials

S. No	Material	S. No & Threshold Quantity (TQ in Kg) as per MSHIC Rules			Chemicals Hazards Potential		Remarks
		Schedule-1, Part-II	Schedule-2, Part-I	Schedule-3, Part-I	Hazards	Toxic	
	ortho-Phenol CAS No:106-95-2 UN No: 2821 A colorless liquid when pure, otherwise pink or red. Combustible. Flash point 175°F.	481	----	----	Flammability: Ignites when moderately heated; Yields flammable vapors when heated, which will form explosive mixtures with air; Health Hazards: Will burn eyes and skin. The analgesic action may cause loss of pain sensation. Readily absorbed through skin, causing increased heart rate, convulsions, and death.	ERPG-1: 10 ppm ERPG-2: 50 ppm ERPG-3: 200 ppm IDLH: 250 ppm	Phenol
	Chlorine CAS No:7782-50-5 UN No:1017 A greenish yellow gas with a pungent suffocating odor. Toxic by inhalation.	119	5 TQ-1: 10MT TQ-2: 25 MT	108 TQ-1: 10MT TQ-2: 25 MT	Non Combustible;May ignite other combustible materials (wood, paper, oil, etc.). Mixture with fuels may cause explosion. Container may explode in heat of fire. Chlorine reacts explosively with or supports the burning of numerous common materials. Ignites steel at 100°C in the presence of soot, rust, carbon, or other catalysts. Ignites dry steel wool at 50°C. Hydrogen and chlorine mixtures (5-95%) are exploded by	ERPG-1: 1.0 ppm ERPG-2: 3.0 ppm ERPG-3: 20 ppm IDLH: 10 ppm	

					almost any form of energy (heat, sunlight, sparks, etc.). Health Hazards: Poisonous; may be fatal if inhaled. Contact may cause burns to skin and eyes. Bronchitis or chronic lung conditions		
	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/m3 ERPG-2: 10 mg/m3 ERPG-3: 30 mg/m3 IDLH: 15 mg/m3	
	Hydrochloric acid (Gas) 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	Plant uses liquid and emits HCl gas
	Sodium Hydroxide CAS No: 1310-730-2 UN No: 1823	571	----	----	Not flammable; Corrosive to metals and tissue. Hazardous.	ERPG-1: 0.5 ppm ERPG-2: 5.0 ppm ERPG-3: 50 ppm IDLH: ---- ppm	

	Dimethyl Amine (40%) CAS No:124-40-3 (Pure DMA) Liquid with strong odour	---	----	----	Very hazardous in case of ingestion, of inhalation. Hazardous in case of skin contact (corrosive, irritant, permeator), of eye Contact (irritant).	Acute toxicity Oral-(LD50): Mouse) Vapor (LC50): 11350 ppm 4 hour(s) (Rat) (Calculated value for the mixture).	Flammable. NFPA: Health: 3 Flammability : 4 Reactivity: 0
	Ethyl Alcohol CAS No:64-17-5 (200 Proof) (Pure DMA) Liquid with alcohol/wine like odour BP: 78.50C FP(CC):18.50C LFL: 3.3%; UFL: 19%	248	----	----	Hazardous in case of skin contact (irritant), of eye contact (irritant), Slightly hazardous in case of skin contact (permeator), of ingestion. Non-corrosive for skin. Non-corrosive to the eyes. Non-corrosive for lungs	Oral (LD50): 7060 [Rat]. 3450 [Mouse]. Vapor (LC50): 20000 ppm 8 hours [Rat]. 39000 4 hours [Mouse].	Flammable. NFPA: Health: 2 Flammability : 3 Reactivity: 0
	Toluene CAS No: 108-88-3 UN No: 1294 A clear colorless liquid with a characteristic aromatic odor. Flash point 40°F	628	----	----	Flammability: Ignites at normal temperatures; Vapor is heavier than air and may travel a considerable distance to a source of ignition and flash back; Health Hazard Vapors irritate eyes and upper respiratory tract; cause dizziness, headache, anesthesia, respiratory arrest. Liquid irritates eyes and causes drying of skin. If aspirated,	ERPG-1: 50 ppm ERPG-2: 300 ppm ERPG-3: 1000 ppm IDLH: 500 ppm	

					causes coughing, gagging, distress, and rapidly developing pulmonary edema. If ingested causes vomiting, griping, diarrhea, depressed respiration.		
	Methanol CAS No:67-56-1 UN No:1230 A colorless fairly volatile liquid with a faintly sweet pungent odor like that of ethyl alcohol.	377	----	----	Health Hazards: Exposure to excessive vapor causes eye irritation, head- ache, fatigue and drowsiness. 50,000 ppm will probably cause death in 1 to 2 hrs. Swallowing may cause death or eye damage.	ERPG-1: 200 ppm ERPG-2: 1000 ppm ERPG-3: 5000 ppm IDLH: 6000 ppm	Highly Flammable; Behavior in Fire: Containers may explode
	n-Hexane CAS No:110-54-3 Clear colorless liquids with a petroleum-like odor. Flash points -9°F	306	---	---	Health Hazards: Inhalation causes irritation of respiratory tract, cough, mild depression, cardiac arrhythmias. Aspiration causes severe lung irritation, coughing, pulmonary edema; excitement followed by depression. Ingestion causes nausea, vomiting,.	TEEL-1: 400 ppm TEEL-2: 3300 ppm TEEL-3: 8600 ppm IDLH 1100 ppm	Highly flammable; Vapours may explode;
	Iso Butylene [C4 H8] CAS No: 115-11-7 UN No: 1055 Extremely Flammable Gas; FP—76.1 0C	----	----	----	Product stable; extremely reactive; incompatible with oxidizing agents.	LC50 (Rat)—550000 mg/M3	O-Xylene

