1.1 RISK ASSESSMENT

Hazard analysis involves the identification and quantification of the various hazards (unsafe conditions) that exist in the proposed project. On the other hand, risk analysis deals with the identification and quantification of risks, the plant equipment and personnel are exposed to, due to accidents resulting from the hazards present in the plant.

Risk analysis follows an extensive hazard analysis. It involves the identification and assessment of risks the neighboring populations are exposed to as a result of hazards present. This requires a thorough knowledge of failure probability, credible accident scenario, vulnerability of populations etc.

In the sections below, the identification of various hazards, probable risks in the Surfactant chemical manufacturing plant, maximum credible accident analysis, and consequence analysis are addressed which gives a broad identification of risks involved in the plant. Based on the risk estimation for fuel and chemical storage, Disaster Management Plan (DMP) has also been presented.

Risk Analysis involves identification of hazards and the associated risks, if any, involved in the plant. Recognition of all possible hazards and analysis of the associated risks is an important first step to improve the safety and reliability of any installation. Such an analysis would provide the necessary inputs for the safe operation of the Plant. The risk analysis study is designed to identify the hazards in terms of the types of materials handled their inventories and vulnerable practices and operations. The chemicals and their quantities involved in the plant are well below the threshold quantities mentioned in the MSIHC rules.

Depending on the type of liquid handled and process conditions, one or more of the following potential hazards/consequences could be encountered due to loss of containment of storages:

- Un-ignited release;
- Pool Fire;
- Thermal radiation;
- Vapour Cloud Explosion; and
- Toxic Impact

Based on the chemical properties of the raw material and products, Loss of containment of fuels (HSD) and consequent Thermal radiation on encountering an ignition source is analyzed using ALOHA. The modelling and consequence results of the study are presented below:

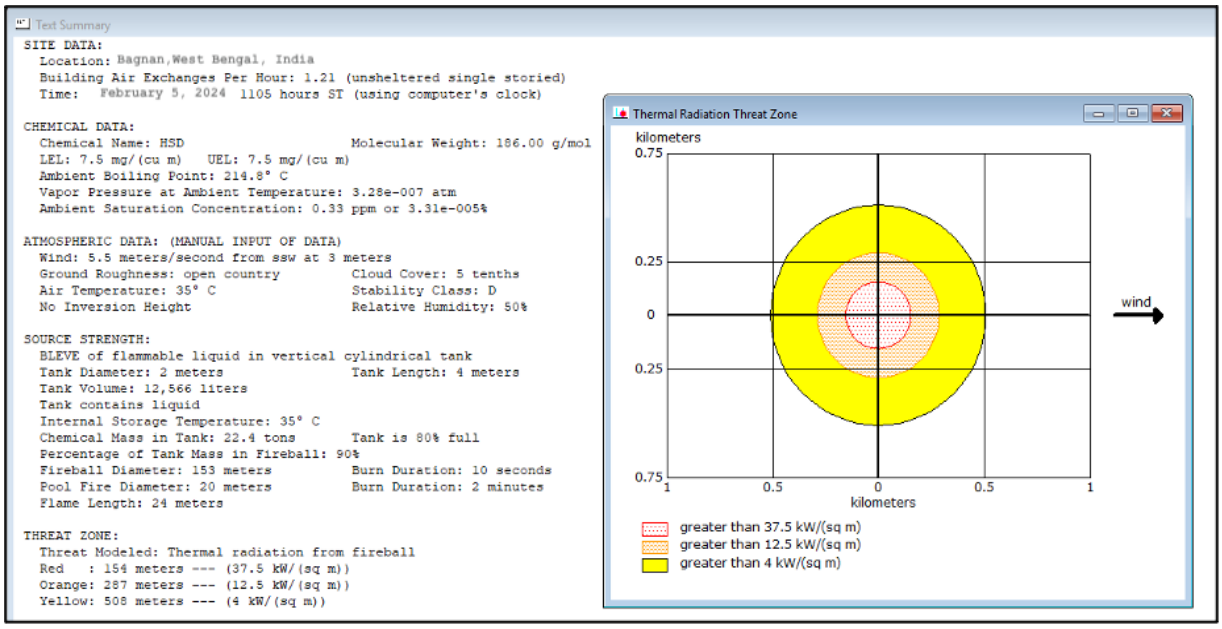
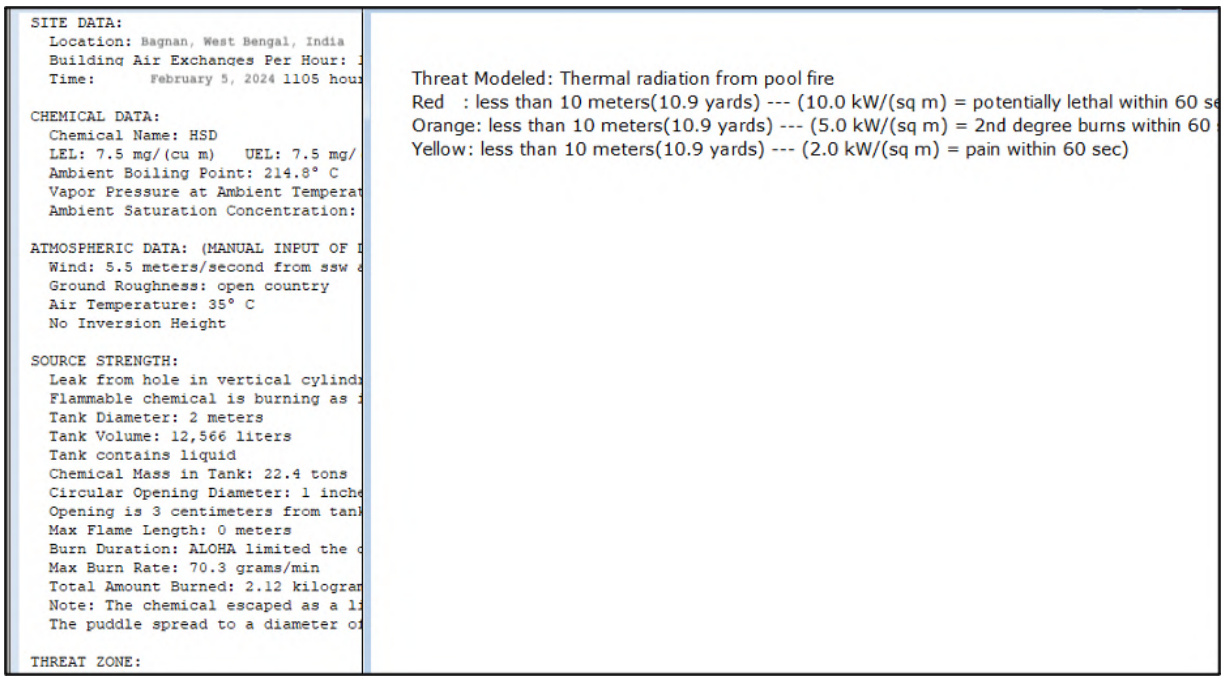


Figure Error! No text of specified style in document..**1 Thermal Radiation Consequence Contour**



for Diesel Tank (Rupture)

Figure Error! No text of specified style in document..**2: Pool Fire Consequence Contour for Diesel Tank (Rupture)**

1.1.1 Approach to the Study

Risk involves the occurrence or potential occurrence of some accidents consisting of an event or sequence of events. The risk assessment study covers the following:

- Identification of potential hazard areas;
- Identification of representative failure cases;
- Visualization of the resulting scenarios in terms of fire (thermal radiation) and explosion;
- Assessment of the overall damage potential of the identified hazardous events and the impact zones from the accidental scenarios;
- Assessment of the overall suitability of the site from hazard minimization and disaster mitigation point of view;
- Furnishing specific recommendations on the minimization of the worst accident possibilities; and
- Preparation of broad DMP, On-site and Off-site Emergency Plan, which includes occupational Health and Safety Plan.

1.2 HAZARD IDENTIFICATION

Identification and quantification of hazards in the Surfactant chemical manufacturing plant is of primary significance in the risk analysis, quantification and cost effective control of accidents. A classical definition of hazard states that hazard is in fact the characteristic of system/plant/process that presents potential for an accident.

