THE ANDHRA SUGARS LIMITED

(CHEMICALS AND FERTILIZERS DIVISION)

SY. NO. 132, 133, 134 AND 137, SAGGONDA VILLAGE, GOPALAPURAM MANDAL, WEST GODAVARI DISTRICT, ANDHRA PRADESH

RISK ASSESSMENT REPORT

Project No. 0219-13-01
February 2019

The Andhra Sugars Limited
(Chemicals and Fertilizers Division)
Kovvur, West Godavari District, Andhra Pradesh
Pin code-534 350
Phone :08813 231597, 98, 99
E-mail: info.kvr@theandhrasugars.com

STUDIES AND DOCUMENTATION BY
TEAM Labs and Consultants
B-115-117 & 509, Annapurna Block,
Aditya Enclave, Ameerpet,
Hyderabad -500 038.
Phone: 040-23748 555/23748616,
Telefax: 040-23748666

SUBMITTED TO

MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE GOVERNMENT OF INDIA INDIRA PARYAVARAN BHAWAN, JOR BAGH ROAD, NEW DELHI

7.0 RISK ASSESSMENT AND DAMAGE CONTROL

7.0 Introduction

This chapter presents the risk assessment study results for the plant operations, transport and storage of raw materials, and identifies maximum credible accident scenarios to draw the emergency management plan addressing various credible scenarios identified.

7.1. Objectives and Scope

The production of caustic soda and synthetic organic chemicals involves usage of many chemicals which are both hazardous and toxic in nature. The risks associated with the chemical industry are commensurate with their rapid growth and development. Apart from their utility, chemicals have their own inherent properties and hazards. Some of them can be flammable, explosive, toxic or corrosive etc. The whole lifecycle of a chemical should be considered when assessing its dangers and benefits. In order to ensure the health and safety of persons at or near the facilities, Govt. has approved some regulations.The regulation requires Employers to consult with employees in relation to:

- Identification of major hazards and potential major accidents
- Risk assessment
- Adoption of control measures
- Establishment and implementation of a safety management system
- Development of the safety report

The involvement of the employees in identification of hazards and control measures enhances their awareness of these issues and is critical to the achievement of safe operation in practice. In order to comply with regulatory authorities, M/s The Andhra Sugars Limited have entrusted Team Labs and Consultants, Hyderabad to review and prepare Hazard analysis and Risk assessment for their facility along with an approach to on-site emergency preparedness plan as required under the acts and rules. (Manual on emergency preparedness for chemical hazards, MoEFCC, New Delhi).In this endeavor, the methodology adopted is based on;

- visualizing various probable undesirable events which lead to major accidents

- detailed and systematic assessment of the risk associated with each of those hazards, including the likelihood and consequences of each potential major accident event; and
- identifying the technical and other control measures that are necessary to reduce that risk to a level that is as low as reasonably practicable

The strategy to tackle such emergencies, in-depth planning and person(s) or positional responsibilities of employees for implementation and coordination of timely and effective response measures are described in onsite detail in Emergency Plan.

7.2 Project Details

The plant site is located at Survey No. 132, 133, 134 and 137 Saggonda village, Gopalapurammandal, West Godavari district, Andhra Pradesh. The site is situated at the intersection of latitude $17^{0}10'49''$N and longitude $81^{0}37'8''$E. The site elevation above mean sea level (MSL) is in the range of 25-48 m. The site is surrounded by open lands in north, South and east directions. Coal Based power plant in west of site. The nearest habitation from the plant is Gopavaram village located at a distance of 2.7 km in southwest direction. The main approach road Hukumpeta to Gopavaram is 2.7 km in southwest direction. The nearest Town and Railway station Kovvuru is at a distance of 30 km in southeast direction and nearest airport is Rajahmundry located at a distance of 40 km in southeast direction. Godavari River is flowing from northeast to southeast direction at a distance of 3.7 km in east direction; KovvadaKalva is flowing from northeast to southeast direction at a distance of 4.2 km in north direction. There are four reserved forests in the study area, Polavaram RF is at a distance of 7.4 km in northwest direction, Polavaram Protected Forest is at a distance of 9 km in north direction, Vinjaram RF is at a distance of 8.9 km in northwest direction, Purushottapatnam RF is at a distance of 9 km in northeast direction. There is no National Park, sanctuary, critically polluted area and interstate boundary within the impact area of 10 km surrounding the site. The manufacturing capacity is presented in **Table 7.1** Chemical inventory is presented in **Table 7.2**

Table 7.1Manufacturing Capacity

S.No.	Product Name	Capacity (TPD)		
		Existing	Proposed	Total after expansion
	I. Chlor-Alkali Plant			
1	Caustic Soda	400	400	800
2	Caustic Soda Flakes	140	140	280
3	Caustic Potash	--	100	100
4	Liquid Chlorine	240	4	244
5	Hydrogen Gas (bottling)	2.83	1	3.83
6	Liquid Hydrogen	1	1	2
	II. Chloromethanes			
1	Methyl Chloride		10	10
2	Methylene Chloride		61	61
3	Chloroform		56	56
	III. Synthetic Organic Chemicals			
1	Mono Chloro Acetic Acid	--	20	20
2	Chlorinated Paraffin Wax (52%)	--	20	20
	IV. Non – EC Products			
1	Sulphuric Acid	300	--	300
2	Poly Aluminum Chloride	90	--	90

	By-Products			
	I. Chlor-Alkali Plant			
1	Hydrochloric Acid (33%)	600	400	1000
2	Sodium Hypochlorite	20	20	40
3	Sodium Chlorate	--	60	60
	II. Chloromethanes			
1	Carbon tetrachloride*		7.6	7.6
2	Hydrochloric Acid		65.8	65.8
	III. Synthetic Organic Chemicals			
1	Hydrochloric Acid (33%) from Chlorinated Paraffin Wax (52%)	--	30	30
2	Hydrochloric Acid (33%) from Monochloro Acetic Acid	--	33	33

**Carbon Tetrachloride (CCl_4) generated will be sold as a feed stack to Authorized users/excess will be incinerated*

Table 7.2 List of Raw Materials and Inventory *(Terms of Reference No. 3(iv) & (3(v))*

S. No	Name of Raw Material	Inventory (MT)	Mode of Storage	Physical Form
Chlor-Alkali				
1	Raw Salt	20000	Open Area	Solid
2	Caustic lye	4 x 600 1 x 750	Storage Tanks	Liquid
3	Sodium Hypo	4 x 20	Storage Tanks	Liquid
4	Potassium Chloride	4000	Covered Shed	Solid
5	Caustic Potash Lye	1x1000 1 x 200	Storage Tanks	Liquid
6	Hydrochloric Acid	6 X 200 2 x 150 14 x 50	FRP Tanks FRP Tanks MSRL tanks	Liquid
7	Chlorine	4 x 120 1 x 48	Pressure Vessels	Liquid
8	Hydrogen	5226 m3	Cylinders	Gas
9	Liquid Hydrogen	25 MT	Pressure Vessels	Liquified
10	Sulphur	15000	Open Area	Solid
11	Sulphuric Acid	3 X 1000 2 X 500	Storage Tanks	Liquid
12	Poly Aluminium Chloride	1 X 200 3 X 100 5 X 50	FRP Storage Tanks & cover shed	Liquid & Powder
Chloromethanes				
1	Methanol	3 x 100	Storage Tanks	Liquid
2	Sulfuric Acid	50	Storage Tank	Liquid
3	Methylene Chloride	2 x 100	Storage Tanks	Liquid

7.3 Process Description

The manufacturing process for all the products is presented in Chapter 2.(**Page No. 2-2 to 2-22**) of the report.

7.4 Plant Facilities

The manufacturing facility shall be provided with

1) Production Area
2) Utilities
3) Quality Control, R&D lab
4) Effluent Treatment plant
5) Warehouses
6) Tank farm area
7) Cylinder Storage
8) Chlorine Storage Area
9) HCl Synthesis area
10) Boiler fuel and Ash Storage Area

The production facilities shall be designed for proper handling of materials and machines. Safety of operators, batch repeatability and process parameter monitoring shall be the major points of focus in the design of facility. The current Good Manufacturing Practices (GMP) guidelines shall be incorporated as applicable to synthetic organic chemicals manufacturing facilities.

7.4.1 Caustic/Potash process area:

Caustic/Potash synthesis consists of

i. Brine dichlorination, saturation and purification
ii. Electrolysis of brine
iii. Chlorine handling
iv. Hydrogen Handling
v. Hydrochloric gas synthesis
vi. Caustic Evaporation and flaking

The following are trip system provided at various section of caustic production area

I. Trip System at Rectifier

1.If chlorine pressure HI-HI

2.Differential Pressure across cathode and Anode HI-HI

3.Emergency push button pressed

4.Catholyte & Pure brine Head Tank levels Low-Low

5.Anolyte Tank HI-HI

6.All Chlorine compressors tripped

7.Waste Air Chlorine Valve Opened

II. Trip System at Electrolyser

1.Current HI-HI on electrolyser

2.Voltage Difference across Electrolyser elements HI-HI

3.Brine & catholyte flow to Electrolyser Low-Low

4.Emergency push button pressed

5.Catholyte Temperature HI-HI

6.Anolyte / Catholyte Valve closed

The entire plant operation is operated by DCS system wherein all the operations including the parameters like temperature, pressure, flow etc. are controlled. In case of emergency, emergency push buttons cane be operated in the DCS room. The DCS has indicators and alarms for process parameters like temperature, pressure, flow, and level.

III. For leakage detection of Chlorine several

1. Chlorine gas detectors are located like chlorine storage, chlorine filling, chlorine neutralization tower outlet, HCl plant, Cell House, Dichlorination to raise alarm.
2. The storage tanks are designed as per codes and periodically tested.
3. The storage tanks are provided with safety valves and alarms for pressure, temperature, flow and level. Dyke walls are provided for the storage tanks.
4. Water seals are provided in Chlorine and Hydrogen headers and the seals, vents etc., in the Chlorine header are connected to the Hypo header.

IV. Chloromethanes

Manufacturing of Chloromethanes consists of Hydrochlorination and Thermal chlorination will be carries out in closed reactor with all in-built safety measures and automatic cut-off valves and switches.

