Chapter-7
Additional Studies

(A) HAZARD ANALYSIS & RISK ASSESSMENT

7.1 INTRODUCTION

Industrial plants deal with materials, which are generally hazardous in nature by virtue of their intrinsic chemical properties or their operating temperatures or pressures or a combination of these. Fire, explosion, toxic release or combinations of these are the hazards associated with industrial plants using hazardous chemicals. More comprehensive, systematic and sophisticated methods of **Safety Engineering**, such as, **Hazard Analysis** and **Quantitative Risk Assessment** have now been developed to improve upon the integrity, reliability and safety of industrial plants.

The primary emphasis in safety engineering is to reduce risk to human life, property and environment. Some of the more important methods used to achieve this are:

- **Quantitative Risk Analysis:** Provides a relative measure of the likelihood and severity of various possible hazardous events by critically examining the plant process and design.
- **Work Safety Analysis:** The technique discerns whether the plant layout and operating procedures in practice have any inherent infirmities.
- **Safety Audit:** Takes a careful look at plant operating conditions, work practices and work environments to detect unsafe conditions.

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

7.2 RISK ASSESSMENT-Identification of Hazards

A three 'levels' risk assessment approach has been adopted for the **M/s. Reynish Pharmachem Pvt. Ltd.** for their greenfield project at 504, 505,

507, Village: Dabhasa, Ta.: Padra, District: Vadodara, Gujarat. The risk assessment levels are generally consistent with the practices encountered through various assignments for medium and large chemical complexes. The brief outline of the three tier approach is given below:

Level 1 – Risk Screening

This is top-down review of worst-case potential hazards/risks, aimed primarily at identifying plant sites or areas within plant, which pose the highest risk. Various screening factors considered include:

- Inventory of hazardous materials;
- Hazardous Materials properties;
- Storage conditions (e.g. temperature and pressure);
- Location sensitivity (distance to residential areas/populace).

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

➢ **Level 2 – Major Risk Survey** (Semi - Quantitative)

The survey approach combines the site inspection with established risk assessment techniques applied both qualitative as well quantitative mode. The primary objective is to identify and select major risks at a specific location in the plant considering possible soft spots/weak links during operation/maintenance. Aspects covered in the risk usually include:

- Process Hazards;
- Process Safety Management Systems;
- Fire Protection and Emergency response equipment and programs.
- Security Vulnerability;
- Impact of hazards consequences (equipment damage, business interruption, injury, fatalities);
- Qualitative risk identification of scenarios involving hazardous materials;
- Risk reduction measures.

Selection of critical scenarios and their potential of damage provide means of prioritising mitigative measures and allocate the resources to the areas with highest risks.

- **Level 3 – Quantitative Risk Assessment** (Deterministic)

This is the stage of assessment of risks associated with all credible hazards (scenarios) with potential to cause an undesirable outcome such as human injury, fatality or destruction of property. The four basic elements include:

- 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 due to weather data, population data, and frequency of occurrences and likely hood of ignition/toxic release. Data are analyzed considering likely damage (in terms of injury/fatality, property damage) each scenarios is likely to cause.

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

Reynish Pharmachem Pvt. Ltd. project is hazardous in nature. The QRA for this plant is based on Level 1 and Level 2. **Table 2.3** in Chapter 2 gives the list of products (and their monthly production capacity) to be manufactured in the proposed project.

7.3 HAZARDOUS MATERIALS STORAGE

The solid raw materials will be received in bags or drums and will be stored in chemicals godowns. The bulk storages of hazardous materials are given in the **Table 7.1** below.

Table 7.1: Bulk Storage of Hazardous Chemicals

Sr. No.	Name of solvent	Maximum storage capacity (KL)
1	Methanol	10 KL tank
2	Dichlo Methane	10 KL tank
3	Iso propyl alcohol	5 KL tank

4	Ethyl Acetate	5 KL tank
5	Sodium Hydroxide Lye	5 KL tank
6	HCl (30-32%)	10 KL tank
7	Sulphuric Acid	5 KL tank
8	Acetone	5 KL tank
9	Toluene	0.2 KL x 5 Drum=1.0 KL
10	Chloroform	0.2 KL x 5 Drum=1.0 KL
11	Benzoyl chloride	0.2 KL x 5 Drum=1.0 KL
12	Hexane	0.2 KL x 5 Drum=1.0 KL
13	Nitric acid	0.08 KL x 20 Carboys =1.6 KL
14	Dimethyl formamide	0.2 KL x 5 Drum=1.0 KL

7.4 RISK SCREENING APPROACH

Proposed Plant: Risk screening of **Reynish** plant was undertaken through process study and study of data/information provided by Reynish. 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. Unit will be used numbers of hazardous chemicals and also producing organic chemicals – hazardous in nature. The chemicals stored in bulk (liquid or gaseous) and defined under MSHIC Rule will be considered for detailed analysis.

The solid materials will be kept in bags or drums and will be stored in chemicals godowns. The products (liquid or solid) will be packed in drums and stored in product godowns as per market demand. The bulk storages of hazardous materials are given in the **Table 7.1** above. In addition, Reynish will store fuels mainly Agro briquette for boiler, TFH & HAG and HSD (in limited quantity) for DG Set (during power failure only). The solid material-powder or granules spillage can results in polluting small area only. The damage to personnel can be through ingress-dermal (if individual come in contact), oral (if individual food gets infected through fugitive dust) or inhalation (fugitive dust). The main route is fugitive dust which in covered area will move to short distance only. The risk is through liquid/gaseous materials which are volatile material. The toxic vapours due to spillage of such material can travel to some distance (as they are stored in covered godowns) and cause damage.

Reynish will be producing 15 Bulk Drug products. All Reynish products are solid (Either simple Solid or crystalline solid or powder). Many of the

Reynish raw materials are hazardous in nature. However, hazards potential (for damage) of materials/chemicals to plant personnel, environment and off-site area is different for different materials. Reynish will be using a number of raw materials but only 14 are stored in bulk. The raw materials coming under hazardous category as specified by MSIHC Rules, 1989 (including subsequent amendments) is given in **Table 7.2** below:

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

Sr. No.	Raw material	Sr. No & Threshold Quantity (TQ in MT) as per MSHIC Rules			Chemicals Hazards Potential
		Sch-1, Part-II	Sch-2, Part-I	Sch-3, Part-I	
1.	Methanol CAS No: 67-56-1 UN No: 1230	377	---	---	Highly flammable, Exposure to excessive vapor causes eye irritation, head- ache, fatigue and drowsiness. High concentrations can produce central nervous system depression and optic nerve damage.
2.	Dichloromethane CAS No.: 75-09-2 UN No.: 1593	--	---	---	Very hazardous in case of eye contact (irritant), of ingestion, of inhalation. Hazardous in case of skin contact (irritant, permeator). Inflammation of the eye is characterized by redness, watering, and itching.
3.	Iso Propyl alcohol CAS No: 67-63-0 UN No: 1219	334	---	---	Highly flammable, Vapors cause mild irritation of eyes and upper respiratory tract; high concentrations may be anesthetic.
4.	Ethyl acetate CAS No: 141-78-6 UN No: 1173	247	---	---	Hazardous in case of ingestion, of inhalation. Slightly hazardous in case of skin contact (irritant, permeator), of eye contact (irritant).
5.	Sodium Hydroxide CAS No: 1310-730-2 UN No: 1823	571	---	---	Not flammable; Corrosive to metals and tissue. Hazardous.
6.	Caustic Lye CAS No.: 1310-73-2 UN No.: 1824	---	---	---	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).
7.	Hydrochloric acid CAS No: 7647-01-0 UN No: 1789	313	---	---	Inhalation of fumes results in coughing and choking sensation, and irritation of nose and lungs. Liquid causes burns
8.	Sulphuric acid CAS No: 7664-93-9 UN No: 1830	591	---	---	Corrosive to all body tissues. Inhalation of vapor may cause serious lung damage. Contact with eyes may result in total loss

Sr. No.	Raw material	Sr. No & Threshold Quantity (TQ in MT) as per MSHIC Rules			Chemicals Hazards Potential
		Sch-1, Part-II	Sch-2, Part-I	Sch-3, Part-I	
					of vision. Skin contact may produce severe necrosis.
9.	Acetone CAS No. 67-64-1 UN No: 109	4	---	---	Hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation. Slightly hazardous in case of skin contact (permeator).
10.	Toluene CAS No: 108-88-3 UN No: 1294	628	--	---	The substance may be toxic to blood, kidneys, the nervous system, liver, brain, central nervous system (CNS). Repeated or prolonged exposure to the substance can produce target organs damage.
11.	Chloroform CAS No: 67-66-3 UN No: 1888	130	---	---	Toxic by inhalation. Irritating to respiratory system. Exposure to decomposition products may cause a health hazard. Serious effects may be delayed following exposure. Toxic if swallowed. Aspiration hazard if swallowed. Can enter lungs and cause damage. Irritating to skin.
12.	Benzoyl chloride CAS No: 98-88-4 UN No: 1736	65	---	---	A colorless fuming liquid with a pungent odor. Irritating to skin and eyes. Corrosive to metals and tissue.
13.	Hexane CAS No: 110-54-3 UN No: 1208	306	---	---	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, swelling of abdomen, headache, depression.
14.	Nitric Acid CAS No.: 7697-37-2 UN No.: 2031	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 of eyes, mouth and respiratory tract.
15.	Dimethyl formamide CAS No.: 68-12-2 UN No.: 2265	---	---	---	Irritation of eyes, skin and nose. May cause nausea

