CHAPTER 6

ADDITIONAL STUDIES

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.

RISK ASSESSMENT

OBJECTIVE OF THE STUDY

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

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 loses. 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.
- To Asses, the potential risks associated with identified hazards to which the plant 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.

SCOPE OF THE STUDY

The Project will undertake Quantitative Risk Assessment (QRA) study for the storage tank area.

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

Table-7.1: Chemical Storage

Name of Raw Material	Storage Facility / Packing	Storage / Packing Capacity (MT)	Storage condition
Methanol	MS Tank	20	NTP
Phenol	MS Tank	20	NTP
Formaldehyde	MS/HDPE Tank	50	NTP
Acetic Acid	HDPE Tank	1	NTP

QRA study will include the following task:

- Hazard Identification
- Failure Scenario
- Consequence Analysis
- Dispersion Modelling
- Risk Assessment
- Evaluation of risk reduction options. and risk management plan

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 consequence of the loss of containment.

- 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.

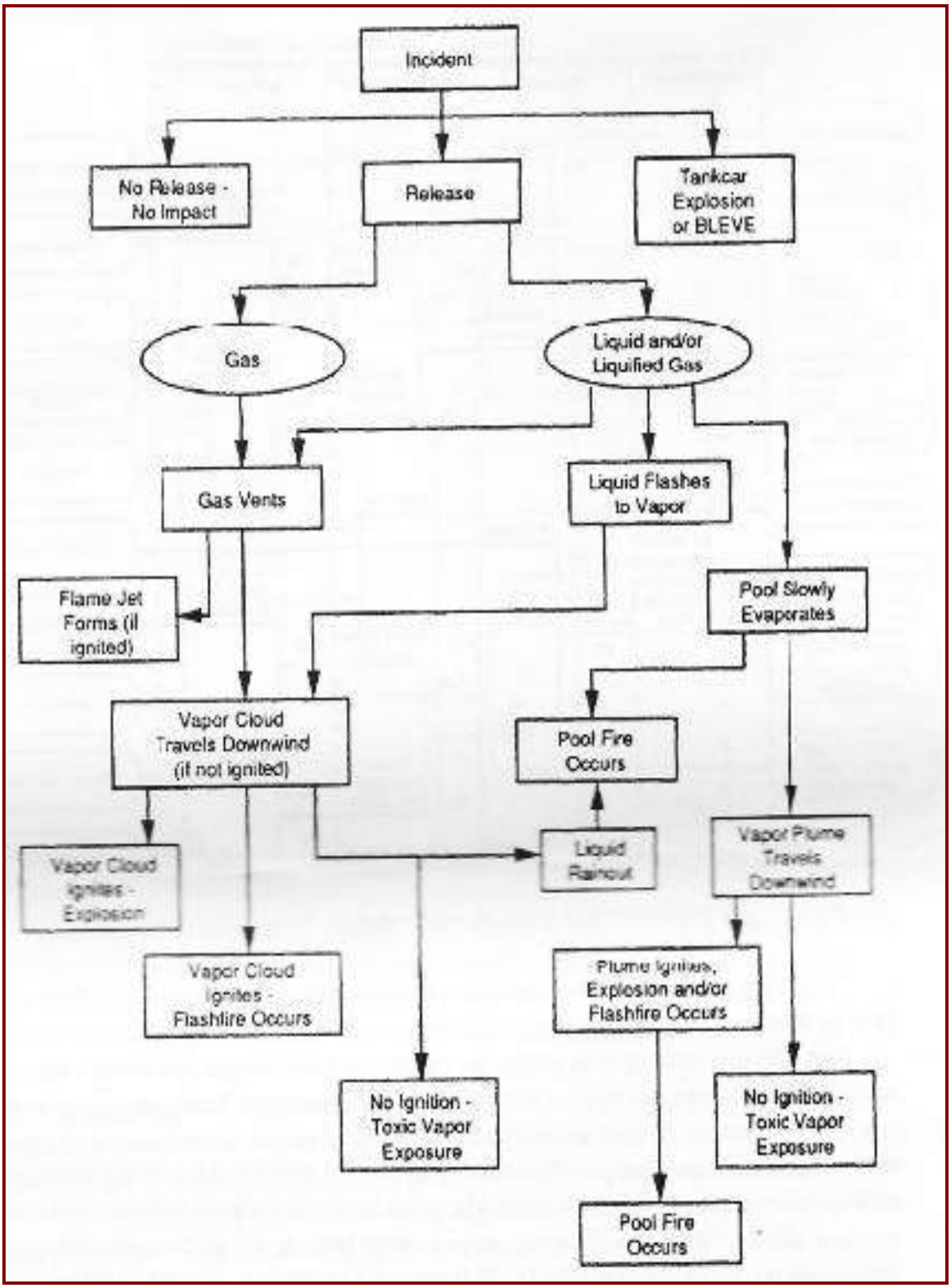
Consequence analysis and calculations are effectively performed by computer software using models validated over a number of applications. Consequence modelling is carried out by PHAST (version 6.53) of DNV Software, UK.

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: Consequence analysis; Event Tree Analysis for release of flammable liquid.



SOFTWARE USED

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

OTHER FACTORS CONSIDERED FOR RISK ASSESSMENT

METROLOGICAL 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 metrological data of the Ahmedabad.

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 insulation) and night time sky cover have been identified as prime factors defining these stability categories.

When the atmosphere 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 distances) occur during low wind speed and very stable weather conditions.

HAZARDS & DAMAGE CRIETERIA 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 pool. 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 vapor 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 heat release rate is a function of the liquid surface area exposed to air. An unconfined 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 vapor 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 vapor 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 limited openings (e.g. due to small leak in a vessel or broken drain valve). Boiling liquid expanding vapor 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 vapor explosion (BLEVE). Fireball duration is typically 5 – 20 seconds.

Vapor cloud explosion:

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

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 the 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 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-6.3: Fatal radiation Exposure level

RADIATION LEVEL kW/m²	FATALITY		
	1%	50%	99%
	EXPOSURE IN SECONDS		
4.0	150	370	930
12.5	30	80	200
37.5	8	20	50

OVERPRESSURE DAMAGE

Table-6.4: Overpressure Damage Criteria

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 Planning Guidelines (ERPG) for many chemicals, describes the various scenarios:

- **ERPG-1** is the maximum airborne 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.
- **ERPG-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.
- **ERPG-3** 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 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 hrs. 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 Time 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.

Physical and Chemical Properties of the Materials, Compatibilities & Special Hazard

SN	Name of Chemical	Hazard	BP	Flash Point ^0C	Flammability Limit (Vol. %)	TLV PPM	IDLH PPM	LC50	Target Actions	Carcigenicity	Antidotes
1.	Methanol	F/T	64.7	11	Lower: 6.7 % Upper: 36 %	200	6000	64000 ppm/4H	Kidneys, heart, central nervous system, liver, eyes	No	10 mg diazepam through injection Activated Charcoal
2.	Phenol	F/T	182	79	Lower: 1.7 % Upper: 8.6 %	5	250	316 mg/m3/4H;	Eyes,skin,inhalation,ingestion	No	No specific antidote but Charcoal hemoperfusion can remove free phenol from blood
3.	Formaldehyde	F/T	101	50 - 78	Lower: 7 % Upper: 73 %	5	20	203 mg /M3	Eyes, skin	No	Milk, Activated Charcoal or water
4.	Acetic Acid	F/T	117.9	39	Lower: 4 % Upper: 19.9 %	10	50	5620 ppm/1H	Teeth, eyes, skin, mucous membranes	No	Milk of magnesia

Precautions to be taken during storage

Control measures for Methanol, Phenol, Formaldehyde, and Acetic Acid Storages

- Stand by Tank provided in case of emergency transfer the material.
- Drain valve with metal plate blind provided.
- Dyke wall provided to all storage tanks, collection pit with valve provision.
- Tanker unloading procedure prepared and implemented.
- Caution note and emergency handling procedure are displayed at unloading area and trained all operators.
- NFPA label is provided on tanks.
- Required PPEs like full body protection PVC apron, Hand gloves, gumboot, Respiratory mask etc. provided to operator.
- Dedicated Airline respiratory system to be provided in this tank farm area to handle major spillage or leakage emergency.
- Neutralizing material kept ready for tackle any emergency spillage.
- Safety shower, eye wash provided near tank farm area.
- Level gauge provided on all storage tanks.
- Storage tank integrity to be checked