7.4.2 Utilities:

The proposed expansion requires additional steam for both process and proposed effluent treatment system. It is proposed to establish coal/husk fired boiler of capacity of 1 x 25 TPH in addition to existing husk fired boilers of capacity 1 x 15 TPH, 1 x 10 TPH and oil-fired boiler of 1 x 6 TPH capacity. The total power required after expansion will be 120 MW. The DG sets required for emergency power during load shut down is estimated at 7750kVA. Existing DG sets of 1 x 4750 kVA and 3 x 1000 kVA will be in operation during load shut down period. The list of utilities is presented in the following **Table 7.3**.

Table 7.3List of Utilities

S.No	Utility	Existing	Proposed	After Expansion
1	Husk Fired Boilers (TPH)	1 x 15 1 x 10	--	1 x 15 1 x 10
2	Coal/Husk Fired Boiler (TPH)		1 x 25	1 x 25
3	Oil Fired Boiler (TPH)	1 x 6	--	1 x 6
4	Waste Heat Recovery Boiler (TPH)	1 x 15	--	1 x 15
5	Incinerator (Kg/hr)	--	1 x 383	1 x 383
6	DG Sets (kVA)*	1 x 4750 3 x 1000	--	1 x 4750 3 x 1000

** DG sets will be used during load shut down by Transco*

7.4.3 Quality Control, R&D Lab

The QC department shall comprise of an in-process lab with instruments like HPLC,GC etc. It will be maintained by highly qualified and trained people. The activities include:

- In-process quality check during manufacturing
- Validation of facilities
- Complaint handling

Also a process development laboratory shall be provided for in-house process development, initial evaluation of process technology in case of technology transfer, back-up for production department to address any issues arising during commercial production

7.4.4 ETP and Solid waste storage

The total effluents segregated into two streams; effluent from chlor-alkali and chloromethanes and wash effluent from monochloro acetic acid. These effluents are treated in individual ETPs based on Zero Liquid Discharge system principle and the treated effluents are reused for cooling towers make-up and brine saturation.

7.4.5 Ware Houses:

The plant shall have sufficient storage facility for safe handling of raw materials. Raw salt & Sulphur stored in open area and other low volume solid materials shall be stored in marked areas with proper identification. Liquid raw materials which are available in drums will be stored according to material compatibilities and flammability. Adequate firefighting facilities shall be provided as per NFPA norms. Dedicated Chlorine cylinder storage area with chlorine sensors.

7.4.6 Tank Farm Area:

A separate tank farm area shall be provided for storing liquid raw materials and products. Dykes shall be provided to ensure safety in case of tank failure. Acid proof lining for the dykes shall be provided for acid storage tanks. Condensers for methylene chloride and chloroform storage tanks vents. Liquid Chlorine will be stored on tonners in closed shed with vents connected to emergency scrubber. 5 no.s of chlorine sensors are provided at storage area.

7.4.7 Cylinders storage Area:

Gas cylinders storage should conform to SMPV-Unfired rules-1981.Chlorine storage tanks are stored in a dedicated area with interlocks and continuous chlorine leak detection system monitoring system. Hydrogen cylinders should be stored in approved Gas Storage pad. Chained and capped when not in use. Operational cylinder should be firmly secured. Pressure regulator, metal piping, non-return valve, and safe residue bleed off arrangement should be incorporated in installation design. Strict hot work control and display of danger signs should be ensured.

Chlorine Filling Section with Sensors

Emergency Scrubber

Rupture Disc

7.4.8 Administrative Office:

An Administrative office shall be provided at the entrance of the factory to ensure the entry of authorized personnel only into the premises.

7.4.9 House Keeping:

A regular housekeeping schedule with adequate preventive maintenance shall be ensured so that the plant is consistently maintained as per GMP standards.

7.4.10 Coal/Husk and Ash Storage:

Husk is stored in dedicated area in closed shed. Coal will be stored under covered shed with water sprinkler system in emergency. Ash silos will be provided for storage and handling of ash generated from combustion of coal.

Water sprinkling system shall be installed on stocks of coal in required scales to prevent spontaneous combustion and consequent fire hazards. The stack geometry shall be adopted to maintain minimum exposure of stock pile areas towards predominant wind direction

7.4.11 Facility layout and design:

The layout of all the various areas required for the facility, as mentioned above is considered. In laying out the above areas, isolation of the various process areas from the utilities and non-process areas is considered in view of both containment and cGMP. A plant layout is shown in **Fig 7.1.**

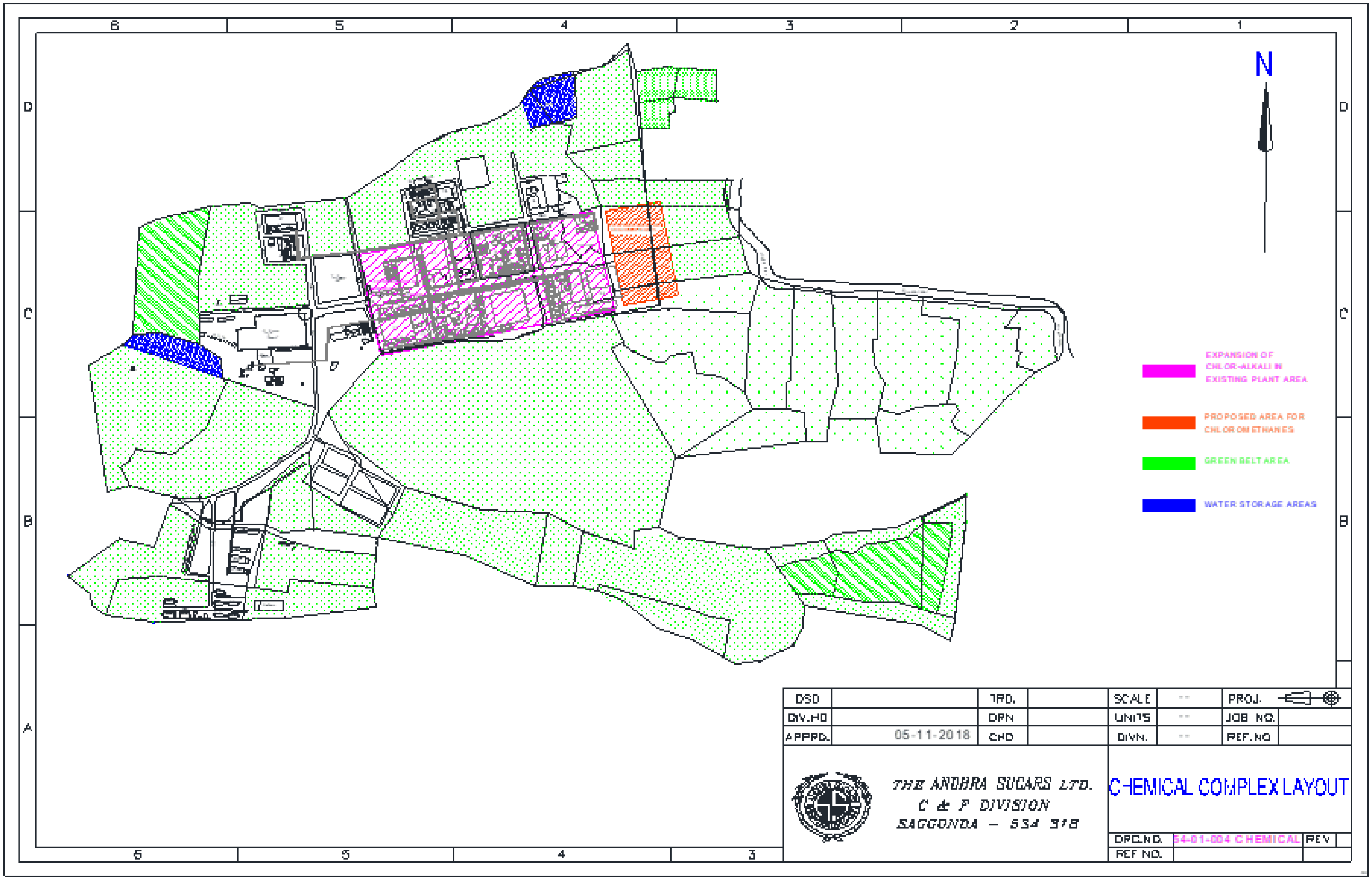

Fig 7.1 Plant Layout of The Andhra Sugars Limited

Table 7.4 Storage of Hazardous Chemicals and Controls

S.No	Name of Material	Quantity	Total Quantity	Type of Storage	Condition	Type of Hazards	Control Measures
1	Liquid chlorine	4 x 120 MT (1No empty tank) 1 x 48 MT	528 MT	MS Tank	Liquid under pressure(11.0kg/cmsq.temp.-5 ^{O}C to 10^{0}C)	Toxic	Following provision have been made field level indicator H/H level alarm Low high-pressure alarm in control room two rupture disc along with two safety valves on each side of tank outlet the safety valve led to Hypo. Storage shed is provided with chlorine sensors and the storage tanks are connected to scrubbing system with isolation valves.
2	Hydrochloric Acid (33%)	6 x 200 2 x 150 14 x 50	2200 m3	MSRL	Liquid at atmospheric pressure and temp.	Spill	Neutralizing & Flushing arrangement have been provided level Measuring device provided to prevent over flow of tank
3	Hydrogen	804 x 6.5 m3	5626 m3	Cylinders	Gas at 150 kg/cm2 at ambient temperature.	Fire.	Hydrogen release to water seal. Fire hydrant network provided. Hydrogen gas detectors.
		5 x 5 MT (Liquid)	25 m3	Bullet			
4	Caustic Soda Lye	4 x 600 1 x 750	3150 m3	Vertical	Liquid at atmospheric pressure and temp.	Spill	Neutralizing & Flushing arrangement have been provided level Measuring device provided to prevent over flow of tank
5	Caustic Potash	1 x 1000 1 x 200	1200 m3	Tank Farm		Spill	
6	Caustic Soda Flakes/Caustic Potash Flakes.	------	--------	Ware House	Solid in HDPE bags at ambient Condition	Spill	Packed in air tight bags to prevent spillage store in ware house which is a closed building. Adequate measure for safe handling are taken
7	Methylene chloride	2 x 100 m3	200 m3	MS Vertical	Liquid at atm pressure and temp	Fire	Fire hydrant network provided with Foam arrangement.
8	Methanol	3 x 100 m3	300 m3			Fire	

7.5 Hazard identification

Identification of possible/credible hazards is the most important step to improve the safety of any plant. The data for most credible hazard scenarios is identified and consequence analysis is carried out and damage distances calculated. Based on the damage distances contours are plotted on the Andhra Sugars Limited, plot plan.