Hence, all the components of a system/plant/process need 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. The following two methods for hazard identification have been employed in the study:

- Identification of major hazardous units based on Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 of Government of India (GOI Rules, 1989); as amended in 2000; and
- Identification of hazardous units and segments of plants and storage units based on relative ranking technique, viz. Fire-Explosion and Toxicity Index (FE&TI).

1.2.1 Classification of Major Hazardous Units

Hazardous substances may be classified into three main classes namely Flammable substances, unstable substances and toxic substances. The storage of the hazardous substance in the proposed project is given in **Table 7.1.**

Table Error! No text of specified style in document.**.1: Category - Wise Schedule of Storage Tanks**

S. No.	Product	No of Tanks	Classification	Design Capacity
1	HSD	1	Flammable	20 KL
2	H_2SO_4	1	Corrosive	420 MT

Hazardous characteristics of the major flammable materials employed in the proposed project are listed in **Table 7.2**.

Table Error! No text of specified style in document.**.2 : Properties of storage fuels**

Chemical	Codes/Label	TLV	FBP	MP	FP	UEL	LEL
			°C			%	
HSD	Flammable liquid	5mg/m^3	400	338	32.96	7.5	0.6

TLV : Threshold Limit Value FBP : Final Boiling Point

MP : Melting Point FP : Flash Point

UEL : Upper Explosive Limit LEL : Lower Explosive Limit

1.2.2 Identification of Major Hazard Installations Based on GOI Rules, 1989

Following the accidents in the chemical industry in India over a few decades, a specific legislation covering major hazard activities has been enforced by Govt. of India in 1989 in conjunction with Environment Protection Act, 1986. This is referred here as GOI rules 1989. For the purpose of identifying major hazard installations the rules employ certain criteria based on toxic, flammable and explosive properties of chemicals.

A systematic analysis of the fuels/chemicals and their quantities of storage has been carried out, to determine threshold quantities as notified by GOI Rules, 1989 and the applicable rules are identified. Applicability of storage rules is summarized in **Table -7.3.**

Table Error! No text of specified style in document.**.3**: **Applicability of GOI rules to fuel storage**

S. No.	Chemical / Fuel	Listed in Schedule	Total Quantity	Threshold Quantity (T) for Application of Rules	
				5, 7-9, 13-15	10-12
1	HSD	3 (1)	20 KL	25 MT	200 MT

1.3 HAZARD ASSESSMENT AND EVALUATION

1.3.1 Methodology

An assessment of the conceptual design is conducted for the purpose of identifying and examining hazards related to feed stock materials, major process components, utility and support systems, environmental factors, proposed operations, facilities, and safeguards.

1.3.2 Preliminary Hazard Analysis (PHA)

A preliminary hazard analysis is carried out initially to identify the major hazards associated with storages and the processes of the plant. This is followed by consequence analysis to quantify these hazards. The various process activities involved in the unit are purely chemical operations; those are not complex or hazardous. Hence, no major hazards with potential for any emergency situation exist in the plant. The preliminary hazard related to the proposed plant in general is given in **Table 7.4.** The preliminary hazard related to the storage tanks are given in **Table 7.5** respectively.

Table Error! No text of specified style in document.**.4**: **Preliminary Hazard Analysis in General**

PHA Category	Description of Plausible Hazard	Recommendation	Provision
Environmental Factors	If there is any leakage and eventuality of source of ignition.	---	All electrical fittings and cables will be provided as per the specified standards. All motor starters will be flame proof.
	Highly inflammable nature of the chemicals may cause fire hazard in the storage facility.	A well designed fire protection including AFFF foam, water sprinkler system, dry powder, CO2 extinguisher will be provided.	Fire extinguisher of small size and big size will be provided at all potential fire hazard places. In addition to the above, fire hydrant network will also provided.

Table Error! No text of specified style in document.**.5: Preliminary Hazard Analysis for Process and Storage Areas**

Equipment	Process	Potential Hazard	Provision
Generator	Converts mechanical energy into electrical energy	Mechanical hazards and fire hazards in Lube oil system Cable galleries Short circuits	Safety interlocks and manhole locks are provided to ensure safe operation and maintenance of the unit.
Power Transformers	-	Fire and explosion	All electrical fittings and cables are provided as per the specified standards.
Switch Yard control room	-	Fire in cable galleries and switch	As above
HSD Storage	Used as start-up fuel for DG sets, and also will be used for vehicular transportation	Fire & explosion	Leaks detection system will be provided.

1.3.3 Hazard Identification in Tank Farm

The chemicals used in the Plant are Linear Alkyl Benzene, Alpha olefin, Lauryl ether, Lauryl alcohol, Sulphuric Acid, Caustic Soda Liquid, Sulfur, Coconut Fatty Acid, Dimethyl aminopropylamine, Monochloroacetic acid, Monoethanolamine, Diethanolamine, Stearic Fatty Acid, Ethylene Glycol. The material safety data sheets are attached as **Annexure –III.**

1.3.4 Hazard Analysis for Tank Farm

The materials involved in storage and transfer system have flammable and toxic hazards. Potential failure scenarios involving loss of containment of the materials are as follows:

- Large spillage of the liquid from above- ground storage tanks into the dykes area due to overflow from tank or leakage from tank and connected piping;
- Spillage of liquid during tanker unloading or transfer to process unit; and
- Spillage of the liquid contained in underground tanks from discharge line of transfer pump.

The causes of hazardous liquid release in tank farm, their consequences and safeguards provided are indicated in Table - 7.6.

Table Error! No text of specified style in document.**.6: Hazard Identification for Tank Farm**

S. No.	Causes	Consequences	Safeguards
1	➢ Leakage from unloading hose ➢ Damaged hose ➢ Improper hose connection ➢ Flange gasket leak ➢ Movement of tanker during unloading	Exposure to toxic chemical Fire/explosion hazard due to flammable liquid release Loss of chemical Soil/Water contamination	✓ Regular inspection & replacement of chemical hoses. ✓ Maintenance system for gaskets, flange & hose connections including leak check. ✓ Procedure to immobilize tanker before start of unloading. ✓ Paved area for tanker unloading with berm for spill containment. ✓ Unloading checklist and display board in local language. ✓ Use of PPE for unloading.
2	➢ Leakage from pump seal	Exposure to toxic chemical Fire/explosion hazard due to flammable liquid release. Loss of chemical Soil/water contamination	✓ Reliable type of mechanical seal for pump. ✓ Stand-by pump ✓ Regular maintenance of pumps
3	➢ Overflow from storage tank by excess filling due to malfunction of tank level instrument.	Exposure to toxic chemical Fire/explosion hazard due to flammable liquid release Loss of chemical Soil/water contamination	✓ Reliable type tank level instrumentation ✓ Multiple level instruments to provide overfill protection for tank ✓ Regular monitoring of tank inventory

S. No.	Causes	Consequences	Safeguards
4	➢ Leakage from flange joint in piping connected to tank bottom	Exposure to toxic chemical. Fire/explosion hazard due to flammable liquid release Loss of chemicals Soil/water contamination	✓ Remote operated shut off valve in tank bottom connection with push button in control room and safe location outside the dyke.

1.3.5 Safety And Fire Fighting Planing

Safety Measures in Storage Facilities

Risk for storage units depends not on the extent of the consequence, but also on the probability of the failure of the safety measures and provisions provided. The safety measures to be provided in storage facilities in the proposed plant are given below:

Substance Stored	Safe Guard
Sulphuric Acid	• Dyke wall of height - 1.0 m and thickness-230 mm will be constructed around the storage tank for acid spillage containment. • Also the provision for automatic emergency shower will be provided.
High Speed Diesel (HSD)	Following Fire Fighting measures will be provided: • DCP (Dry Chemical Powder) Extinguisher; • AFFF (Aqueous Film Forming Foam) Extinguisher; • Water cum Foam Monitor; and d) Sand Bucket

General Safety Measures for Chemicals Storage & Handling.

Following safety measures for chemicals storage and handling will be provided.

- Availability of MSDS (Material Safety Data Sheets) information for all chemicals Proper layout of tank farm and other storage areas for chemicals.
- Proper segregation of chemicals storage taking into account compatibility Matrix Instrumentation and control system for tanks, Sulphonator etc. SO_2 and SO_3 Gas detection and fire protection systems.
- Periodic inspection and maintenance system Standard operating procedures and check lists Training of operation and maintenance personnel Safety work permit system.
- Electrical hazardous area classification for process units and storage areas Incident investigation and implementation of recommendations.