	Explosive Limit-Lower-1.8%; Upper-9.6%						
	Triflouro Acetic Acid C2HF3O2 CAS No: 76-05-1 Clear colorless liquid with pungent odor	----	----	----	Harmful by inhalation. Causes severe burns. Skin Contact: Causes severe burn Organisms, may cause long-term adverse effects in the aquatic environment. Hazardous Decomposition Products: Carbon monoxide, Carbon dioxide, Hydrogen fluoride.	LC50 (Rat)—10000 mg/M3	NFPA RATING HEALTH: 3 FLAMMABILITY: 0 REACTIVITY: 1
	Dichloromethane CAS No: 75-09-2 UN No: 1294 A clear colorless liquid with a characteristic Etheral odor. BP-40 0C	----	----	----	Skin: May be absorbed through the skin. Causes irritation with burning pain, itching, and redness. Prolonged exposure may result in skin burns. Ingestion: Causes gastrointestinal irritation with nausea, vomiting and diarrhea. May cause kidney damage Inhalation of high concentrations may cause central nervous system effects	ACGIH-50ppm TWA STEL (15 min)-125 ppm	NFPA Rating: (estimated) Health: 2; Flammability: 1; Instability: 0

					characterized by nausea, headache, dizziness, unconsciousness and coma		
	Sodium cynide CAS No:143-33-9 White Granules or powder	569	---	---	Poison - may be fatal if inhaled, swallowed or absorbed through the skin. Contact with acid releases highly poisonous HCN gas. Note low LD50s below. Corrosive - causes burns. Skin and eye irritant	ORL-RAT LD50 6.4 mg kg-1 IPR-RAT LD50 4.3 mg kg-1 SKN-RBT LD50 10.4 mg kg-1	
	Bromine CAS No:7726-95-6 UN No:1744	84	17 TQ-1: 10 50 MT TQ-2: 500 MT	106 TQ-1: 40 MT TQ-2: 500 MT	Stable. Incompatible with reducing agents, alkali metals, powdered metals, steel, iron, copper, organic materials. Toxicology May be fatal if inhaled. Highly toxic by inhalation, ingestion or skin contact. Causes severe burns. Lachrymator. Typical TLV 0.1 ppm. Typical STEL 0.3 ppm		
	MEG CAS No;107-21-1 Sligtly viscous colourless Odorless liquid BP:197 0C FP: 110 0C	---	---	---	Harmful if swallowed; May cause damage to organs on prolonged exposure	Oral LD50 (rat): 4700 mg/kg Skin corrosion /irritation: Mild irritant (rabbit).	

	Aromax Mixture Blue colour liquid	---	---	---	Corrosive to the eyes, skin, gastrointestinal tract, and respiratory system. Can cause gastrointestinal irritation, swelling of the larynx, difficulty in breathing	ORAL (LD50):1000 mg/kg 9RAT0 Dermal (LD50):2000 mg/Kg (Rabbit)	
	Cyclo Hexane CAS No: 110-82-7 Liquid.with: Chloroform-like odor; LFL: 1.3% UFL:8.4% BP: 80.70C FP: -18 0C	---	---	---	Slightly hazardous in case of skin contact (irritant, permeator), of eye contact (irritant), ofingestion, of inhalation	ORAL (LD50): Acute: 12705 mg/kg [Rat]. 813 mg/kg [Mouse]. DERMAL (LD): Acute: >18000 mg/kg [Rabbit].	Flammable
	KESOL 100 (C-9 Solvent) CAS No:64742-95-6 Clear colourless liquid LEL:0.8% UEL: 7.0% BP 155 0C	---	---	---	Inflammable, vapors toxic, may cause cancer. Liquid floats on water and travels along with water to far away locations where fire risk may exist. Harmful if swallowed.	ORAL (LD50): Acute: 5 g/kg [Rat]. LC 50: 3760 ppm (rat, 4 hrs.)	

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

1. **Note:**
    1. Oral Toxicity (OT) in LD_{50} (mg/kg)
    2. Dermal Toxicity (DT) in LD_{50} (mg/kg)
    3. Inhalation Toxicity in LC50 (mg/l) [4 hrs.]

4. ATE Acute Toxicity

The petroleum materials used in Ambey plant and their hazardous nature are as below:

Table 7.4. Petroleum Products

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 HazardsSignals 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 through inhalation, 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
	Vapour Density (Air-1)-3 to 5		
	Solubility in water at 30°C- 0.001mg/100 ml	Incompatible with oxidizing agents.	TLV(ACGIH)- 5 mg/kg;
	Vapour Density (Air-1)-3 to 5		
LSHS/FO UN No.-1270 Flammable Liquid-Class-3 Hazardous Waste ID No.-17 Hazchem Code-3Y*E NFPA HazardsSignals 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.

Products Hazards Analysis

Pesticide products are designed to kill harmful insects and as such all are hazardous. Many of these products are new molecules created to achieve the said objective and only limited data of these molecules are available. As detailed in the above table out of 36 products materials only two have been mentioned in the MSIHC list namely Cypermethrin (Schedule 1 and Ethion (Schedule 1 and 3). Twenty two products are solid (crystalline/ powder or solid). Fourteen are

toxic liquids. Four of these products are extremely toxic, two are highly toxic and fourteen are toxic as per MSIHC rules.

Raw Materials Hazards Analysis

As detailed in the above table out of 19 materials only ten have been mentioned in the MSIHC list and three are gases, two toxic gases (namely Chlorine and Bromine) and one (isobutylene) is extremely inflammable / explosive gas. Fourteen are toxic/inflammable liquids. Four of these liquid (highly inflammable) materials are stored in bulk in underground tanks and rest liquids are received in above ground tanks. Isobutylene gas is stored in bullet tank. Chlorine is stored in 900 kg cylinders. Bromine is stored in 5 kg bullets.