Table: - Transportation, Unloading and handling procedure For Methanol, Phenol, Formaldehyde, Acetic Acid

Sr.No.	Activity	Type of possible hazard	Control measures and handling procedures.
1	Transportation of Methanol,Phenol,Formaldehye, Acetic Acid by road tanker	Leakage, Spillage, Toxic release	• Training is provided to driver and cleaner regarding the safe driving, hazard of Flammable chemicals, emergency handling, use of SCBA sets administration. • TREM card will kept with TL. • SCBA set is kept with TL. • Instructions is given not to stop road tanker in populated area. • Clear Hazard Identification symbol and emergency telephone number is displayed as per HAZCHEM CODE. • Appropriate PPEs is kept with TL. • Emergency telephone numbers list of OFF site emergency agencies is provided in TREM CARD

2	Methanol, Phenol,Formaldehye, Acetic Acid Road tanker unloading at site.	Leakage, Spillage, toxic release	• Priority is 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 Licence, 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 is allowed be started. **Following precautions is adopted during unloading** • Wheel stopper is provided to TL at unloading platform. • Tanker unloading procedure is followed according to check list and implemented. • Flexible hose connection is done at TL outlet line and checked for no leakage. • Every time rubber gasket is changed. • The quantity remaining in the hose pipeline is drained to a small container, which is subsequently transferred to the main storage tank thus ensuring complete closed conditions for transfer from road tanker. • All TL valves is closed in TL.
3	Methanol,Phenol,Formaldehye, Acetic Acid Storage tank safety	Leakage, Spillage, Toxic release.	• Storage tank is stored away from the process plant. • Tanker unloading procedure is prepared and implemented. • Caution note and emergency handling procedure is displayed at unloading area and trained all operators. • NFPA label is provided. • Required PPEs like full body protection PVC apron, Hand gloves, gumboot, Respiratory mask etc. is provided to operator.

Sr.No.	Activity	Type of possible hazard	Control measures and handling procedures.
			• Neutralizing agent is kept ready for tackle any emergency spillage. • Safety shower, eye wash with quenching unit is provided in acid storage area. • Material is handled in close condition in pipe line. • Dyke wall is provided to all storage tanks, collection pit with valve provision. • Double drain valve will provided. • Level gauge is provided on all storage tanks. • Safety permit for loading unloading of hazardous material is prepared and implemented. • TREM CARD is provided to all transporters and is trained for transportation Emergency of Hazardous chemicals. • Fire hydrant system with jockey pump as per TAC norms is installed.
4	Methanol,Phenol, Formaldehye, Acetic Acid ,transferred from storage tank to Day tank	Leakage, Spillage due to Line rupture, Flange Gasket failure, Toxic release.	• Double mechanical seal type pump is provided. • Double on / off switch will provided at tank farm and process area near day tank. Pump auto cut off with day tank high level is provided. • Flame arrestor is provided on day tank vent. • Over flow is provided for additional safety and it is connected to main storage tank. • NRV is provided on pump discharge line. • Flange Guard is provided to all flanges.
5	Methanol,Phenol,Formaldehye, Acetic Acid ,transfer from Day tank to reactor.	Leakage, Spillage due to Line rupture, Flange Gasket failure, Toxic release.	• Gravity transfer. • Double valve is installed on day tank outlet line. • Total quantity of day tank material is charged in to reactor at a time. • NRV is provided on day tank outlet line. • Flange guard is provided to pipeline flanges.

Table: Drums Transportation, Unloading and handling procedure

Sr. No.	Activity	Type of possible hazard	Procedures.
1	Transportation of drums	Leakage, Spillage, fire, explosion, Toxic release	• Training will be provided to driver and cleaner regarding the safe driving, hazard of Flammable chemicals, emergency handling, and use of SCBA sets. • TREM card will kept with TL. • SCBA set will be kept with TL. • Fire extinguishers will be kept with TL. • Flame arrestor will be provided to TL exhaust. • Instructions will be given not to stop road tanker in populated area. • Clear Hazard Identification symbol and emergency telephone number will be displayed as per HAZCHEM CODE. • Appropriate PPEs will be kept with TL.

Sr. No.	Activity	Type of possible hazard	Procedures.
2	Drums unloading at site.	Leakage, Spillage, fire, explosion, toxic release	• Priority will be given to truck 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 Licence, TREM CARD, Fire extinguisher condition; SCBA set 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. • Only day time unloading will be permitted.
3	Godown / warehouse safety	Leakage, Spillage, Fire, Explosion, Toxic release.	• FLP type light fittings will be provided. • Proper ventilation will be provided in godown. • Proper label and identification board /stickers will be provided in the storage area. • Conductive drum pallets will be provided. • Drum handling trolley / stackers/fork lift will be used for drum handling. • Separate dispensing room with local exhaust and static earthing provision will be made. • Materials will be stored as per its compatibility study and separate area will be made for flammable, corrosive and toxic chemical drums storage. • Smoking and other spark, flame generating item will be banned from the Gate.
4	Acids, Solvents, etc. transfer from drum to Day tank/ reactor	Leakage, Spillage due to Line rupture, Flange Gasket failure, Fire, Explosion, Toxic release.	• Acids and solvents transfer by vacuum or by pump only. • Static earthing will be provided. • SS flexible hose / conductive hose will be used.
5	Acids, Solvents, from Day tank to reactor.	Leakage, Spillage due to Line rupture, Flange Gasket failure, Fire, Explosion, Toxic release.	• Gravity transfer. • Total quantity of day tank material will be charged in to reactor at a time. • NRV will be provided on day tank outlet line. • Static earthing will be provided to storage tank. • Double Jumpers will be provided to pipeline flanges.

FACILITIES / SYSTEM FOR PROCESS SAFETY, STORAGE, TRANSPORTATION,

FIRE FIGHTING SYSTEM AND EMERGENCY CAPABILITIES TO BE ADOPTED.

PROCESS SAFETY:

- Flameproof equipments and fittings will be provided for handling of hazardous chemicals.
- Tanks and all pump motors will be properly earthed.
- Housekeeping of the plant will be as per prescribed norms. Floors, platforms, staircases, passages will be kept free of any obstruction.
- All hazardous operations will be explained to the workers. They will be periodically trained on the hazardous processes.
- Dedicated supply of firewater will be made available in the plant.
- Only authorized persons will be allowed inside the plant.
- All instrument and safety devices will be checked and calibrated during installation. They will be also calibrated, checked at a frequent interval. Calibration records will be maintained.
- All electrical equipments will be installed as per prescribed standards.
- All the equipments of the plant will be periodically tested as per standard and results are documented. All equipments undergo preventive maintenance schedule.
- Hydrant system will be pressured with a Jockey Pump.
- Pressure gauge will be provided on each tank.
- In addition to fire hydrant system, nos. of fire extinguishers will be also installed at different locations within premises.
- Retention basin will be provided to collect the contaminated water used during fire fighting.
- Adequate ventilation arrangement will be provided for safe and better working in the plant as per the standard.
- Process, equipments, plant involving serious fire hazards will be designed as per prescribed guideline.

STORAGE TANK SAFETY

- Fire load calculation will be done and as per fire load Hydrant System will be provided as per NFPA std. and Fire extinguishers will be provided as per fire load calculation.
- Spark arrestor will be provided to all vehicles in side premises.
- Flame proof type equipments and lighting will be provided.
- Lightening arrestor will be provided on the top of chimney.
- Raw material will be transferred by pump only in plant area and day tank will be provided. Overflow line will be return to the storage tank or Pump On-Off switch will be provided near day tank in plant.
- Jumpers will be provided on solvent handling pipe line flanges.
- Flexible SS hose will be used for road tanker unloading purpose and other temperature connection.

SAFE DESIGN AND MAINTENANCE

After studying the properties of the material to be stored, proper selection of the material construction, metal thickness, design, nozzles, connections, pipe lines, fittings, valves, pumps, lining, coating, jacketing, insulation, cladding etc. and colour coding are necessary.

HANDLING OF CORROSIVE CHEMICALS

Important corrosive substances are: Acids and alkalis

When in contact with human tissues, most corrosive substances will produce chemical burns, while certain other substances produce deep ulceration. Many corrosive substances have defeating action on the skin and may cause dermatitis.

