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 plant layout & 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.

7.2 RISK ASSESSMENT-Identification of Hazards

A three 'levels' risk assessment approach has been adopted for **M/s. Meghmani Industries Ltd. (Unit-V)** (Henceforth **Meghmani Industries**) facilities. Meghmani Industries proposes Manufacturing of Technical Pesticide & Pesticide Intermediates at Plot No. 42/5, GIDC Estate-Dahej, Tehsil: Vagra, Dist. Bharuch. Total production capacity of all products will be 4050 MT/month [(Technical Pesticide – 2900 MTPM & Pesticide Intermediates – 1150 MTPM)].

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 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. Proposed project of Meghmani Industries is hazardous in nature. The QRA for this plant is based on Level 1 and Level 2. **Table 2.2** in Chapter 2 gives the list of products (and their monthly production capacity) to be manufactured in the proposed project. Table below gives the bulk storages of liquid and gaseous raw materials and their consumption.

7.3 HAZARDOUS MATERIALS STORAGE

The solid raw materials will be received in bags or drums and will be stored in chemicals godowns. The products (liquid or solid) will be packed in bags or drums and stored in product godowns as per market demand. The solid products 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 products which are volatile material. The liquid products will be packed in drums (50 litres, 100 litres or 200 litres drums). The bulk storages of liquid hazardous materials are given in the **Table 7.1** below:

Table 7.1: Bulk Storage of Hazardous Chemicals

Sr. No.	Hazardous Chemical	State (Solid/ Liquid/Gas)	Stored in	Storage (MT)
1	Chlorine	Gas	20*0.9 Cylinder	180
2	Toluene	Liquid	Tank (UG)	32
3	Hexane	Liquid	Tank (UG)	25
4	EDC	Liquid	Tank (UG)	32
5	Methanol	Liquid	Tank (UG)	25
6	Solvent C9	Liquid	Tank (UG)	30
7	Bromine	Liquid	Bottle (4 Kg x 100)	0.4
8	Dichloroethane	Liquid	Drum (200 Kg x 10)	2.0
9	DMF	Liquid	Drum (200 Kg x 25)	5.0
10	EDC	Liquid	Drum (200 Kg x 25)	5.0
11	Ethyl Acetate	Liquid	Drum (200 Kg x 25)	5.0
12	IPA	Liquid	Drum (200 Kg x 25)	5.0
13	Nitric Acid	Liquid	Drum (200 Kg x 10)	2.0
14	Sulfuric acid	Liquid	Tank (GL)	20
15	Hydrochloric Acid	Liquid	Tank (GL)	20
16	NaOH	Liquid	Tank (GL)	20

7.4 RISK SCREENING APPROACH

Risk screening of Meghmani Industries plant was undertaken through process study and study of data/information provided by Meghmani Industries. 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. The chemicals stored in bulk (liquid or gaseous) and defined under MSIHC Rule will be considered for detailed analysis. Meghmani Industries will be using large numbers of raw materials but few of them are stored in bulk. The raw materials stored in bulk and coming under hazardous category as specified by MSIHC Rules, 1989 (including subsequent amendments) and their properties are given in **Table 7.2** below:

Table 7.2 (a) Hazard Analysis- Raw materials

Sr. No.	Raw material	Sr. No & Threshold Quantity (in MT) as per MSHIC Rules			Chemicals Hazards Potential
		Sch-1, Part-II	Sch-2, Part-I	Sch-3, Part-I	
1.	Chlorine CAS No:7782-50-5 UN No: 1017	119	5 TQ1: 10 MT TQ2: 25 MT	108 TQ1: 10 MT TQ2: 25 MT	Poisonous; may be fatal if inhaled. Contact may cause burns to skin and eyes. Bronchitis or chronic lung conditions.