Note:

- 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)

Table: 7.3 Properties of Hazardous materials

Chemicals	Physical form	BP °C	FP °C	LEL %	UEL %	TLV ppm	LD_{50} mg/Kg or LC_{50} mg/l	Vapour Density	Specific Gravity
Methanol	Liquid	64.5	12	6	36.5	250	LD_{50}: 5628 LC_{50}:64000	1.11	0.7915
Dichloro methane	Liquid	39.75	NA	12	19	50	LD_{50}: 1600 LC_{50}: --	2.93	1.32
Iso Propyl alcohol	Liquid	82.5	18.3	2	12.7	400	LD_{50}: 5045 LC_{50}: --	2.07	0.84
Ethyl acetate	Liquid	77	-4.4	2.2	9	400	LD_{50}: 5620 LC_{50}:16000	3.04	0.902
Sodium hydroxide	Solid	1388	NA	NA	NA	2	NA	NA	2.13
Caustic Lye	Liquid	140	NA	NA	NA	2 mg/m^3	NA	0.62 (Water)	1.53
Hydrochloric acid	Liquid	108.58	NA	NA	NA	5	LD_{50}: 900 LC_{50}: 3124	1.267	1.1
Sulphuric acid	Liquid	270	NA	NA	NA	3	LD_{50}: 2140 LC_{50}: 510	3.4	1.84
Acetone	Liquid	56.2	-20	2.6	12.8	750	LD_{50}: 5800 LC_{50}: 50100	2	0.79
Toluene	Liquid	110.6	4.44	1.1	7.1	300	LD_{50}: 636 LC_{50}: 440	3.1	0.8636
Chloroform	Liquid	61	NA	NA	NA	10	LD_{50}: 695 LC_{50}: 47702	4.36	1.484
Benzoyl chloride	Liquid	198	72	1.2	4.9	1	LD_{50}: 1900 LC_{50}: 1870	4.88	1.211
Hexane	Liquid	69	-26	1.2	7.5	50	LD_{50}: 25000 LC_{50}: 48000	2.97	0.659
Nitric acid	Liquid	121	NA	NA	NA	4	NA	2.5	1.408
Dimethyl formamide	Liquid	153	58	2.2	15.2	10	LD_{50}: 2800 LC_{50}: 15	0.95	2.51
NA= Not Available									

Note:

1. Oral Toxicity (OT) in LD50 (mg/kg)
2. Dermal Toxicity (DT) in LD50 (mg/kg)
3. Inhalation Toxicity in LC50 (mg/l) [4 hrs.]

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

As detailed in the above table out of 14 raw materials stored in bulk, none are listed in Schedule 2 and 3 of MSIHC Rules. None of the raw materials are extremely toxic.

7.4.1 Acute Exposure Guideline Levels (AEGLS)

AEGLs estimate the concentrations at which most people - including sensitive individuals such as old, sick, or very young people - will begin to experience health effects if they are exposed to a hazardous chemical for

a specific length of time (duration). For a given exposure duration, a chemical may have up to three AEGL values, each of which corresponds to a specific tier of health effects. AEGLs of the materials at Reynish are as below.

	10 min	30 min	60 min	4 hr	8 hr	Unit
Methanol (67-56-1)						
AEGL 1	670	670	530	340	270	ppm
AEGL 2	11000*	4000	2100	730	520	ppm
AEGL 3	40000**	14000*	7200*	2400	1600	ppm
Dichloromethane (75-09-2)						
AEGL 1	290	230	200	NR	NR	ppm
AEGL 2	1700	1200	560	100	60	ppm
AEGL 3	12000	8500	6900	4900	2100	ppm
Hydrogen Chloride (7647-01-0)						
AEGL 1	1.8	1.8	1.8	1.8	1.8	ppm
AEGL 2	100	43	22	11	11	ppm
AEGL 3	620	210	100	26	26	ppm
Sulphuric acid (7664-93-9)						
AEGL 1	0.20	0.20	0.20	0.20	0.20	mg/m^3
AEGL 2	8.7	8.7	8.7	8.7	8.7	mg/m^3
AEGL 3	270	200	160	110	93	mg/m^3
Acetone (67-64-1)						
AEGL 1	200	200	200	200	200	ppm
AEGL 2	9300*	4900*	3200*	1400	950	ppm
AEGL 3	**	8600*	5700*	2500	1700	ppm
Toluene(108-88-3)						
AEGL 1	67	67	67	67	67	ppm
AEGL 2	1400	760	560	310	250	ppm
AEGL 3	10000	5200	3700	1800	1400	ppm
Chloroform (67-66-3)						
AEGL 1	NR	NR	NR	NR	NR	ppm
AEGL 2	120	80	64	40	29	ppm
AEGL 3	4000	4000	3200	2000	1600	ppm
Hexane (110-54-3)						
AEGL 1	NR	NR	NR	NR	NR	ppm
AEGL 2	4000	2900	2900	2900	2900	ppm
AEGL 3	12000	8600	8600	8600	8600	ppm
Nitric acid (7697-37-2)						
AEGL 1	0.16	0.16	0.16	0.16	0.16	ppm
AEGL 2	43	30	24	6	3	ppm
AEGL 3	170	120	92	23	11	ppm

NR = Not recommended due to insufficient data
* indicates value is 10-49% of LEL. Safety consideration against explosions must be taken into account.
** indicates value is 50-99% of LEL. Extreme safety consideration against explosions must be taken into account.

- **AEGL-3** is "the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening adverse health effects or death."

- **AEGL-2** is "the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape."
- **AEGL-1** is "the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic no sensory effects."

7.4.2 Emergency Response Planning Guidelines (ERPGs)

ERPGs estimate the concentrations at which most people will begin to experience health effects if they are exposed to a hazardous airborne chemical for 1 hour. (Sensitive members of the public - such as old, sick, or very young people - aren't covered by these guidelines and they may experience adverse effects at concentrations below the ERPG values). ERPGs of the materials at Reynish are as below.

	ERPG-1	ERPG-2	ERPG-3	Unit
Acetic acid	5*	35	250	ppm
Chloroform	NA	50	5000	ppm
Dimethylamine	0.6*	100	350	ppm
Hydrogen Chloride	3*	20	150	ppm
Methanol	200	1000	5000	ppm
Sodium Hydroxide	0.5	5.0	50	mg/m^3
Sulphuric Acid	2	10	120	mg/m^3
Dichloromethane	300	750	4000	ppm
Toluene	50*	300	1000	ppm
*indicates that odor should be detectable near ERPG-1;NA=Not Appropriate				

The 3 *ERPG* tiers are defined as follows:

- **ERPG-3** is "the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects."
- **ERPG-2** is "the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action."
- **ERPG-1** is "the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour

without experiencing other than mild transient health effects or perceiving a clearly defined, objectionable odor."

7.5 QRA APPROACH

Identification of hazards and likely scenarios (based on Level-1 and Level-2 activities) calls for detailed analysis of each scenario for potential of damage, impact area (may vary with weather conditions/wind direction) and safety system in place. Subsequently each incident is classified according to relative risk classifications provided in **Table 7.4.**

Table 7.4: Risk Classification

Stage	Description
High (> 10^{-2}/yr.)	A failure which could reasonably be expected to occur within the expected life time of the plant. Examples of high failure likelihood are process leaks or single instrument or valve failures or a human error which could result in releases of hazardous materials.
Moderate (10^{-2} --10^{-4}/yr.)	A failure or sequence of failures which has a low probability of occurrence within the expected lifetime of the plant. Examples of moderate likelihood are dual instrument or valve failures, combination of instrument failures and human errors, or single failures of small process lines or fittings.
Low (<10^{-4})	A failure or series of failures which have a very low probability of occurrence within the expected lifetime of plant. Examples of 'low' likelihood are multiple instruments or valve failures or multiple human errors, or single spontaneous failures of tanks or process vessels.
Minor Incidents	Impact limited to the local area of the event with potent for 'knock – on- events'
Serious Incident	One that could cause: ❖ Any serious injury or fatality on/off site; ❖ Property damage of $ 1 million offsite or $ 5 million onsite.
Extensive Incident	One that is five or more times worse than a serious incident.

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

7.6 THERMAL HAZARDS

In order to understand the damages produced by various scenarios, it is appropriate to understand the physiological/physical effects of thermal radiation intensities. The thermal radiation due to tank fire usually results in burn on the human body. Furthermore, inanimate objects like equipment, piping, cables, etc. may also be affected and also need to be evaluated for damages. **Table 7.5, Table 7.6** and **Table 7.7**,

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. Thermal hazards have been considered for various scenarios including- Fire in inflammable chemicals storage tanks.