The safeguards against these hazards are:

- Preventing or minimising contact between corrosive substances and skin, mucous membranes and eyes.
- Corrosive substances are not allowed to come in contact with materials that may react.
- All the containers, pipes, apparatus, installations and structures used for the manufacture, storage, transport or use of these substances are protected by suitable coatings, impervious to and unaffected by corrosives.
- All containers or receptacles are clearly labelled to indicate their contents and should bear the danger symbol for corrosives.
- A high standard of maintenance and good housekeeping is essential.
- Adequate ventilation and exhaust arrangement whether general or local, should be provided whenever corrosive toxic gases or dust are present.
- Personal protective devices are used depending upon the nature of work viz.
    - ✓ Corrosion-resistant and impervious suits, or hand-gloves, aprons etc.
    - ✓ Respirator, gas mask or self-contained breathing apparatus,
    - ✓ Barrier cream when exposure is not severe.
- First aid treatment facilities are provided and all concerned will be instructed to follow safe practices such as Prolonged washing with water, Removing contaminated clothing, Seeking immediate medical help.
- Safety showers and eye washers are provided.

EMPLOYEE SELECTION AND TRAINING:

Persons affected with asthma, bronchitis chronic lung conditions, and irritations of the upper respiratory tract are not employed where exposures to chlorine might occur.

Training classes for both new and old employees conducted periodically to keep them conscious and informed of the hazards.

They are instructed and trained to adopt preventive measures in case of emergency and to use safety equipment.

LEAKAGE TOOLS REQUIREMENT:

1. Do not use water directing on leak.
2. Keep "emergency kits' handy and in proper working condition to control leakage and train workers in their use.
3. Appropriate facility for chlorine absorption through caustic soda/lime/soda ash solutions will be established and maintained in the event of leakage.
4. The containers should not be immersed in same absorption media.
5. Self-breathing apparatus, gas mask and 'emergency kits' are located at strategic Points under working condition and to be easily accessible in the event of emergency.

STORAGE AREA:

Storage area should be cool, dry, well ventilated, clean and protected from external heat source. It should be remote from elevators, gangways or ventilating systems.
Ventilation is sufficient to prevent accumulation of vapour pockets. All fan switches have been outside the storage area.
As far as possible, the building for the storage of chemicals is entirely of non-combustible construction and separate from other building.

PERSONAL PROTECTIVE EQUIPMENT :

Adequate-and suitable personal protective equipments will be provided e.g. gastight chemical goggles, self contained breathing apparatus, positive pressure hose masks, chemical cartridge respirators, hard hats, soft-brimmed hats or caps, safetytoed rubber boots, rubber gloves, rubber apron or rubber coat, sleeves and trousers legs, etc.

OCCUPATIONAL HEALTH PROGRAMME
Health hazards associated with the occupation are called occupational hazards. In chemical industry due to handling of toxic and hazardous chemicals there are possibilities of developing occupational diseases.

OCCUPATIONAL HEALTH

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

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 TLV's, necessary protective equipment shall be supplied to workers.

Work permit procedures for Hot Work, Excavation Work, Work on Electric System and Work at Height shall be followed. A qualified doctor has been appointed as FMO on retainer ship basis. Apart from him, require medical facilities applicable as per Gujarat Factories Rules and Factories Act are made available.

PROPOSED FACILITY TO BE MADE AVAILABLE AT OHC
A Room is provided & operated as OHC. The centre is 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

AMBULANCE VAN & FIRST AID BOX

An Emergency Vehicle from Guj- Govt-108 available round the clock to be used as an ambulance.

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

MEDICAL EXAMINATION

Unit carrys out the following checks to curb the problem:

i) Pre - employment medical check-up at the time of employment.
No person shall be employed for the first time without a certificate of fitness granted by the Factory Medical Officer.

ii) Periodic Medical examination is being conducted as per the following schedule;
Workers employed are examined by a qualified medical practitioner/ Factory Medical Officer, in the following manner:

(a) During employment, 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., LFT, Chest X-rays, Audiometry, Spirometry, Vision testing (Far & Near vision, color vision and any other ocular defect) ECG, Blood Pressure, Sugar, CBC, Lung Function test & routine urine test and other parameters as will be found necessary as per the opinion of Factory Medical officer.be carried out at frequent intervals, the records of which shall be documented.

All precautions shall be taken to avoid foreseeable accidents like spillage, fire and explosion hazards and to minimize the effect of any such accident and to combat any emergency at site level. Some of the preventive safety measures shall be taken to minimize the risk of accident with respect to Technical Safety, Organizational Safety and Personal Safety are listed below:

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.

It is proposed to formulate and implement an EMP for Occupational Safety and Health with following aim…

- To keep air-borne concentration of toxic (if available) and hazardous chemicals below PE Land TLV.
- Protect general health of workers likely to be exposed to such chemicals
- 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.

(1) 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.
(2) Proposed EMP will be incorporated in Standard Operating Procedure also.
(3) The proposed EMP will also include measure to keep air-borne concentration of toxic and hazardous chemicals below its PEL and TLV, like…
a. Leak Surveys
b. Separate storage for toxic chemicals
c. Exhaust Ventilation
d. Proper illumination
e. On-line detectors toxic chemical
f. Close processes to avoid spills and exposures
g. Atomization of process operations to hazards of manual handling of chemicals
h. 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
i. Decontamination procedure for empty drums and carboys.
j. Regular maintenance program for pumps, equipment, instruments handling toxic and corrosive chemicals
k. Display of warning boards
l. Training to persons handling toxic and corrosive chemicals

Workplace Monitoring Plan

- It is proposed that a Workplace Monitoring Plan to be prepared & implemented in o consultation with FMO and industrial hygienists.
- 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.
- 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 near the worker's area, within the worker's breathing zone, and have it operate for nearly the full shift. Client has proposed to study the exposure data when the plant is operative.

- Unit carries out indoor work environment monitoring on quarterly basis to check working condition of our employees. If any abnormalities observed, we will take corrective actions for the same

Health Evaluation of Workers

- It is proposed that management will devise a plan to check and evaluate the exposure specific health status evaluation of workers.
- 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.
- While in work, all the workers will be periodically examined for the health with specific reference to the hazards which they are likely to be exposed to during work. Health evaluation will be carried out considering the bodily functions likely to be affected during work. The parameters and frequency of such examination will be decided in consultation with Factory Medical Officer and Industrial Hygienists. Plan of monthly and yearly report of the health status of workers with special reference to Occupational Health and Safety, will be maintained.

SAFETY ORGANIZATION

Construction and Erection Phase

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

Operation and Maintenance Phase

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

SAFETY CIRCLE

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

SAFETY TRAINING

Safety training shall be provided by the Safety Officers with the assistance of faculty members called from Professional Safety Institutions and Universities. In addition to regular employees, limited contractor labors shall also be provided safety training. To create safety awareness safety films shall be shown to workers and leaflets shall be distributed.

Some precautions and remedial measures proposed to be adopted to prevent fires are:

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

FIRE FIGHTING SYSTEM

HYDRANT SYSTEM

- Fire water reservoir
- Fire water pumps:
- Jockey pumps
- Fire pumps operation/status indication panel provided at on automatic
- Single hydrant points
- Double hydrant points
- D.G. set-125 KVA

FIRE EXTINGUISHERS

Adequate numbers of dry chemical powder type, chemical and mechanical foam type and Carbon dioxide type fire extinguishers shall be installed as per the requirement of fire risk in all plants / sections / depts.

Based on the fire load the fire extinguisher will be installed

FIRE DETECTION SYSTEM:

Automatic detection of fire is essential especially for hazard, sensitive and unmanned area. Unit shall provide automatic fire detection system which includes heat, smoke detector to give audio / visual alarm / signal locally as well as in the permanently manned area. This in turn helps in early detection of the fire and to start fire-fighting activity at early stage.

FIRE ALARM

200 V AC operated fire alarm, with manual call points shall be provided in plant call points location to start, activate alarm, siren shall be indicated in site plant provided in ECC, control rooms and OHC. Zone indication is received at main gate. To identify problem area and

communicate to main gate security officer, coordinate with OHC / fire station, to organize help to respective zones with ambulance and fire tender.

Flame proof Electric Fittings

All electrical fittings provided in sensitive areas are flame proof and intrinsically safe.

Tools and Tackles

In chemical industry, it is customary to use non-sparking type tools (spanners, wrenchesetc). Electrical hand tools like torches; lamp etc. to be used in the hazardous area should be flame proof type. All tools should be of approved quality and make and will be purchased with test certificates

CONSEQUENCE ANALYSIS

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, overpressures, 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 con sidered 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.

