CHAPTER – 7

RISK ASSESSMENT

ADDITIONAL STUDIES

In order to support the environment impact assessment and environment management plan, following additional studies have been included in this report.

- Risk Assessment.
- Onsite and Offsite Emergency Plan.
- Occupational Health Program.

7.1 SCOPE OF THIS STUDY:

The QRA study in this report has been conducted considering the Terms of References (TORs) given by Expert Appraisal Committee of MoEF for Environment Clearance (EC).

The study has been carried out with a view to comply the following TOR points:

- **TOR No. 53:** Occupational health impacts on the workers and mitigation measures proposed to avoid the human health hazards along with the personal protective equipment to be provided. Provision of industrial hygienist and monitoring of the occupational injury to workers as well as impact on the workers. Plan for periodic medical checkup of the workers exposed. . Details of work place ambient air quality monitoring plan as per Gujarat Factories Rules.
- **TOR No. 55:** Risk assessment including prediction of the worst-case scenario and maximum credible accident scenarios should be carried out. The worst-case scenario should take into account the maximum inventory of storage at site at any point of time. The risk contours should be plotted on the plant layout map clearly showing which of the facilities would be affected in case of an accident taking place. Based on the same, proposed safeguard measures including On-Site / Off-Site Emergency Plan should be provided.

- **TOR No. 57:** Details of hazardous characteristics and toxicity of raw materials and products to be handled and the control measures proposed to ensure safety and avoid the human health impacts. This shall include the details of Antidotes also.
- **TOR No. 58:** Details of quantity of each hazardous chemical (including solvents) to be stored, Material of Construction of major hazardous chemical storage tanks, dyke details, threshold storage quantity as per schedules of the Manufacture, Storage & Import of Hazardous Chemicals Rules of major hazardous chemicals, size of the biggest storage tank to be provided for each raw material & product etc. How the manual handling of the hazardous chemicals will be minimized?
- **TOR No. 59:** Details of the separate isolated storage area for flammable chemicals. Details of flame proof electrical fittings, DCP extinguishers and other safety measures proposed. Detailed fire control plan for flammable substances and processes showing hydrant pipeline network, provision of DG Sets, fire pumps, jockey pump, toxic gas detectors etc.
- **TOR No. 60:** Submit checklist in the form of Do's & Don'ts of preventive maintenance, strengthening of HSE, manufacturing utility staff for safety related measures.
- **TOR No. 61:** Specify safety precautions to be taken for Chemical storage, process, and handling& transportation hazard.
- **TOR No. 62:** Details on workers training before engaging work, periodical, in-house, outside etc.
- **TOR No. 63:** Details on various SOP to be prepared.
- **TOR No. 64:** Details on safety audit to be carried out and their compliance status.
- **TOR No. 65:** Specific safety measures to be taken for general Public living in the vicinity.
- **TOR No.66:** Details on hazard identification i.e. HAZOP, HAZAN, Fault tree analysis, Event tree analysis, Checklist, Audit etc. to be adopted for the safety operation of the plant.

7.2 INTRODUCTION TO RISK ASSESSMENT

M/s. Chemox International, Ankleshwar, handles various chemicals, some of which are hazardous in nature by virtue of their intrinsic chemical properties or their operating temperatures or pressures or a combination of them. Fire, explosion, toxic release or combinations of them are the hazards associated with industrial plants using hazardous chemicals. More comprehensive, systematic and sophisticated methods of Safety Engineering, such as, Hazard Identification and Qualitative/Quantitative Risk Assessment have been

developed to improve upon the integrity, reliability and safety of industrial plants, the same has been discussed in detail under their respective headings.

7.2.1 OBJECTIVES OF RISK ASSESSMENT

Risk analysis follows an extensive hazard analysis. It involves the identification and assessment of risks the neighbouring populations are exposed to as a result of hazards present. This requires a thorough knowledge of failure probability, credible accident scenario, vulnerability of population etc. Much of this information is difficult to get or generate. Consequently, the risk analysis is often confined to maximum credible accident studies.

Risk assessment is carried out with the following objectives:

1. To identify hazard and risk resulting from the hazards
2. To study and foresee the effects of such risks on the workers, public, property and environment and to find out necessary control measures to prevent or minimize risk.
3. To comply the legal requirement by various safety and environment laws of the country like…

- The Factories Act, 1948.
- The Gujarat Factories Act, 1963.
- The Environment Protection Act and Rules, 1986.
- Hazardous waste (Management & Handling) Rules, 1989.
- Public Liability Insurance Act & Rules, 1991.
- Chemical Accident, (Emergency, planning, preparedness and response) Rules, 1996.

4. To get the necessary information for Emergency planning and evacuation.

7.2.2 PLANT LAYOUT

The below plant layout shows details of storage of Raw materials & ADEQUATE MARGIN ALL ROUND THE PERIPHERY.

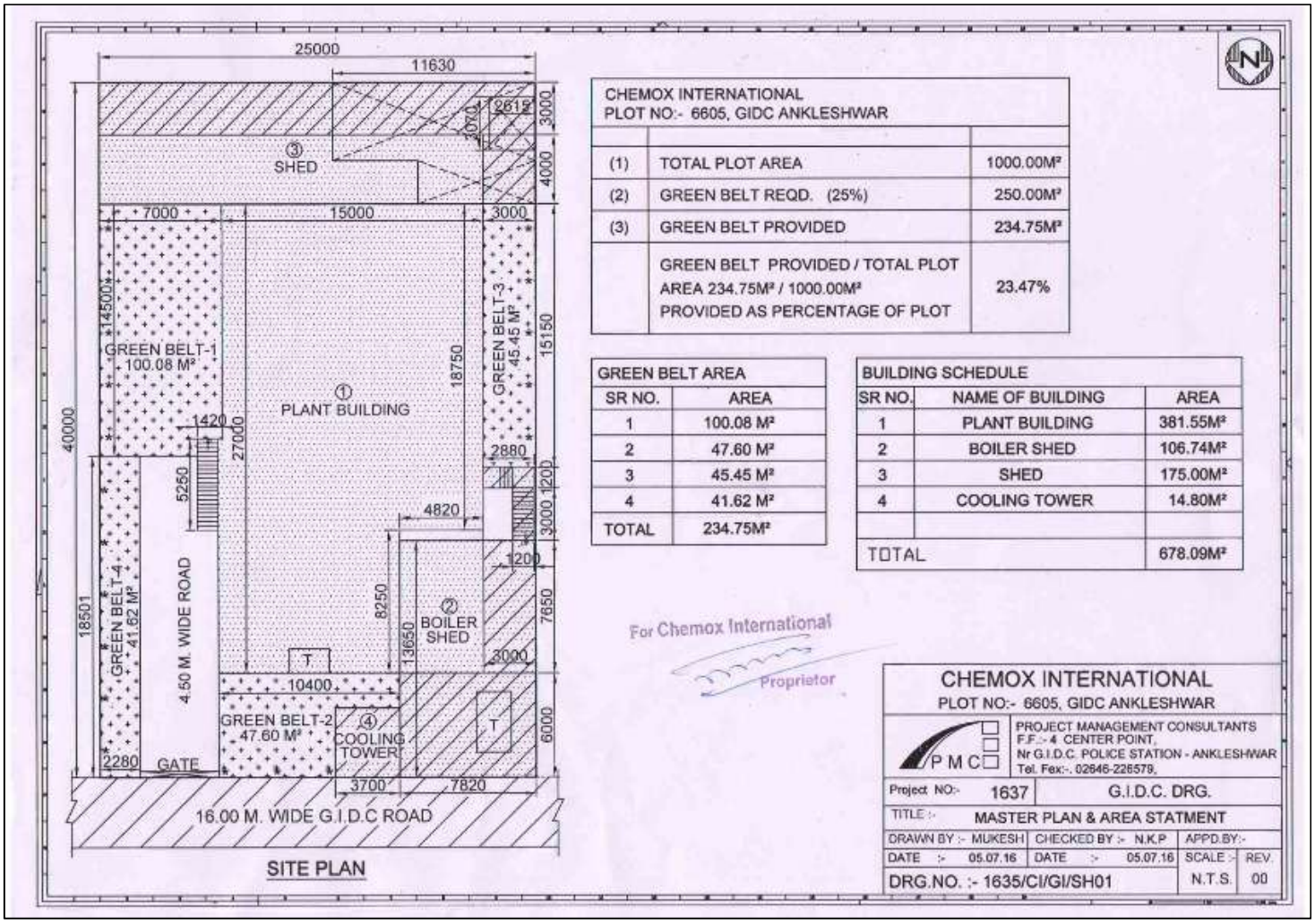

Table 7.1: Storage Details of Raw Materials

SR. No.	NAME OF THE RAW MATERIALS	CAPACITY IN KG	MODE OF STORAGE	STATE	POSSIBLE TYPE OF HAZARDS	CONTROL MEASURES PROVIDED
1.	Acrylonitrile	200	Drum	Liq.	• Flammable	• Proper storage area is provided. • Well ventilated storage area is provided. • Eye wash Stations are provided. • PPEs like Splash goggles, Vapour respirator, Boots, Gloves etc., are used while handling this chemical. Specialist will be consult, if required.
2.	Acetic Anhydride	200	Drum	Liq.	• Flammable • Toxic	

NOTES:

1. Since all the chemicals are stored in drums the size of the biggest storage tank and Dyke of sufficient capacity (i.e. 10% extra than tank capacity) is not applicable to this unit.
2. The unit shall be classified as Non Major Accident Hazard (MAH) unit based on the quantity of Hazardous Chemicals stored at site, as the quantity of these chemicals being stored within the factory premises are well within the threshold storage quantity as per schedules of Manufacture, Storage & Import of Hazardous Chemicals (MSIHC) Rules of major hazardous chemicals.