2.	Toluene CAS No: 108-88-3 UN No: 1294	628	---	---	Hazardous in case of skin contact (irritant), eye contact (irritant), ingestion, inhalation. Slightly hazardous in case of skin contact (permeator).
3.	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.
4.	EDC (Ethylene Dichloride) CAS No: 107-06-2 UN No: 1184	---	---	---	Highly flammable. Slightly water soluble. Inhalation of vapors causes nausea, drunkenness, depression. Contact of liquid with eyes may produce corneal injury. Prolonged contact with skin may cause a burn.
5.	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.
6.	Bromine CAS No: 7726-95-6 UN No: 1744	84	---	106 TQ1: 40 MT	Non-combustible, corrosive, inhalation, ingestion or skin contact with material may cause severe injury or death. Contact with molten substance may cause severe burns to skin and eyes. Avoid any skin contact. Effects of contact or inhalation may be delayed. Fire may produce irritating, corrosive and/or toxic gases.
7.	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.
8.	Dimethyl Formamide CAS No.: 68-12-2 UN No.: 2265	---	---	---	Irritation of eyes, skin and nose. May cause nausea
9.	Ethylene Di Chloride CAS No.: 107-06-2 UN No.: 1184	308	---	---	Extremely hazardous in case of ingestion. Very hazardous in case of inhalation. Hazardous in case of skin contact. Corrosive to skin and eyes on contact. Liquid/spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth & respiratory tract. Inhalation of spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath. Inflammation of eye is characterized by redness, watering, itching.
10.	Ethyl acetate CAS No: 141-78-6 UN No: 1173	247	---	---	Flammable, Headache, irritation of respiratory passages and eyes, dizziness and nausea, weakness, loss of consciousness.
11.	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.
12.	Nitric Acid CAS No.: 7697-37-2	423	---	--	Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye

	UN No.: 2031				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.
13.	Sodium hydroxide CAS No:1310-73-2 UN No: 1823	571	---	---	Corrosive, toxic, non-combustible. INHALATION: Dust may cause damage to upper respiratory tract and lung itself, producing from mild nose irritation to pneumonitis. INGESTION: Severe damage to mucous membranes; severe scar formation or perforation may occur.
14.	Hydrochloric acid CAS No: 7647-01-0 UN No: 1789	313	---	---	Not Flammable; Inhalation of fumes results in coughing and choking sensation, and irritation of nose and lungs. Liquid causes burns.
15.	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 of vision. Skin contact may produce severe necrosis. Fatal amount for adult: between 1 teaspoonful and one-half ounce of conc. chemical.

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 7.2 (b) Properties of Raw 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
Chlorine	Liquid	100	NA	NA	NA	NA	NA	0.62	1
Toluene	Liquid	110.6	4.44	1.1	7.1	300	LD_{50}: 636 LC_{50}: 440	3.1	0.8636
Hexane	Liquid	69	-26	1.2	7.5	50	LD_{50}: 25000 LC_{50}: 48000	2.97	0.659
EDC	Liquid	85	13	6.2	15.9	5	LD_{50}: 500 LC_{50}: 5100	3.4	1.250
Methanol	Liquid	64.5	12	6	36.5	250	LD_{50}: 5628 LC_{50}: 64000	1.11	0.7915
Bromine	Liquid	58.78	NA	NA	NA	0.2	LD_{50}: 2600 LC_{50}: 750	7.1	3.11
Dichloro methane	Liquid	39.75	NA	12	19	50	LD_{50}: 1600 LC_{50}: --	2.93	1.32
Dimethyl formamide	Liquid	153	58	2.2	15.2	10	LD_{50}: 2800 LC_{50}: 15	0.95	2.51
EDC	Liquid	83.5	13	6.2	15.6	300	LD_{50}: 2800 LC_{50}: 1414.2	3.42	1.2351
Ethyl acetate	Liquid	77	-4.4	2.2	9	400	LD_{50}: 5620 LC_{50}:16000	3.04	0.902
IPA	Liquid	82.5	18.3	2	12.7	400	LD_{50}: 5045 LC_{50}: --	2.07	0.84
Nitric acid	Liquid	121	NA	NA	NA	4	NA	2.5	1.408
Sodium hydroxide	Solid	1388	NA	NA	NA	2	NA	NA	2.13
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
NA= Not Available									

Note:

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

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

Summary: 15 raw materials are listed under "List of hazardous and Toxic Chemicals" category under MSIHC Rules, 1989 (including subsequent amendments). Chlorine and Bromine are listed under Sch 2 and 3 of MSIHC Rules.

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 Meghmani Industries are as below.

- **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."

