RISK ASSESSMENT & DISASTER MANAGEMENT PLAN

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

- Risk assessment
- Disaster Management Plan
- On-site and off-site emergency action plan
- Occupational Health and Safety Management System

7.1 PUBLIC CONSULTATION

As per para 7 (i) Stage III (3)(i)(b) of the EIA notification, 2006, all projects or activities located within industrial estates or parks (item 7(c)of the Schedule) approved by the concerned authorities, and which are not disallowed in such approvals.

Unit is located in Notified Industrial area of GIDC Panoli. Hence, Public hearing is exempted.

7.2 REHABILITATION AND RESETTLEMENT (R & R)

Unit is located in Notified Industrial estate of GIDC Panoli. Hence, R & R is not applicable to us.

7.3 RISK ASSESSMENT

7.3.1 INTRODUCTION

Hazard analysis involves the identification and quantification of the various hazards (unsafe conditions). On the other hand, risk assessment deals with recognition and computation of risks, the equipment in the plant and personnel are prone to, due to accidents resulting from the hazards present in the plant.

Risk assessment 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 population etc. Much of this information is difficult to get or generate. Consequently, the risk assessment is often confined to maximum credible accident studies. It provides basis for what should be type and capacity of its on-site and off-site emergency plan also what types of safety measures shall be required.

7.3.2 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:

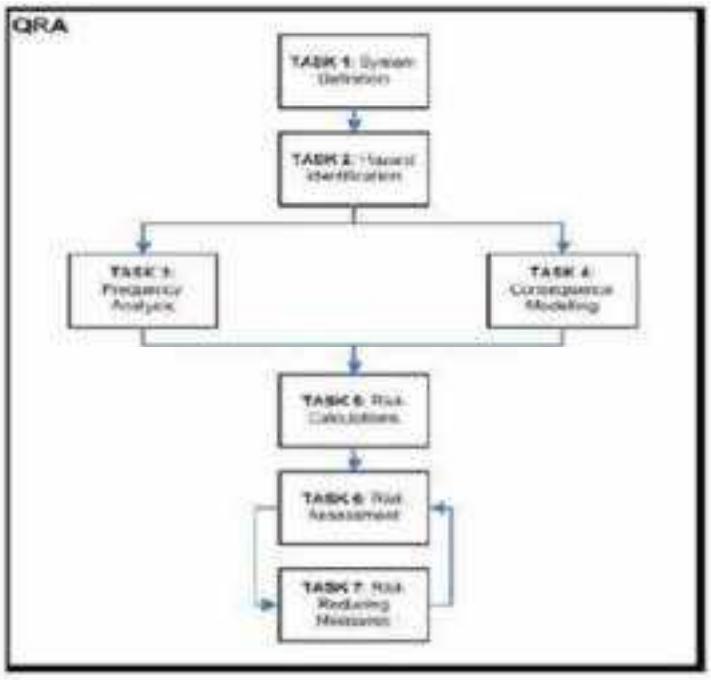
- Identification of potential hazard area;
- Identification of representative failure cases;
- Visualization of the resulting scenarios in terms of fire and explosion;
- Assess the overall damage potential of the identified hazardous events and the impact zones form the accidental scenarios;
- Furnish the recommendations on the minimization of the worst accident possibilities
- Preparation of Disaster Management Plan;
- Emergency Plan, which includes Occupational and Health Safety Plan;

7.3.3 METHODOLOGY

Quantitative risk assessment (QRA) is a means of making a systematic assessment of the risks from hazardous activities, and forming a rational evaluation of their significance, in order to provide input to a decision-making process. The term 'quantitative risk assessment' is widely used, but strictly this refers to the purely numerical assessment of risks without any evaluation of their significance. The study has been conducted based on the premises of a traditional Quantitative Risk Assessment. The key components of a QRA are explained below, and illustrated in Figure-7.1 and Figure-7.2.

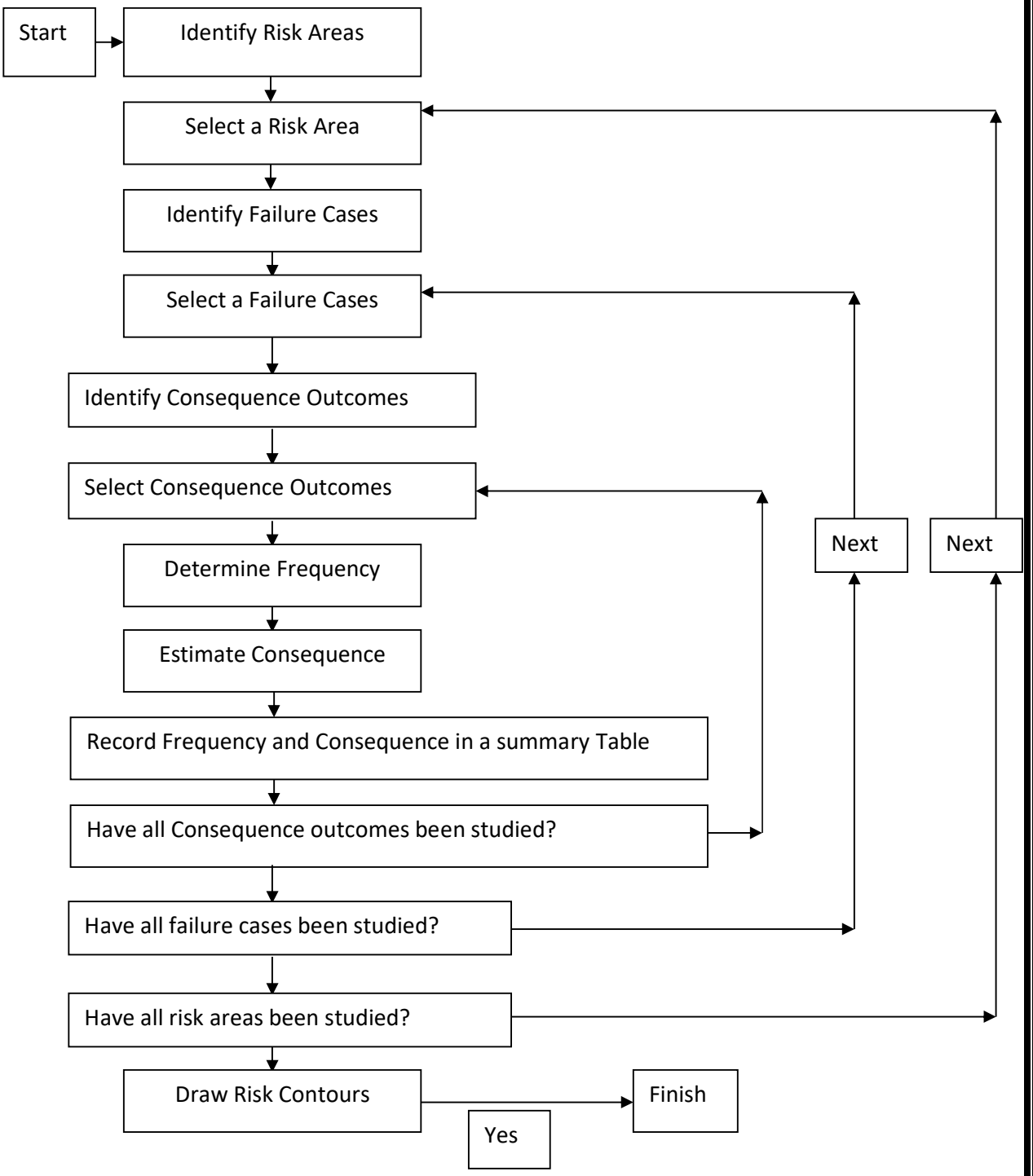
FIGURE – 7.1

QRA METHODOLOGY



FIGURE–7.2

FLOW CHART FOR QUANTITATIVE RISK ASSESSMENT



7.3.4 HAZARD IDENTIFICATION

Identification of hazards in the proposed project activity is of primary significance of the analysis, and quantification. Hazard states the characteristics of system/plant/process that presents potential for an accident. 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.

7.3.4.1 IDENTIFICATION OF HAZARDOUS AREAS

The procedure for QRA starts with identification of major risk areas in the installation. Operation carried out in specialty and agrochemical Industries usually come under certain board, general categories. At **M/s. Remark Technologies**, major risk areas are as follows:

- Bulk storage area for Raw Materials at ambient temperature and atmospheric pressure.
- Process Plant involving pumping, transportation, reactors, distillation, heating, cooling, etc.

7.3.4.2 IDENTIFICATION OF FAILURE CASES FOR HAZARDOUS AREAS

- Release due to catastrophic failure of storage tanks or process vessels.
- Rupture of connected pipe with storage tank or process vessels.
- Continuous release at significant rates for long durations transfer pipelines caused by sudden, major break of the pipeline.
- Continuous release at low rate through small holes or cracks in piping and vessels, flange leaks, and leakage from pump glands and similar seals.

It is to be noted that for Quantitative Risk Assessment, worst case scenarios has been considered, though their frequency of occurrence is much lower than the cases of small leaks.

7.3.4.3 MAJOR HAZARDOUS AREAS AND SAFETY PRECAUTIONS

The hazardous chemical storage area is shown in Figure-7.3. The major Hazardous chemicals to be stored, transported, handled and utilized within the plot area are summarized in the Table-7.1. Other hazards and control measures are summarized in Table-7.2. Facilities / System for process safety, transportation, firefighting system and emergency capabilities to be adopted are stated below.

FIGURE-7.3

HAZARDOUS CHEMICAL STORAGE AREA

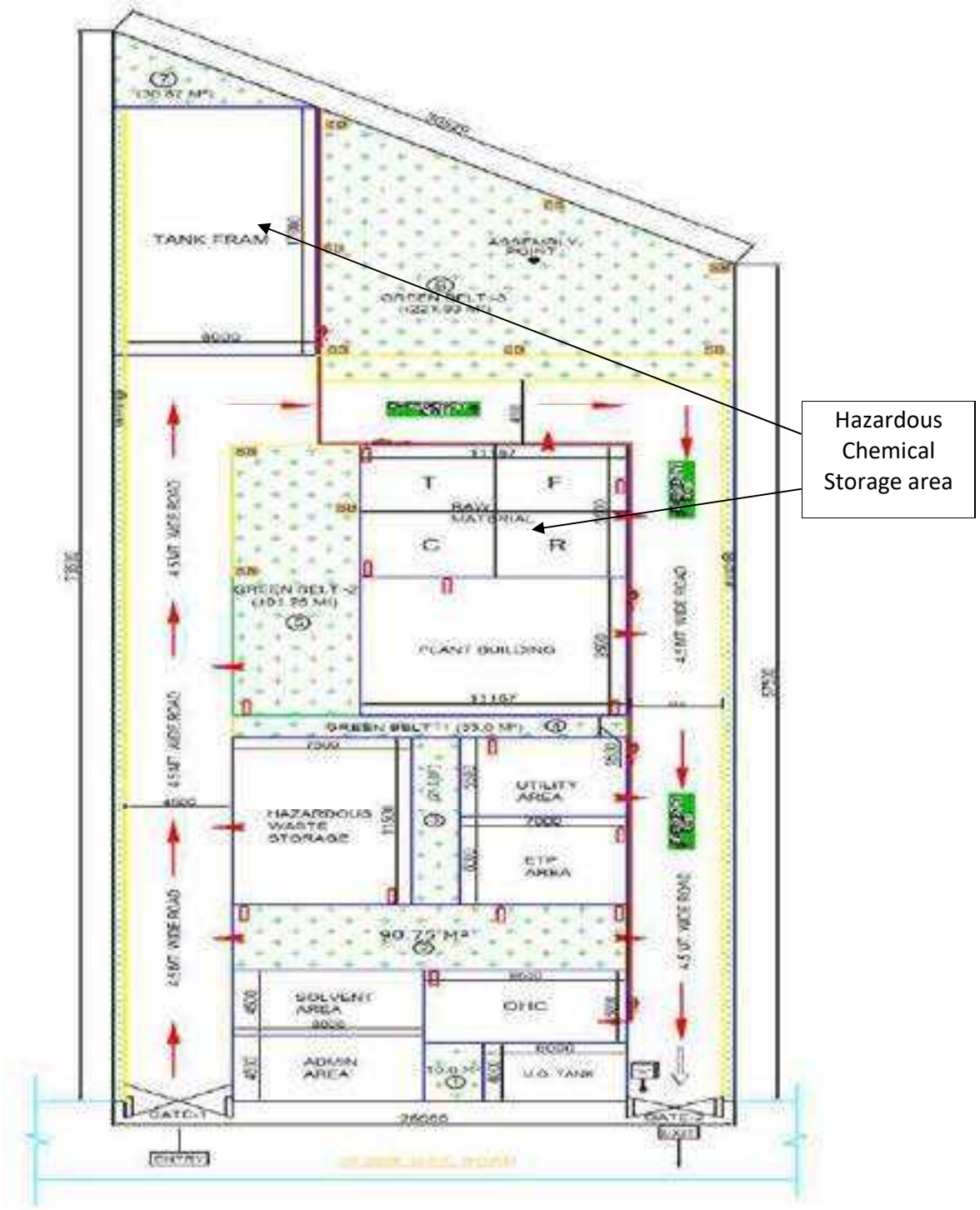


TABLE-7.1

STORAGE AND HANDLING DETAILS OF HAZARDOUS CHEMICALS

Sr. No.	Name of Raw material	Physical form	Type of hazard	State & Operating pressure & tem.	Mode of storage	Maximum Storage	No. of Tanks/Drums / Bags/ Cylinder	Capacity of each Storage
1	Acetic acid	Liquid	Flammable/Toxic	NTP	Tank	10 KL	1	10 KL
2	Iso Propyl Alcohol	liquid	Flammable/Toxic	NTP	Tank	20 KL	2	10 KL
3	Toluene	Liquid	Flammable	NTP	Tank	20 KL	2	10 KL
4	Thionyl chloride	Liquid	Toxic if inhaled	NTP	Tank	10 KL	1	10 KL
5	Methanol	Liquid	Flammable/Toxic	NTP	Tank	20 KL	2	10 KL
6	N-Butanol	Liquid	Flammable/Toxic	NTP	Tank	10 KL	1	10 KL
7	Xylene	Liquid	Flammable/Toxic	NTP	Tank	10 KL	1	10 KL
8	Hydrochloric Acid	Liquid	Corrosive/Toxic	NTP	Tank	10 KL	1	10 KL
9	EDC	Liquid	Flammable/Toxic	NTP	Tank	10 KL	1	10 KL
10	Oleum	Liquid	Flammable/Toxic	NTP	Tank	10 KL	1	10 KL
11	Hexane	Liquid	Flammable/Toxic	NTP	Drum	8 MT	40	200 kg
12	DMF	Liquid	Flammable/Toxic	NTP	Drum	8 KL	40	200 kg
13	Sulphuric Acid	Liquid	Corrosive/Toxic	NTP	Drum	8 MT	40	200 kg
14	Acetonitrile	Liquid	Flammable/Toxic	NTP	Drum	7 MT	35	200 kg
15	Ethyl Acetate	Liquid	Flammable/Toxic	NTP	Drum	7 MT	35	200 kg
16	Formic Acid	Liquid	Flammable/Toxic	NTP	Drum	4 MT	20	200 kg
17	Benzene	Liquid	Flammable/Toxic	NTP	Drum	5 MT	25	200 kg
18	Acetone	Liquid	Flammable/Toxic	NTP	Drum	7 MT	35	200 kg
19	Methylene dichloride	Liquid	Flammable/Toxic	NTP	Drum	7 MT	35	200 kg
20	Heptane	Liquid	Flammable/Toxic	NTP	Drum	8 KL	40	200 kg
21	Phenol	Liquid	Flammable/Toxic	NTP	Drum	8 MT	40	200 kg
22	Catalyst	Liquid	Flammable/Toxic	NTP	Drum	3 MT	15	200 kg
23	Ammonia	Gas	Flammable/Toxic	29.04 KG/CM^2	Cylinder	1 MT	16	60 kg
24	HCl Gas	Gas	Corrosive/Toxic	25.5 KG/CM^2	Cylinder	0.6MT	10	60 kg
25	Hydrogen Gas	Gas	Flammable/Toxic	3.0 KG/CM^2	Cylinder	1 MT	16	60 kg
26	Chlorine	Gas	Corrosive	19.9 KG/CM^2	Tonner	4.5MT	5	900 kg
27	Bromine	Liquid	Corrosive/Toxic	NTP	Bottle	0.9	300	3 kg
28	Sodium Hydroxide	Solid	Toxic	NTP	Bags	5 MT	200	25 kg

29	Sodium Nitrite	Solid	Toxic	NTP	Bags	5 MT	200	25 kg
30	Caustic Lye	Solid	Toxic	NTP	Bags	5 MT	200	25 kg
31	Sulfone	Solid	Toxic	NTP	Bags	3 MT	120	25 kg
32	Sodium carbonate	Solid	Toxic	NTP	Bags	5 MT	200	25 kg
	Total Tanks	130 KL	13 Nos.					
	Total Drums	81 MT	405 Nos.					
	Total Bottle	0.9 MT	300 Nos.					
	Total Cylinders	2.6 MT	42 Nos.					
	Total Bags	23 MT	920 Nos.					
	Total Tonner	4.5 MT	5 Nos.					

TABLE 7.2

OTHER HAZARDS AND CONTROL

SR. NO.	NAME OF THE POSSIBLE HAZARD OR EMERGENCY	ITS SOURCES & REASONS	ITS EFFECTS ON PERSONS, PROPERTY & ENVIRONMENT	PLACE OF ITS EFFECT	CONTROL MEASURES PROVIDED
1	**BOILER** (1) Burning (2) Physical injury (3) Explosion	Over pressure in the boiler if safety valve not working. Water level indicator not working. Low water level indicator fails. High temp. System fails.	Minor/Major Injury Loss of human life Loss of property (Loss of Main/ Machine Material)	Boiler House and surrounding places	Lower & Upper Level Indication System provision. Safety valves for pressure control fixed temp. & pressure indicator provided. Blow down & blowing system provided for cleaning tube and shell. Soft water used. Inter locking provided on pumps, FD fan, ID fan. Periodical checking & inspection maintenance done. Yearly inspection done by Boiler Inspector.
2	**ELECTRICITY** (1) Burning (2) Fire (3) Shock	Loose Contacts, Weak earthling Short Circuit Improper Insulation	Burning, Shock, Death	Surrounding the accident area	Proper Earthing, Periodical Checking of joints, proper insulations of Equipments, etc. Flame proof fitting in solvent storage area, bounding and jumpers to all solvent barrier lines provided.
3	**HOUSE KEEPING** (1) Physical (2) Burning (3) Fire (4) Chemical Exposure	Bad House keeping	Physical / Chemical Thermal Burn Injury (Major / Minor)	In all surrounding areas i.e. Storage, Plants	Proper Handling, regular cleaning, Proper placement of material **(RIGHT THING AT THE RIGHT PLACE)**
4	**PIPE LINE LEAKAGES Spillages etc**. (1) Corrosion (2) Toxic gas release	Leaking of pipe line due to corrosion, Loose contact etc.	Physical / Chemical Thermal Burn Injury (Major / Minor)	Plant area	Proper maintenance, Proper Selection of Material for pipe lines, Immediate attention, Earthing provided, flame proof fitting, NO SMOKING Boards displayed.
5	**Structural Failure**	Inside the factory (Corrosion)	Injury/Death to persons, damage to property	Within the factory	Automatic operation Periodic Testing of safety valves Regular Inspection and Maintenance
6	**Toxic Release from outside**	Outside the factory	Injury/Death	Within & outside the unit	Alarm, Evacuation rescue & shelter/ Welfare
7	**Natural Calamity**	Nature	Injury / Death to persons, damage to property	Within & outside the unit	Alarm, Evacuation rescue & shelter/ Welfare

TABLE 7.3

HAZARDOUS PROPERTIES OF THE CHEMICALS, COMPATIBILITIES, SPECIAL HAZARD AND ANTIDOTES

Name of Chemical	Hazard	F.P (^{0}C)	BP (^{0}C)	LEL %	UEL %	SP.GR. 20 ^{0}C	VD	NFPA H F R	TLV/ TWA	IDLH	LC50 / LD50	Antidote
Hexane	**T**	(-) 23.2	68.9	1.2	7.5	0.659	2.97	3-0-0-X	260	1100	**NA**	**NA**
Acetic acid	C	39	118	4	19.9	1.05	2.1	Miscible	3 2 1	10 ppm	50 ppm	3,310 mg/kg(Rat)
Iso Propyl Alcohol (IPA)	F	11.7°C (53°F)	82.3°C	2.0	12.0	0.770	2.1	soluble	1 3 0	400 ppm	NA	64,000 mg/l
Bromine	T	NA	58.78	NA	NA	3.11	7.1	3 0 0	0.66 ppm	3 ppm	2,600 mg/kg [Rat]	No specific antidote
Toluene	F	4.444	110.6	1.1	7.1	0.8636	3.1	2 3 0	300 ppm	500 ppm	49000 mg/m 4 hours [Rat]	Oxygen, Novasine Eye drops.
Thionyl chloride	C	N/A	79	N/A	N/A	N/A	N/A	3 0 2	NA	1 ppm	--	500 ppm 1 hours [Rat]
DMF	F/T	58	NA	NA	NA	1.030	NA	2 2 1	NA	10 ppm	500 ppm	2,800 mg/kg [rat]
Methanol	F	12	64.5	6	36.5	0.7915	1.11	1 3 0	250 ppm	6000 ppm	64000 ppm 4 hours [Rat]	Oxygen, Baking Soda in a glass of water, ethanol, Novasine Eye drops.
N-Butanol	T	29	118	1.4	11.2	Yes	NA	3-2-0-X	60	140	-	NA
Sulphuric Acid	C	NA	340	NA	NA	1.84	NA	3 0 2	1 mg/m3	15 mg/m3	510 mg/m3 for 2H Rat	Sodium Hydro-Carbonate (4% Conc.), Milk, Lime Juice, Milk of Megnesia
Acetonitrile	F/T	(42.1°F)	81.6 (178.9°F	4.4%	16%	0.783 (W = 1)	1.42 (Air = 1)	Soluble	2 3 0	40 ppm	--	--
Ethyl Acetate	F/T	(-) 5.3	77.2	2.0	11.5	0.902	3.04	No	3 1 0	1200	2000	--
Formic Acid	F/T	50 °C / 122 °F	101 °C / 213.8 °F @ 760 mmHg	10 vol %	45 vol %	1.220	NA	miscible	3 2 1	5 PPM	30 PPM	730 mg/kg
O-Xylene	F & T	31	143 to 145	0.9	6.7	0.865	3.7	2 3 0	N.A	724 ppm	3608 mg/kg	No specific antidote