Table 7.2 : Properties of Hazardous Chemicals (i.e. Hazardous Characteristics & Toxicity)

Sr. No.	CHEMICAL	PHYSICAL STATE	FP (^{O}C)	BP (^{O}C)	SP. GR @ 20^{O}C	VAP. DEN. VS AIR	VAP. PR. @ 20^{O}C	LEL %	UEL %	LD_{50} ORAL MG/ KGS	LD_{50} DERMAL MG/KGS	LC_{50} MG/L	IDLH VALUE BY ACGIH/ NIOSH	STEL BY OSHA (PPM)	TLV-TWA BY OSHA (PPM)
1.	Acrylonitrile	Liq.	-1.1	77.3	0.806	1.8	11.1 kPa	3.1	17	78 mg/kg [Rat].	63 mg/kg [Rabbit]	333 ppm 4 hours [Rat]	85 ppm	10 ppm	2 ppm
2.	Acetic Anhydride	Liq.	49	139.9	1.08	3.5	0.5	2.7	10.3	1780	4000	1000 ppm	200 ppm	-	-

7.3 RISK ASSESSMENT

Identification of hazards in the proposed project activity is of primary significance. Hazard states the characteristics of system/plant/process that presents potential for an accident. All the components of a system/plant/process needs to be thoroughly examined to assess their potential for initiating or propagating an unplanned event/sequence of events, which can be termed as an accident.

HAZARDS IDENTIFICATION AND DETAILS OF PROPOSED SAFETY SYSTEMS

At **M/s. CHEMOX INTERNATIONAL,** major risks have been identified for the following area:

- Storage Shed.

As a conservative approach, we have analysed the risk qualitatively and quantitatively both, as mentioned below.

In this study,

- The Storage & Handling of Acrylonitrile and Acetic Anhydride have been considered for Quantitative Risk Assessment (Consequence Analysis). Their storage location has been shown in Figure-7.2. Hazardous properties of these chemical have been summarized in Table 7.2 B.
- Storage & Handling of Solid Chemicals, Acids, Caustic lye and Drum Handling have been considered for Qualitative Risk Assessment.

7.3.1 QUALITATIVE RISK ASSESSMENT

Many a times Risk involved in various processes / process equipments cannot be addressed completely by Consequence Analysis. As a conservative approach, these risks have been considered separately under this topic. The approach is to identify hazards associated in operation of equipments as well as in processes, assessing its impacts, ranking the risk posed by it and finally to propose remedial actions/mitigation measures such that the risk is minimized to tolerable level. The **Risk Matrix** presented below should be referred in evaluating this assessment.

In **Qualitative Risk Assessment**, risk has been analysed using methodology called HIRA-Hazards Identification & Risk Assessment. In HIRA, major manual activities carried out by plant personnel as well as contract labours have been considered.

For the following areas, Qualitative Risk Assessment has been carried out to identify the risk, ranking them as per their severity & probability, identifying the existing mitigation measures and finally to propose recommendations, if existing measures are not enough.

1. Storage & Handling of Solid Chemicals.
2. Storage & Handling of Acids.
3. Storage & Handling of Caustic Lye.
4. Storage & Handling of Drums.

RISK MATRIX FOR QUALITATIVE RISK ASSESSMENT

LIKEHOOD/ PROBABILITY		SEVERITY				
		Catastrophic (Death/ System Loss)	Major/ Critical (Serious injury/ Illness)	Moderate (Less Serious Injury/ Illness)	Minor/ Marginal (Minor Injury/ Illness)	Insignificant/ Negligible (No injury/ Illness)
		5	**4**	**3**	**2**	**1**
Almost Certain	**5**	**H**	**H**	**H**	**M**	**M**
Likely	**4**	**H**	**H**	**M**	**M**	**L**
Possible	**3**	**H**	**M**	**M**	**M**	**L**
Unlikely	**2**	**M**	**M**	**M**	**L**	**L**
Impossible	**1**	**M**	**M**	**L**	**L**	**L**

RISK RANGE	RISK ACCEPTABILITY CRITERIA	REMARKS
H	Unacceptable/ High	Management's Decision/Action Plan Required. Potential off-site Impact.
M	Medium	Generally Minor Impact. Acceptable with Management's Review. Specific monitoring or SOP to be followed.
L	Low	Acceptable without Review. Manage through Routine Procedure.

7.3.1.1 STORAGE AND HANDLING OF SOLID CHEMICALS

RISKS AND RECOMMENDATIONS FOR SOLID CHEMICALS HANDLING

Sr.	Process Or Activity	Associated Hazards	Health & Safety Impact (Risk)	Initial Risk			Existing Measures	Residual Risk			Additional Recommendations
				Severity	Likelihood	Risk		Severity	Likelihood	Risk	
1.	Handling Chemical bags	• Chemical dust Exposure	• Skin/Eye irritation.	2	3	M	• Chemicals are stored in isolated storage rooms having provision for natural & forced ventilation. • Suitable protective clothing, gloves, respirator and other PPEs are used.	2	2	L	1. Operators/ Workers to be trained for Safe Work Practices. 2. Chemical handling bags to be labeled and segregated properly.
2.	Cleaning of Chemical Spillage.	• Fumes Inhalation. • Dust Exposure.	• Severe irritation to eyes, skin. • Inhalation.	4	3	M	• Spillage is cleaned or neutralized with suitable media. • Cleaning activities are carried out under Strict vigilance. • Provision for natural & forced ventilation is available.	2	2	L	

7.3.1.2 STORAGE AND HANDLING OF ACIDS

RISKS AND RECOMMENDATIONS FOR ACID HANDLING

Sr. No	Process Or Activity	Associated Hazards	Health & Safety Impact (Risk)	Initial Risk			Existing Measures	Residual Risk			Additional Recommendations
				Severity	Likelihood	Risk		Severity	Likelihood	Risk	
1.	Acids Loading & Unloading.	• Exposure to acidic fumes due to leakage. • Spillage of acids.	• Skin/Eye irritation. • Toxic Vapour inhalation etc.	4	C	M	• Loading & Unloading activity is carried out in well-ventilated area. • Neutralization media is made available in areas where acids are stored/ handled/ used. • PPEs are used.	5	B	L	3. Operators/ Workers to be trained for Safe Work Practices. 4. Health checkup of the concerned personnel to be carried as per the plan.
2.	Working in Storage Area.	• Exposure to acid fumes.	• Severe irritation to eyes, skin. • Body burns.	4	C	M	• Storage area is well ventilated. • Acid proof flooring is available. • Neutralization is done immediately with soda	5	B	L	

							ash/lime or spill is absorbed in sand or by suitable adsorbent. • PPEs like face mask, gloves etc. are worn by concerned person.				

7.3.1.3 STORAGE AND HANDLING OF CAUSTIC LYE

RISKS AND RECOMMENDATIONS FOR CAUSTIC LYE HANDLING

Sr. No	Process Or Activity	Associated Hazards	Health & Safety Impact (Risk)	Initial Risk			Existing Measures	Residual Risk			Additional Recommendations
				Severity	Likelihood	Risk		Severity	Likelihood	Risk	
	NaOH handling /Loading & Unloading	• Exposure due to leakage from joints, corroded lines failure etc.	• Skin burn. • Eye irritation and respiratory disorder.	4	C	M	• Dyke is available. • NaOH is stored in well ventilated area. • Eye wash station is available nearby. • Maintenance is carried out as per schedule. • PPEs are used.	5	B	L	5. Proper trainings to be provided to the operators/workers. 6. SOPs to be prepared and followed the same.

	Working in Storage Area	• Exposure due to spillage	• Severe irritation to eyes, skin etc. • Internal body burns.	4	C	M	• Neutralization media is kept available. • PPEs like face mask, gloves etc. are worn by concerned person. • Eye wash station is available nearby.	4	B	L	

7.3.1.4 STORAGE AND HANDLING OF DRUM HANDLING

RISKS AND RECOMMENDATIONS FOR DRUM HANDLING

Sr. No.	Process Or Activity	Associated Hazards	Health & Safety Impact (Risk)	Initial Risk			Existing Measures	Residual Risk			Additional Recommendations
				Severity	Likelihood	Risk		Severity	Likelihood	Risk	
1.	Unloading of chemical drums from truck.	✓ Drum rupture ✓ Fall of drums	✓ Toxic Vapour inhalation etc. ✓ Fire	3	3	M	✓ Loading & Unloading activity is carried out in well-ventilated area. ✓ Pellets are used for handling of drums. ✓ Trained workers ✓ PPEs	1	2	L	
2.	Handling of	✓ Exposure to	✓ Skin/Eye	2	3	M	✓ Storage and handling of drums	2	2	L	✓ Allied facilities to be

	Drums (during storage and usage)	fumes due to leakage in drums. ✓ Spillage of chemicals.	irritation. ✓ Toxic Vapour inhalation etc.				is carried out in well-ventilated area. ✓ PPEs are used.				inspected on periodic basis. ✓ Neutralization media is made available in areas where acids are stored/ handled/ used.
3.	Unloading/Emptying of chemical from drums	✓ Exposure to chemical fumes.	✓ Severe irritation to eyes, skin. ✓ Body burns.	3	3	M	✓ Storage area is well ventilated. ✓ Acid proof flooring is available. ✓ Neutralization is done immediately with soda ash/lime or spill is absorbed in sand or by suitable adsorbent. ✓ PPEs like face mask, gloves etc. are worn by concerned person.	1	3	L	--
4.	Transfer of chemicals from drums to plant/reactor	✓ Exposure to chemical fumes.	✓ Skin/Eye irritation.	3	3	M	✓ PPEs like face mask	1	3	L	--
5.	Cleaning of empty drums	✓ Exposure to chemical fumes.	✓ Toxic Vapor inhalation etc.	2	3	M	✓ PPEs like face mask	1	3	L	--

7.3.2 QUANTITATIVE RISK ASSESSMENT

Quantitative Risk Assessment (QRA) is a structured approach to identifying and understanding the risks associated with Storage and Handling of flammable/toxic chemicals. The assessment starts by taking into account an inventory of hazardous chemicals stored, likelihood of leakage/spillage associated with it and selecting the worst case scenario for consequence estimation.

Finally, suggesting the measures to minimize or mitigate risks to meet appropriate acceptability criteria. The planning for emergency evacuation shall be borne in mind whilst interpreting the results.