7.5. Acids & Alkali Hazards

Acids and bases are corrosive substances. The amount of tissue damage they cause is related to the strength and concentration of the acid or base and the duration of exposure. Acids with a pH of less than 4 can cause chemical burns. Some common strong acids are hydrochloric, nitric, and sulfuric acids. Weak acids are such as acetic, citric and carbonic are not so corrosive. Bases with a pH greater than 10 can cause chemical burns. Strong bases include calcium hydroxide, sodium hydroxide and potassium hydroxide. Some common weak bases are ammonia and sodium bicarbonate. Chemical burns from bases do not cause as much pain as acid burns, but the damage can be more extensive

7.5.1. Respiratory Hazards

Many acids and bases are highly toxic by inhalation. The fumes or airborne mist will irritate the mucous membranes of the nose, throat and lungs. In severe cases, exposure may result in pulmonary edema, a life-threatening condition in which fluid in the lungs prevents oxygen from reaching the bloodstream.

7.5.2. Contact Hazards

Concentrated acids and bases are corrosive and cause chemical burns if they come into contact with the skin, eyes or internal organs. Acid burns usually cause immediate pain and tissue damage. Hydrofluoric acid penetrates the skin rapidly and may even result in bone damage. In contrast,

7.5.3. Protective Equipment

Protective gear should be used every time you handle acids and bases. Wear safety goggles or safety glasses that include side shields, as well as a laboratory coat or coveralls, and closed-toe shoes. Choose protective gloves that are resistant to the chemical you are handling. Nitrile gloves are useful for most acids, but you should check the safety requirements for all chemicals and concentrations that you use. Depending on the amounts you work with, you may need to add a face shield or respiratory equipment

7.6. Chlorine & Bromine Hazards

Chlorine

Chlorine is one of the active halogen gases heavier than air with toxic –irritating odour (MW: ~ 71Can remain in confined space). It is a toxic gas and is included as toxic material in MSIHC Rules (in the entire three Schedules). Some of the hazards of Chlorine gas to human are as below:

Signs and symptoms: The signs of acute chlorine gas poisoning are primarily respiratory, and include difficulty in breathing and cough; listening to the lungs will generally reveal crackles. There will generally be sneezing, nose irritation, burning sensation, and throat irritation. There may also be skin irritation or chemical burns and eye irritation or conjunctivitis. A person with chlorine gas poisoning may also have nausea, vomiting, or a headache.

Chronic exposure to relatively low levels of chlorine gas may cause pulmonary problems like acute wheezing attacks, chronic cough with phlegm, and asthma.

Dose toxicity

Humans can smell chlorine gas at ranges from 0.1–0.3 ppm. "At 1–3 ppm, there is mild mucus membrane irritation that can usually be tolerated for about an hour. At 5–15 ppm, there is moderate mucus membrane irritation. At 30 ppm and beyond, there is immediate chest pain, shortness of breath, and cough. At approximately 40–60 ppm, a toxic pneumonitis and/or acute pulmonary edema can develop.... Concentrations of about 400 ppm and beyond are generally fatal over 30 minutes, and at 1,000 ppm and above, fatality ensues within only a few minutes."

Bromine

Bromine, Br2, is the only non-metallic element that is liquid at ordinary temperatures and pressures. It has a dark, amber-red color and an intensely irritating odour.

Bromine exposure, either by liquid contact or vapor inhalation, represents a hazard with the potential of serious injury or death. The liquid rapidly attacks skin and other tissues to produce irritation and necrosis. Comparatively low concentrations of vapor are quite painful and are highly irritating to the eyes and the entire respiratory tract.

Excessive exposure to acutely dangerous concentrations will result in serious inflammation and edema, frequently followed by pneumonia.

Excessive exposure to low concentrations, although not acutely dangerous, will result in inflammatory reactions in the eyes and respiratory passages. Vapor concentrations of 500-1000 parts per million (ppm) by volume are dangerous to life at exposures for 0.5 to 1 hour.

The maximum permissible exposure weighted over 8 hours is 0.1 ppm. At this level bromine can still be detected by its odour. A concentration of 10 ppm can hardly be tolerated for more than a few moments.

Bromine, a powerful oxidizing agent, is capable of causing combustibles to ignite on contact. It is Extremely Hazardous Substances.

Procedures for the Safe Handling of Bromine

Extreme care must be exercised in the storage, handling, shipping and use of bromine. Vapors

are a severe skin, eye and mucous membrane irritant. Contact with liquid bromine can cause severe burns. The readily identifiable color and pungent odor gives immediate warning of bromine's presence. At a concentration of only one part per million (ppm), bromine is easily detectable and even lesser amounts can cause eye irritation. The OSHA Permissible Exposure Limit (PEL) for bromine is 0.1 ppm.

Safety Practices in the Work Area

General Instructions

- Read and follow all directions and warning labels carefully.
- Inform all personnel of the potential hazards of contact with bromine and train them in appropriate first-aid procedures.
- Store and handle bromine over drip pans drained by a sump that is vented to a scrubber system.
- Bromine handling areas should be clearly marked and restricted to qualified, trained personnel only.
- Maintain uncontaminated equipment, floors and work areas. As routine maintenance, periodically scrub floors.
- Immediately contain and clean up all bromine spills.
- Wear approved respiratory equipment and protective clothing.
- Pour soda ash solution or hypo solution on the liquid bromine to neutralize.
- Using cold water, wash neutralized bromine to a sump for disposal.
- Open doors and windows to ventilate.
- Avoid contact of bromine with strong reducing agents, strong alkalis, metals, wood, paper products, fabric, grease and oil or other combustible materials.