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 for consequence analysis is 50mm 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 judgment, 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.

EFFECT OF RELEASE

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

1. Dispersion of hydrocarbon vapor 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.
2. 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.
3. A fireball or BLEVE (Boiling Liquid expanding Vapor Explosion) occurs when a vessel containing a highly volatile liquid (e.g. LPG, Propylene etc.) fails and the released large mass of vapor 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.
4. Catastrophic failure of tanks/ pressurized vessels, rotary equipment and valves etc. can result in equipment fragments flying and hitting other equipment of the plant.
5. Release of toxic compounds results in the toxic vapour cloud traveling over long distances, affecting a large area, before it gets sufficiently diluted to harmless concentration in the atmosphere.
6. The material is in two phases inside the containment - liquid & vapor. Depending on the location of the leak liquid or vapor will be released from the containment. If vapor is released a vapor cloud will form by the mixing of the vapor and air. The size of the vapor cloud will depend on the rate of release, wind speed; wind direction & atmospheric stability will determine the dispersion and movement of the vapor cloud.
7. If liquid is released there will be some flashing as the boiling point of liquid is below the ambient temperature. The vapor formed by immediate flashing will behave as vapor release. The liquid will fall on the ground forming a pool. There will be vaporization from the pool due to the heat gained from the atmosphere & ground.
8. There will be dispersion and movement of vapor cloud formed by evaporation of liquid.

The behaviour of material released by loss of containment depends on the following factors:

1. Physical properties of the material
2. Conditions of material in containment (pressure and temperature)
3. Phase of material released (liquid or gas)
4. Inventory of material released
5. Weather parameters (temperature, humidity, wind speed, atmospheric stability)
6. Material with boiling point below ambient condition.

Consequence Analysis

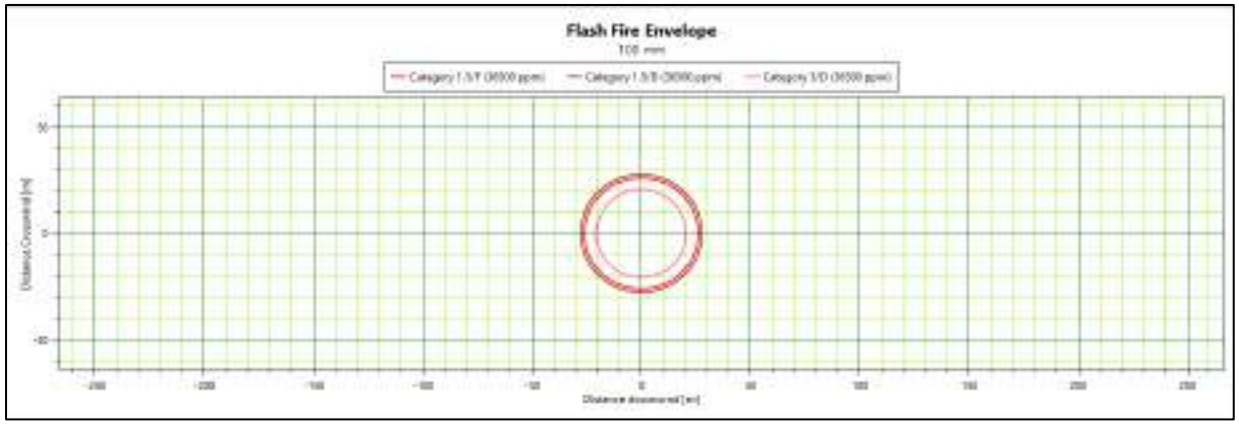
1. Methanol

Scenario details		5 mm leak			25 mm leak			100 mm leak			Catastrophic Rupture		
Weather Category		1.5 F	1.5 D	5D	1.5 F	1.5 D	5D	1.5 F	1.5 D	5D	1.5 F	1.5 D	5D
Flash Fire Envelope (m)													
Conc. (ppm)	7500	3	3	2	8	8	6	11	11	11	11	12	26
	15000	8	7	2	18	16	9	26	28	21	64	52	78
Thermal Damage Distance by Pool Fire (m)													
Radiation Intensity (KW/m^2)	4	15	15	15	63	62	62	103	102	104	102	102	104
	12.5	9	9	10	41	40	44	67	67	73	66	66	73
	37.5	N/A	N/A	N/A	26	26	25	43	43	43	41	41	42
Thermal Damage Distance by Jet Fire (m)													
Radiation Intensity (KW/m^2)	4	5	5	4	15	15	13	41	41	38	N/A	N/A	N/A
	12.5	N/A	N/A	N/A	N/A	N/A	11	N/A	N/A	31	N/A	N/A	N/A
	37.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Maximum Distance at Overpressure Level (m)													
Overpressure (bar)	0.02068	N/A	N/A	N/A	24	23	N/A	106	89	105	231	232	243
	0.1379	N/A	N/A	N/A	5	5	N/A	21	17	20	45	45	14
	0.2068	N/A	N/A	N/A	3	3	N/A	15	13	15	34	33	10

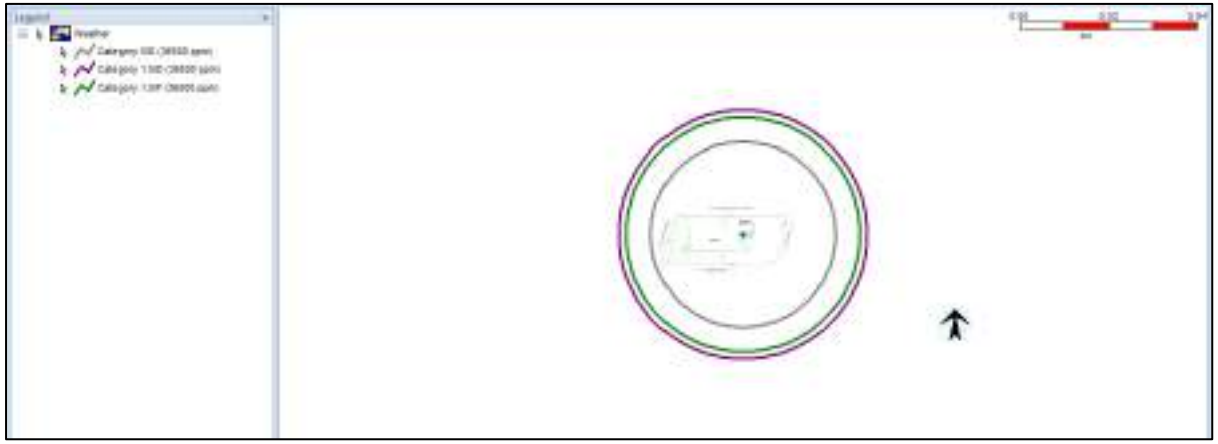
NA- Not Applicable

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.

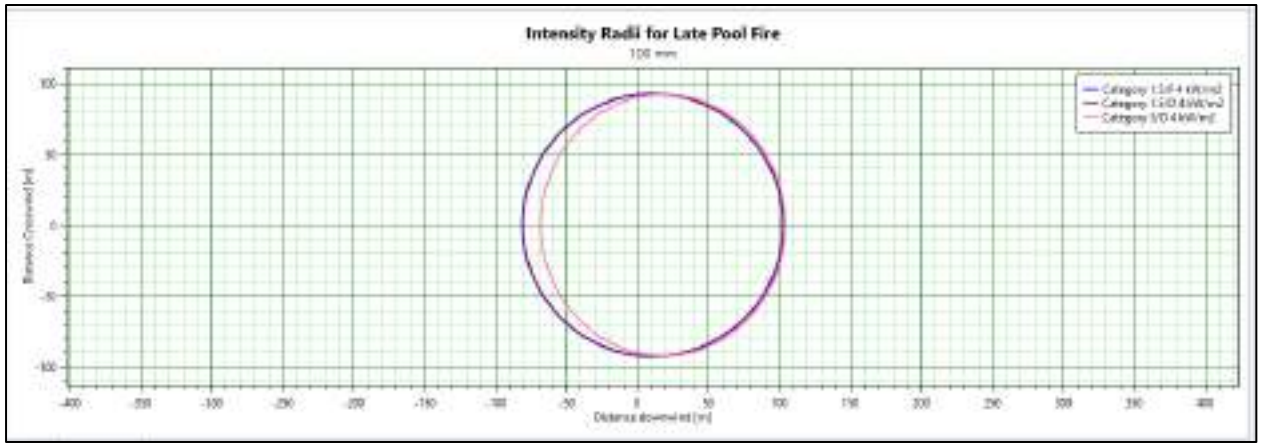
Flash fire in case of 100mm leak of Methanol Storage Tank