1.3.6 Risk Analysis for chemical storage

Details of Chemical storage

Details of raw material & products are shown in Table-7.7.

Table Error! No text of specified style in document.**.7: Details of Raw Material & Products**

S. No.	Description	Physical Form	Type of Storage	Capacity, MT	Flash Point (°C)	Possible Effects as per MSDS
Raw Materials						
1.	Linear Alkyl Benzene	Liquid	MS Tank	500	140	Non- toxic, Non-Flammable
2.	Alpha Olefin	Liquid	SS Tank	100	135	Non- toxic, Non-flammable, Contact with eyes and skin can cause irritation.
3.	Lauryl Ether	Liquid	SS Tank	750	162	Non- toxic, Nonflammable. Skin Corrosion/Irritation
4.	Sulfuric Acid	Liquid	MS Tank	420	-	Carcinogenic to humans(IARC Group-1)
5.	Caustic Soda Liquid	Liquid	SS Tank	650	-	Skin burns and eye irritant
6.	Sulfur	Solid	Closed Yard	1000	207	Corrosive to metals
7.	Coconut Fatty Acid	Liquid	SS Tank	200	>100	Not flammable, non-explosive, No reactivity hazard
8.	Dimethylaminopropylamine	Liquid	SS Tank	36	30.5	flammable, corrosive
9.	Monochloroacetic acid	Solid	Closed Yard	30	126	Non flammable, toxic if swallowed
10.	Monoethanolamine	Liquid	SS Tank	36	91	Corrosive, skin irritation
11.	Diethanolamine	Liquid	SS Tank	36	138	Irritation of eyes and skin
12.	Stearic Fatty Acid	Liquid	SS Tank	200	200	Non toxic, non flammable
13.	Ethylene Glycol	Liquid	SS Tank	36	111	Must be preheated before ignition can occur.
Products						
1.	Linear Alkyl Benzene Sulphonic Acid LABSA 96%	Liquid	MS Tank	300	>200	Non- toxic, Nonflammable and harmful if swallowed.
2.	Alpha Olefin Sulfonate 38%	Liquid	SS Tank	120	>93.9	Non-flammable. Contact with eyes and skin can cause irritation.
3.	Sodium Lauryl Ether Sulphate 28%	Liquid	SS Tank	300	>93.9	Non-flammable Mist can be irritating to nose, throat & upper respiratory tract
4.	Sodium Lauryl Sulphate 28%	Liquid	SS Tank	120	170	Non- toxic, Non-flammable

S. No.	Description	Physical Form	Type of Storage	Capacity, MT	Flash Point (°C)	Possible Effects as per MSDS
Raw Materials						
5.	Cocoamidopropyl Betaine	Liquid	SS Tank	42	>100	Slightly flammable,
6.	Cocamide Monoethanolamine	Solid	Closed Yard	40	>150	Harmful if swallowed
7.	Cocamide Diethanolamine	Liquid	SS Tank	42	>93.3	May be combustible at high temperature.
8.	Ethylene Glycol Distearate	Solid	Closed Yard	40	297.9	Non flammable, Non explosive
9.	Ethylene Glycol Monostearate	Solid	Closed Yard	40	>400	May be combustible at high temperature
10.	Dilute Sulphuric Acid	Liquid	MS Tank	420	-	Corrosive

1.3.7 Hazard Identification

The chemical raw materials and products (LAB, AO, LE, LA, LABSA, AOS, SLS & SLES) with high flash point (about 100 °C or higher) do not have any significant flammable hazard. Nor are they associated with toxic dispersion hazards.

Sulphur is stored in solid forms. Solid sulphur in the storage yard may be ignited by sparks or hot surfaces in machinery. However, solid sulphur burns slowly and such sulphur fires can be easily detected by the fumes of sulphur dioxide. Incipient fires in storage piles may be smothered by gently shoveling sulphur onto them.

1.3.8 Consequence Analysis

Damage Effects of Pool Fire Radiation

The effect from jet fire and pool fire is thermal radiation intensity on the receptor surface as shown in **Table-7.8.**

Table Error! No text of specified style in document.**.8: Damage Effects due to Pool Fire Radiation**

Heat Radiation Intensity (kW/m^2)	Observed Effect
4	Sufficient to cause pain to personnel if unable to reach cover within 20 seconds; 0% lethality.
12.5	Minimum energy required for piloted ignition of wood, melting of plastic tubing.
37.5	Sufficient to cause damage to process equipment.

- Thermal radiation intensity exceeding 37.5kW/m^2 may cause escalation due to damage of other equipment.
- Thermal radiation intensity exceeding 12.5kW/m^2 may cause ignition of combustibles on buildings and impairment of escape route.
- Thermal radiation intensity exceeding 4kW/m^2 may cause burn injury on personnel injury.

1.3.9 Consequence Analysis Results

Consequence analysis for the identified failure scenario is carried out using the renowned PHAST software of DNV-GL. The results of consequence analysis are summarized in **Table-7.9** and consequence analysis result in graphical form for the worst cases are shown in **Figure-7.1 & Figure-7.2.**

Table Error! No text of specified style in document.**.9**: **Summary of Consequence Analysis Results**

Scenario considered	Pasquill stability class	LFL concentration PPM	Flash fire At LFL concentration distance (m)	Overpressure Damage distance for various heat loads (m)			Pool Fire Damage distance for various heat loads (m)		
				0.02068 bar	0.1379 bar	0.2068 bar	4 kW/m²	12.5 kW/m²	37.5 kW/m²
HSD Tank Rupture	2F	8000	11.66	53.92	18.53	16.4	32.87	17.84	6.64
	3D		12.18	51.59	18.08	16.06	33.84	19.93	6.72
	5D		12.54	53.02	18.36	16.27	35.11	22.41	6.81
HSD Tank (Leak 50mm)	2F	8000	2.32	NR	NR	NR	29.80	17.96	6.79
	3D		2.41	NR	NR	NR	30.54	19.56	7.08
	5D		2.47	NR	NR	NR	31.52	21.22	7.27
HSD storage Tank (Leak 10mm)	2F	8000	1.92	NR	NR	NR	11.61	8.02	4.46
	3D		2.04	NR	NR	NR	11.92	8.46	4.91
	5D		2.15	NR	NR	NR	12.16	8.95	5.47

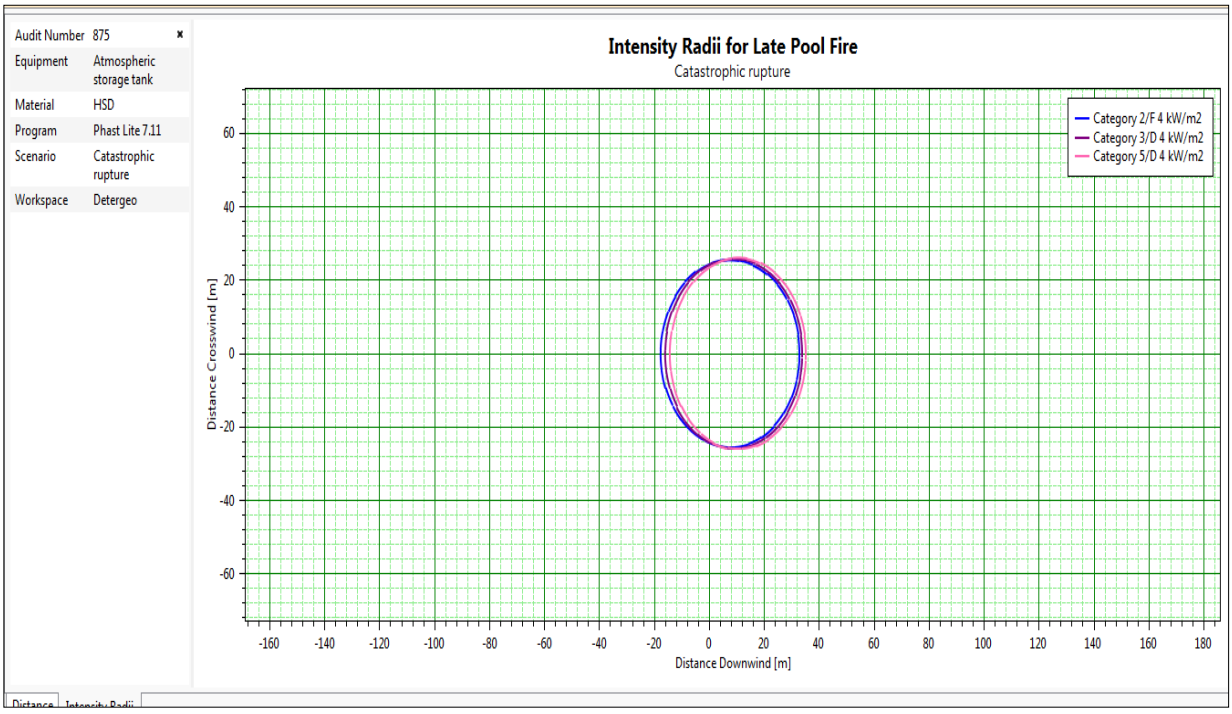


Figure Error! No text of specified style in document.**3: Graph showing intensity radii for pool fire for HSD Storage Tank of 20 KL**