Benzene	F	-11	80.1	1.3	7.1	0.8765	2.8	2 3 0	0.1 ppm	500 ppm	930 mg/kg [Rat]	No specific antidote
Hydrochloric Acid	C	NA	108.58	NA	NA	1.1-1.19	1.267	3 0 1	5 ppm	50 ppm	4701 ppm 0.5 hours [Rat]	Milk of Magnesia, Drink Large Quantity of Water
EDC	T & F	13	82 - 84	0.062	0.162	1.25	1.24	3 3 0	1 ppm	50 ppm	2646 ppm 1 hours [Rat]	No specific antidote
Sodium Hydroxide	T	1390	NA	NA	NA	NA	1.38	NA	2 mg/m^3	10 mg/m^3	NA	No specific antidote
Acetone	T & F	-20 deg C	56.5 deg	2.5 %	12.8 %	0.788	2.0	1 3 0	750 ppm	2500 ppm	5800 mg/kg	NA
Methylene dichloride	T & F	NA	39.75°C (103.5°F)	12%	19%	1.3266	2.93	2 1 0	NA	NA	1600 mg/kg	NA
Ammonia	T	NA	36	NA	NA	yes	3.38	3 0 0	NA	NA	NA	NA
Heptane	F & T	24.80	98	1.05	6.7	3.5	NA	1 3 0	NA	NA	103 gm/m3	NA
Sodium Nitrite	F/T	NA	320	NA	NA	Yes	NA	3 0 2	NA	5 ppm	NA	5.5 mg/kg [rat-4h]
Chlorine gas	T	-	-34	-	-	1.40	2.45	4 0 0	0.5	10	<5000 mg/kg (Rat)	No specific antidote
Phenol	F & T	79	182	1.7	8.6	1.057	3.24	4 2 0	5 ppm	250 ppm	317 mg/kg [Rat]	No specific antidote
Caustic Lye	T	NA	NA	NA	NA	YES	NA	0-3-1-0	0.5	10	NA	NA
Sulfone	T	NA	NA	NA	NA	No	NA	2 1 0	NA	NA	NA	NA
Oleum	T	NA	NA	NA	NA	NA	3.9	3 0 0	NA	NA	NA	NA
Sodium carbonate	C	1600	NA	NA	NA	2.53	NA	1 0 0	NA	NA	4090 mg/kg (Rat)	
Hydrogen Gas	F	-252.87 °C	NA	4.0	75	0.0898	0.07	0 4 0	NA	NA	NA	Fresh air

F	= FIRE	T	= TOXIC
E	= Explosive	R	= REACTIVE
BP	= BOILING POINT	LEL	= LOWER EXPLOSIVE LIMIT
UEL	= UPPER EXPLOSIVE LIMIT	SP.GR	= SPECIFIC GRAVITY
VD	= VAPOUR DENSITY	ER	= EVAPORATION RATE
H	= HEALTH HAZARD CLASS	F	= FIRE HAZARD CLASS
R	= REACTIVE HAZARD	BR	= BURNING RATE

7.4 SAFETY PRECAUTIONS

7.4.1 Control measures provided for Solvent Tank Farm:

1. Construction & Installation of solvent storage facility will be providing as per explosive act, (License & local rules / regulation followed).
2. Flame proof electrical fitting & intrinsically safe instruments will be install.
3. Flame arrestor will be install on vent pipe with breather valve & emergency vent valve will be provide.
4. Earth fault relay trip will be install for solvent tanker unloading system (Solvent pump having interlock with grounding of the tanker to make 100% grounding.).
5. Grounding (double earthing) & Jumper for flange joint will be provide for all installation & it will be monitored periodically.
6. Road Tanker will be grounded before unloading.
7. Convenient metallic SS hose pipes will be provided for tanker unloading for better connectivity.
8. Deep in let pipe will be provided inner side of the solvent tanks.
9. Check list will be follow for loading & unloading.
10. Level indicator will be provided on the tank.
11. Adequate dyke wall (noncombustible) will be provide.
12. Leakage collection bund with foam system will be provide.
13. Combustible Gas Detection system, Fire (Foam / Powder) extinguisher, Foam monitors will be provided.
14. F-30 coating shall be provided for solvent storage tanks.
15. Nitrogen blanketing system will be provided.
16. Closed handling system will be provided.

7.4.2 Control measures provided for Acid / Alkali Tank Farm:

1. Storage tank will be stored away from the process plant.
2. Tanker unloading procedure will be prepared and implemented.
3. Caution note and emergency handling procedure will be displayed at unloading area and trained all operators.
4. NFPA label will be provided.
5. Required PPEs like full body protection PVC apron, Hand gloves, gumboot, Respiratory mask etc. will be provided to operator.
6. Neutralizing agent will be kept ready for tackle any emergency spillage.
7. Safety shower, eye wash with quenching unit will be provided in acid storage area.
8. Material will be handled in close condition in pipe line.
9. Dyke wall will be provided to all storage tanks, collection pit with valve provision.
10. Double drain valve will be provided.
11. Level gauge will be provided on all storage tanks.

12. Safety permit for loading unloading of hazardous material will be prepared and implemented.
13. TREM CARD will be provided to all transporters and will be trained for transportation Emergency of Hazardous chemicals.
14. Fire hydrant system with jockey pump as per IS 13039 will be installed.

7.4.3 Control measures provided for Warehouse:

Some chemicals will be received at plant in drums by road truck and stored in a separate drum storage area.

1. Fixed electrical fitting will be provided. Lighting will be install between racks above the gangways & away from material storage to avoid heating to storage goods.
2. Electrical fitting will be test periodically (i.e. electrical load thermo graphic temperature measurement, mechanical integrity of cables, physical condition of cable & other electrical appliances / installation.)
3. FLP type light fittings will be provided.
4. Proper ventilation will be provided in Godown.
5. Proper label and identification board /stickers will be provided in the storage area.
6. Conductive drum pallets will be provided.
7. Drum handling trolley / stackers/fork lift will be used for drum handling.
8. Separate dispensing room with local exhaust and static earthing provision will be make.
9. Smoking and other spark, flame generating item will be banned from the Gate.
10. Fire detection system (Beam Detector) shall be provided.
11. Adequate portable fire extinguishers will be install at noticeable position & kept easily accessible.
12. Fire hydrant system will be provided.
13. Auto sprinkler system will be provided on individual racks compartments at Ware House: this system will be independent system having Separate Pumps with separate piping from Pump House to Ware House, it consists of automatic operated sprinkler on 59°C.
14. Fire Alarm System: Automatic fire detection & alarm system consists of Fire Detectors, Addressable Manual Call Points (MCP) & Hooters Beam Detectors (Ware House) will be placed at strategic locations and connected by cable to central control panel at ECC with repeater panel at DCS Control Room.
15. Emergency exit will be provided.
16. Chemical segregation will be done based on reactivity.

7.5 PRECAUTIONS DURING STORAGE AND TRANSPORTATION OF HAZARDOUS CHEMICALS

LIQUIDS

- Always use the road tankers having authorization for transporting the said liquids.
- Driver to have concerned Safety Officer's contact details to contact him in case of emergency.
- Muffler will be Provide on exhaust while entering tanker within premises.
- Ensure Earthing connection before starting any transferring.
- Tanks will be inspected physically daily for having any visual abnormality.
- Scheduled testing of tanks to be done for thickness testing.
- Vendor will be asked to provide MSDS to Truck Driver.
- Truck will have clearly marked identification of material being contained with mentioning Safety Card.
- SOP to cover routine checking of Hazardous chemical storage area to be carried out for checking any spillage / leakage.
- Hazardous chemical storage area will be inspected physically daily for having any visual abnormality.
- Readings of Temperature & Pressure will be noted, recorded & reported immediately for abnormality.
- Barrels to be checked for proper fixing of bungs before sending it outside the premises.
- Barrels will be monitored physically daily for developing any pressure or vacuum within it on long storage.
- Concerned persons will be trained properly to use spill kit in case of observing any spillage inside warehouse.

SOLIDS

- Vendor will be asked to provide MSDS to Truck Driver.
- Driver to have concerned Safety Officer's contact details to contact him in case of emergency.
- Muffler will be provided on exhaust while entering truck within premises.
- SOP to cover routine checking of Bags & Containers for checking any damage.
- Containers will be tested for safe racking & transportation.
- Proper PPE will be used while handling the material & concerned persons to be trained for usage of the same.
- Concerned persons will be trained properly to use spill kit in case of observing any spillage inside warehouse.

7.6 HAZARD IDENTIFICATION

In the storage of chemical & manufacturing operation various flammable / toxic / corrosive material, compressed gases will be utilized & also the stock of the combustible material will be maintained. These items have potential to lead to an accident (explosion / fires etc).

The major industrial hazards can be divided into following different categories.

1. FIRE HAZARD.
2. EXPLOSION HAZARD.
3. TOXIC HAZARD.

Above hazard should be taken into consideration because some of the chemical used, stored are having inflammable / flammable, toxic, corrosive and explosion properties.

7.6.1 Hazard Control Measures

A) Hazard Control Measures:		
1) Fire Hazard	**2) Others Hazard**	**3) Chemical / Solvent leakage**
▪ Flameproof electrical apparatus installed at probable fire hazard area. ▪ Well maintained Fire Fighting Apparatus (fire extinguisher, fire hydrant system) in sufficient quantity. ▪ Well defined storage facility for fire hazard substances. ▪ Copper Jumpers are provided on solvent transferring lines. ▪ Earthing/Bonding system is provided at designated areas. ▪ Smoke detectors and fire alarm system installed at site. ▪ Process / operation handling by competent person only. ▪ Permit to work system. ▪ Round the clock availability of qualified Safety Officer & Paramedic. ▪ Mutual aid with nearby industries and Disaster Preventive Management Centre.	❖ WH & Solvent Building located away from other plants. ❖ Online flammable gas detection meters with audible alarm / hooter. ❖ Explosion proof wall & doors of process area where such hazards are apparent. ❖ Copper Jumpers are provided on solvent transferring lines. ❖ Earthing/Bonding system is provided at designated areas. ❖ Process operated by competent person only. ❖ Regular testing / inspection of pressure vessels by competent person ❖ Installation of safety valve on probable explosion hazards vessels. ❖ Permit to work system.	✓ Handling of chemicals with confined containers / drums only. ✓ Availability of spillage control kit & sand buckets on specific locations. ✓ Regular monitoring of VOC level of plant by internally and externally agency and precaution are taken to avoid exposure. ✓ PPEs like organic cartridge mask, air bubbler and full body pressure suit with breathing air provision are provided as and when required. ✓ People in vicinity of area are trained to use spillage control kit. ✓ SCBA set is readily available at designated locations for emergency scenario.

7.7 CONSEQUENCE ANALYSIS

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

Operating Parameters

Potential vapour release for the same material depends significantly on the operating conditions. Especially for any liquefied gas, the operating conditions are very critical to

assess the damage potential. If we take up an example of ammonia, if it is stored at ambient temperature, say 30°C, and then the vapour release potential of the inventory is much higher as compared to the case if it is stored at 0°C.

Inventory

Inventory Analysis is commonly used in understanding the relative hazards and short listing of release scenarios. Inventory plays an important role in regard to the potential hazard.

Larger the inventory of a vessel or a system, larger the quantity of potential release. The potential vapour release (source strength) depends upon the quantity of liquid release, the properties of the materials and the operating conditions (pressure, temperature). If all these influencing parameters are combined into a matrix and vapour source strength estimated for each release case, a ranking should become a credible exercise.

Loss of Containment

Plant inventory can get discharged to Environment due to Loss of Containment. Certain features of materials to be handled at the plant need to the clearly understood to firstly list out all significant release cases and then to short list release scenarios for a detailed examination. Liquid release can be either instantaneous or continuous. Failure of a vessel leading to an instantaneous outflow assumes the sudden appearance of such a major crack that practically all of the contents above the crack shall be released in a very short time. The more likely event is the case of liquid release from a hole in a pipe connected to the vessel. The flow rate is depending on the size of the hole as well as on the pressure, which was present, in front of the hole, prior to the accident. Such pressure is basically dependent on the pressure in the vessel. The vaporisation of released liquid depends on the vapour pressure and weather conditions. Such consideration and others have been kept in mind both during the initial listing as well as during the short listing procedure. In the study, Maximum Credible Loss accident methodology is to be used, therefore, the largest potential hazard inventories have been considered for consequence estimation.

7.7.1 DAMAGE CRITERIA

In consequence, analysis, use is made of a number of calculation models to estimate the physical effects of an accident (spill of hazardous material) and to predict the damage (lethality, injury, material destruction) of the effects. The calculations can roughly be divided in three major groups:

a) Determination of the source strength parameters;
b) Determination of the consequential effects;
c) Determination of the damage or damage distances.

The basic physical effect models consist of the following.

Source strength parameters

* Calculation of the outflow of liquid, vapour or gas out of a vessel or a pipe, in case of rupture. Also two-phase outflow can be calculated.
* Calculation, in case of liquid outflow, of the instantaneous flash evaporation and of the dimensions of the remaining liquid pool.
* Calculation of the evaporation rate, as a function of volatility of the material, pool dimensions and wind velocity.
* Source strength equals pump capacities, etc. in some cases.

Consequential effects

* Dispersion of gaseous material in the atmosphere as a function of source strength, relative density of the gas, weather conditions and topographical situation of the surrounding area.
* Intensity of heat radiation [in kW/ m^2] due to a fire or a BLEVE, as a function of the distance to the source.
* Energy of vapour cloud explosions [in N/m^2], as a function of the distance to the distance of the exploding cloud.
* Concentration of gaseous material in the atmosphere, due to the dispersion of evaporated chemical. The latter can be either explosive or toxic.

It may be obvious, that the types of models that must be used in a specific risk study strongly depend upon the type of material involved:

- Gas, vapour, liquid, solid
- Inflammable, explosive, toxic, toxic combustion products
- Stored at high/low temperatures or pressure
- Controlled outflow (pump capacity) or catastrophic failure?

Selection of Damage Criteria

The damage criteria give the relation between extent of the physical effects (exposure) and the percentage of the people that will be killed or injured due to those effects. The knowledge about these relations depends strongly on the nature of the exposure. For instance, much more is known about the damage caused by heat radiation, than about the damage due to toxic exposure, and for these toxic effects, the knowledge differs strongly between different materials.

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

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

In the next three paragraphs, the chosen damage criteria are given and explained.

Heat Radiation

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

- The radiation energy onto the human body [kW/m^2];
- The exposure duration [sec];
- The protection of the skin tissue (clothed or naked body).
- The limits for 1% of the exposed people to be killed due to heat radiation, and for second-degree burns are given in the table herein:

Damages to Human Life Due to Heat Radiation

Exposure Duration	Radiation for 1% lethality (kW/m^2)	Radiation for 2nd degree burns (kW/m^2)	Radiation for first degree burns (kW/m^2)
10 Sec	21.1	16	12.4
30 Sec	9.3	7.0	4.0

Since in practical situations, only the own employees will be exposed to heat radiation in case of a fire, it is reasonable to assume the protection by clothing. It can be assumed that people would be able to find a cover or a shield against thermal radiation in 10 sec. time. Furthermore, 100% lethality may be assumed for all people suffering from direct contact with flames, such as the pool fire, a flash fire or a jet flame. The effects due to relatively lesser incident radiation intensity are given below.

Effects Due To Incident Radiation Intensity

INCIDENT RADIATION kW/m^2	TYPE OF DAMAGE
0.7	Equivalent to Solar Radiation
1.6	No discomfort for long exposure
4.0	Sufficient to cause pain within 20 sec. Blistering of skin (first degree burns are likely)
9.5	Pain threshold reached after 8 sec. second degree burns after 20 sec.
12.5	Minimum energy required for piloted ignition of wood, melting plastic tubing etc.

Explosion

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

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

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

For the blast wave, the lethality criterion is based on:

* A peak overpressure of 0.1 bar will cause serious damage to 10% of the housing/structures.
* Falling fragments will kill one of each eight persons in the destroyed buildings.

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

Damage Due to Overpressures

Peak Overpressure	Damage Type
0.83 bar	Total Destruction
0.30 bar	Heavy Damage
0.10 bar	Moderate Damage
0.03 bar	Significant Damage
0.01 bar	Minor Damage

From this it may be concluded that p = 0.17 E+5 pa corresponds approximately with 1% lethality. Furthermore, it is assumed that everyone inside an area in which the peak overpressure is greater than 0.17 E+ 5 pa will be wounded by mechanical damage. For the gas cloud explosion this will be inside a circle with the ignition source as its centre.

Intoxication

The consequences from inhalation of a toxic vapour/gas are determined by the toxic dose. This dose D is basically determined by:

- Concentration of the vapour in air;
- Exposure duration.

Furthermore, of course, the breathing rates of the victim, as well as the specific toxic mechanism unto the metabolism play an important role.

The dose is defined as $D = C^n.t$, with:

C = concentration of the toxic vapour, in [ppm] or [mg/m^3];

t = exposure duration, in [sec] or [min];

n = exponent, mostly > 1.0; this exponent takes into account the fact that a high concentration over a short period results in more serious injury than a low concentration over a relatively longer period of exposure. The value of n should be greater than zero but less than 5.

The given definition for D only holds if the concentration is more or less constant over the exposure time; this may be the case for a (semi) continuous source. In case of an instantaneous source, the concentration varies with time; the dose D must be calculated with an integral equation:

$D = \int C^n.dt$

For a number of toxic materials, so-called Vulnerability Models (V.M.) has been developed. The general equation for a V.M. (probit function) is:

$Pr = a + b.\ln (C^n.t)$, with

Pr = probit number, being a representation of the percentage of people suffering a certain kind of damage, for instance lethality

Pr = 2.67 means 1% of the population;

Pr = 5.00 means 50% of the population;

a and b material dependent numbers;

$C^n.t$ = dose D, as explained above.

The values for a and b are mostly derived from experiments with animals; occasionally, however, also human toxicity factors have been derived from accidents in past. In case only animal experiments are available, the inhalation experiments with rats seem to be best applicable for predicting the damage to people from acute intoxication. Although much research in this field have been done over the past decades, only for a limited number of toxic materials consequence models have been developed. Often only quite scarce information is available to predict the damage from an acute toxic exposition. Data transformation from oral intoxication data to inhalation toxicity criteria is sometimes necessary. Generally, in safety evaluations pessimistic assumptions are applied in these transformation calculations. The calculated damage (distance) may be regarded as a maximum. For the purposes of a response to a major incident, the IDLH value level has been chosen for the 'wounded' criteria. This type of injury will require medical attention.

7.7.2 MAXIMUM CREDIBLE LOSS ACCIDENT SCENARIOS

A Maximum Credible Accident (MCA) can be characterised as the worst credible accident. In other words: an accident in an activity, resulting in the maximum consequence distance that is still believed to be possible. A MCA-analysis does not include a quantification of the probability of occurrence of the accident. Another aspect, in which the pessimistic approach of MCA studies appears, is the atmospheric condition that is used for dispersion calculations. As per the reference of the study, weather conditions having an average wind speed have been chosen.

The Maximum Credible Loss (MCL) scenarios have been developed for the Facility. The MCL cases considered, attempt to include the worst "Credible" incidents- what constitutes a credible incident is always subjective. Nevertheless, guidelines have evolved over the years

and based on basic engineering judgement, the cases have been found to be credible and modelling for assessing vulnerability zones is prepared accordingly. Only catastrophic cases have been considered and not partial or small failures (as is the case in Quantitative Risk Assessment where contributions from low frequency - high outcome effect as well as high frequency - low outcome events are distinguished). The objective of the study is emergency planning, hence only holistic & conservative assumptions are used for obvious reasons. Hence though the outcomes may look pessimistic, the planning for emergency concept should be borne in mind whilst interpreting the results.

7.7.2.1 CONSEQUENCE ANALYSIS CALCULATIONS

The Consequence Analysis has been done for selected scenarios. This has been done for weather conditions having wind speed. In Consequence Analysis, geographical location of the source of potential release plays an important role. Consideration of a large number of scenarios in the same geographical location serves little purpose if the dominant scenario has been identified and duly considered.

7.7.2.2 SOFTWARE USED FOR CALCULATIONS

PHAST MICRO: Phast is the most comprehensive software available for performing Process Hazard Analysis (PHA), Quantitative Risk Assessment (QRA) and Financial Risk Analysis (FRA). Our extensively validated software for consequence and risk assessment is used by governments and industry helping them to comply with local safety regulation and their own corporate best practice. Phast contains all the discharge, dispersion, effects and risk models you will need to accurately assess all your major hazards and associated risks. Phast Consequence provides you with comprehensive hazard analysis facilities to examine the progress of a potential incident from the initial release to its far-field effects.

TOXIC AND FLAMMABLE IMPACT

It calculates the initial discharge, as the material expands from its storage conditions to atmospheric, through dispersion, as the material mixes with air and dilutes, and the subsequent toxic or flammable effects. Phast includes a wide range of models for discharge and dispersion as well as flammable, explosive and toxic effects.