The major hazardous chemicals involved in the plant are Chlorine, Hydrogen and Hydrochloric acid, Methylene chloride, methanol and Diesel oil, furnace oil among the utilities.

Chlorine is toxic and in gaseous state at normal temperature and pressure. Hydrogen gas is flammable and explosive. Hydrochloric acid are corrosive chemicals and in liquid state at normal temperature and pressure. Methanol is flammable, Methylene chloride is carcinogenic and is in liquid state at ambient temperature and pressure.

7.5.1 Hazard and Operability Study (HAZOP)

Hazard and Operability Study (HAZOP) is a highly structured and detailed technique, developed primarily for application to chemical process systems. A HAZOP can generate a comprehensive understanding of the possible 'deviations from design intent' that may occur. However, HAZOP is less suitable for identification of hazards not related to process operations, such as mechanical integrity failures, procedural errors, or external events. HAZOP also tends to identify hazards specific to the section being assessed, while hazards related to the interactions between different sections may not be identified. However, this technique helps to identify hazards in a process plant and the operability problems. It is performed once the engineering line diagrams of the plant are made available. It is carried out during or immediately after the design stage. The purpose of the study is to identify all possible deviations from the way the design/operation is expected to work and all the hazards associated with these deviations. A multi-disciplinary team was constituted with chemical, mechanical and instrumentation engineers, R&D chemist and production manager. It is important to keep the team small enough to be efficient, while retaining a sufficient spread of skills and disciplines for all aspects of the study to be covered comprehensively. The group discussion is facilitated by a Chairman and the results of the discussion are recorded by a Secretary. Every investigation must be led by Chairman who is familiar with the HAZOP study technique, which is primarily concerned with applying, controlling the discussions and stimulating team thinking.

The preparative work for HAZOP studies consisted of four stages i.e., obtaining the data, converting into usable form, planning the sequence of the study and arranging the necessary meetings. The documents referred to for the study include process description, process flow diagrams, P&I diagrams plant layout, operating manuals including startup & shutdown, safety instructions etc., The parameters such as temperature, pressure, flow, level were investigated for deviation and hazard situations are identified.

Some basic definitions of terms frequently used in HAZOP studies are deviation, causes, consequences and guide words etc., Deviations are departures from the design intent which are discovered by systematically applying the guide words. Causes are the reasons why deviations might occur. Consequences are the reasons why deviations should they occur. Guide words are simple words used to understand a particular plant section in operating condition in order to guide and simulate the creative thinking process and so discover deviations. NO, less, more, as well as, part of, reverse, other than are guide words used.

Potential problems as represented by the consequences of the deviation should be evaluated as they arise and a decision reached on whether they merit further consideration or action. Except for major risk areas where a fully quantitative assessment is required this decision is made semi-quantitatively on the consequence (usually scaled as trivial, important or very probable).

7.5.2 Hazard Factors

A study of past accident information provides an understanding of failure modes and mechanisms of process and control equipment and human systems and their likely effects on the overall plant reliability and safety. Some of the major contributing factors for accidents in chemical industries are:

S. No	Contributing Factor	Percent Loss
1	Equipment design faults	41
2	Process design faults	10
3	Operator errors	31
4	Maintenance deficiencies	12
5	Material hazards	6

7.5.3 Common Causes of Accidents

Engineering and Instrumental

Based on the analysis of past accident information, common causes of major chemical plant accidents are identified as:

- Poor house keeping
- Improper use of tools, equipment, facilities
- Unsafe or defective equipment facilities
- Lack of proper procedures
- Improving unsafe procedures
- Failure to follow prescribed procedures
- Jobs not understood
- Lack of awareness of hazards involved
- Lack of proper tools, equipment, facilities
- Lack of guides and safety devices
- Lack of protective equipment and clothing

Failures of Human Systems

An assessment of past chemical accidents reveals human factor to be the cause for over 60% of the accidents while the rest are due to other plant component failures. This percentage will increase if major accidents alone are considered for analysis. Major causes of human failures reported are due to:

- Stress induced by poor equipment design, unfavorable environmental conditions, fatigue, etc.
- Lack of training in safety and loss prevention.
- Indecision in critical situations.
- Inexperienced staff being employed in hazardous situations.

Often, human errors are not analyzed while accident reporting and accident reports only provide information about equipment or component failures. Hence, a great deal of uncertainty surrounds analysis of failure of human systems and consequent damages. The number of persons/materials are potentially exposed to a specific hazard zone is a function of the population density and distribution near the accident location. The failure rate data and ignition sources of major fires are presented in the following **Tables 7.5 and 7.6**.

Table 7.5 Failure Rate Data

S.No	Item	International Data
1.	Process Controllers	2.4×10^{-5} hr^{-5}
2.	Process control valve	2.0×10^{-6} hr^{-1}
3.	Alarm	2.3×10^{-5} hr^{-1}
4.	Leakage at biggest storage tank	5.0×10^{-5} yr^{-1}
5.	Leakage of pipe line	1×10^{-7} m^{-1} yr^{-1}
6.	Human Failure	1×10^{-4} $(demand)^{-1}$

Table 7.6 Ignition Sources of Major Fires

S.No	Ignition Source	Percent
1.	Electrical (wiring of motors)	23%
2.	Smoking	18%
3.	Friction	10%
4.	Over heated material	8%
5.	Burner flames	7%
6.	Combustion sparks	5%
7.	Spontaneous ignition	4%
8.	Cutting & welding	4%
9.	Exposure (fires jumping into new areas)	3%
10.	Mechanical sparks	2%
11.	Molten substances	1%
12.	Chemical actions	1%
13.	Static sparks	1%
14.	Lightening	1%
15.	Miscellaneous	1%

7.6 Maximum Credible Accident and Consequence Analysis (MCACA)

The potential hazards due to flammable and toxic nature of the raw materials/products, process streams and products can be quantified. However, it is necessary to carry out a hazard analysis study to visualize the consequences of an unexpected release from chemical plant, which consists of a number of process units and tank farm facilities. The present study provides quantified picture of the potential hazards and their consequences.

7.6.1 Methodology

MCACA aims at identifying the unwanted hazardous events, which can cause maximum damage to plant and personnel. At the first instance, all probable accident scenarios are developed. Scenarios are generated based on properties of chemicals, physical conditions under which reactions occur or raw materials stored, as well as material strength of vessels and conduits, in-built valves and safety arrangements, etc. Creating a scenario does not mean that it will occur, only that there is a reasonable probability that it could. A scenario is neither a specific situation nor a specific event, but a description of a typical situation that covers a set of possible events or situations.

The following steps are involved in identifying the maximum credible accident scenarios.

a. A detailed study of the process and plant information including process flow diagrams and piping & instrumentation diagrams.

b. Hazard classification of chemicals, operations and equipment.

c. Identification of representative failure cases of vessels and the resulting release scenarios

d. Establishment of credibility of visualized scenarios based on past accident data.

7.6.2 Identification of Vulnerable Areas

The unit operations in the process and storage areas involve mass and energy transfer operations to effect the necessary physical changes. Nature of chemicals and the operating conditions create special hazardous situations. In the present case the chemicals handled are flammable and toxic in nature. With these factors in mind a thorough examination of the process information is carried out and a list of inventories of the hazardous chemicals is prepared to identify the hazardous situations. Based on the raw material consumptions determined from the pilot scale studies, experience in handling commercial scale processes and logistics in procurement of raw materials, the inventories to be maintained for each of the raw material and its mode of storage is determined. High inventory liquid raw materials like solvents are usually stored in tank farms, while solids and other low inventory liquids are stored in ware house based on compatibility, reactivity, toxicity etc. with appropriate safety and firefighting facilities to handle any kind of emergencies.

7.6.3 Representative Accident Scenarios

A study of past accidents, which took place in similar process units and the present plant, provides reasons and course of accidents and there by focusing on most critical areas. A thorough examination of engineering details indicated many possible scenarios like gasket leak, pinholes in pipes and vessels apart from rupture of pipelines and vessels and catastrophic failure of vessels resulting in a pool. Heat radiation damage distances for Pool fire was considered.

Failure Frequency:

The release scenarios considered above can be broadly divided in to two categories

(i) Catastrophic failures which are of low frequency and

(ii) Ruptures and leaks which are of relatively high frequency

Vapor or liquid release from failure of gasket, seal and rupture in pipe lines and vessels fall in second category whereas catastrophic failure of vessels and full-bore rupture of pipe lines etc., fall in to first category. Typical failure frequencies are given in **Table 7.7.**

Table 7.7 General Failure Frequencies

Item	Mode of failure	Failure frequencies
Pressure Vessel	Serious leak	$1.0*10^{-5}$/Year
	Catastrophic	$3.0*10^{-6}$/Year
Pipe lines		
=50 mm dia	Full bore rupture	$8.8*10^{-7}$/m.year
	Significant leak	$8.8*10^{-6}$/m.year
>50 mm =150 mm dia	Full bore rupture	$2.6*10^{-7}$/m.year
	Significant leak	$5.3*10^{-6}$/m.year
>150 mm dia	Full bore rupture	$8.8*10^{-8}$/m.year
	Significant leak	$2.6*10^{-6}$/m.year
hose	Rapture/Failure	$4.0*10^{-5}$/hr
Unloading arm	Rapture/Failure	$3.0*10^{-8}$/hr
Check valve	Failure on demand	$1.0*10^{-4}$/on demand
motor operated valve	Failure on demand	$1.0*10^{-3}$/ on demand
Flange	Leak	$3.0*10^{-4}$/ Year
Pump seal	Leak	$5.0*10^{-3}$/ Year
Gasket failure	Failure	$5.0*10^{-5}$/ Year
Process safety valve(PSV)	Lifts heavily	$4.0*10^{-3}$/ Year
	Blocked	$1.0*10^{-3}$/ Year
	Lifts lightly	$6.0*10^{-2}$/ Year

7.7Consequence Analysis

The accidental release of hazardous chemicals leads to subsequent events, which actually cause the damage. The damages are of three types.