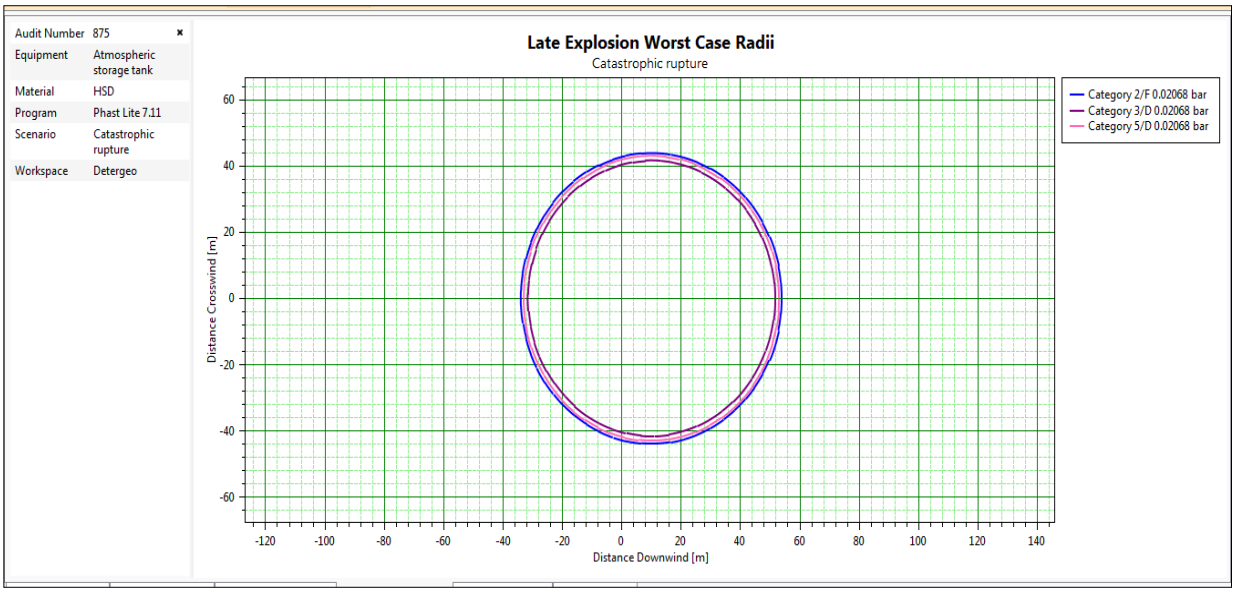


Figure Error! No text of specified style in document.**.4: Graph showing explosion worst-case radii for HSD Storage Tank of 20 KL**

Recommendations

The following recommendations are provided for the purpose of minimizing risk due to HSD tank and chemicals storage.

- Provision of foam pourer in the HSD tank will be useful to fight tank fire with the help of foam generating branch pipe.
- The flexible hoses used for road tanker unloading (chemicals) should be maintained and checked regularly to prevent leaks.
- Road tanker unloading operation should be covered by written standard operating procedure (SOP). The instructions in local language should be displayed on a board at each unloading station.
- Good housekeeping is required in sulphur yard to prevent accumulation of sulphur dust on structural members. Compressed air should not be used for removal of sulphur dust.
- Proper ventilation system need to be provided to avoid the accumulation of sulphur dust.

1.3.10 Risk Mitigation Measures to be adopted at Sulphonation Plant

Hazard Control Measures

Apart from the above other mitigation measures are given below:-

- Procedures and actions will be well defined and known to all operating personnel's for safe shut down of plant incase of failure of any power, instrumentation, cooling water, air, etc;
- All the vessels and tanks will be provided with temperature indicator, pressure gauge and safety valves as depending upon the process and operating parameters;
- Plant specific HAZOP studies will be carried out using P&IDs (Piping and Instrumentation Diagrams) for identification of hazards during operation considering deviation of operational parameters, their possible cause and consequence and safe guards;
- Interlocks and DCS (Distributed Control System) control will be provided during reaction process;
- All the reactors which will not working at atmospheric temperature will be provided with glass wool lagging to contain the heat;
- All the motors and other rotating equipment machines will be provided with suitable safety guards;

- First Aid Fire extinguishers will also be installed in the plant area;
- Flame arrestors will be provided at all vent lines at solvent tanks;
- Suitable first aid fire extinguishers, such as, DCP (Dry Chemical Powder), CO2 & foam type will be kept in every plant area at easily approachable spots and in sufficient numbers;
- Fire hydrant points with sufficient length of hose reel will be provided at major emergency spots;
- Emergency Safety shower will be installed at crucial places;
- Sufficient space will be provided for free movement in the plant area;
- Safe distances have been considered in designing of plant layout;
- Regarding all components of the plant proper certificate will be taken. Also testing and inspection will not be compromised before deliveries;
- Certificate of structure stability will be taken from competent person;
- Insulation of piping will be provided as per requirement;
- All elevated structures will be provided with lightening arrestors;
- All exposed parts of moving machineries will be provided with suitable guards for personnel safety;
- All piping and equipment will be provided with earthing connection and it will be tested regularly;
- Safety valves & rupture disc will be provided to prevent over pressurization of vessels and reactors; and
- SOP (Standard Operating Procedure) will be available of safe shut -down of plant during any emergency situation.

Spillages, Leakages: Controls

Depending on the leaking rate/source the following actions will be taken:

- Isolation/cutting of supply at the leaking point, transfer to some other vessel/equipment, and using protective appliances like hand gloves, helmets, PVC suits etc;
- Efforts will be made, to prevent the spread of spillage by neutralization/ earth barriers; and
- Outgoing effluents will have to be blocked and taken to effluent collection tanks. It will be taken for treatment.

Hazzard and Operability Study (HAZOP):

A hazard and operability study (HAZOP) is a structured and systematic examination of a complex system, usually a process facility, in order to identify hazards to personnel, equipment or the environment, as well as operability problems that could affect operations efficiency.
The study data of HAZOP in sulphonation plant is attached as **ANNEXURE-IV.**

1.3.11 Risk Mitigation Measures to be adopted During Transport

S. No	Improvement Areas	Risk Mitigation Measures
1	Driver Management	Driver training shall be mandated through Detergeo approved DTI.
		Driver medical shall be mandated through Detergeo approved medical centers.
		Defensive driving training to errant driver
		Minimum age of Driver is required to be 25 Years
		Keep a record of the substances being transported i.e., shipping papers and written emergency instructions are critical for safety
2	Journey Management	Buyer/customer to be informed to define route with proper rest stations. Customer to submit the document to Detergeo.