Table 7.5: 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 7.6: 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 7.7: Tolerable Intensities for Various Objects

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

6	Personnel in Emergencies	3 (up to 30 secs.)
7	Plastic Cables	2
8	Stationary Personnel	1.5

7.7 DAMAGE DUE TO EXPLOSION

The explosion of a dust or gas (either as a deflagration or detonation) results in a reaction front moving outwards from the ignition source preceded by a shock wave or pressure front. After the combustible material is consumed the reaction front terminates but the pressure wave continues its outward movement. Blast damage is based on the determination of the peak overpressure resulting from the pressure wave impacting on the object or structure. Damage estimates based on overpressure are given in **Table 7.8** below:

Table 7.8: Damage due to Overpressure

Sr. 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

In Reynish case explosion probability is remote.

7.8 TOXIC RELEASE

Hazardous materials handled and stored in bulk in Reynish complex are hazardous materials (as detailed in **Table 7.1**) as defined in MSHIC rules and indicated in **Table 7.2**. Some of these chemicals are stored in bulk (in tank farm). For toxic release the damage criteria considered is IDLH concentration (if data are available). The Immediately dangerous to life or health air concentration values (IDLH values) developed by the National Institute for Occupational Safety and Health (NIOSH) characterize these high-risk exposure concentrations and conditions and are used as a component of respirator selection criteria first developed in the mid-1970s. IDLH values are established (1) to ensure that the worker

can escape from a given contaminated environment in the event of failure of the respiratory protection equipment and (2) to indicate a maximum level above which only a highly reliable breathing apparatus, providing maximum worker protection, is permitted. IDLH of all the materials stored in bulk at Reynish are as below.

	IDLH Value	Unit
Acetic acid	50	ppm
Acetone	2500	ppm
Chloroform	500	ppm
Dichloromethane	2300	ppm
Dimethylamine	500	ppm
Ethyl Acetate	2000	ppm
Hexane	1100	ppm
Hydrochloric acid	50	ppm
Methanol	6000	ppm
Sodium Hydroxide	10	mg/m^3
Nitric acid	25	ppm
Sulfuric Acid	15	mg/m^3
Isopropyl Alcohol	2000	ppm

7.9 ACID/ALKALI HAZARDS

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

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

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

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

- Double drain valve will be provided to sulphuric acid storage tank.
- Full body protection will be provided to operator.
- Caution note and emergency first aid will be displayed
- All employees will be trained for use of emergency first aid.
- Safety shower and eye wash will be provided in storage tank area and plant area.
- Total close process will be adopted for Sulphuric acid handling.

- Dyke wall will be provided to storage tank
- Tanker unloading procedure will be prepared.
- SOP will be prepared for Hydrochloric acid handling.
- Training programme will be conducted for safe handling and emergency handling of Acids.
- In storage tank area, reaction with water generating fumes should be displayed and avoided.
- Suitable extinguishing media-Extinguish with dry powder/sand. DO NOT USE WATER.

7.10 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 7.9** below:

Table 7.9: Different Failure Scenarios

S. No.	Scenario	Remark
RM-1	Methanol tank BLEVE	Thermal
RM-2	Dichloromethane tank leakage	Toxic
RM-3	Ethyl Acetate tank leakage pool fire	Thermal
RM-4	Acetone tank leakage	Toxic
RM-5	Hydrochloric Acid tank leakage	Toxic

(B) QUANTITATIVE RISK ASSESSMENT & CONSEQUENCE ANALYSIS

7.11 PREAMBLE

In the previous Chapter we have carried out the hazards analysis of the Reynish complex considering various aspects including bulk storages of hazardous chemicals, plant process system, plant incidents/accidents records, critical appraisal and discussion at site for soft spots in the plant etc. Based on the hazards analysis few critical scenarios have been selected for QRA and consequence analysis. QRA quantifies vulnerable zones for a conceived incident with various levels of severity. Consequence calculations for risk assessment are invariably in terms of percentage of fatalities but for emergency handling, fatalities are of no interest saving lives is the main objectives then. The injury criteria have to be agreed in terms of thermal load or toxic concentration versus exposure duration in the first instance.

In consequence calculation, use is made of a number of calculation models to estimate the physical effects of an accident (spill of hazardous material) and to predict the damage (lethality, injury, material destruction and other property damage). The risk assessment modelling can be roughly divided into three groups:

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

7.11.1 Weather Effect

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

7.12 INCIDENTS IMPACTS

The identified failure scenarios **(Table 7.9)** 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 7.10.**