	10 min	30 min	60 min	4 hr	8 hr	Unit
Chlorine (7782-50-5)						
AEGL 1	0.5	0.5	0.5	0.5	0.5	ppm
AEGL 2	2.8	2.8	2	1	0.71	ppm
AEGL 3	50	28	20	10	7.1	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
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
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
Bromine (7726-95-6)						
AEGL 1	0.033	0.033	0.033	0.033	0.033	ppm
AEGL 2	0.55	0.33	0.24	0.13	0.095	ppm
AEGL 3	19	12	8.5	4.5	3.3	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
DMF(68-12-2)						
AEGL 1	NR	NR	NR	NR	NR	ppm
AEGL 2	110	110	91	57	38	ppm
AEGL 3	970	670	530	280	140	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
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

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.
*** indicates value is 100% or more of LEL. Extreme safety consideration against explosions must be taken into account.

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 Meghmani Industries are as below.

	ERPG-1	ERPG-2	ERPG-3	Unit
Chlorine	1	3	20	ppm
Toluene	50*	300	1000	ppm
EDC	50	200	300	ppm
Methanol	200	1000	5000	ppm
Bromine	0.1*	0.5	5	ppm
Dimethylamine	0.6*	100	350	ppm
DMF	2	100	200	ppm
EDC	50	200	300	ppm
Nitric Acid	1	10	78	ppm
Sulfuric acid	2	10	30	mg/m^3
Hydrochloric Acid	3*	20	150	ppm
NaOH	0.5	5.0	50	mg/m^3
*indicates that odor should be detectable near ERPG-1 **indicates the value is 10-49% of LEL.				

- **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 7.3.**

Table 7.3: Risk Classification

Stage	Description
High (> 10^{-2}/yr.)	A failure which could reasonably be expected to occur within the expected life time of the plant. Examples of high failure likelihood are process leaks or single instrument or valve failures or a human error which could result in releases of haz. materials

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

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

7.6 THERMAL HAZARDS

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

BLEVE (boiling liquid expanding vapour explosion) occurs if a vessel containing a liquid at a temperature above its atmospheric boiling point ruptures. The subsequent BLEVE is the explosive 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 7.4: Effects due to Incident Radiation Intensity

Incident Radiation kW/m^2	Damage Type
0.7	Equivalent to Solar Radiation
1.6	No discomfort on long duration
4.0	Sufficient to cause pain within 20 sec. Blistering of skin (first degree burn are likely).
9.5	Pain threshold reached after 8 sec. Second degree burn after 20 sec.
12.5	Minimum energy required for piloted ignition of wood, melting of plastic tubing etc.
25	Minimum Energy required for piloted ignition of wood, melting, plastic tubing etc.
37.5	Sufficient to cause damage to process equipment
62.0	Spontaneous ignition of wood.

Table 7.5: Thermal Radiation Impact to Human

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

Table 7.6: Tolerable Intensities for Various Objects

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

7.7 DAMAGE DUE TO EXPLOSION

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

Table 7.7: Damage due to Overpressure

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 Meghmani Industries case explosion probability is remote.

7.8 TOXIC RELEASE

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 Meghmani Industries are as below.

	IDLH Value	Unit
Chlorine	10	ppm
Toluene	500	ppm
Hexane	1100	ppm
EDC	50	ppm
Methanol	6000	ppm
Bromine	3	ppm
Dichloroethane	2300	ppm
DMF	500	ppm
EDC	50	ppm
Ethyl Acetate	2000	ppm

Isopropyl Alcohol	2000	ppm
Nitric Acid	25	ppm
Sodium Hydroxide	10	mg/m^3
Hydrochloric Acid	1.49	mg/m^3
Sulfuric Acid	15	mg/m^3

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 & Sulphuric 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 7.8** below:

Table 7.8: Different Failure Scenarios

Sr. No.	Chemical	Hazard	Type of Failure Possible	Leak Size Hole Diameter	Chain of events
1	Toluene	Flammable & Toxic	leakage from transfer pipeline of 40 mm	Full bore rupture	Liquid Release → Pool Evaporation→ **Flammable Dispersion of Toluene Vapour**
2	Hexane	Flammable & Toxic	leakage from transfer pipeline of 40 mm	Full bore rupture	Liquid Release →**Pool Fire of Hexane**
3	EDC	Flammable & Toxic	leakage from transfer pipeline of 40 mm	Full bore rupture	Liquid Release → Pool Evaporation→ **Flammable Dispersion of EDC**
4	Methanol	Flammable & Toxic	leakage from transfer pipeline of 40 mm	Full bore rupture	Liquid Release → Pool Evaporation→ **Flammable Dispersion of Methanol Vapour**
5	Solvent C9	Flammable & Toxic	leakage from transfer pipeline of 40 mm	Full bore rupture	Liquid Release → Pool Evaporation→ **Flammable Dispersion of Solvent C9 Vapour**
6	Chlorine	Toxic	leakage from Chlorine tonner	16 mm	**Toxic Dispersion of Chlorine gas**

(B) QUANTITATIVE RISK ASSESSMENT & CONSEQUENCE ANALYSIS

3D Modelling & Consequence Analysis Study is attached as **Annexure-XIII** of EIA/EMP report.

