CHAPTER 7. RISK ASSESSMENT

7.1. Introduction

This chapter deals with the study of prevention and mitigation of incidents/ accidents which can lead to personal injuries, damage or loss of property, material plant, equipment and the environment.

The study is mainly concerned with conducting a risk assessment to identify the hazards and risks associated with the various activities and to identify and evaluate the control measures to eliminate/ prevent accidents and loses, and/ or mitigate the risk to minimum acceptable level.

The other aspect considered for the study includes the disaster management plan. Even after providing all necessary control measures, things may go wrong. The study includes the conditions, activities, material, manmade or natural, will be considered, which can lead to an emergency situation. A well defined, disaster management plan will provide awareness and prompt action by employees to control emergency situation promptly and effectively and will minimize the losses.

7.1.1. Risk Assessment

Objective of the study

Quantitative Risk Assessment (QRA) study for M/s. Maruti Polymers has been carried out based on data provided by M/s. Maruti Polymers.

The main objective of risk assessment- Quantitative Risk Assessment (QRA) is to identify and determine the potential damage or loss of life, property and environment and to provide a scientific argument for decision makers to provide and maintain the safety levels of the facilities to prevent or mitigate harm and losses. This is achieved by the following:

- Identification of hazards that could be realized from manufacturing processes, plant equipment and machinery, raw materials and products.
- Identify the potential failure scenarios that could occur within the facility.
- The Assess, the potential risks associated with identified hazards to which the planat and its personal and community outside may be subjected. Consequences analysis of various hazards is carried out to determine the vulnerable zones for each probable accident scenario.

- Evaluate the process hazards emanating from the identified potential accident scenarios.
- Analyse the damage effects to the surroundings due to such accidents.
- Conclusion and recommendation to mitigate measures to reduce the hazard/ risks.
- To provide guidelines for the preparation of On-site response plan.

7.2. Scope of the study

The project will undertake Quantitative Risk Assessment (QRAA) study for the storage tank area.

Table 7.1 Following listed material below are stored, used and handled in the premises

Name of Raw Material	Storage Facility / Packing	Storage / Packing Capacity (MT)	Storage condition
Styrene Monomer	Storage tank	26	NTP
Butyl acrylate Monomer	Drums	10	NTP
Methyl Metha Acrylate	Drums	10	NTP
Vinyl Acrylate Monomer	Drums	1	NTP
Mix Xylene	Storage tank	26	NTP
MTO	Storage tank	26	NTP

QRA study will include the following task:

- Hazard Identification
- Failure scenario
- Consequence Analysis
- Risk Assessment
- Evaluation of risk reduction options and risk management plan

7.2.2. Methodology Adopted For Quantitative Risk Assessment (QRA)

Failure or ineffectiveness of the controls can lead to hazardous situation in any industry handling potentially hazardous materials. Following factors govern the severity of consequences of the loss of containment energy:

- Intrinsic properties: Flammability, instability and toxicity.
- Dispersive energy: pressure, temperature and state of matter
- Quantity present
- Environmental factors; topography and weather
- Handling and storage facilities and procedures
- Awareness, training and Communication

The study has been carried out in accordance with the National and International codes of practices using Process Hazard Analysis Software Tool (PHAST) software. The latest version of the renowned PHAST software package of DNV is used for carrying out the risk analysis.

The full terms of potential hazardous scenarios and consequence events associated with the installation and operation was considered in the analysis.
Based on the operations to be carried at the plant, the Risk Analysis conducted to identify the affected distances and the damage of property and population from the identified scenarios considering the Maximum Credible Loss Scenario (MCLS) & worst case scenario.

Maximum credible loss scenarios have been worked based on the inbuilt safety systems and protection measures to be provided for the operation of the facility & the worst case scenario i.e. 100% catastrophic rupture have been worked out based on failure of the inbuilt safety system.

The worst case scenario assumed as catastrophic rupture, as per the guidelines suggested by DNV-UK and maximum inventory at the time of failure.

Consequence analysis and calculation are effectively performed by computer software using models validated over a number of applications. Consequence modelling is carried out by PHAST (version 6.53) of DNV Software, UK.

PHAST uses the Unified Dispersion Model (UDM) capable of describing a wide range of types of accidental releases. The Model uses a particularly flexible form, allowing for sharp edged profiles, which become more diffuse downwind.

PHAST contains data for a large number of chemicals and allows definition of mixtures of any of these chemicals in the required proportion. The calculations by PHAST involve following steps for each modelled failure case:

- Run discharge calculations based on physical conditions and leak size.
- Model first stage of release (for each weather category)
- Determine vapour release rate by flashing of liquid and pool evaporation rate.
- Dispersion modelling taking into account weather conditions
- In case of flammable release, calculate size of effect zone for fire and explosion.
- The hazardous materials considered in this study are mostly flammable liquids

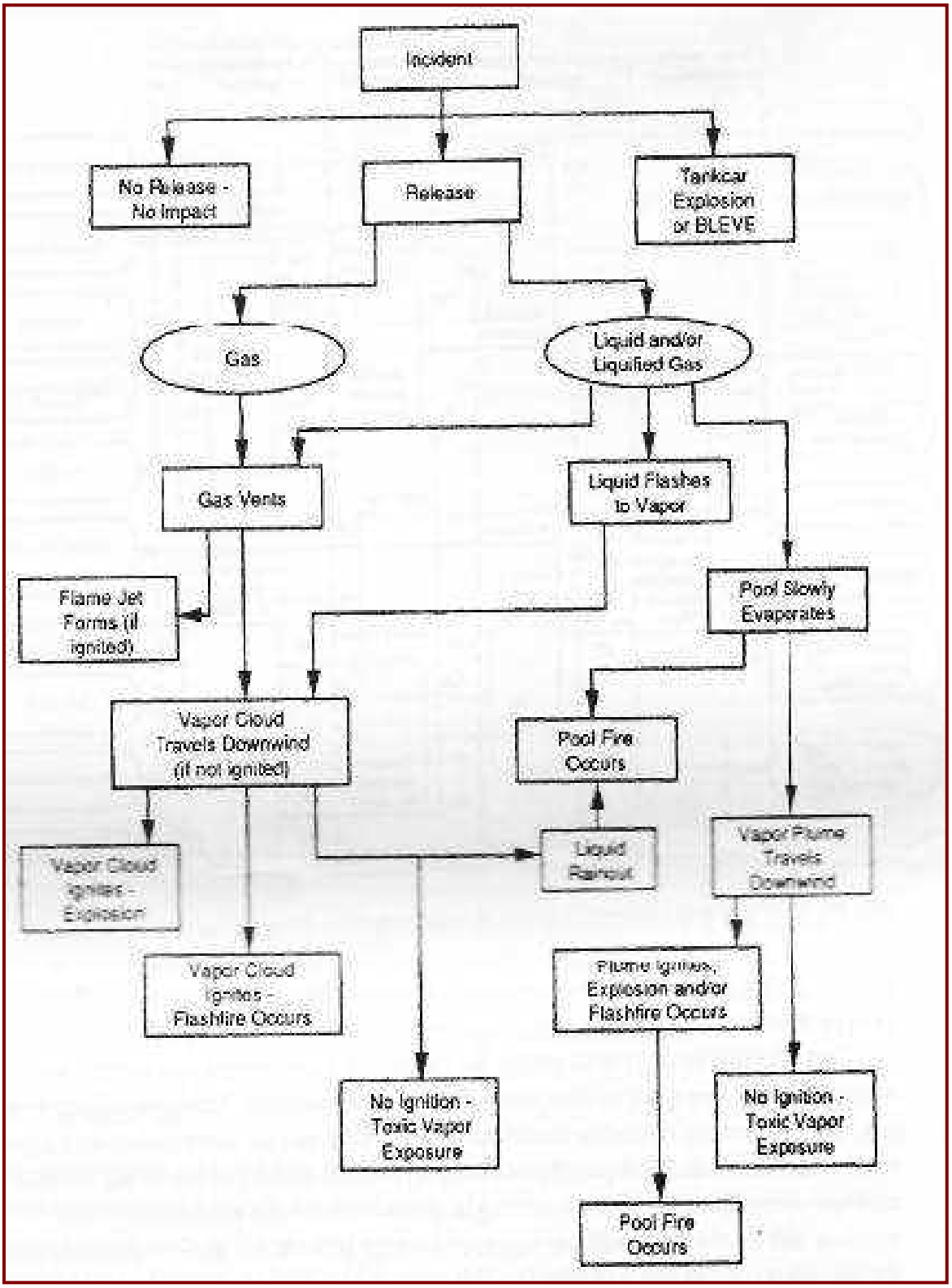


Figure 7.1 Consequence analysis; Event tree analysis for release of flammable liquid

Software used

PHAST has been used for consequence analysis include discharge and dispersion calculations.

7.2.3. Other factors Considered for Risk Assessment

Meteorological Condition

The consequences of released toxic or flammable material are largely dependent on the prevailing weather conditions. For the assessment of major scenarios involving release of toxic or flammable materials, the most important meteorological parameters which affect the atmospheric dispersion of the escaping material include crucial variables such as wind direction, wind speed, atmospheric stability and temperature. Rainfall does not have any direct bearing on the results of the risk analysis; however, it can have beneficial effects by absorption/washout of released materials. Actual behaviour of any release would largely depend on prevailing weather condition at the time of release.

For the present study we used the meteorological data of the Anand

Atmospheric parameters

The wind speed and wind direction data which have been used for the study is summarized below:

Wind speed : 1.5 & 5 m/s

Atmospheric Stability: D and F

Weather category

One of the most important characteristics of atmosphere is its stability. Stability of atmosphere is its tendency to resist vertical motion or to suppress existing turbulence. This tendency directly influences the ability of atmosphere to disperse pollutants emitted into it from the facilities. In most dispersion scenarios, the relevant atmospheric layer is that nearest to the ground, varying in thickness from a few meters to a few thousand meters. Turbulence induced by buoyancy forces in the atmosphere is closely related to the vertical temperature gradient.

Temperature normally decreases with increasing height in the atmosphere. The rate at which the temperature of air decreases with height is called Environmental Lapse Rate ((ELR). It will vary from time to time and from place to place. The atmosphere is said to be stable, neutral or

unstable according to ELR is less than, equal to or greater than Dry Adiabatic Lapse Rate (DALR), which is a constant value of 0.98 ˚C/100 meters.

Pasquill stability parameter, based on Pasquill- Gifford categorization, a meteorological parameter, describes the stability of atmosphere, i.e., the degree of convective turbulence.

Pasquill has defined six stability classes ranging from 'A' (extremely unstable) to 'F' (moderately stable). Wind speeds, intensity of solar radiation (daytime unstable) and night time sky cover have been identified as prime factors defining these stability categories.

When the atamosphere is unstable and wind speeds are moderate or high or gusty, rapid dispersion of pollutants will occur. Under these conditions, pollutant concentrations in air will be moderate or low and the material will be dispersed rapidly.

When the atmosphere is stable and wind speed is low, dispersion of material will be limited and pollutant concentration in air will be high. In general, worst dispersion conditions (i.e. contributing to greater hazard distance) occur during low wind speed and very stable weather conditions.

7.3. Hazards & Damage Criteria of materials

Definitions

Hazards associated with Flammable Chemicals

The release of flammable gas or liquid can lead to different types of fire or explosion scenarios and will depend on the material released, mechanism of release, temperature and pressure of the material and the point of ignition. Types of flammable effects are as follows:

Pool Fire

The released flammable material, a liquid stored below its normal boiling point, will collect in a pooll. The geometry of the pool will be dictated by the surroundings. If the liquid is stored under pressure above its normal boiling point , then a fraction of the liquid will flash into vapour and the remaining portion will form a pool in the vicinity of the release point. Once sustained combustion is achieved , liquid fires quickly reach steady state burning. The hear release rate is a function of the liquid surface area exposed to air. An confined spill will tend to have thin fuel depth (typically less than 5 mm) which will result in slower burning rates. A confined spill is limited by the boundaries (e.g. a dyked area) and the depth of the resulting pool is greater than that for an unconfined spill.

Flash Fire:

It occurs when a vapour cloud of flammable material burns. The cloud is typically ignited on the edge and burns towards the release point. The duration of flash fire is very short (seconds), but it may continue as jet fire if the release continues. The overpressures generated by the combustion are not considered significant in terms of damage potential to persons, equipment or structures. The major hazard from flash fire is direct flame impingement. Typically, the burn zone is defined as the area the vapour cloud covers out to half of the LFL. This definition provides a conservative estimate, allowing for fluctuations in modelling. Even where the concentration may be above the UFL, turbulent induced combustion mixes the material with air and results in flash fire.

Jet Fire:

Jet flames are characterized as high-pressure release of gas from llimited openings (e.g. due to small leak in a vessel or broken drain valve). Boiling liquid expanding vapour explosion (BLEVE) or fireball: A fireball is an intense spherical fire resulting from a sudden release of pressurized liquid or gas that is immediately ignited. The best known cause of a fireball is a boiling liquid expanding vapour explosion (BLEVE). Fireball duration is typically 5-20 seconds.

Vapour Cloud Explosion:

When a large quantity of flammable vapour or gas is released, mixes with air to produce sufficient mass in the flammable range and is ignited, results a vapour cloud explosion ((VCE). Without sufficient air mixing, a diffusion- controlled fireball may result without significant overpressures developing. The speed of flame propagation must accelerate as the vapour cloud burns. Without this acceleration, only a flash fire will result.

7.4. Hazards Associated with explosives chemicals

Damage Criteria

Damage due to thermal radiations and overpressure have been arrived at by taking in to consideration the published literature on the subject. The consequences are then visualized by superimposing the damage effects zones on the proposed plan site and identifying the elements within the project site as well as in the neighbouring environment, which might be a adversely affected, should one or more hazards materialize.

Thermal damage

The effect of thermal radiation on people is mainly a function of intensity of radiation and exposure time. The effect is expressed in terms of the probability of death and different degrees of burn. The following tables give the effect of various levels of heat flux.

Fatal Radiation Exposure Levels

Table 7.2 Fatal Radiation Exposure Levels

RADIATION LEVEL kW/m^2	FATALITY		
	1%	50%	99%
	EXPOSURE IN SECONDS		
4.0	150	370	930
12.5	30	80	200
37.5	8	20	50

Table 7.3 Overpressure Damage

OVER PRESSURE (mbar)	MECHANICAL DAMAGE TO EQUIPMENTS	DAMAGE TO PEOPLE
300	Heavy damage to plant & structure	1% death from lung damage >50% eardrum damage >50% serious wounds from flying objects
100	Repairable damage	>1% eardrum damage >1% serious wounds from flying objects
30	Major glass damage	Slight injury from flying glass
10	10% glass damage	***

Hazards Associated with Toxic Materials

- It is necessary to specify suitable concentration of the toxic substance under study to form the end point for consequence calculations. American Industrial Hygiene association (AIHA) has issued Emergency Response Panning Guidelines (EPRG) for many chemicals, describes the various scenarios:
- EPRG-1 is the maximum air borne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odour.
- EPRG-2 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms, which could impair an individual's ability to take protective action.
- EPRG-3is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.
- Toxic limit values as TLV (Threshold Limit Value). STEL (Short Term Exposure Limit), Immediately Dangerous to Life or Health (IDLH) concentrations are issued by US National Institute for Occupational Safety and Health (NIOSH).
- TLV: Threshold Limit Value- is the permitted level of exposure for a given period on a weighted average basis (usually 8 hours for 5 days in a week)
- STEL: A Short Term Exposure Limit (STEL) is defined by ACGIH as the concentration to which workers can be exposed continuously for a short period of time without suffering from: Irritation
- Chronic or irreversible tissue damage
- Narcosis of sufficient degree to increase the likelihood of accidental injury, impair self-rescue or materially reduce work efficiency.
- The permitted Short Term Exposure Limit usually have maximum exposure for 15 minute.
- IDLH: IDLH is an acronym for Immediately Dangerous to Life or Health. This refers to a concentration, formally specified by a regulatory value, and defined as the maximum exposure concentration of a given chemical in the workplace from which one could escape within 30 minutes without any escape- impairing symptoms or any irreversible health effects. This value is normally referred to in respirator selection.

Table 7.4 Properties of Chemicals

SN	Name of Chemical	Storage Facility / Packing	Storage of Chemical (MT/M)	Flash Point ^{0}C	Flammability Limit (Vol. %)	Storage condition
	Styrene Monomer	Storage Tank	26	31.1	LEL-6.2 UEL-15.6	NTP
	Butyl acrylate Monomer	Drums	10	37	LEL-1.3-1.7 UEL-9.4-9.9	NTP
	Methyl Metha Acrylate	Drums	10	13	LEL-2.1 UEL-12.5	NTP
	Vinyl Acrylate Monomer	Drums	1	2.2	LEL-2.6 UEL-13.4	NTP
	Mix Xylene	Storage tank	26	24	LEL-1 UEL-7	NTP
	MTO	Storage Tank	26	35	N/A	NTP

7.5. Consequence Analysis

7.5.1. Introduction

The consequence analysis is carried out to determine the extent of spread (dispersion) by accidental release which may lead to jet fire, pool fire, tank fire resulting into generating heat radiation, over pressures, explosions etc.