❖ **CONSEQUENCE ANALYSIS**

In a plant handling hazardous chemicals, the main hazard arises due to storage and handling of hazardous chemicals as mentioned above. If these chemicals are released into the atmosphere, it may cause damage due to resulting fires or vapour clouds. Blast Overpressures depend upon the reactivity class of material between two explosive limits.

❖ **DAMAGE CRITERIA**

In Consequence Analysis studies, in principle three types of exposure to hazardous effects are distinguished:

1. Heat radiation, from a jet, pool fire, a flash fire or a BLEVE.
2. Explosion
3. Toxic effects, from toxic materials or toxic combustion products.

In the next three paragraphs, the chosen damage criteria are given and explained as per the Guidelines for QRA – Phast (Micro) Software (DNV) & Purple Book for QRA released by Centre for Chemical Process Safety (CCPS).

Heat Radiation

The consequence caused by exposure to heat radiation is a function of:

- The radiation energy onto the human body [kW/m^2];

- The exposure duration [sec];
- The protection of the skin tissue (clothed or naked body).

In this report following damage criteria has been considered for the effects due to Fire/Explosion.

Table 7.2 Effects Due To Incident Radiation Intensity

INCIDENT RADIATION – kW/m^2	TYPE OF DAMAGE
37.5	Immediate ignition of wood (without flame contact). 100 % fatal.
25	Minimum Energy required for igniting wood. (without flame contact). 100 % fatal in 1 min. Significant injury in 10 sec.
12.5	Minimum heat required to ignite wood (with flame contact). 1 % fatal in 1 min. First. degree burn in 10 sec.
4	Pain after 20 sec. Blistering unlikely.
2	No discomfort for long exposure.

Explosion

In case of vapour cloud explosion, two physical effects may occur:

* a flash fire over the whole length of the explosive gas cloud;
* a blast wave, with typical peak overpressures circular around ignition source.

As explained above, 100% lethality is assumed for all people who are present within the cloud proper.

The following damage criteria may be distinguished with respect to the peak overpressures resulting from a blast wave:

Table 7.3 Damage Due To Overpressures.

Peak Overpressure	Damage Type
0.40 bar	Ear Drum Rupture to humans 50 % probability of fatality inside 15% probability of fatality in open
0.21 bar	Structural Damage to buildings 20% probability of fatality to personnel inside 0% probability of fatality in the open
0.1 3 bar	Minor Structural Damage to nearby structures 10% probability of fatality to personnel inside 0% probability of fatality in the open
0.02 bar	Glass Damage
0.01 bar	Minor Damage

Intoxication

In this report, LC_{50} concentration and IDLH concentrations have been considered for Consequence Analysis.

❖ **ASSUMPTIONS FOR CONSEQUENCE ANALYSIS**

For Consequence Analysis, assumptions regarding Meteorological, Pasquil Stability Classes, Wind velocity, Ambient Temperature, Relative Humidity, Inventory, Ground Roughness, Model used etc. are very important. In this report, the following assumptions have been considered.

i. Meteorological Paste other tables

- Atmospheric Conditions: No Inversion
- Ambient Temperature: 30^0C has been considered as MCA approach.
- Relative Humidity: As the site is not in rainy zone RH of 50% has been considered.

ii. Pasquil Stability Classes

- Pasquil Stability category D/F is considered as conservative approach.

iii. Other assumptions:

- Ground Roughness: Ground Roughness has been considered as 0.3 M.
- Dispersion model of both Heavy Model and also Gaussian distribution have been used as applicable/appropriate.
- Inventory: Release of 100% of the inventory has been considered. For this, failure of the container has been considered from the bottom.
- Storage conditions: Storage conditions have been considered as they are practically stored at site.

Following Weather data has been used for the study:

Table no 7.4 Weather data used for the study

WIND SPEED (M/S)	PASQUILL STABILITY
1.5	F
1.5	D
5	D

❖ **SOFTWARE USED FOR CALCULATIONS**

1. PHAST MICRO.
2. ALOHA

❖ **SCENARIOS CONSIDERED FOR CONSEQUENCE ANALYSIS**

1. In this study, the scenarios for consequence analysis have been selected considering:
   - The physical and chemical properties of hazardous materials,
   - Storage conditions & Modes of Storage (Tank, Drums, Cylinder & Glass Bottles),
   - Hazards ranking by NFPA,
   - Guidelines by OSHA (29 CFR),
   - Operating and storage conditions of handling and storage of hazardous chemical.

2. This report considers the worst case scenario which is possible during any set of operation variable and production methodologies. The objective of the study is emergency planning, hence only holistic & conservative assumptions are used for obvious reasons. Hence though the outcomes may look pessimistic, the planning for emergency concept should be borne in mind whilst interpreting the results.

In this regard, **the failure cases which may lead to release of hazardous chemicals are as under, put of which the worst case relevant scenario shall be considered:**

- Possible Release/Leakage from Drum.
- Release due to tilting of drum having open lid.

3. In this study, results of consequence analysis shall be used for;
   a. Emergency Planning
   b. Deciding Evacuation Routes
   c. Deciding Location of Assembly Points and ECC
   d. Resource Allocation for mitigation

4. SCENARIOS IDENTIFIED FOR CONSEQUENCE ANALYSIS

Scenarios	Description of Scenario	Storage Pressure & Temp.	Scenarios considered
FIRE SCENARIOS			
1.	Acrylonitrile	Ambient	Flash Fire, UVCE, Late Pool Fire
FIRE & TOXIC SCENARIOS			
2.	Acetic Anhydride	Ambient	Flash Fire, Late Pool Fire, Dispersion

Considerations Made:

- In Case of **Acrylonitrile & Acetic Anhydride** we have considered the failure case of Release of Inventory due to 2" leakage or due to tilting of Drums.
- In **Case of Dispersion for Acetic Anhydride ,** we have considered the following scenarios:

  ✓ Leak from 50 mm hole size for LC_{50} (1000 ppm) concentration.

  ✓ Leak from 50 mm hole size for IDLH (200 ppm) concentration.

Selection Criteria of Scenarios:

- As per the relevant guidelines for consequence analysis, we have considered the **maximum credible scenarios** for all the above mentioned chemicals, for a period of 600 sec leakage duration, which is the representative of all kinds of minor/major leakages.
- Modeling has been carried out for dispersion up to LC_{50} concentration and IDLH concentration, in case of toxic chemical. Evacuation should be carried out in less than 30 min from the area covered under IDLH in case of relevant leakage scenario. The purpose is to avoid irreversible health effects to persons inside the area of IDLH concentration.
- Based on the above considerations and the input parameters considered for worst case scenarios, the risk contours are plotted on the plant layout map clearly showing which of the facilities would be affected in case of an accident taking place. Based on the same the safety measures/recommendations are proposed and On-Site & off-Site emergency plan is prepared as mentioned under the section 7.6.

TABLE: 7.6

SCENARIO # 1 – RELEASE OF ACRYLONITRILE

Basis: Possible Release/Leakage due to 2" damage to drum or tilting of drum with open lid.	
Input Data	
Leak Size Considered	50mm
Release rate	5144.10gms/s
Drum gets empty in	30.92 s
Pressure	Ambient
Temperature	30 deg C
Weather Condition	1.5/F, 1.5/D, 5/D
LFL	24200
UFL	173400

CASE:1 FLASH FIRE

			Distance (m)		
			Category 1.5/F	Category 1.5/D	Category 5/D
Furthest Extent	12100	ppm	13.7426	14.45	8.93967
Furthest Extent	24200	ppm	7.40363	5.86245	2.52525

CASE:2 VAPOUR CLOUD EXPLOSION (OVERPRESSURE RESULTS)

			Maximum Distance (m) at Overpressure Level	
			Category 1.5/F	Category 1.5/D
Overpressure	0.02068	bar	25.0565	24.3077
Overpressure	0.1379	bar	13.8985	13.7046
Overpressure	0.2068	bar	13.0166	12.8665

CASE:3 LATE POOL FIRE (EFFECTS OF RADIATION LEVEL)

			Distance (m)		
			Category 1.5/F	Category 1.5/D	Category 5/D
Radiation Level	4	kW/m2	12.5604	12.5607	13.3376
Radiation Level	12.5	kW/m2	8.30031	8.3006	9.59282
Radiation Level	25	kW/m2	6.00954	6.00983	7.91756
Radiation Level	37.5	kW/m2	4.35183	4.35212	5.77563

FIGURE: 2

RISK CONTOUR FOR FLASH FIRE:

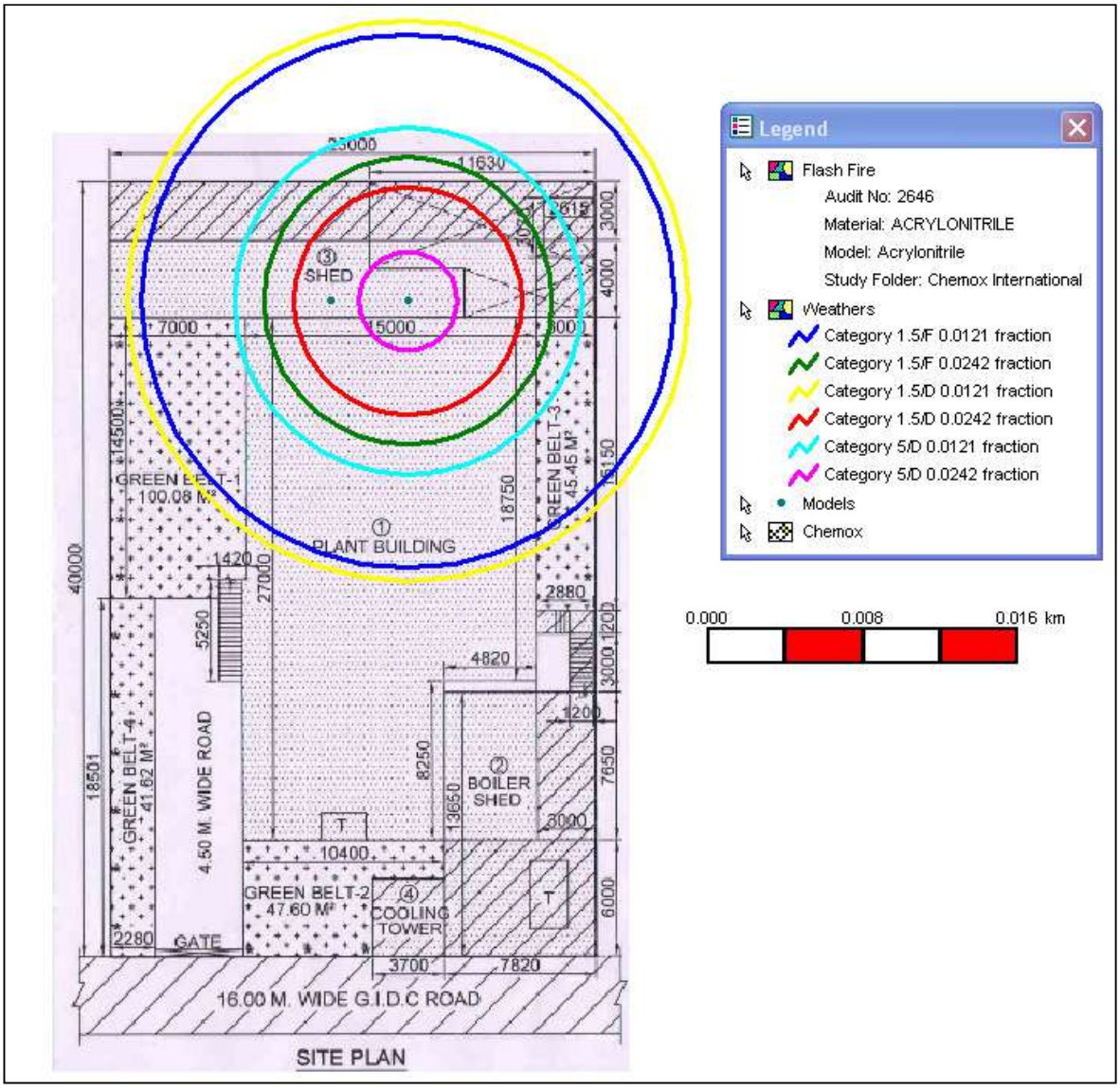

FIGURE: 3

RISK CONTOUR FOR UVCE:

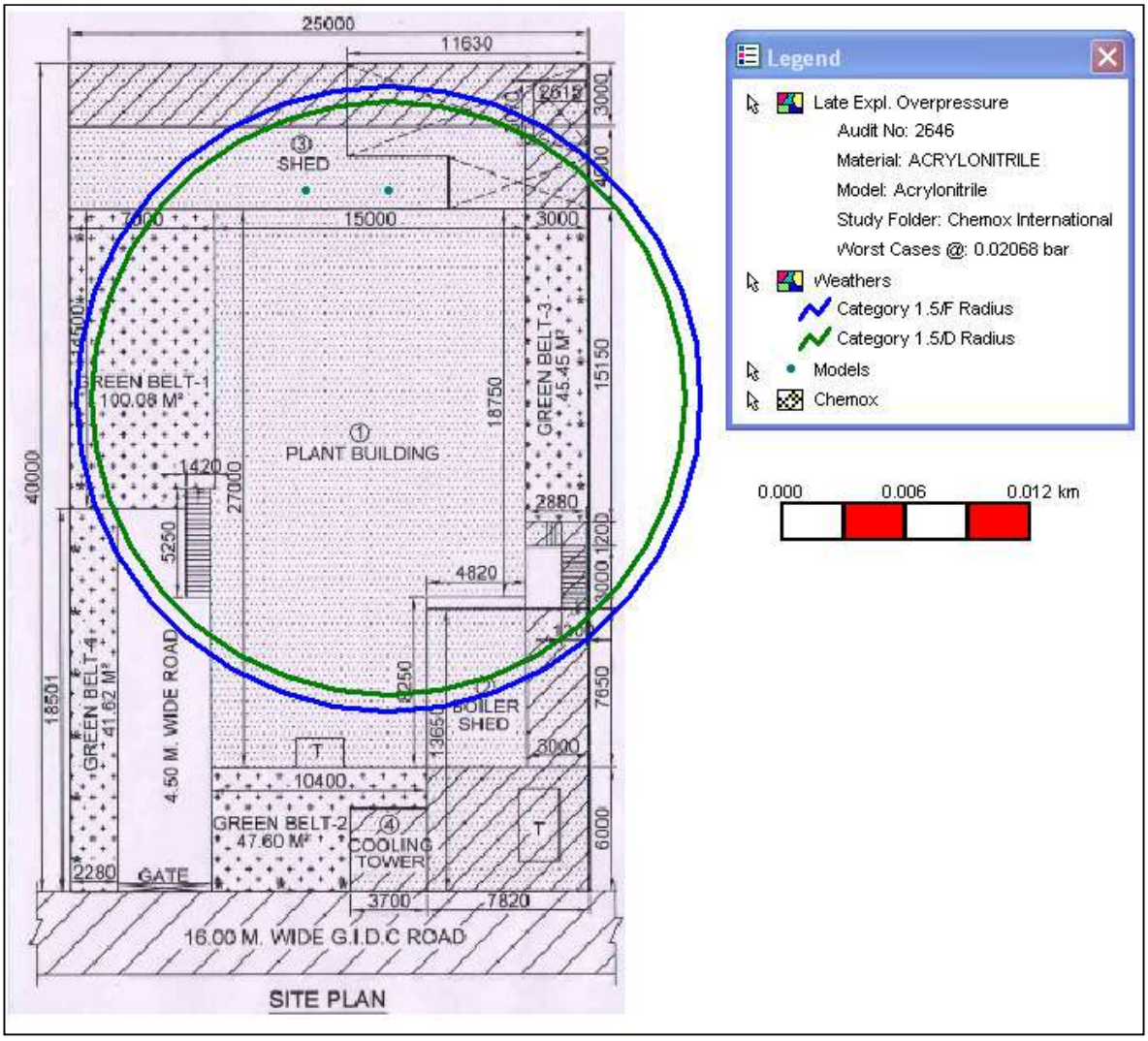

FIGURE: 3

RISK CONTOUR FOR LATE POOL FIRE:

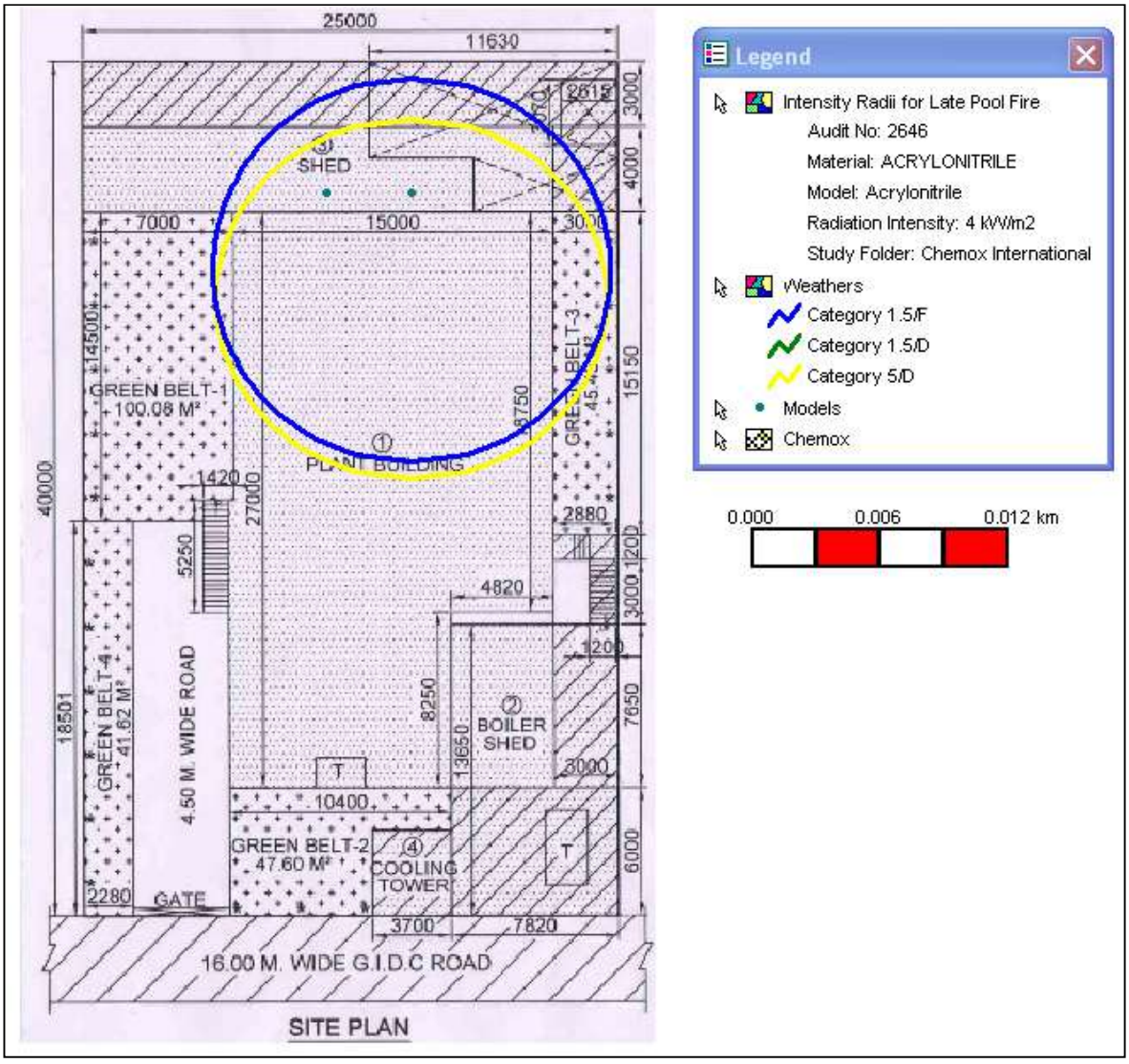

TABLE: 7.7

SCENARIO # 2 – RELEASE OF ACETIC ANHYDRIDE

Basis: Possible Release/Leakage due to 2" damage to drum or tilting of drum with open lid.	
Input Data	
Leak Size Considered	50mm
Release rate	402.33gms/min
Drum gets Empty In	2 min
Pressure	Ambient
Temperature	30 deg C
Weather Condition	1.5/F, 1.5/D, 5/D
LFL	27000
UFL	100000
Flash Fire :	
Concentration (ppm)	**Distance in (m) Category 1.5/F**
16200 ppm 60%	<10
2700 ppm 10%	<10
Toxic	
IDLH (200)	<10
LC_{50} (1000)	<10

Note: Risk Contour not drawn for fire and toxic scenarios due to lesser distance.