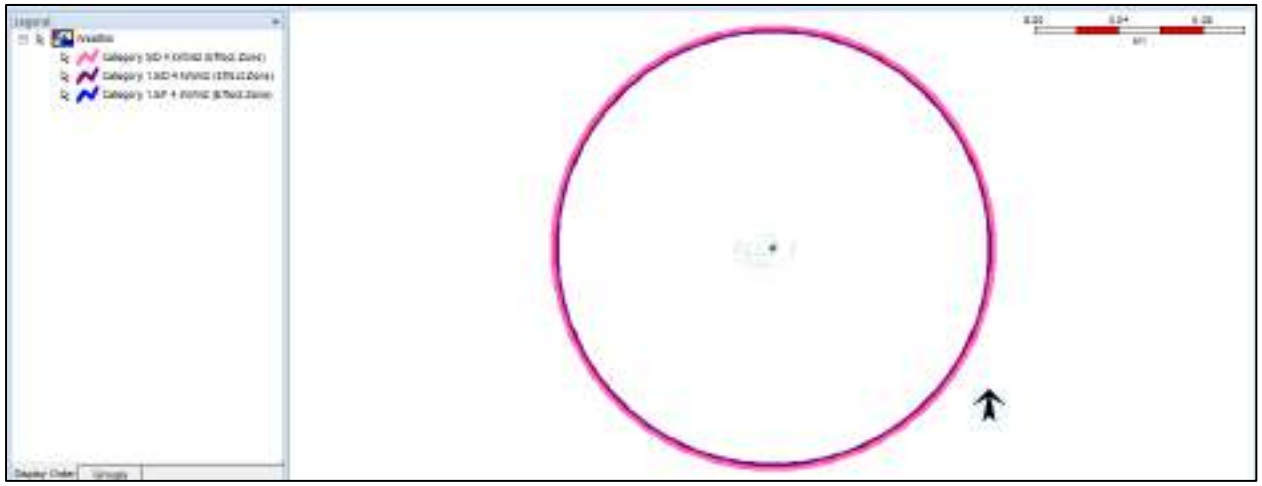
Flash fire envelope in case of 100mm leak of Methanol Storage Tank



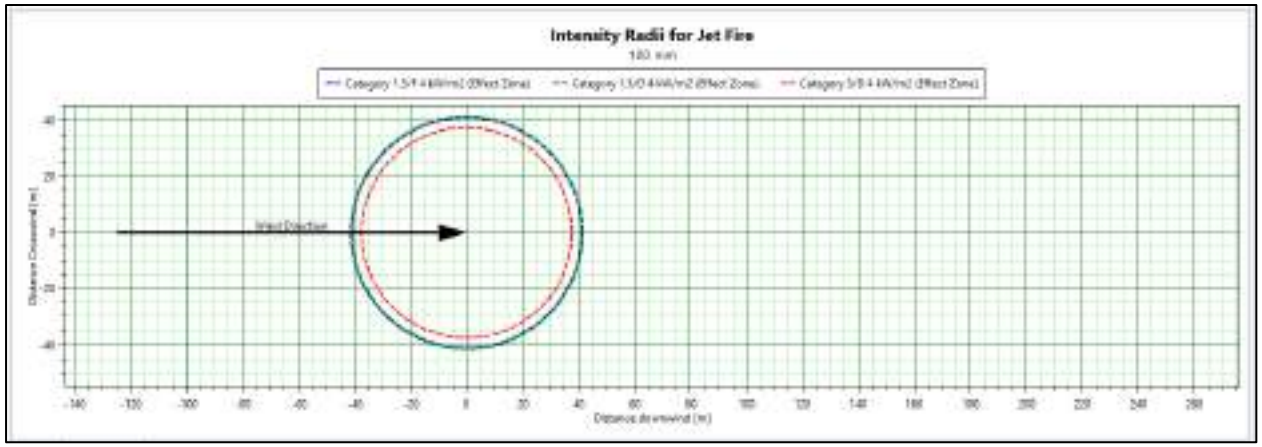
Late pool fire Intensity radii in case of 100mm leak of Methanol Storage Tank



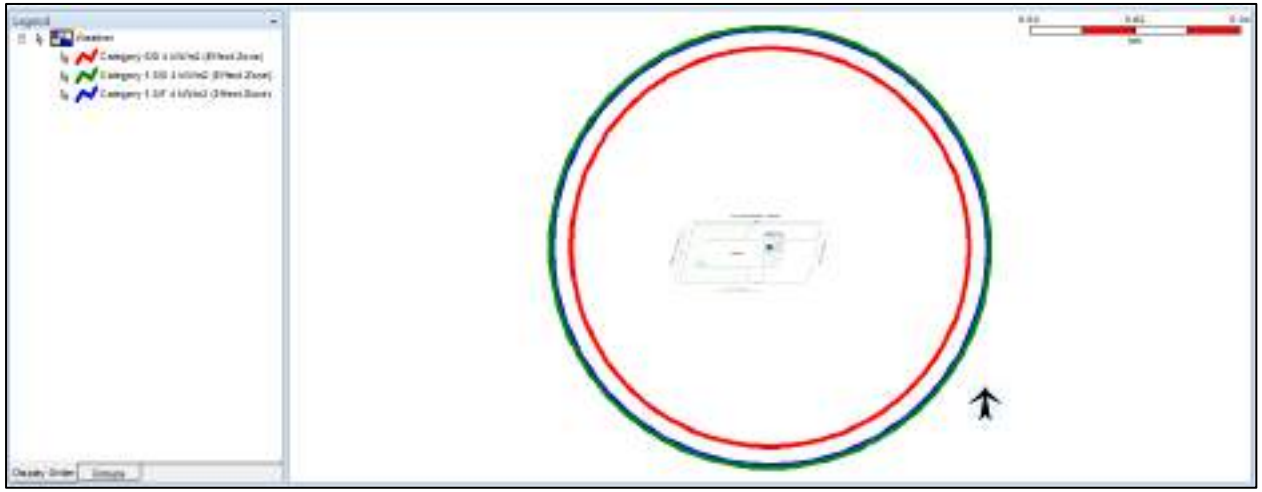
Late pool fire Intensity radii in case of 100mm leak of Methanol Storage Tank



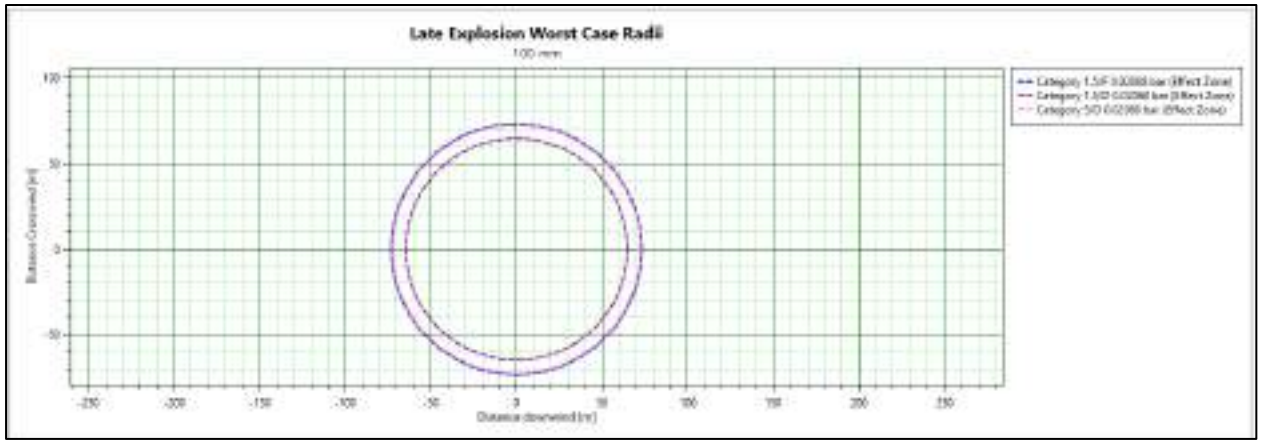
Jet Fire Intensity radii in case of 100mm leak of Methanol Storage Tank