In order to form an opinion on potentially serious hazardous situations and their consequences, consequence analysis of potential failure scenarios is conducted. It is qualitative analysis of hazards due to various failure scenarios. In consequence analysis, each failure case is considered in isolation and damage effects predicted, without taking into the account of the secondary events or failures it may cause, leading to a major disastrous situation. The results of consequence analysis are useful in developing disaster management plan and in developing a sense of awareness among operating and maintenance personnel. It also gives the operating personnel and population living in its vicinity, an understanding of the hazard they are posed to.

7.5.2. Selected Failure Cases

Earlier, it was the practice to select a particular item in a unit as failure scenario, e.g. rupture of reactor outlet pipe. Such selection is normally subjective on following parameters:

- Properties of material namely Toxic or Flammable
- The likely severity of consequence in the event of accidental release based on inventory, operated pressure & operated temperature.
- The probability of failure of various equipments such as valves, flanges, pipe, pressure vessels etc. Used in the plant.

Size of Release: For accidental releases identified or consequence analysis is 50 mm leakage. The scenarios are considered to be confined to those equipment failures which involve the leakage of flammable or toxic products, of which the frequency of occurrence and the severity of the consequences have been taken into consideration and which may have a low probability of early detection.

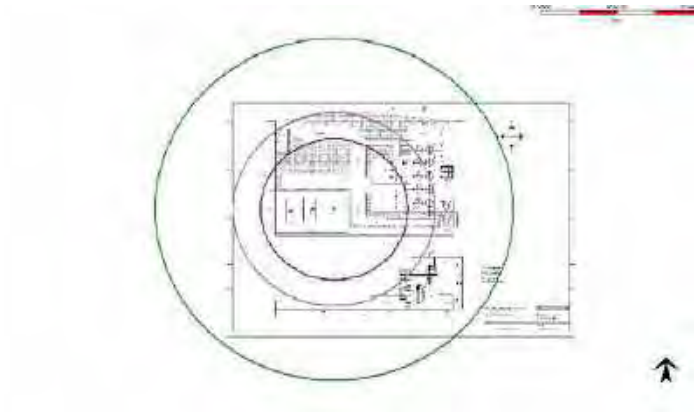
Taking this factor into consideration, a list of selected failure cases was prepared based on process knowledge, inventory, engineering judgement and experience past incidents associated with such facilities and considering the general mechanisms for loss of containment. Cases have been identified for the consequence analysis.

7.5.3. Effect of release

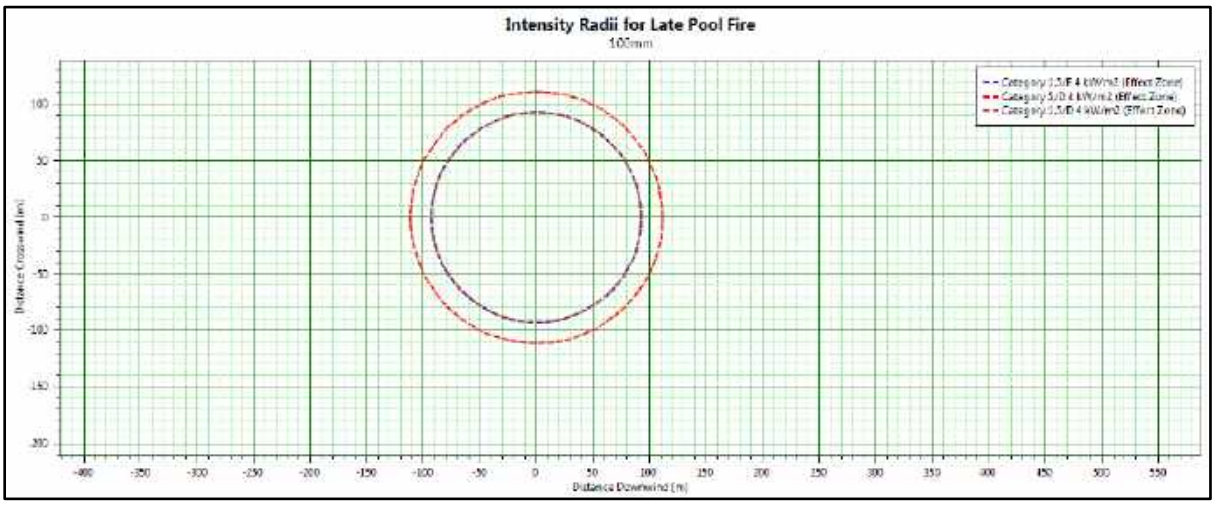
When hazardous material is released to atmosphere due to any reason, a vapour cloud is formed. Direct cloud formation occurs when a gaseous or flashing liquid escapes to the atmosphere.

- Dispersion of hydrocarbon on vapour with wind till it reaches its lower flammability limit (LFL) or finds a source of ignition before reaching LFL, which will result in a flash fire or explosion.
- Spillage of liquid hydrocarbons will result in a pool of liquid, which will evaporate taking heat from the surface, forming a flammable atmosphere above it. Ignition of this pool will result in pool fire causing thermal radiation hazards.
- A fireball or BLEVE (Boiling Liquid Expanding Vapour Explosion) occurs when a vessel containing a highly volatile liquid (e.g. LPG, Propylene etc.) fails and the released large mass of vapour cloud gets ignited immediately. It has damage potential due to high intensity of radiation and generation of the overpressure waves, causing large scale damage to nearby equipment and structures.

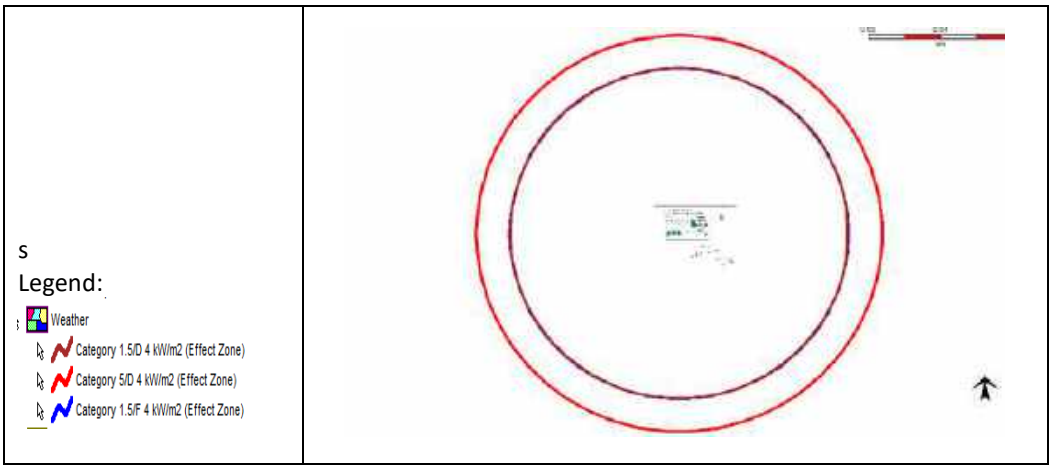
Flash fire envelope in case of 100 mm leak of Styrene Monomer

Legend: Weather Category 1.5/D (5500 ppm) Category 5/D (5500 ppm) Category 1.5/F (5500 ppm)	

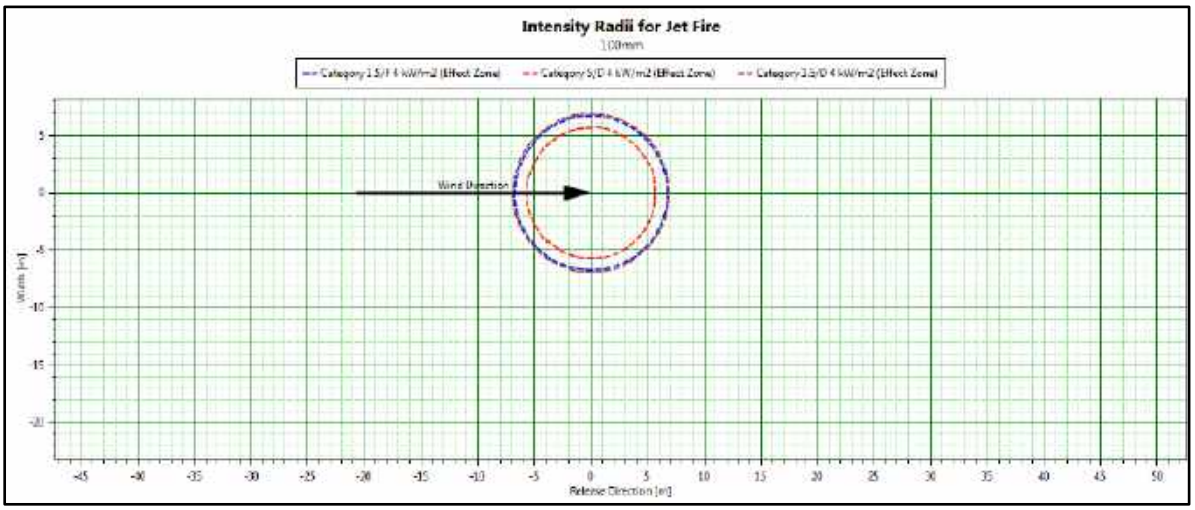
Late pool Fire intensity radii in case of 100 mm leak of Styrene Monomer



Late pool Fire envelope in case of 100 mm leak of Styrene Monomer



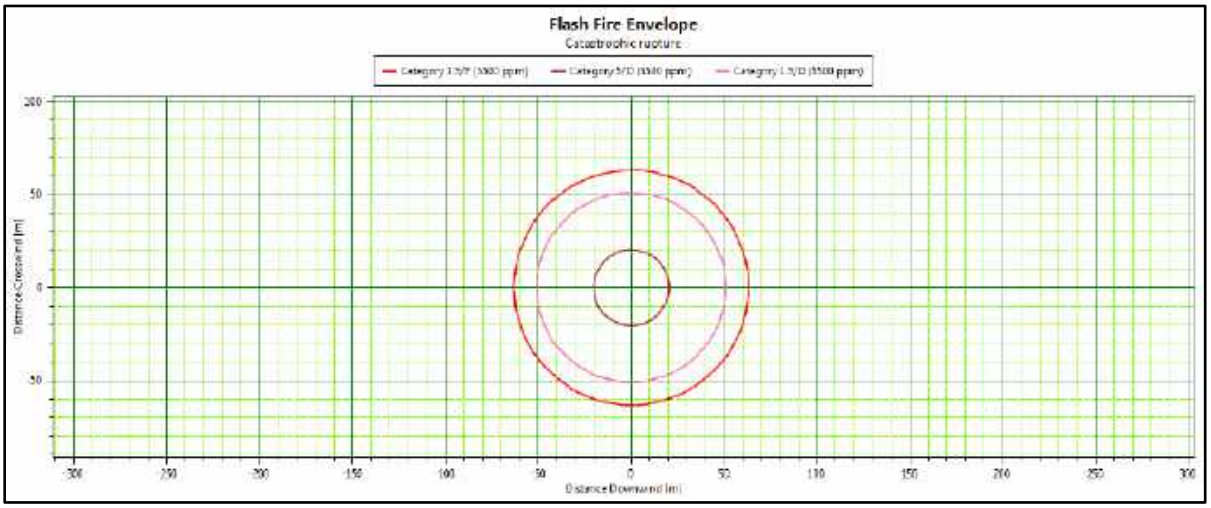
Jet Fire Intensity radii in case of 100 mm leak Styrene Monomer



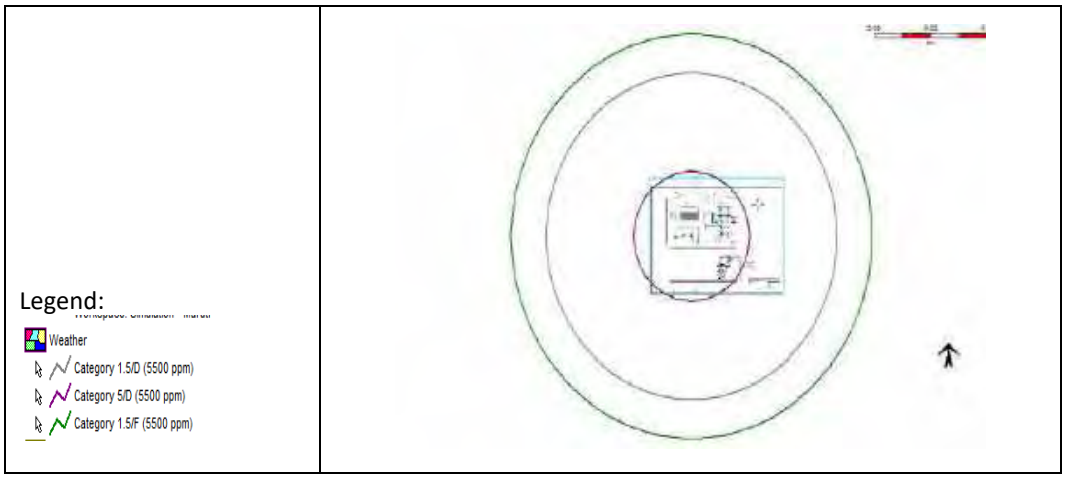
Jet Fire envelope in case of 100 mm leak Styrene Monomer

Legend: Weather Category 1.5/D 4 kW/m2 (Effect Zone) Category 5/D 4 kW/m2 (Effect Zone) Category 1.5/F 4 kW/m2 (Effect Zone)	

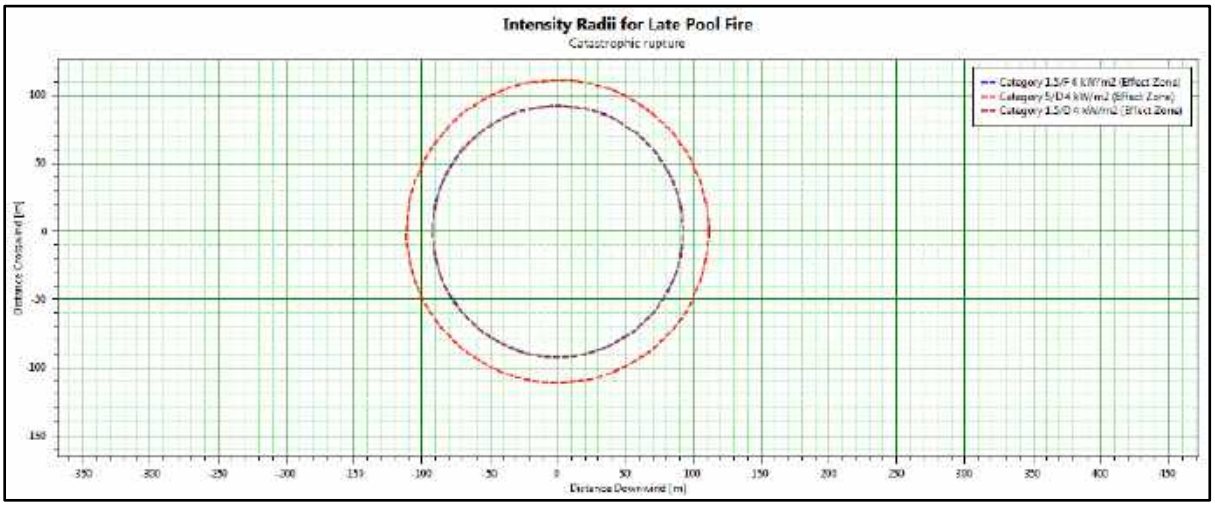
Flash fire in case catastrophic rupture of Styrene Monomer



Flash fire envelope in case of catastrophic rupture of Styrene Monomer



Late pool fire Intensity radii in case of catastrophic rupture of Styrene Monomer