1) Damage due to heat radiation.

2) Damage due to Over pressure effects subsequent to explosion

3) Damage due to toxic effects

The type of damage and extent of damage depends on nature of chemical, the conditions of release, atmospheric conditions and the subsequent events. The sequence of probable events following the release of a hazardous chemical is schematically shown in **Figure 7.2.**The best way of understanding and quantifying the physical effects of any accidental release of chemicals from their normal containment is by means of mathematical modeling. This is achieved by describing the physical situations by mathematical equations for idealized conditions and by making corrections for deviation of the practical situations from ideal conditions. In the present study ALOHA software from USEPA. These models for various steps are described in the following sub-sections.

7.7.1 Release Models and Source strength

This depends on the nature of failure of the unit and the content of the unit and operating temperature and pressure of the unit. The release may be instantaneous due to total failure of storage unit or continuous due to leakage or rupture of some component of the storage facility. The material discharged may be gas or liquid or the discharge could be manifested through two phase flow. The models that are used to calculate the quantity of liquid/vapor released are:

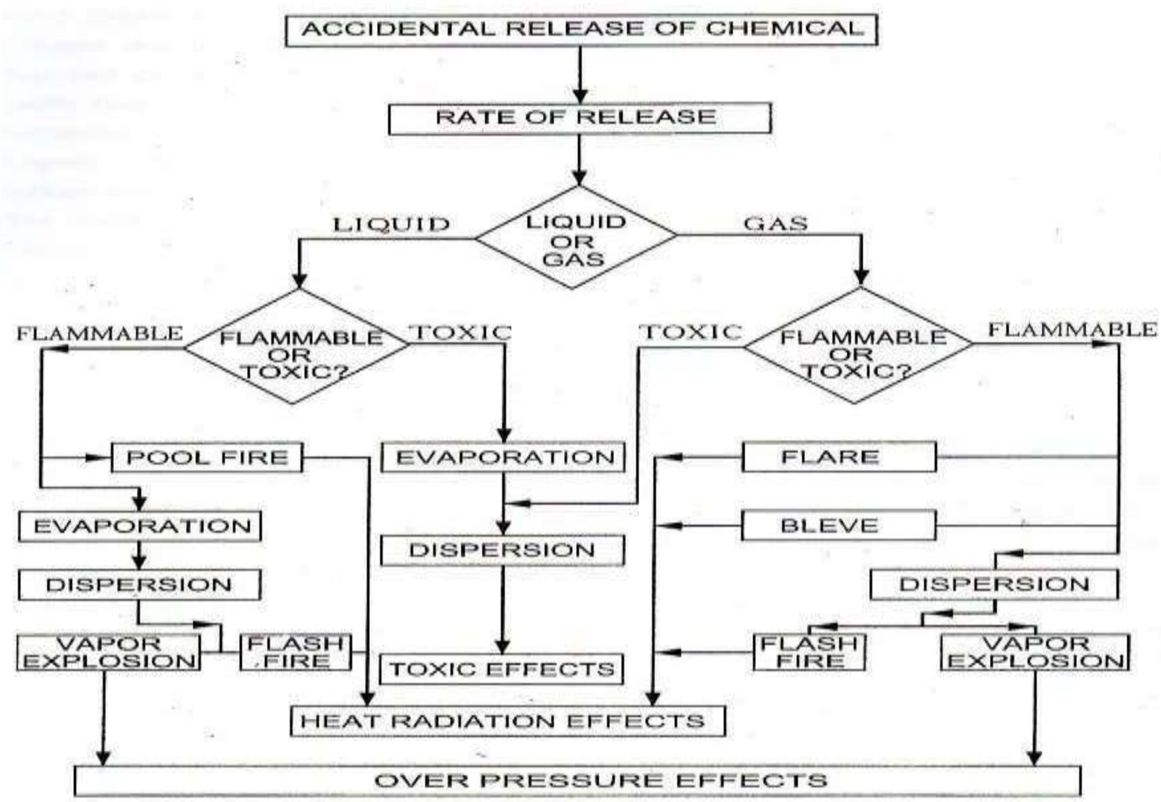

Fig 7.2 Steps in Consequence Calculations

The following criteria tables present heat radiation intensities (**Table 7.8**), radiation exposure and lethality (**Table 7.9**), and damage due to peak over pressure is presented in **Table 7.10.**

Table 7.8Damage Due to Incident Radiation Intensities

S. No	Incident Radiation (KW/m2)	Type of Damage Intensity	
		Damage to Equipment	Damage to the People
1	37.5	Damage to process Equipment	100% lethality in 1 min. 1% lethality in 10 sec.
2	25.0	Minimum energy required to ignite wood at indefinitely long exposure without a flame	50 % lethality in 1min. Significant injury in 10 sec.
3	19.0	Maximum thermal radiation intensity allowed n thermally unprotected adjoining equipment.	---
4	12.5	Minimum energy to ignite with a flame, melts plastic tubing	1% lethality in 1 min.
5	4.0	--	Causes pain if duration is longer than 20 sec, however blistering is unlikely (First degree burns)
6	1.6	--	Causes no discomfort on Longer exposure

Source: Techniques for Assessing Industrial Hazards by World Bank

Table 7.9 Radiation exposure and lethality

Radiation Intensity (KW/m2)	Exposure Time (seconds)	1% Lethality	Degree Burns
1.6	--	0	No Discomfort even after longer exposure
4.5	20	0	1st
4.5	50	0	1 st
8.0	20	0	1 st
8.0	50	<1	3 rd
8.0	60	<1	3 rd
12.0	20	<1	2 nd
12.0	50	8	3 rd
12.5	--	1	--
25.0	--	50	--
37.5	--	100	--

Table 7.10Damage Due to Peak Over Pressure

Human Injury		Structural Damage	
Peak Over Pressure(bar)	Type of Damage	Peak over Pressure(bar)	Type of Damage
5 – 8	100% lethality	0.3	Heavy (90%Damage)
3.5 – 5	50% lethality	0.1	Repairable (10%Damage)
2 – 3	Threshold lethality	0.03	Damage of Glass

1.33 – 2	Severe Lung damage	0.01	Crack of Windows
1 – 1 1/3	50% Eardrum rupture	-	-

Source : Marshall, V.C.(1977)' How lethal are explosives and toxic escapes.

7.7.2 Results of Consequence Analysis

The damages due to the accidental release of chemicals are of three types.

a) Damage due to heat radiation

b) c) Damage due to Toxic effects

Effect of damage due to hazardous incidents such as Heat Radiation and toxic gas release are computed and damage contours of these scenarios are marked on the plot plan/map. All the calculations are assumed for duration of 5 minutes release by which time it is assumed that maintenance team/response team will initiate the corrective action. The damage distances are calculated for wind velocities 2m/sec and 4m/sec for the weather conditions stability class D & F respectively. All the results are considered for ground elevation unless otherwise specified. PHAST software is used for quantifying the damage. Damage contours are drawn for the worst-case scenarios (Highlighted)

7.7.2.1 Toxic Dispersion Damage Distances

The IDLH value for chlorine for duration of 1800 seconds is 10 ppm and ERPG3 value is 20 ppm for duration of 3600 seconds. LC10 value for duration of 300 seconds is 393 ppm. Several scenarios have been considered and the damage distance values for LC10 (393 ppm), IDLH (10 ppm) and ERPG3 (20 ppm) have been noted. The scenarios considered for the release of chlorine are given below. The results of the same are presented in **Table 7.3 to 7.5.**

1. Rupture of 500 mm Chlorine line – 393 ppm – 82 m
2. Rupture of 400 mm Chlorine line – 393 ppm – 104 m
3. Rupture of 350 mm Chlorine line – 393 ppm – 21 m