DISCHARGE

- Phast requires basic information about storage or process conditions and material properties in order to perform discharge calculations
- The software comes with an integrated material property database containing more than 1,600 pre-defined pure component chemicals
- Various discharge scenario options have been implemented to represent common process failures, and model their behaviour. These include:

- ❖ Leaks and line ruptures from long & short pipelines
- ❖ Catastrophic ruptures
- ❖ Relief valve and disc ruptures
- ❖ Tank roof collapse
- ❖ Vent from vapour spaces
- ❖ In building release effects

DISPERSION

The dispersion models within Phast are able to model the following phenomena

- Dispersion of gas, liquid and two-phase releases
- Liquid droplet thermo dynamics calculations and liquid droplet rainout
- Pool spreading and vaporization
- Building wake dispersion effects for vapour releases

FLAMMABLE EFFECTS

For releases of flammable material Phast calculates

- Radiation profiles and contours from a range of fire scenarios including pool fires, flash fires, jet fires and fire balls, including cross-wind effects on a jet fire
- Vapour Cloud Explosion modeling using industry standards models including the TNO Multi-energy, Baker Strehlow Tang and TNT Equivalence models
- Overpressure contours from Boiling Liquid Expanding Vapour Explosions

TOXIC EFFECTS

- Graphs of toxic concentration profile
- Indoor and outdoor toxic dose prediction
- Reporting of distance to specific dose and concentration
- Calculated exposure time and use as “averaging time” for passive dispersion effects

PHAST RISK

Phast Risk allows you to combine the flammable and toxic consequences from each scenario in your QRA model with their likelihood to quantify the risk of fatalities. Phast Risk allows you to take account of local population distribution, sources of ignition, land usage and local prevailing weather conditions. It is designed to perform all the analysis, data handling and results presentation elements of a QRA within a structured framework.

Phast Risk allows you to quickly identify major risk contributors so that time and efforts can be directed to mitigating these highest risk activities. Based on effects calculations and population vulnerabilities, Phast Risk can integrate over all scenarios and weather conditions to estimate the total risk. The established individual and societal risk indicators

are predicted by Phast Risk across your facility and surrounding area using the classical QRA methodology. Risk ranking reports can be produced at points of strategic importance to show the relative influence of the various failure scenarios and their contribution to both the individual and societal risk metrics.

A key benefit of Phast Risk is the ability to identify major risk contributors and differentiate these from incidents with worst case consequences which might otherwise dominate the safety reviews. Whilst medium scale incidents have lesser consequences, they may have a higher frequency, which, when combined with their hazardous effects, generate a higher level of risk. Time and effort directed to mitigating high consequence but often low frequency events may not be well spent. Phast Risk helps you direct this effort more effectively.

Phast Risk also provides facilities to help you manage large quantities of input data, including scenarios, parameters, wind roses, ignition and population, and combine these in many ways. This is critical when looking at sensitivity analyses and assessing the merits of a range of risk reduction measures.

Benefits

- Facilitates cost reduction in terms of losses and insurance
- Allows optimization of plant and process design
- Assist in compliance with safety regulators
- Enables quicker response to hazardous incidents
- Improve engineer's understanding of potential hazards
- Regular software upgrades incorporate industry experience and expertise, and advances in consequence modeling technology

TABLE 7.4

POSSIBLE ACCIDENT SCENARIOS

Scenario	MCL Scenario	Quantity in KL
1	Unconfined Pool Fire Simulations for Drum Storage Area	80
2	Release of Acetic Acid	10
3	Release of IPA	20
4	Release of Acetic Toluene	20
5	Release of Thionyl Chloride	10
6	Release of Methanol	20
7	Release of Xylene	10
8	Release of HCL	10
9	Release of EDC	10
10	Release of Ammonia Gas	1
11	Release of Hydrogen Gas	1
12	Release of Chlorine	4.5

Scenario#1: Unconfined Pool Fire Simulations for Drum Storage Area

Catastrophic Rupture		
Input Data		
Stored quantity - 80 MT		
Wind speed - 2.21 m/s		
Density (Air) – 0.867 g/cm^3		
Results indicate		
Pool Fire Scenario		
Radiation Level (KW/n	Distance in mete	**Effect if IHR at Height of simulation**
4	64.03	This level is sufficient to cause personnel if unable to reach cover within 20s; however blistering of the skin (second degree burn) is likely; 0: lethality
12.5	32.59	This level will cause extreme pain within 20 seconds and movement to a safer place is instinctive. This level indicates around 6% fatality for 20 seconds exposure.
37.5	15.67	This level of radiation is assumed to give 100% fatality as outlined above.

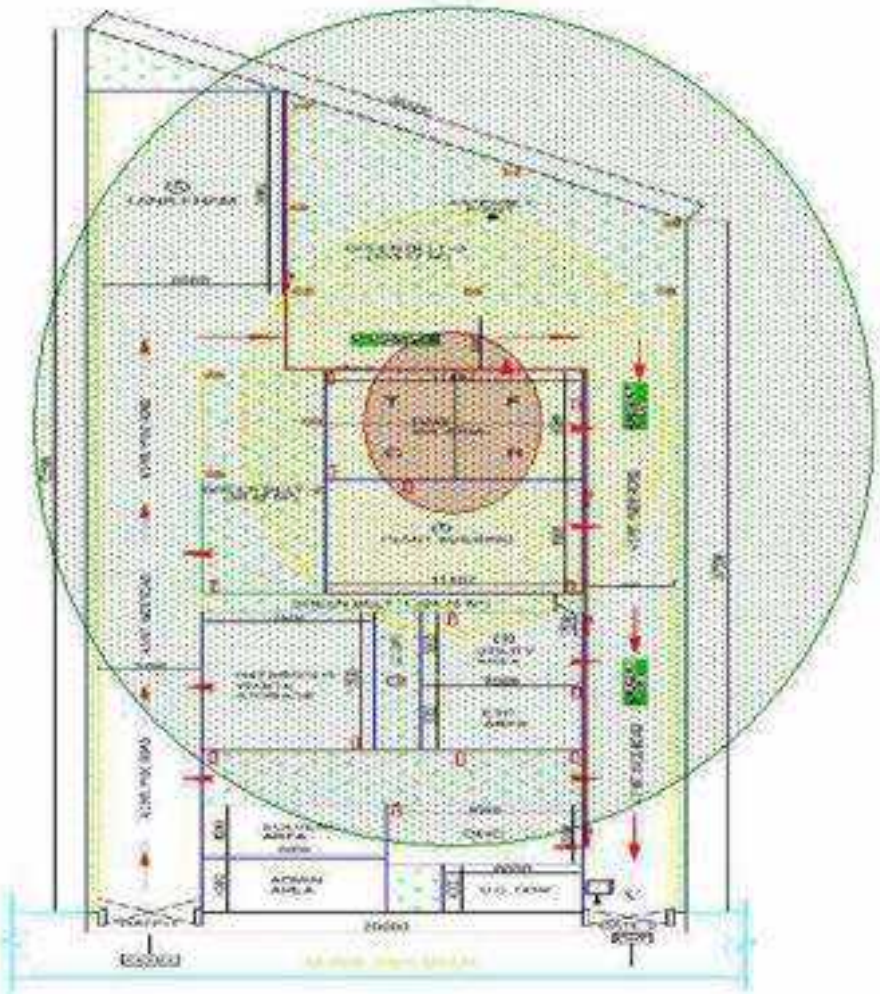
Fire Ball Scenario		
Radiation Level (KW/m^2)	**Distance in meter**	**Injury Type**
4	69.63	Pain after 20secs.
12.5	41.23	1st degree Burn
37.50	15.89	100% Fatal

Pool Fire Scenario:

Green – 4 KW/m^2

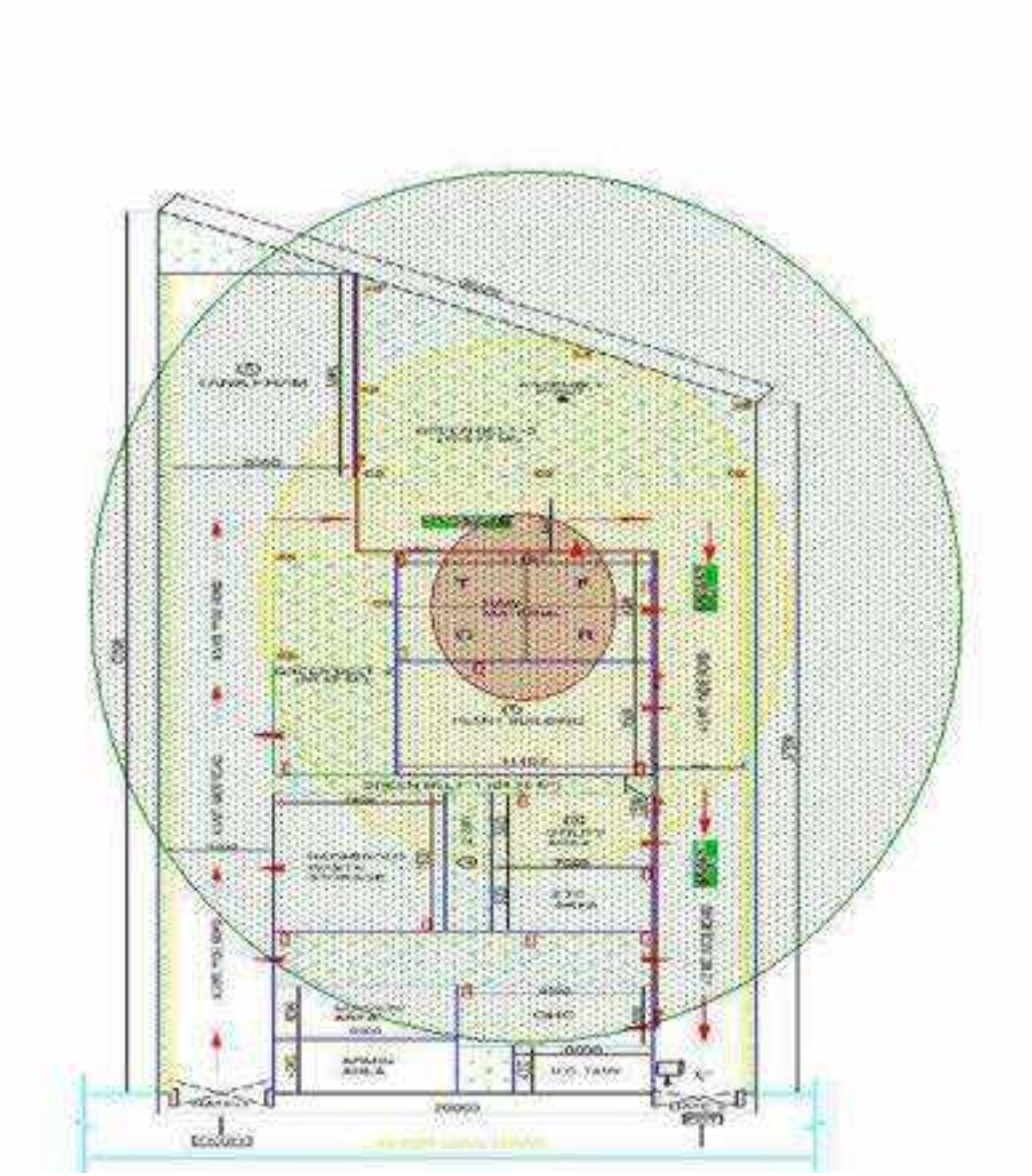
Yellow – 12.5 KW/m^2

Red – 37.5 KW/m^2



Fire Ball Scenario:

Green – 4 KW/m^2
Yellow – 12.5 KW/m^2
Red – 37.5 KW/m^2



Measures to be taken to prevent such accident:

- Priority will be given to Tanker to immediately enter the storage premises at site and will not be kept waiting near the gate or the main road.
- Security person will check License, TREM CARD, Fire extinguisher condition, Antidote Kit, required PPEs as per SOP laid down.
- Store officer will take sample as per sampling SOP from sampling point.
- After approval of QC department unloading procedure will be allowed be started.

Following precautions will be adopted during unloading

- Wheel stopper will be provided to TL at unloading platform.
- Static earthing will be provided to road tanker.
- Tanker unloading procedure will be followed according to check list and implemented.
- Flexible SS hose connection will be done at TL outlet line.
- The quantity remaining in the hose pipeline will be drained to a small underground storage tank, which will be subsequently transferred by nitrogen pressure to the main storage tank thus ensuring complete closed conditions for transfer from road tanker.
- All TL valves will be closed in TL.
- Finally earthing connection and wheel stopper will be removed.
- Only day time unloading will be permitted.

Following precautions will be adopted Storage of such chemicals

- Storage tank shall be stored away from the process plant.
- Tanker unloading procedure will be prepared and implemented.
- Caution note and emergency handling procedure will be displayed at unloading area and trained all operators.
- NFPA label shall be provided.
- Required PPEs like full body protection PVC apron, Hand gloves, gumboot, Respiratory mask etc. will be provided to operator.
- Neutralizing agent will be kept ready for tackle any emergency spillage.
- Safety shower, eye wash with quenching unit will be provided in acid storage area.
- Material will be handled in close condition in pipe line.
- Dyke wall will be provided to all storage tanks, collection pit with valve provision.
- Double drain valve will be provided.
- Level gauge shall be provided on all storage tanks.
- Safety permit for loading unloading of hazardous material will be prepared and implemented.
- TREM CARD will be provided to all transporters and will be trained for transportation Emergency of Hazardous chemicals.

6.1.6 RISK ASSESSMENT SUMMARY

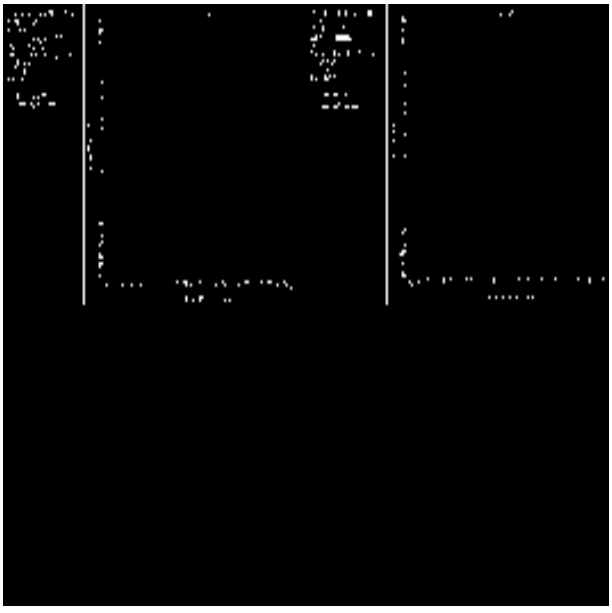
- From the Risk Assessment studies conducted, it would be observed that by and large, the risks are confined within the factory boundary walls.

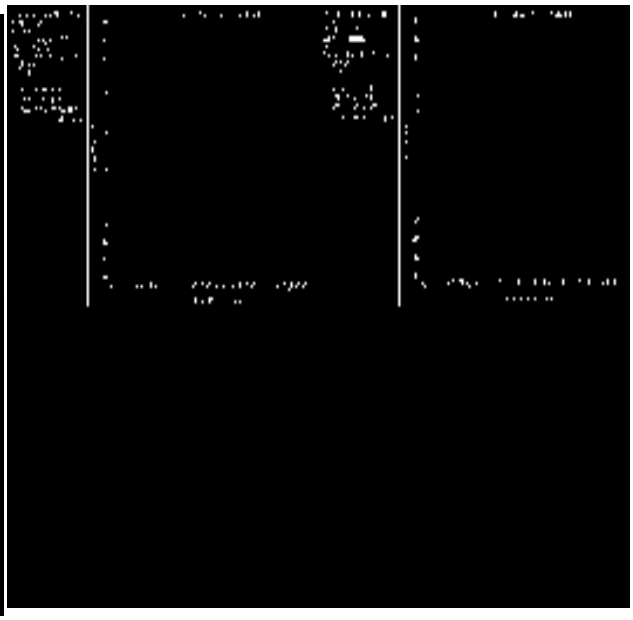
- Based on these studies company will be proposed to plan its facility sitting as well as location of operator cabin, open area, etc.
- Company will increase awareness programme in the surrounding vicinity and educate people for safe evacuation at the time of toxic chemical release.
- A HAZOP study to be carried out for all product plant and storage facilities.
- Induction safety course will be prepared and trained all new employees before starting duties in plant.

Scenario – 2: Release of Acetic Acid

Catastrophic Rupture		
Input Data		
Stored quantity - 10 KL		
Molecular weight -60.05		
Wind speed - 2.21 m/s		
Density (Air) –1.049 g/cm^3		
Results indicate		
Pool Fire Scenario		
Radiation Level (KW/m^2)	**Distance in meter**	**Effect if IHR at Height of simulation**
4	43	This level is sufficient to cause personnel if unable to reach cover within 20s; however blistering of the skin (second degree burn) is likely; 0: lethality
12.5	28	This level will cause extreme pain within 20 seconds and movement to a safer place is instinctive. This level indicates around 6% fatality for 20 seconds exposure.
37.5	15	This level of radiation is assumed to give 100% fatality as outlined above.

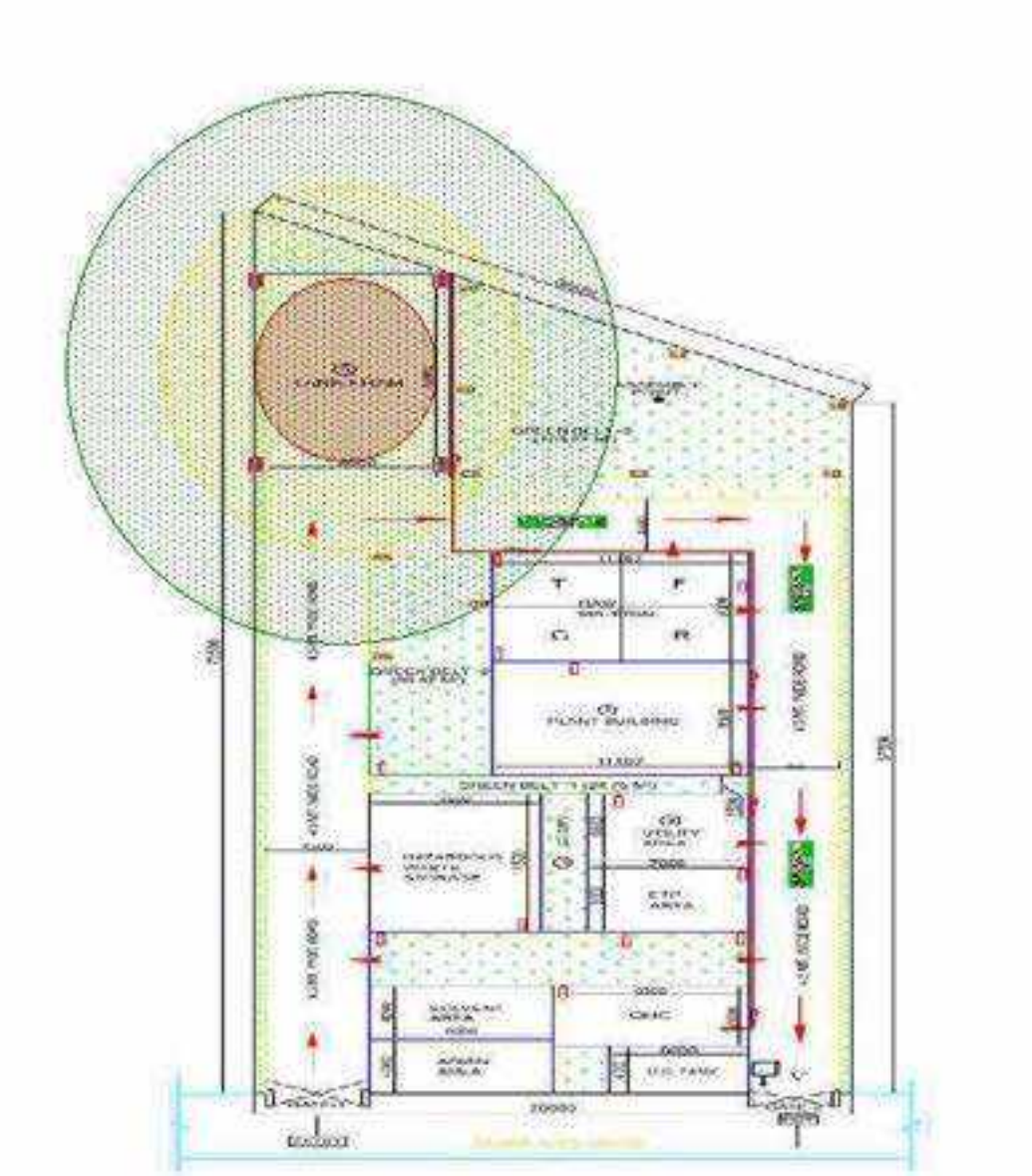
Release of Acetic Acid





Pool Fire Scenario

Green – 4 KW/m^2
Yellow – 12.5 KW/m^2
Red – 37.5 KW/m^2



Scenario – 3 Release of IPA

This scenario considers release of IPA from Storage Tank:
Results indicate:

Catastrophic Rupture					
Input Data					
Stored quantity - 20 KL					
Molecular weight -32.04					
Wind speed – 2.21 m/s					
Density (Air) – 785 kg/m^3					
Results indicate					
Pool Fire Scenario					
Radiation Level (KW/m^2)	Distance in meter	**Effect if IHR at Height of simulation**			
4	43.33	This level is sufficient to cause personnel if unable to rea cover within 20s; however blistering of the skin (second degree burn) is likely; 0: lethality			
12.5	28.66	This level will cause extreme pain within 20 seconds and movement to a safer place is instinctive. This level indicates around 6% fatality for 20 seconds exposure.			
37.5	16.33	This level of radiation is assumed to give 100% fatality as outlined above.			
Vapor Cloud Explosion					
Radial Distance (m)	**Over Pressure (psi)**	**Fatality lung Rupture (%)**	**Eardrum Rupture (%)**	**Structure Damage (%)**	**Glass Rupture (%)**
6.50	36.7	100.0	100.0	100.0	100.0
6.83	8.4	0.0	73.3	100.0	100.0
10.02	1.9	0.0	2.8	12.8	100.0
In case of Unconfined Vapor Cloud Explosion up to 6.50 meter is considered as 100% fatality and 100% ear drum rupture radius.					
In case of Unconfined Vapor Cloud Explosion up to 6.83 meter is considered as 100% structure damage and up to 10.02 meter 100% glass rupture area.					