Late pool fire envelope in case of catastrophic rupture of Styrene Monomer

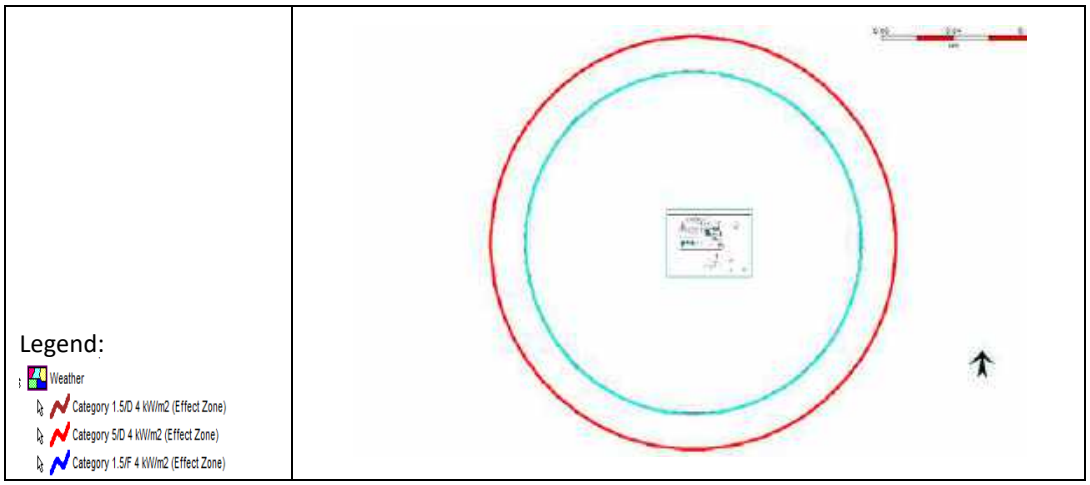


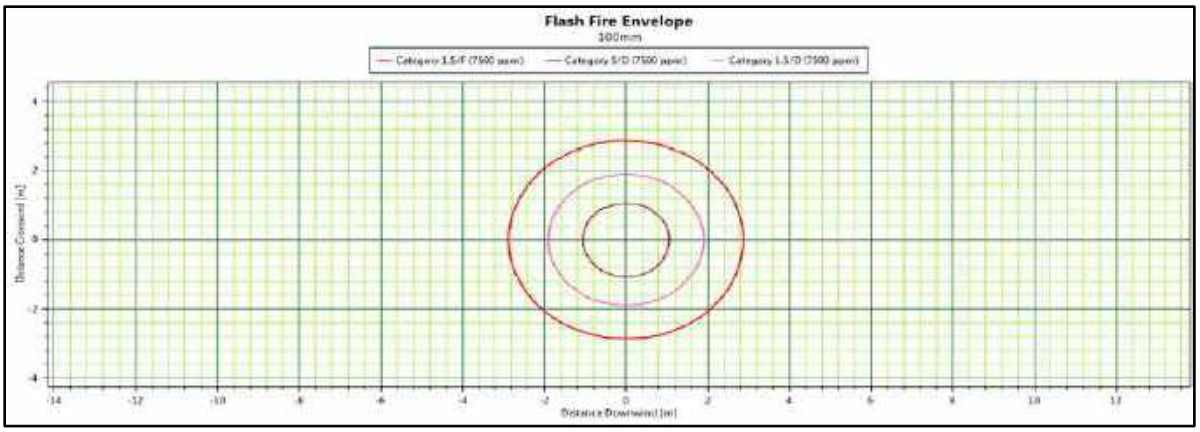
Table 7.6 Butyl Acrylate Monomer

Scenario details		5 mm leak			25 mm leak			100 mm leak			Catastrophic Rupture		
Weather Category		1.5 F	5 D	1.5 D	1.5 F	5 D	1.5 D	1.5 F	5 D	1.5 D	1.5 F	5 D	1.5 D
Flash Fire Envelope (m)													
Conc. (ppm)	7500	0	1	0	1	1	1	3	1	2	100	117	108
	15000	0	0	0	0	1	1	1	1	1	82	77	87
Thermal Damage Distance by Pool Fire (m)													
Radiation Intensity (KW/m²)	4	8	9	8	21	23	21	39	46	39	61	72	61
	12.5	5	6	5	13	16	13	17	21	17	26	29	26
	37.5	3	4	3	5	7	5	NR	NR	NR	NR	NR	NR
Thermal Damage Distance by Jet Fire (m)													
Radiation Intensity (KW/m²)	4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NH	NH	NH
	12.5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NH	NH	NH
	37.5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NH	NH	NH
Maximum Distance at Overpressure Level (m)													
Overpressure (bar)	0.02068	NH	NH	NH	NH	NH	NH	NH	NH	NH	373	343	370
	0.1379	NH	NH	NH	NH	NH	NH	NH	NH	NH	163	140	168
	0.2068	NH	NH	NH	NH	NH	NH	NH	NH	NH	147	127	152

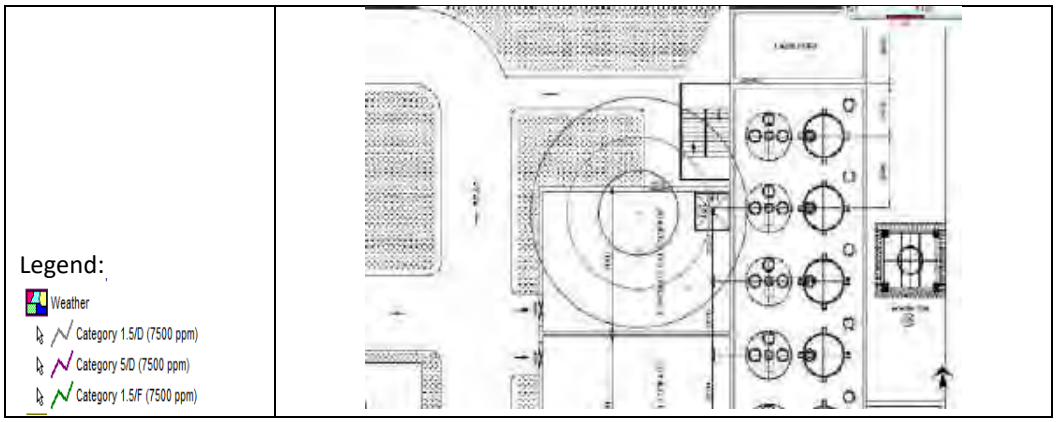
NR- NOT REACHABLE NH-NO HAZARD

The results for 100mm leak and catastrophic case are superimposed on plot plan and presented in below figures. The results for only credible scenarios are presented.

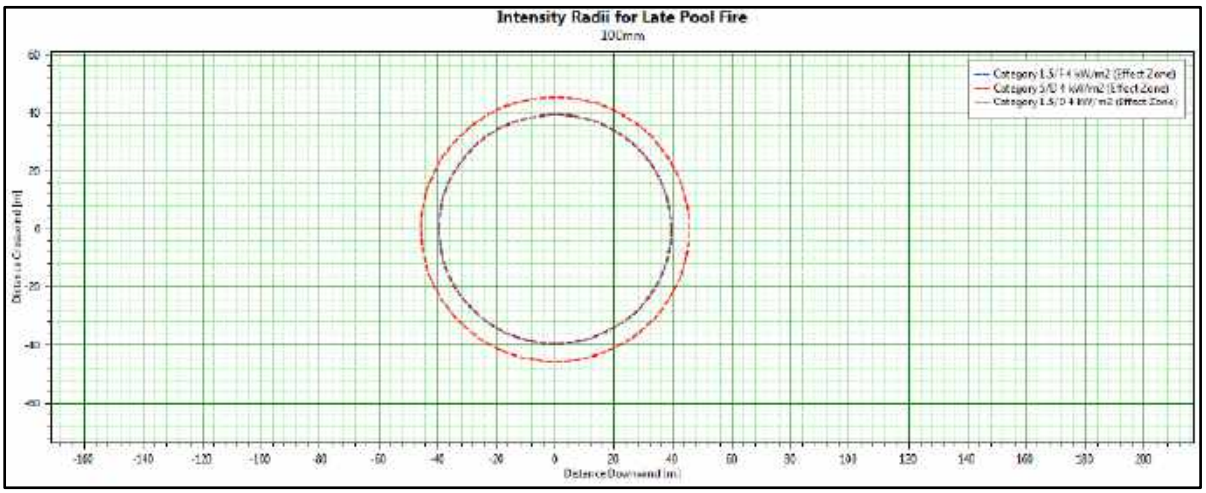
Flash Fire in case of 100 mm Leak of Butyl Acrylate Monomer



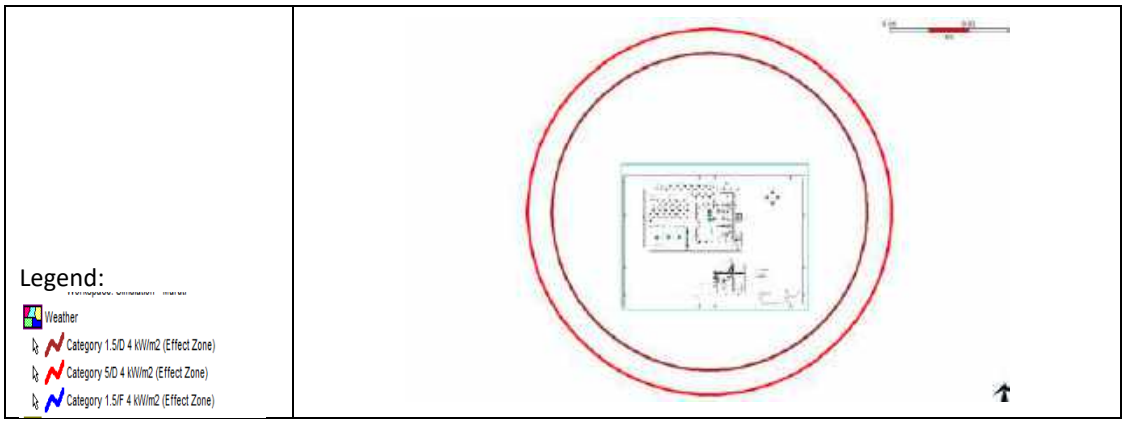
Flash fire envelope in case of 100 mm leak of Butyl Acrylate Monomer



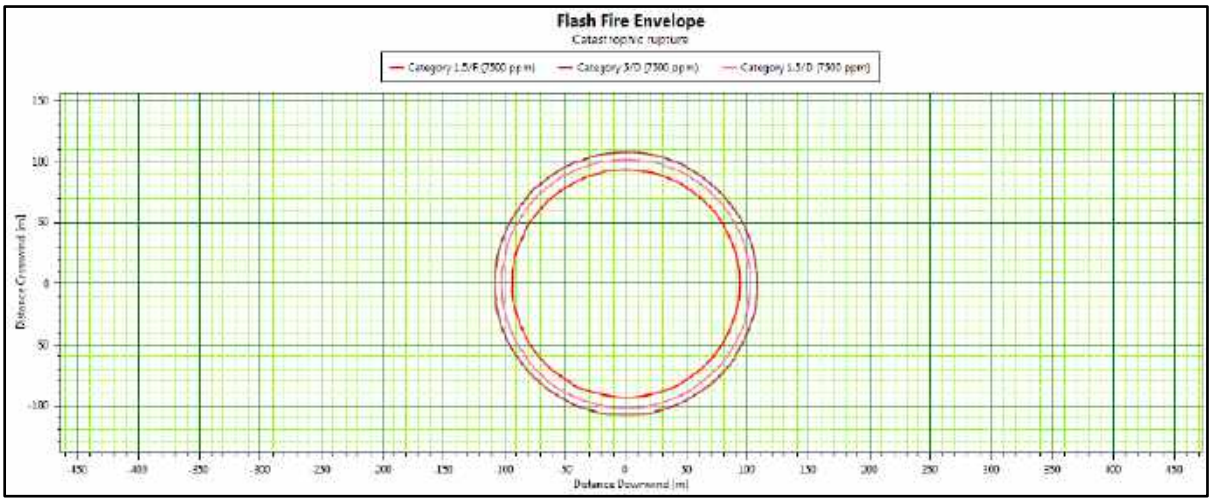
Late pool Fire Intensity radii in case of 100 mm leak of Butyl Acrylate Monomer



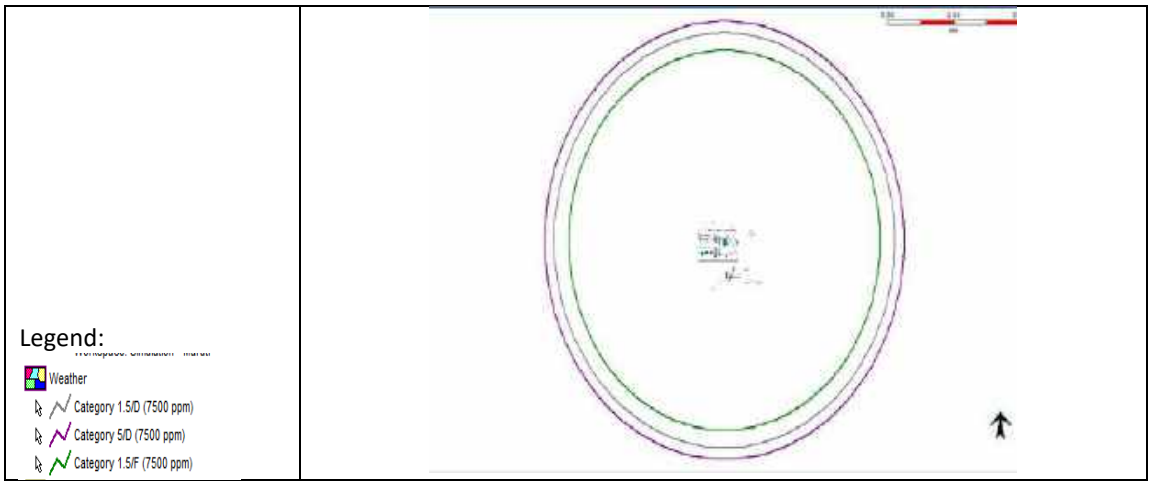
Late pool Fire envelope in case of 100 mm leak of Butyl Acrylate Monomer



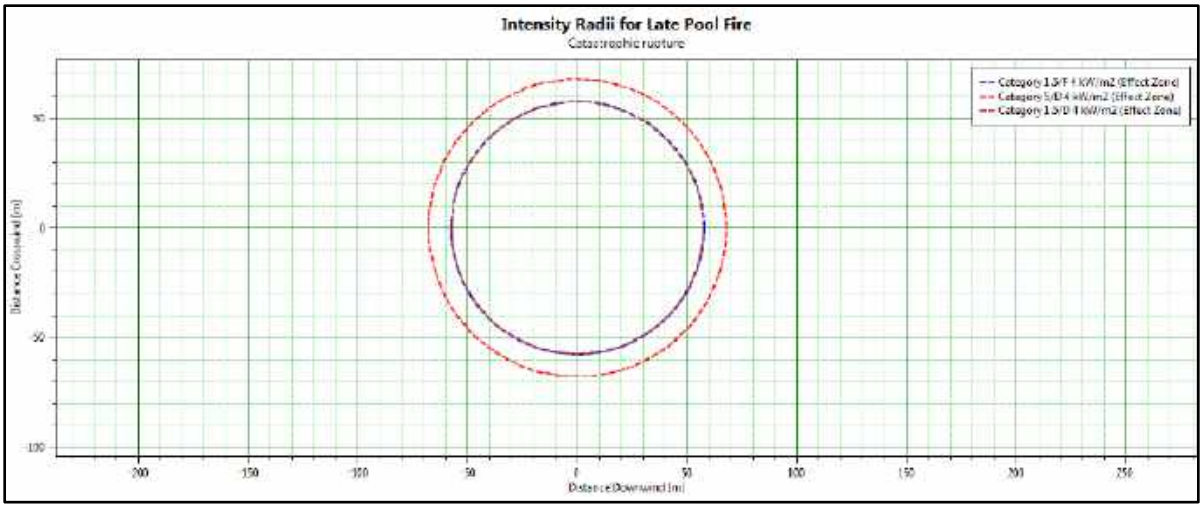
Flash fire in case catastrophic rupture of Butyl Acrylate Monomer



Flash fire envelope in case of catastrophic rupture of Butyl Acrylate Monomer



Late pool fire Intensity radii in case of catastrophic rupture of Butyl Acrylate Monomer



Late pool fire envelope in case of catastrophic rupture of Butyl Acrylate Monomer