❖ CONSEQUENCE ANALYSIS SUMMARY

Flash Fire Scenarios:

SR. No.	Scenario	Concentration (ppm)	Distance (meters)		
			Category 1.5/F	Category 1.5/D	Category 5/D
1.	Release of Acrylonitrile	LFL Frac.12100	13.74	14.45	8.93
		LFL. 24200	7.40	5.86	2.52
2.	Release of Acetic Anhydride	60% LFL	<10	-	-
		10% LFL.	<10	-	-

Explosion Overpressure Scenarios:

SR. No.	Scenario	Overpressure (Bar)	Downwind Distance (meters)		
			Category 1.5/F	Category 1.5/D	Category 5/D
1.	Release of Acrylonitrile	0.02068	25.05	24.30	NR
		0.1379	13.89	13.70	NR
		0.2068	13.01	12.86	NR
2.	Release of Acetic Anhydride	0.02068	NR	NR	NR
		0.1379	NR	NR	NR
		0.2068	NR	NR	NR

Late Pool Fire:

SR. No.	Scenario	Radiation Level (KW/m^2)	Downwind Distance (meters)		
			Category 1.5/F	Category 1.5/D	Category 5/D
1	Release of Acrylonitrile	4	12.56	12.56	13.33
		12.5	8.30	8.30	9.59
		25	6.00	6.00	7.91
		37.5	4.35	4.35	5.77
3	Release of Acetic Anhydride	4	NR	NR	NR
		12.5	NR	NR	NR
		25	NR	NR	NR
		37.5	NR	NR	NR

Toxic Release Scenarios:

Sr. No.	Concentration	Downwind Distance (meters)
		Category 1.5/F
1	LC_{50} (1000 ppm)	<10
	IDLH(200 ppm)	<10

7.4 COMMENTS / RECOMMENDATIONS BASED ON CONSEQUENCE ANALYSIS

Flash Fire, UVCE & Late Pool Fire:

- From the scenarios considered above vapor travels to a maximum distance 14.45 m in case of release on Acrylonitrile in 1.5/D weather condition. If it gets a source of ignition within this radius, it may create UVCE (Unconfined vapor cloud explosion) and effects of overpressure (0.02068 bar) would be felt up to 25.05 m.
- In case of Late pool fire, Acrylonitrile will cover the distance of 13.33m in 1.5/D weather condition for 4 KW/m2 radiation level.

Dispersion:

- In case of dispersion of Acetic Anhydride (<10m) IDLH Concentration covers distance in 1. 5/F weather condition.
- Evacuation plan to be designed considering the above mentioned worst case scenario.

Recommendations:

- Evacuation routes shall be planned such that alternate route is available from any corner in more than one direction.
- Extra precautions to be taken in unloading of flammable/toxic chemicals. The details of precautions during storage handling and transportation of chemicals have been given in separate paragraph.
- Firefighting arrangements shall be provided as per the guidelines of OISD.
- Hazard Identification Studies like HAZOP, HAZAN, Fault tree analysis, Event tree analysis, Checklist Audit etc. will be carried out (if required) for safe operation of plant.
- Safety audit (i.e. Third Party Safety Audit as per IS: 14489) and it's Compliance shall be carried out as per the frequency decided by the management. Audit is an important tool to identify organizational & operational safety policy, and practices, plant conditions or operating procedures that could lead to an accident and significant losses in life or property and their effectiveness against accident preventative program.

7.5 ARRANGEMENTS FOR ENSURING HEALTH & SAFETY OF WORKERS ENGAGED IN HANDLING OF HAZARDOUS MATERIALS.

7.5.1 Following Safety Precautions Are Considered during Transportation, Unloading, Handling & Storage of Solvent and also for Toxic Chemicals, etc.) for its existing facilities, the same shall be updated to cover the new facilities, if required:

Sr. No.	ACTIVITY	SAFETY PRECAUTIONS
1	Transportation of Solvents/ chemicals by road trucks.	• Training is given to driver and cleaner regarding the safe driving, hazards of chemicals, emergency handling, and use of SCBA sets. • TREM card is kept with TL. • SCBA set is kept with TL. • Fire extinguishers are kept with TL. • Instructions are given not to stop road truck in populated area. • Hazard Identification symbol and emergency telephone number are displayed as per HAZCHEM CODE. • Appropriate PPEs are kept with TL.
		In case of leak or spill: • Source of leakage are checked. • Damaged containers or spilled materials are not attended without wearing appropriate protective clothing. • Leak is stopped, if possible to do so without risk. • Water spray is used to reduce vapors (but do not put water directly on leak, spill area or inside container). • Combustibles (wood, paper, oil, etc.) are kept away from spilled material.
2	Unloading Activity	• Priority is given to Truck to immediately enter the storage premises at site and is not kept waiting near the gate. • Security person checks License, TREM CARD, Fire extinguisher condition; and required PPEs as per SOP laid down. **Following precautions are taken during unloading:** • Wheel stopper is provided to TL. • Flexible SS hose connection is done at TL outlet line. • All TL valves are closed in TL. • Only day time unloading is permitted.

3	Solvents Storage safety.	• All storage areas are isolated from all sources of open flame and well posted with' NO SMOKING' signs and provided with adequate fire fighting/extinguishing systems. • Spark-resistant tools are used. • Water spray is used to reduce vapors (but do not put water directly on leak, spill area or inside container). • Combustibles (wood, paper, oil, etc.) are kept away from spilled material. • Fire fighting facilities (along with foam attachment) are available as mentioned below. • Sand Buckets are available.
4	Solvents transfer from storage to process plant.	• Flame arrestor with breather valve is provided on vent line. • Lightening arrestor is provided on the top of tallest structure. • Over flow system is provided for additional safety and it is connected to vessel. • NRV's are provided on pump discharge line. • Double Jumper clip is provided to all solvent handling pipelines.

7.5.1.1 SAFETY PRECAUTIONS FOR SULPHURIC ACID STORAGE AND HANDLING:

MITIGATION MEASURES FOR SULPHURIC ACID LEAKAGE:

- Source shall be isolated, if possible without risk.
- Calcium hydroxide shall be used to neutralize sulphuric acid spillage. Sufficient quantity of Calcium hydroxide shall be maintained for this purpose.
- Leakage will be absorbed with DRY earth, sand or other non-combustible material.
- Do not get water inside container. Do not touch spilled material. Use water spray curtain to divert vapour drift.
- Water spray shall be used to reduce vapors.
- Entry into sewers, basements or confined areas shall be prevented.
- Residue will be neutralized with a dilute solution of sodium carbonate.
- In case of skin contact, person shall be taken to activate shower immediately within 10 sec.

- It shall be ensured that, neutralizing agents like oil and ointments shall never be applied to burns as these aggravate the burn.

PREVENTIVE MEASURES TO AVOID SULPHURIC ACID LEAKAGE:

- A dyke wall will be provided to accommodate the full quantity in tank.
- Periodic testing of storage tank will be done by competent person.
- Exhaust ventilation or other engineering controls shall be provided to keep the airborne concentrations of vapors below their respective TLVs.
- It shall be ensured that the container is kept dry and water is not added to this product.
- In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, medical advice shall be taken immediately.
- Skin and eye contact shall be avoided. Shall be kept away from incompatibles such as oxidizing agents, organic materials, metals, alkalis, moisture.
- Storage: Container shall be kept tightly closed. Keep container in a cool, well-ventilated area.
- While handling always use face shield. Full suit, Vapour respirator. Be sure to use an approved/certified respirator or equivalent.
- It shall be ensured that eyewash stations and safety showers are proximal to the work-station location. Electrical wiring shall be made up of acid-resistant insulation and encased in rigid metals or PVC conduits.
- Smoking and welding shall be strictly prohibited in storage area.
- The flooring shall be of acid resistant materials.
- The flange on the acid pipeline shall be covered for avoiding leakage.
- Action will be taken according to emergency plan.

Specific Guidelines for Handling, Transportation and Storage of Sulphuric Acid:

Recommendations for safe storage of Sulphuric Acid:

- There will be no flange at the road crossing area.
- Seamless joints shall be provided. Number of joints shall be kept minimum.
- The storage area should be well-ventilated.
- LDR (Leak Detection and Rectification) program shall be implemented. In this program, a routine checkup of all the flange joints shall be carried out in order to find out any leakage due to corrosion.

- It is purposed that the storage tank shall be surrounded by a dyke wall, with an acid-resistant protective coating. The capacity of the dyke shall be sufficient to store the inventory in the tank, in case of leakage. The dyke shall be provided with an isolation valve at the bottom, from where the leakage material shall be transferred to appropriate place for neutralization.
- Bulk storage tanks shall be built for atmospheric pressures only.

Recommended Measures for safe handling of sulphuric acid:

- During dilution, always acid will be added to water. Never add water to the acid.
- Proper designing of the tank overflow system shall be done to prevent acid from being expelled from the vent.
- Well-marked showers and eye wash fountains shall be kept accessible.
- Water lines should be tested frequently and the water supply must be tempered (close to body temperature).
- Large amount of water shall be used for washing down a spill, because adding a small amount to sulphuric acid will cause a violent heat generating reaction.
- Small spills during loading or unloading shall be neutralized immediately with soda ash or calcium hydroxide.

Following PPEs shall be used:

- Complete protective clothing shall be worn while working near sulphuric acid
- Acid resistant coveralls that fit snugly at the neck.
- Steel-toed acid resistant boots.
- Acid resistant gloves.
- A face shield to protect the rest of the face.
- A hard hat for protection against overhead drips or spills.