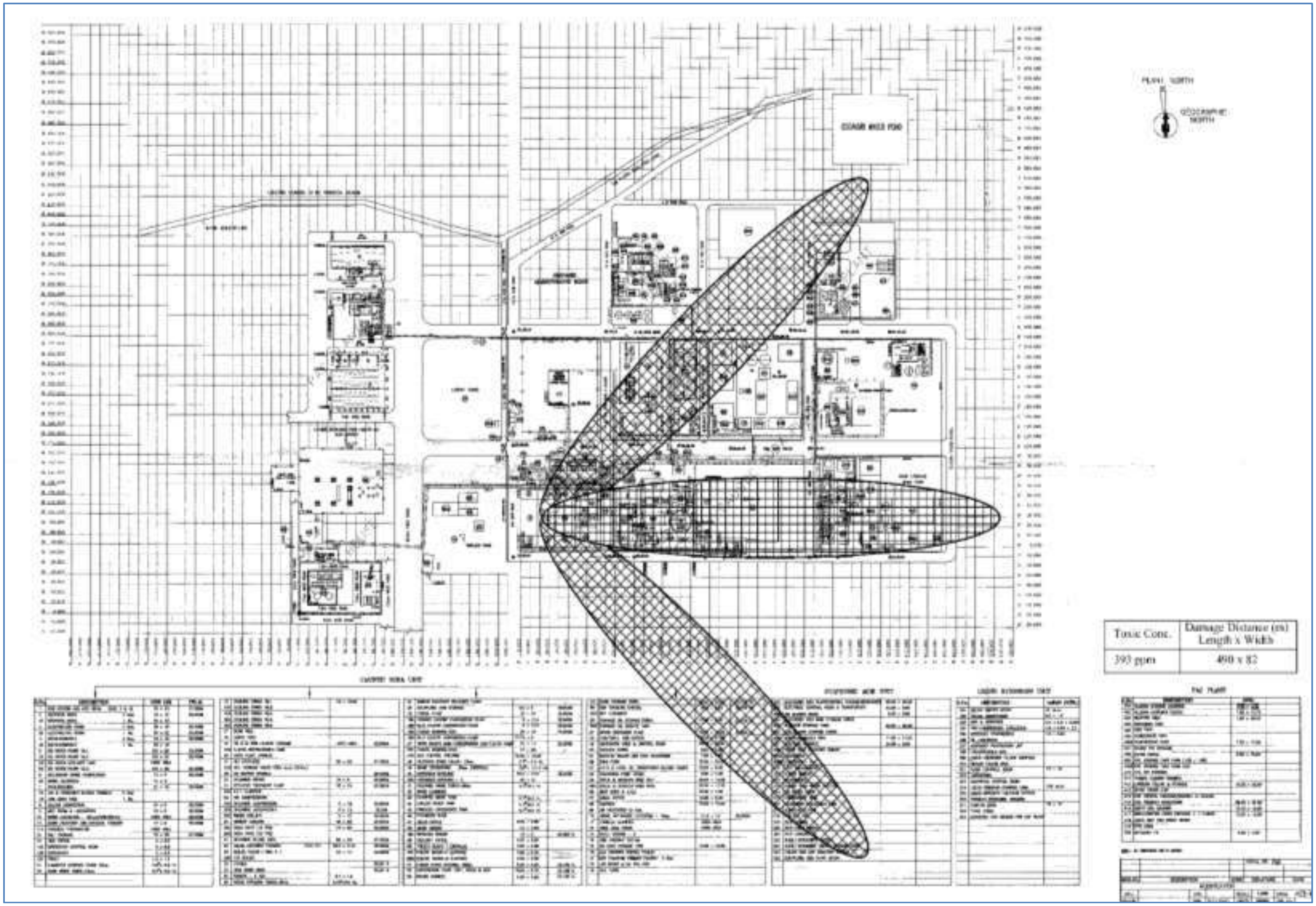

Fig 7.3 Toxic Dispersion Damage Distance – Rupture of 500 mm Chlorine Line

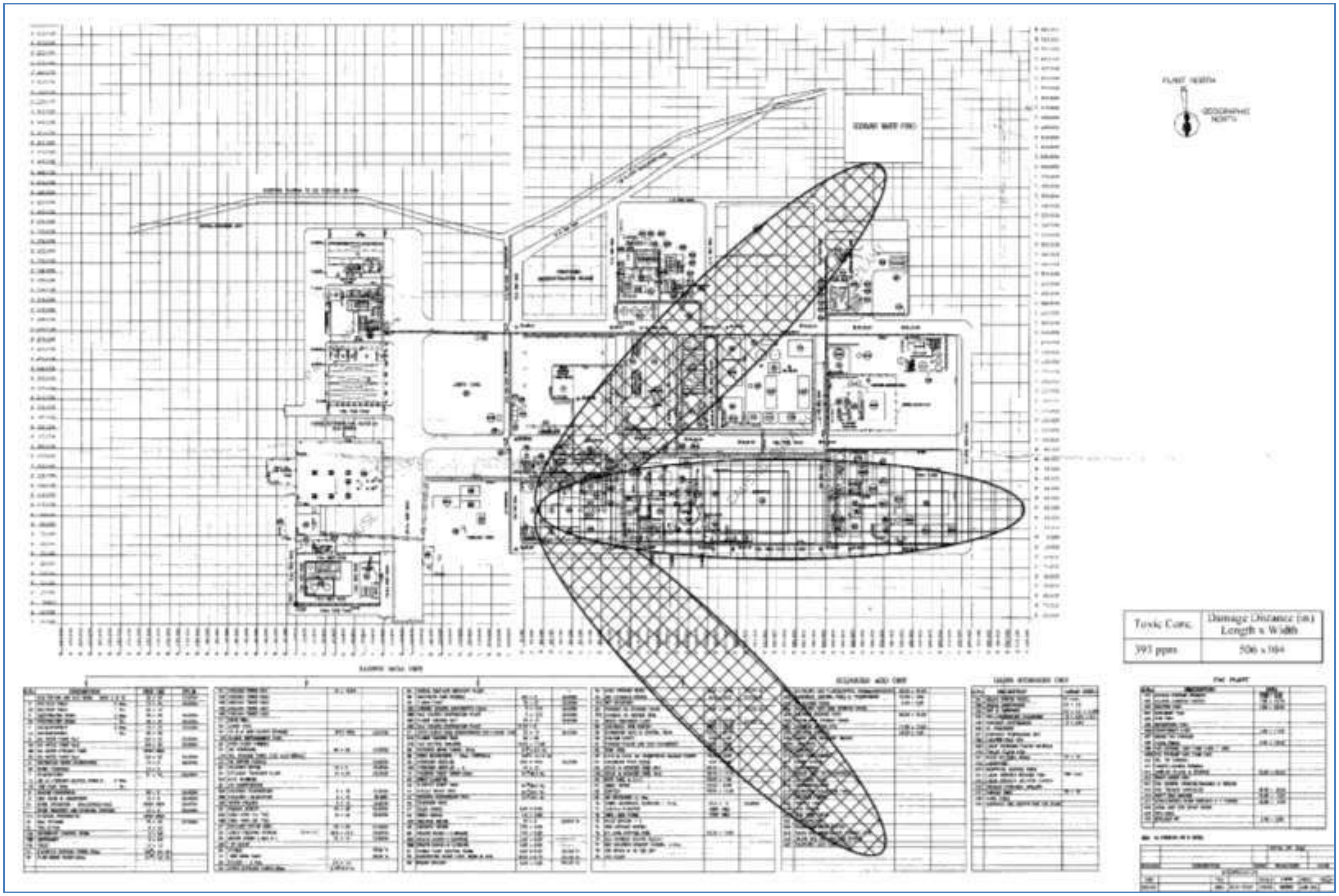

Fig 7.4 Toxic Dispersion Damage Distance – Rupture of 400mm Chlorine Line

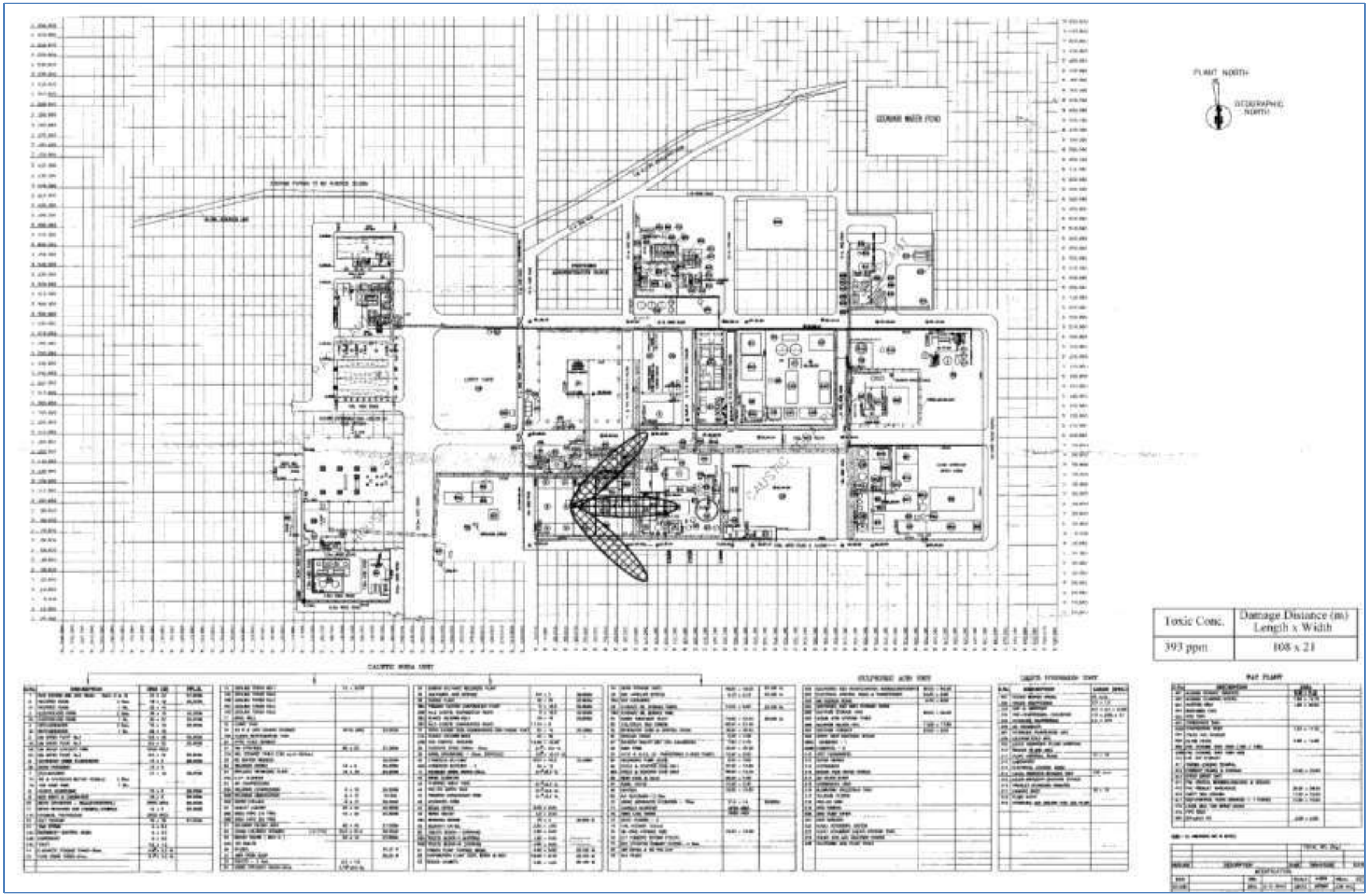

Fig 7.5 Toxic Dispersion Damage Distance – Rupture of 350 mm Chlorine Line

7.7.2.2 Overpressure effects:

When an unignited gas cloud mixes with air and reaches the flammable range and if the cloud ignites wither a flash fire or flash fire explosion can occur. Since the burning time is shorter, instead of heat radiation from a flash fire, peak overpressure as a function of distance from the centre of the cloud is derived. In case of pipeline leaks, damage distances due to overpressure effects are not observed. The values are found to be similar as there are no pressurized storage tanks in the tank farm, and the over pressure distances are contingent on the tank capacity.

7.7.3 Recommendations:

The following are the recommendations to minimize the hazards and improve the safety of the plants. It has been observed that the damage distances are more or less confined to the plant area only. Taking precautionary safety measures as outlined below can further minimize these effects.