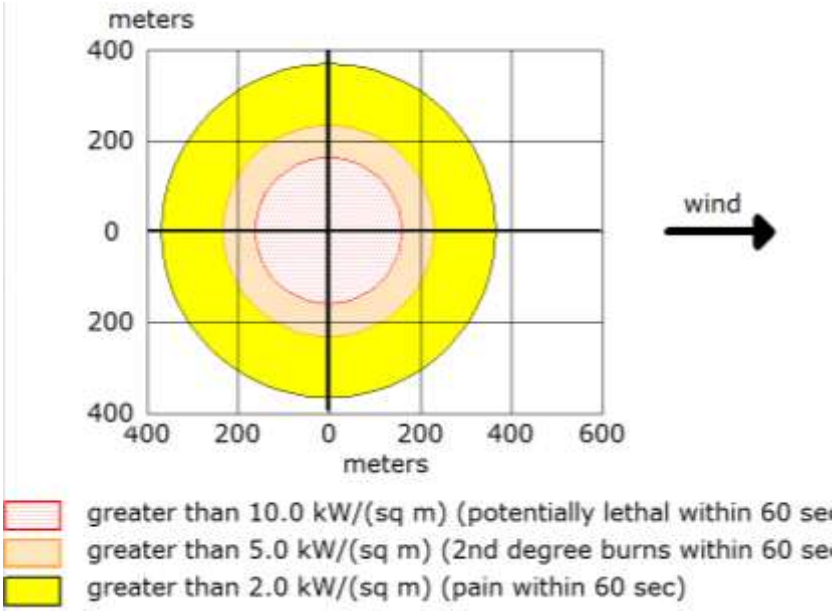

Figure-7.1 Methanol Tank BLEVE — Thermal Impact Zone

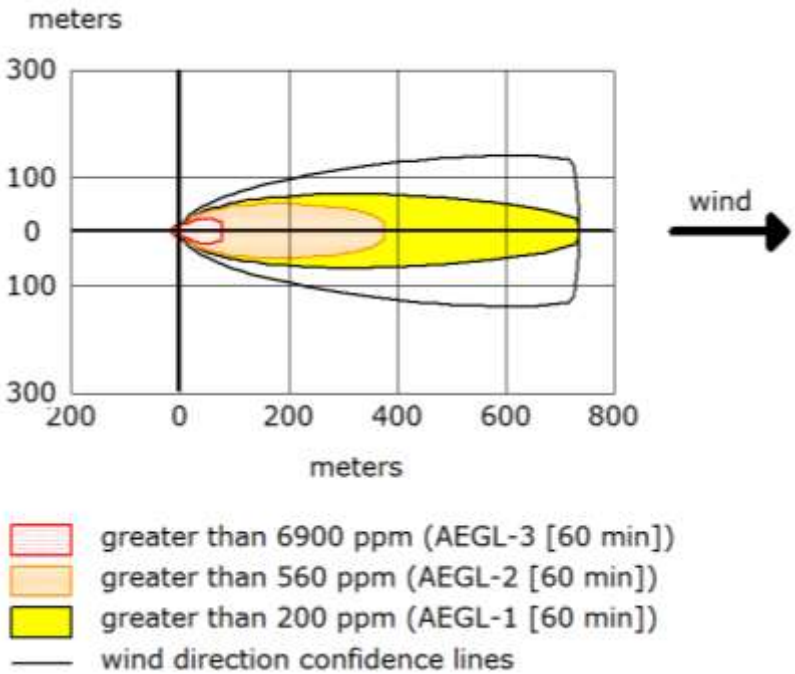

Figure-7.2 Dichloromethane Tank Leakage — Toxic Impact Zone

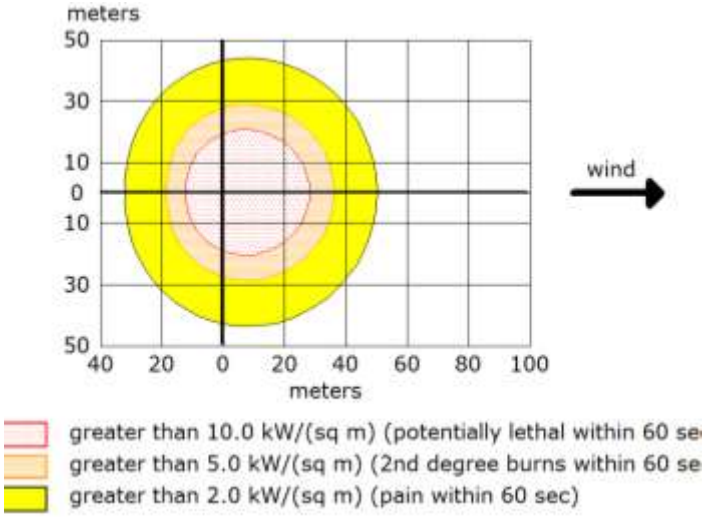

Figure-7.3 Ethyl Acetate Tank Leakage Pool Fire —Thermal Impact Zone

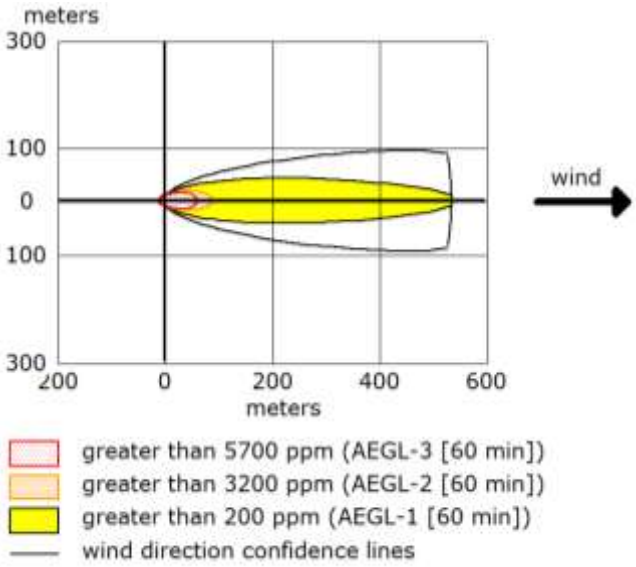

Figure-7.4 Acetone Tank Leakage — Toxic Impact Zone

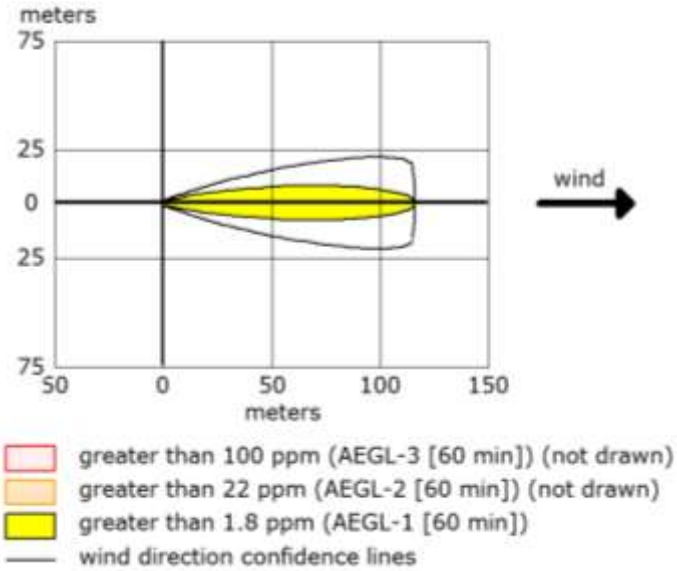

Figure-7.5 Hydrochloric Acid Tank Leakage – Toxic Impact Zone

Table 7.10: Hazards Scenario Impact

Scenario	Impact Zone (m)
Methanol tank BLEVE	Red : 161 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec) Orange: 234 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec) Yellow: 369 meters --- (2.0 kW/(sq m) = pain within 60 sec)
Dichloromethane tank leakage	Red : 79 meters --- (6900 ppm = AEGL-3 [60 min]) Orange: 378 meters --- (560 ppm = AEGL-2 [60 min]) Yellow: 739 meters --- (200 ppm = AEGL-1 [60 min])
Ethyl Acetate tank leakage pool fire	Red : 29 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec) Orange: 37 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec) Yellow: 51 meters --- (2.0 kW/(sq m) = pain within 60 sec)
Acetone tank leakage	Red : 59 meters --- (5700 ppm = AEGL-3 [60 min]) Orange: 88 meters --- (3200 ppm = AEGL-2 [60 min]) Yellow: 536 meters --- (200 ppm = AEGL-1 [60 min])
Hydrochloric Acid tank leakage	Red : 14 meters --- (100 ppm = AEGL-3 [60 min]) Note: Threat zone was not drawn because effects of near-field patchiness make dispersion predictions less reliable for short distances. Orange: 32 meters --- (22 ppm = AEGL-2 [60 min]) Note: Threat zone was not drawn because effects of near-field patchiness make dispersion predictions less reliable for short distances. Yellow: 116 meters --- (1.8 ppm = AEGL-1 [60 min])

7.13 CONSEQUENTIAL IMPACTS

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

7.13.1 Thermal and Explosion Hazards

Incidents involving thermal hazards are mainly due to BLEVE and fire (in tank farms). The impact (1st degree burn due to Methanol tank BLEVE) is limited to ~161 m (i.e. within plant boundary and adjoining premises). However the consequences can go to worse if the incidents lead to domino effect to other tanks.

7.13.2 Toxic Hazards

Toxic hazards are mainly due to Dichloromethane, Acetone, and Hydrochloric Acid tank leakage/spillage. The impact (AEGL-3) is limited to ~79 m (i.e. within plant boundary and adjoining premises). However, their impact can cross the plant boundary and adjoining premises (if not controlled in time).

7.13.3 Other Hazards

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

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

7.13.4 Other Toxic Hazards

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

7.14 OCCUPATIONAL HEALTH

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

Treatment of workers affected by accidental spillage of chemicals

There is wide range of chemicals present in the Chemical plants. The safe cleanup of a chemical spill requires some knowledge of the properties and hazards posed by the chemical & any added dangers posed by the location of the spill. Employees must notify their immediate supervisor of injury by spillage of chemicals or exposure to hazardous materials. All injuries must be reported. Supervisor is responsible for reporting any injuries or occupational illnesses to the management.

Following steps will be immediate taken by the Supervisor.

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

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

- **Chemical Exposure to Skin – Serious:**

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

- **Chemicals in Eyes:**

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

- **Acid Fumes:**

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

- **Chemical Spills:**

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

  Following Steps to be taken for ensuring health and safety of workers engaged in handling of Hazardous materials

  - Identify chemicals to be used, amounts required, condition followed as per the MSDS guideline.
  - Evaluate the hazards posed by the chemicals and the process conditions. The evaluation should cover toxic, physical, reactive, flammable, explosive as well as any other potential hazards posed by the respective chemicals.
  - Select appropriate controls to minimize risk, including use of engineering controls, administrative controls, and personal protective equipment (PPE) to protect workers from hazards. The controls must

ensure that OSHA's Permissible Exposure Limits (PELs) are not exceeded.

- Avoid Underestimation of Risk of handling and its reaction.
- Before working with chemicals, know the facility's policies and procedures for how to handle an accidental spill or fire. Emergency telephone numbers should be posted in a prominent area. Know the location of all safety equipment and the nearest fire alarm and telephone.
- Provide popper Ventilation in the plant/process area.
- Corrosive chemicals that require vented storage should be stored in vented cabinets instead of in a chemical hood.
- Local exhaust ventilation devices should be appropriate to the operations in the plant.
- Chemicals should be separated and stored according to hazard category and compatibility.

Antidotes

Antidotes are used to reduce morbidity and mortality in certain intoxications, but they are unavailable for most toxic agents. Antidotes may reverse or reduce poisonous effects by a variety of means. They may prevent absorption, bind and neutralize poisons directly, antagonize end-organ effects, or inhibit conversion to more toxic metabolites. The antidotes considered to be stored at Reynish and/or supplied to nearest hospital are shown below.

Name of Antidote	Usage
Inj. Avil/ Inj. Dexona	Allergic/Anaphylaxis Reaction
Inj. Bal	Heavy Metal, Mercury, Lead, Arsenic
Inj. Sneak Venom	Sneak Bites
Inj. Adrenalin/ Inj. Atropine	Poisoning
Inj. Deriphyllin	Abnormal Breathing
Inj. Voveran	Pain Relief
Milk of Magnesia	Gastric Problems
T.T	For Tetanus
Calmpose (Diazepam)	Convulsion

7.15 CONCLUSION & RECOMMENDATIONS

The hazard analysis and risk assessment of few possible selected incident scenarios indicates that such incidents mostly are not limited to plant battery limits and have impact on adjoining plants. There are possibilities of domino effect and the secondary scenario not predictable can be worse than the primary one.

Incidents involving thermal hazards are mainly due to BLEVE and fire (in tank farms). The impact (1st degree burn due to Methanol tank BLEVE) is limited to ~161 m (i.e. within plant boundary and adjoining premises). Toxic hazards are mainly due to Dichloromethane, Acetone, and Hydrochloric Acid tank leakage/spillage. The impact (AEGL-3) is limited to ~79 m (i.e. within plant boundary and adjoining premises). The direction of impact will be in down wind direction (wind direction and speed varies with season).

Some of the recommendations for Tank farm storage system are as given below:

- Provision of flame detectors/ thermal sensors at strategic locations in the tank farm area.
- Auto water deluge system on each bulk storage tank for inflammable liquids. The system should automatically start taking signal from flame detectors or thermal relay.
- Fixed foam system with adequate capacity.

Regular 'Hazard Survey' ensures the detection of leakage in the plant. In house 'capability building' to attend hazardous scenarios is to be taken up through mock drills. Train staff in attending such scenarios.

Human Factors: Reynish should have well equipped Toxic and fire handling system and also safety department – safety practices. Human factors role in safety cannot be ignored. Odd hours working and over/long hours work can drain out individual. It shows in lack of efficiency and also the lack of apt attention the modern chemical complex demand.

'Safety' has unique features:

- If no accident has happened so far probability of incident/accident occurring increases.