Results

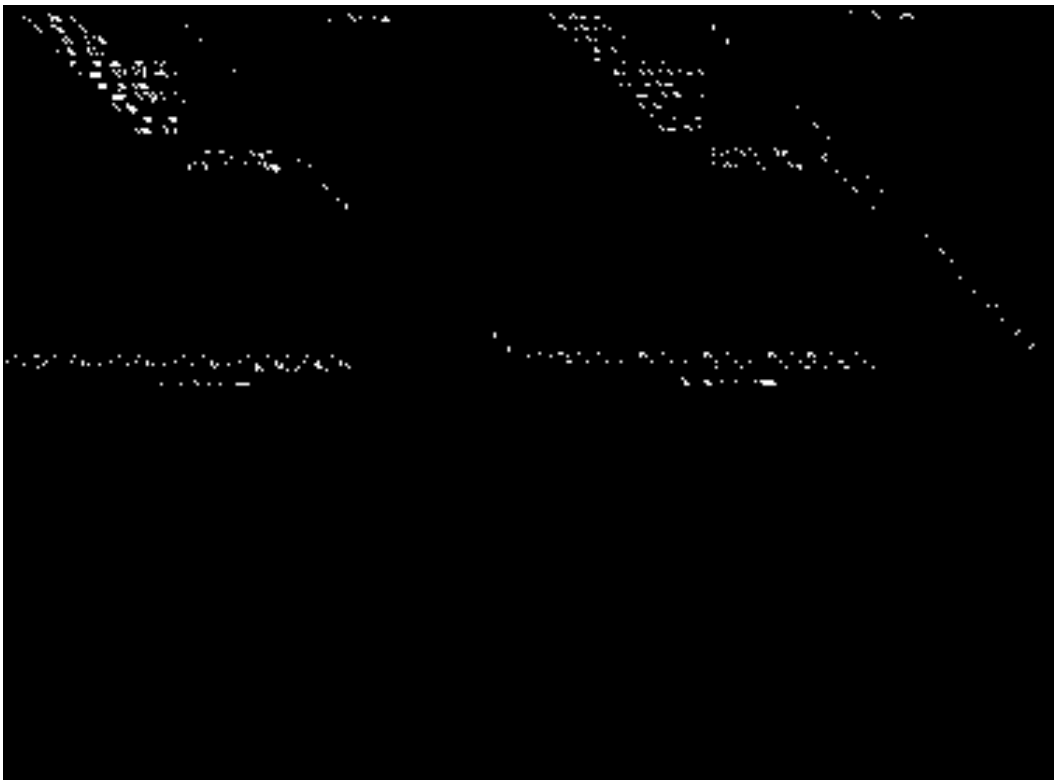
- 37.5 KW/m^2 IHR **-** In the 24.5 meter radius area is considered as 100% fatality in 1 min.
- 12.5 KW/m^2 IHR **-**In the 43.0 meter radius first degree burn in 10 sec.
- 4 KW/m^2 IHR **-**In the 65.0 meter radius area will give pain after 20 seconds. Blistering unlikely.

Fireball Scenario		
Fireball Radius: 6.36m		
Fireball intensity of Heat Radiation (KW/m^2) – 134.186		
Fireball rate of Energy release (KJ/Sec)- 68393.6		
Fireball total energy released (KJ)- 96888.6		
Fireball duration (Sec) – 1.40		
Radiation Level (KW/m^2)	**Distance in meter**	**Injury Type**
100.20	6.0	100% Fatal
42.09	9.33	100% Fatal
12.5	14.66	1st degree Burn
9.96	18.66	Pain after 20secs.
4.0	26.0	Pain after 20secs.
1.54	41.33	No Injury

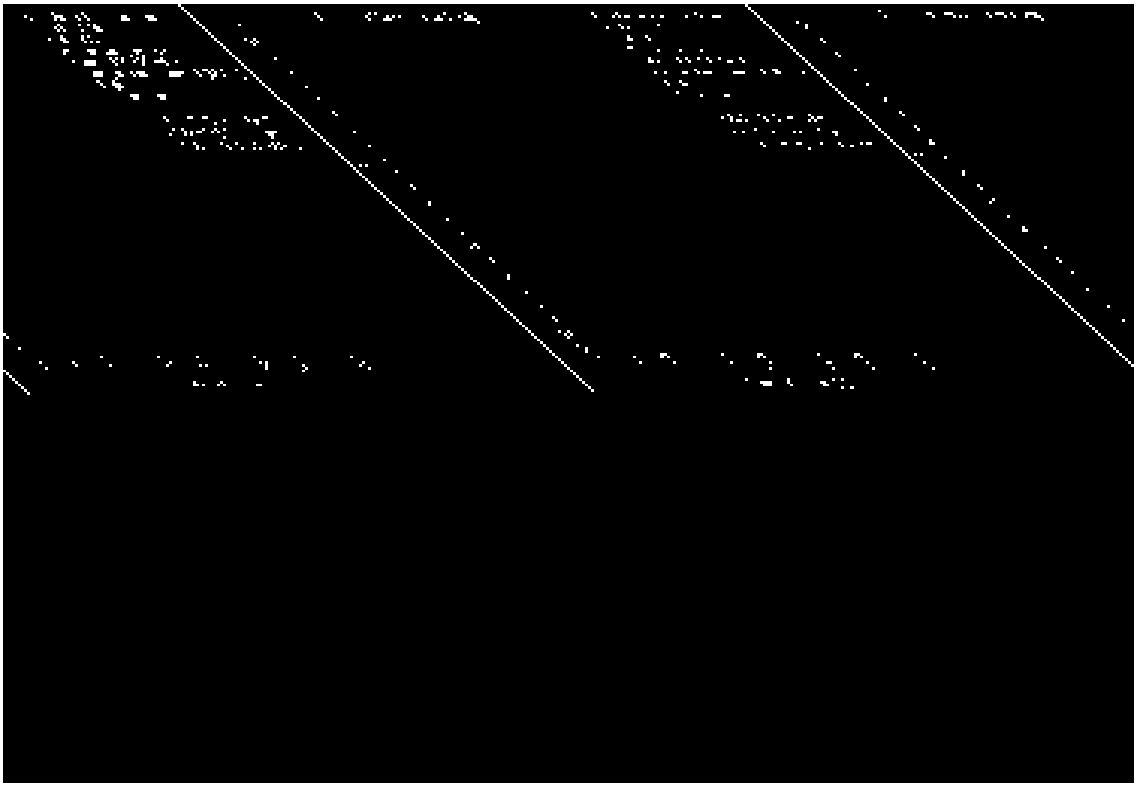
Results

- 37.5 KW/m^2 IHR **-** In the 12.0 meter radius area is considered as 100% fatality in 1 min.
- 12.5 KW/m2 IHR - In the 22.0 meter radius first degree burn in 10 sec.
- 4 KW/m2 IHR - In the 39.0 meter radius area will give pain after 20 seconds. Blistering unlikely.

CLOUD FOORPRINT

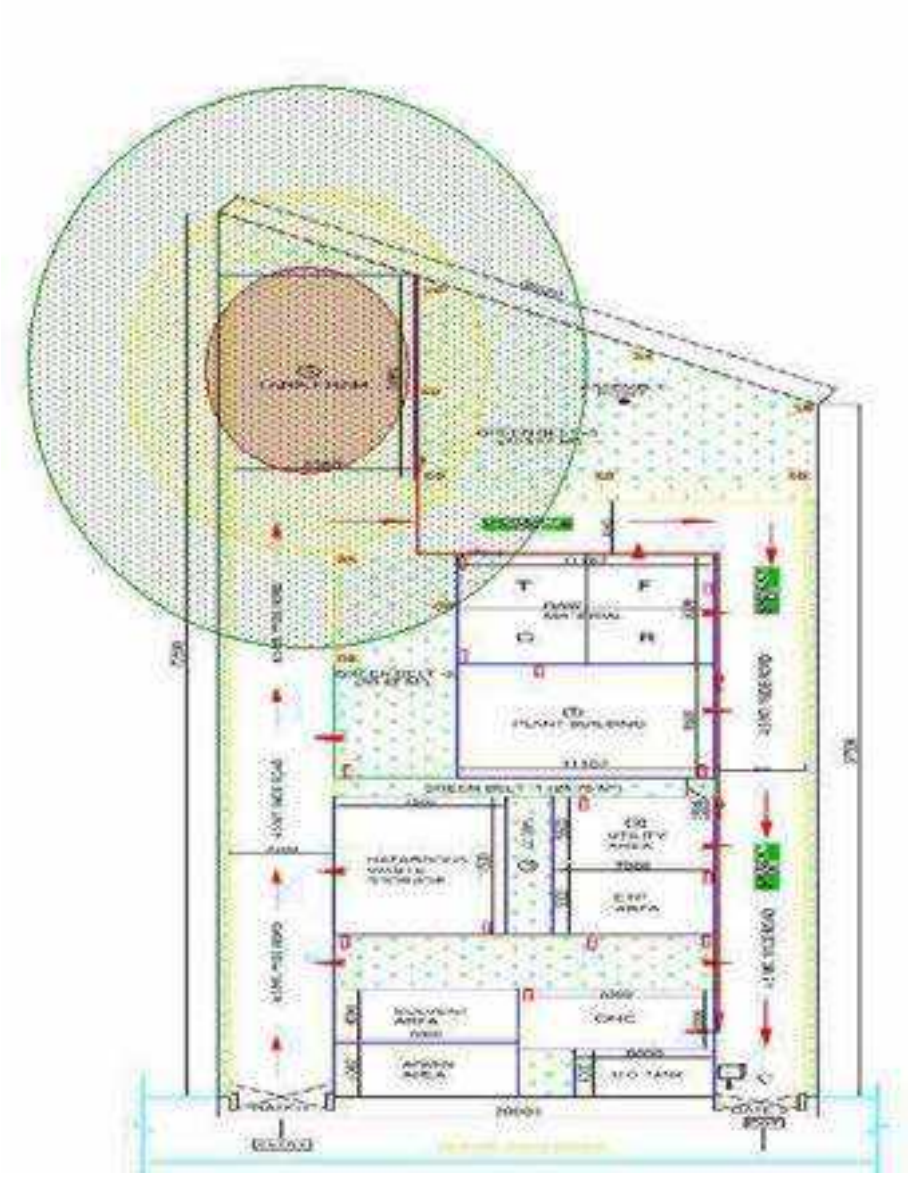


MAXIMUM CONCENTRATION



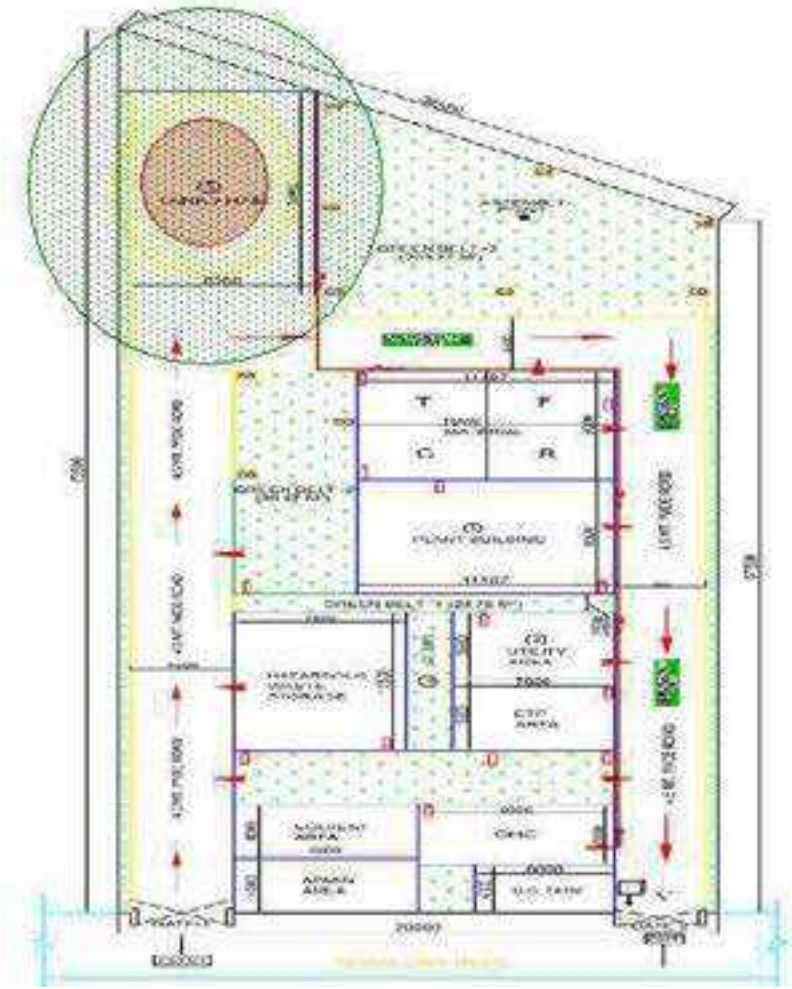
Pool Fire

Green – 4 KW/m^2
Yellow – 12.5 KW/m^2
Red – 37.5 KW/m^2



FIRE BALL

Green – 4 KW/m^2
Yellow – 12.5 KW/m^2
Red – 37.5 KW/m^2



ENVIRONMENTAL IMPACT & RISK ASSESSMENT REPORT

Scenario – 4 Release of Toluene

Catastrophic Rupture		
Input Data		
Stored quantity - 20 MT		
Molecular weight -92.14		
Wind speed - 2.21 m/s		
Density (Air) – 860 kg/m^3		
Results indicate		
Pool Fire Scenario		
Radiation Level (KW/m^2)	**Distance in meter**	**Effect if IHR at Height of simulation**
4	19.4	This level is sufficient to cause personnel if unable to reach cover within 20s; however blistering of the ski (second degree burn) is likely; 0: lethality
12.5	11.33	This level will cause extreme pain within 20 seconds and movement to a safer place is instinctive. This level indicates around 6% fatality for 20 seconds exposure.
37.5	5.33	This level of radiation is assumed to give 100% fatality as outlined above.

Vapor Cloud Explosion

Radial Distance (m)	Over Pressure (psi)	Fatality lung Rupture (%)	Eardrum Rupture (%)	Structure Damage (%)	Glass Rupture (%)
5.2	36.2	100.0	100.0	100.0	100.0
5.9	8.9	0.0	77.0	100.0	100.0
8.9	2.0	0.0	3.1	14.5	100.0

In case of Unconfined Vapor Cloud Explosion up to 5.2 meter is considered as 100% fatality and 100% ear drum rupture radius.

In case of Unconfined Vapor Cloud Explosion up to 5.9 meter is considered as 100% structure damage and up to 8.9 meter 100% glass rupture area.

Fireball Scenario

Fireball Radius: 8.33656 m

Fireball intensity of Heat Radiation (KW/m^2) – 149.074

Fireball rate of Energy release (KJ/Sec)- 107389

Fireball total energy released (KJ)- 185056

Fireball duration (Sec) – 1.72334

Radiation Level (KW/m^2)	Distance in meter	Injury Type
37.50	9.33	100% Fatal

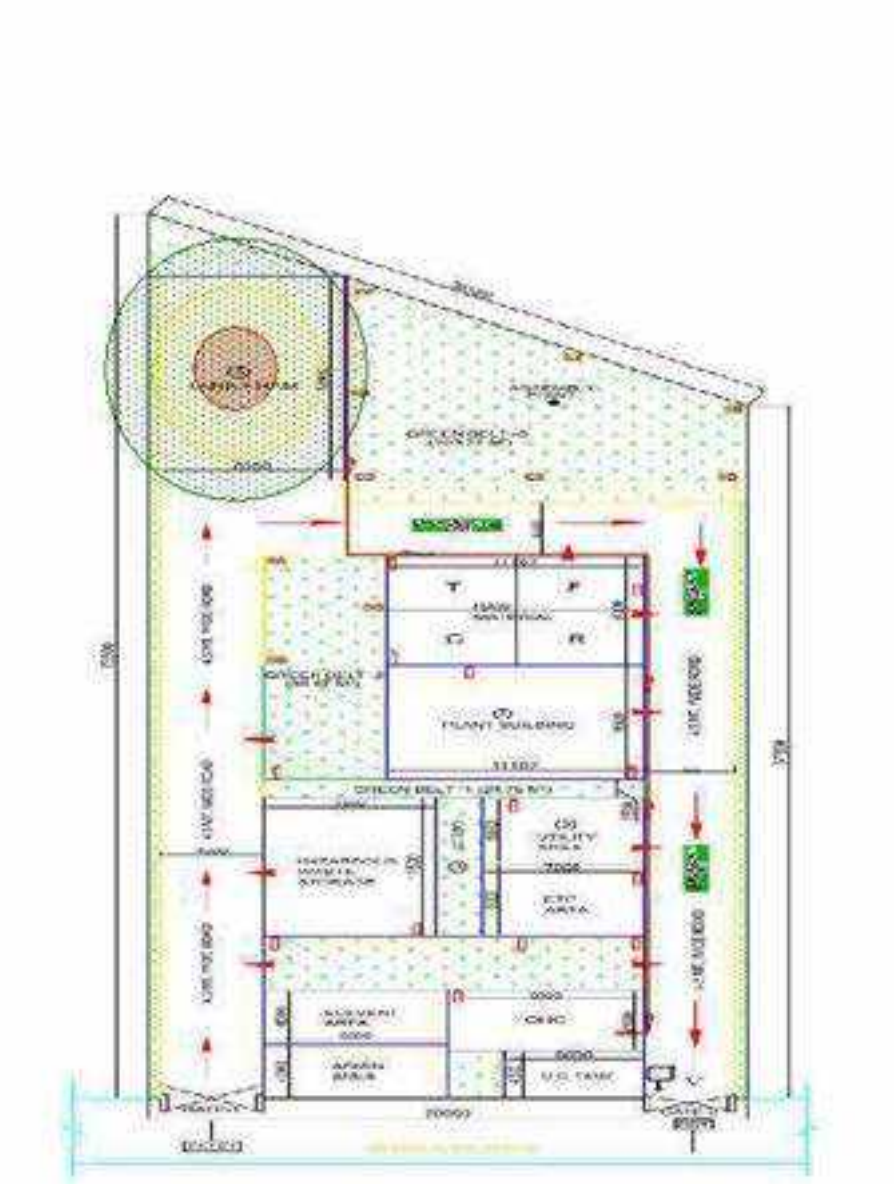
22.04	12.66	Significant Injury
12.5	16.66	1st Degree burn
4	26	Pain after 20secs.
1.6	50	No Injury
Flash Fire		
Radiation Level (KW/m^2)	**Distance in meter**	**Injury Type**
50.79	8.66	100% Fatal
37.5	10.73	100% Fatal
28.24	12.66	Significant Injury
17.95	14.66	1st Degree burn
12.5	18	Pain after 20secs.
4	28	Pain after 20secs.
1.6	46.66	No Injury

SAFETY PRECUASION:

- Flame proof pumping and other equipments will be provided.
- Transfer will be done in close process,
- Double Static earthling and Jumper clips will be provided on flanges,
- Hydrant system and Fire extinguishers will be provided.
- Automatic Sprinklers will be provided.
- Tanker unloading procedure will be made and followed.
- Dyke around the tank will be provided.