S. No	Improvement Areas	Risk Mitigation Measures
		Detergeo may review and provide input. Customer shall review and release final document to Detergeo and communicate to all transporters and driver by the customers, via Journey Route Management document for every journey. Journey management documents should also take care of details like on route nearby Hospital, Crane provider etc. A sample format may be shared by Detergeo to customer.
		Restrict night time driving (12:00 am – 5:00 am) inclusive of empty vehicles which is the most accident-prone time zone
		Mandate resting time of at least 30 minutes for drivers after continuous driving of maximum of 4 hours.
		Vehicles are not allowed to driver more than 60 Km/hr.
		24x7 Proactively monitor all safety violations and provide timely alerts to drivers/ SPOC for controlling any possible damage through VTS compatible with Detergeo System
3	Vehicle Management	All the vessels and tanks will be provided with temperature indicator, pressure gauge and safety valves as depending upon the material being transported and operating parameters
		Suitable fire extinguishers, such as, DCP (Dry Chemical Powder), CO2 & foam type to be kept in the transporter vehicle at easily approachable spots and in sufficient numbers
		Inspect the vehicle's general condition, including tires, condition of valves, electrical wiring, adequate sealing, condition of wipers, headlights, signal lights, etc.
		Following the dangerous goods segregation rules for carrying mixed classes of hazardous chemicals; chemicals must be separated when being transported/stored to ensure incompatible chemicals do not mix if there is a spill
		Placards are standard hazmat identifiers, designed to meet individual specifications, will be placed on outer containers, trucks, cylinders, or other vehicles used for transport
		Have an emergency kit readily available with safety goggles, chemical information sheets, and MSDS
		Securing container tanks against movement on transportation vehicles i.e., proper loading and bracing all containers so they do not fall, slide, or bounce around during transportation
		Suraksha certification from Detergeo authorized center for liquid tankers
		Periodic Testing of Safety Relief Valve (SRV) and EFCV/IEFCV (Excess Flow/Internal Excess Flow Check Valve) under Rule 18 and Tanker testing under Rule 19 for Tanker integrity testing through Hydrotesting through DETERGEO approved centers along with TPI presence during testing.
		Speed Governor Speed limiting devices can avoid the risk of accidents due to over-speeding

S. No	Improvement Areas	Risk Mitigation Measures
		ABS (Anti-Lock Braking system) and EBS in Trailers with ESC – Electronic Stability Controller
		RUPD/SUPD should be available in the vehicle. The rear bumper should not extend beyond the RUPD.
		Vehicle Age: Age of vehicle restricted up to 10 yrs. to improve distribution safety and sustainability
4	Emergency Response	Customer should have their own Offsite Transport Emergency Response Plan

1.3.12 Risk Reduction Measures

Based on hazard identification, consequence analysis and safety measures to be adopted at the plant, following suggestions for improvement of safety at the plant are emerged.

For risk mitigation/reduction, attempts should be made to either reduce inventories that could get released in the event of loss of containment or failure likelihood's or both as feasible. Risk analysis identifies the major risk contributors, which enables prioritization of the plant that deserve special attention in terms of inspection and maintenance in particular and over all safety management as a whole.

For the risk reduction at the proposed plant, the following salient suggestions and recommendations are made:

- A written process safety information document may be compiled for general use.
- Personnel especially contractor workers at the plant should be made aware about the hazardous substance stored at the plant and risk associated with them.
- The process design information in the process safety information compilation must include P&IDs/PFDs (Process Flow Diagrams); process chemistry; maximum intended inventory; acceptable upper and lower limits, pressures, flows and compositions and process design and energy balances.
- The document compilation should include an assessment of the hazards presented including (i) toxicity information (ii) permissible exposure limits. (iii) physical data (iv) thermal and chemical stability data (v) reactivity data (vi) corrosivity data (vii) information on process and mechanical design.
- The adequate numbers of heat and smoke detectors may be provided at strategic locations in the plant and indication of detectors/sensors should be provided in main control room.
- Predictive and preventive maintenance schedule should be prepared for equipment, piping, pumps, etc. and thickness survey should be done periodically as per standard practices.
- Safety measures in the form of Dos and Don'ts should be displayed at strategic locations especially in Bengali and English language.
- Safe work practices should be developed to provide for the control of hazards during operation and maintenance.
- The plant should check and ensure that all instruments provided in the plant are in good condition and documented.
- Apart from occupational health centre, first aid boxes including eye wash containers will be placed in all the work areas for immediate first aids.

1.4 DISASTER MANAGEMENT PLAN

The Disaster Management Plan is aimed to ensure safety of life, protection of environment, protection of installation, restoration of production and salvage operations in this same order of priorities. For

effective implementation of the Disaster Management Plan, it should be widely circulated and personnel training should be provided through rehearsals/drills.

To tackle the consequences of a major emergency inside the factory or immediate vicinity of the factory, a Disaster Management Plan has to be formulated and this planned emergency document is called "Disaster Management Plan".

The objective of the Industrial Disaster Management Plan is to make use of the combined resources of the plant and the outside services to achieve the following:

- Effect the rescue and medical treatment of casualties;
- Safeguard other people;
- Minimize damage to property and the environment;
- Initially contain and ultimately bring the incident under control;
- Identify any dead;
- Provide for the needs of relatives;
- Provide authoritative information to the news media;
- Secure the safe rehabilitation of affected area;
- Preserve relevant records and equipment for the subsequent inquiry into the cause and circumstances of the Emergency.

In effect, it is to optimize operational efficiency to rescue, rehabilitate and render medical help and to restore normalcy.

1.4.1 Emergencies

1.4.1.1 General and Industrial Emergencies

The emergencies that could be envisaged in the plant and tank farm are as follows:

- A situation of fire at the tank farm of all storages;
- Slow isolated fires;
- Fast spreading fires;
- Structural failures;
- Contamination of food/water; and
- Sabotage/Social disorder.

1.4.1.2 Specific Emergencies Anticipated

Fire and Explosion

Fire consequences can be disastrous, since they involve huge quantities of fuel either stored or in dynamic inventory in pipelines or in nearby areas. Toxic releases can affect persons working around. Preliminary hazard Analysis has provided a basis for consequence estimation.

1.4.2 Emergency Organization

The DCEPL will set up an Emergency Organization. A senior executive who has control over the affairs of the plant would be heading the Emergency Organization. He would be designated at Site Controller. As per the General Organization chart, Chief Operating Officer will be the Site Controller. General Manager will be designated as the Incident Controller. All the Incident Controllers would be reporting to the Site Controller.

All the department heads, fire & security officer, communication officer and personal manager will be reporting to the Incident Controller. This team will be responsible for controlling the incidence with the personnel under their control. Shift In charge will be the reporting officer, who would bring the incidence to the notice of the Incidence Controller and Site Controller. The team co-ordinates

during eventualities and responsible for fire fighting, rescue, rehabilitation, transport and provide essential and support services. For this purposes, security in charge, personnel department, and essential services personnel are engaged. All these personnel will be designated as key personnel.

In each shift, electrical supervisor, electrical fitters, pump house in charge and other maintenance staff will be drafted for emergency operations. In the event of power or communication system failure, some of staff members in the office/plant offices will be drafted and their services would be utilized as messengers for quick passing of communications.

1.4.2.1 Emergency Communication

Whoever notices an emergency situation such as fire, escalation of fire, leakage etc will inform his immediate superior and Emergency Control Center. A place nearer to the security office shall be identified as Emergency Control Center. The person on duty in the Emergency Control Center would appraise the Site Controller. Site Controller verifies the situation from the Incident Controller of that area or the Shift In- charge and takes a decision about an impending On Site Emergency. This would be communicated to all the Incident Controllers, Emergency Co-ordinators. Simultaneously, the emergency warning system would be activated on the instructions of the Site Controller.

1.4.3 Onsite Emergency Preparedness and Response for Accidents

1.4.3.1 Emergency Responsibilities

The responsibilities of the key personnel are appended below:

Site Controller:

On receiving information about emergency he would rush to Emergency Control Center (ECC) and take charge of ECC and the situation and;

- Assesses the magnitude of the situation on the advice of incident Controller and decides, whether the affected area needs to be evacuated,
- Whether personnel who are at assembly points need to be evacuated,
- Declare Emergency and order for operation of emergency siren,
- Organizes announcement by public address system about location of emergency,
- Assesses which areas are likely to be affected, or need to be evacuated or need to be alerted,
- Maintains a continuous review of possible development and assesses the situation in consultation with Incident Controller and other Key Personnel as to whether shutting down the plant or any section of the plant is required and if evacuation of persons is required,
- Directs personnel for rescue, rehabilitation, transport, fire brigade, medical and other designated mutual support systems locally available, for meeting emergencies.
- Controls evacuation of affected areas, if the situation is likely to go out of control or effects are likely to go beyond the premises of the factory, informs the District Emergency Authority, Police, Hospital and seeks their intervention and help,
- Informs the Inspector of Factories, Deputy Chief Inspector of Factories, WBPCB and other statutory authorities,
- Gives a public statement if necessary,
- Keeps record of chronological events and prepares an investigation report and preserve evidence,
- On completion of On Site Emergency and restoration of normalcy, declares all clear and orders for all clear warning.