- 'No accident'/good safety record develops complacency inertia/over confidence in the team. This attitude gives rise to gaps/soft spots in the system giving chances to incidents/accidents.
- Safety requires novelty. Routine training practices get stale with no positive results. Look for novel scheme of training/ safety practices to build up fresh impetus in safety. Involvement of employees with refreshed outlook for safety is to be achieved.

7.16 ACTION PLAN FOR HANDLING & SAFETY SYSTEM OF CHEMICAL

Flammable chemicals will be stored in open area outside the process plant with all the safety measures. Hazardous chemicals will be stored and handle in dispensing room for taking out sample from the container for quality check-up purpose or for the partial use. This activity for Hazardous material handling will be carried out by using all PPEs with proper ventilation & under supervision.

7.16.1 Safety Measures for Transportation and Unloading of Hazardous Chemicals

- Solvent unloading standard procedure will in place and will be implemented for safe unloading of road tanker.
- Static earthing provision will be made for tanker unloading.
- Drum handling trolleys will be used for transportation of drums up to plant and internal handling from storage to process area.
- Display Boards will be provided on all storage tanks which include the name of the chemicals and its major hazardous characteristics.
- Fire extinguishers will be provided as required.
- First aids boxes will also be provided at different places wherever required.
- Water showering system will be provided to the flammable chemicals storage area.
- Area will be declared as "NO SMOKE ZONE".

7.16.2 Safety Measures for Storage/Handling of Hazardous Chemicals

All Hazardous and flammable chemicals will store separately and away from the strong oxidant & kept it in well ventilated room. Adequate firefighting system will be installed. Safety shower and eye washer will be installed near storage area. Flame proof light fitting will be provided at

storage area. Sprinkler system will be installed near storage area. Safety permit system will be followed for loading and unloading. Isolate storage will be provided with wire fencing under lock and key. Caution note, hazardous identification board will be provided. Only authorized person will be permitted in storage area and register will be maintained. "NO SMOKING" board will be displayed and Wind Indicator and siren will be provided.

7.16.3 Safety Measures for Process Units

Safety measures are the most important aspect of selection of process technology to ensure safety in production unit. For the safety in production area some important critical safety measures will be provided within the process technology/equipment itself & will put continue efforts for developing new technology/equipment. Company will ensure such provision in the technology/equipment/machineries at time of purchase. The details of the critical safety measures for process unit are as below; any reaction upsets will be confined to the reaction vessel itself as defined quantity of raw materials will be issued to the reaction vessel by metering pumps/load cells. Process parameters control will be provided as per SOP- Standard Operating Procedures. Materials will be transferred by pumping through pipeline or by vacuum from drums. All reaction vents will be connected to vapor condensers system. Hazardous materials will be transferred by pipelines and in controlled manners. Trained person will be engaged for handling of hazardous materials. Proper safety precautions will be taken during handling of hazardous materials. All solvents and flammable material with required quantity will be charge in reactor by pump or by gravity. All the vessels will be examined periodically by a recognized competent person. All the vessels and equipments will be well earthed appropriately and well protected against Static Electricity. Temperature indicators will be provided near all reactor and distillation systems. Flame proof light fittings will be installed in the plant. All the Plant Personnel will be provided with Personal Protection Equipments to protect against any adverse health effect during operations, leakage, spillages or splash. PPE like Helmets, Safety Shoes and Safety Glasses will be provided to the employees.

7.16.4 Safety Measures for Preventive Maintenance

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

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

7.16.5 Safety measures to prevent spillage/leakage of toxic chemicals

The preventive maintenance will be planned and carried out as per plan to avoid the failure of valve, pipelines and other component of transferring line. The spillage will be confined to the dyke area underneath the vessel. The resultant splash of such chemicals will result in exposure of toxic chemicals to employees. Decontamination facilities (Safety shower and eye wash fountains) will be provided in the plant area, which can be used to decontaminate the affected employees. Suitable decontamination procedure will be used to decontaminate the spilled or leaked material. The SOP for decontamination will be available with all related department.

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

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

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

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

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

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

- Identify the hazards
- Decide who might be harmed and how
- Evaluate the risks and decide on precaution
- Record your findings and implement them
- Review your assessment and update if necessary

Following Information workers should know regarding hazardous chemicals

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

- The contents of the hazardous chemical substances
- Potential source exposure to chemicals

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

(C) DISASTER MANAGEMENT PLAN (DMP)

Disaster/Emergency Management Plan is essential for a chemical plant as the processes adopted for manufacturing are classified under Factory Act as Hazardous due to handling and storage of toxic, flammable and explosive hazardous materials. DMP is proposed here is to meet the extremely adverse situations caused by the various hazardous accident scenarios. Mock drills are to be carried out in association with district authorities. Any weak points observed during the mock drills are to be strengthened.

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

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

Definitions

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

Accident: An accident may be defined as "an undesirable and unplanned event with or without or major damage consequence of life and /or property.

Major Accident: It is a sudden, unexpected, unplanned event resulting from uncontrolled developments during an industrial activity, which causes or has the potential to cause, death or hospitalization to a number of people, damage to environment, evacuation of local population or any combination of above effects.

Emergency: This can be defined as any situation, which presents a threat to safety of person's or/and property. It may require outside help also.

Major Emergency: Occurring at a work is one that may affect several departments within and/or may cause serious injuries, loss of life, extensive damage to properly or serious disruption outside the works. It will require the use of outside resources to handle it effectively.

Disaster: Disaster is a sudden calamitous event, bringing great damage, loss or destruction.

Hazards: Hazard may be defined as "the potential of an accident". Hazard exists in man and the system of materials and machines.

Chemical Hazards: It is a hazard due to chemical(s) (including its storage, process, handling, etc.) and it is realized by fire, explosion, toxicity, corrosively, radiation, etc.

Risk: Risk may be defined as the combination of consequence and probability or likelihood of an accident being caused in a given man-material – machine system.

On-Site Emergency plan: It deals with measures to prevent and control emergencies within the factory and not affecting outside public or environment.

Off-Site Emergency plan: It deals with measures to prevent and control emergencies affecting public and the environment outside the premises.

Objective of the Disaster Management Plan

The DMP document is prepared keeping in view and to confirm the requirements of the provisions of The Factories Act, 1948, Guidelines

issued by the MoEF&CC and MSIHC, 1989 amended in 2000, Schedule 11 under Environmental Protection Act, 1986.

Following are the main objectives of the plan to:

- Defined and assess emergencies, including hazards and risk
- Control and contain incidents.
- Safeguard employees and people in vicinity.
- Minimize damage to property and/or the environment.
- Minimization of risk and impact of event accident.
- Preparation of action plan to handle disasters and to contain damage.
- Inform employees, the general public and the authority about the hazards/risk assessed, & role to be played in the event of emergency.
- Be ready for 'mutual aid' if need arises to help neighbouring unit.
- Inform authorities and mutual aid centres to come for help.
- Effect rescue and treatment of casualties.
- Effective rehabilitation of the affected persons and prevention of damage to the property.
- Secure the safe rehabilitation of affected areas & to restore normalcy.
- Provide authoritative information to the news media.

7.18 ONSITE EMERGENCY PLAN

7.18.1 Incident Controller

Incident Controller's role is to control the emergency at the incident site.

7.18.1.1 Duties of Incident Controller

Incident Controller will proceed to the place of emergency after hearing siren/announcement. He will:

- Assess the scale of emergency and decide if a major emergency exists or is likely, accordingly activate emergency procedure.
- Immediately give his feedback to Emergency Control Centre (ECC) regarding emergency.
- Direct all operations within the area with following priorities.
  - Secure the safety of personnel
  - Minimize damage to plant property and environment.
  - Minimize loss of material.
- Direct rescue and firefighting operations till the arrival of the outside Fire Brigade; he will relinquish control to Sr. Officer of Fire Brigade.

- Ensure that the affected area is searched for causalities.
- Ensure that all non-essential workers in the affected area evacuate to the appropriate assembly point.
- Set up communication point to establish Radio/Telephone/Messenger contact as with emergency control centre.
- Pending arrival of works site controller, assume the duties of the post in particular to:
  - Direct the shutting down and evacuation of plant and areas likely to be threatened by emergency.
  - Ensure that the outside emergency services have been called in.
- Ensure that the key personnel have been called in.
- Report all significant development to the Site Main Controller.
- Provide advice and information, as required to the Senior Officer of the Fire Brigade.
- Preserve evidence that would facilitate any subsequent inquiry into the cause and circumstances of emergency.

Dy. Incident Controller will carry out above said duties in absence of Incident Controller.

7.18.2 Site Main Controller

Site Main Controller will be overall in-charge of emergency organization.

7.18.2.1 Duties of Site Main Controller:

- Relieve the Incident Controller of responsibility of overall main control.
- Co-ordinate ECC or if required, security for raising evacuation siren and also all clear siren, in case emergency is over.
- Declaration of major emergency ensures that outside emergency services will be called and when required nearby firms will be informed.
- Ensure that key personnel will be called in.
- Exercise direct operational control on parts of the works outside the affected area.
- Maintain a speculative continuous review of possible development and assess these to determine most possible cause of events.
- Direct the shutting down and evacuation of plants in consultation with key personnel.