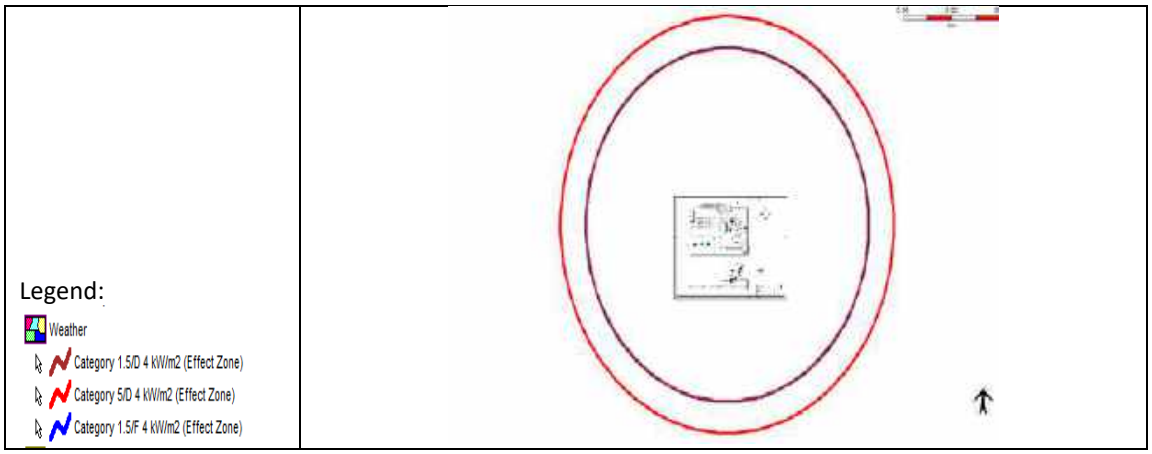


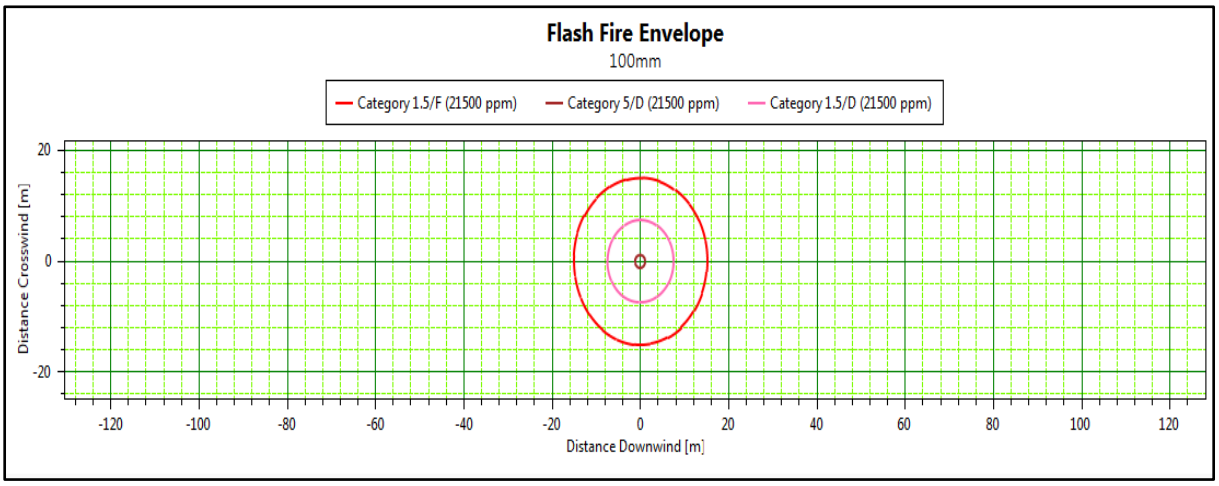
Table 7.7 Methyl Methacrylate

Scenario details		5 mm leak			25 mm leak			100 mm leak			Catastrophic Rupture		
Weather Category		1.5 F	5 D	1.5 D	1.5 F	5 D	1.5 D	1.5 F	5 D	1.5 D	1.5 F	5 D	1.5 D
Flash Fire Envelope (m)													
Conc. (ppm)	7500	0	1	0	1	1	1	15	1	7	162	101	81
	15000	0	0	0	0	1	1	6	1	3	81	67	52
Thermal Damage Distance by Pool Fire (m)													
Radiation Intensity (KW/m²)	4	4	5	4	13	14	13	45	45	44	95	97	95
	12.5	2	3	3	8	10	8	28	30	27	60	65	60
	37.5	NR	NR	NR	4	5	4	12	14	12	31	38	31
Thermal Damage Distance by Jet Fire (m)													
Radiation Intensity (KW/m²)	4	NR	NR	NR	NR	NR	NR	NR	2	NR	NR	NR	NR
	12.5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	37.5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Maximum Distance at Overpressure Level (m)													
Overpressure (bar)	0.02068	NH	NH	NH	NH	NH	NH	28	NH	NH	223	210	221
	0.1379	NH	NH	NH	NH	NH	NH	15	NH	NH	119	99	94
	0.2068	NH	NH	NH	NH	NH	NH	14	NH	NH	117	93	84

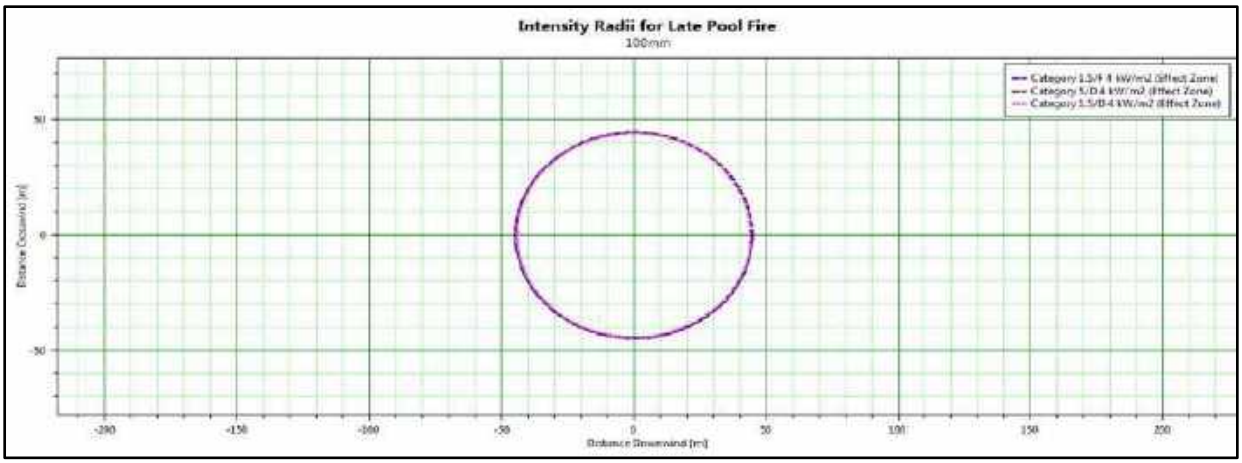
NR- NOT REACHABLE NH-NO HAZARD

The results for 100mm leak and catastrophic case are superimposed on plot plan and presented in below figures. The results for only credible scenarios are presented.

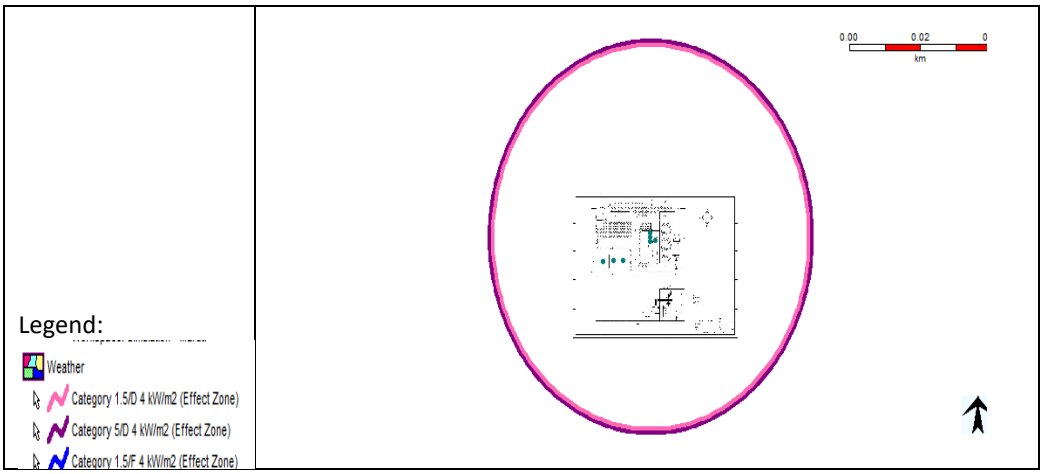
Flash Fire in case of 100 mm Leak of Methyl Metha acrylate



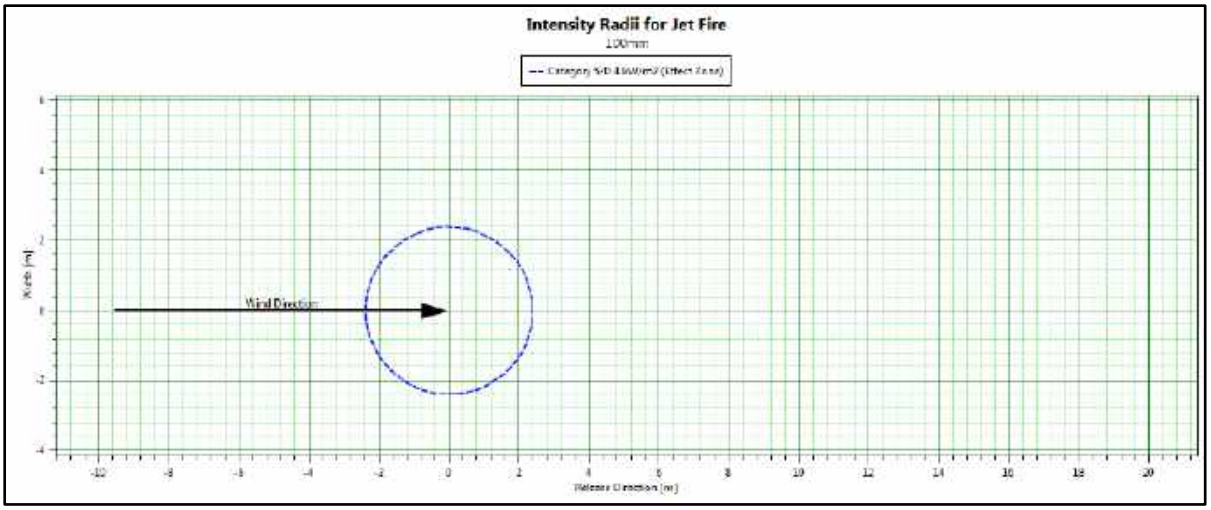
Late pool Fire Intensity radii in case of 100 mm leak of Methyl Metha acrylate



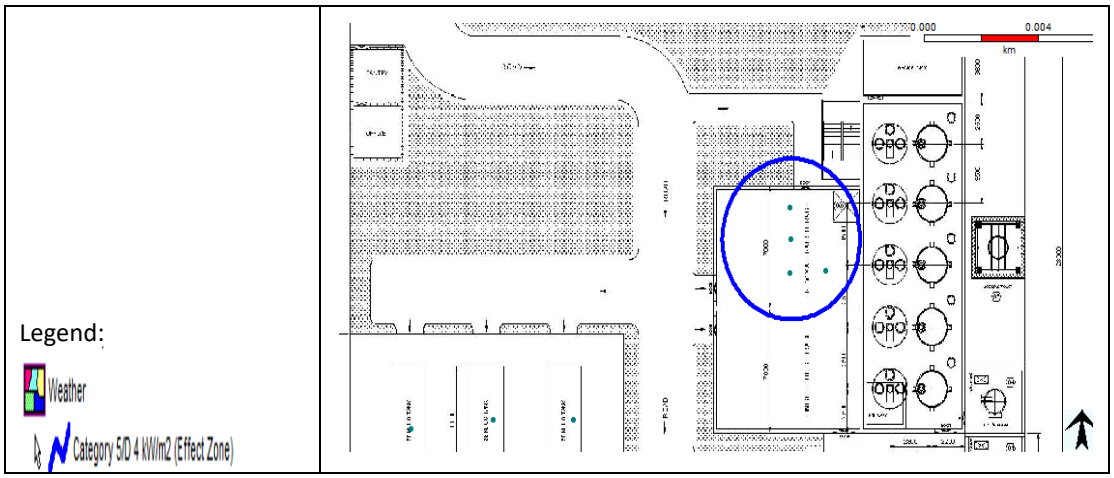
Late pool Fire envelope in case of 100 mm leak of Methyl Metha acrylate



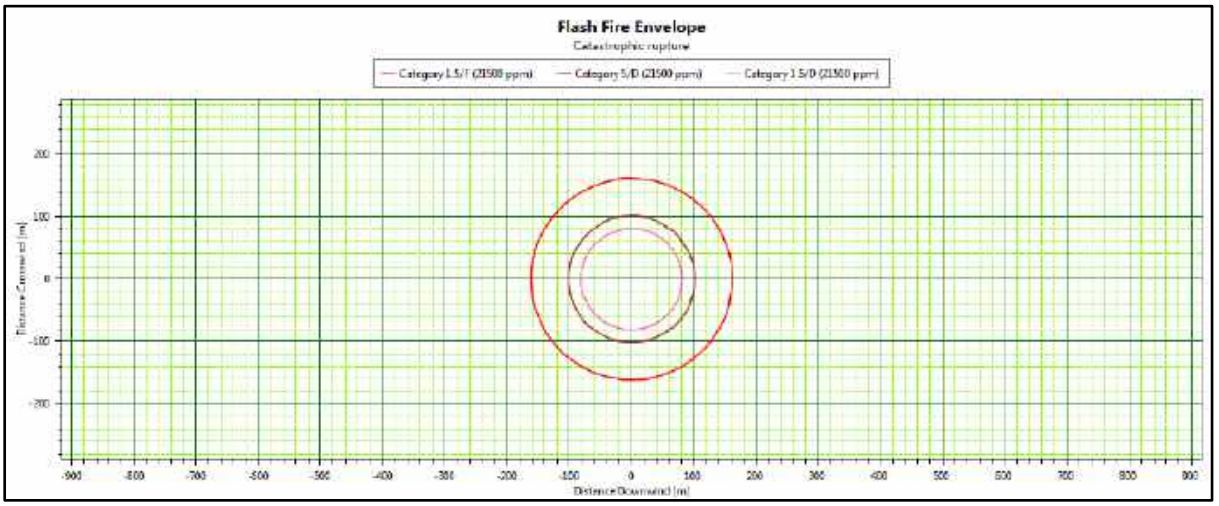
Jet Fire Intensity radii in case of 100 mm leak Methyl Metha acrylate



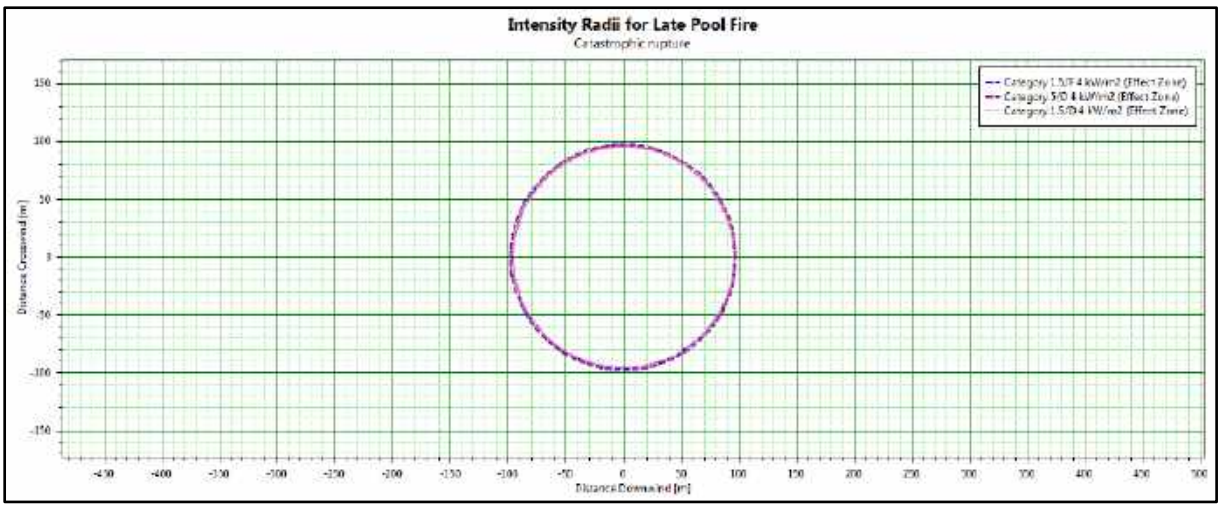
Jet Fire envelope in case of 100 mm leak Methyl Metha acrylate



Flash fire in case catastrophic rupture of Methyl Metha acrylate



Late pool fire Intensity radii in case of catastrophic rupture of Methyl Metha acrylate



Late pool fire **envelope in case of catastrophic rupture of Methyl Metha acrylate**