7.5.2 FIRE CONTROL PLAN.

M/s. CHEMOX INTERNATIONAL, Ankleshwar, has considered fire prevention measures at the project planning stage to avoid any outbreak of fire. But the chances of outbreak of fire cannot be totally ignored. Hence to tackle such a situation, company has planned to develop a well- resourced and adequate fire protection system/fire fighting network. The same facilities shall be updated to cover the expansion facilities also, if required.

Other details on Fire Control Plan and same shall be updated for expansion facility if required:

- Fire fighting facilities comprising has been installed as per the GFR and TAC guidelines, the same shall be updated after the expansion of new facilities, if required.
- Fire Extinguishers like DCP, Carbon Dioxide & Foam types has been provided as per the GFR and TAC guidelines, at conspicuous locations.
- Other Fire fighting facilities like, fire monitor, foam trolley, fire hose boxes with hose pipe, sand buckets, fire blanket, Jumbo bags, Water Jet Fire Blanket, etc. shall be provided within the company at conspicuous locations.
- Working staff is given training to operate DCP and CO_2 extinguishers.
- Emergency Action Team members are working round the clock in all shifts.
- First aid is available round the clock in all shifts of all plants / sections.
- Rescue kits with SCBA sets are available at site to treat with any kind of chemical emergencies.
- Volume level indication with alarm and trips for high level are provided for vessels containing flammable materials.
- DG Set is available for power backup.

7.5.3 WAYS TO MINIMIZE THE MANUAL HANDLING OF THE HAZARDOUS CHEMICALS.

1. Forklifts are used for unloading chemical barrels/carboys, their movements within plant, handling carboys, bulk chemical bags, etc.
2. Cranes, hoists, pallet trucks, conveyors, etc. are used as per the requirement, to eliminate manual handling.
3. Lifting tools & tackles are used, wherever required.
4. SOPs, work instructions are prepared and followed.
5. Trainings are provided to relevant staff, operators, workers for the risk associated with manual handling of hazardous chemicals, ways to overcome those risk, etc.

7.5.4 SAFE OPERATING PROCEDURE

- SOP is a procedure which is specific to the operation that describes the activities necessary to complete tasks in accordance with industrial activities.

- SOP shall be well prepared, documented and displayed in local language.
- SOPs like Raw Material Charging, Operation of APCM and Operation in utilities already being followed.
- Some of the following SOPs will be prepared on need basis:
  - Raw material Charging
  - Loading & Unloading Activities
  - Pre Start Up Safety Review (PSSR)
  - Reactor Cleaning
  - Etc.

7.5.5 DO'S & DON'TS

Management has listed some of the Do's & Don'ts activities to strengthen the **SAFETY AT WORK**, which will be followed strictly:

For Preventive Maintenance

Do's:

- Inspection of Storage Area, Earthing & Bonding system.
- Inspection of all Fire Fighting Facilities /Check Alarms operation.
- Ensuring that operators/workers etc. follows the SOPs, Safety procedures & standards, work permit system etc.
- Checking the availability of Spill Containment Kit.
- Make sure existing fire extinguishers are fully charged and ready for action.
- Inspections of plant, machinery, tools, equipment, premises, work practices, processes, procedures and general environment must be carried out for the health and safety of plant, people and surrounding.
- On-site and Offsite Emergency Plans shall be reviewed and updated, as per the requirement.

Don'ts:

- Don't allow anyone who hasn't received specific safety and operational training to get indulge in any site activity.
- Don't perform your own maintenance.
- Don't compromise on Design and Engineering part.
- Don't perform any activity without proper permit.
- Don't panic if you are in a risky situation.

- Don't allow spilled chemicals to drain to sewers/gutters etc.

Strengthening of HSE (Applicable for Manufacturing Utility Staff)

Do's:

- Correct or report unsafe conditions.
- Include a timeline for completion of each recommendation.
- Make recommendations that are measurable and track able.
- Ensure that each recommendation is assigned to an individual to oversee implementation.
- Help keep things clean & orderly. Keep gangways clear.
- Report all injuries. Get first aid promptly.
- Use, adjust and repair equipment only, when authorized.
- Use right tools & equipments for the job, use them safely.
- Use prescribed protective equipment; keep them in good working conditions.
- Respect signs / warnings. Abide by rules laid down for your safety.

Don'ts:

- Do not take chances. If you don't know, ask. Follow instructions.
- Do not make vague statements, do not overrule supervisor, do not adopt shortcuts.
- Do not smoke in restricted areas. Do not flick cigrate/ beedi in company.
- Do not Horseplay. Do not run. Avoid distracting others. Avoid throwing things

1) No worker in a factory-

- Shall wilfully interfere with or misuse any appliance, convenience or other thing provided in the factory for the purpose of securing the Health, Safety or Welfare of the workers therein:
- Shall wilfully and without reasonable cause do anything likely to endanger himself or others; and
- Shall wilfully neglect to make use of any appliance or other thing provided in the factory for the purposes of securing the Health or Safety of the workers therein.

7.5.6 ANTIDOTES DETAILS:

The appropriate antidotes for the hazardous chemicals for the existing facility are available at site and the same shall be updated & kept available for the expansion facility also.

Following Antidotes for major hazardous chemicals are kept available at the site.

Chemical	Antidote / Medical Treatment
Acrylonitrile	• Very careful treatment of cobalt E.D.T.A. (calocynor) and if that is not effective give nitrite/thiosulphate treatment
Acetic Anhydride	• Ensure that adequate decontamination has been carried out. If patient is not breathing, start artificial respiration, preferably with a demand-valve resuscitator, bag-valve-mask device, or pocket mask, as trained. Perform CPR as necessary. Immediately flush contaminated eyes with gently flowing water. Do not induce vomiting. If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain an open airway and prevent aspiration. Keep patient quiet and maintain normal body temperature. Obtain medical attention. /Organic acids and related compounds

7.5.7 LEAK DETECTION & REPAIR PROGRAM

Leak Detection and Repair (LDAR) is a program implemented to comply with environmental regulations for reducing the fugitive emissions of targeted chemicals into the environment. In addition to control fugitive emissions, LDAR Program also helps the industries to reduce unwanted losses of chemicals and thereby conserving energy & increasing their profitability.

Need of Leak detection and Repair (LDAR) programs:

Fugitive emissions constitute a source of air pollution and fire. EPA has determined that leaking equipment, such as valves, pumps, and connectors, are the largest source of emissions of volatile organic compounds (VOCs) and volatile hazardous air pollutants (VHAPs) from chemical manufacturing facilities.

A benefit of LDAR program is reduction of product losses. Facility that apply LDAR also increase safety for workers and operators, decrease exposure of the surrounding community, reduce emission fees and help facilities avoid enforcement action.

Following steps shall be followed for effective implementation of LDAR Program:

1. **Identification of volatile chemicals which may contribute in VOCs:**

In existing plant, following are the list of chemicals which may contribute in VOCs.

- Acrylonitrile
- Acetic Anhydride

2. **Identification of all the probable sources of leakage**; such as valves, pumps, and connectors.

List of the sources of probable leakage is as follows:

- Valves/Flanges
- Pump glands handling above chemicals
- Open vents from the tank top
- Pump seals
- Compressor seals
- Pressure relief devices
- Process drains
- LPDs (Low Point Drains)
- HPVs (High Point Vents)

A list of all such items shall be made and same shall be incorporated in the checklist for LDAR.

3. **Selection of appropriate method for leak detection:**

Considering the nature of the chemical; appropriate method shall be selected for leak detection of individual chemicals from the list given below:

- Visual Checks
- LEL meter
- VOC meter
- Gas Detector
- Etc.

4. **Scheduling and checklist for Leak Detection:**

   All points shall be checked as per the checklist given below.

5. **Methods for rectification of identified leaks:**

   For all identified leaks, closure shall be ensured with the help of maintenance department and records for the same shall be maintained.

Checklist for implementation of LDAR Program to reduce emissions of VOCs.

Sr. No.	List of Source of leakage	Name of Chemical	Method of leak check	Frequency Weekly/Monthly / Quarterly	Checked on	Checked by	Observations/ Remarks	Leak to be attended by (Repair to be done within 5 working days)	Leak attended on	Closure Note

NOTE: we have not addressed the recovery of solvents. You may prepare write up about maximizing the recovery of solvents to reduce emissions.

Records of leak detection have been maintained by client and are available at site.

7.6 ONSITE AND OFFSITE EMERGENCY PLAN

M/s. CHEMOX INTERNATIONAL, Ankleshwar has prepared the On-site emergency Plan which is linked with District Disaster Management Plan. This plan has been prepared based on the risk contours plotted on the plant layout map clearly showing the facilities that would be affected, in case an accident takes place.

The purpose of this plan is to provide **M/s. CHEMOX INTERNATIONAL,** Ankleshwar. With the means to effectively utilize all the resources at its disposal for the protection of life, environment and property. The same ERP shall be updated after expansion to cover new plants or facilities, if required. The details of the same are discussed in the following sections.

7.6.1 DEFINING THE NATURE/LEVEL OF EMERGENCY

THE LEVEL OF EMERGENCY CAN BE CLASSIFIED IN THREE CATEGORIES:

LEVEL - 1:

The leakage or emergency, which is confinable within the plant/area. It may be due to:

a) Small pipe/valve rupture or similar leakages that do not affect outside premises.
b) Release of toxic chemicals for short duration.
c) Small fire in the plant.

LEVEL - 2:

The emergency, which is confinable within the factory premises. It may arise due to -

a) Leakage of toxic chemicals for long duration.
b) Medium scale explosion confined to the factory premises.
c) Medium scale fire inside the factory premises.

LEVEL - 3:

The emergency, which is not confinable within the factory premises and general public in the vicinity are likely to be affected. It may arise due to -

a) Heavy / Profuse leakage of toxic / flammable gases for a long duration.
b) Explosion of high magnitude affecting the adjacent area.

c) Major fire inside the factory premises.