Incident Controller:

- Assembles the incident control team.
- Directs operations within the affected areas with the priorities for safety to personnel minimize damage to the plant, property and environment and minimize the loss of materials.

- Directs the shutting down and evacuation of plant and areas likely to be adversely affected by the emergency.
- Ensure that key personnel help is sought.
- Provides advice and information to the Fire and Security Officer and the Local Fire Services as and when they arrive.
- Ensures that all non-essential workers/staff of the affected areas evacuated to the appropriate assembly points, and the areas are searched for casualties.
- Has regard to the need for preservation of evidence so as to facilitate any inquiry into the causes and circumstances, which caused or escalated the emergency.
- Co-ordinates with emergency services at the site.
- Provides tools and safety equipment to the team members.
- Keeps in touch with the team and advice them regarding the method of control to be used.
- Keeps the Site Controller of Emergency informed of the progress being made

Emergency Coordinator - Rescue, Fire Fighting:

- Helps the incident Controller in containment of the emergency;
- Ensures fire pumps are in operating conditions and instructs pump house operator to be ready for any emergency with standby arrangement;
- Guides the fire fighting crew i.e. firemen, trained plant personnel and security staff;
- Organizes shifting of the fire fighting facilities to the emergency site, if required;
- Takes guidance of the Incident Controller for firefighting as well as assesses the requirements of outside help;
- Arranges to control the traffic at the gate and the incident area;
- Directs the security staff to the incident site to take part in the emergency operations under his guidance and supervision;
- Evacuates the people in the plant or in the nearby areas as advised by Site Controller;
- Searches for casualties and arranges proper aid for them;
- Assembles search and evacuation team;
- Arranges for safety equipment for the members of this team;
- Decides which paths the evacuated workers should follow;
- Maintains law and order in the area, and if necessary seeks the help of police.

Emergency Coordinator-Medical, Mutual Aid, Rehabilitation, Transport and Communication:

- In the event of failure of electric supply and thereby internal telephone, sets up communication point and establishes contact with the ECC;
- Organizes medical treatment to the injured and if necessary will shift the injured to nearby hospitals;
- Mobilizes extra medical help from outside, if necessary;
- Keeps a list of qualified first aid providers of the factory and seek their assistance;
- Maintains first aid and medical emergency requirements;
- Makes sure that all safety equipment is made available to the emergency team;
- Assists Site Controller with necessary data and to coordinate the emergency activities;
- Assists Site Controller in updating emergency plan, organizing mock drills verification of inventory of emergency facilities and furnishing report to Site Controller;
- Maintains liaison with Civil Administration;
- Ensures availability of canteen facilities and maintenance of rehabilitation center;
- He will be in liaison with Site Controller/Incident Controller;
- Ensures transportation facility;

- Ensures availability of necessary cash for rescue/rehabilitation and emergency expenditure;
- Controls rehabilitation of affected areas on discontinuation of emergency;
- Ensures availability of diesel/petrol for transport vehicles engaged in emergency operation.

Emergency Coordinator - Essential Services:

- He would assist Site Controller and Incident Controller.
- Maintains essential services like Diesel Generator, Water, Fire Water, Compressed Air/Instrument Air, power supply for lighting.
- He would plan alternate facilities in the event of power failure, to maintain essential services such as lighting, refrigeration plant etc.
- He would organize separate electrical connections for all utilities and emergency services so that in the event of emergency or fires, essential services and utilities are not affected.
- Gives necessary instructions regarding emergency electrical supply, isolation of certain sections etc. to shift in-charge and electricians.
- Ensures availability of adequate quantities of protective equipment and other emergency materials, spares etc.

General Responsibilities of Employees during an Emergency:

During an emergency, it becomes more enhanced and pronounced when an emergency warning is raised, the workers if they are in-charge of process equipment should adopt safe and emergency shut down and attend any prescribed duty as essential employee. If no such responsibility is assigned, he should adopt a safe course to assembly point and await instructions. He should not resort to spread panic. On the other hand, he must assist emergency personnel towards objectives of DMP.

1.4.3.2 Emergency Facilities

Emergency Control Center (ECC):

For the time being, Office Block or a place nearer to the security office is identified as Emergency Control Center. It would have external Telephone, Fax, and Telex facility. All the Site Controller/ Incident Controller Officers, Senior Personnel would be located here. Also, it would be an elevated place.

The following information and equipment are to be provided at the Emergency Control Center (ECC).

- Intercom, telephone
- P and T telephone
- Safe contained breathing apparatus
- Fire suit/gas tight goggles/gloves/helmets
- Hand tools, wind direction/velocities indications
- Public address megaphone, hand bell, telephone directories
- (Internal P and T) factory layout, site plan
- Emergency lamp/torch light/batteries
- Plan indicating locations of hazard inventories, plant control room, sources of safety equipment, work road plan, assembly points, rescue location vulnerable zones, escape routes.
- Hazard chart
- Emergency shut- down procedures
- Nominal roll of employees
- List of key personnel, list of essential employees, list of Emergency Co-ordinators
- Duties of key personnel.
- Address with telephone numbers and key personnel, emergency coordinator, essential employees.

Important address and telephone numbers including Government agencies, neighboring industries and sources of help, outside experts, chemical fact sheets population details around the factory.

Assembly Point:

Number of assembly points depending upon the plant location would be identified wherein employees who are not directly connected with the disaster management would be assembled for safety and rescue. Emergency breathing apparatus, minimum facilities like water etc. would be organized. In view of the size of plant, different locations are ear marked as assembly points. Depending upon the location of hazard, the assembly points are to be used.

Fire Fighting Facilities:

First Aid Fire fighting equipment suitable for emergency should be maintained in each section in the plant. This would be as per statutory requirements. However, fire hydrant line covering major areas would be laid. It would be maintained at 6- 7 kg/cm2 pressure. Fire alarms would be located in the bulk storage areas. Fire officer will be the commanding officer of fire fighting services.

Location of Wind Sock:

On the top of the Administration block and the top of each production blocks, windsocks shall be installed to indicate direction of wind for emergency escape.

Emergency Medical Facilities:

Stretchers, gas masks and general first aid materials for dealing with fire burns would be maintained in the medical center as well as in the emergency control room. Medical superintendent of the township will be the head of the casuality services ward. Private medical practitioners help would be also are sought. Government hospital would be approached for emergency help.

Apart from plant first aid facilities, external facilities would be augmented. Names of Medical Personnel, Medical facilities in the area would be prepared and updated. Necessary specific medicines for emergency treatment of Burns for Patients and for those affected by toxicity would be maintained. Breathing apparatus and other emergency medical equipment would be provided and maintained. The help of near by industrial management in this regard would be taken on mutual support basis.

Ambulance:

An ambulance with driver availability in all the shifts and an emergency shift vehicle would be ensured and maintained to transport injured or affected persons. Number of persons would be trained in first aid so that, in every shift, first aid personnel would be available.

1.4.3.3 Emergency Actions

Emergency Warning

Communication of emergency would be made familiar to the personnel inside the plant and people outside. An emergency warning system shall be established.

Emergency Shutdown

There are number of facilities which can be provided to help deal with hazardous conditions, when a tank is on fire. The suggested arrangements are:

- Stop the production;
- Dilute contents;
- Remove heat;
- Deluge with water; and
- Transfer contents.

Whether a given method is appropriate depends on the particular case. Cessation of agitation may be the best action in some instances but not in others. Stopping of the feed may require the provision of by pass arrangements. Methods of removing additional heat include removal through the normal

cooling arrangements or use of an emergenc y cooling system. Cooling facilities, which use vapouring liquid, may be particularly effective, since a large increase in vaporization can be obtained by dropping pressure.

Evacuation of Personnel:

There could be more number of persons in the storage area and other areas in the vicinity. The area would have adequate number of exits and staircases. In the event of an emergency, unconnected personnel have to escape to assembly point. Operators have to take emergency shutdown procedure and escape. Time Office maintains a copy of deployment of employees in each shift, at ECC. If necessary, persons can be evacuated by rescue teams.