Due to size limit of 1 MB, detailed 3D modelling is uploaded at 'Additional File'.

7.11 OCCUPATIONAL HEALTH

Meghmani Industries 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 immediately 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 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 to protect workers from hazards. 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 & 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.

7.12 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 premises. Incidents involving thermal hazards are mainly due to raw material – solvents fire (in tank farms) and BLEVE of solvent tanks. The impact of Flammable Area of burning puddle resulting from Leak from cylindrical Toluene tank will be 36 m (i.e. within plant boundary). The impact of Thermal radiation from fireball resulting from BLEVE of Methanol tank will be 196 m (10.0 kW/(sq m) = potentially lethal within 60 sec) (i.e. within plant boundary and adjoining premises).

Toxic Impact from Leakage from pipe of Ammonia cylinder will be 36 m (1100 ppm = AEGL-3 [60 min]) and Leak from cylindrical Toluene tank will be 28 m (3700 ppm = AEGL-3 [60 min]) (i.e. within plant boundary). However major toxic hazard is HBr. Toxic Impact from Leak from cylindrical HBr tank will be 3.2 km (120 ppm = AEGL-3 [60 min]) (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:

- Storage tanks of Ethanol, Methanol, Cyclohexane, Toluene, Ethyl Acetate, Xylene, Benzene and Hexane shall be **underground (UG)**.
- 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.

Human Factors: Meghmani Industries 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. They are to be closely looked into and avoided.

Safety' has unique features:

a. If no accident has happened so far probability of incident/accident occurring increases.
b. '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.
c. 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.

(C) MATERIAL HANDLING AND SAFETY MEASURES

7.13 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.

7.13.1 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 aid boxes will 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”.

7.13.2 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.

7.13.3 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. 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 PPEs 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 employees.

7.13.4 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 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.

7.13.5 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.

7.14 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 workplace and personal hygiene
- Safe working procedures
- Procedures to be followed in the event of spillages or leakages.

(D) 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. Proposed DMP shall be submit to Factory inspector for approval and updated whenever necessary. 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,
- Organization set up,
- Training rehearsal and record aspect
- Action on site,
- Objectives,
- Communication System,
- Link with Off-site Emergency Plan,

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/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: 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 factory and not affecting outside public/environment.

Off-Site Emergency plan: It deals with measures to prevent and control emergencies affecting public and environment outside 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 MoEFCC 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.
- Preparation of action plan to handle disasters and to contain damage.
- Inform employees, the general public and the authority about the hazards/risk assessed and to provide safeguard, and the role to be played by them in the event of emergency.
- Be ready for 'mutual aid' if need arises to help neighbouring unit.
- Inform authorities and mutual aid centres to come for help.
- Effect rescue and treatment of casualties.
- Effective rehabilitation of affected persons and prevention of damage to the property.
- Provide authoritative information to the news media.

7.15 ONSITE EMERGENCY PLAN

7.15.1 Incident Controller

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

7.15.1.1 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.

7.15.2 Site Main Controller

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

7.15.2.1 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 & when required nearby firms will be informed.
- Ensure that key personnel will be called in.
- 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.
- 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 preservation of evidence.
- Control rehabilitation of affected areas after control of the emergency.

7.15.3 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.

7.15.3.1 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.

7.15.3.2 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.

7.15.3.3 Assembly Points

At least 2 assembly points will be identified and marked properly.

7.15.4 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 & 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.

7.15.4.1 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 activities in the factory premises including that of storage's utility services, production area, administration, will be kept for ready reference, showing the location of fire hydrant and fire-fighting aids.