- In view of hazardous nature of operations, it is recommended to adopt best practices with respect to design, operation and maintenance.
- It is recommended that all flammable areas and process area be maintained free of ignition sources. Ensure that sources of ignition, such as pilot lights, electrical ignition devices etc., at strategic locations like storage areas are avoided.
- All electrical fittings involved in and around the pipeline and operation system should conform to flame/explosion proof regulations.
- Strict hot work control and display of danger signs should be ensured.
- It is recommended to provide one fire hydrant point in the storage area to take care of any emergency. Installation of fire water hydrant network is suggested.
- It is suggested to provide fire extinguishers in process plant at solvent storage area and the vents of solvent tanks to be provided with PESO approved flame arrestors.

- Fire protection equipment should be well maintained so that it is available when required. They should be located for quick accessibility. Provide carbon dioxide fire extinguishers and DCP extinguishers for Electrical fires.
- It is suggested to have a periodical review of safety awareness and safety training requirements of plant employees with respect to hazards present in the plant.
- In general, all pipelines carrying flammable liquids/vapor are periodically checked for their integrity. Spillages have to be avoided and disposal should be done quickly.

7.7.4 Toxic Management Plan ***(Terms of Reference No. Sp. TOR (14))***

Handling: Storage & handling in compliance with MSDS. The transfer of raw materials shall be mainly by closed pipeline systems. The complete operation will be operated by DCS system.

Engineering Control Measures: Automatic cut-off valves, switches are provided for control addition and separation. Vent condensers in series with chilled water circulation to distillation columns of CMS plants to mitigate atmospheric emissions of toxics.

Personnel Protective Equipment: Personal protective equipment shall be provided to all employees including contract employees. All the employees shall be provided with gumshoe, helmet, masks, goggles. The other equipment like ear muffs, gloves, respirators, aprons etc., will be provided to employees depending on the work area allocated to them. The PPE selection shall strictly follow the prescribed guidelines of MSDS.

Health Monitoring of Employees: The pre-employment screening and periodic medical examination shall follow the guidelines of factories act. The pre-employment screening shall obtain medical history, occupational history followed by physical examination and baseline monitoring for specific exposures.

Frequency of Health Monitoring

Occupation	Type of evaluation		Frequency
Process area	Physical Observation	Height Weight	Annual
	Eyes	Color vision	Annual
	Detailed Test	Lung Functioning test, Hearing Ability; Physical Status, General Condition; Previous Accidents, Skin Infections; Any Physical Handicap	Once in six months
	Clinical Observation	Heart; Hydrocele; Central Nervous System; Liver functioning; Diabetes; Any operations undergone; Symptoms of communicable and other contagious disease and Medical fitness	
Noise prone areas	Audiometry		Annual

7.7.5Transportation (*Terms of Reference No. 7(iii)*)

All the raw materials and finished products are transported by road. Dedicated parking facility is provided in an area of 3 acres for transport vehicles. There will be 120-150 additional truck trips per day to the factory due to proposed expansion. Traffic signs are placed in the battery limit. The drivers of the vehicles will be provided with TREM cards and will be explained the measure to be adopted during various emergencies. Drivers transporting hazardous chemicals are periodically trained.

The truck trips shall be staggered to ensure a maximum of 25 truck trips per hour. It is also proposed to avoid material transport to and from the plant during 8 to 10 AM and 4 to 6 PM. It is also proposed to utilize returning trucks for product/ waste transport to reduce the number of truck trips. The initiating and contributing causes are presented in **Table 7.11**

Table 7.11 Truck Incidents – Initiating and Contributing Causes

Human Errors	Equipment Failures	System or Procedural Failures	External Events
Driver Impairment Speeding Driver Overtired Contamination Overfilling	Non-dedicated trailer RR crossing guard Failure Leaking Valve Leaking Fitting	Driver incentives Driver training Carrier selection Container Specification Route selection	Vandalism/ Sabotage Rain Fog Wing Flood/washout
Other Vehicle's Driver Taking Tight	Brake Failure Insulation/Thermal Protection Failure	Emergency response training Speed Enforcement	Fire at rest areas/parking areas Earthquake
Unsecured Load	Relief device failure Tire failure	Driver rest periods Maintenance Inspection	Existing accident
	Soft shoulder Overpressure Material defect Steering failure Sloshing High center of gravity Corrosion; Bad Weld; Excessive Grade Poor Intersection design Suspension system	Time of day Restrictions	

The scenarios presented for storages are calculated for transport related incidents/accidents and presented in **Table 7.12.**

Table 7.12 Transportation Specific Concerns

Concern	Road
Spill on Water	Over or near a body of water
Unconfined Pools	In an undisturbed flat area
BELVE-Induced catastrophic vessel failure	Possible if sufficient quantity in car with small leak to feed fire or if double tank trailer or burning fuel leak
Toxic products of combustion or reaction	Dependent on material and whether ignition occurs

7.8Disaster Management Plan *(Terms of Reference No. 7(xiii)*

7.8.1 Introduction

A disaster is a catastrophic situation in which suddenly, people are plunged into helplessness and suffering and, as a result, need protection, clothing, shelter, medical and social care and other necessities of life.

Disasters can be divided into two main groups. In the first, are disasters resulting from natural phenomena like earthquakes, volcanic eruptions, storm surges, cyclones, tropical storms, floods, avalanches, landslides, and forest fires. The second group includes disastrous events occasioned by man, or by man's impact upon the environment. Examples are armed conflict, industrial accidents, radiation accidents, factory fires, explosions and escape of toxic gases or chemical substances, river pollution, mining or other structural collapses, air, sea, rail and road transport accidents and can reach catastrophic dimensions in terms of human loss.

There can be no set criteria for assessing the gravity of a disaster in the abstract since this depends to a large extent on the physical, economic and social environment in which it occurs. However, all disasters bring in their wake similar consequences that call for immediate action, whether at the local, national or international level, for the rescue and relief of the victims. This includes the search for the dead and injured, medical and social care, removal of the debris, the provision of temporary shelter for the homeless, food, clothing and medical supplies, and the rapid re- establishment of essential services.

An emergency may be said to begin when operator at the plant or in charge of storage of hazardous chemicals cannot cope up with a potentially hazardous incident, which may turn into an emergency. The emergencies could be a major fire or explosion or release of toxic gas or a combination of them.

The proposed plant will store fuels, which are flammable in nature, and the storage will be as per the Controller of Explosives and OISD norms. The hierarchy of the employees is yet to be determined and the project is still in the initial stages of designing. Hence a tentative disaster management plan is prepared to be suitably modified before commissioning of the plant.

7.8.2 Objectives of Emergency Management Plan (ON-SITE)

(Terms of Reference No. 7(xiii)

The methodology to be followed for formulating the strategy plan for onsite emergencies consists of the following steps;

1. Assessment of risk
2. Organization and command structure
3. Emergency Control Centre

I. Assessment of Risk

Assessment of risk involves

i) Identification of emergency situations
ii) Basic events that can escalate to on-site emergencies

Identification of Hazard

The following scenarios are likely to create onsite emergencies:

a. Fire and Explosion Hazard
b. Release of toxic chemical/vapor/flammable gases
c. Pool fires

A major fire is in general that which can spread to other equipment or other area or that threatens to spread beyond the control of the personnel engaged in fighting the fire. It can also be a violent explosion causing a large fire.

Fire Hazard will be likely to occur in the storage areas of the following raw materials/intermediates/products/utilities: Furnace oil and diesel oil in the Utilities storage area and hydrogen gas leakage in HCl plant.

The following inflammable materials are likely to cause Fire Hazard in the process areas: Hydrogen and Diesel oil.

The release of any of the above flammable materials and gas leak of toxic chemicals like chlorine will spread in the direction of wind causing a major hazard of Fire and Explosion or toxicity. Keeping the above Hazards in view, the strategy plan and Action Plan have been developed to combat any such emergency.

Organization and Command Structure

The organization structure necessary to combat onsite emergencies is shown in **Figure 4.1** (No organization chart enclosed. Chart may be prepared) with a clearly defined chain of command and designated roles and responsibilities. The roles and responsibilities of each of the coordinators are specified in the following pages. The duties are further demarcated as those to be carried "prior to emergencies", i.e., in preparation for tackling emergencies are described in this chapter and those "during and after the emergencies" are described in the next chapter.

On receiving announcements in PA system or sounding of emergency siren. Key persons rush to emergency control room. Simultaneously they alert the support teams for emergency services. Key persons will be fed accurate information of the event and given appropriate instructions of the event and given appropriate instructions to be followed. Key persons with support teams leave to the accident scene to render emergency actions.

Manager (Personnel), Medical, Security

- Personnel evacuation, first aid to victims to be arranged without time delay
- Directing security personnel for firefighting and rescue operations
- Communicate to local hospitals and arrange transport of victims
- Provide drinking water, food etc. to the personnel combating emergency
- Contact with local village authorities and notary persons in the nearby villages if needed

Works main controller

He is responsible for the overall organization and facilitation of the emergency response team. He is responsible for overseeing all aspects of preparing for and responding to an emergency situation. It requires making decisions on protective actions, operations, and expenditures. Prior to emergency he shall identify functions to be performed by works incident controller, endorse the onsite emergency plan appoint personnel from each plant unit to perform emergency tasks , review the response procedures and update the same periodically to accommodate any new process modification or equipment addition or facility modification**.**

- Ultimate control over the emergency handling and govern all the actions from control room
- Declaring on site emergency in consultation with works incident controller and key persons
- Review the progress of emergency control measures and decisions making time to time
- Provide additional facilities, equipment's, manpower and external help when required.
- Arrange offsite emergency measures in co-ordination with crisis management groups
- Contact with local and district authorities and statutory authorities for additional help

Works incident controller

He is responsible for maintain the site emergency plan and ensuring that all the employees are trained and knowledgeable in performing their tasks before an emergency occurs.