All Clear Signal:

Also, at the end of an emergency, after discussing with Incident Controllers and Emergency Co-ordinators, the Site Controller orders an all clear signal. When it becomes essential, the Site Controller communicates to the District Emergency Authority, Police, Fire service personnel regarding help required or development of the situation into an Off-Site Emergency.

Employee Information:

During an emergency, employees would be warned by raising siren in specific pattern. Employees would be given training of escape routes, taking shelter, protecting from toxic effects. Employees would be provided with information related to fire hazards, antidotes and first aid measures. Those who would be designated as key personnel and essential employees should be given training to emergency response.

Public Information and Warning:

The industrial disaster effects related to this plant may mostly be confined to the plant area. The detailed risk analysis has indicated that the pool fire effects would not be felt outside. However, as an abundant precaution, the information related to chemicals in use would be furnished to District Emergency Authority for necessary dissemination to general public and for any use during an off site emergency. Factories of this size and nature are in existence in our state since long time.

Co-ordination with Local Authorities:

Keeping in view of the nature of emergency, two levels of coordination are proposed. In the case of an On Site Emergency, resources within the organization would be mobilized and in the event of extreme emergency, local authorities help should be sought.

In the event of an emergency developing into an off site emergency, local authority and District emergency Authority (normally the Collector) would be appraised and under his supervision, the Off Site Disaster Management Plan would be exercised. For this purpose, the facilities that are available locally, i.e. medical, transport, personnel, rescue accommodation, voluntary organizations etc. would be mustered. Necessary rehearsals and training in the form of mock drills should be organized.

Mutual Aid:

Mutual aid in the form of technical personnel, runners, helpers, special protective equipment, transport vehicles, communication facility etc should be sought from the neighboring industrial management.

Mock Drills:

Emergency preparedness is an important step in planning of Industrial Disaster Management. Personnel would be trained suitably and prepared mentally and physically in emergency response through carefully planned, simulated procedures. Similarly, the key personnel and essential personnel should be trained in the operations.

Important Information:

Once the Plant goes into stream, important information such as names and addresses of key personnel, essential employees, medical personnel, outside the plant, transporters address, address of those connected with Off Site Emergency such as Police, Local Authorities, Fire Services, District Emergency Authority should be prepared and maintained.

1.4.4 Off-Site Emergency Preparedness Plan

Introduction

Off-site emergency plan follows the on-site emergency plan. When the consequences of an emergency situation go beyond the plant boundaries, it becomes an off -site emergency. Off-site emergency is essentially the responsibility of the public administration. However, the factory management will provide the public administration with the technical information relating to the nature, quantum and probable consequences on the neighboring population.

The off- site plan in detail will be based on those events, which are most likely to occur, but other less likely events, which have severe consequence, will also be considered. Incidents which have very severe consequences yet have a small probability of occurrence should also be considered during the preparation of the plan. However, the key feature of a good off-site emergency plan is flexibility in its application to emergencies other than those specifically included in the formation of the plan.

The roles of the various parties who will be involved in the implementation of an off - site plan are described below. Depending on local arrangements, the responsibility for the off- site plan should be either rest with the works management or, with the local authority. Either way, the plan should identify an emergency coordinating officer, who would take the overall command of the off-site activities. As with the on-site plan, an emergency control center should be setup within which the emergency coordinating officer can operate.

An early decision will be required in many cases on the advice to be given to people living "within range" of the accident - in particular whether they should be evacuated or told to go indoors. In the latter case, the decision can regularly be reviewed in the event of an escalation of the incident. Consideration of evacuation may include the following factors:

- In the case of a major fire but without explosion risk (e.g. an oil storage tank), only houses close to the fire likely need to be evacuated, although a severe smoke hazard may require this to be reviewed periodically;
- If a fire is escalating and in turn threatening a store of hazardous material, it might be necessary to evacuate people nearby, but only if there is time; if insufficient time exists, people should be advised to stay indoors and shield them from the fire. This latter case particularly applies if the installation at risk could produce a fireball with very severe thermal radiation effects;
- For release or potential release of toxic materials, limited evacuation may be appropriate down wind, if there is time. The decision would depend partly on the type of housing "at risk".

Conventional housing of solid construction with windows closed offers substantial protection from the effects of a toxic cloud, while shanty house, which exist close to factories, offer little or no protection.

The major difference between releases of toxic and flammable materials is that toxic clouds are generally hazardous down to much lower concentrations and therefore hazardous over greater distances. Also, a toxic cloud drifting at, say 300 m per minute covers a large area of land very quickly.

Any consideration of evacuation should take this into account. Although the plan will have sufficient flexibility built in to cover the consequences of the range of accidents identified for the on-site plan, it will cover in some detail the handling of the emergency to a particular distance from each major hazard works.

Aspects Proposed to be considered in the Off-Site Emergency Plan

The main aspects, which should be included in the emergency plan are:

Organization

Details of command structure, warning systems, implementation procedures, emergency control centers.

Names and appointments of incident controller, site main controller, their deputies and other key personnel.

Communications

Identification of personnel involved, communication center, call signs, network, list of telephone numbers.

Specialized knowledge

Details of specialist bodies, firms and people upon whom it may be necessary to call e.g. those with specialized chemical knowledge and laboratories.

Voluntary organizations

Details of organizers, telephone numbers, resources etc.

Chemical information

Details of the hazardous substances stored or procedure on each site and a summary of the risks associated with them.

Meteorological information

Arrangements for obtaining details of weather conditions prevailing at the time and weather forecasts.

Humanitarian arrangements

Transport, evacuation centers, emergency feeding treatment of injured, first aid, ambulances and temporary mortuaries.

Public information

Arrangements for dealing with the media press office and informing relatives, etc.

Assessment of emergency plan

Arrangements for: (a) Collecting information on the causes of the emergency; (b) Reviewing the efficiency and effectiveness of all aspects of the emergency plan.

1.4.4.1 Role of the Emergency Co-ordinating Officer

The various emergency services should be co-ordinated by an Emergency Co-ordinating Officer (ECO), who will be designated by the district collector. The ECO should liaison closely with the site main controller. Again, depending on local arrangements, for very severe incidents with major or prolonged off-site consequences, the external control should be passed to a senior local authority administrator or even an administrator appointed by the central or state government.

1.4.4.2 Role of the Local Authority

The duty to prepare the off-site plan lies with the local authorities. The Emergency Planning Officer (EPO) appointed should carry out his duty in preparing for a whole range of different emergencies within the local authority area. The EPO should liaison with the works, to obtain the information to provide the basis for the plan. This liaison should ensure that the plan is continually kept up to date.

It will be the responsibility of the EPO to ensure that all those organizations, which will be involved in off-site handling of the emergency situation, know of their role and are able to accept it by having for example, sufficient staff and appropriate equipment to cover their particular responsibilities. Rehearsals for off- site plans should be organized by the EPO.

1.4.4.3 Role of Police

Formal duties of the police during an emergency include protecting life and property and controlling traffic movements.

Their functions should include controlling bystanders, evacuating the public, identifying the dead and dealing with casualties, and informing relatives of death or injury.

1.4.4.4 Role of Fire Authorities

The control of a fire should be normally the responsibility of the senior fire brigade officer who would take over the handling of the fire from the site incident controller on arrival at the site. The senior fire brigade officer should also have a similar responsibility for other events, such as explosions and toxic release.

Fire authorities in the region should be appraised about the location of all stores of flammable materials, water and foam supply points, and fire-fighting equipment. They should be involved in on-site emergency rehearsals both as participants, and on occasion, as observers of exercises involving only site personnel.

1.4.4.5 Role of Health Authorities

Health authorities, including doctors, surgeons, hospitals, ambulances, and so on, should have a vital part to play following a major accident, and they should form an integral part of the emergency plan. For major fires, injuries should be the result of the effects of thermal radiation to a varying degree, and the knowledge and experience to handle this in all but extreme cases may be generally available in most hospitals. For major toxic releases, the effects vary according to the chemical in question, and the health authorities should be apprised about the likely toxic releases from the plant, which will enable them in dealing with the aftermath of a toxic release with treatment appropriate to such casualties.

Major off-site incidents are likely to require medical equipment and facilities additional to those available locally, and a medical "mutual aid" scheme should exist to enable the assistance of neighboring authorities to be obtained in the event of an emergency.