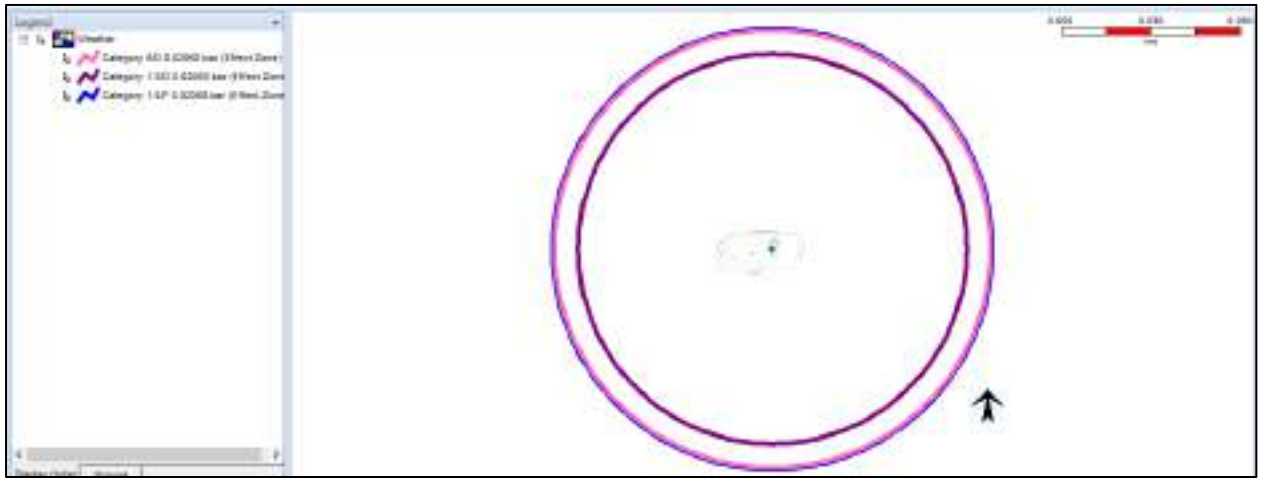
Jet Fire envelope Intensity radii in case of 100mm leak of Methanol Storage Tank



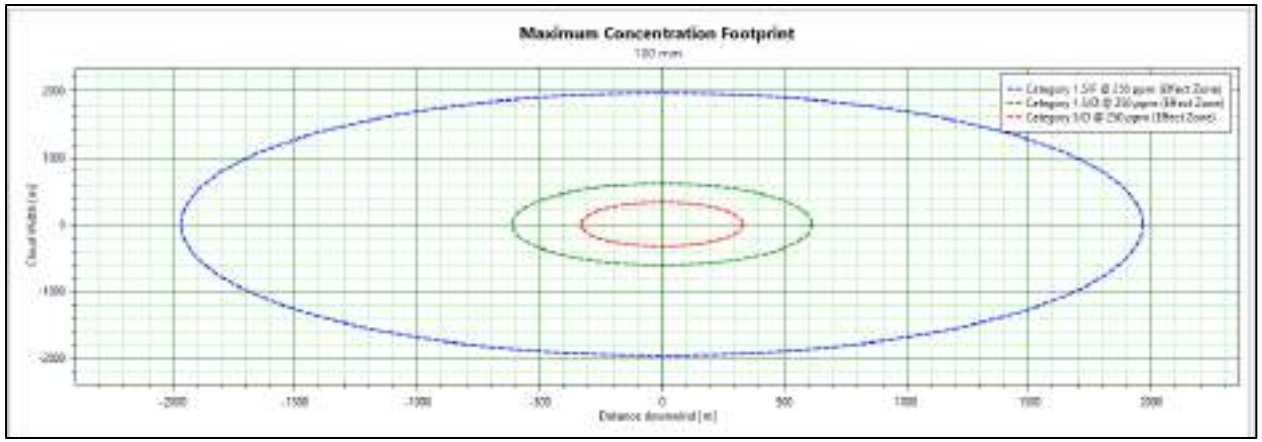
Late Explosion worst case radii in case 100mm leak of Methanol Storage Tank



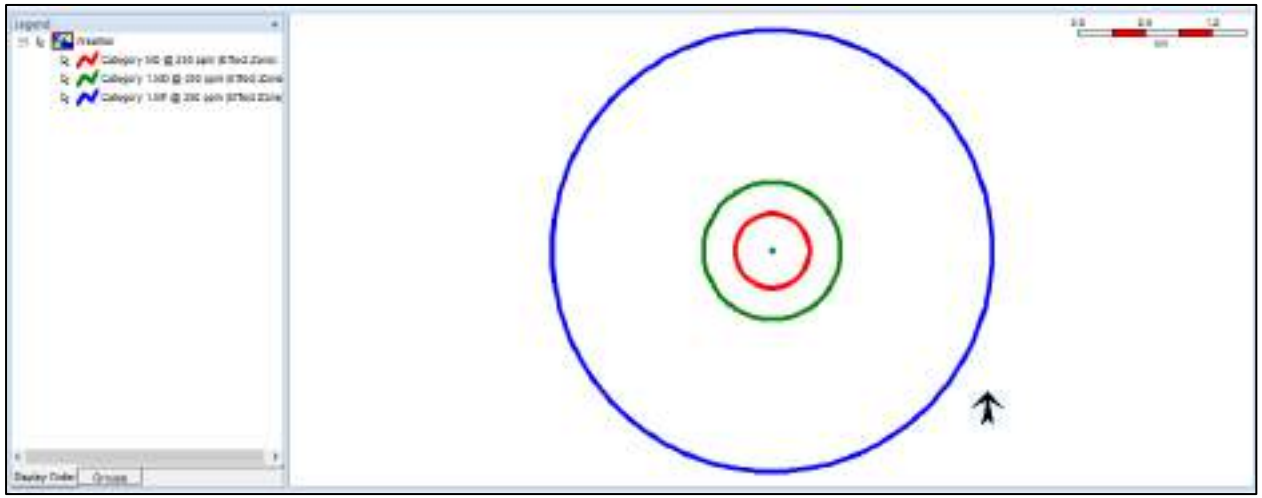
Late Explosion worst case radii in case 100mm leak of Methanol Storage Tank



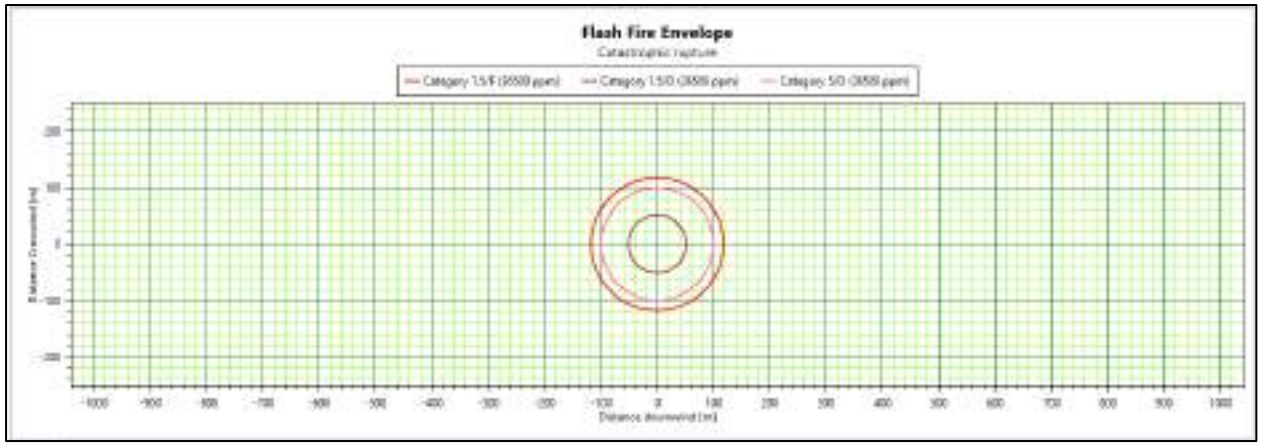
Maximum Concentration Footprint in case 100mm leak of Methanol Storage Tank