7.6.2 OBJECTIVES OF EMERGENCY MANAGEMENT SYSTEM

The objectives of the emergency management system are summarized as under.

- To define and assess emergencies, including risk and environment impact assessment.
- To control and contain incidents.
- To safeguard employees and people in vicinity.
- To minimize damage to property or/and the environment.
- To inform employees, the general public and the authority about the hazards/risks assessed, safeguards provided, residual risk if any and the role to be played by them in the event of emergency.
- To be ready for 'mutual aid' if need arises to help neighbouring unit. Normal jurisdiction of an OEP is limited to the own premises only, but looking to the time factor in arriving the external help or off-site plan agency, the jurisdiction must be extended outside to the extent possible in case of emergency occurring outside.
- To inform authorities and mutual aid centers to come for help.
- To effect rescue and treatment of casualties. To count injured.
- To identify and list any serious injuries and or fatalities.
- To inform and help relatives.
- To secure the safe rehabilitation of affected areas and to restore normally.
- To provide authoritative information to the news media.
- To preserve records, equipment etc, and to organize investigation into the cause of the emergency and suggest preventive measures to stop its recurrence.
- To ensure safety of the works before personnel re-enter and resume duty.
- To work out a plan with all provisions to handle emergencies and to provide necessary inputs for emergency preparedness and the periodical rehearsal.

7.6.3 STRUCTURE OF EMERGENCY MANAGEMENT SYSTEM

M/s. CHEMOX INTERNATIONAL, Ankleshwar has developed an emergency management team. The management structure includes the following personnel's;

- Site Main Controllers.
- Incident Controllers and Deputy Incident Controllers.
- Key Personnel's.

- Essential Workers.

The other elements of Disaster Management Plan are:

- Assembly points.
- Emergency control center.
- Fire control arrangements.
- Medical arrangements.
- Other arrangements.

❖ **SITE MAIN CONTROLLER**

He is the head authority of the organization. V.P. – Operations holds the responsibilities of the site main controller or emergency controller. He is having overall responsibilities for directing operation.

Immediately on hearing of emergency, he will proceed to Gate House, where he will meet the Communication Officer.

- From time to time, he will assess the magnitude of the situation and decide if staff needs to be evacuated.
- Exercise direct operational control of those parts of the works outside the affected area.
- Maintain a continuous review of possible developments and assess these to determine the most probable course of event.
- Initiate the shutting down and evacuation of plant in consultation with the Incident Officer.
- Liaise with Police Services and provide advice on possible effects on areas outside the factory.
- Issue authorized statements to the news media. Where appropriate, inform the Director.
- Ensure that proper consideration is given to the preservation of evidence.
- Control rehabilitation of affected areas on cessation of emergency.
- Determine what investigations and reporting should be carried out and by whom, to determine cause and prevention of reoccurrence.

❖ ROLE OF INCIDENT CONTROLLER AND DEPUTY INCIDENT CONTROLLER

His primary duties shall be to take charge at the scene of the incident. In the initial stage he may be required to take decisions involving the operation of the other plants or to stop or continue any process and to take technical decisions to control the incident. The deputy incident controller will take the charge of incident controller, if he is not available due to any reason. They will be always available in each shift and can take charge of the incident.

Responsibilities/Duties of Incident Controller and Deputy Incident Controller:

- Managers connected with Plants/the respective Plant-In-Charge from each shift have been designated as I.C.
- Two Production officers in each shift will be identified as Deputy Incident Controllers.
- He shall take charge at the scene of incident.
- He shall immediately assess the gravity of risk and alert panel and field operators to start controlling their respective section.
- He will work under the direction of the SMC, but till his arrival he may have to execute following responsibilities.
- He will ensure that all the Key Personnel are called.
- Direct for evacuation of plant and areas likely to be affected by the emergency.
- He shall communicate to the SMC the type of outside help needed.
- He shall direct all emergency operations within the affected area with the following priorities.
- Personnel safety, including of surrounding community.
- Minimum damage to Plant, Property and Environment.
- Appropriate actions to minimize loss of Production and Material.
- Give information to the head of fire fighting and rescue team and other emergency services.
- Depending on the incident, instruct partial or total shut down, isolations, depressurization, Nitrogen purging, fire fighting, rescue operations.
- Instruct upstream/downstream units to take emergency shutdown /cutting off supply and other appropriate actions and emergency evacuation help etc.
- Direct for search of casualties.
- Evacuate non-essential workers/visitors/contractors to safe assembly points.

- Brief site main controller and keep him informed about the developments.
- Preserve evidences. This will be necessary for investigation for cause and concluding preventive measures.

❖ **KEY PERSONNELS**

Senior officers of various departments like Fire, Security, Safety, Administration, Engineering, Project, Production, Transport, Pollution control, Technical Services and Stores shall be nominated as Key Personnel in their respective fields. As necessary, they shall decides the actions needed to shutdown plants, evacuate personnel, carryout emergency engineering work, arrange for supplies of equipments, utilities, carryout environment monitoring, provide catering facilities, liaise with police, fire brigade and other local authorities, relative of casualties, hospital, press & neighbouring industries, action at assembly points, outside shelters and mutual aid centre under the direction of the SMC. All the key personnel and other called in so to assist, shall report to the ECC. They are available at any time on duty or on call or on holidays.

❖ **ESSENTIAL WORKERS:**

Essential Workers shall be those who shall be trained in Fire Fighting and First Aid. One Supervisor and two helpers from each shift will be Identified as E.W.'s & shall suppose to report at EMERGENCY SITE to take instructions from I.C. or Dy. I.C. Such work instructions will include:

- Fire fighting and spill control till a Fire Brigade takes the charge.
- To help the Fire Brigade and mutual aid teams, if it is so required.
- Shutting down plant and making it safe.
- Emergency engineering work e.g. isolating equipment, material process, providing temporary by-pass lines, safe transfer of materials, urgent repairing or replacement, electrical work, etc.
- Provision of emergency power, water, lighting, instruments, equipments, materials, etc.
- Movement of equipment, special vehicle and transport to or from the scene of the accident.
- Search, evacuation, rescue and welfare.
- The injured will be given First Aid.

- Carrying out atmospheric test and pollution control.
- Manning of assembly points to record the arrival of evacuated personnel. Manning for outside shelters and welfare of evacuated persons there.
- Assistance at causalities reception areas to record details of causalities.
- Assistance at communication centres to handle outgoing and incoming calls and to act as messengers if necessary.
- Manning of works entrances in liaison with the police to direct emergency vehicles entering the work, to control traffic leaving the works and to turn away or make alternative safe arrangements for visitors, contractors and other traffic arriving at the works.
- Informing surrounding factories and the public as well as directed by the Site Main Controller.
- Any special help required.

OTHER ELEMENTS OF DMP:

❖ **ASSEMBLY POINT**

In affected & vulnerable plants, all nonessential workers (who are not assigned any emergency duty) will be evacuated from the area & they shall report to specified Assembly Points. Assembly Point is marked at a safe place, well away from area of risk and least affected by the down wind direction.

To ensure that workers do not have to approach the affected area to reach the Assembly Point, proper location and number shall be marked at Assembly Points. Each Assembly Point shall be manned by a nominated person to record the names and dept. At each Assembly Point, duties of Assembly Point In-charge are displayed in brief. Before reaching an Assembly Point or subsequently, if it is required to pass through an affected area or due to presence of toxic substances, suitable PPE's including respirators, helmet etc., shall be issued & made available with workers.

❖ **EMERGENCY CONTROL CENTER**

The Emergency Control Centre is the place or room from where the operations to handle the emergency are directed and coordinated. A room near Security Gate has been earmarked/identified as the Emergency Control Room.

Telephone and other facilities required with necessary documents are displayed in ECC for ready reference. ECC has been operated by Site Main Controller, key personnel and Senior Officers of the Fire, Police, Factory Inspectorate, District Authorities and Emergency Services.

The ECC centre is equipped with the following facilities:

- Internal and external telephone including STD facility.
- Telephone directory/ Telephone nos. of mutual aid centres.
- Factory Layout showing evacuation plan, fire fighting arrangements, emergency control centre, location of assembly points, etc.
- First Aid.
- Gate pass book.
- Muster roll of Workers.
- Work permit book.
- Identity card register.
- Copy of ON SITE/ OFF SITE PLAN.
- Stationeries like- note book, pen, pencils etc.
- SCBA Sets.
- Sand Buckets & Hydrant Network.
- Adequate numbers of PPE's (like dust mask, Air Mask, safety dress, PVC hand gloves, Full Face piece respirator with 3M cartridge, helmet, goggles, etc).

❖ **FIRE CONTROL ARRANGEMENTS (FIRE FIGHTING, GAS LEAK CONTROL AND RESCUE OPERATION)**

A. Role of Manager (Fire and Safety) / Shift In-Charge (Fire & Safety)

1. Incident Controller directs the firefighting and Emergency operation. His duties include…
2. Keep the constant touch with the SMC / In charge - EHS.
3. Direct the crew members to the scene of emergency and arrange replenishment of Manpower / equipment / extinguishing media etc.

B. Role of EHS Representative:

1. On being notified about the location of fire/ gas leakage, he immediately proceeds to the help.

2. Decides his line of action in consultation with Incident controller and takes appropriate measures to handle the emergency.
3. Assessing the severity of the incident, immediately report to emergency controller about the gravity of the situation.
4. He assesses the extra requirement required if any, from the neighbouring industry.

C. Fire crew members

1. On hearing fire alarm, emergency siren they immediately reports to control room and proceed to the scene of emergency and work under the direction of IC/ Dy IC.
2. The personal availability at the scene of incident to be made optimize.

❖ **MEDICAL SERVICES**

The roles of Medical officers are as follows;

(a) He will report immediately to the SMC/IC.

(b) He will render necessary treatment, at Occupational Health Center.

(c) He will arrange for Hospitalization and Treatment at outside hospitals, if required.

(d) He will mobilize in getting the services of External medical agencies, other Para – medical services etc. and transportation services etc.

(e) He will arrange for extra medical assistance/antidotes, from out, if required.