1.4.4.6 Role of Government Safety Authority

This will be the factory inspectorate available in the region. Inspectors are likely to satisfy themselves that the organization responsible for producing the off-site plan has made adequate arrangements for handling emergencies of all types including major emergencies. They may wish to see well-documented procedures and evidence of exercise undertaken to test the plan.

In the event of an accident, local arrangements regarding the role of the factory inspector will apply. These may vary from keeping a watching brief to a close involvement in advising on operations in case involvement in advising on operations. In cases where toxic gases may have been released, the factory inspectorate may be the only external agency with equipment and resources to carry out tests.

1.5 OCCUPATIONAL HEALTH AND SAFETY

Large industries, in general and chemical plants in particular where multifarious activities are involved during construction, erection, testing, commissioning, operation and maintenance, the men, materials and machines are the basic inputs. Along with the boons, the industrialization generally bring several problems like occupational health and safety.

The industrial planner, therefore, has to properly plan and take the steps to minimize the impacts of industrialization and to ensure appropriate occupational health and safety plan including fire plans. All these activities again may be classified under construction and erection, operation and maintenance. The proposed safety plan is given below:

1.5.1 Occupational Health

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

Erection Phase

The occupational health problems envisaged at this stage can mainly be due to constructional accident and noise. To overcome these hazards, in addition to arrangements to reduce it within TLV's, personal protective equipment should also be supplied to workers.

Operation and Maintenance

The problem of occupational health, in the operation and maintenance phase is due to noise hearing losses. Suitable personnel protective equipment should be given to employees. The working personnel should be given the following appropriate personnel protective equipment.

- Industrial Safety Helmet
- Crash Helmets
- Face shield with replacement acrylic vision
- Zero power plain goggles with cut type filters on both ends
- Zero power goggles with cut type filters on both sides and blue color glasses
- Welders equipment for eye and face protection
- Cylindrical type earplug
- Ear muffs
- Canister Gas mask
- Self contained breathing apparatus
- Leather apron
- Aluminized fiber glass fix proximity suit with hood and gloves
- Safety belt/line man's safety belt
- Leather hand gloves
- Asbestos hand gloves
- Acid/Alkali proof rubberized hand gloves
- Canvas cum leather hand gloves with leather palm
- Lead hand glove
- Electrically tested electrical resistance hand gloves
- Industrial safety shoes with steel toe
- Electrical safety shoes without steel toe and gum boots

Full-fledged hospital facilities should be made available round the clock for attending emergency arising out of accidents, if any. All working personnel shall be medically examined every six months and at the end of his term of employment. This is in addition to the pre-employment medical examination. The fund allocation for occupational health and safety are presented in Table 7.10

Table Error! No text of specified style in document.**.10**: **Details of Fund Allocation for Health and Safety**

S. No.	Particulars	Fund Allocation/Year (In Lakhs)
1	Periodic Health Screening for Employees	1,20,000
2	Workplace Safety Responsibility	2,00,000
3	Employees Health and Hygiene	1,80,000
Total		**5,00,000**

Source: DCPL

1.5.2 Safety Plan

Safety of both men and materials during construction and operation phases is of concern. The preparedness of an industry for the occurrence of possible disasters is known as emergency plan. The disaster in sulphonation plant is possible due to leakage of hazardous chemicals, collapse of structures and fire/explosion etc.

The details of the fire fighting equipments to be installed are given below;

- Dry Chemical Powder (DCP) Fire Extinguisher
- CO_2 Fire Extinguisher
- Foam type Fire Extinguisher
- Soda acid type Fire Extinguisher
- Fire buckets
- Fire Hydrants

Keeping in view the safety requirement during construction, operation and maintenance phases at sulphonation plant, safety policy should be formulated with the following regulations:

- To allocate sufficient resources to maintain safe and healthy conditions of work.
- To take steps to ensure that all known safety factors are taken into account in the design, construction, operation and maintenance of plants, machinery and equipment.
- To ensure that adequate safety instructions are given to all employees.
- To provide necessary protective equipment, safety appliances and clothing wherever necessary and to ensure their proper use.
- To inform employees about materials, equipment or processes used in their work, which are known to be potentially hazardous to health or safety.
- To keep all operations and methods of work under regular review for making necessary changes from the point of view of safety.
- To provide appropriate facilities for first aid and prompt treatment of injuries and illness at work.
- To provide appropriate instruction, training, retraining and supervision to employees in health and safety, first aid and to ensure that adequate publicity is given to these matters.
- To ensure proper implementation of fire prevention methods and an appropriate fire fighting service together with training facilities for personnel involved in this service.
- To organize collection, analysis and presentation of data on accident, sickness and incident involving personal injury or injury to health with a view to taking corrective, remedial and preventive action.
- To promote through the established machinery, joint consultation in health and safety matters to ensure effective participation by all employees.
- To publish/notify regulations, instructions and notices in the common language of employees.
- To prepare separate safety rules for each types of occupation/processes involved in a project.
- To ensure regular safety inspection by a competent person at suitable intervals of all buildings, equipment, work places and operations.

1.5.3 Safety Organization

1.5.3.1 Erection Phase

A qualified and experienced safety officer should be appointed. The responsibilities of the safety officers include identification of the hazardous conditions and unsafe acts of workers and advice on corrective actions, conduct safety audit, organize training programs and provide professional expert advice on various issues related to occupational safety and health. He is also responsible to ensure compliance of Safety Rules/ Statutory Provisions. In addition to employment of safety

officer by sulphonation plant, every contractor, who employs more than 250 workers, should also employ one safety officer to ensure safety of the worker, in accordance with the conditions of contract.

1.5.3.2 Operation and Maintenance Phase

When the construction is completed the posting of safety officers should be in accordance with the requirement of Factories Act and their duties and responsibilities should be as defined thereof.

1.5.3.3 Safety Circle

In order to develop the capabilities of the employees in identification of hazardous processes and improving safety and health, safety circles would be constituted in each area of work. The circle would consist of 5-6 employees from that area. The circle normally should meet for about an hour every week.

1.5.3.4 Safety Training

A full-fledged training center should be set up at the plant. Safety training should be provided by the Safety Officer with the assistance of faculty members called from Corporate Center, Professional Safety Institutions and Universities. In addition to regular employees, limited contractor labors should also be provided safety training. To create safety awareness safety films should be shown to workers and leaflets etc. should be distributed. Some of the precautions and remedial measures proposed to be adopted to prevent fires are:

- Compartmentation of cable galleries, use of proper sealing techniques of cable passages and crevices in all directions would help in localizing and identifying the area of occurrence of fire as well as ensure effective automatic and manual fire fighting operations;
- Spread of fire in horizontal direction would be checked by providing fire stops for cable shafts;
- Reliable and dependable type of fire detection system with proper zoning and interlocks for alarms are effective protection methods for conveyor galleries.
- Housekeeping of high standard helps in eliminating the causes of fire and regular fire watching system strengthens fire prevention and fire fighting; and
- Proper fire watching by all concerned would be ensured.

1.5.4 Health and Safety Monitoring Plan

All the potential occupational hazardous work places such as fuel storage, material handling areas should be monitored regularly. The health of employees working in these areas should be monitored once in a month for early detection of any ailment due to exposure to hazardous chemicals.

1.5.4.1 Medical Surveillance

The industry has tie up with the medical center for all the employees health monitoring. All the employees will be examined periodically by the standard qualified doctors once in a month to determine the health status of the workers in respect of occupational health hazard to which they are exposed.

- Hazardous area wise list will be prepared by the medical officers to perform the specific test for the working employees.
- No person will be sign up to operate the crane, locomotive or work- lift or give signals unless his eye sight and color vision will be properly examined by the concern ophthalmologist.

1.5.4.2 Industrial Medical Center Responsibilities

- Surveillance of workers health in relation to work;
- Surveillance of working environments;
- Identification and evaluation of environmental factors which may affect the worker's health;

- Assessment of conditions of occupational workers health; and
- Observance of safety norms and reduce/eliminate exposure to hazardous environs.

1.5.4.3 Employees Training Programme

The industry will provide the certain training program to the working employees. The training programme will includes the hazardous operation, usage of the nose mask and earplugs, Engineering Act and working process in connection with their jobs roles.

1.5.4.4 List of Test for Working Employees

List of test are being conducted for every month to the workers such as:

- X-ray Chest View
- Electro Cardiogram (ECG)
- Eye Fitness
- Spirometry Test
- Audiogram Test