- Over all control on the emergency actions, services carried on at the accident scene
- Report latest information about emergency action to the main controller and advise to make right decisions in time.
- Provide essential information, tools, equipment's; to the key persons as required
- Supervise the emergency actions such as leaks control, firefighting etc.
- Monitor the conditions prevailing at the accident scene and assess the consequences time to time
-

Safety officer

- Supply essential personal protective equipment's and guide the persons to wear properly
- Guide fire fighting personnel to use correct techniques in combating Hydrogen fires
- Assist key persons in taking adequate safety precautions particularly regarding personal safety
- Assist emergency teams to render service in leaks control and mitigation measures if needed

Adviser (Mechanical)

- Divert Support team to stop or arrest leaks by any practical means
- Arrange rescue squad on watch to the crew enter into dangerous area
- Supply additional trained crew for firefighting if necessary
- Guide emergency teams in special techniques in equipment isolation, pressure release, blinding leak spot etc.

Engineer (Instrument)

- Set up emergency control centre and contact local and external agencies
- Follow up the emergency communication under the instructions of workers main controller
- Contact with the mutual aid industries and alert them quick response when needed
- Attend to render services for instrumentation related workers at accident scene.

Adviser (Electrical)

- Arrange to cut off power supply in case of hydrogen leaks in the plant
- Arrange alternate lighting which is totally safe at the scene
- Co-ordinate with the other key persons for taking right decisions
- Attend electrical related workers at the scene

Laboratory In-Charge

- Arrange measurement of flammable gas concentration at selected places near the scene
- Arrange measurement of oxygen content in the contaminated places where persons require entering

A.E.(Civil)

- Supply man Power, materials as needed

Fire Fighting Team

He shall perform the following responsibilities

Prior to emergency

- He shall ensure that adequate firefighting equipment is available at all plant area and maintain them in perfect condition
- Train Sufficient manpower in handling firefighting equipment and in use of personal protective equipment, emergency tool kits and similarly establish emergency teams in each unit, in addition to maintaining his own team.
- Conduct mock drills at regular intervals

Medical Team

The medical team is responsible for providing immediate care to injured persons, as well as collecting and compiling of health and medical related disaster information. He will also coordinate offsite medical assistance.

- Keep record of all toxic chemicals, health hazards and antidotes.
- He shall stock adequate quantity of antidotes and first aid equipment and other medicines
- Train medical and paramedical teams to handle emergencies
- Maintain a list of all local hospitals/ major clinics in the surrounding district
- Prepare plans for use of alternate/additional medical centers as and when required
- Keep a record of all previous accident scenarios and actions taken.
- Participate in site emergency plan review and updates

Security Team

Security persons are available round the clock. Total number of security persons in the plant: 45 with one security officer.

- The security team is responsible for controlling the movement of people and vehicles at the site, preventing unauthorized entry into site etc. His primary duties are

- Ensure availability of adequate number of vehicles, PA system during emergency
- Train his manpower to handle emergency situation
- Train his manpower in first aid procedures
- Ensure that telephone / mobile phones meant for emergency use are in working order
- Ensure that his staff is available at the designated location for taking any material during an emergency
- Participate in on-site emergency plan review and updates
- Maintain addresses and phone numbers of external agencies and local authorities
- Maintain liaison with statutory authorities, local hospitals etc.

Transport Team

- He will establish requirement of vehicles in good condition for use during emergencies
- He will ensure availability of trained drivers
- He will ensure availability of spares for vehicles
- He will maintain Ambulance service vehicles in good condition at all units or at a centralized place
- He will keep record of local transport agencies

Finance Team

- He will estimate budget requirements for all levels of emergency and sanction the requisite amount for purchase of all safety appliances, firefighting equipment etc.
- He will participate in site emergency plan review and updates

Plant Training Team

- He will maintain a record of all accident scenarios and action taken reports
- He will maintain Material Safety Data Sheets of all the chemicals involved in the various plants/units
- He will especially train and caution the contract labor about the nature of the chemicals and safe handling methods of these chemicals
- He will ensure that all plants storing hazardous chemicals, processing units involving hazardous chemicals etc. display prominently the hazardous properties of these chemicals in all three languages thereby cautioning the staff workers casual labor and visitors to the site
- He will coordinate with all the UEC to train the regular staff
- He will participate in on-site emergency plan review and updates

Maintenance Team

Mechanical Engineering Team

- Inspect and keep maintenance of storage tanks and critical equipment's and test them at regular intervals
- Prepare and maintain equipment specifications, drawings and technical data for ready reference
- Train the maintenance personnel for emergency situations
- Participate in mock drills and exercises

Electrical engineering Team

- Keep emergency power supply a system ready to meet any emergency situation
- Plan and maintain essential items such as cables, lights, fans, battery lights etc. for emergency use.
- Train and maintenance personnel for emergency situations

Instrument Engineering Team

- Maintain and plan for instruments required for emergencies
- Maintain and ensure function of gas detection systems, trips and alarms and sirens at regular intervals

Electronics engineering Team

- Provide equipment's required for emergency communication and warning systems
- Maintain update information of meteorological data

Suggested authority for each coordinator is chosen from the organization chart of M/S Andhra Sugars Limited, Saggonda

Coordinator	**Suggested Authority**
Chief Emergency Controller	Executive Director
Incident Controller	Shift Chemist of Concerned Plant
Emergency Operations Coordinator	Chief Chemical Engineer
Emergency Communications Coordinator	DCS Shift Chemist, Instrument Engineer
Communication for external Help	Asst. Instrument Engineer, Electronics
Safety Team, Safety In charge members	Safety Officer, Safety Committee
Fire Fighting and emergency control team	Shift Chemist, Operating and maintenance personnel from the plant and neighboring sections, Security
Rescue Team	Manager (Personnel), Sr. Chemist, Trained personnel from other

Repair Team	Adviser(Mechanical), A.E(Civil)
Security Team	Security officer
Medical Team	Medical officer
Transport Team	Time Keeper

7.8.3 Emergency Responsibility Team

To combat emergency situations, emergency planning and procedures specifying the roles and responsibilities of various functionaries in the organization is important. Developing the action plan is the process of assigning emergency related tasks to individuals in the organization and outlining protective actions to be taken during and after an emergency. This chapter details the action plan to be adopted for onsite emergency situations of this organization. The organization structure necessary to combat onsite emergencies has already been shown in Fig 4.1 with a clearly defined chain of command and designated roles and responsibilities. The roles and responsibilities of each of the coordinators during an emergency situation are specified in the following pages.

Chief Emergency Controller

The chief emergency coordinator is responsible for the overall organization and facilitation of the emergency Response Team. He is responsible for overseeing all aspects of preparing for and responding to an emergency situation. It requires making decisions on protective actions, operations, and expenditures.

During Emergency

- Assumes charge as Head of the Emergency Control Centre (ECC)
- Declares emergency and monitors all rescue and damage control operations
- Authorize the use of the Organization's resources to tackle the emergency situation

After Emergency

- Call all coordinators and appoint a fact-finding committee to know the factual facts.
- Assign the committee to prepare a detailed report of the accident giving details of the property damaged and loss of life etc.

- Based on the findings of the committee take appropriate action and suggest suitable remedial measures
- Inform the local PCB Chairman / Secretary the findings of the committee.

Incident Controller

He is responsible for maintaining the site emergency plan and ensuring that all the members are trained and knowledgeable in performing their tasks before an emergency occurs. During an actual emergency, Incident controller coordinates the implementation of all necessary tasks in the site emergency team. He will be the Operational In-Charge of the Emergency Control Centre (ECC) and directs the onsite response. It is suggested Shift chemist will be the Incident controller.

During Emergency

- He shall perform the following functions
- Activate the site emergency plan and coordinates with Chief emergency controller and all other coordinators for implementing protective action.
- Directs all rescue operations
- Notify the local government authorities of an onsite emergency situation
- Interact with the media for providing factual information to press, TV, Radio etc.
- Interact with other local industries for getting help such as Fire Fighting services, Medical Aid, Personnel requirement etc. if the situation demands (Mutual Aid Scheme)
- Interact with Red cross or any other voluntary organization for help in rescue / rehabilitation
- Interact with next of the kin of affected persons in providing actual information about the injured, causalities etc.
- Inform CEC of the latest situation
- Implement the decisions and directives of the CEC
- He will instruct maintenance personnel other unaffected areas/plants to suspend product filling or raw material unloading until emergency situation is over through ECC.
- He will instruct maintenance personnel to report to workshop, electricians to the sub-station and all other personnel to remain at their respective sites and wait for further orders through ECC

- After reviewing the situation with other coordinators, he will declare the end of onsite emergency situation and communicate the same to all external agencies
- He will give instructions to give "All Clear" signal to the ECC
- Convene a meeting of all the coordinators to prepare the detailed report of the incident.

After Emergency

- Act as convener of the fact-finding committee of the accident and report the findings of the committee to the ECC
- Asses the loss of property due to the accident and take action to restore normal operations in the affected area.
- Interact with the families of the affected persons and provide necessary help

Emergency Operations Coordinator (Chief Chemical Engineer)

He is responsible for ensuring that protective actions for all plant areas are implemented.

He will coordinate with the other coordinators to train all employees under his supervision in the different protective actions before an actual emergency occurs.

During emergency

- He shall perform the following responsibilities
- He will assume complete control of the emergency situation and implement the emergency response plan of the particular nature of emergency for effective control of the emergency.
- He shall asses the nature of emergency, location, dimension and seriousness of the incident and take appropriate decision and accordingly advice Incident controller and other key personnel
- He will take all necessary steps to control the emergency situation.
- He will interact with incident controller and along with him and the maintenance team control the emergency situation and prevent it from escalating
- He will alert all other units and if necessary, suspend all operations and seek their help in controlling the emergency situation
- He will interact with the incident controller and suspend all work permits jobs and inform neighboring units and take assistance
- He shall inform the Chief Emergency Controller and emergency Control Centre of the nature of the emergency

- Liaise with the chief officers of the Fire, Safety, Health centre, security and administration and provide information regarding possible effects of the emergency on areas outside the plant and seek their help and advice
- Ascertain the wind direction and determine the safe escape route and announce the same.
- Direct the shut down and evacuation of plant personnel in consultation with the Incident controller and key personnel
- Coordinates the plant shut-down (and Start up) procedures with the plant personnel
- Coordinate with all other departments for effective and quick control of the emergency situation.
- In case the emergency situation becomes uncontrollable and likely to escalate to an off-site emergency case, he will inform the Incident controller and other higher authorities for appropriate action and help from other external sources.
- Maintain a diary of all important events during an emergency, including actions taken, decisions made and by whom, personnel involved.
- Inspect work area for damage as soon as conditions permit
- Prepare an after-action report
- Coordinate unit start-up procedure as necessary
- He will assess the situation and inform incident controller to declare termination of emergency in consultation with other coordinators report to Chief emergency controller.