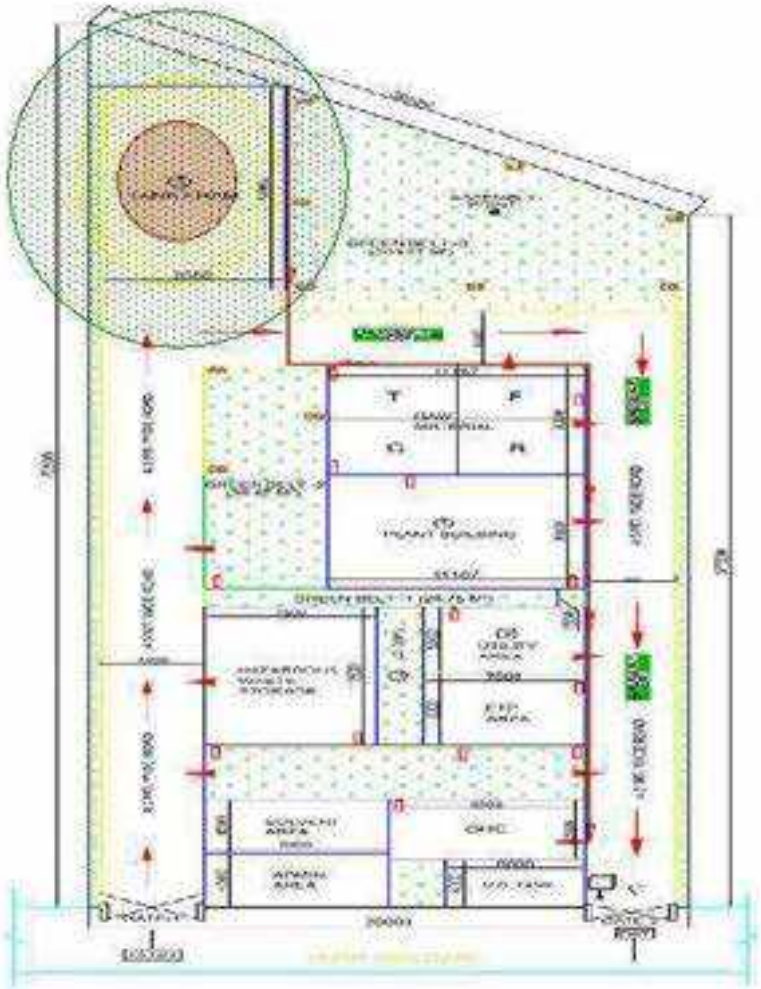
Pool Fire Scenario

Green – 4 KW/m^2
Yellow – 12.5 KW/m^2
Red – 37.5 KW/m^2



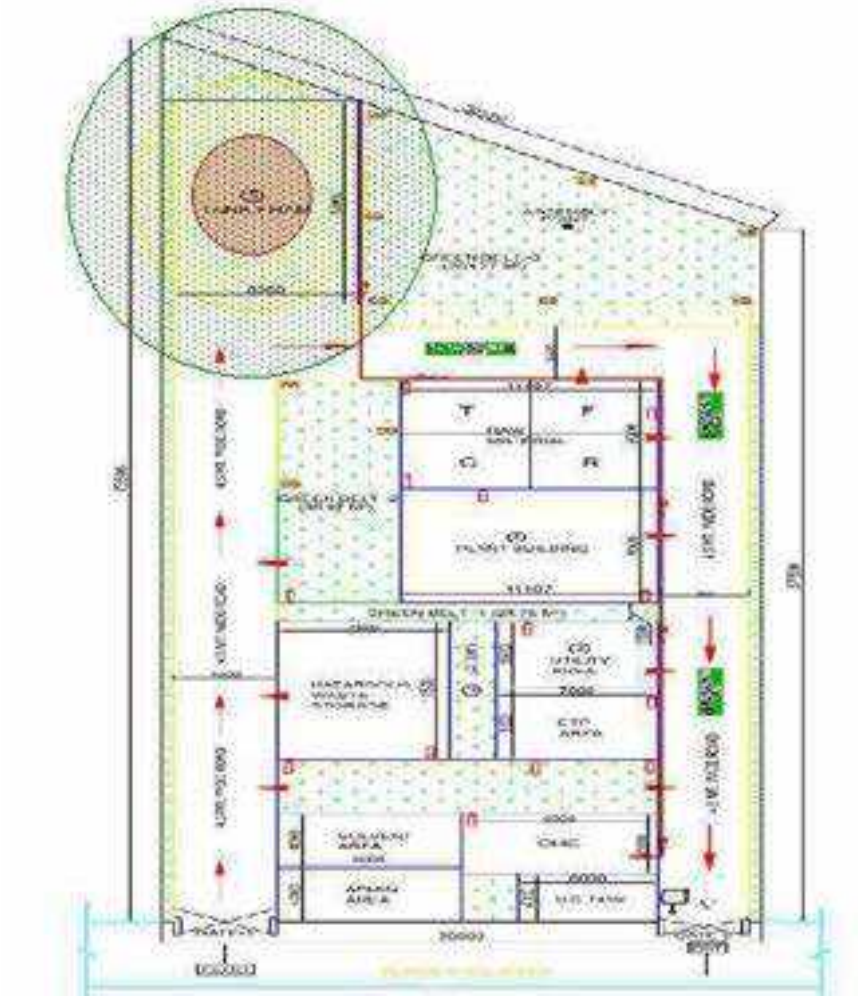
Fireball Scenario

Green – 4 KW/m^2
Yellow – 12.5 KW/m^2
Red – 37.5 KW/m^2



Flash Fire Scenario

Green – 4 KW/m^2
Yellow – 12.5 KW/m^2
Red – 37.5 KW/m^2



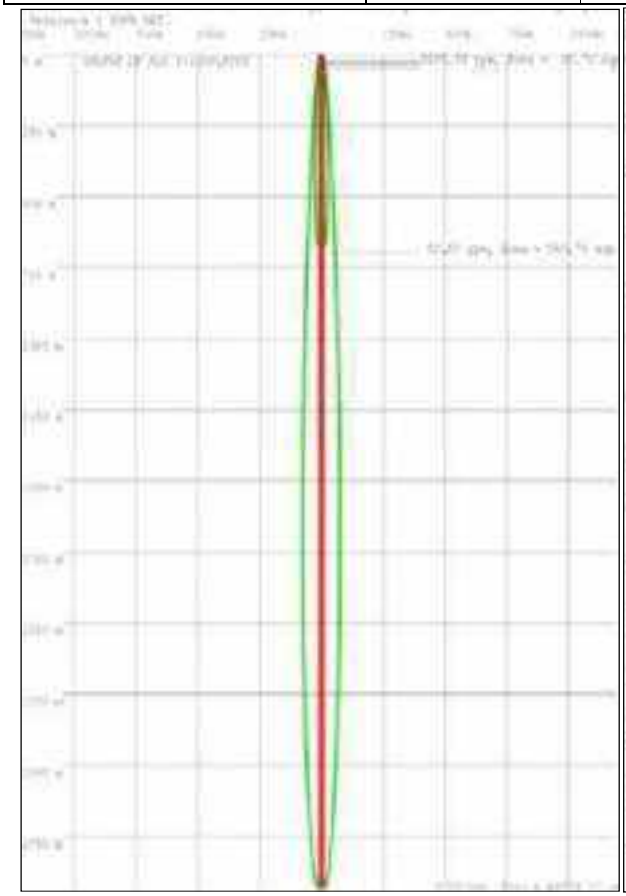
ENVIRONMENTAL IMPACT & RISK ASSESSMENT REPORT

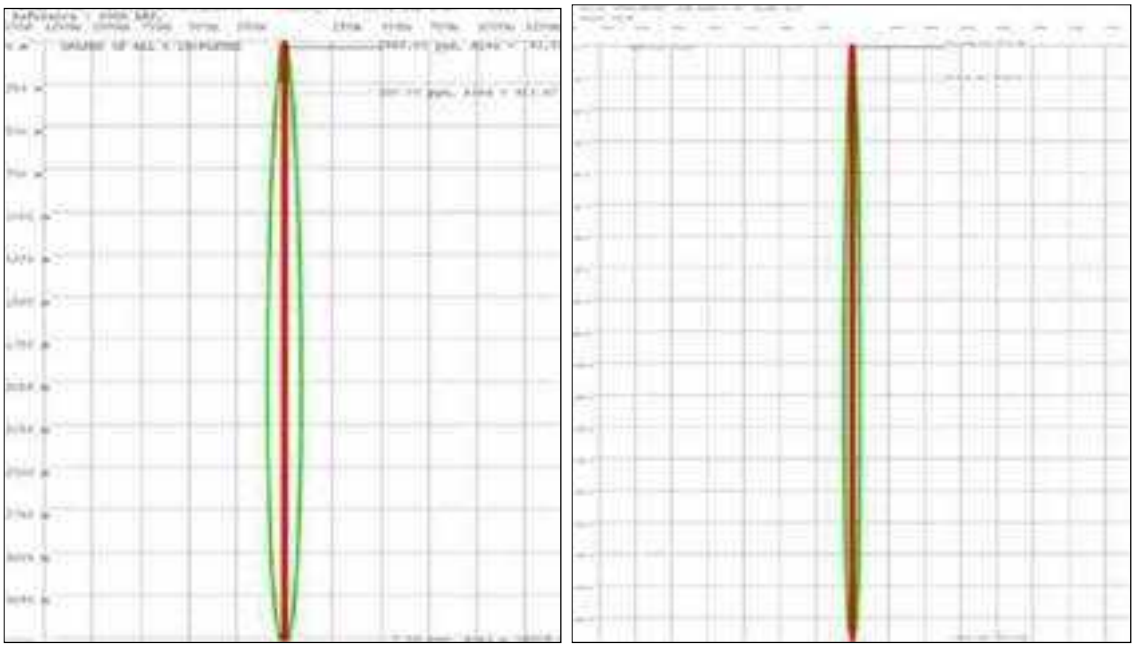
Scenario 5: Release of Thionyl Chloride

Spill pool Evaporation for Thionyl Chloride storage tank catastrophic failure

Scenario : Spill pool Evaporation			
Input Data		**Results of Computations**	
Stored quantity	10 KL	Max. ground level conc.	4895 ppm(SO2) 1630ppm(HCL)
Rate of release	1000 g/s	Dist. of maxi. ground level conc.	78 meter
Molecular weight	119		
Wind speed	2.21 m/s		
Density (Air)	1.64kg/m^3		

Hazard Level	Concentration (PPM)	D weather condition (Meter)	F weather condition (Meter)
LC50(As HCL gas)	3940	20	80
IDLH (As HCL gas)	50	330	1320
LC50(As SO2 gas)	5784	10	34
IDLH (As SO2 gas)	100	150	586





Measures to control and mitigate Emergency of Thionyl Chloride:

- Priority will be given to Tanker to immediately enter the storage premises at site and will not be kept waiting near the gate or the main road.
- Security person will check License, TREM CARD, Fire extinguisher condition; SCBA set condition, required PPEs as per SOP laid down.
- Store officer will take sample as per sampling SOP from sampling point.
- After approval of QC department unloading procedure will be allowed be started.

Following precautions will be adopted during unloading

- Wheel stopper will be provided to TL at unloading platform.
- Tanker unloading procedure will be followed according to check list and implemented.
- Flexible hose connection will be done at TL outlet line and checked for no leakage.
- Every time gasket will be changed.
- The quantity remaining in the hose pipeline will be drained to a small container, which will be subsequently transferred to the main storage tank thus ensuring complete closed conditions for transfer from road tanker.
- All TL valves will be closed.

Following precautions will be adopted Storage of such chemicals

- Storage tank will be stored away from the process plant.
- Tanker unloading procedure will be prepared and implemented.
- Caution note and emergency handling procedure will be displayed at unloading area and trained all operators.
- NFPA label will be provided.

- Required PPEs like full body protection PVC apron, Hand gloves, gumboot, Respiratory mask etc. will be provided to operator.
- Neutralizing agent will be kept ready for tackle any emergency spillage.
- Safety shower, eye wash with quenching unit will be provided in acid storage area.
- Material will be handled in close condition in pipe line.
- Dyke wall will be provided to all storage tanks, collection pit with valve provision.
- Double drain valve will be provided.
- Level gauge will be provided on all storage tanks.
- Safety permit for loading unloading of hazardous material will be prepared and implemented.
- TREM CARD will be provided to all transporters and will be trained for transportation Emergency of Hazardous chemicals.
- Fire hydrant system with jockey pump as per TAC norms will be installed.

Mitigation measures to control Emergency:

- Safety Shower and eye wash will be provided away from the tank and unloading station.
- Sand bags/ buckets will be provided near tank area.
- Neutralizing medium (Lime and dry sand) will be kept ready near tank farm.
- For Thionyl Chloride evacuate area in down wind direction up to 0.3 km (300 meter) in small spillage and in case of large spillage, evacuate the area in down wind direction 0.9 kms (900 meters).
- Emergency siren and wind sock will be provided.
- Tele Communication system and mobile phone will be used in case of emergency situations for communication.
- First Aid Boxes and Occupational health center will be made at site.
- Emergency organization and team will be prepared as per On site-Off site emergency planning.
- Full body protection suite and other PPEs will be kept ready in ECC at site.
- Emergency team will be prepared and trained for scenario base emergency. Like Toxic control team, Fire control team, First aid team, communication and general administration team, Medical team etc.

EMERGENCY RESPONSE SPILL OR LEAK

- Do not touch damaged containers or spilled material unless wearing appropriate protective clothing.
- Stop leak if you can do it without risk.
- Use water spray to reduce vapors; do not put water directly on leak, spill area or inside container.
- Keep combustibles (wood, paper, oil, etc.) away from spilled material.

Small Spill

- Cover with DRY earth, DRY sand or other non-combustible material followed with plastic sheet to minimize spreading or contact with rain.
- Use clean non-sparking tools to collect material and place it into loosely covered plastic containers for later disposal.
- Prevent entry into waterways, sewers, basements or confined areas.

Scenario 6: Release of Methanol

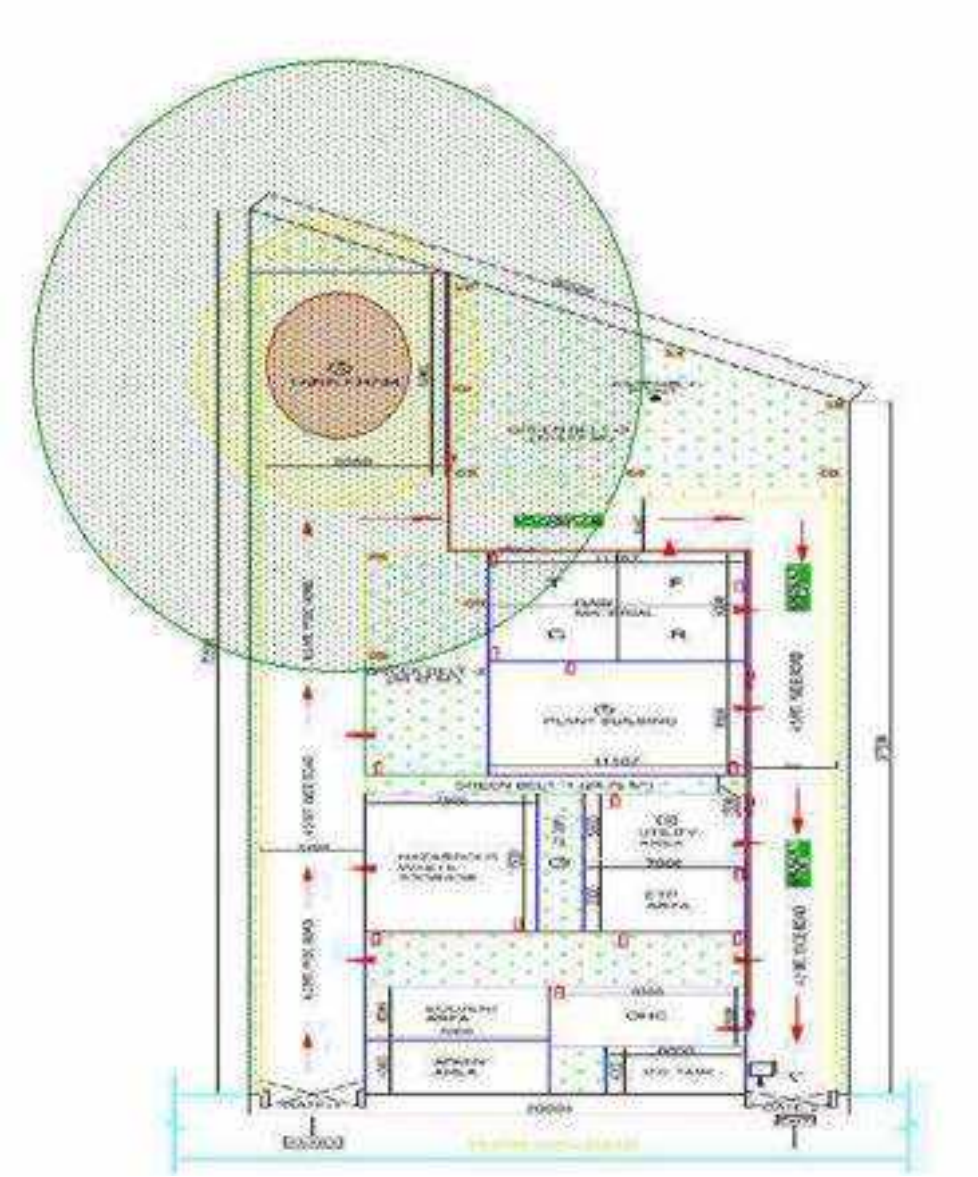
This scenario considers release of Methanol from Storage Tank:

Results indicate:

Catastrophic Rupture		
Input Data		
Stored quantity - 20 MT		
Molecular weight -33.05		
Wind speed - 2.21 m/s		
Density (Air) –0. 791 g/cm^3		
Results indicate		
Pool Fire Scenario		
Radiation Leve (KW/m^2)	**Distance in mete**	**Effect if IHR at Height of simulation**
4	47.09	This level is sufficient to cause personnel if unable to reach cover within 20s; however blistering of the skin (second degree burn) is likely; 0: lethality
12.5	22.12	This level will cause extreme pain within 20 seconds and movement to a safer place is instinctive. This level indicates around 6% fatality for 20 seconds exposure.
37.5	11.2	This level of radiation is assumed to give 100% fatality as outlined above.
Flash Fire Scenario		
Radiation Level (KW/m^2)	**Distance in meter**	**Injury Type**
4	50.66	This level is sufficient to cause personnel if unable to reach cover within 20s; however blistering of the skin (second degree burn) is likely; 0: lethality
12.5	32.66	This level will cause extreme pain within 20 seconds and movement to a safer place is instinctive. This level indicates around 6% fatality for 20 seconds exposure.
37.5	8.66	This level of radiation is assumed to give 100% fatality as outlined above.
Fireball Scenario		
Radiation Level (KW/m^2)	**Distance in meter**	**Injury Type**
4	36	Pain after 20secs.
12.5	21.33	1st degree Burn
37.5	10	100% Fatal

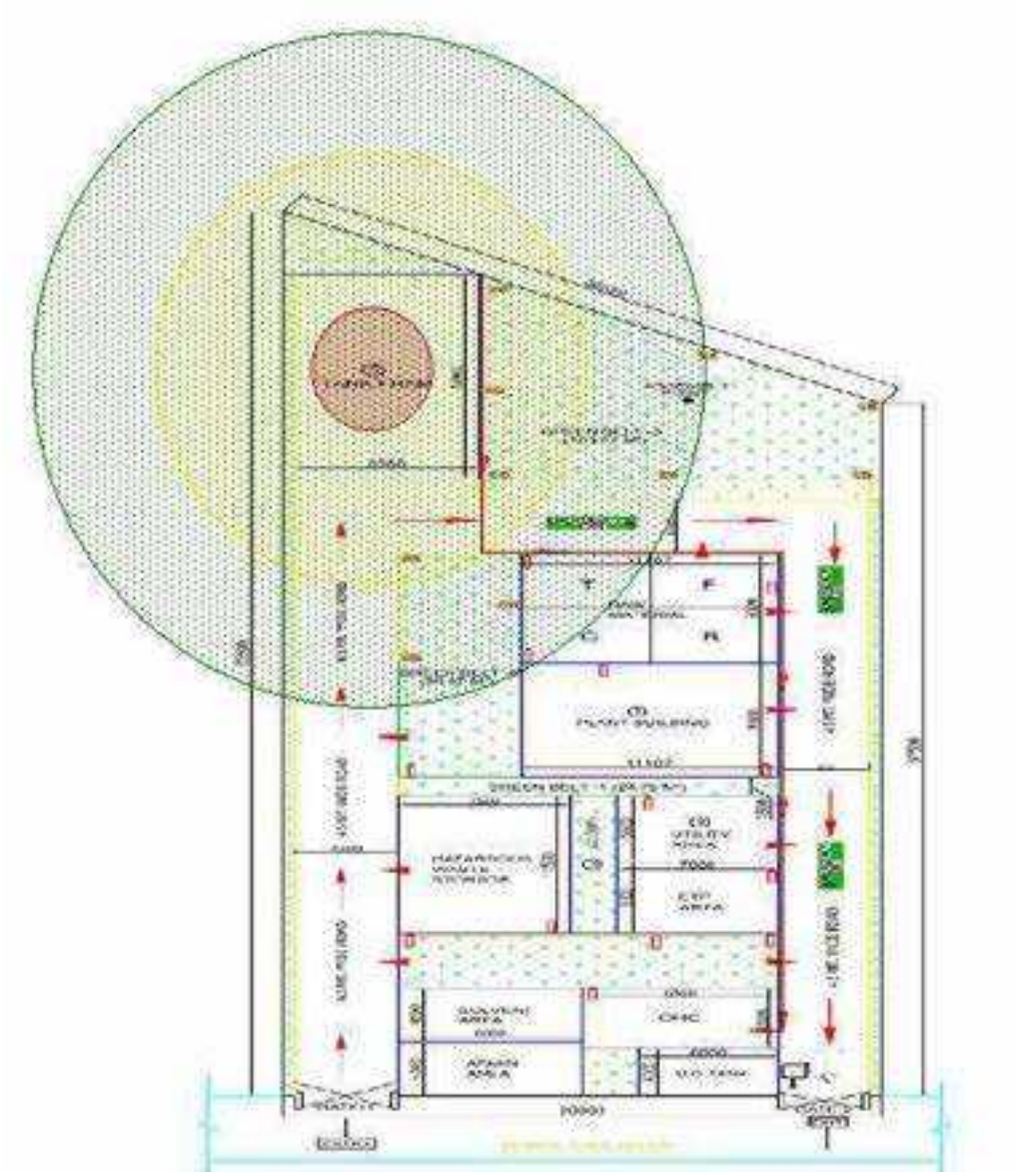
Pool Fire Scenario:

Green – 4 KW/m^2
Yellow – 12.5 KW/m^2
Red – 37.5 KW/m^2



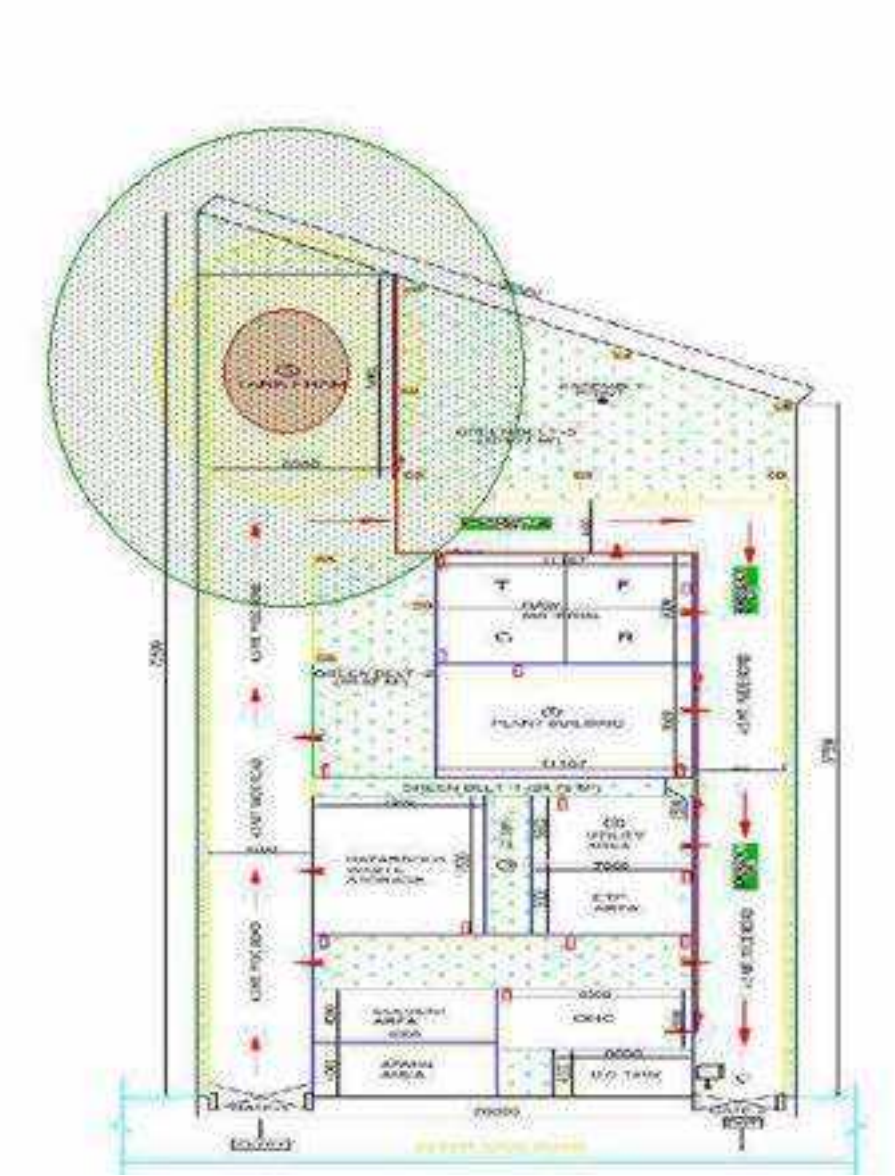
Flash Fire Scenario:

Green – 4 KW/m^2
Yellow – 12.5 KW/m^2
Red – 37.5 KW/m^2



Fireball Scenario:

Green – 4 KW/m^2
Yellow – 12.5 KW/m^2
Red – 37.5 KW/m^2

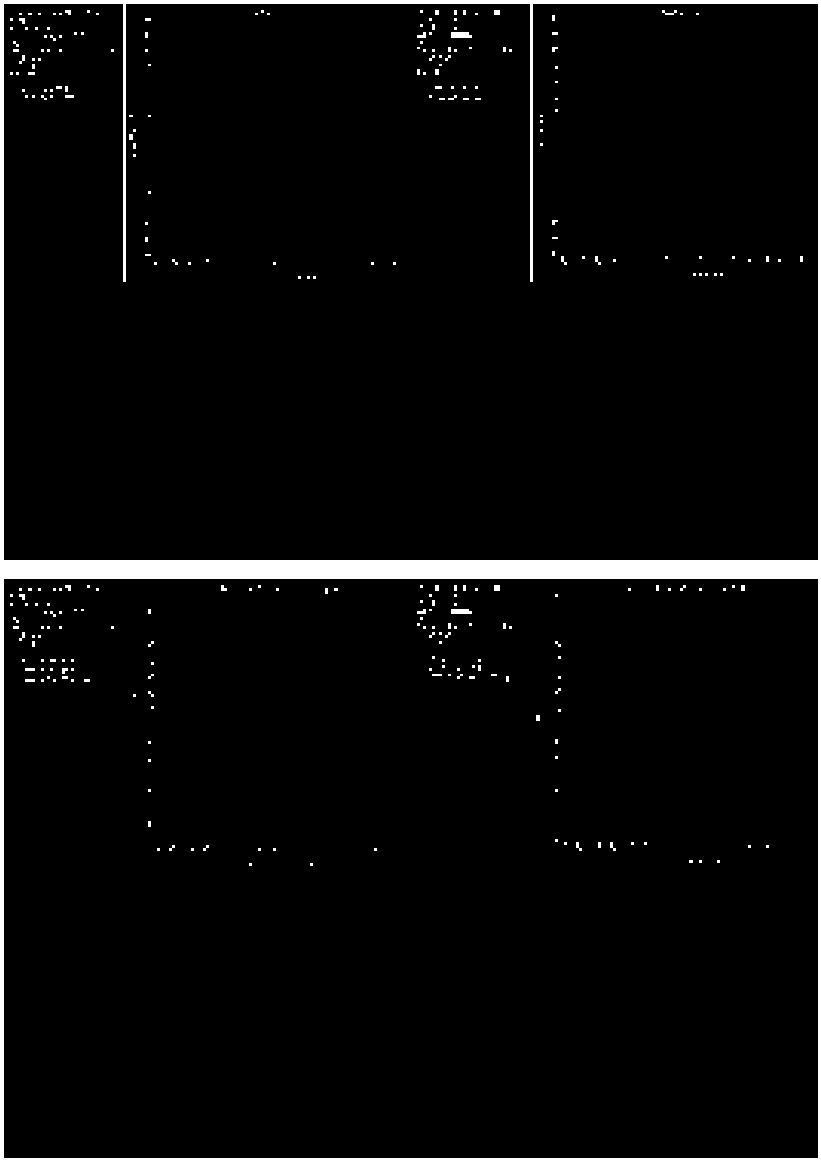


Scenario 7: Release of Xylene

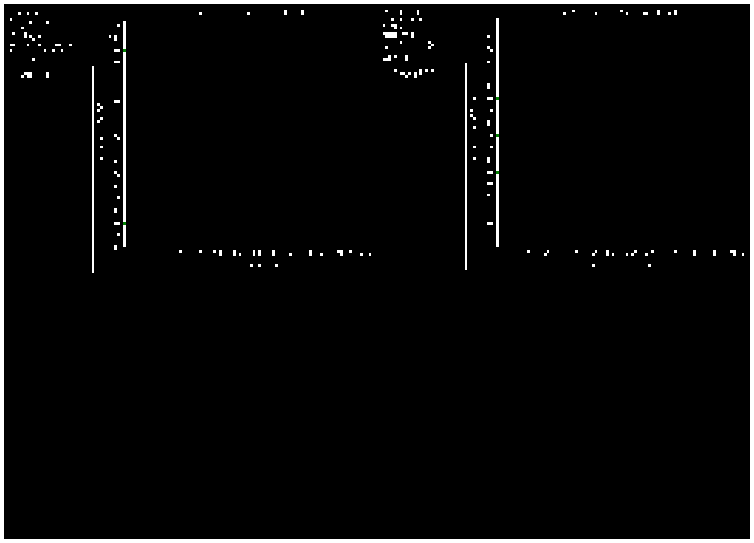
Results indicate:

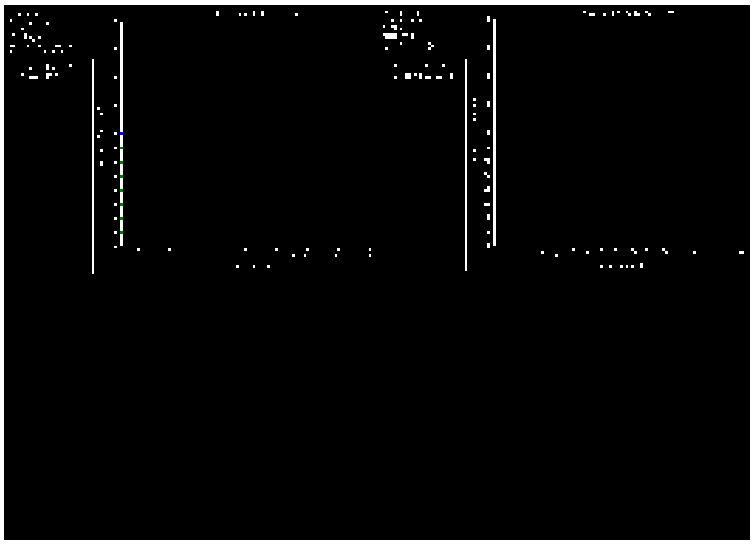
Pool Diameter 24.32m
Cloud center has reached the UFL concentration 18.75 fraction at distance 15.3 m and time 15.8 s
Cloud center has reached the LFL concentration 2.32 fraction at distance 23.7 m and time 35.7 s
Cloud center has touched down at distance 0.3266 m and time 0.7 s
Dispersion modeled as passive plume/cloud at distance 32.5 m and time 351.9 s
Cloud center has reached the user-specified concentration 0.001 fraction at distance 44.3 m and time 485.2 s

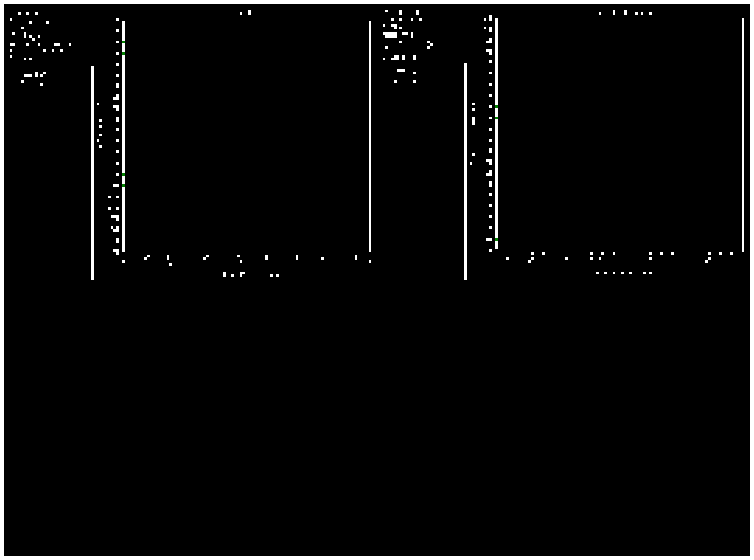
Cloud Foot Print



Maximum Concentration







Scenario 8: Release of Hydrochloric Acid:

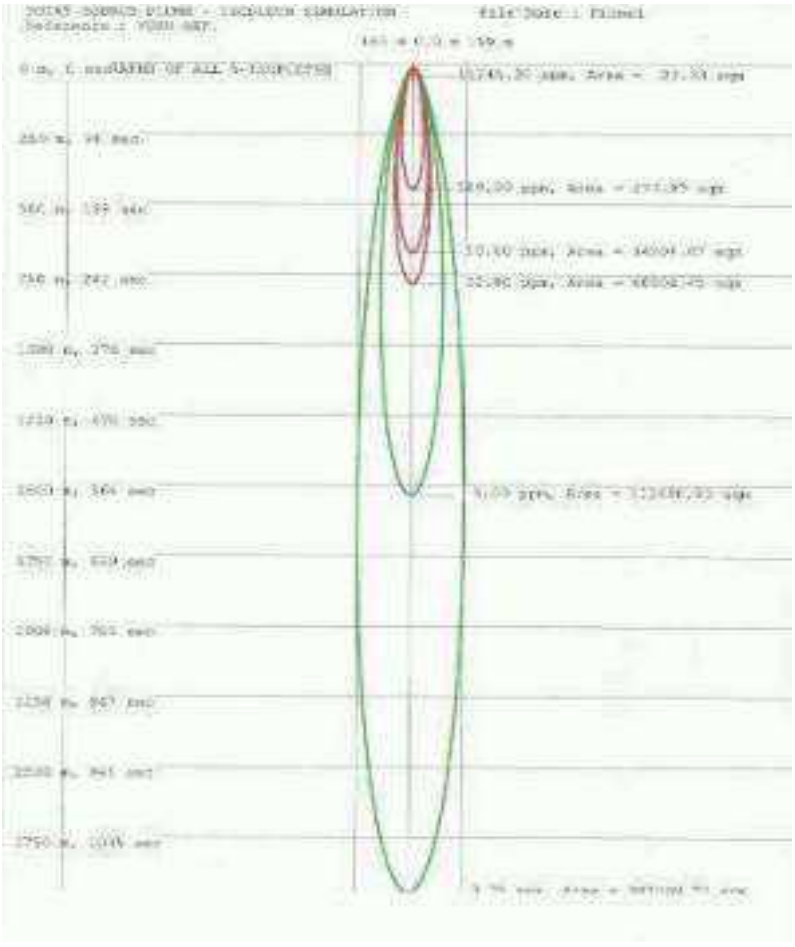
This scenario considers release of HCl from Storage Tank:

Results indicate:

Catastrophic Rupture	
Input Data	
Stored quantity = 10 MT	
Molecular weight = 36.46	
Wind speed = 2.21 m/s	
Vapor Density (Air=1) = 1.267	
Results indicate	
LD50 = 900 mg/kg	44.69 meter
IDLH = 5 ppm	1532.66 meter
TLV = 5 ppm	2943.00 meter

Results

LD50 (900 mg/kg) area up to 44.69 meter, Immediate danger to life and health (5 ppm) concentration area up to 1532.66 meter and TLV (5 ppm) area up to 2943 meter. Therefore 1532.66 meter area in wind direction is considered as evacuation area.



Measures to be taken to prevent such accident:

- Priority will be given to Tanker to immediately enter the storage premises at site and will not be kept waiting near the gate or the main road.
- Security person will check License, TREM CARD, Fire extinguisher condition, required PPEs as per SOP laid down.
- Store officer will take sample as per sampling SOP from sampling point.
- After approval of QC department unloading procedure will be allowed be started.

Following precautions will be adopted during unloading

- Tanker unloading procedure will be followed according to check list and implemented.
- Flexible hose connection will be done at TL outlet line and checked for no leakage.
- Every time gasket will be changed.
- The quantity remaining in the hose pipeline will be drained to a small container, which will be subsequently transferred to the main storage tank thus ensuring complete closed conditions for transfer from road tanker.
- All TL valves will be closed.

Following precautions will be adopted Storage of such chemicals

- Storage tank will be stored away from the process plant.
- Tanker unloading procedure will be prepared and implemented.
- Caution note and emergency handling procedure will be displayed at unloading area and trained all operators.
- NFPA label will be provided.
- Required PPEs like full body protection PVC apron, Hand gloves, gumboot, Respiratory mask etc. will be provided to operator.
- Neutralizing agent will be kept ready for tackle any emergency spillage.
- Safety shower, eye wash with quenching unit will be provided in acid storage area.
- Material will be handled in close condition in pipe line.
- Dyke wall will be provided to all storage tanks, collection pit with valve provision.
- Double drain valve will be provided.

- Level gauge will be provided on all storage tanks.
- Safety permit for loading unloading of hazardous material will be prepared and implemented.
- TREM CARD will be provided to all transporters and will be trained for transportation Emergency of Hazardous chemicals.
- Fire hydrant system with jockey pump as per TAC norms will be installed.

Mitigation measures to control Emergency:

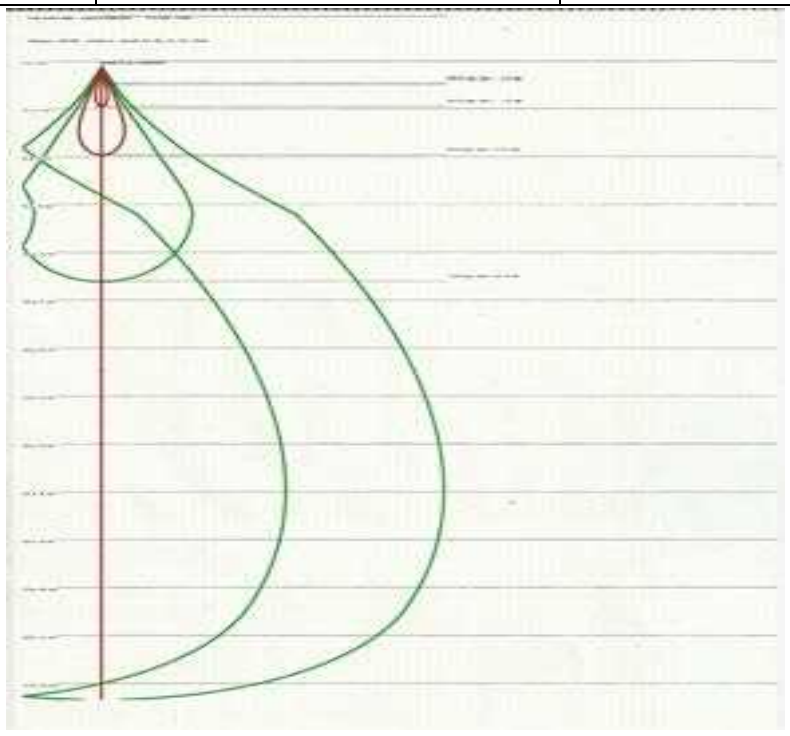
- Safety Shower and eye wash will be provided away from the tank and unloading station.
- Sand bags/ buckets will be provided near tank area.
- Neutralizing medium (Lime and dry sand) will be kept ready near tank farm.
- Emergency siren and wind sock will be provided.
- Tele Communication system and mobile phone will be used in case of emergency situations for communication.
- First Aid Boxes and Occupational health center will be made at site.
- Emergency organization and team will be prepared.
- Full body protection suite and other PPEs will be kept ready in ECC at site.
- Emergency team will be prepared and trained for scenario base emergency. Like Toxic control team, Fire control team, First aid team, communication and general administration team, Medical team etc.

Scenario 9: Release of EDC:

Catastrophic Rupture		
Input Data		
Stored quantity - 10 MT		
Molecular weight -96.94		
Wind speed - 2.21 m/s		
Vapor density (air=1)– 3.34		
Results indicate		
Pool Fire Scenario		
Radiation Level (KW/m^2)	**Distance in meter**	**Effect if IHR at Height of simulation**
4	55.32	This level is sufficient to cause personnel if unable to rea cover within 20s; however blistering of the skin (second degree burn) is likely; 0: lethality
12.5	23.9	This level will cause extreme pain within 20 seconds and movement to a safer place is instinctive. This level indicates around 6% fatality for 20 seconds exposure.
37.5	13.88	This level of radiation is assumed to give 100% fatality as outlined above.

Dispersion		
Release Rate	**1000 gms/sec. (assumption)**	
Hazard Level	**Concentration (ppm)**	**Distance (meter)**
LC50	1414.2	23.42
IDLH	300	49.71
TWA/ TLV	75	116

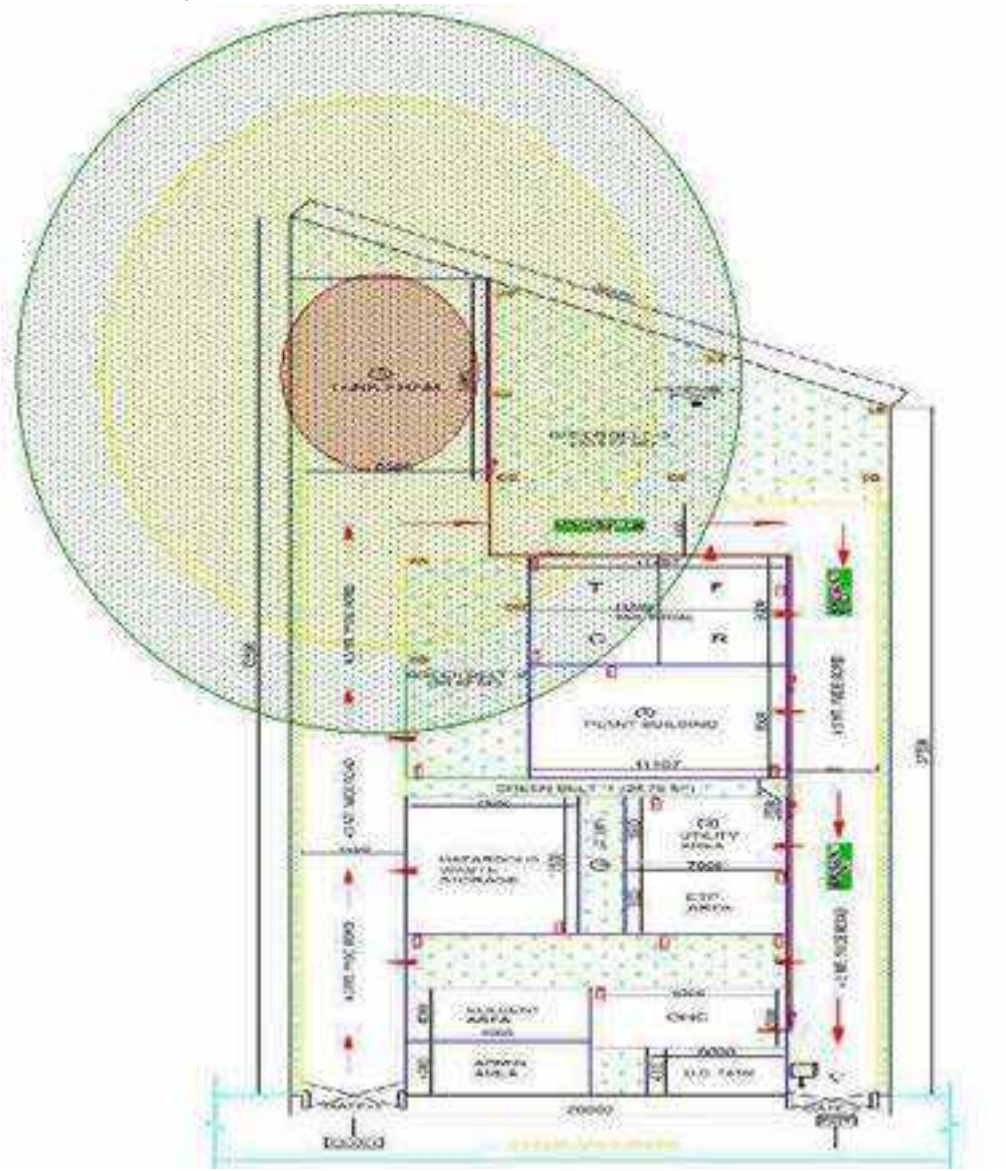
TOXIC RELEASE:



ENVIRONMENTAL IMPACT & RISK ASSESSMENT REPORT

Pool Scenario:

Green – 4 KW/m^2
Yellow – 12.5 KW/m^2
Red – 37.5 KW/m^2



SAFETY PRECUASION:

- Flame proof pumping and other equipments will be provided.
- Transfer will be done in close process,
- Double Static earthling and Jumper clips will be provided on flanges,
- Hydrant system and Fire extinguishers will be provided.
- Automatic Sprinklers will be provided.
- Tanker unloading procedure will be made and followed.
- Dyke around the tank will be provided.