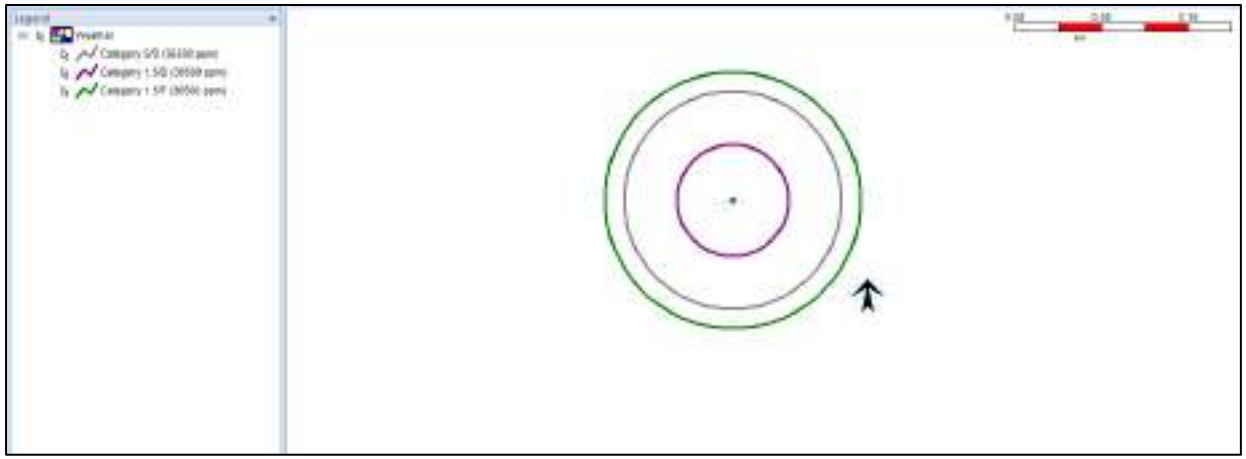
Maximum Concentration Footprint envelope in case 100mm leak of Methanol Storage Tank



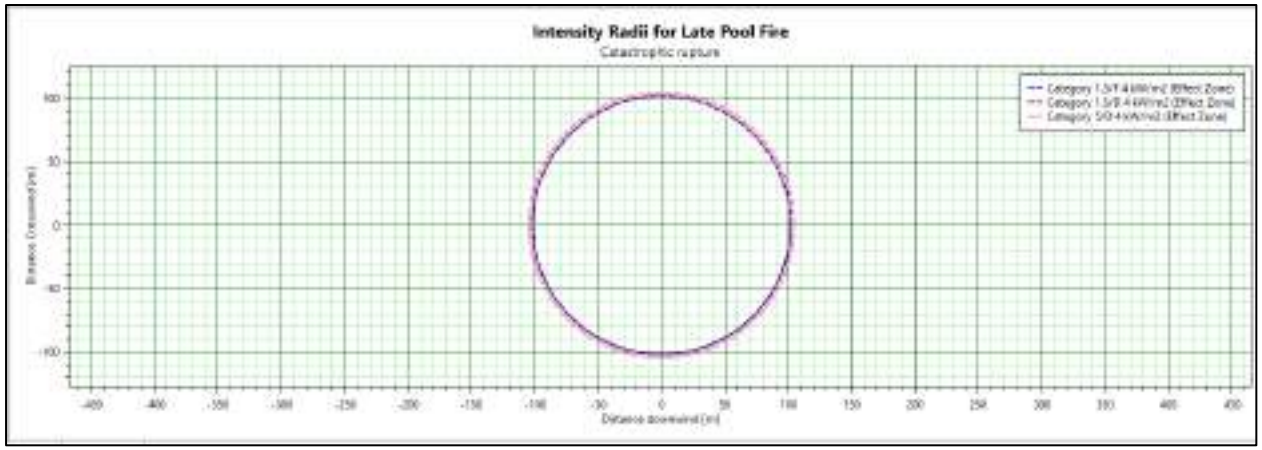
Flash Fire in case of catastrophic rupture of Methanol Storage Tank



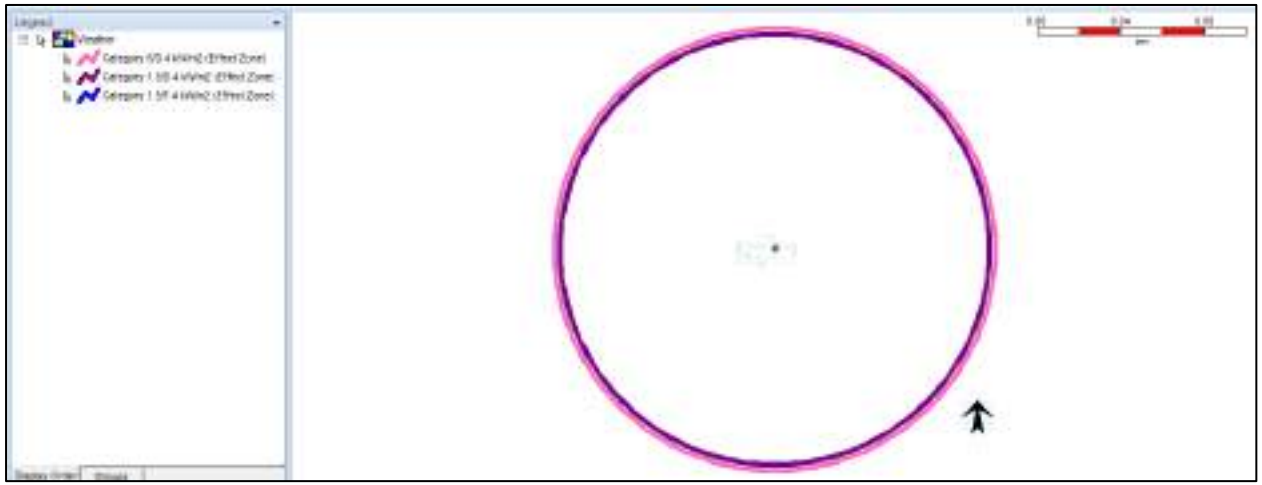
Flash Fire envelope in case of catastrophic rupture of Methanol Storage Tank



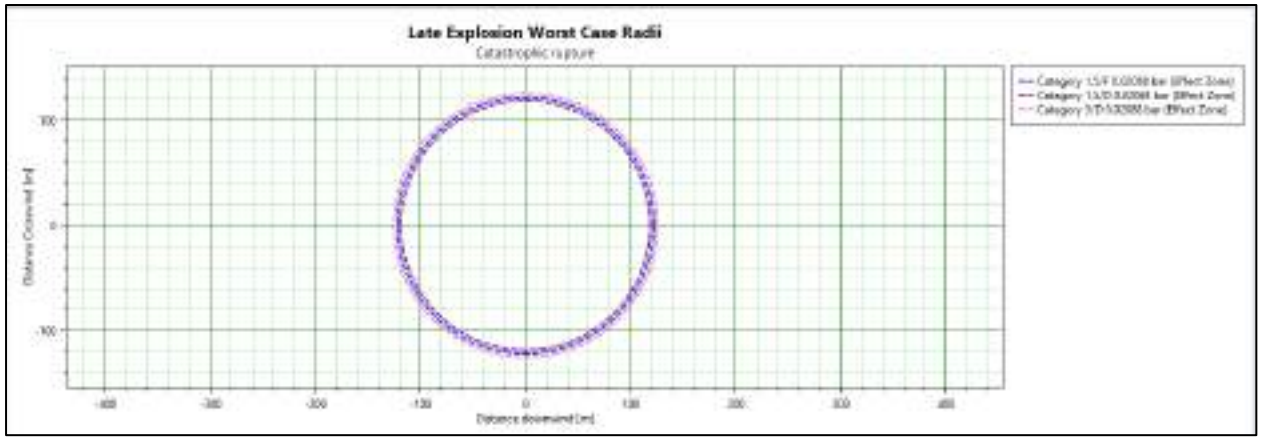
Late Pool Fire intensity radii in case catastrophic rupture of Methanol Storage Tank