After Emergency

- Prepare the emergency report and assist the fact-finding committee
- Take action to restore normal plant operations

Emergency Services Coordinator (Manager Personnel)

He is responsible for ensuring that protective actions for a certain plant area are carried out. He should train personnel of his plant in the different protective actions before an actual emergency occurs and notify the personnel of the decision for protective action during an emergency. It is suggested that DCS in-charge be appointed as unit emergency coordinators. The coordinators of all units/sections have to train the supporting personnel and also the casual labor in safe handling of all the chemicals and what immediate actions are to be taken in case of an accident.

During Emergency

- He shall perform the following responsibilities
- He will take charge of the situation and alerts all other personnel in the unit., suspend all work permits and also alerts the operating personnel of neighbor units and takes their assistance to control the emergency situation and implement the emergency response plan.
- He shall assess the nature of Emergency, location, dimension and seriousness of the incident and take appropriate decision and help of the safety officer and key personnel
- He will take all necessary steps to control the emergency situation.
- He shall inform the CEC and emergency control centre of the nature of the emergency
- Direct all operations to either stop or remain continue within the affected area taking into consideration, the priorities for safety of personnel minimize damage to the plant, property and environment and follow the departmental emergency Response plan.
- Notify the safety and fire officer of the nature of the emergency and seek their help.
- Notify the Medical officer and request for Ambulance services and medical aid
- He will inform the security Team and rescue team and medical team to arrange their services.
- Interacts with the emergency operations coordinator and then inform the plant personnel of the need to evacuate
- Ascertain the wind direction and determine the safe escape route and inform Chief emergency controller
- Direct all non-essential workers / staff to reach designated assembly points
- Report all significant developments to the Emergency operations coordinator
- Also have regard to the need to preserve the evidence, so as to facilitate any investigation into the cause and circumstances, which has caused or escalated the emergency
- Coordinated the plant shut down (and start-up) procedures with the plant personnel
- Coordinate with all other departments for effective and quick control of the emergency situation
- Coordinate unit start-up procedure as necessary

After Emergency

- Assist Emergency operations coordinator in preparing the emergency report and assist the fact-finding committee
- Take action to restore normal plant operations

Fire Fighting Coordinator

He shall perform the following responsibilities during an emergency

During emergency

- As soon as fire alarm is received, identify the location from where the manual call originated. In case the message is communicated through telephone, note the location and type of emergency and immediately send the fire crew along with fire engine to the emergency site.
- Direct all firefighting operations and help to bring the situation under control
- In case more firefighting materials are required, arrange to send them to the site.
- Render assistance in evacuation of personnel
- Render assistance in taking injured to hospitals
- Ensure adequate water supply for fire fighting
- Inform the Medical Coordinator about the assessment of the injured
- In case the situation is not brought under control, contact local firefighting brigades and seek their assistance.
- Keep informing Incident controller, Emergency operations Coordinator and other key personnel of the latest situation
- Arrange to send information to the local statutory authorities as requires

Medical Coordinator

The medical Team is responsible for providing immediate care to injured persons, as well as collecting and compiling of health and medical related disaster information. He will also coordinate offsite medical assistance. He shall perform the following responsibilities.

During Emergency

- After receiving information about the emergency, prepare for rendering medical aid.
- Ensure proper information about the nature of burns, toxic gas poisoning, physical injuries etc. and likely number of personnel affected to get prepared for a medical emergency.

- Keep the necessary antidotes and medicines ready
- Arrange to send the ambulance to the site
- Ensure that emergency medical care is provided to the injured persons.
- Get prepared to shift the Ambulance room to a safe place if it also comes under the preview of affected area along with necessary first aid equipment, antidotes and other equipment.
- Coordinate with external medical team

Security Coordinator

The security coordinator is responsible for controlling the movement of people and vehicle at the site, preventing unauthorized entry into site etc. His primary duties are

During emergency

- On receiving emergency message, he shall listen carefully and record the same
- On hearing a fire alarm, he shall ascertain the location and level of emergency
- He will not allow visitors and off duty employees other than staff connected with firefighting and control operations
- He will receive outside fire brigade, medical team and guide them as per instructions from emergency operations coordinator.
- He will control movement of people and private vehicles and tankers at the site and maintain direct access lanes for emergency vehicles and personnel to the and also road access to the factory is made clear
- He will communicate messages as received from emergency operations coordinator
- He will assist firefighting coordinator in smooth start-up of firefighting operations
- He will prevent gathering at the emergency site
- He will prevent unauthorized entry into hazardous secured areas
- He will guide the evacuating personnel to a safe place as directed by emergency operations coordinator.
- He will assist with the care and handling of injured personnel
- He will arrange for shifting of gas affected/fire accident victims to the Health centre on the site and if necessary, to the local hospital
- He will guide media representatives to the Emergency operations coordinator as directed by emergency chief controller
- He will prevent panic among the staff caused by false information
- He will keep liaison with police/fire brigade teams

- He will maintain a log of events and persons entering or leaving the factory premises

Communications coordinator

The communications coordinator is responsible for maintain communication equipment such as cell phone, telephone systems, call out systems etc. an establishing the emergency Control Centre

During Emergency

- He will set up communication facelift for assemble points, Emergency Chief Controller and incident point
- He will help other coordinators for their communication needs
- He will receive and disseminate information about an emergency situation that has occurred
- He will establish a message control system for logging messages received by and dispatched from emergency Chief Controller
- He can also activate the Emergency siren / alarm if not already activated by Emergency operations coordinator
- He will direct quick retrieval of information from the database
- He will keep contact with Chief emergency controller and act on his instructions

Transport Coordinator
During emergency

- He will coordinate with Security Team and Medical Team and provide required number of vehicles with drivers for transporting personnel to hospitals
- He will contact local transport agencies for additional vehicles, if required
- He will coordinate with emergency Services coordinator
- Only raw materials and product carrying Lorries will move from 7:00 AM to 7:00 PM daily.

Materials Coordinator
During emergency

- He will immediately dispatch required type of safety systems, material, personnel protective gear and equipment's to the site.
- He will arrange for emergency purchase of medicines or any other emergency procurement etc.

In-Plant Training Coordinator

- He will coordinate with the coordinators in controlling the emergency situation and for smooth operations
- In case the situation gets out of control and likely to be an offsite emergency case, he will ensure proper communication about the actions to be taken by the local people and prevent panic among them
- He will coordinate with the concerned local authorities to hospitalize the injured, evacuate the affected public, maintain law and order and rehabilitate the affected persons.
- He will contact Red cross and other voluntary organizations for getting help in rescue / rehabilitation
- He will keep contact with Chief emergency Controller and act on his instructions
- He will collect data from the affected area regarding the cause of fire or explosion or toxic gas release and accordingly update case histories for training of plant personnel

Maintenance Team
During emergency

- Provide all assistance and advice to the coordinators and key personnel rendering emergency services for quick and effective control of the emergency situation.
- Mobilize their respective teams to assist in dealing with the emergency

7.8.4 EMERGENCY CONTROL CENTRE

For effective implementation of the Onsite Emergency Preparedness Plan timely advice and support is required from the Emergency Responders. To control various operations during an emergency it is necessary to set up an Emergency Control Centre (ECC) at ASL, Saggonda. IICT has identified requirements of an ECC describing the guidelines for the design, construction and facilities of the ECC to be set up at ASL, Saggonda.

Proposed Emergency Control Centre

The proposed Emergency Control Centre shall consist of the following

i) Emergency Control Room (ECR)
ii) Conference Room
iii) Room for meeting the press

In the ECR the necessary communications along with computerized information facilities for handling various types of emergencies shall be installed. These requirements are described in detail in sections 6.2 and 6.3 respectively. The ECR shall be manned 24 hours-a-day competent persons.

The conference room shall be large enough to allow several groups to work independent of one another. Maps and drawings indicating the location of various units of ASL and other information such as important telephone numbers, checklists for various emergencies etc., shall be provided in the conference room for ready reference.

The task of meeting the press and the next of kin of affected personnel shall be performed by officers assigned for this purpose

The Emergency Control Centre shall also have the following facilities.

a) Uninterrupted Power Supply (UPS) for the entire centre.
b) Emergency Lighting Systems
c) Smoke and fire detection systems coupled with dedicated fire extinguishing
d) facilities.
e) Air curtains for maintaining positive pressure.
f) Seating arrangement for the key personnel
g) Intercom telephone
h) Site drawings and route maps
i) Lists of key personnel, emergency crew
j) Addresses, Phone numbers of local authorities, external agencies
k) Telephone Directory
l) P.A. System
m) Hand Mike
n) Technical information, Safety manual
o) Black Board
p) Personal protective equipments
q) Emergency ladder, Safety nets
r) Torch lights, Gas lights
s) Firefighting equipment and accessories

The emergency control room is intended to be the main Control Room from which the emergency operations are governed in the event of an emergency. Decision making, communication of latest information obtained from the emergency control room.

Communication Facilities

The following are the suggested communications facilities to be located in the ECR.

a. A minimum of three telephone lines with unlisted numbers shall be available with facility of preprogramed dialing of sixteen numbers, shall be provided so that the necessary messages can be sent to different locations. These phones shall be of 'speaker' type with three-way conference/communication facility. They shall also be provided with voice recording facility to avoid the necessity of writing down all messages at once during the emergency.
b. Fax facility, Phone facilities indicated above can be through an independent digital PABX.
c. High frequency radio communications. (Walkie Talkies)

Emergency Communication systems (Existing)

- Emergency siren
- Internal and external telephones
- PA system, Hand mike sets
- Lists of key persons, emergency crew
- Addresses of statutory authorities, external agencies
- List of hospitals and phone numbers
- Telephone directory

Assemble Points

Assemble points are designated conveniently at the following places for safe evacuation of plant personnel.

- Assemble points are designated at three places in the factory site.
- Open space in front of the main gate. This is designated as main place for assemble
- South – East corner of factory site near to the Caustic Soda Lye storage tanks
- North – East side of factory site near the Sulphur storage yard