- Ensure causalities are receiving adequate attention; arrange for additional help if required. Ensure relatives are advised.
- Ensure the accounting of personnel.
- Control traffic movement within the work.
- Arrange for a chronological record of the emergency to be maintained.
- During prolonged emergency, arrange for the relief of the personnel and provision of catering facilities.
- Contact the local office to receive early notification of impending changes in weather conditions, in case of prolonged emergency.
- Issue authorized statements to the news media and informs H.O.
- Ensure that proper consideration is given to the preservation of evidence.
- Control rehabilitation of affected areas after control of the emergency.

7.18.3 Other Key Personnel

The key personnel required for taking decision about further action for shutting down the plant, evacuate the personnel, and carry out emergency engineering works in consultation with Site Main Controller in light of the information received. HOD's /Senior Managers/ Section Heads will be responsible for safety, security, fire, gas and pollution control, spillage control, communication system including telephone, wireless etc. Also medical services, transport, engineering, production, technical services, will form part of advising team.

7.18.3.1 Emergency Response Team

The role of Emergency Response Team members is to actually combat the emergency at the site and control the emergency situation and carry out rescue operations. All team members will be thoroughly trained to deal with fires, explosions, chemical spills and atmospheric releases, first aid. As per priority list during emergency, the activities will be carried out as per emergency control plan.

7.18.3.2 Emergency Personnel's Responsibilities outside Normal Working Hours of the Factory.

The duties of Shift In-charge & **team members** have been brought out in emergency control plan. **All team members** after evacuating the area shall report to ECC/Incident Place. The non-essential workers shall be

evacuated from the plants if need arises and this will be determined with the forcible rate with which incident may escalate. Non-essential workers shall assemble at the earmarked/specified point of assembly.

7.18.3.3 Assembly Points

At the proposed plant, at least 2 assembly points will be identified and marked properly.

7.18.4 Emergency Control Centre

It will be headed by Site Main Controller, HOD – PD, HOD- P&A and it is sited in **Office of Site Main Controller in Admin Building & New security office** (after office hours), which is readily accessible & with minimum risk, equipped with telephone facilities and other announcements extra communications facilities needed. It has enough means to receive and transmit information and directions from site main controller to incident controller and other areas. In emergency control centre due to its safer location and advantage of easier accessibility, all necessary personnel protective equipment's fire-fighting extinguishers will be stocked in sufficient quantity.

7.18.4.1 Role of Emergency Control Centre

In case of mishap or accident like fire, toxic gas leakage, explosion in the factory, The Emergency Control Centre will be Office of Head-Operations.

- The plot plan indicating all the activities in the factory premises including storage's utility services, production area, administration, will be kept for ready reference, showing the location of fire hydrant and fire-fighting aids.
- Normal role of employees, work permits, gate entries and documents for head count, employees blood group, other information and addresses will be available.
- Stationery required is available in the Control Centre (ECC) and HOD (P & A) looks after it.
- The requirement of personnel protective equipment and other material, like torches, have been worked out and the quantity required during emergency will be kept in the Control Room (ECC). The responsible person for maintaining the said requirement/inventory will be HOD-HSE.

7.18.5 Fire & Toxicity Control Arrangements

The plant will be well equipped with suitable numbers of fire-fighting and personnel protective equipment. The staff will be trained regularly to handle the various emergency situations.

7.18.6 Medical Arrangements

Availability of first aid facilities in sufficient quantity will be always ensured. In case of emergency arrangements will be made to avail outside medical help immediately.

7.18.7 Transport & Evacuation, Mutual Aid Arrangements

Emergency Transport & Evacuation and Mutual Aid arrangements will be available in the factory.

7.19 COMMUNICATION SYSTEM

7.19.1 Declaring the Emergency

In case of any emergency in the plant, speedy and effective communication of the same to all concerned in least possible time is the most important aspect of any emergency-handling plan. An early communication increases the chances of control of emergency in the bud stage. Blowing siren will be adopted as method of communication of emergency, to all employees in the plant.

7.19.1.1 Type of Sirens

Three different types of sirens have been identified for communication of emergency.

Alert Siren: <u>Single Continuous Siren for One Minute</u>. This indicates that there is some accidental happening in the plant. All have to become alert. Incident controller will be rush to the site of emergency. Plant area people have to start safe shut down. Rescue team and other emergency control teams have to reach at the site of emergency.

Siren for evacuation: <u>wailing & waning siren for three minutes</u>. This siren indicates that emergency is of serious proportion and everybody has to leave his work place. All people having their role in emergency control have to assume their assigned role. All non-essential workers have to proceed immediately to assembly area and wait for further instruction.

All clear siren: Long continuous siren for two minutes. This is a sign of return of normalcy. On hearing this siren everybody should go back to his or her respective workplace.

7.19.1.2 Location of Siren

Siren will be located in centre of the pant for wide coverage of the whole campus. Switch for siren will be provided at security gate. The switch at Security gate should be operated only as a general rule.

Emergency manual call bell will be installed which will be used in case of total failure of electricity. It is responsibility of HOD (HSE) to maintain the upkeep of electric call bell and HOD- Security and administration to maintain manual and Hand operated siren.

7.19.1.3 Raising Alarm

Any person noticing any emergency situation in the plant should immediately call security gate with following information:

- Identify oneself
- State briefly the type of emergency i.e. whether fire, explosion, toxic gas release etc.
- Give the location of the incident
- Estimated severity of the incident

Security personnel after ensuring genuineness of the call shall raise the ALERT SIREN. At the same time, he will also contact the incident controller and ECC in order and inform about the incident. He will keep the gate open and rush his two security personnel at the site of emergency with appropriate PPEs. ECC will be located at the office of Head-Operations on normal working hours and at Security gate after normal working hours (during night). ECC shall be immediately manned on hearing alert siren. If the authorized people to handle ECC are not available, any senior most people out of the available person nearby shall occupy ECC till authorized person comes. Incident controller, on hearing alert siren or by any other way of information of the emergency, will immediately reach at the site of incident and assess the situation. He will immediately give his feed back to ECC. ECC shall direct security gate to raise evacuation siren, if the need arise. SIREN FOR EVACUATION shall be raised on instruction from Site Main Controller or any Manager of the

plant in the ECC. Security gate person will be authorized to raise ALL CLEAR SIREN on instruction from Site Main Controller or ECC, after the emergency is over.

7.19.2 Internal Communication

It shall be responsibility of ECC to communicate to all employees in the plant. They may take help of telephone operator for such communication. However, telephone operator can directly communicate information about emergency to all internal departments, if such message comes from incident controller or site main controller. Telephone operator will continue to operate the switchboard advising the callers that staffs are not available and pass all calls connected with the incident to ECC.

7.19.2.1 Availability of Key Personnel outside Normal Working Hours

The details of key personnel availability after working hours will be made available at Security Gate, ECC, telephone operator as well as production units. Security personnel shall call required key personnel from their residence in case emergency occurs outside normal working hours. Availability of emergency vehicle/Ambulance will be ensured to fetch the key personnel residing outside. It will be the responsibility of HOD (P & A) to maintain it.

To the Outside Emergency Services

Decision to call outside help to deal with emergency like fire brigade, ambulance, police, etc., shall be taken by Site Main Controller. However, in absence of Site Main Controller, if the incident controller realizes the situation going out of control, he may ask for immediate help from outside. ECC will be responsible for calling help from outside. A list of emergency services available in the area with their telephone numbers will be provided at ECC, at Security gate and with telephone operator. Facilities such as phones, emergency vehicle, and security personnel will be available to help calling outside emergency services and authorities.

7.19.3 Communication to the Authorities

The emergency will be immediately communicated to the government officers and other authorities such as SPCB, police, district emergency authority, Factory Inspectorate, hospital etc. by Emergency Control Centre.

Communication to Neighboring Firms & the General Public

In case of emergency having its outside impact, public will be cautioned regarding the same. Co-ordination of police will be sought for speedy action. This is to be ensured by ECC.

7.20 Pre-emergency activities

Internal Safety survey with regard to identification of hazards, availability of protective equipment's, checking for proper installation of safety devices will be carried out periodically.

- Periodic pressure testing of equipment
- Periodic pressure testing of lines
- Periodic safety/relief valve testing
- Periodic fire hydrant system testing
- Mock drill to check up level of confidence, extent of preparedness of personnel to face emergency is being contemplated
- Regular training is being imparted to all personnel to create awareness
- Adequate safety equipment will be made available
- Periodic check-up of emergency lights
- Safer assembly points will be identified
- Storage of adequate first aid treatment facilities

7.21 POST-EMERGENCY ACTIVITIES

Following post emergency actions will be carried out to study in detail and preventive measures to be taken

- Collection of records
- Inquiries
- Insurance claims
- Preparation of reports comprising suggestion and modification
- Rehabilitation of affected personnel
- Normalization of plant

7.21.1 Evacuation and Transportation

In case of emergency, evacuation and transportation of non-essential workers will be carried out immediately. The affected personnel will be transported for medical aid.

7.21.2 Safe Close Down

During emergency plant shut down will be carried out if situation warrants. This will be as per the instruction of site main controller under guidance of incident controller.

7.21.3 Use of Mutual Aid

Mutual aid agreement with nearby industries will be ensures to provide help to each other in the emergency,

7.21.4 Use of External Authorities

As and when necessary, statutory authorities, police, pollution control personnel, medical aid/center, ambulance etc. will be contacted.