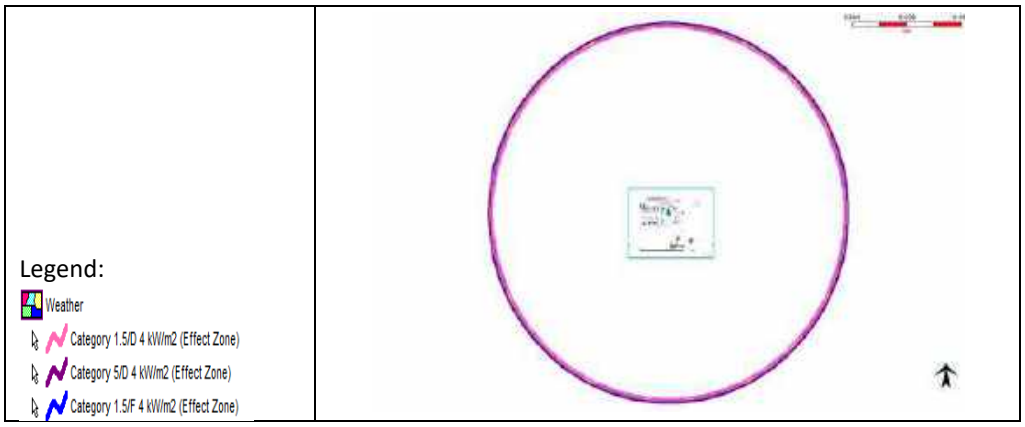


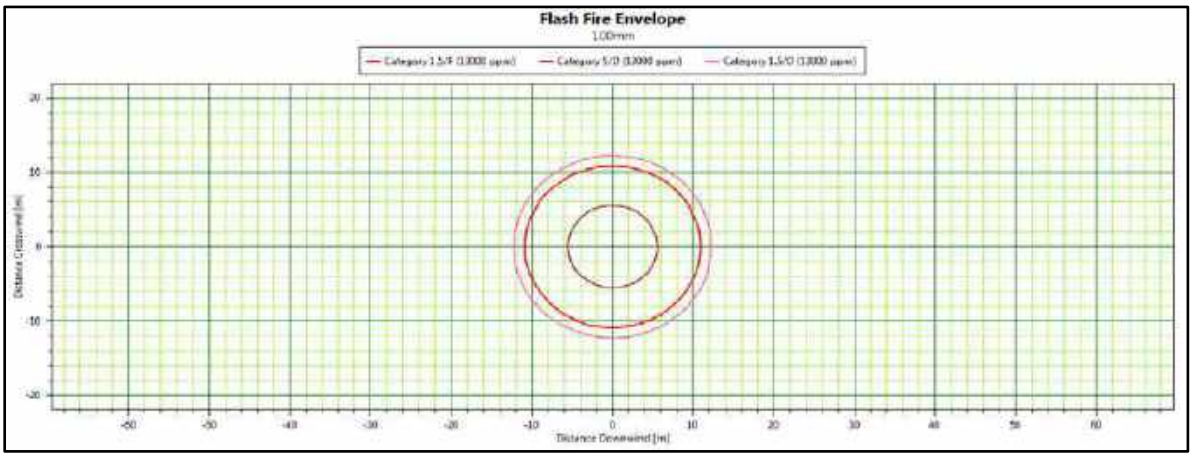
Table 7.8 Vinyl Acrylate Monomer

Scenario details		5 mm leak			25 mm leak			100 mm leak			Catastrophic Rupture		
Weather Category		1.5 F	5 D	1.5 D	1.5 F	5 D	1.5 D	1.5 F	5 D	1.5 D	1.5 F	5 D	1.5 D
Flash Fire Envelope (m)													
Conc. (ppm)	75000	0	1	0	3	1	1	11	5	12	14	19	18
	15000	0	0	0	1	1	1	7	2	8	10	12	13
Thermal Damage Distance by Pool Fire (m)													
Radiation Intensity (KW/m²)	4	4	5	4	14	15	14	40	41	39	46	48	46
	12.5	2	3	2	8	10	8	24	27	23	27	32	27
	37.5	NR	NR	NR	3	4	4	9	11	9	12	13	11
Thermal Damage Distance by Jet Fire (m)													
Radiation Intensity (KW/m²)	4	NR	NR	NR	NR	NR	NR	5	4	5	NR	NR	NR
	12.5	NR	NR	NR	NR	NR	NR	NR	3	NR	NR	NR	NR
	37.5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Maximum Distance at Overpressure Level (m)													
Overpressure (bar)	0.02068	NH	NH	NH	NH	NH	NH	40	NH	31	33	41	35
	0.13 79	NH	NH	NH	NH	NH	NH	18	NH	15	16	18	16
	0.20 68	NH	NH	NH	NH	NH	NH	16	NH	14	15	16	15

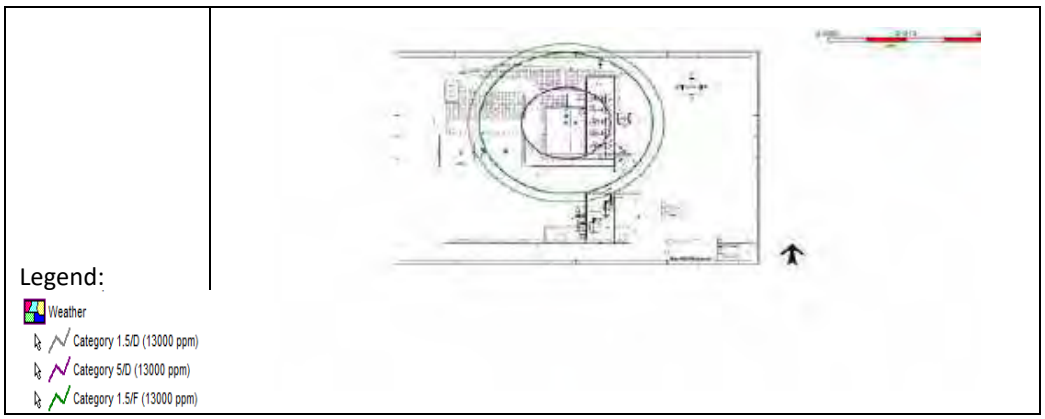
NR- NOT REACHABLENH-NO HAZARD

The results for 100mm leakand catastrophic case are superimposed on plot plan and presented in below figures. The results for only credible scenarios are presented.

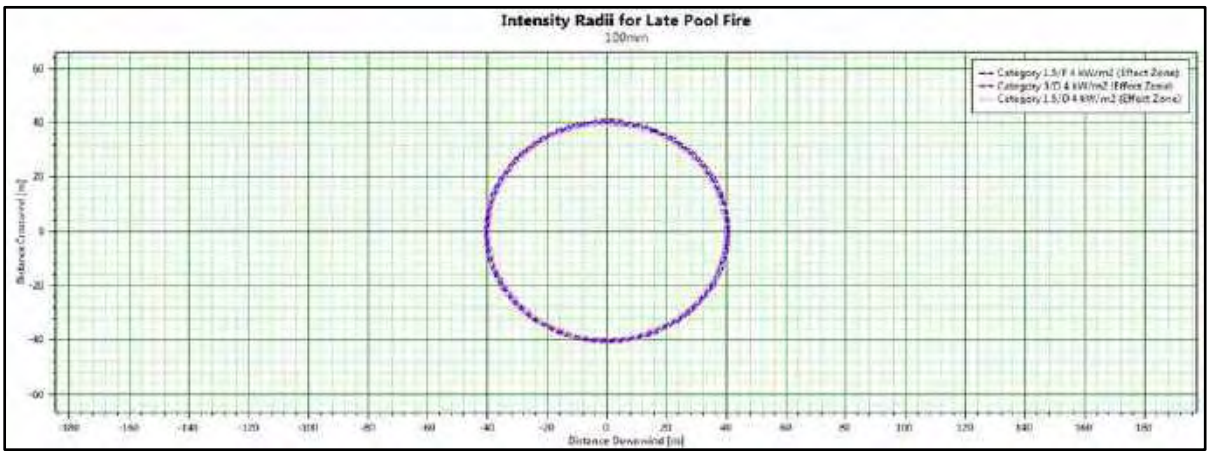
Flash Fire in case of 100 mm Leak of Vinyl Acrylate Monomer



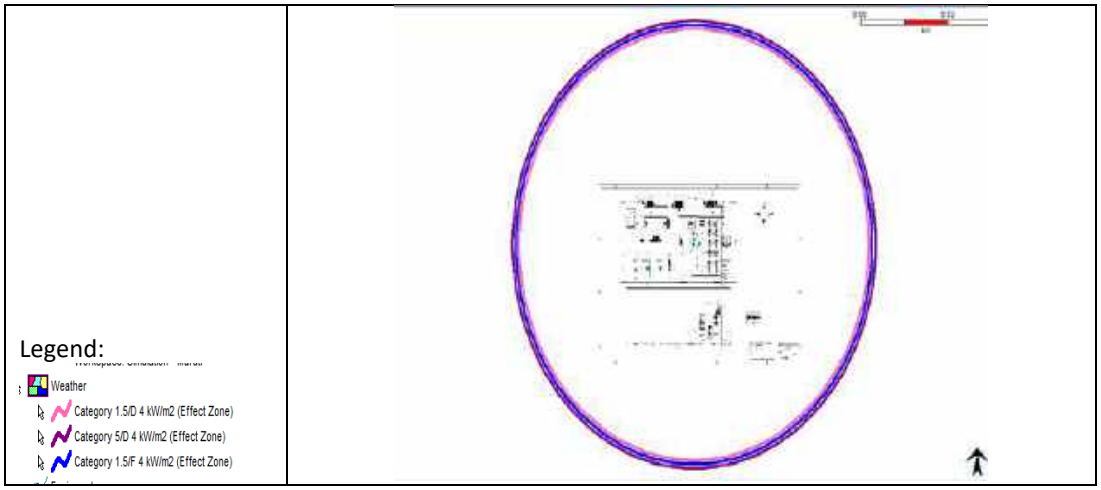
Flash fire envelope in case of 100 mm leak of Vinyl Acrylate Monomer



Late pool Fire Intensity radiiin case of 100 mm leak of Vinyl Acrylate Monomer

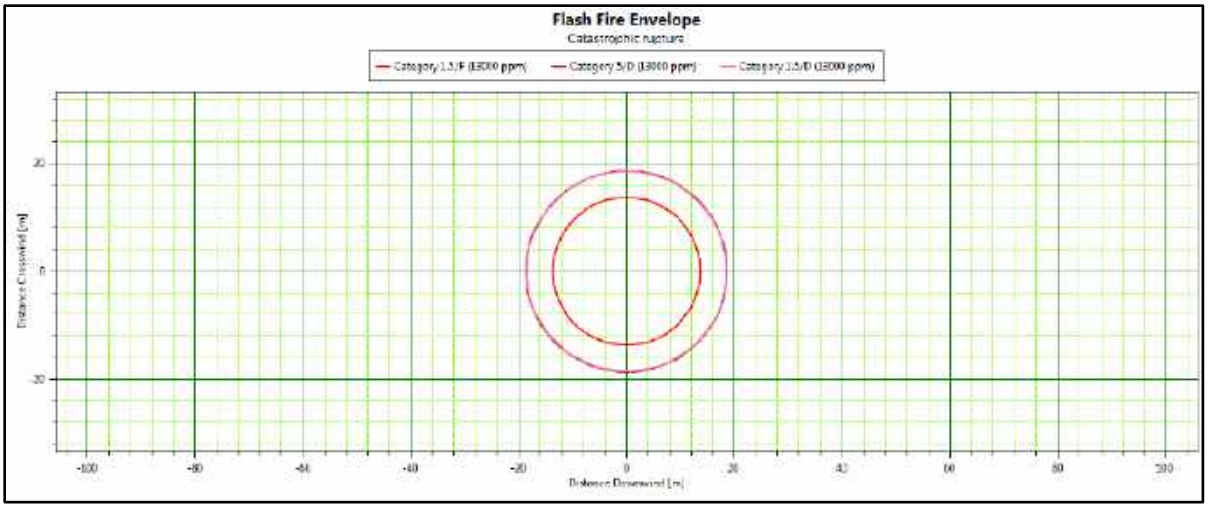


Late pool Fire envelope in case of 100 mm leak of Vinyl Acrylate Monomer

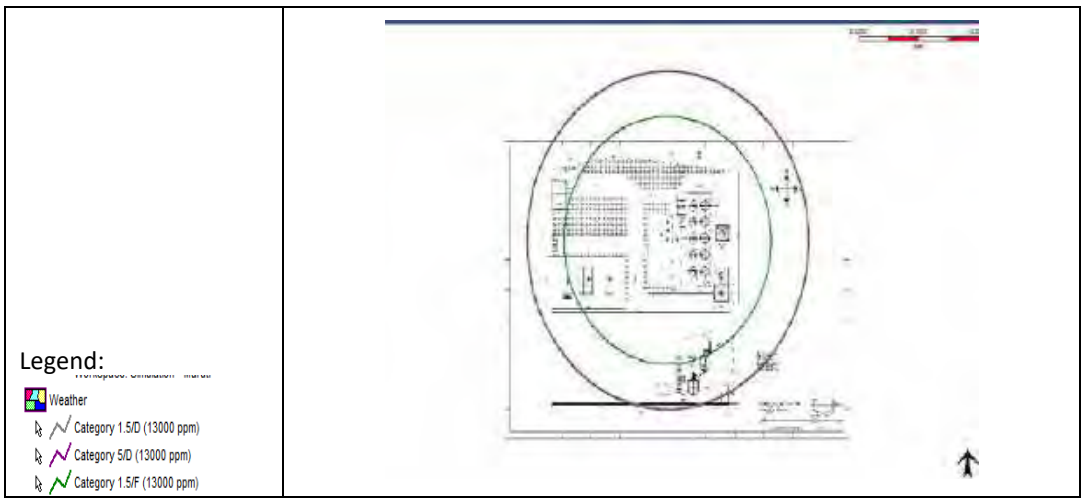


Jet Fire Intensity radii in case of 100 mm leak Vinyl Acrylate Monomer

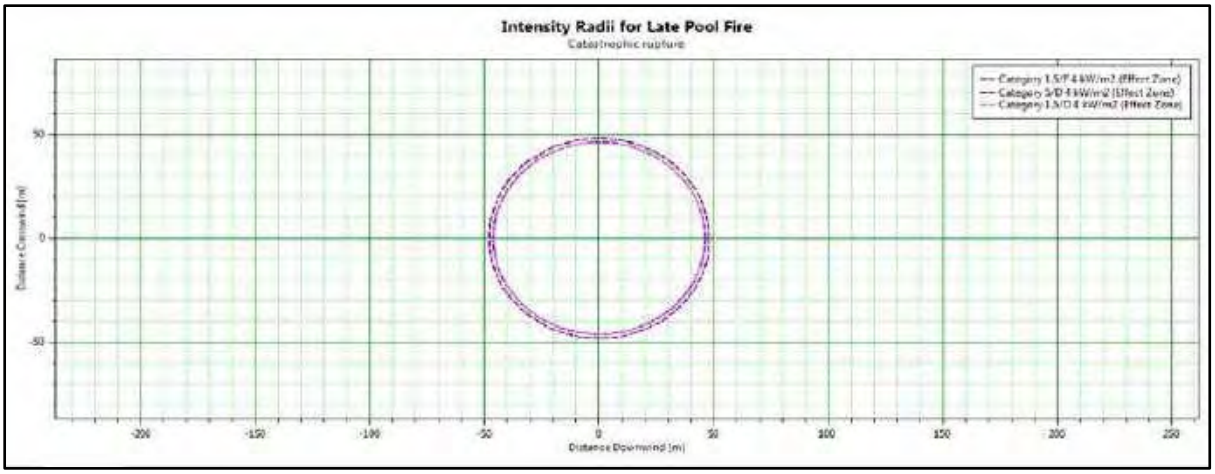
Flash fire in case catastrophic rupture of Vinyl Acrylate Monomer



Flash fire envelope in case of catastrophic rupture of Vinyl Acrylate Monomer



Late pool fire Intensity radii in case of catastrophic rupture of Vinyl Acrylate Monomer



Late pool fire envelope in case of catastrophic rupture of Vinyl Acrylate Monomer

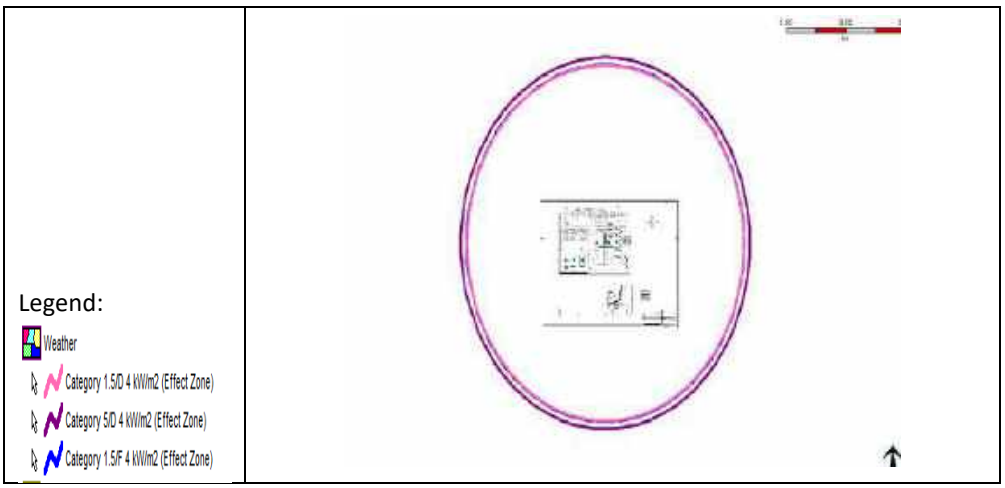


Table 7.9 Mix Xylene

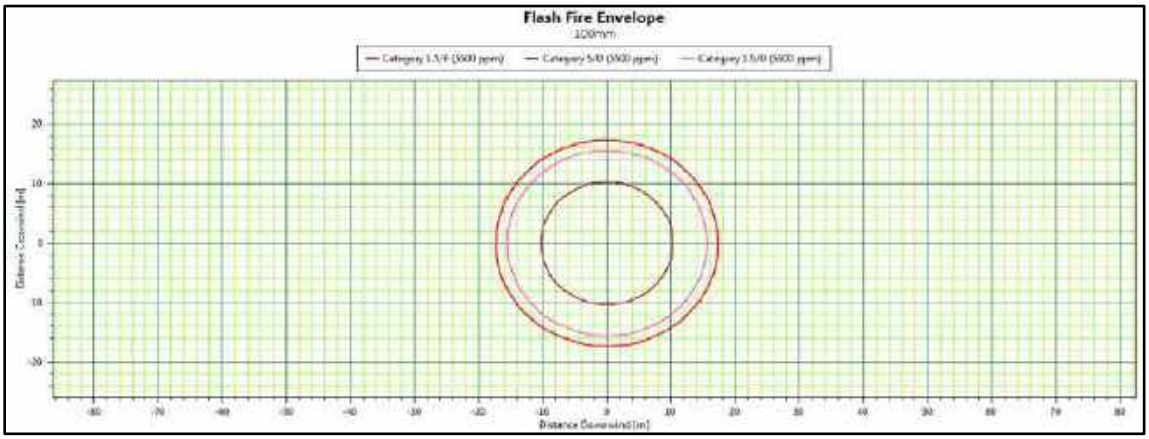
Scenario details		5 mm leak			25 mm leak			100 mm leak			Catastrophic Rupture		
Weather Category		1.5 F	5 D	1.5 D	1.5 F	5 D	1.5 D	1.5 F	5 D	1.5 D	1.5 F	5 D	1.5 D
Flash Fire Envelope (m)													
Conc. (ppm)	7500	1	2	2	2	2	9	18	10	16	117	26	42
	15000	1	2	1	2	2	4	10	6	8	69	6	18
Thermal Damage Distance by Pool Fire (m)													
Radiation Intensity (KW/m²)	4	24	25	24	47	56	47	99	120	99	100	120	100
	12.5	14	18	14	19	22	19	45	47	45	45	47	45
	37.5	6	8	6	NR	NR	NR	NR	NR	NR	NR	NR	NR