- Normal roll of employees, work permits, gate entries and documents for head count, employees blood group, other information and addresses will be available and person, who will handle this operation will HOD P&A.
- Stationery required is available in the Control Centre (ECC) and HOD (P&A) looks after it.
- The requirement of PPE 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.

7.15.5 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.

7.15.6 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.

7.15.7 Transport & Evacuation, Mutual Aid Arrangements

Transport & Evacuation and Mutual Aid arrangements will be available.

7.16 COMMUNICATION SYSTEM

7.16.1 Declaring the Emergency

In case of any emergency, speedy & 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.

7.16.1.1 Type of Sirens

3 different types of sirens are 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: wailing & waning siren for three minutes. 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.

7.16.1.2 Location of Siren

Siren will be located in centre of plant for wide coverage of the whole campus. Switch for siren will be provided at security gate. 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.

7.16.1.3 Raising Alarm

Any person noticing any emergency situation in 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 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 feedback to ECC. ECC shall direct security gate to raise evacuation siren. SIREN for Evacuation shall be raised on instruction from Site Main Controller or any Manager of the plant. Security gate person will be authorized to raise all clear sirens on instruction from Site Main Controller or ECC, after the emergency is over. Incident controller shall assume the responsibility of site main controller in his absence.

7.16.2 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.

7.16.2.1 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.

<u>To the Outside Emergency Services</u>

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.

7.16.3 Communication to the Authorities

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

Communication to Neighbouring 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.

7.17 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/ lines/safety/relief valve
- 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
- Storage of adequate first aid treatment facilities

7.18 POST-EMERGENCY ACTIVITIES

Following post emergency actions will be carried out,

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

7.18.1 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.

7.18.2 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.

7.18.3 Use of Mutual Aid

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

7.18.4 Use of External Authorities

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

7.18.5 Medical Treatment

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

7.18.6 Accounting for Personnel

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

7.18.7 Access to Records

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

7.18.8 Public Relations

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

7.18.9 Rehabilitation

The affected area will be cleared from emergency activities only after positive ascertaining of system in all respects. The entry to affected area will have to be restricted until statutory authorities visit and inspect the spot. Nothing should be disturbed from area till their clearance. The plan will cover emergencies, which can be brought under control by the works with help of emergency team/fire services. The DISASTER CONTROL PLAN for gas leak and fire will be prepared for entire factory.

7.19 CAUSES OF EMERGENCY

7.19.1 Risk

7.19.1.1 Nature

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

- Fire : Chemical/Electrical
- Toxic Release : From chemicals
- Leakages : Equipment, pipe lines, valves, etc.

Release of vapours like bromine/chlorine gas or hexane can result in highly toxic environment or in fire or explosion.

- 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/ruptures of vessels.

7.19.1.2 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 to the extent possible from fire prone area
- 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.
- 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.

7.19.1.3 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		

7.20 OFF-SITE EMERGENCY PLAN

7.20.1 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.

7.20.2 Structure of the Off-Site Emergency Plan

Available with concerned authorities.

7.20.3 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.

7.20.4 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.

7.20.5 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.

7.20.6 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.

7.20.7 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.

7.20.8 Role of Health Authorities

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

7.20.9 Role of Mutual Aid Agencies

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

7.20.10 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.

7.21 MOCK DRILLS AND RECORDS

7.21.1 Need of Rehearsal & Training

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

7.21.2 Some Check Points

- The extent of realistic nature of incidents.
- Adequate assessment of consequences of various incidents.
- Availability of sufficient resources such as water, fire-fighting aids, personnel.
- The assessment of time scales.
- Logical sequences of actions.
- The involvement of key personnel in the preparation of plan.
- At least 24 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.

7.21.3 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.

(E) Social Impact Assessment

Meghmani Industries is a large industry. The proposed manpower requirement during construction will be 120-125 nos. During the operation phase, 200 nos. of skilled and unskilled manpower will be required for proposed activities. Total area of the proposed project is **97756.87 m^2.** Proposed project will be situated within the designated notified area promoted by GIDC, so there will be no Rehabilitation & Resettlement (R&R) involved.

Social Corporate Responsibilities

Corporate Environmental Responsibility (CER) refers to a company's duties to withdraw from damaging natural environments. 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.

Survey Methodology

The survey aims to document the living conditions, level of socio-economic development of the region and the socio-economic profile of people in the core and buffer zones of the study area. The village level data were collected from Censuses.