7.21.5 Medical Treatment

The affected personnel will be brought to safer place immediately to give them first aid. Immediate medical attention will be sought.

7.21.6 Accounting for Personnel

Proper accounting for personnel will be laid down in all the shifts. The number of persons present inside the plant premises, their duty etc. will be available with the P & A. This record will be regularly updated.

7.21.7 Access to Records

The relatives of affected personnel will be informed. The details regarding all employees will be made available to Administration building.

7.21.8 Public Relations

In case of emergency, Manager P & A will be available for official release of information pertaining to the incident.

7.21.9 Rehabilitation

The affected area will be cleared from emergency activities only after positive ascertaining of the system in all respects. The entry to affected area will have to be restricted until statutory authorities visit and inspect the spot of incident. The site main controller will be in charge of the activities to be undertaken. The plan will cover emergencies, which can be brought under control by the works with the help of emergency team/fire services. The DISASTER CONTROL PLAN for gas leak and fire will be prepared for entire factory.

7.22 CAUSES OF EMERGENCY

7.22.1 Risk

7.22.1.1 Nature

In the plant, the nature of dangerous events could be of the following:

- Fire : Chemical/Electrical
- Toxic Release : From chemicals
- Leakages : Equipment, pipelines, valves, etc.
- Improper handling of products (raw materials/finished products)
- Large spillage to ground floors resulting in pollution & fire.
- Failures of Equipment/Instruments.
- Release of safety valves or ruptures of vessels due to excessive pressures.

7.22.1.2 Various Emergency Actions

a) Onsite

- Safe shut down of the plant and utilities
- Emergency control measures.
- To attempt with the help of trained crew in firefighting to contain the fire spread up/gas emission and limit within limited space.
- To cut off source of oxygen by use of firefighting appliances.
- Cut off fall sources of ignition like electrical gadgets.
- To protect fire prone area from the fire.
- To remove material which can catch fire.
- Evacuation of non-essential persons.

b) Medical Facilities/Treatment

- The Plant will have a Health centre which is manned with trained male nurse on continuous basis who can render medical first aid. Doctor will visit two times a week for two hour each time.
- Depending on seriousness the injured person shall be shifted to any other hospital.
- Vehicle will be available round the clock for transportation. Ambulance will be also made available in the campus on regular basis.

c) In the event of Fatal Accidents

The information shall be given to following authorities:

- Inspector of Police

- Inspector of Factories
- Mamlatdar
- Corporate Office
- Regd. Office
- Insurance the plant
- Regional Officer, SPCB

d) Emergency Siren

Emergency siren shall be blown for announcing the emergency which shall have different sound for identification/differentiation than the normally used for commencement of factory working etc.

- Location of Siren Above Plant
- Type of Siren Industrial Siren
- Position of siren switch Located at Main Gate

e) Seeking help from neighboring industries/sources for fire engine

f) Advise for vacation of other areas

- Since the effect of fire/gas emission shall be contained within the area of the plant advice of vacation of other areas is not necessary.

7.22.1.3 Response Time-Minutes

Hazard	Fire Fighting	Police	Medical Services
Fire & Explosion	Immediate with whatever facilities available with the plant	10 min.	10 minutes
	External Help within 15 minutes		

7.23 OFF-SITE EMERGENCY PLAN

7.23.1 Need of the Site Emergency Plan

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

A purpose of the off-site emergency plan is:

- To provide the local/district authorities, police, fire, brigade, doctors, surrounding industries and public the basic information of risk and environmental impact assessment and appraise them of the

consequences and the protection/prevention measures and to seek their help to communicate with public in case of major emergency.

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

7.23.2 Structure of the Off-Site Emergency Plan

Available with concerned authorities.

7.23.3 Role of the Factory Management

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

7.23.4 Role of Emergency Co-ordination Office (ECO)

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

7.23.5 Role of Local Authority

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

7.23.6 Role of Fire Authorities

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

7.23.7 Role of the Police and Evacuation Authorities

Senior Police Officer designated, as emergency co-ordination officer shall take over all control of an emergency. The duties include protection of life, property and control of traffic movement. Their functions include controlling standards, evacuating public and identifying dead and dealing with casualties and informing relatives of dead or injured. There may be separate authorities/agencies to carry out evacuation and transportation work. Evacuation depends upon the nature of accident, in case of fire only neighboring localities shall be alerted. Whole areas have to be evacuated in case of toxic release.

7.23.8 Role of Health Authorities

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

7.23.9 Role of Mutual Aid Agencies

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

7.23.10 Role of Factory Inspectorate

In the event of an accident, the Factory Inspector will assist the District Emergency Authority for information and helping in getting Neighbouring Industries/mutual aid from surrounding factories. Factory Inspector may wish to ensure that the affected areas are rehabilitated safely.

7.24 MOCK DRILLS AND RECORDS

7.24.1 Need of Rehearsal & Training

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

7.24.2 Some Check Points

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

7.24.3 Records and Updating the Plan

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

(D) PUBLIC CONSULTATION

The public hearing was conducted by GPCB on 18.10.2019 on the basis of the draft EIA/EMP incorporating the Terms of References. Point raised during the public hearing by participants is summarized below with reply/action taken by project proponent.

Table 7.11 Points raised during public hearing

Statement of issues raised by the public and response of the project proponent with action plan is as follows.					
Sr. No.	**Name and Address**	**Point Represented**	**Reply from Project Proponent**	**Time Bound Action Plan proposed**	**Budgetary provision**
1.	Shri Chauhan Javed Vill. Dabhasa Ta. Padra	• It was informed that local people of an area are poor and are in dire need of employment and therefore establishment of an industry in an area is welcome. He subsequently, inquired to know about the employment creation.	• Representative of project proponent, Dr. Mahendrabhai Sadaria informed that local residents of village : Dabhasa would be given preference and then to an area covered within 10 km. Total manpower requirements would be 65. He further informed that only in case of non-availability of the requisite qualified persons; outsider would be considered over local people.	Appointment office staff/ skill/unskilled employs start during construction and operational phase	--
2.	Shri Deval Patel Vill. Padra Ta. Padra	• He inquired to know the expected benefits to the society due to social activities by industry.	• Representative of project proponent, Dr. Mahendrabhai Sadaria briefed about the various six activities that would be considered under their CER activities over the five years with a budgetary provisions of Rs. 100 Lakhs. He further informed that any suggestions from the local people or from the local district administration would be positively considered and	CER activities Immediately start before starting of construction activities of project	Rs.100 Lakh earmark for CER activities

			will be accommodated.		
3	Shri Ketal Patel Vill. Dabhasa Ta. Padra	• He inquired to know the management plan for the air pollution control.	• Representative of project proponent, Dr. Mahendrabhai Sadaria informed that coal is proposed to be used as a fuel and therefore cyclone and bag filter with the adequate stack height is proposed to be provided for the air pollution control whereas water and alkali scrubber is proposed to be provided for the process gas emission and exhausted scrubbing media will be reused / sold to the authorized actual users. He further informed that APCMs would be operated judiciously without any flexibility.	Immediately with Plant operation	Rs. 32 Lakh as capital investment and Rs.5.0 Lakh/Year as recurring cost for installation and operating APCM for Air Pollution Control
4	Shri Bhupendrasinh Mohansinh Mahida Vill. Chokari – Sarpanch, Ta. Padra	• He quoted that industry is to spend about 2% as per the legal requirements for the CSR and demanded that such amount shall be spent in an area where industries are not located. • He also demanded to give preference to local people for the employment who are residing within 10 km radius.	• Representative of project proponent, Dr. Mahendrabhai Sadaria welcomed the suggestion about the amount of CSR to be spent as well as that of employment to the local people. He further added that adequate care would be taken while implementation.	CER activities Immediately start before starting of construction activities of project	Rs.100 Lakh earmark for CER activities
5	Shri Manojbhai Patel, Vill. Abhor – Sarpanch, Ta. Padra.	• He opined that industry shall strive to use agro based fuel being generated from the local farmers in lieu of proposed fuel of coal which may not only reduce the air pollution but would	• Representative of project proponent, Dr. Mahendrabhai Sadaria welcomed the suggestion and recommended to plan a briquette manufacturing plant for their agro waste being	CER activities Immediately start before starting of construction activities of project	Rs.100 Lakh earmark for CER activities

		in turn also support the local farmers in revenue generation and will result into building up of inter relationship. He informed that sister concern unit Lakshya Group is carrying out good CSR activities and opined that such action will further support the farmers of an area where there are no industries.	generated from an area. He further informed that final EIA report would be submitted with agro briquette as an alternate fuel to proposed fuel of coal.		
6	Shri Dhanajibhai Ratanabhai Padhiyar Vill. Ekalbara, Member – Gram Panchayat Ta. Padra	• He inquired to know the waste water management plan and also demanded to provide preference to local for employment.	• Representative of project proponent, Dr. Mahendrabhai Sadaria once again explained the waste water treatment scheme that was already shown during presentation and informed that industry will aim at resource conservation, will reuse the treated waste water and will maintain ZLD. It was further informed that deserving local people will be given preference for the employment based on the requirements.	Immediately with Plant operation	Rs.141 Lakh as capital investment and Rs.95 Lakh/Year as recurring cost for installation and operating wastewater treatment
7	Shri Jhahirkhan Pathan Vill. Ranu Ta. Padra	• He quoted that he has provided employment to around 10 – 12 local people even though running a very small business and therefore the estimated employment of 65 persons seems very less for an industry and therefore has an objection. • He further inquired to know about the steps proposed to be taken by the	• Representative of project proponent, Dr. Mahendrabhai Sadaria informed that requirements of manpower are a proprietary decision of an industry based on their requirements and cannot be compared. • With regard to foul smell, he further informed that it is proposed to provide alkali	Immediately with Plant operation	Rs. 32 Lakh as capital investment and Rs.5.0 Lakh/Year as recurring cost for installation and operating APCM for Air Pollution Control

		industry for the control of foul smell being pharmaceutical industry.	scrubber for the scrubbing of the process emission. Further opined that, though industry is committed for the control of pollution Additionally, general awareness would also not allow industry to be non-compliant.		