(f) He will arrange for first-aid trained volunteers for necessary help.

(g) He will liaise with the Government Health Authorities for treatment of the affected persons nearby.

❖ **ROLE OF SECURITY IN-CHARGE (SECURITY OFFICER)**

- On hearing the emergency siren, he shall find out the location of the incident (fire / gas leak / spill / explosion) and inform the location of the same to the key personnel coming to the plant.
- He will depute the security guards for managing gates and traffic control at the incident site & send remaining guards to the site of incident.
- He will prevent unauthorized entry in to the site
- He will render assistance as demanded by the safety in-charge.
- He will mobilize additional security force for help, if required.
- He will direct ambulance(s) and emergency vehicle(s) to the scene of incident.
- He will help evacuate persons within the scene of incident.

- As directed by the site main controller, he may be required to address the public of surrounding villages for warning / evacuation.

❖ **ROLE OF MUTUAL-AID MEMBERS**

- Company has Mutual Aid with various nearby factories and GIDC fire station etc.
- On receiving the call, they shall proceed immediately with fire squad & fire tenders.
- They will be guided to the place of the incident by the main gate security guard.
- The fire squad in-charge will report to the safety in-charge of the unit in which the incident has occurred.

❖ **OTHER ARRANGEMENTS**

Other arrangements include external transport (transport centre), heavy vehicles, lift/cranes, Utilities, generator sets to supply emergency power, environment monitoring equipment, special instruments/equipments, rescue items etc. is made available from Ankleshwar Association or nearby locations, when available resources do not meet the requirements.

STANDARD OPERATING PROCEDURE (FOLLWED DURING EMERGENCY)

- As soon as emergency alarm is heard, all essential workers shall report to IC or SMC.
- They shall carefully listen to the instructions given by IC or SMC
- According to the type of emergency/accident, they shall get equipped with PPE/Fire fighting equipment and devices.
- The runner among the workers shall inform SMC/IC and key personnel if they are not at site.
- The messenger amongst the workers shall deliver messages to nearby units as per the instructions of SMC/IC.
- The in-charge of medical arrangements shall prepare first-aid and other required facilities for the injured.
- The other essential workers shall try to control the emergency as per the instructions given to IC.
- IC would keep SMC informed about the status of control measures being taken at the site and ask for other requirements e.g. Mutual aid, equipment etc. if he find necessary.
- SMC would co-ordinate with outside agencies regarding control measures being taken, need for external help, evacuation, medical treatment etc.

7.6.4 COMMMUNICATION SYSTEM FOR ON-SITE & OFF-SITE EMERGENCIES

After assessing the risk of the emergency / incident, the second step of the plan is communication.

This chapter deals with the procedure to be followed at the time of emergency to inform following personnel.

- Incident controller
- Site main controller
- Other key personnel
- Mutual aid centers
- Neighbouring industries and public in vicinity
- Government authorities.

The communication of emergency begins with sounding the siren from the emergency. The procedure us as under;

❖ **RAISING THE ALARM**

As soon as incident takes place inside the factory and is noticed by someone, the first step shall be to raise the nearest manual emergency bell to alert the nearby people. Next, he/she shall inform the security persons to raise the emergency siren located at the factory gate. The security personnel sound the siren.

The alarm sound informs the I.C and the S.M.C that an emergency has been created and emergency organization is to be activated. The I.C. rushes to the site and shall takes charge of the scene.

❖ **DECLARING THE MAJOR EMERGENCY**

The nominated persons are technically qualified and experienced. They will advice the incident controller or the Site main controller. The site main controller with the consultation to technical persons declare major emergency.

The joint decision to declare major emergency shall be taken as early as possible and without wasting time.

❖ **TELEPHONE MESSAGES**

After hearing the emergency siren or even receiving the emergency message on phone, the telephone operator (security officer) transmit the message to site main controller and key personnel as per the instruction received from incident controller.

❖ **COMMUNICATION OF EMERGENCY & STATUTORY INFORMATION**

Communication of Emergency:

An effective system to communicate emergency has been made to communicate about the emergency situation as mentioned below:

- Inside the factory i.e. workers including key personnel and essential workers, on duty & inside during normal working hours.
- To key personnel and essential workers not on duty and outside during normal working hours.
- To the outside emergency services and the Government authorities.
- To the neighbouring factory & the General Public in the vicinity.

STATUTORY INFORMATION:

a) Information to Workers

Set of Statutory information regarding types of hazards and their prevention and control as directed in the Factories Act is prepared by the unit. This information is printed in the local language and given in the form of booklet to all workers including contract workers.

b) To the outside emergency services and District Emergency Authority

Statutory information in the form of booklet is given to outside emergency services and authorities, if required.

c) Specific Safety Measure to be taken for neighbouring firms, general public vicinity& Factory Inspectorate

- Statutory information in the form of booklet, is given to neighbouring units and the general public of the villages in the vicinity of the unit, if required.
- General Public in the vicinity shall be trained for associated chemical hazards, safety measures, on-site & off-site emergencies, individual actions required during emergencies, first aid, etc.

- General Awareness Seminars will be conducted.
- Required safety drills, Off Site drill, etc will be conducted.

7.7 OCCUPATIONAL HEALTH & SAFETY

M/s. CHEMOX INTERNATIONAL, Ankleshwar, has prepared the **Occupational Health Surveillance Programme** for its existing facility. The same programme shall be updated (if required) after the expansion, to cover new plants or facilities. The details of the existing programme are described in the following sections.

7.7.1 OCCUPATIONAL HEALTH

Occupational health needs attention both during construction & erection and operation & maintenance phases. However, the problem varies both in magnitude and variety in the above phases.

7.7.2 HOSPITAL FACILITIES

Company has made formal agreements with the hospitals Jayaben Modi Hoapital, having facilities to attend fire and toxic effect cases, emergency cases, attending the affected persons in the emergency arising out of accidents, if any, etc.

Emergency vehicle is available round the clock in the factory to transport the victim/injured person from the factory to the nearby hospital. Ambulance is equipped with Stretcher, First aid box, Oxygen Cylinder, Mask, etc.

7.7.3 FACTORY MEDICAL OFFICER/OHC

A qualified doctor has been appointed as FMO on retainer ship basis. Apart from him, Paramedical Staff has also been employed. Adequate no. of employees is trained in First aid.

7.7.4 PLAN FOR PERIODIC MEDICAL CHECKUP

Periodic Medical Examination is being conducted as per the following schedule;

Workers employed are examined by a Qualified Medical Practitioner/ Factory Medical Officer, in the following manner:

(a) Before employment, to ascertain physical fitness of the person;

(b) During employment, once in a period of 6 months, to ascertain physical fitness of the person to do the particular job;

Medical examinations are then documented in Form no.: 32 & 33 and maintained.

7.7.5 DETAILS OF OCCUPATIONAL HEALTH IMPACTS AND SAFETY HAZARDS

Occupational Hazards	Occupational Health Impacts
• Exposure to Toxic Chemicals.	• Toxication, Irritation,
• Exposure to Flammable Solvents.	• Fall Injury, Electrocution,
• Fire due to Static charge generation	• Body Injury, Burns, Skin sensitization,
• Slip/trip, fall, electric shock, etc.	• Severe irritation to eyes & skin,
• Spillage/leakage,	• Respiratory disorder,
• Overflow,	• Damage to nearby equipments,
• Exposure to Corrosive Chemicals.	• Fatality, etc

Mitigation measures/Safety Measures proposed to avoid the human health hazards are mentioned under section 7.5. Personal protective equipments like Helmet, Safety shoes/ Gumboots Hand gloves, Gas Mask / Nose Mask, PVC apron, SCBA Set, PVC pressure suit, Bobble hood are also provided to the required personnel.

7.7.6 WORKZONE MONITORING ARRANGEMENTS FOR HAZARDOUS CHEMICALS

Work zone monitoring is carried out by independent competent third party every month. Records are kept in Form No. 37 as per Gujarat Factories Rules. Location for samplings shall be identified. Samples are analysed for Air borne concentration of hazardous chemicals in ppm. Following information is incorporated in the format for maintaining records of work zone monitoring:

Location/Operation monitored

- Identified contaminant
- Sampling instrument used
- Number of Samples
- Range of contaminant concentration as measured in sample
- Average concentration
- TWA concentration of contaminant (As given in Second Schedule of Factories Act)
- Reference method used for analysis
- Number of workers exposed at the location being monitored
- Signature of the person taking samples
- Other relevant details

7.7.7 PROVISION OF INDUSTRIAL HYGIENIST & HEALTH EVALUATION OF WORKERS

1. Management has device a plan to check and evaluate the exposure specific health status evaluation of workers.
2. Workers are checked for physical fitness with special reference to the possible health hazards likely to be present, where he/she is being expected to work before being employed for that purpose. Complete medical examinations including PFT, Urine and Blood examination, Liver Function tests, chest X-ray, Audiometry, Spirometry Vision testing, ECG, etc. is carried out. However, the parameters and frequency of such examinations are decided in consultation with Factory Medical Officer and Industrial Hygienists and the details of the same are maintained in record.
3. While in work also, all the workers are periodically examined for the health with specific reference to the hazards which they are likely to be exposed to, during work. Again, the parameters and frequency of such examination are decided in consultation with Factory Medical Officer and Industrial Hygienists. Monthly and yearly report of the health status of workers with special reference to Occupational Health and Safety is maintained.

7.7.8 SAFETY TRAININGS & MOCK DRILLS

Safety trainings (on Safe Material Handling, First Aid, & all Safety Aspects) shall be provided every 15 days by the Safety Officers with the assistance of faculty members called from other Professional Safety Institutions and Universities. In addition to regular employees, limited contractor labours will also be given safety training. To create safety awareness, safety films shall be shown to workers and leaflets are distributed.

MOCK DRILLS

To evaluate the effectiveness of emergency preparedness and to spread the awareness among employees mock drill will be carried out at the interval of every six months.

After completion of the mock drill, summary report shall be made and corrections will be done if any weakness has been observed.

FREQUENCY OF MOCK DRILLS:

- On-site emergency : Once every 6 months
- Off-site emergency : Once every year