7.7. 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 7.5:**

Table 7.5. : 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	Impact limited to the local area of the event with potent for 'knock – on- events'

Stage	Description
Incidents	
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 prioritizing associated risk mitigation measures and planned actions.

7.8. 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 causing a 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 7.6, Table 7.7 and Table 7.8 (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 vaporization of large fraction of its vapour contents; possibly followed by combustion or explosion of the vaporized cloud if it is combustible range.

Thermal hazards have been considered for various scenarios including:

Fire in inflammable chemicals storage tanks;

Table 7.6. 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 7.7. 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 7.8. 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 sec.)
6	Personnel in Emergencies	3 (up to 30 sec.)
7	Plastic Cables	2
8	Stationary Personnel	1.5

7.9. 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.

AMBEY does not store explosive material. Damage estimates based on overpressure are given in **Table 7.9** below:

Table 7.9. : Damage due to Overpressure

S. 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

7.10. Toxic Release

Hazardous materials handled and stored in bulk in AMBEY complex are toxic liquids and

gaseous (as detailed in Table above) and other raw materials as defined in MSHIC rules and indicated in the Table. Some of these chemicals are stored in bulk (in tank farm).

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 (IT) data for rats' are considered. 'IT' data are used for the products as IDLH are not available for these chemicals.

7.11. Data Limitations

It is also observed that very little data or information (regarding physical properties required for modeling) is available for pesticide products and liquid /gas mixtures.

7.12. 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 7.10 below:

Table 7.10. Different Failure Scenarios

S. No.	Scenario	Remark
	Raw materials	
RM-1	Chlorine Tonner heavy leak	Chlorine Down wing toxic effect
RM-2	Isobutylene gas heavy leak; Jet Fire Bleve	Inflammable
M-3	Hexane—Heavy Spillage	Inflammable
M-4	Toluene—Heavy Spillage	Toxic
M-5	Cyclohexane Heavy Spillage	Thermal
M-6	Dichloromethane Leakage	Toxic
M-7	Bromine Bottle (5 Kg) Breaking, Spillage	Toxic

7.13. 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) 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.

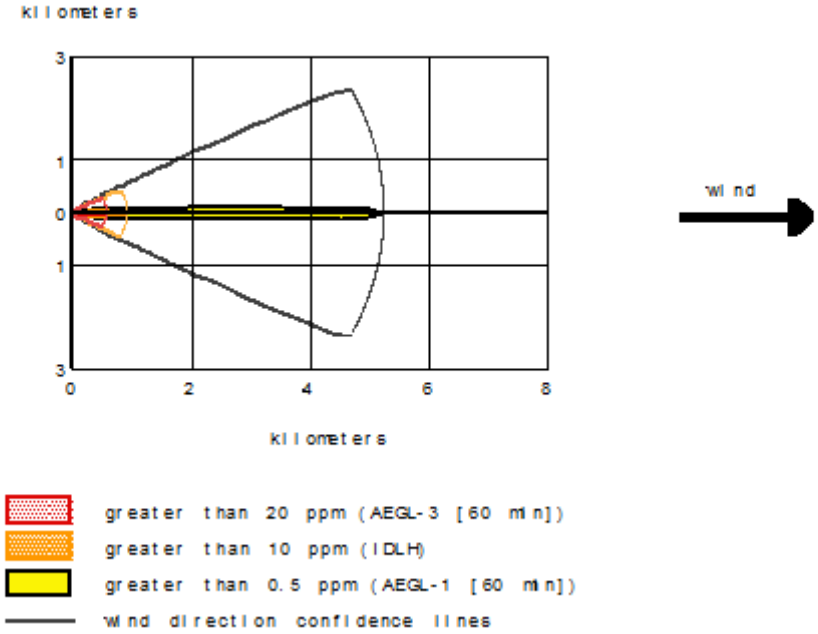
7.14. Incidents Impacts

The identified failure scenarios **(Table 7.11)** have been analyzed (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 7.11.**

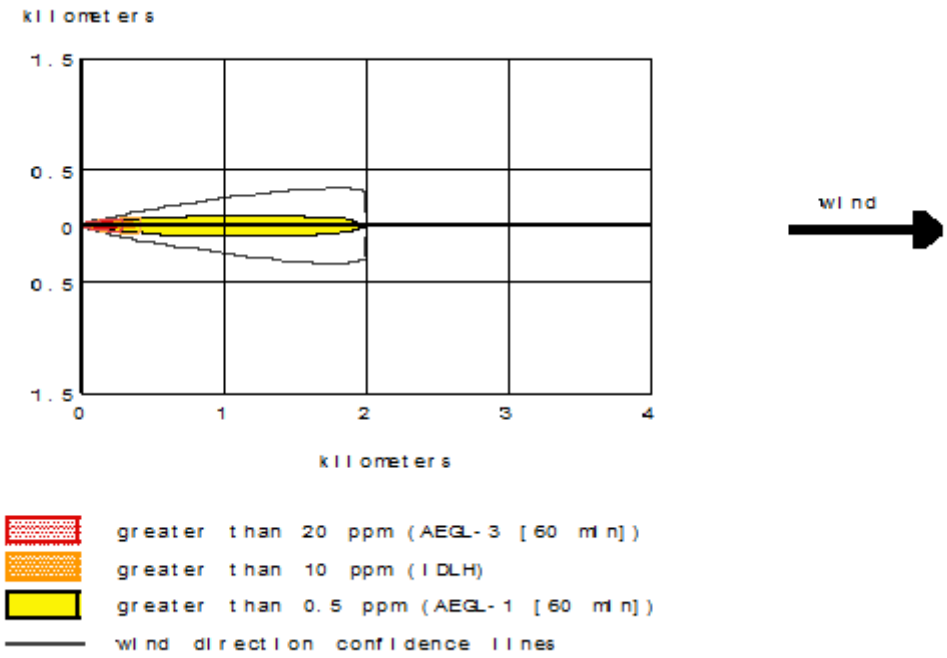
Table 7.11. Impact Zones: Hazardous Scenarios