(E) Social Impact Assessment

Reynish Pharmachem Pvt. Ltd. is a green field project, proposes to set up bulk drugs manufacturing unit. Total production capacity of all products will be tune around 50 MT/month. There will be no Rehabilitation & Resettlement (R&R) involved. However, preference will be given to local people for employment and contribute to improve the physical infrastructure in vicinity of plant. Detailed Social Impact Assessment (SIA) study is given below:

Introduction

Corporate Environmental Responsibility (CER) refers to a company's duties to withdraw from damaging natural environments. The term derives from Corporate Social Responsibility (CSR). Also can be referred as corporate initiative to assess and take responsibility for the company's effects on the environment and impact on social welfare. The term generally applies to companies efforts that go beyond what may be required by regulators or environmental protection groups.

CSR is a way of conducting business, by which corporate entities visibly contribute to the social good. Socially responsible companies do not limit themselves to using resources to engage in activities that increase only their profits. They use CSR to integrate economic, environmental and social objectives with the company's operations and growth.

Corporate Social Responsibility is not a new concept in India, however, the Ministry of Corporate Affairs, Government of India has recently notified the Section 135 of the Companies Act, 2013 along with Companies (Corporate Social Responsibility Policy) Rules, 2014 "hereinafter CSR Rules" and other notifications related thereto which

makes it mandatory (with effect from 1st April, 2014) for certain companies who fulfill the criteria as mentioned under Sub Section 1 of Section 135 to comply with the provisions relevant to Corporate Social Responsibility. CSR is generally understood as being the way through which a company achieves a balance of economic, environmental and social imperatives ("Triple-Bottom-Line- Approach"), while at the same time addressing the expectations of shareholders and stakeholders. The term "Corporate Social Responsibility (CSR)" can be referred as corporate initiative to assess and take responsibility for the company's effects on the environment and impact on social welfare. The term generally applies to companies efforts that go beyond what may be required by regulators or environmental protection groups.

Purpose of the CER/CSR

Corporate Environment/ social responsibility (CSR) is a broad term used to describe a company's efforts to improve society in some way. These efforts can range from donating money to non-profits to implementing environmentally-friendly policies in the workplace. The group's CSR activities are rooted in the knowledge that businesses have a duty to enable all living beings to get a fair share of the planet's resources. Businesses are powerful constituents of society and the most successful, respected, and desirable businesses exist to do much more than make money; they exist to use the power of business to solve social and environmental problems. Unit will involve in a community development and environment preservation projects. Social activities relate to health, primary education, skills training and entrepreneurship, livelihoods and women empowerment.

Objective of the study

The main objectives are as follows:

1. To assess the impact of the project on agricultural situation;
2. To examine the impact of the project on pattern of demand;
3. To assess the in impact of the project on consumption pattern;
4. To examine employment and income effects of the project;
5. To explore the possibility of local industrialization as an offshoot of the Project;

6. To examine the effect of the project on education status of the people in the study area; and
7. To judge peoples' perception regarding the project

Survey Methodology

The survey aims to document the living conditions, level of socio-economic development of the region and the socioeconomic profile of people in the core and buffer zones of the proposed project area. The survey was organized to collect information on socio-economic variables at the village level as well as household level. The village level data are collected from revenue offices, Panchayat office; Censuses while the household level data are collected through questionnaire method. The agreed methodology has been followed with the tools of SIA. The following strategies were adopted for undertaking the study.

Consultation with Representatives of focus area

Close coordination was maintained with concerned Public Representative's Offices, Local representatives and common village people. Assessment of the area was made by industry representative along with Team of M/s San Envirotech Pvt. Ltd.

Assessment of studied area

Pre-contract field visit was conducted with assessment of the area and people interacting with concerned employees and few opinion leaders of the area. This visit facilitated the strategic plan to complete the study in stipulated time.

Focus Group Discussion:

A guiding principle was developed to conduct focused group discussion with different categories of people of the studied villages.

Study of Village Profile

This study includes village level survey of Population, Economics, Land use Pattern, Employment pattern, Healthcare Facilities, Amenities for Livelihood. This primary data is statistically validated and the statistical differences and is interpreted in the light of economic impacts.

Sources of Information

As per the scope of present study, the information on the sociological aspects like demography, human settlements, social aspects like SC & ST

population, literacy levels and economic aspects like occupational structure of workers has been gathered and complied from secondary sources viz. the District Census Statistical Handbook, 2011 for Vadodara District as these documents being comprehensive and authentic.

Socio Economic Survey within study area:

1) **Educational facility**

Literacy is an important indicator for understanding the socio-economic development of any area. Many villages of the study area have no proper education facility and literacy rate is very low especially women. Overall literacy ratio in the study area is 70.41%. The male literacy in the study area is found to be 52.16% and the female literacy in the study area is found to be 47.84%. However, the difference in literacy rate between male and female is found be much wider. The overall study indicates that the literacy rate in female population is low which can be attributed to the social structure prevailing in the villages and traditional family trends. The educational facilities in the study area are good due to the presence of good infrastructure for basic education like primary schools and high schools for higher education.

As per 2011 census, there are primary school in all 53 villages, 31 Pre-primary school, 50 Secondary schools, 34 Senior Secondary schools, and 27 Arts, Science and Commerce College.

Area is an industrial zone and skilled manpower is essential. Unit will contribute to start give contribution in terms of stipend to unskilled employs for vocational training or join hands with other industrial group to start training institute.

2) **Drinking water and Sanitation Facilities**

All the 53 villages in the study area have two or more sources of drinking water. Most of the villages have tube well water supply in addition to Tap water. Moreover, all villages have facility of well water and some villages have hand pump, river & tank water, tube well or other facilities for water. Unit proposed to provide drinking water facility in nearby 2 villages where quality of potable water is poor. Unit will contribute fund towards storage of drinking water facility at selected villages.

3) **Health & Family welfare**

In the study area, there are 7 primary health centers, 17 primary health sub-centers. There is no any Employees' State Insurance (ESI) Hospital within the study area. Based on above study, it is concluded that heath and family welfare facility found good in the study area. However unit will arrange 2-3 health checkup camp during monsoon and provide fee medicines.

4) **Women Empowerment activities**

In some cases, women bear larger losses in terms of educational attainment, employment and wages. In terms of employment, which is a major determinant of livelihood, Vadodara rural talukas shows lower than state average in Worker Participation Rates (WPR). There is distinct Gender disparity in WPR across all talukas, with women substantially under-represented in main workers category. Thus, unit proposes to provide education and training to engage more women in employment opportunities.

Need Analysis of the Target Beneficiaries in the Project Area

Various needs were identified during the baseline survey within the study area. Major problems they are facing are given below.

- Poor availability of water for irrigation and drinking purpose
- Lack of good medical facilities
- Unemployment
- Health and sanitation program
- Poor educational facilities

In the assessment of socio-economic conditions, few indicators were identified for further attention and strategic planning as given below:

Target Project Area

Total 53 villages fall within the study area; Out of which unit will give priorities to 2 villages namely Dabhasa and Dhobikuwa for CER activities according to the below mentioned criteria.

- Largely affected by industrial growth
- Vicinity to the project site
- Sourcing of employees from these areas
- Low level socio-economic status of the people

- Lack of adequate intervention of voluntary organization in the area

The focus area of comprehensive program includes: health, education, sanitation, sustainable livelihood & infrastructure development.

Details of expenditure for ESR activities:

Cost of the proposed project : Rs. 40 Crores

Expenditure earmarked towards ESR : Rs. 1.0 Crore

(2.5% of the total project cost)

Table 7.12 Detailed expenditure break-up for CER activities

Sr. No.	Activities	Years (Rs. in lakhs)			Total Budget (Rs. in Lakhs)
		1st	2nd	3rd	
1	Educational activities including distribution of text books/stationary and educational scholarship to selected student of surrounding villages	10	10	10	**30.0**
2	Technology support for Agro Briquette manufacturing by Farmers and small entrepreneurs who proposed to start Agro Briquette from agriculture waste.	7	7	7	**21.0**
3	Health camp and free medicine provide to surrounding villagers during monsoon.	7.5	7.5	7.5	**22.5**
4	Women Empowerment to providing sawing machine and embroidery machine	3	3	3	**9.0**
5	Ground water recharging and rain water harvesting	6	6	6	**18.0**
	Total	**16.5**	**16.5**	**16.5**	**100.5**