Scenario details		5 mm leak			25 mm leak			100 mm leak			Catastrophic Rupture		
Weather Category		1.5 F	5 D	1.5 D	1.5 F	5 D	1.5 D	1.5 F	5 D	1.5 D	1.5 F	5 D	1.5 D
Thermal Damage Distance by Jet Fire (m)													
Radiation Intensity (KW/m²)	4	NR	NR	NR	1	1	1	8	7	8	NR	NR	NR
	12.5	NR	NR	NR	NR	NR	NR	6	5	6	NR	NR	NR
	37.5	NR	NR	NR	NR	NR	NR	NR	4	NR	NR	NR	NR
Maximum Distance at Overpressure Level (m)													
Overpressure (bar)	0.02068	NH	NH	NH	NH	NH	NH	45	26	37	125	NR	47
	0.1379	NH	NH	NH	NH	NH	NH	19	14	17	90	NR	27
	0.2068	NH	NH	NH	NH	NH	NH	17	13	15	87	NR	25

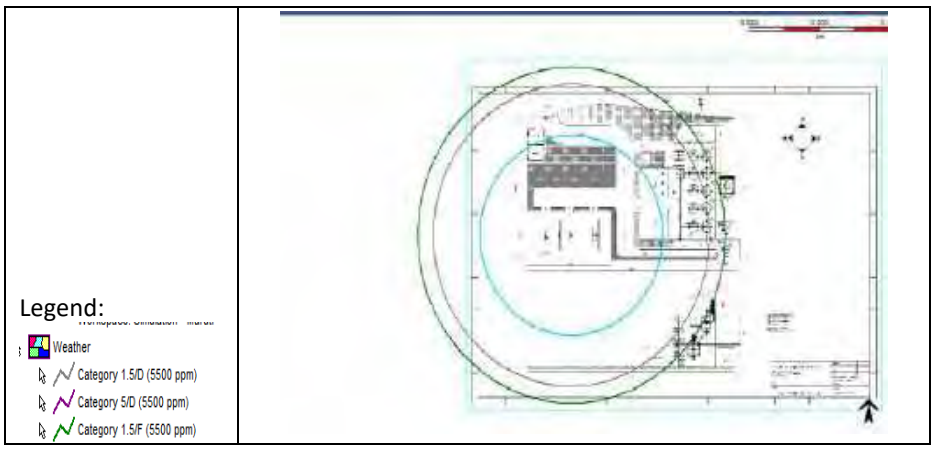
NR- NOT REACHABLE NH-NO HAZARD

The results for 100mm leakand catastrophic case are superimposed on plot plan and presented in below figures. The results for only credible scenarios are presented.

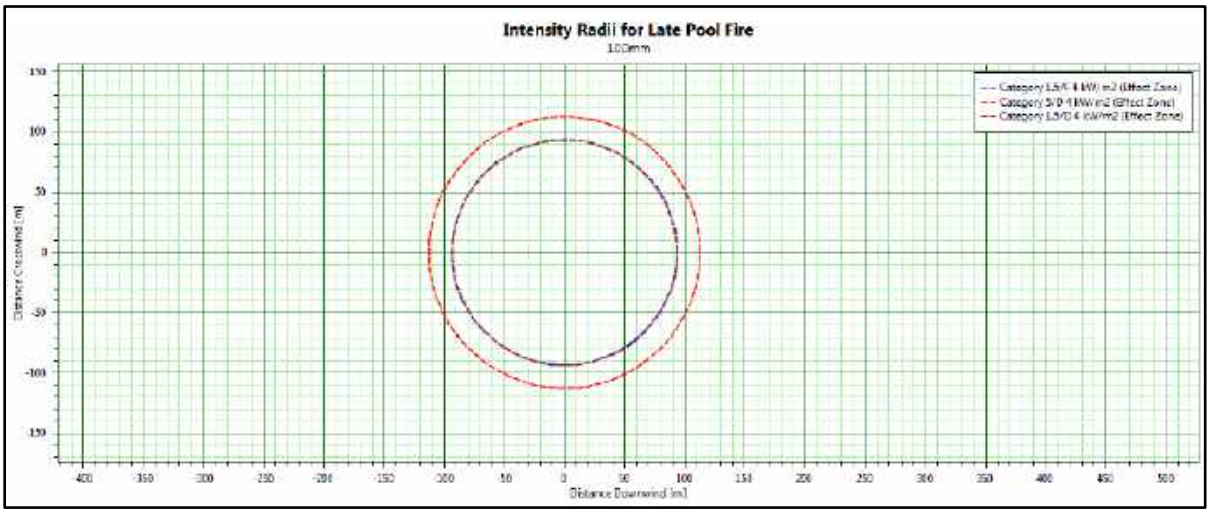
Flash Fire in case of 100 mm Leak of Mix Xylene



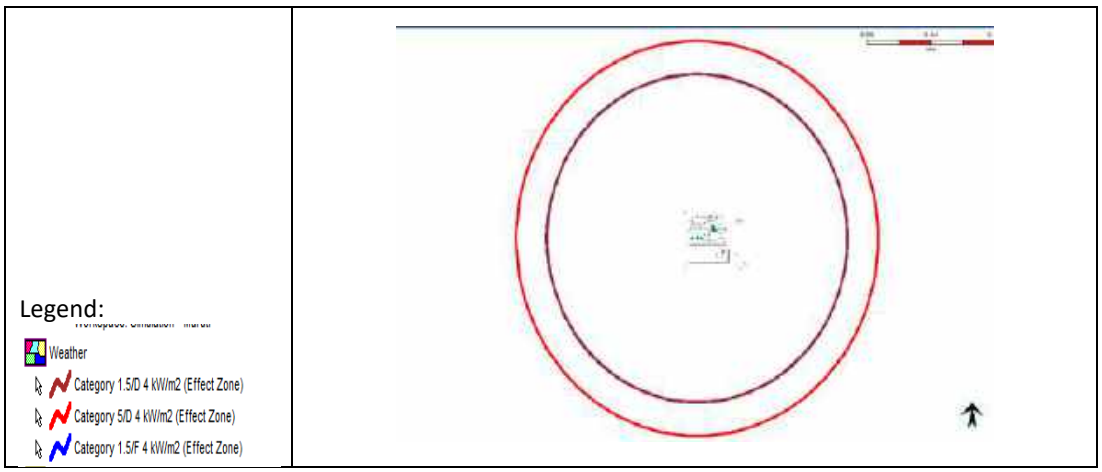
Flash fire envelope in case of 100 mm leak of Mix Xylene



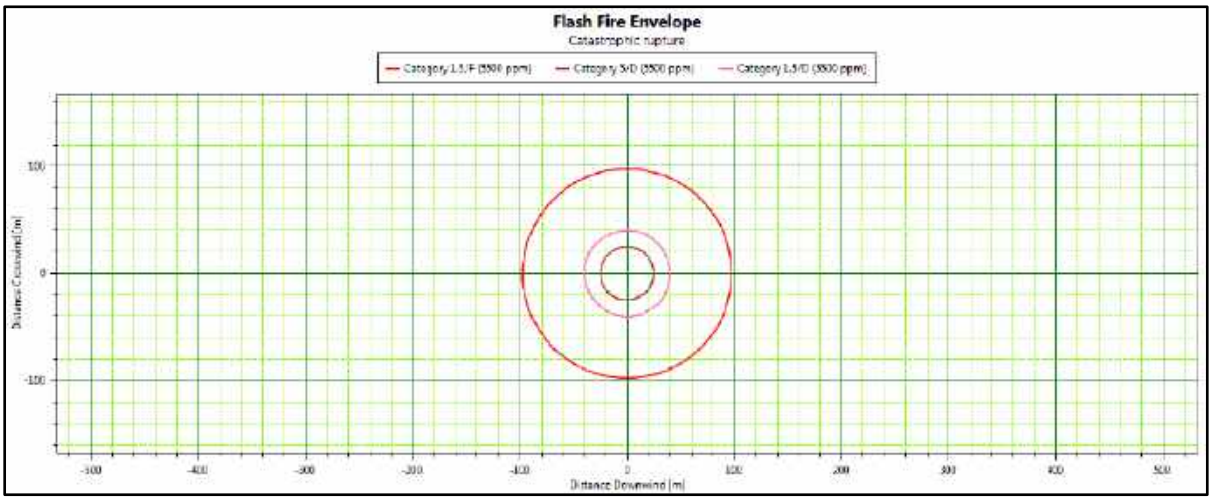
Late pool Fire Intensity radiiin case of 100 mm leak of Mix Xylene



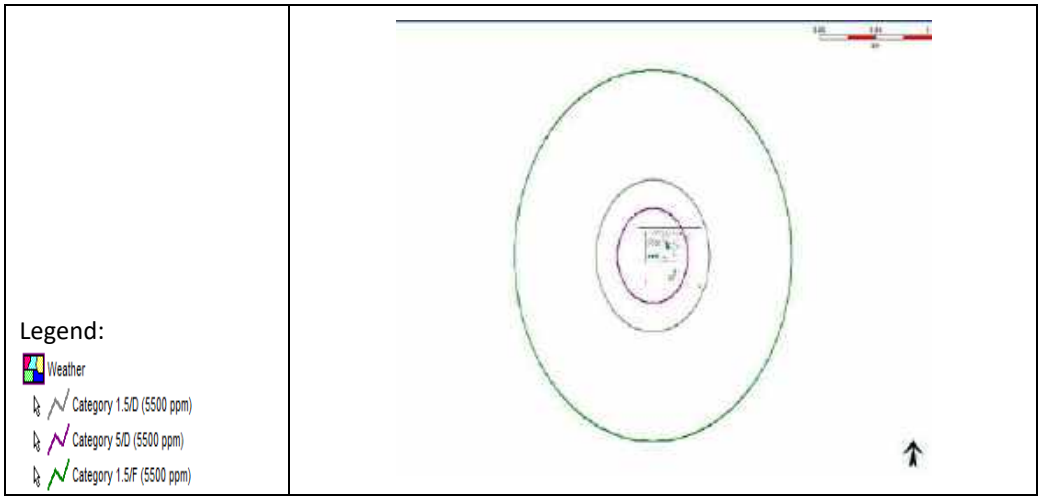
Late pool Fire envelope in case of 100 mm leak of Mix Xylene



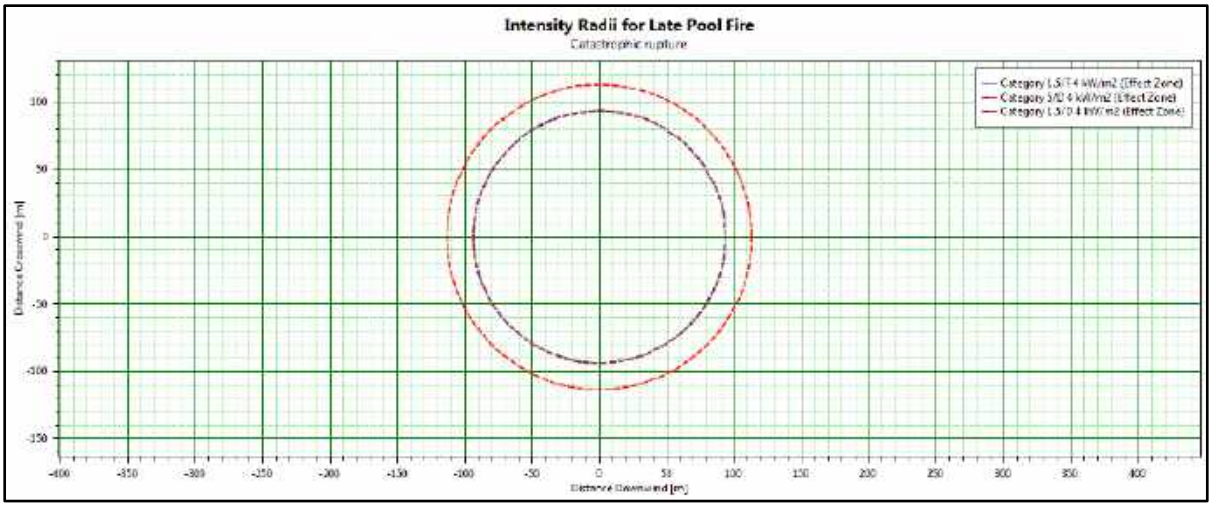
Flash fire in case catastrophic rupture of Mix Xylene



Flash fire envelope in case of catastrophic rupture of Mix Xylene



Late pool fire Intensity radii in case of catastrophic rupture of Mix Xylene



Late pool fire envelope in case of catastrophic rupture of Mix Xylene

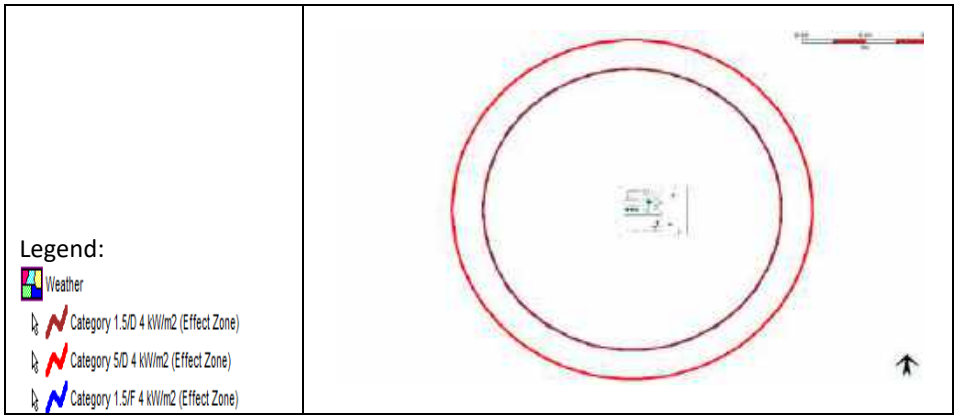


Table 7.10 MTO

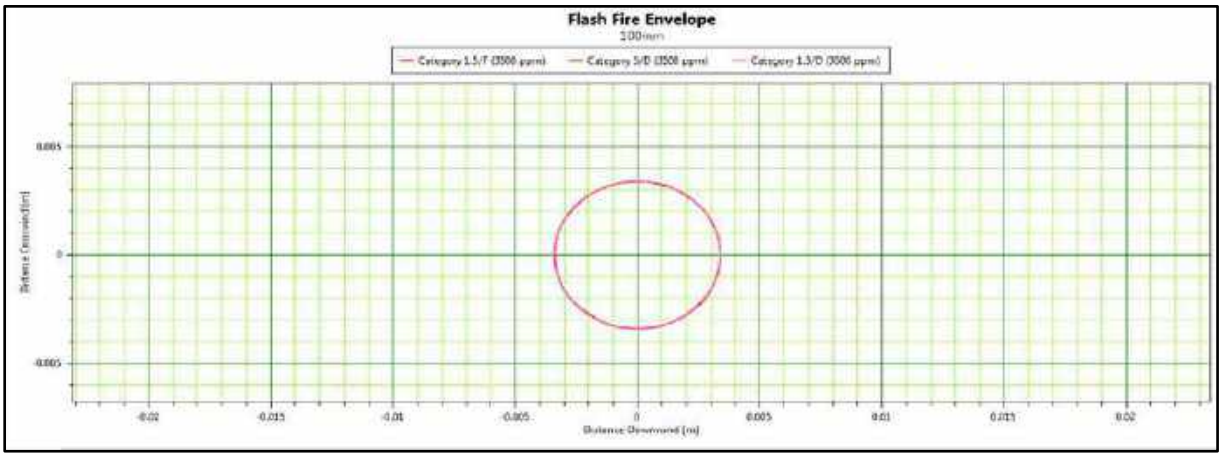
Scenario details		5 mm leak			25 mm leak			100 mm leak			Catastrophic Rupture		
Weather Category		1.5 F	5 D	1.5 D	1.5 F	5 D	1.5 D	1.5 F	5 D	1.5 D	1.5 F	5 D	1.5 D
Flash Fire Envelope (m)													
Conc. (ppm)	3500	0	0	0	0	0	0	0	0	0	48	11	19
	7000	0	0	0	0	0	0	0	0	0	43	8	15
Thermal Damage Distance by Pool Fire (m)													
Radiation Intensity (KW/m²)	4	10	11	10	28	30	28	52	62	52	108	129	108
	12.5	6	7	6	16	20	16	20	23	20	49	51	49
	37.5	3	4	3	6	6	6	NR	NR	NR	NR	NR	NR