Scenario No.	Scenario	Impact Zone (m)	Remarks
	Scenario Raw Material		

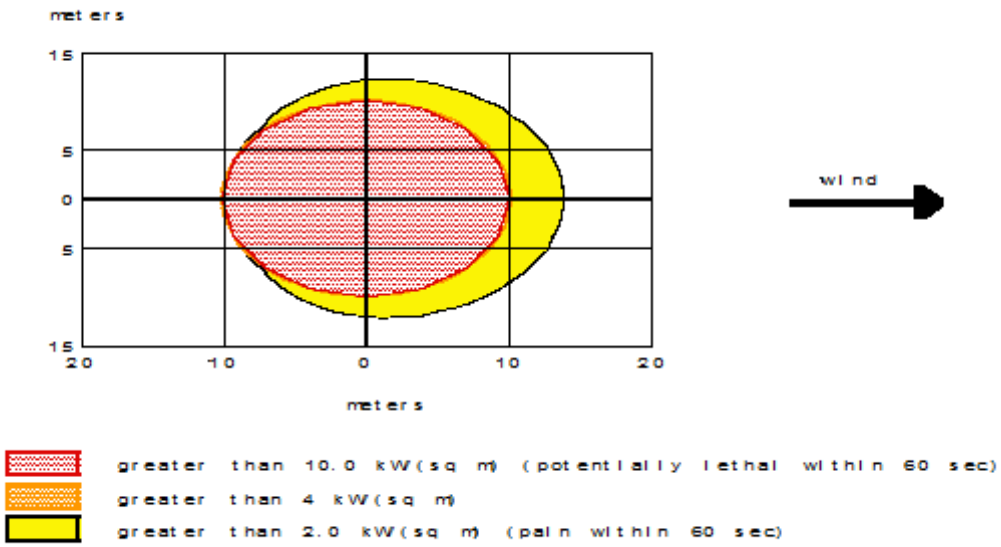
Scenario No.	Scenario	Impact Zone (m)	Remarks
Scenario Raw Material			
RM-1	Chlorine Tonner heavy leak	~ 910 0 419	IDLH; Stability Class F Template 7.1 IDLH; Stability Class D Template 7.2
RM-2	Isobutylene gas leak; Jet fire BLEVE	~10 430	1st degree burn; Template7. 3 1st degree burn from fireball Template 7.4
RM-3	Heavy Spillage Hexane	20	1st degree burn Template 7.5
RM-4	Toluene Heavy Spillage	~13	IDLH; Stability Class D
RM-5	Cyclohexane Heavy Spillage	~ 15	1st degree burn Template 7.6
RM-6	Dichloromethane Leakage	~ 35	AEGL -2 Template 7.7
RM-7	Bromine Bottle (5 Kg) Breaking, Spillage	~ 64 O 116	IDLH; Stability Class "D" Template 7.8 IDLH; Stability Class "F" Template 7.9



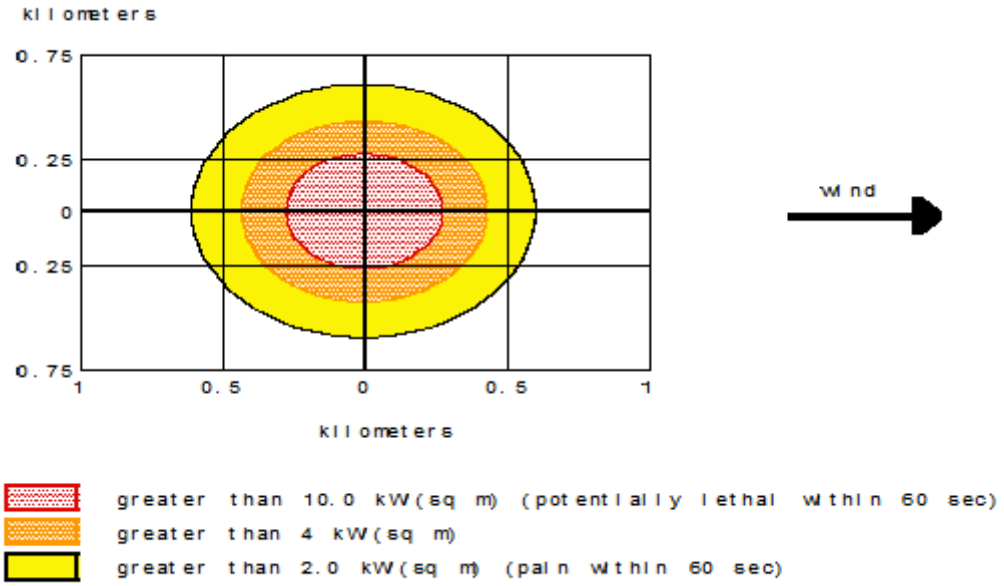
Template7. 1. Chlorine Tonner Leakage-Toxic Impact Zone (Stability Class D)