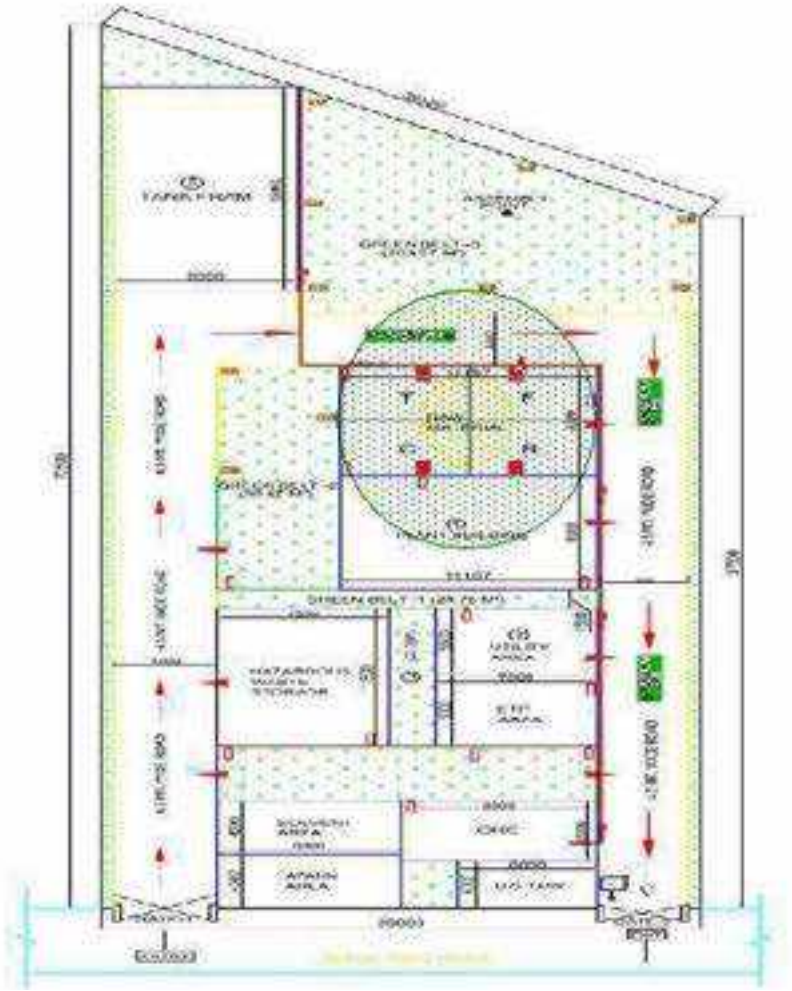
Scenario 10: Release of Ammonia Gas:

This scenario considers release of Ammonia from 60 Kg Cylinder

Catastrophic Rupture		
Input Data		
Stored quantity - 60 Kg		
Molecular weight - 17.031 g/mol		
Wind speed – 2.21 m/s		
Density (Air) – 0.86 kg/m		
Results indicate		
Fireball Scenario		
Radiation Level (KW/m^2)	**Distance in meter**	**Injury Type**
4	20.5	Pain after 20secs.
12.5	7.9	1^{st} degree Burn
37.5	--	100% Fatal

Fireball Scenario

Green – 4 KW/m^2
Yellow – 12.5 KW/m^2



Scenario 11: Release of Hydrogen Gas:

SCENARIO : UNCONFINED JET FIRE		
Input Data		
Stored quantity		60 Kg
Wind speed		2.14 m/s
Gas Density		67 kg/m^3
Incident Intensity of Heat Radiation (IHR) at ground level KW /m^2	**IHR- Isopleths Distance (Meters)**	**Effect if IHR at Height of Simulation**
37.5	8.5	Damage to process equipment. 100 % Fatal in 1 Min. 1 % fatal in 10 sec.
25.0	10.6	Min. to ignite wood (without flame contact). 100 % fatal in 1 Min. Significant injury in 10 sec.
12.5	14.8	Min. to ignite wood (with flame contact). 1 % fatal in 1 min. 1 st deg. burn in 10 sec.
4.0	29.0	Pain after 20 secs. Blistering unlikely.

Results:

In the 8.5 meter radius area is considered as 100% fatality in 1 min.

In the 14.8 meter radius first degree burn in 10 sec.

In the 29.0 meter radius area will give pain after 20 seconds. Blistering unlikely.

SCENARIO : FLASH FIRE		
Input Data		
Stored quantity		60 Kg
Heat of combustion		42267 KJ/kg
Fuel-Air volume ratio in Flash fire cloud		0.600
Stochiometric Fuel-Air Mixture		0.029
Wind speed		2.14 m/s
Gas Density		0.067
Incident Intensity of Heat Radiation (IHR) at ground level KW /m^2	**IHR- Isopleths Distance (Meters)**	**Damage effects**
37.5	5	100 % Fatal. Min. to ignite wood (without flame contact)
25.0	11	Significant injury. Min. to ignite wood (without flame contact).
12.5	15	Min. to ignite wood (with flame contact). 1 st deg. burn.
4.0	26	Pain after 20 secs. Blistering unlikely.
1.6	41	No discomfort even on long exposure.

Results:

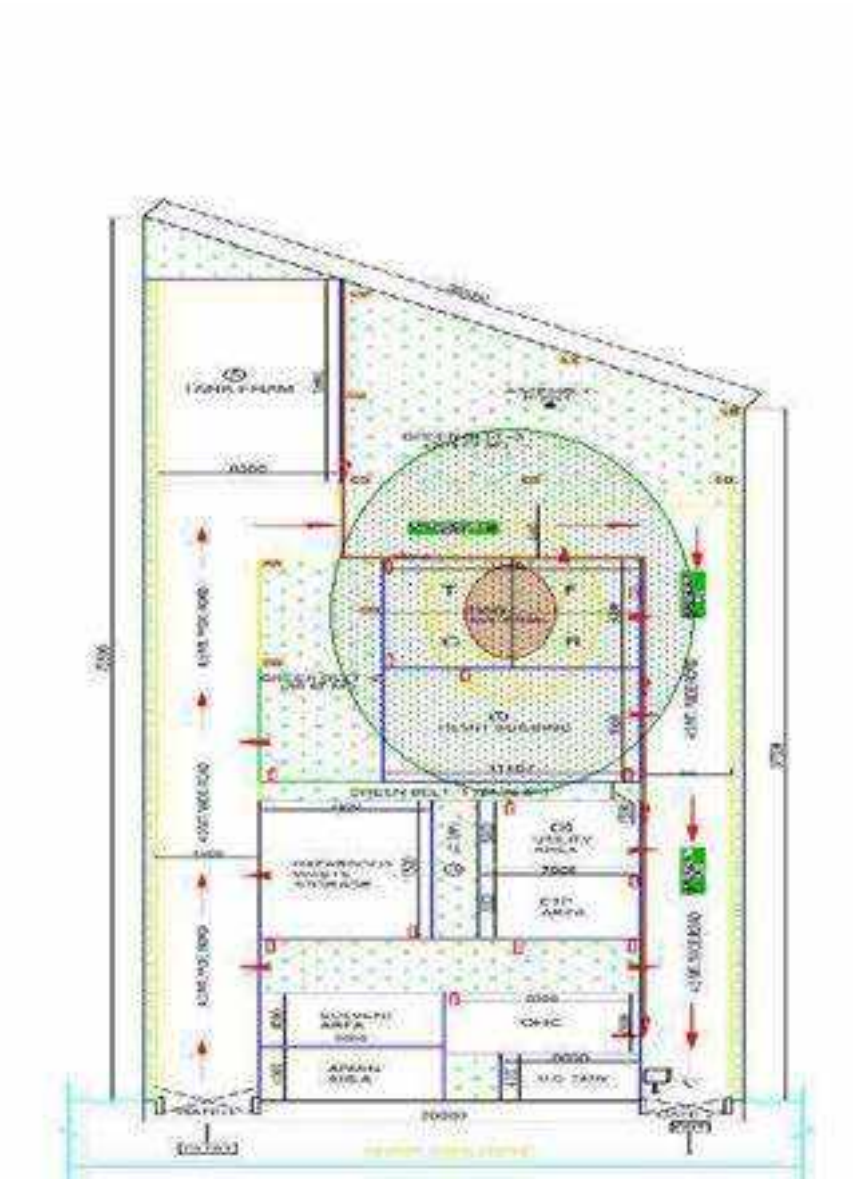
In the 5 meter radius area is considered as 100% fatality in 1 min.

In the 15 meter radius first degree burn in 10 sec.

In the 26 meter radius area will give pain after 20 seconds. Blistering unlikely.

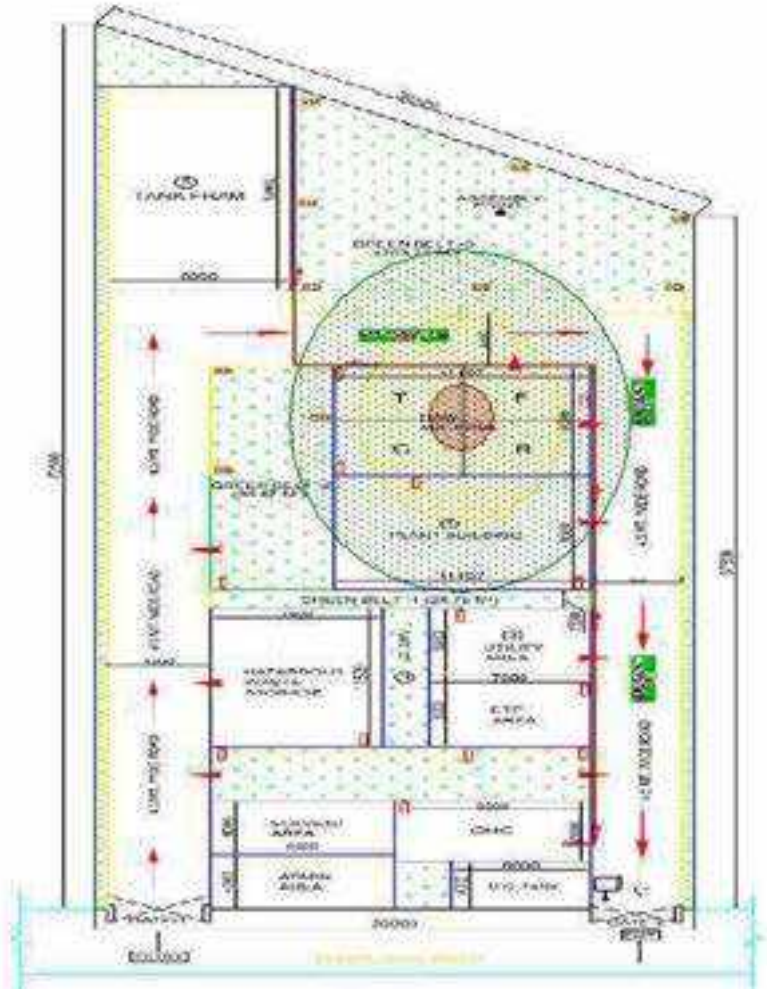
Jet Fire Scenario

Green – 4 KW/m^2
Yellow – 12.5 KW/m^2
Red – 37.5 KW/m^2



Flash fire scenario

Green – 4 KW/m^2
Yellow – 12.5 KW/m^2
Red – 37.5 KW/m^2



Safety Measures

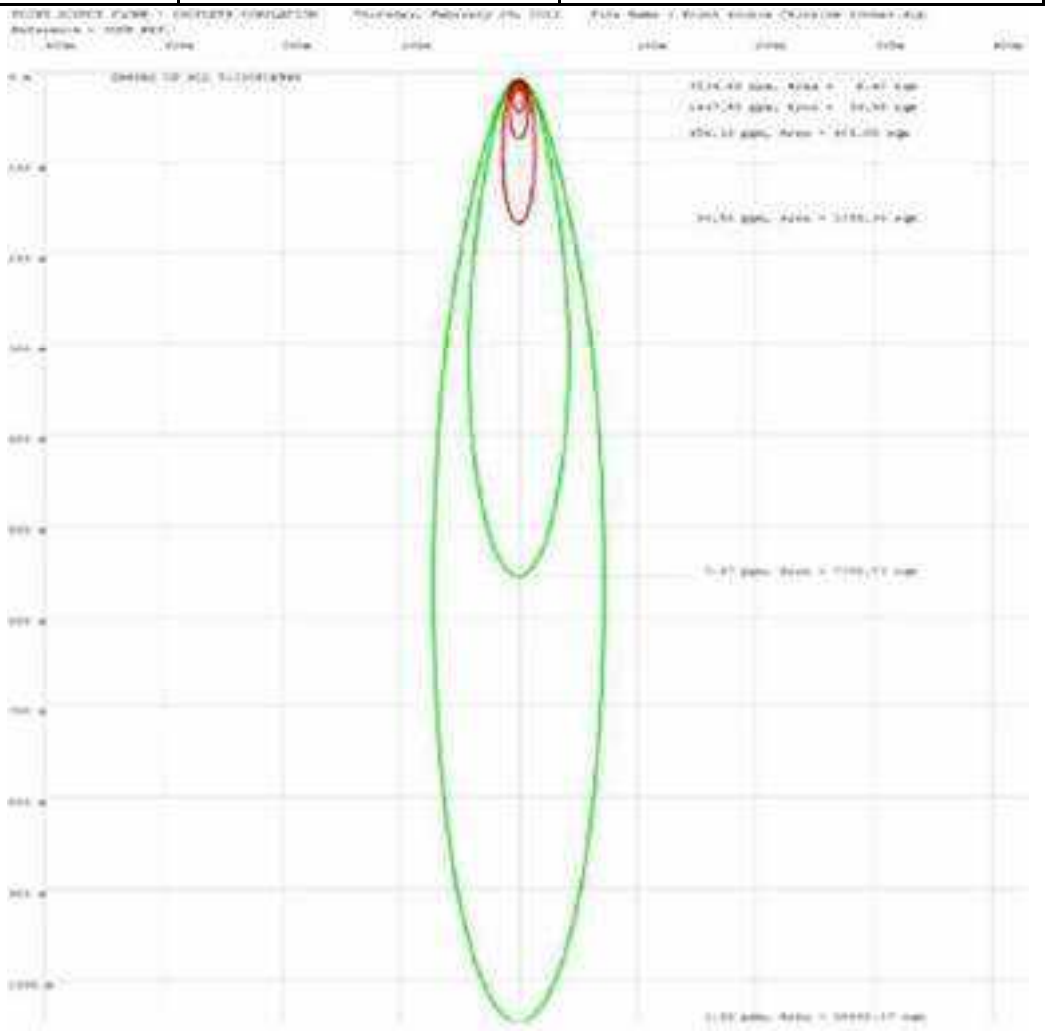
- FLP type area will be provided.
- Total enclosed process system.
- Instrument & Plant Air System.
- Nitrogen blanketing in Hydrogenation reactor.
- Safety valve provided on reactor.
- Cooling Chilling and power alternative arrangement have been made on reactor.
- Hydrogen Cylinder away from the auto clave reactor.
- PRV station with shut off valve, safety valve provision will be made for hydrogenation reaction safety.
- Before Hydrogen Gas charging in to reactor and after completion of reaction Nitrogen flushing will be done.
- Open well ventilated and fragile roofs will be provided to on reactor.
- Safe Catalyst charging method will be adopted.
- SOP will be prepared and operators will be trained for the same.
- Static earthing and electric earthing (Double) provided.
- Reactor vent extended outside the process area and flame arrestor provided on vent line.
- Dumping vessel arrangement will be made.
- Separate Isolated Cylinder manifold
- H2 cylinder stand with Chain link supporting
- Trained Operator
- Flameproof Electrical Installation
- Spark proof Spanner set
- Earthing, Grounding and Bonding on the Pipeline
- Well Supported fixed Line

Scenario 12: Release of Chlorine:

Point source (3/4" nozzle in the toner) plume release for Chlorine tonner liquid/ gas phase valve failure

Input Data	
Stored quantity	900 Kgs
Rate of release	718 gram/sec
Molecular weight	70.9
Density (Air)	2.49 kg/m^3

Hazard Level	**Concentration (PPM)**	**Ground level distance (Meter)**
LC_{50}	293	166
IDLH	10 (ACGIH)	555
STEL 15 Min	1.00 (OSHA)	1045
TWA/TLV	0.5 (OSHA)	1524



7.8 ONSITE/OFFSITE EMERGENCY PLAN

DISASTER MANAGEMENT PLAN

Company has developed the emergency management system to tackle the emergency situation, apart from its emergency management system. The detail of disaster management system is discussed in the following section.

7.8.1 DEFIING THE NATURE OF EMERGENCY

7.8.1.1 LEVEL OF EMERGENCY CAN BE CLASSIFIED IN THREE CATEGORIES.

LEVEL - 1:

The leakage or emergency, which is confinable within the plant, premises. It may be due to -

a) Small fire in the plant

b) Low toxic gas release for short duration.

c) Collapsing of equipment that do not affect outside premises.

LEVEL - 2:

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

a) Major fire inside the factory premises.

b) Medium scale explosion confined to the factory premises.

c) Heavy toxic/flammable gas leakage for short duration.

LEVEL - 3:

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

a) Explosion of high magnitude affecting the adjacent area

b) Heavy / Profuse leakage of toxic / flammable gases for a long duration.

7.8.2 OBJECTIVES OF EMERGENCY MANAGEMENT SYSTEM

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

- To identify and assess types of emergencies due to different types of hazards.
- To work out plan with all provisions to handle emergencies and safeguard employees and people in the vicinity of the factory.
- To provide for emergency preparedness and the periodical rehearsal of the plan.
- To plan mode of proper communication and actions to be followed in the event of emergency.
- To keep all necessary information with respect to hazard/accident control and emergency contacts in one document for easy and speedy reference.

- To inform employees, general public and the authorities about the hazards/risk if any and the role to be played by them in the event of emergency.
- To control and contain the accident.
- To effect rescue and treatment of casualties.
- To inform and help relatives of casualties.
- To secure rehabilitation of affected area and restore normalcy.
- To provide information to media and government agencies.
- To preserve record, equipment etc. for investigating cause of emergency.
- To be ready for "mutual aid" if need arises to help neighboring units.

7.8.3 STRUCTURE OF EMERGENCY MANAGEMENT SYSTEM

Company has developed an emergency management team. The management structure includes the following personnel's;

- Chief Emergency Controller
- Incident Controllers
- Site Main Controllers
- Key Personnel's
- Essential Workers
- Assembly points
- Emergency control center
- Fire control arrangements
- Medical arrangements
- Other arrangements

7.9 DETAILS OF THE SEPARATE ISOLATED STORAGE AREA FOR FLAMMABLE CHEMICALS. DETAILS OF FLAME PROOF ELECTRICAL FITTINGS, DCP EXTINGUISHERS AND OTHER SAFETY MEASURES PROPOSED. DETAILED FIRE CONTROL PLAN FOR FLAMMABLE SUBSTANCES AND PROCESSES SHOWING HYDRANT PIPELINE NETWORK, PROVISION OF DG SETS, FIRE PUMPS, JOCKEY PUMP, TOXIC GAS DETECTORS ETC.

FIRE FIGHTING SYSTEM

Company management takes into consideration fire prevention measures at the project planning and during plant commissioning stage to avoid any outbreak of fire. But looking to the hazardous nature of process and the chemicals that are handled and processed, the chances of outbreak of fire cannot be totally ignored. Hence to tackle such a situation a good well laid fire protection system will be provided in the factory.

PROPOSED FACILITIES TO BE MAINTAINED FOR FIRE FIGHTING:

Sr. No.	Type of Fire-Extinguisher	Numbers
1	CO2 (Capacity : 4.5 KG)	20
2	ABC (Capacity : 9 KG)	15
3	ABC(Capacity : 5 KG)	18
4	DCP (Capacity : 5 KG)	8
5	DCP Capacity : 6 KG)	12
6	DCP/ABC (Capacity : 2 KG)	10
7	M Foam (Capacity : 9 L)	7
8	M Foam (Capacity : 6 L)	10
	Total	**100**

FIRE HYDRANT SYSTEM: Consists of external & Internal Hydrant with Hose Boxes, Hose Reel, Water / Foam Monitors, Water Curtain, Foam Inductor for Solvent Tank Farm and Fixed Foam System for Production Building.

SPRINKLER SYSTEM: Provided at Ware House, this system is independent system having Separate Pumps with separate piping from Pump House to Ware House, it consists of automatic operated sprinkler on 59°C.

POTABLE FIRE EXTINGUISHERS: Suitable portable fire extinguishers like CO_2, DCP, Foam type provided for plant & non-plant buildings.

FIRE ALARM SYSTEM: Automatic fire detection & alarm system consists of Fire Detectors, Addressable MCP & Hooters Beam Detectors (Ware House) are placed at strategic locations and connected by cable to central control panel at ECC with repeater panel at DCS Control Room.

DISASTER MANAGEMENT PLAN

Company has developed the emergency management system to tackle the emergency situation, apart from its emergency management system. The detail of disaster management system is discussed in the following section.

Fig. 7.5 - LOCATION OF FIRE NEAREST STATION

Fire Station Building GIDC, Panoli is 0.84 km from project site.