Scenario details		5 mm leak			25 mm leak			100 mm leak			Catastrophic Rupture		
Weather Category		1.5 F	5 D	1.5 D	1.5 F	5 D	1.5 D	1.5 F	5 D	1.5 D	1.5 F	5 D	1.5 D
Thermal Damage Distance by Jet Fire (m)													
Radiation Intensity (KW/m²)	4	NH	NH	NH	NH	NH	NH	NH	NH	NH	NH	NH	NH
	12.5	NH	NH	NH	NH	NH	NH	NH	NH	NH	NH	NH	NH
	37.5	NH	NH	NH	NH	NH	NH	NH	NH	NH	NH	NH	NH
Maximum Distance at Overpressure Level (m)													
Overpressure (bar)	0.02068	NH	NH	NH	NH	NH	NH	NH	NH	NH	49	17	16
	0.1379	NH	NH	NH	NH	NH	NH	NH	NH	NH	42	12	12
	0.2068	NH	NH	NH	NH	NH	NH	NH	NH	NH	42	11	11

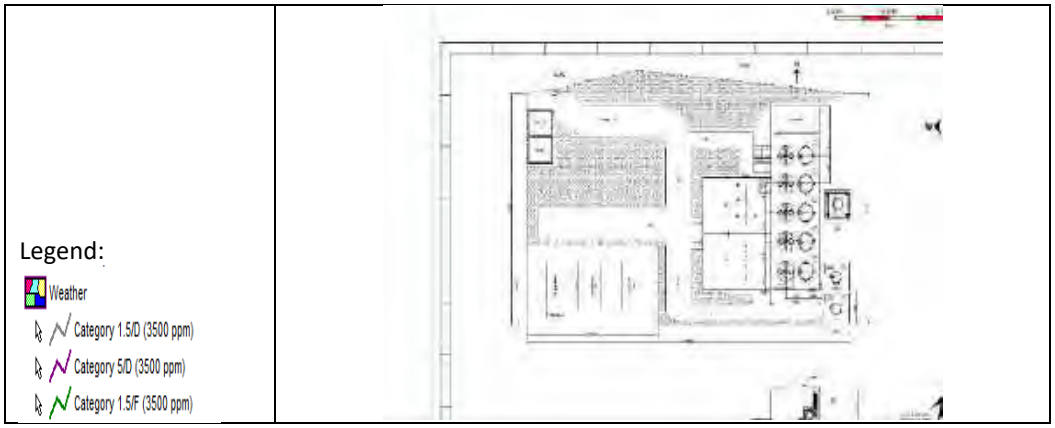
NR- NOT REACHABLE NH-NO HAZARD

The results for 100mm leakand catastrophic case are superimposed on plot plan and presented in below figures. The results for only credible scenarios are presented.

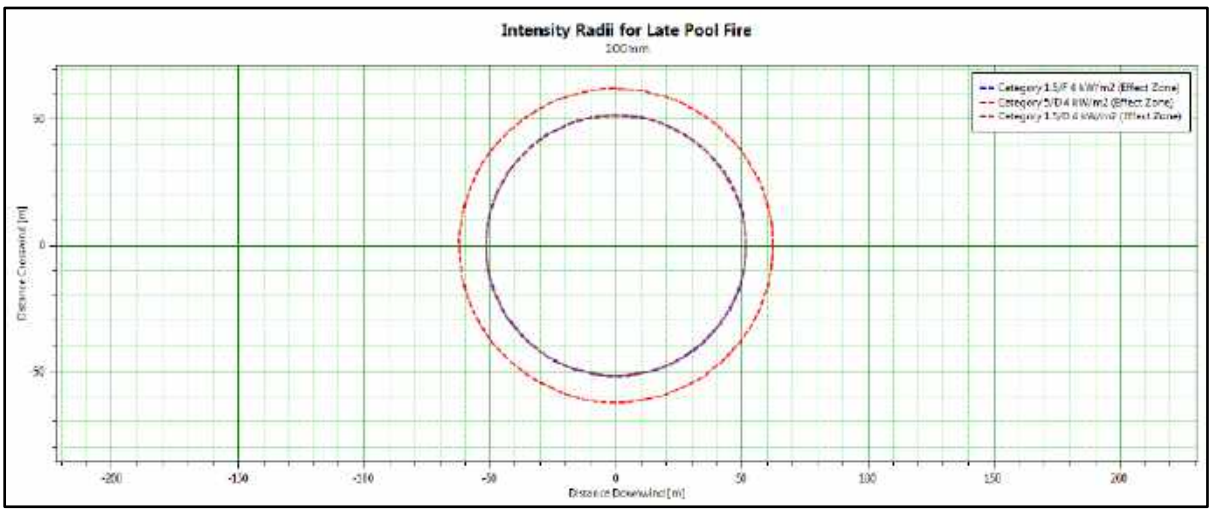
Flash Fire in case of 100 mm Leak of MTO



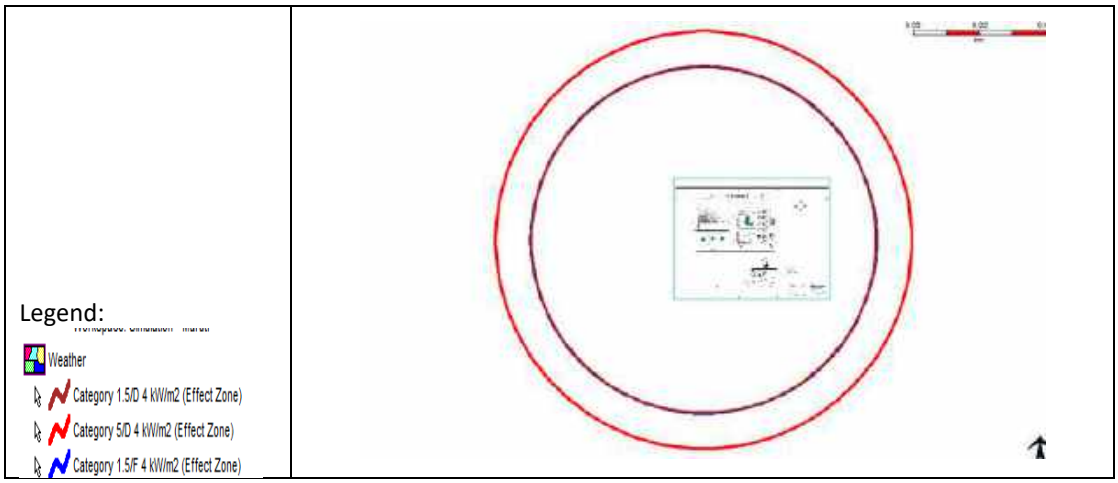
Flash fire envelope in case of 100 mm leak of MTO



Late pool Fire Intensity radii in case of 100 mm leak of MTO



Late pool Fire envelope in case of 100 mm leak of MTO



Conclusion

In above QRA study we found that this industry stored hazardous material like corrosive and toxic acids and flammable chemicals etc. In case of any leakage or fire the damage distance and affected area around 373 m from the object during worst case. In case of any toxic material release or spill around 5 m, the concentration is very high. Follow disaster management plan/ procedure in case of any spillage, release and fire of hazardous material. Provide specific active and passive fire fighting system.

Proposed Control Measures

1. To prevent fatalities, injuries and to reduce damage to buildings and contents follow Workplace Emergency Planning & Preparedness procedure:
2. Onsite emergency response plan will be prepared and implement.
3. Trained employees will be deployed for operation.
4. Adequate personal protective equipment will be provided to all working personnel.
5. Fire hydrant system and fire extinguishers will be installed.
6. Regular training programs will be conducted for enhancement of employees' competence.
7. Earthing and bonding will be provided to all the storage tanks and pipeline to prevent accumulation of static charge.
8. Safe operating procedures will be developed and implemented.
9. National / International engineering standards in the Design, Construction and testing of the storage tanks, equipment and other hardware will be adhered.
10. Visual display signage will be provided.
11. Material safety sheet and SOP will be displayed.
12. Safety appliances and equipment (Self-contained breathing apparatus, safety shower etc.) will be provided.

7.6. Disaster Management Plan

7.6.1. Introduction to Disaster Management Plan

The various controls including engineering, procedural and administrative are provided to control the manufacturing activities at the industries; however things may go wrong even with the best arrangements. The Disaster Management Pan is prepared to control and minimize the effect of any emergency which may occur within the industrial premises affecting the employees or the people in the surrounding; it may also affect the environment.

The disaster/emergency may arise as a natural calamity such as floods, earthquakes, etc. or may be a Man-made Disaster such as a leakage/ Spillage of Hazardous chemicals/ Gases or Fire and Explosion.

A Disaster Management Plan is an action plan drawn to fix responsibility and actions to be taken by various groups to contain the disaster/emergency incident within shortest possible time and with minimum losses to people, material, property and environment.

It is the responsibility of the establishment/industry that the disaster/emergency plan is widely circulated for benefit/training of all the employees within the premises and the individuals residing in the surrounding areas of the premises. It is the responsibility of all the individuals in their respective areas to ensure the success of this plan.

7.6.2. Objective

The main objectives of preparing the On Site / Off Site Emergency Plan are:

1. To define and assess emergencies, including risk and environmental impact assessment.
2. To establish the procedures to handle emergency situation that may arise due to spillage and fire while handling plant & equipment.
3. To control and contain incidents within shortest possible time and to restore normalcy.
4. To safeguard employees and people in vicinity and to minimize damage/loss to property or/and the environment.
5. To inform employees, the general public and the authority about the hazards/risks assessed, safeguards provided, residual risk if any and the role to be played by them in the event of emergency.

6. To be ready for 'mutual aid' if need is arise to help neighbouring unit. Normal jurisdiction of an OEP is the own premises only, but looking to the time factor in arriving the external help or off-site plan agency; the jurisdiction must be extended outside to the extent possible in case of emergency occurring outside.

7. To establish procedures to appraise District Administration / Civil authorities/ and mutual aid centres etc. in order to ensure prompt relief for execution of Emergency Response Plan.

8. To secure the safe rehabilitation of affected areas and to restore normalcy.

9. To provide authoritative information to the news media.

10. To preserve records, equipments etc., and to organize investigation into the cause of the emergency and preventive measures to stop its recurrence.

11. To ensure safety of the works before personnel re-enter and resume work.

12. To work out a plan with all provisions to handle emergencies and to provide for emergency preparedness and the periodical rehearsal of the plan.

7.6.3. Definition

An emergency could be defined as any situation which presents a threat to safety of persons or/and property. It may require outside help also.

A major emergency occurring at a work is one which may affect one or several sections of the plant and possibly extend beyond the factory boundaries that may cause serious injuries, loss of life, and extensive damage to property or serious disruption outside the works. It will require the use of outside resources to handle it effectively.

Disaster is a catastrophic situation in which the day-to-day patterns of life are, in many instances, suddenly disrupted and people are plunged into helplessness and suffering and as a result need protection, clothing, shelter, medical and social care and other necessities of life, such as -

(1) Disasters resulting from natural phenomena like earthquakes volcanic eruptions, storm, surges, cyclones, tropical storms, floods, landslides, forest fires and massive insect infestation. Also in this group, violent drought which will cause a creeping disaster landing to famine, disease and death must be included.

(2) Second group includes disastrous events occasioned by man, or by man's impact upon the environment, such as armed conflict, industrial accidents, factory fires, explosions and escape of toxic gases or chemical substances, river pollution, mining or other structural collapses; air, sea, rail and road transport accidents, aircraft crashes, collisions of vehicles carrying inflammable liquids, oil spills at sea, and dam failures.

The on-site emergency plan deals with measures to prevent and control emergencies within the factory and not affecting outside public or environment.

The off-site emergency plan will deal with measures to prevent and control emergencies affecting public and the environment outside the premises. The manufacturer should provide the necessary information on the nature, extent and likely effects of such incidents.

7.6.4. Level of disasters

The NDMA Guidelines categorize the levels of disasters, based on the ability of various authorities to deal with them. In order to facilitate the responses and assistances to States and Districts, the levels of disasters have been defined as follows.

1. **L0 level** denotes normal times which will be utilized for close monitoring, documentation, prevention and preparatory activities. Training on search and rescue, rehearsals, evaluation and inventory updation for response activities will be carried out during this time.

2. **L1 level** specifies disaster that can be managed at the District level, however, the State and Centre will remain in readiness to provide assistance if needed.

3. **L2 level** disaster situations are those which require assistance and participation of State, mobilization of its resources for management of resources.

4. **L3 level** disaster situation is in case of large scale disaster where the State and District authorities have been overwhelmed and require assistance from the Central Government for reinstating the State and District machinery as well as for rescue, relief, other response and recovery measures. In most cases, the scale and intensity of the disaster as determined by the concerned technical agencies like Indian meteorological department (IMD)/ Indian National Centre for Ocean Information Services (INCOIS) are sufficient for the declaration of L3 disaster.

7.7. Scope

The M/s Maruti Polymers Incorporation has prepared Disaster Management Plan in order to provide proper guidance to plant operating personnel to confidently handle any accidental spillage or fire / explosion / bursting of vessel/tank or any natural calamity or sabotage.

With this objective comprehensive information has been gathered and analyzed on the resins handling plant and equipment which includes the hazardous properties of materials/chemicals, fire hazards, safety appliances, safety measures incorporated in the plant, emergency procedures and finally regarding the constitution & responsibility of Emergency Rescue Team (Emergency Response & Management Team / Task Force).

The potential hazards which may cause emergency includes:

- Chemical Fire / Explosion in the plant or storage area
- Electrical Fire in the plant or storage area.
- Accidental spillages and leakages during handling of material and plant / equipment failure causing severe health hazard due to employees exposure to the hazardous substances.

7.7.1. Methodology

A major emergency occurring at a plant is one that may cause serious injuries, loss of life, extensive damage to property or environment or serious disruption inside or outside the plants.

This may demand the rescue and relief measures on a war footing to handle it effectively and quickly. Within the high-risk technology industries, the need for well-planned measures should be self-evident.

No matter how well a process is controlled and safeguarded by instruments and process safety procedures, it is inevitable that there is a residual risk, which is capable of causing a variety of emergencies.

The Disaster Management Plan describes the Organization & procedures for dealing with potential accidents arising from the operations of M/s. Maruti Polymer Incorporation.

Experiences of accidents that have occurred in various other similar plants were considered in the preparation of DMP especially storing & handling the materials identical to this plant. This

plan will need periodic review & modification following emergency exercise, or include any new information relating to changes to the facilities.

The Factories Act, 1948 as amended in the year 1987 under section 41B requires that every occupier shall draw up a Disaster Management Plan and detailed disaster control measures for his plant and make them know to the employees and to the general public living in the vicinity of the plant.

Its objective is to reduce the severity of loss following particular hazardous incidents. At the same time, it must be clearly understood that it is not a substitute for maintaining good standards for working consistence with the requirements of safety and health inside the plants.

7.8. Information on risk evaluation preliminary hazard analysis

The DMP is needed to respond to a variety of emergencies / disasters:

i) Disasters due to emergency on account of:

a. Fire or Explosion

b. Electrical Fire

c. Spillages and Leakages

d. **Fire or explosion:** The organization is storing &handlingflammable chemicalswhich can ignite if exposed to source of heat / ignition. The various sources of heat / ignition include hot work, mechanical frictions, naked flames, static electricity, hot surfaces etc.

e. **Electrical Fire:** The Electrical fire may be caused due to generation of static charge during charging of materials. The other reasons for fire include use of faulty or inappropriate electrical equipment, transformers, DG sets etc. Also dry grass is normally avoided in the premises and it will be ensured that there is no grass (dry) at any point of time by ensuring better housekeeping

f. **Spillages and Leakages:** During handling of material and plant / equipment failure causing severe health hazard due to employees exposure to the hazardous substances. Spillages and leakages of flammable substances may also lead to fire.

ii) Disaster due to natural calamities such as:

a. Flood

b. Earth quake

c. Cyclone/Storm

d. Heat Wave

a. Flood:

The nearest water body from the facility are Mahi River (approx. 1.05km in N direction). The heavy rainfall and water released from the Dam may increase water level in the river bed creating flood situation.

Four villages of Anand district were inundated while around 100 villagers of 13 villages have been re-located to safer spots in the villages following discharge of 1.43 lakh cusecs water from the Dharoi dam into Sabarmati River.

b. Earthquake:

It is found that the district falls in the seismic zone 3.

c. Storm/Cyclone:

Cyclones make impact by killing people, damaging property, crops and infrastructure. The area falls under category in which wind of 1-35 KMH air blown. So the chances are there for storm & cyclone

d. Heat Wave:

The Anand region experienced the heat wave in the past history. Also it was observed that the Anand Divisions comes under vulnerable area.

iii) Disaster due to external factors such as:

a. Sabotage, Civil Riots or War, Terrorism: No solution can be offered to eliminate either terrorist threats or planted bombs, but one can be well or badly prepared to cope with them when such incidents happen. It is essential for organizations to design and implement both good physical security and a comprehensive bomb threat response plan.