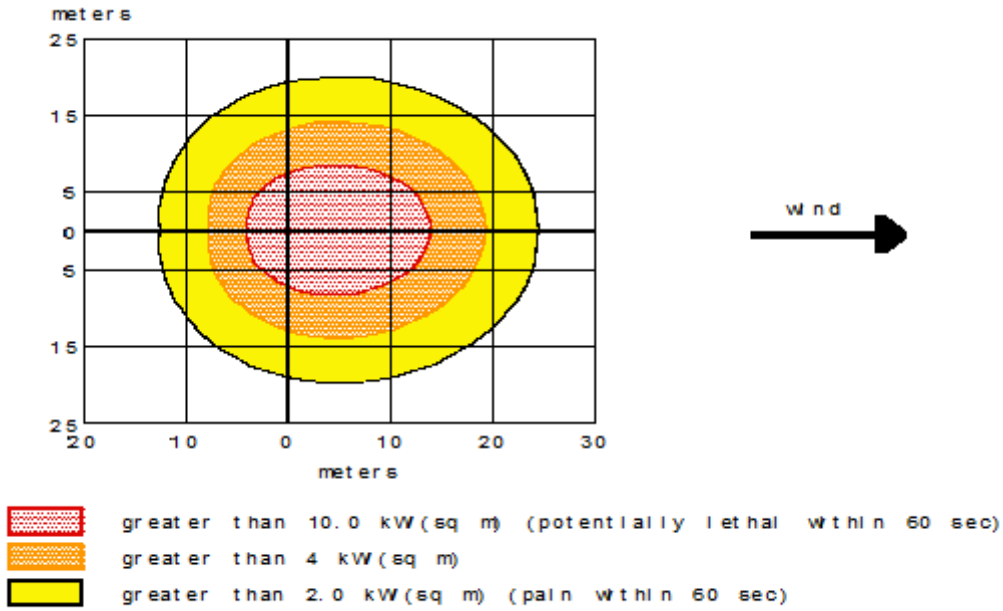
Template7. 2. Chlorine Tonner Leakage-Impact Zone (Stability Class F)



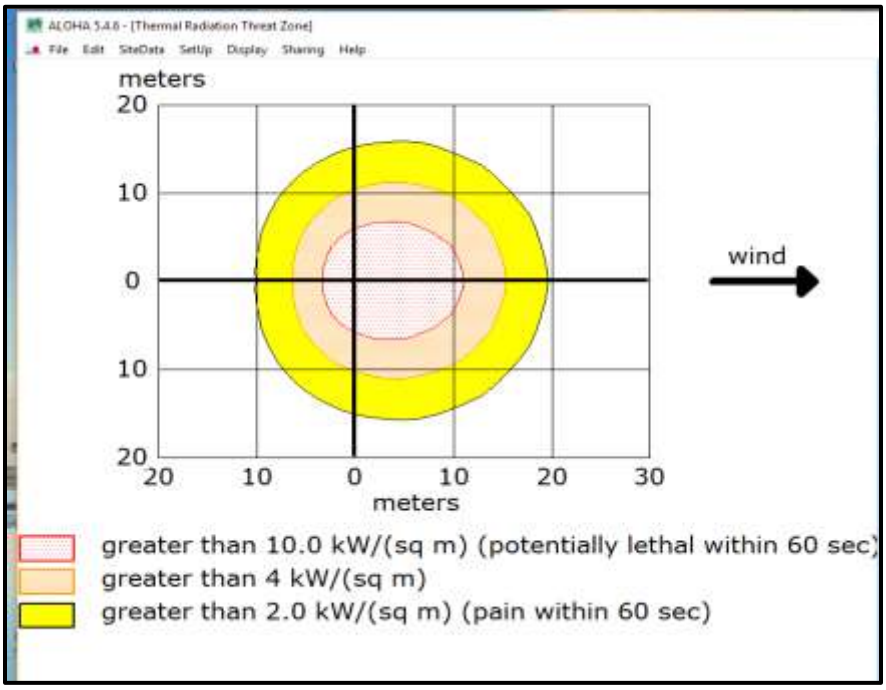
Template7. 3. Isobutylene Leakage-Jet Fire-Thermal Impact Zone



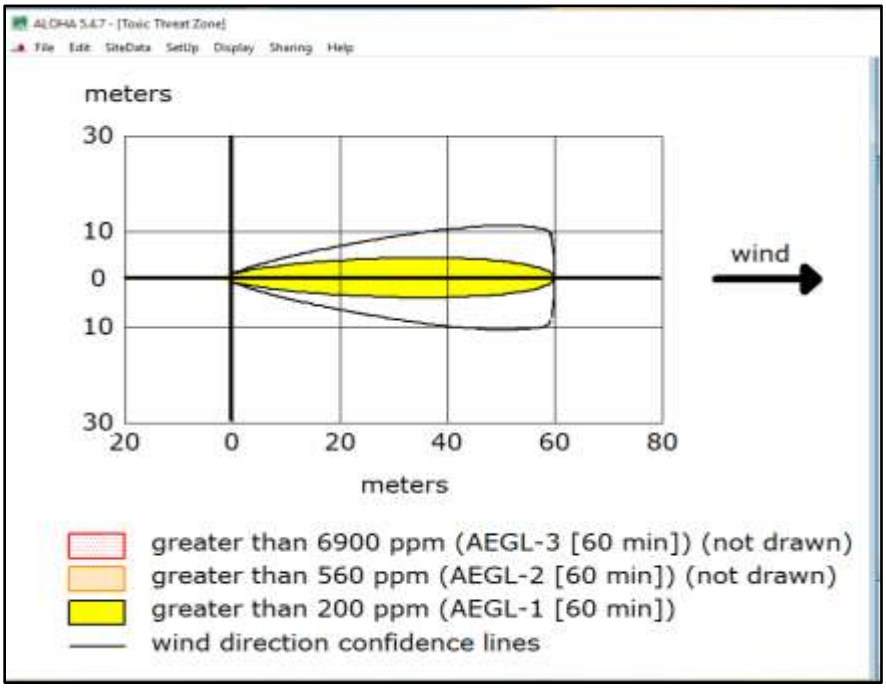
Template7. 4. Isobutylene Tank Leakage-BLEVE: Thermal Impact Zone