7.9.1 DEFIING THE NATURE OF EMERGENCY

7.9.1.1 LEVEL OF EMERGENCY CAN BE CLASSIFIED IN THREE CATEGORIES.

LEVEL - 1:

The leakage or emergency, which is confinable within the plant, premises. It may be due to -

a) Small fire in the plant

b) Low toxic gas release for short duration.

c) Collapsing of equipment that do not affect outside premises.

LEVEL - 2:

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

a) Major fire inside the factory premises.

b) Medium scale explosion confined to the factory premises.

c) Heavy toxic/flammable gas leakage for short duration.

LEVEL - 3:

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

a) Explosion of high magnitude affecting the adjacent area

b) Heavy / Profuse leakage of toxic / flammable gases for a long duration.

7.9.2 OBJECTIVES OF EMERGENCY MANAGEMENT SYSTEM

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

- To identify and assess types of emergencies due to different types of hazards.
- To work out plan with all provisions to handle emergencies and safeguard employees and people in the vicinity of the factory.
- To provide for emergency preparedness and the periodical rehearsal of the plan.
- To plan mode of proper communication and actions to be followed in the event of emergency.
- To keep all necessary information with respect to hazard/accident control and emergency contacts in one document for easy and speedy reference.
- To inform employees, general public and the authorities about the hazards/risk if any and the role to be played by them in the event of emergency.
- To control and contain the accident.
- To effect rescue and treatment of casualties.
- To inform and help relatives of casualties.
- To secure rehabilitation of affected area and restore normalcy.
- To provide information to media and government agencies.
- To preserve record, equipment etc. for investigating cause of emergency.
- To be ready for “mutual aid” if need arises to help neighboring units.

7.9.3 STRUCTURE OF EMERGENCY MANAGEMENT SYSTEM

Company has developed an emergency management team. The management structure includes the following personnel’s;

- Chief Emergency Controller
- Incident Controllers
- Site Main Controllers
- Key Personnel’s
- Essential Workers
- Assembly points
- Emergency control center
- Fire control arrangements
- Medical arrangements
- Other arrangements

7.10 OCCUPTIONAL HEALTH AND HAZARD AND SAFETY MESUARES

General Safety Precautions:

Occupational Health is eventually a branch of preventive medicine which examines the relationship between work and health and effects of work on the health of the worker. Occupational health service is operated to achieve the statutory declared aim of occupational health by medical and technical measures. Its role is mainly preventive and to give first aid and emergency treatment. It is certainly useful in early detection of any occupational or non-occupational disease or any man-adjustment of the man-job relationship.

7.10.1 OCCUPATIONAL HEALTH

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

7.10.1.1 CONSTRUCTION AND ERECTION

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 Threshold Limit Values (TLV's), necessary protective equipments shall be supplied to workers.

7.10.1.2 OPERATION AND MAINTENANCE

The problem of occupational health in operation and maintenance phase is primarily due to noise which could affect consultation. The necessary personal protective equipments will be given to all the workers. The working personnel shall be given the following appropriate **personnel protective equipments**.

- Industrial Safety Helmet
- Face shield
- 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
- Boiler suit
- 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

7.10.1.3 HOSPITAL FACILITIES

It is proposed that client will make formal agreements with nearby hospital having facilities to attend fire and toxic effect cases for attending the affected persons in the emergency arising out of accidents, if any.

7.10.1.4 FACTORY MEDICAL OFFICER (FMO)

A qualified doctor will be appointed as FMO on retainer ship basis. Apart from FMO, paramedical staff will be employed.

7.10.1.5 PROPOSED FACILITY TO BE MADE AVAILABLE AT OHC

One Room is proposed to be provided to be operated as OHC. The center will be equipped with following medical equipments: —

1.	Examination Table	
2	Dressing Tables	For performing Dressing
3.	Glucometer	For measurement of Blood Sugar
4	Vision chart	To evaluate vision acuity
5.	Nebuliser	For relieving coughs & Breathing Difficulty
6.	Infra-red light	for relieving muscular pain
7.	Suction machine	For cleaning airway
8.	Autoclave machine	For sterilizing cotton &dressing material
9.	Weighing Machine	For measuring body weight
10.	Medical Oxygen Cylinder kit	
11.	Sphygmomanometer	To measure blood pressure
12.	Refrigerator	To preserve medicines
13.	Thermometer	

7.10.1.6 AMBULANCE VAN

An ambulance van proposes to be made available 24 hours at Fire Station.

7.10.1.7 FIRST AID BOX

First Aid Boxes propose to be made available at the different location in the plant, Training to be given to employees for First Aid.

7.10.1.8 PERIODIC MEDICAL EXAMINATION

It is proposed that client will ensure that…

(1) Workers employed shall be medically examined by a qualified medical practitioner/ Factory Medical Officer, in the following manner;

a) Once in a period of 6 months, to ascertain physical fitness of the person to do the particular job;

b) Once in a period of 6 months, to ascertain the health status of all the workers in respect of occupational health hazards to which they are exposed and in cases where in the opinion of the Factory Medical Officer it is necessary to do so at a shorter interval in respect of any workers;

C) In periodic and pre-medical examinations, various parameters will be checked. Viz., LIVER FUNCRION TESTS, Chest X-rays, Audiometry, Spirometry, Vision testing (Far & Near vision, color vision and any other ocular defect) ECG and other parameters as will be found necessary as per the opinion of Factory Medical officer.

(2) No person shall be employed for the first time without a certificate of granted by the Factory Medical Officer.

7.10.1.9 EMP FOR THE OCCUPATIONAL SAFETY & HEALTH HAZARDS SO THAT SUCH EXPOSURE CAN BE KEPT WITHIN PERMISSIBLE EXPOSURE LEVEL (PEL)/THRESHOLD LEVEL VALUE (TLV) SO AS TO PROTECT HEALTH OF WORKERS

1. **Mitigation Measures for OSH: It is proposed to formulate and implement a structure for Occupational Safety and Health with following aims…**

    - To keep air-borne concentration of toxic and hazardous chemicals below PEL and TLV.
    - Protect general health of workers likely to be exposed to such chemicals.
    - Providing training, guidelines, resources and facilities to concerned department for occupational health hazards.
    - Permanent changes to workplace procedures or work location to be done if it is found necessary on the basis of findings from workplace Monitoring Plan.

2. It is proposed that this EMP be formulated on the guidelines issued by Bureau of Indian Standards on OH&S Management Systems: IS 18001:2000 Occupational Health and Safety Management Systems.
    a. Propose EMP will also include measure to keep air-born concentration of toxic and hazardous chemicals below its PEL and TLV, like…
    b. Leak Surveys

c. Separate storage for toxic chemicals
d. Exhaust Ventilation
e. Proper illumination
f. On-line detectors toxic chemicals
g. Close processes to avoid spills and exposures
h. Atomization of process operations to hazards of manual handling of chemicals.
i. Supply of proper PPEs like Air mask, Berating canisters, SCBA sets, On-line breathing apparatus at the places where there is possibility of presence of toxic chemicals.
j. Decontamination procedure for empty drums and carboys.
k. Regular maintenance program for pumps, equipment, instruments handling toxic and corrosive chemicals.
l. Display of warning boards.
m. Training to persons handling toxic and corrosive chemicals.

3. ARRANGEMENTS FOR ENSURING HEALTH & SAFETY OF WORKERS ENGAGED IN HANDLING OF TOXIC MATERIALS

- The top management is committed towards safety & employees' well-being is the numerous no and safety always takes precedence over production.
- Each and every process will be assessed with safety tools like HAZOP, JSA, PSSR, JRA etc.
- Emergency Response Team will be formed and mock drills will be conducted regularly.
- Appropriate engineering controls will be provided to prevent any mishap.
- Scheduled preventive maintenance will be carried out in the plant including that of safety equipment.
- Standard Operating Procedures will be provided to workers to ensure that all the work is done in a safe manner.

4. It is proposed that a Workplace Monitoring Plan to be prepared & implemented in consultation with FMO and industrial hygienists.

5. Each workplace must be evaluated to identify potential hazards from toxic substances or harmful physical agents. Air-borne concentration of toxic chemicals will be measured and record will be kept.

6. The current state-of-the-art exposure measurement model is as follows: For purposes of measuring worker exposure across a single shift it is sufficient to place a reasonably accurate exposure measuring device on the worker, within the worker 's breathing zone, and have it operate for nearly the full shift.

7. Health Evaluation of Workers

1. It is proposed that management will devise a plan to check and evaluate the exposure specific health status evaluation of workers
2. Workers will be checked for physical fitness with special reference to the possible health hazards likely to be present where he/she is being expected to work before being employed for that purpose. Basic examinations like Liver Function tests, chest x ray, Audiometry, Spirometry Vision testing (Far & Near vision, color vision and any other ocular defect) ECG, etc. will be carried out. However, the parameters and frequency of such examination will be decided in consultation with Factory Medical Officer and Industrial Hygienists.

7.10.1.10 MEDICAL SURVEILLANCE PROGRAM

Pre-employment Medical Check Up

1. Chest X-ray
2. Cardiogram
3. Audiometry
4. Hematological Examination: - CBC, SGOT, SGPT, Cholesterol, Blood Sugar etc.
5. Urine Examination
6. Vision test
7. Colour blindness test
8. Lung function test- Spirometry

Periodical Medical Check up

1. Lung Function test
2. Cardiogram
3. Audiometry
4. Hematological Examination
5. Urine examination
6. Vision test
7. Colour blindness test
8. Biomarker in Blood & Urine

7.11 SOLVENT MANAGEMENT PLAN

SOLVENT MANAGEMENT PLAN

- All the solvents will be directly distilled from product mixes and; if required shall be purified in packed column with the help of reflux and therefore there is no generation of any distillation residue from the solvent distillation.
- The solvent distillation system will be designed so as to achieve minimum 90 % recovery of solvent.
- Pure solvent, crude solvent and distilled (recovered) solvent will be stored only in storage tanks and company will not use drums at any stage in the Solvent Management System.
- Wherever required, the solvents will be directly pumped into day tanks from the storage tanks and shall be charged into the reactors without involving any manual handling.
- All the pumps will be mechanical seal type to avoid any leakage of solvent.
- All necessary firefighting systems will be provided with alarm system. Flame proof wiring and flame proof electrical accessories shall be provided to avoid any mishap.
- All the storage tank and day tank will be connected to a vent system through cooling water and chilled brine condensers to prevent loss of solvents in the atmosphere.
- All the distillation column vents are also connected to cooling water/ chilled brine condensers for maximum possible recovery of the solvents.
- All the vents will be connected to a common carbon Adsorber for removing traces of solvent from vent gases.
- Residue generated from the distillation will be incinerated in-house or sent to BEIL incinerator site.
- Coolant to be used

Primary Condensers	Cooling Water
Secondary Condensers	Chilled Brine up to -15^{0}C
Vent Condensers	Chilled Brine up to -35^{0}C

Figure 7.6: FLOW DIAGRAM OF SPENT SOLVENT MANAGEMENT SYSTEM

FLOW DIAGRAM OF SPENT SOLVENT MANAGEMENT SYSTEM

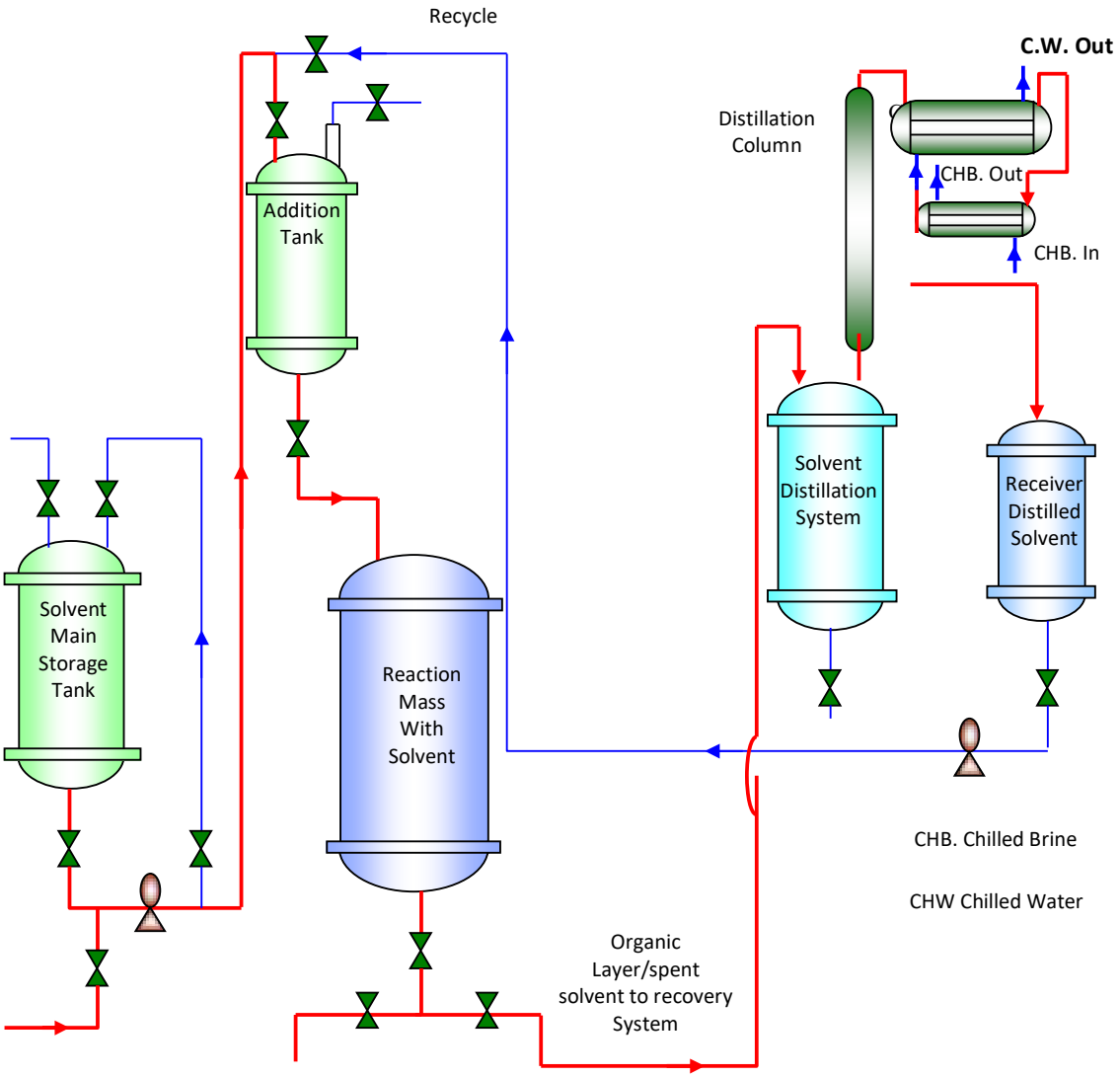


TABLE: 7.5

SOLVENT BALANCE

Solvent	B.P °C	V.P.	Input (MT/Month)	Recovery (MT/Month)	% Recovery
Methanol	64.5	96 mm of Hg (@ 20°C)	140.2	136.5	97.4
Toluene	110.6	30.89 hPa (@21.1 °C)	1096	1077	98.3
Ethylene Dichloride	83	87 hPa (@ 20°C)	400	390	97.5
Xylene	144	882 Pa (@ 25 °C)	160	152	95.0
Hexane	68	17.3 kPa (@ 20°C)	99.11	96.53	97.4
Acetonitrile	81.6	9.7kPa (@ 20°C)	372.6	354.6	95.2
IPA	82.5	4.4 kPa (@ 20°C)	255	207	95.3
MDC	39.75	46.5 kPa (@ 20°C)	179	169	96.6
DMF	NA	NA	328	320	97.6
Heptane	98	48 mbar @ 20 °C	45.5	43.8	96.3

7.12 SUBMIT CHECKLIST IN THE FORM OF DO'S & DON'TS OF PREVENTIVE MAINTENANCE, STRENGTHENING OF HSE, MANUFACTURING UTILITY STAFF FOR SAFETY RELATED MEASURES.

Do's:

- To store used oil at proper place as per plant guidelines.
- To use lubricating oil carefully to avoid spillage on ground.
- To use lubricating oil as per requirement.
- To use minimum amount of water wherever it is required as per plant guidelines.
- Waste disposal system for all plants should be separate.
- Avoid spillage of liquid, hand gloves, cotton waste on road, which will cause pollution. Recycle or dispose that material.
- To use cleaning equipment carefully. (i.e. cotton waste, oil & chemicals)
- To place all the equipments (i.e. Fire Hose, Rubber Pipe and Chisel) at proper place.
- Handling of chemicals should be as per plant guidelines to avoid undesired chemical reaction.
- Safety training and correct use of PPE's must for all the employees.
- Environment guidelines should follow during cleaning of vessels, Tank, channels etc.
- To follow shift in charge's instructions during loading or unloading of chemicals.
- In case of fire or any accident, immediately inform to responsible person.
- In case of emergency, to inform operator as well as control room.
- Area of work during excavation, radiography, sand blasting shall be cordoned with warning tags of "work in progress", "no entry", "radiography" in progress' etc.
- Switch off lights and computers when not in use.
- To shut the water cock properly when not in use.
- To always follow safety rule during the plant operation.

Do's during shut down:

- All equipment, vessels, lines where hot work is envisaged shall be purged, flushed thoroughly and positively isolated. Similar precautions should be taken for vessel entry also.
- Back flow of materials from sewers, drains should be avoided by proper isolations.
- In case of confined space entry and other cleaning jobs etc. which are to be carried out by the process department, vessel entry permit should be issued to immediate supervising officer/operator by shift in charge. This permit should be renewed by incoming shift in charge during every shift.
- Hoist, Platform, cages used for lifting persons or to send persons inside vessels by such means must be of sound construction with wire ropes slings, etc. to avoid failure.

- All steam, condensate, hot water connections should be made tight with clamps.
- Nitrogen hazard should be kept in mind. All nitrogen sources should be positively isolated from vessels/confined spaces to avoid oxygen deficiency where vessel entry is required.
- All nitrogen hoses used for purging before vessel entry should be removed from source/utility point.
- All underground sewers shall be flushed, protected from sparks.
- Full PPEs like PVC suits, gum boots, face shield & other required shall be used while draining, flushing and other reclaiming activities to avoid burn, poisoning etc.
- Wet asbestos cloth/metallic plate should be used to collect flying sparks.
- Water, steam flushing, nitrogen blanketing shall be continued where spontaneous combustion takes place. Precautions should be taken for pyrophoric nature of material.
- Temporary electrical connections, cords, boards and other electrical fixtures should be of sound material to prevent electrical shock.
- Oil spillage in the pit of oil slope tank should be cleaned with water/sand.
- Proper approach like aluminum ladder should be provided to reach to the platforms of scaffolding and ladder must be tied.
- All clumps of scaffolding should be tightened properly and planks should be tied at both ends and supported at proper distances along span to avoid sagging and failure.
- Always use safety belt while working at height of more than 2 meters and ensure tieing the life line of safety belt with firm support.
- Ensure area cordoning for hot work, X-ray, excavation, hazard material temporary storage.
- Ensure proper tagging of valves, switches etc. to prevent its use.
- Ensure proper guidance to workman and make him aware about local area hazards before start of the job.
- All welding machines should be provided with power isolation switch of suitable rating.
- Portable electrical appliances/tools earthing should be in good working condition. Insulation portion should be free from damages.
- All electrical cables should be joints free and connection taken by using three pin plugs.
- While inserting fuse all care should be taken so that no one touches conductor to avoid the shock to the persons.
- During hydro jetting work workers should wear hand gloves, safety helmet goggles and PVC suit.

Don'ts:

- Do not use fire hydrant water for washing/bath purpose.
- Do not use water for cleaning purpose, use broomstick if possible.
- Do not wash or clean trolley, tractor or trucks which are used for chemical/fertilizer's transportation. Wash them at proper place.
- Smoking & carrying matchbox, cigarettes, lighter, bidis etc. are prohibited.
- Photography & carrying cameras/Mobile phones are strictly prohibited in all areas.
- Do not spill liquid or chemicals in open atmosphere.
- The use of Radio Active Source within the plant shall not be allowed without obtaining valid permission/work permit and intimation in the form of a circular to all plant persons shall be given in advance.
- Unauthorized entry into any battery limit of plant is strictly prohibited.
- Sitting or walking on rail tracks, crossing between wagons, taking rest under stabled wagons, crossing the rail through the openings underneath the stationary wagons are strictly prohibited.

Don'ts during shut down:

- Do not use gasket or other blinds as it can fail during job. All blinds should be metallic.
- No toxic/corrosive/irritating materials should remain plants or sections where hot work is to be carried out.
- No hot work should be permitted in battery limits near sewers till areas have been cleaned flushed properly.
- No hot work irrespective of place of area shall be done without valid permit.
- No combustible material shall be there in flare line for taking up of flare line job. Isolations shall be ensured.

7.13 DETAILS ON VARIOUS SOP TO BE PREPARED.

Description	Distribution
Procedure on Approvals	All Departments
Health Care Program	All Departments
Employee participation	All Departments
Contractor Management	All Departments
Risk Assessment	All Departments
Management of Change	All Departments
Inspection of Fire & Safety Equipments and Facilities	All Departments
Work Permit	All Departments
Control of Spillage	All Departments
Vehicle Gate Check Entry / Exit Procedure (Raw Material and Finished Goods)	All Departments
Waste Handling and Storage	All Departments
Waste Gas Handling	All Departments
Waste Water Treatment & Disposal	All Departments

7.14 TRANSPORTATION

- Road tanker unloading procedure will be in place and will be implemented for safe unloading of road tanker.
- Static earthing provision will be made for tanker unloading.
- Earthed Flexible Steel hose will be used for solvent unloading from the road tanker.
- Fixed pipelines with pumps will be provided for solvent transfer up to Day tanks/reactors.
- Double mechanical seal type pumps will be installed.
- NRV provision will be made on all pump discharge line.