Study of Village Profile

This study includes village level survey of Population, Economics, Land use Pattern, Employment pattern, Healthcare Facilities, Amenities for Livelihood.

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 as these documents being comprehensive and authentic.

Socio Economic Survey within study area:

The Study area in 10 km radius has 15 villages including project site. The total no. of household in the villages are 8052 and the total population is 33860 (57.61% men & 42.39% women).

1) **Educational facility**

Literacy is an important indicator for understanding the socio-economic development of any area. 75.44% of are literate while literacy rate among women & men is 67.31% & 81.43% respectively. 49.90% of male population is part of main worker, while only 7.98% of female population is a part of main workers. 6.74% of male workers are marginal workers, while 4.97% of female workers are engaged in such type of activities. 43.36% of male population and 87.04% of female population are non-workers.

As per census, there are primary school in all 15 villages, 10 secondary schools, and 9 senior secondary school in the 10 km study area. Keeping in view of the industrialization around these villages and there is need of semi-skilled and skilled labor for the industrial units. Unit will motivate educational activities by awarding meritorious school students in SSC & HSC, science lab - equipment & books in libraries for schools, and supports for sport & cultural competitions in schools. Women bear larger losses in terms of educational attainment, employment and wages. Thus, more focus will be on Women Education considering the gap in literacy rate and employment rate.

2) **Health & Family welfare**

15 villages in the study area have 11 primary health centers, 12 primary health sub centers, 9 Maternity & Child Welfare Centre, 1 T.B Clinic, 8 Family Welfare Centre, and 1 Veterinary hospital in study area of 10 km. Unit will contribute in health checkup camps organized by different agencies by providing man, medicine, and money.

3) **Drinking Water Facilities**

All the 15 villages in the study area have two or more sources of drinking water. Most of the villages in study area have Hand pump supply in addition to Tube well (almost all). Water quality of this area is saline and not feet for drinking purpose.

Keeping in the mine of high salinity, unit will contribute in government and NGOs efforts to provide drinking water systems in this area.

4) Preservation of Environment and Sustainable Development

For Preservation of Environment, unit will promote tree plantation in surrounding villages. Unit will promote uses of non-conventional source of energy i.e. solar power. Additionally, unit will raise awareness and promote rain water harvesting in nearby villages.

Details of expenditure for CER activities:

Estimated cost of the project : **Rs. 110 Crores**

Expenditure earmarked towards CER : **Rs. 1.65 Crores**

(1.5% of the project cost)

Primary focus area for these activities will be Lakhigam, Luvara, Dahej and Ambetha area. The detailed expenditure break-up of above activities for the five years are given below:

Table 7.9 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	20	15	15	**50**
2	Drinking Water Facilities	16	16	16	**48**
3	Public Health and family welfare	15	15	12.5	**42.5**
4	Preservation of Environment, rain water harvesting & tree plantation	10	10	7.5	**27.5**
	Total	**61**	**56**	**51**	**168**

Table 7.10 Proposed Activities for CER

(Quantify CER activities)

Proposed Activities	Selected areas or villages	Frequency	Financial provision in Lakhs
Educational			
Contribution for Proposal of ITI training Institute	Vicinity of Plant	One time	**Total Rs. 50.0**
Drinking water facility			
RO and water cooler	4 sets of RO and water cooler at Primary school of 4 villages	One time	350000 x 12 **Total Rs. 42.0**
	8 sets of RO and water cooler at Village Panchayat of 8 villages		
Operation and maintenance cost	--	Three Years	12 x 0.5 **Total Rs. 6.0**
Public Health and family welfare			
Medical camp, Eye camp and free medicine	Around 10 camp with cluster of 5 to 6 villages	10 camp up to three Years during rainy days	10 x 0.5 x 3 years **Total Rs. 15.0**
		5 Eye camp up to three Years during rainy days	5 x 0.4 x 3 years **Total Rs. 7.5**
		Free cataract to identify patient coming from BPL family.	50 x 0.40 **Total Rs. 20.0**
Women Empowerment & children Development activities			
Provide Sewing and embroidery machine to women coming from BPL family and widow women.	All 42 villages in the study area 100	One time 100 nos. Sewing machine	100 x 0.15 **Total Rs. 15.0**
		One time 50 no embroidery Machine	50 x 0.25 **Total Rs. 12.5**
		Total	**Rs. 168 Lakhs**