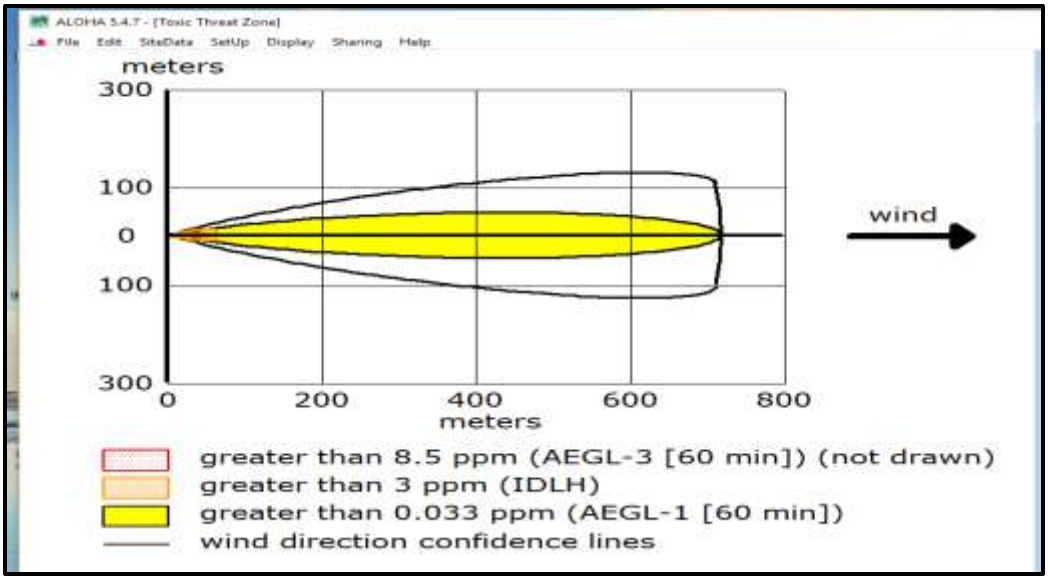
Template7. 5. Hexane Spillage Pool Fire: Thermal Impact Zone



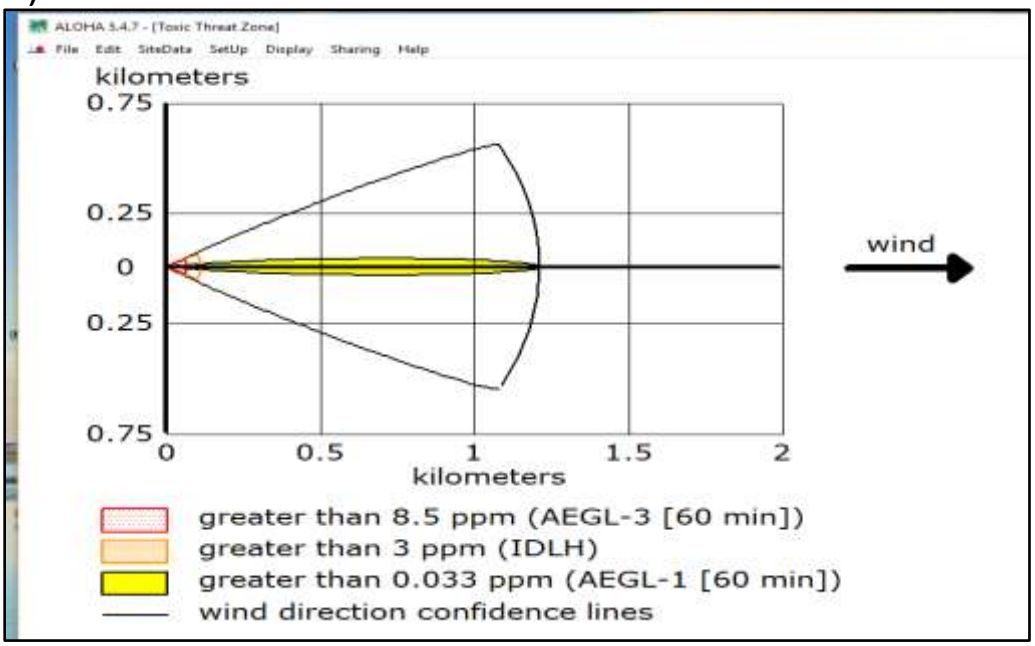
Template7. 6. Cycloheane Burning Puddle-Thermal Impact Zone



Template7. 7. Dichloromethane Leakage-Toxic Impact Zone



Template7. 8. Bromine Bottle Breaking, Spillage-Toxic Impact Zone (Stability Class "D")



Template7. 9. Bromine Bottle Breaking, Spillage-Toxic Impact Zone (Stability Class "F")

7.15. Consequential Impacts

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

7.16. Thermal and Explosion Hazards

Incidents involving thermal hazards are mainly due to Isobutylene jet fire / BLEVE; Hexane or Cyclohexane spillage and fire. The impact due to heavy spillage and fire (1st degree burn) is limited to ~20 m (within plant area). The impact due to BLEVE can cross plant boundary limit (419 m). However the consequences can go worse if the incidents lead to domino effect /impact.

7.17. Toxic Hazards

Toxic hazards are mainly due to Chlorine and Bromine leakage and their impacts zone (419--910 m) can cross plant boundary limit depending upon atmospheric conditions.

Other hazardous chemicals, their impact will be limited to spillage area. The acid 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.

7.18. General Control Measures

Since some of the substances (mainly Isobutylene, Chlorine, Bromine and acids; HSD etc.) in use at Ambey are hazardous with high Toxic and fire potential and also toxic in nature, it is necessary to use appropriate control measures recommended for such substances. Ambey proposes to have following OHC Measures in the proposed Project.