The action plan responding to an emergency situation depends very much on the level of the emergency which, itself is defined by the consequences arising from the types of hazard identified.

RECOMMENDATIONS

Flood:

- Introduce better flood warning systems
- Modify homes and businesses to help them withstand floods nearby river side.
- Construct buildings above flood levels
- Protect wetlands and introduce plant trees strategically
- Put up more flood barriers.

Earthquake:

- Find a clear spot away from buildings, trees, and power lines. Drop to the ground.
- Don't Rush Indoors
- Stay Put remain there until the earth stops shaking
- Remain Calm until the earth stops shaking

Cyclone/Storm:

- Immediately call ambulance & NDRF team.
- Provide shelter for the victims and provide first aid on site.
- Survey site and remove people from covered collapse material.

Terrorist Attack/ Political Violence:

- Don't be panic and threatened.
- Call the police, ambulance & District Collector.

The above summarized results of an analysis of hazard, risk and disaster impact in AnandFor more study of risk criteria please refer, Anand State Disaster Management Plan.

Disaster Preparedness

This section highlights the Organization for disaster preparedness. For an industry storing / handling flammable substances, it is essential to prepare a good effective disaster plan to control On Site – Off Site emergencies and to mitigate losses. The disaster management plan (emergency response plan) ensures that all available resources, facilities etc., are enforced into services at right time to tackle an emergency.

It is not possible to envisage and detail every action which should be taken in emergency and to harness the basic elements of emergency preparedness such as Gravity of emergency, Communication of information, on-site action for process and emergency controls, Mobilization of internal and external resources for fire and spillage etc.

Emergency Organization is set up specifying duties and responsibilities of all to make best use of all resources and to avoid confusion while tackling the emergency.

Disaster Management Plan / On-Site Emergency Plan (Emergency Response Plan) highlights the flow of information and co-operation among various action groups within the factory. Off-site Emergency Plan indicates various action groups at district levels which will be engaged in case of off-site emergency.

Emergency organization and arrangement include:

This section is devised to suggest the organization for emergency preparedness. Key personnel to combat emergency are nominated with specific responsibilities according to set procedures and making best use of the resources available and to avoid confusion. Such key personnel include Site Main Controller, Incident Controller; Services Coordination includes Fire & Safety, security, engineering Services (maintenance),environment, Lab (QC/QA), HR & Admin, Accounts & Finance, Store & purchase and Process.

All such key personnel (Annexure 1- Emergency Management Chart) shall be available in all the office timings and shall be called during emergency on holidays.

Safe Assembly Points

Assembly Point will be provided at the green belt area. The safe assembly points are selected considering the distance from the hazardous/ flammable storage, wind direction, capacity to accommodate the required number of people and availability of other resources in that area.

In case of emergency,it will be necessary to evacuate all personnel from effected area, except personnel who will be directly involved in dealing with the incident. On evacuation people will go to designated assembly points.

Emergency Control Centre (ECC)

During Working Hours the Emergency Control Centre (ECC) will be situated at Reception Building, and during Non-Working Hours the Emergency Control Centre (ECC) will be situated at Security Cabin from where the operation to handle the emergency are directed and coordinated.

The ECC will be equipped with all necessary emergency equipment, communication arrangement to receive and transmit information and directions from and to the incident controller and areas of the works as well as outside. 1 Direct Line with Emergency Contact Numbers will be available at both the places.

The emergency contact numbers for the mutual aids like nearest police station, fire station, hospital, ambulance service etc. & list of emergency team members and various activity coordinators will be displayed at the emergency control Centre, security gate and other prominent locations.

Emergency Control Centre will be having the following facilities:

a. List of telephone numbers for external & internal communication

b. Plans of the location

c. Stationeries

d. Copies of the on-site and off-site emergency plans

e. Details and location plans of firefighting equipment such as fire extinguisher, fire hoses & nozzles etc.

f. Details and location plans of safety equipment such as SCBA, gum boots, gloves, goggles, cover all etc.

Emergency Warning System

A siren audible in all parts of the facility, to warn the people for the evacuation with different sounds for declaration of emergency or emergency call off will be provided along associated with manual call point are provided at prominent locations. Warning system will always be kept in working order.

The mode of siren for evacuation is wailing pitch. On hearing the siren, people will disperse from the work area and will evacuate to safe assembly points. Proper instruction will be given to all the employees about the rising of siren and the emergencies. The same instructions will also be displayed at prominent places within the plant area.

The employees will proceed to the predetermined assembly points on hearing the siren and the support staff / security forces will instruct and divert the people away from the affected area towards the assembly points.

Medical Services and First Aid

The First aid team will play critical role in attending the victims in case of any accident.

First Aid boxes will be provided at prominent locations & trained first-aider will be available in all working shifts. The list of trained first aiders will be displayed at prominent locations and is also available at security gate office.

In case of any medical assistance other than first aid, the Admin In-charge/ Site- SHE representative will arrange for a vehicle to shift the casualty to the company accredited hospital, or call an ambulance to mobilize the casualty to the medical center/ hospital.

Transport and Evacuation Arrangements

In a major emergency, it is essential to evacuate personnel from affected areas and to further evacuate non-essential workers from areas likely to be affected,should the emergency escalate.

Communication and help from external emergency services

Communication is a critical factor in handling an emergency. To control the situation by the earliest possible action. 1 Direct Line with list of emergency contact numbers will be provided at emergency control center as well as at security gate.

The external emergency services which can be contacted for help during emergency include:

SN	Services/Authorities	Telephone no.
1	District Collector (DC)	+91 2692 262271 +91 2692 261575
2	Control Room Anand	02692261033
3	Police Station, Anand	+91 2692252450
4	Sardargunj Fire Brigade Station, Anand	+91 2692 243101
5	Anand general hospital	9898197301

The above emergency services telephone numbers are displayed at emergency control room and prominent locations within the plant.

Other Arrangements

Power Supply Interruption

For Emergency, Plant Operations and Emergency Lighting provisions will be made according to requirements. A DG set of 220 KVA capacity will be provided as backup.

Electrical Supply

Electricity is considered as a major cause of fire in industries. To prevent fires due to electricity, adequate control measures will be provided which includes regular inspections and preventive maintenance. To prevent other electrical accidents such as electric shock etc. the adequate safety precautions will be implemented including provision of Fuse, MCB, ELCB, rubber mats in front of panels, proper laying of cables, etc.

Trade Waste Disposal

Organization will be more concerned for environment protection and pollution abatement at all times. Provision will be made to dispose Solid wastes. The company will dispose off all solid waste in safe manner.

Emergency Action

Though it will be an impractical to describe all the foreseeable scenarios involving flammable/combustible materials and the suggested action for the same, some important ones are discussed here briefly. Even in identical incidents the right course of action may not necessarily be the same every time as the actual action will depend on the several factors, such as the place of incident, quantity of material involved, the amount of release, the nature of material, the wind direction, the wind velocity, temperature of surrounding, time of day, prevailing season and weather condition.

In case of Fire

In case of declaration of onsite emergency (Hearing of emergency siren), evacuate the area as per evacuation plan & exit signs on instruction of shift in-charge / incident controller as quickly as possible after safe shutdown of the plant. See that the wind direction is in opposite direction of assembly point by wind direction indicator. If not, change the assembly point.

Following are the general guideline for emergency action.

- Raise the alarm through nearest MCP
- Inform security and shift in charge.
- Carry nearest fire extinguisher & try to extinguish if possible.
- Assemble emergency team and inform other emergency members.
- Check the wind direction, then decide the assembly point and inform accordingly.
- Warn the people nearby.
- Attempt to isolate /extinguish the fire with the help of others with available appropriate extinguishers.
- Arrange fire hydrant hose and try to cool surrounding
- Cordon the area and try to shift the drum of flammable material.
- Used foam generating nozzle and create foam to extinguish fire.
- If fire beyond control call fire brigade after consultation with chief controller.
- Cool the surrounding or remove flammable material if possible.

- Take head count at site and inform to the chief controller.
- Also take head count at the assembly point and tally.
- Search for missing person if any.
- Call for mutual aid members for help, if require.
- Arrange for rescue, if required.
- Give first aid to the injured person and check for further treatment is required.
- Give priority to saving life and preventing further injuries.
- Confirm the message of incident attend to the main controller & raise the all clear siren.
- Collect the photograph and other evidence to cause fine

In Case of spillage of chemicals/materials while unloading & loading activity Tankers/Tanks inside the factory premises:

Special instruments for storing, Handling & emergency actions in case of spillage of chemicals/materials are given separately in MSDS.

Following are the general guideline for action:

- Use PPE's like SCBA/Gas mask/Respirator & evacuate the area.
- Designated area will be provided for tanker parking.

In case of declaration of onsite emergency (Hearing of emergency siren), evacuate the area as per evacuation plan & exit signs on instruction of shift in-charge / incident Controller as quickly as possible after safe shut down of the plant. See that the wind direction is in opposite direction of assembly point by wind direction indicator. If not, change the assembly point.

In case of Flood / Earthquake:

In case of natural calamity like flood, Storm or earth quake (remote possibility) the management may seek outside help. The help may be for firefighting, Evacuation (of surrounding population), Medical treatment, shelter, food, transport or communications.

Following are the general guideline for emergency action:

- Close main valve
- Switch off electricity (main).
- Assemble outside the office, away from Electric Poles & Wires.
- Evacuate the areas after initiating (communication in working condition) off site organization.

In case of War/Civil riots:

Following are the general guideline for emergency action:

- Intimate nearest police station & stimulate off site emergency plan
- Stop unloading / loading operations (if any)
- Intimate civil defense dept. about the situation
- Security persons shall protect & control law & order.

General action plan

- All personnel handling the emergency should wear PVC suit / alkali suit, gumboot, PVC hand gloves, PVC goggles.
- Isolate the sources of supply.
- Cordon off the area.
- Avoid the entry of unnecessary people.
- Start barricading the area with sand / earth.
- Flush the affected body parts with plenty of water and seek medical help.

Evacuation Plan

On hearing the siren all employees shall evacuate the area by safely closing down all operation as per instructions from their Incident Controller or in nighttime Shift supervisor. After gathering at assembly points, shift-in-charge should take the roll call & ensure that no person is left trapped.

The Rescue Coordinator or Guard (who is inside the plant for duty) shall ensure that none is trapped inside the plant. Security guards shall ensure total evacuation.

Main gate will be used for movement of personnel, movement of rescue, medical aid.

Traffic Control

The Security In-charge or Guard shall contact Service Coordinator and shall make himself available at main gate for traffic control till local authorities help is available.

Unwanted traffic and public gathering shall be controlled & avoided by security personnel till local help from police is available.

Public Relations

Inevitably a major incident will attract the attention of the press, television and radio services and anxious inquiries from friends and relatives will be flooding the factory. It is essential to make arrangements for authoritative release of information to them. SMC/IC who is familiar with procedures of dealing with such situations, shall take charge of public Relations, information etc. He will be the sole authoritative source of information to the news media and others.

Declaration of cessation of emergency

Only the Main Site Controller in consultation with Incident Controller and The Service coordinator (Emergency Fire, Rescue & Security Co-ordinator etc.) will declare the cessation of emergency ensuring that all the spillage are arrested or fires are extinguished and there is no risk of re-ignition (in case of fire).

In the case of gas, the all clear will be declared only when the source of emission has been effectively isolated and gas clouds dispersed well below safe level.

Even when the all clear Signal has been given, great care is needed while entering affected areas and no work in connection with salvage, collection of evidence should be commenced until a thorough examination of the area has been carried out.

The siren code will follow for declaring the cessation of an emergency.

All clear signed shall be given by SMC / Incident Controller.

Plan appraisal and updating

The Onsite Emergency Plan Mock drills will be conducted for the appraisal and updating the Onsite Emergency Plan.

The Onsite Emergency Plan Mock drills will review the adequacy and effectiveness of the arrangements made / provided for emergency planning and will cover:

- Awareness and promptness of action taken by the employees.
- The adequacy of evacuation routes and safe assembly points.
- The adequacy of fire fighting system and equipment.
- The adequacy of leak / spillage control system and equipment.
- The adequacy of transport and medical arrangements.
- The adequacy of personal protective equipment and safety equipment etc.

Any inadequacy observed during the mock drill will be corrected and incorporated, the Onsite Emergency Plan will be updated and any changes made in the Onsite Emergency Plan will be made known to all.

Safety and mitigating measures

Safety is major consideration for M/s. Maruti Polymer Incorporation and the industry is committed to mitigate the risk. Important mitigating measures will be provided to contain and control the emergency are outlined below:-

Fire Prevention and Protection measures

Fire is the major risk at M/s. Maruti Polymer Incorporation because of storage handling and use of flammable substances within the premises as raw material and products. Adequate control measures will be provided to detect and fight fires. The major firefighting arrangements provided include.

Emergency siren system and outside communication system provision will be made available.

Firefighting Arrangement: Fire Extinguishers, Foam type, Dry Chemical Powder Type, Water sprinkler system and sand bucket will be installed at various locations in the premises.

The nearest fire brigade station is Sardargunj, Anand Fire Brigade Station. Approx.7km

The plant will be equipped with a comprehensive fire protection system. Following facilities will be provided for the fire protection:-

- Fire sprinkler system with smoke/fire detectors.
- Portable Fire Extinguishers

Equipments and Process safety

M/s. Maruti Polymer Incorporation will comply the statutory requirements and provide safety measures. The following points to be considered:

- Guard shall be provided on moving parts of machineries.
- Adequate ventilation or other engineering controls shall be provided to keep the airborne contaminants below their respective threshold limit value.
- Lifting tools, tackles and machines and pressure systems will be tested and examined as per statutory requirement.
- Proper earthing and bonding shall be provided etc.

Post emergency planning

- All evidences should be collected and accident should be investigated.
- Before restart up of the activities, assess the situation and ensure that it is safe to restart the plant activities.
- Re-start the plant in the standard sequence.

Health, Safety and Environmental Protection

The policy of the company is to manufacture, handle and dispose off all substances safely and without creating unacceptable risk to human health or the environment.'

Company is committed to complete safety and accident prevention policies for ensuring the elimination of risk, accidents by conscientious involvement in Safety and Health Programme. The industry will;

- Establishment and maintain programmes to ensure that laws and regulations applicable to its products and operations are known as obeyed.
- Develop its own standards where laws or regulations may not be adequately protective and adopt, where necessary, its own standard where laws do not exists.
- Stop manufacturing any product or any operation if hazards of the same, to the human beings and environment are unacceptable.
- Each and every employee is expected to adhere to the spirit as well as letters of company policy.
- Any hazards, adverse situation or environmental risk which comes to their attention should be promptly reported for the corrective measures.
- Safety has been accepted as complete and separate functions like other functions such as production, maintenance, marketing, etc.
- Auditing is necessary for an effective health and safety programmes, and periodical auditing will be carried out.
- We believe safety is a team work and each and every employee of the company is responsible and accountable for the safety.

Employee responsibility

- Follow the policy and applicable laws and regulation to protect your own health and safety as well as that of other workers, the public and the environment.
- Present ideas that support the goals of policy.
- Promptly report concerns about possible violation of this policy to the persons listed or to your manager.

Managers responsible for a facility, activity, product or service will:

- Communicate responsibility with employees, communities, customers and government agencies regarding environmental health and safety issue.
- Cooperate with the public, government and other interested parties to develop appropriate regulatory and public policies that protect employee and public health and the environment.
- Implement effective programs, training and best practices for health, safety and environment protection and for the elimination or reasonable reduction of materials.
- Regularly assess plant operations & management. Establish measurements to ensure compliance with this policy and applicable laws & regulations, when appropriate; review assessment results with environmental programs.
- Ensure that an employee with EHS responsibilities is appropriately screened before appointment and that continued appropriateness for their position is periodically reviewed.
- Develop appropriate program for safety reviews of new and redesigned products prior to sale and distribution to customers. Monitor after-sale safety performance to identify and address significant product safety issues.
- Work cooperatively with, contractors, business partners & suppliers to ensure that our relationships with them are supportive of this policy.
- Promptly report to medical Services, Environmental Program & your assigned legal counsel any,
- Emergency evacuation, communicable disease or other serious health indent.

- Work related employee facilities & other serious safety incidents requiring a report to a governmental agency.
- Information regarding a report to a governmental agency or any governmental allegations of substantial violations of environmental laws or regulations.
- Legal proceedings alleging significant property damage or personal injury from environmental contamination or exposure to dust/chemical fumes & other information requested by medical services or Environmental programs.

Training and rehearsing

All employees should know the details of Disaster Management plan and they must receive initial training in emergency procedures. At suitable intervals this knowledge must be exercised and the basic plan reviewed and brought up-to-date. It is essential to establish the necessary confident volunteers and better expertise, so the individuals can carry out their allocated duties. Rehearsal of evacuation should be regularly carried out efficiently and should cause minimum disruption to the normal activities. As per MFR, Mock Drill should be conducted six monthly.

An after-mock drill report may be prepared detailing the lacunas & strong points so as to make improvements in the emergency action plan.