7.19. Flammable Materials

Fire control generally consists of directing, diluting and dispersing the inflammable gas/ vapor to prevent contact with persons, to prevent it from infiltrating in structures if the leak is out door, and to avoid its contact with other inflammable materials while, if possible, simultaneously stopping the flow of gas. Water in the form of spray, applied from hoses or monitors nozzles or by fixed water spray system cools the burning vapours / gas. AMBEY has got fire fighting team

7.20. Process Safety System

Process & Plant Safety (PPS):

Some of the safety measures are as below:

- Every change in the process, procedure, equipment, etc. will be done through robust management of change (MOC) procedure
- Pre-Start up Safety Reviews for all modification
- Pressure testing of pipelines and replacement of fragile pipelines and tanks by prevention project
- Hazardous area classification
- Internal safety rounds for P&PS
- Control P&IDs, and Lock opened (LO)/ Lock closed (LC) procedures are in place
- TOPPS (Top Performance in Process & Plant Safety) training to all employees

- Root Cause Analysis of all incidents
- Pre-Start up Safety Reviews for all modification

Occupational Safety:

- Permit to Work procedure and Monthly monitoring of all filled permit for continual improvement
- Mobilized Near- Miss Reporting and award scheme
- HSE rounds: PMT (Plant Management Team) of one plant takes HSE round of another plant. Exchange of best practices among plants
- MSDS Management
- Tool Box talk with contractors
- Central Safety Committee
- Departmental Safety Committees
- HSE Coordinator and Monitor program: Shop floor employees' participation in Safety activities
- Celebration of theme based Safety days/ weeks at site
- Safety Induction program for new joiners (both company & contract employees)

Emergency Preparedness:

- On-Site Emergency Plan for the site
- Training on On-Site Emergency Action Plan
- Regular Site level Mock drills and Plant specific Fire Drills and Leak, spill drills
- Availability of First aiders, Fire Fighters and Rescue members in each shift
- Maintenance of Fire hydrant system, sprinkler system and portable fire extinguishers
- Periodic testing of fire hydrant and sprinkler systems
- Fire Tenders and Ambulances kept ready

Occupational Health Centre:

AMBEY has occupational health center in the premises. Regular employees health checkup is carried out.

Proposed Systems at OHC:

1. Pre-employment check-up company employees:

When a candidate is selected for employment (management / non-management) – HR, directs the candidate to OHC for medical fitness before offer letter is given

2. Periodical Medical Examinations; Company Employees:

PME for company employees is conducted once in six months – once by a certifying surgeon and another by Factory Medical Officer.

3. Sickness:

If any person is sick, he reports to OHC on duty and after treatment he is sent back to his department or detained in OHC for some time before he goes back to duty or sent home or nearby Hospital depending on the condition of the patient in Ambulance / Company vehicle.

4. Injury:

If any employee suffers from occupational injury he reports to OHC on his own and after treatment resumes duty immediately but if injury is serious, his supervisor or co-worker informs OHC and there by Ambulance is sent to bring the casualty from the place of injury to OHC, and depending on the severity the causality is treated, detained in OHC or hospitalized.

5. First Aid Training:

First aid training is imparted through recognized Institution in two to three batches every year in view to cover minimum 10% of plant strength. The names of first aiders are displayed department wise in OHC and in concerned departments.

Apart from this “AMBEY”, will have safety showers and eye wash facilities throughout the plant, wherever required.

7.21. Emergency Response & Disaster Management Planning (ERDMP) Study

Scope of the study involves the

AMBEYhas an Emergency Management Plan giving also details of Safety system and training. Ambey has to upgrade it considering expansion of the plant and develop “Mutual Aid Agreement” with adjoining industries.

CHAPTER 8. PROJECT BENEFITS

Demand of Pesticides is growing fast and India at times is importing the same using hard earned foreign exchange. The proposed Expansion Project of AMBEY Pesticide Complex will provide following benefits:

- Availability of desired quality (as per crop and soil demand) pesticides to farmers
- Pesticides production will increase and will meet the farmers demand.

8.1. Improvement of Social Infrastructure

The proposed AMBEY Pesticide Complex expansion will create opportunities for direct and indirect employment in the area .The proposed plant will initiate local economic growth and thereby the potential to enhance quality of life of the local communities .Local population may get benefited due to increased business activities and with the availability of specific pesticides.

8.2. Employment Potential

The project is intended to use skilled manpower. At present the unit is operating in batch mode. At present 100 employee are working in the industry. After the proposed expansion unit will provide permanent employment to another 50 person. Total employment generated from the industry after expansion will be around 150 people.

8.3. CSR Activities

Some suggestion is made for the CSR activities by the consultant. According to the CER (Govt of India 2017) project cost <100 crore for brown field project there will be 1% fund of the capital investment should be allocated for the CSR activities. This is a Brownfield project and cost of the project is 100 Crore. So according to the project cost 1% that is 12 Lack should be invested for the local area development.

8.4. Other Project Benefits

The proposed expansion project of AMBEY Pesticide Complex will be helpful in ensuring in availability of desired pesticides to farmers to some extent.

8.5. Other Tangible Benefits

The proposed AMBEY Pesticide Complex shall create tangible benefits as described below:

No private land acquisition is required for construction of proposed expansion of AMBEY Pesticide Complex.

The socio-economic impacts linked to the acquisition of land and structures will not appear in the project .During operation phase of the project positive impacts (due to reduced emission) on environment are anticipated.

The proposed AMBEY Pesticide Complex will generate indirect employment opportunities mainly during the operation phase .Local semi-skilled and unskilled labourers will get indirect employment in operation phase .This is a moderate positive impact of the proposed project.