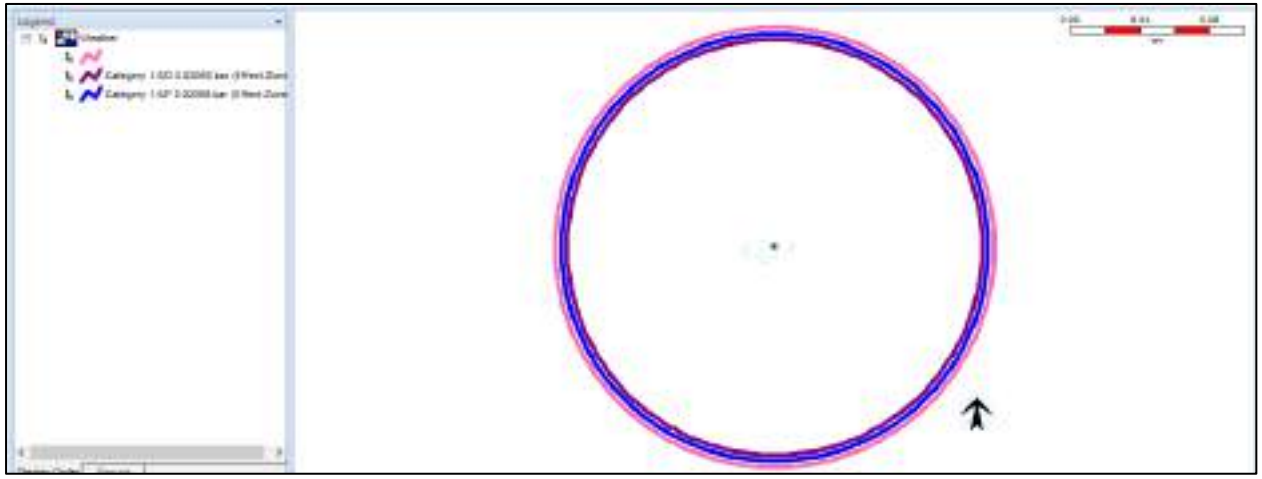
Late Pool Fire envelope intensity radii in case catastrophic rupture of Methanol Storage Tank



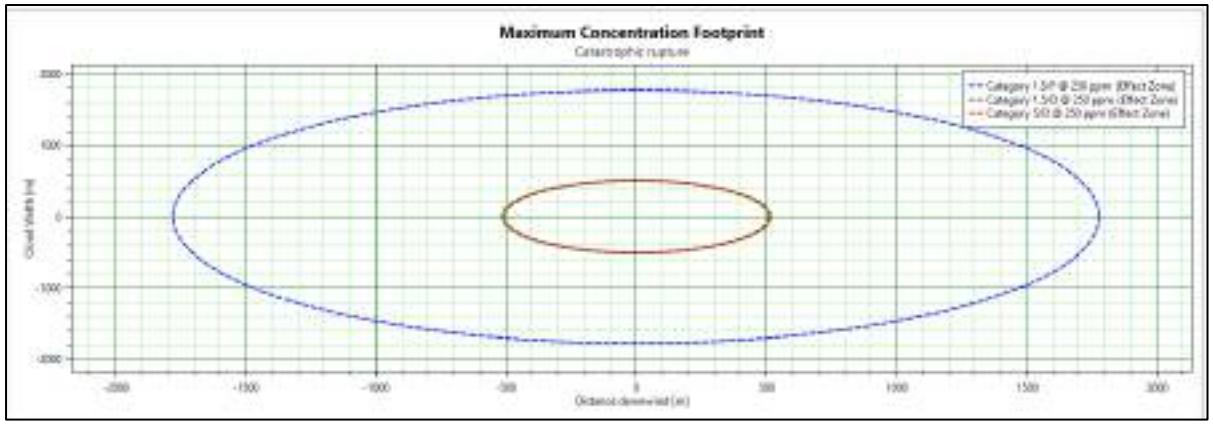
Late Explosion worst case radii in case catastrophic rupture of Methanol Storage Tank



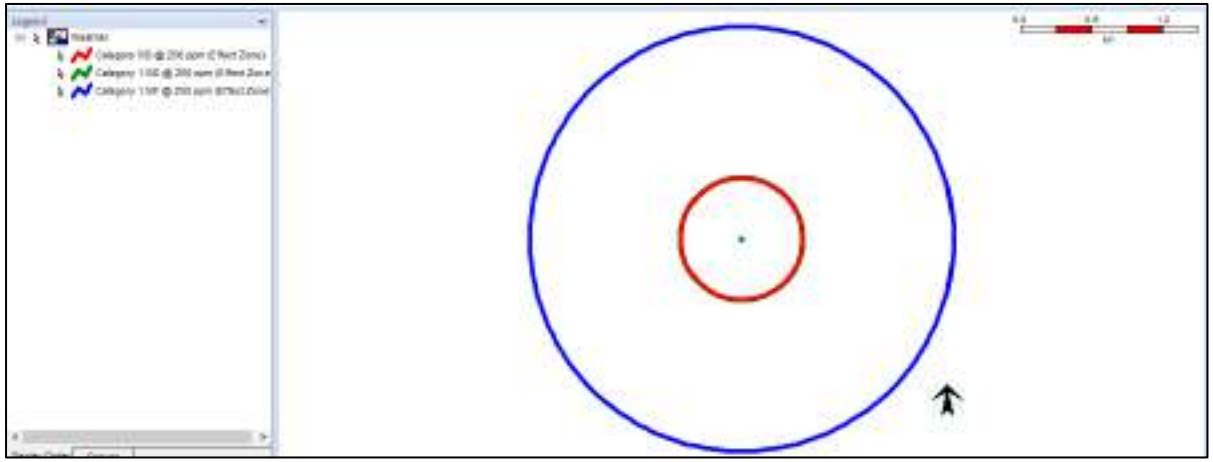
Late Explosion worst case radii in case catastrophic rupture of Methanol Storage Tank



Maximum Concentration footprint in case of catastrophic rupture of methanol Storage Tank



Maximum Concentration footprint in case of catastrophic rupture of methanol Storage Tank

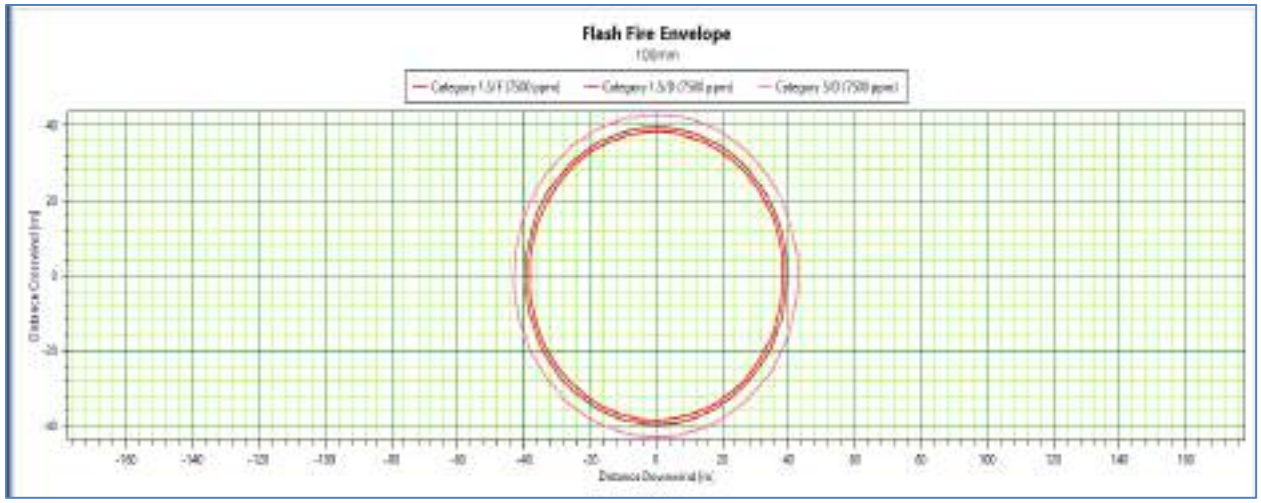


2. Phenol

Scenario details		5 mm leak			25 mm leak			100 mm leak			Catastrophic Rupture		
Weather Category		1.5 F	5D	1.5D	1.5 F	5D	1.5D	1.5 F	5D	1.5D	1.5 F	5D	1.5D
Flash Fire Envelope (m)													
Conc. (ppm)	7500	3	3	3	15	17	16	0	6	0	508	162	47
	15000	0	9	1	12	11	13	2	3	0	315	94	40
Thermal Damage Distance by Pool Fire (m)													
Radiation Intensity (KW/m^2)	4	27	28	27	62	70	63	75	84	75	73	83	73
	12.5	17	20	17	31	33	30	38	41	38	34	37	35
	37.5	8	9	9	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R
Thermal Damage Distance by Jet Fire (m)													
Radiation Intensity (KW/m^2)	4	11	13	12	48	41	48	148	130	148	N/A	N/A	N/A
	12.5	9	9	8	38	32	38	117	100	117	N/A	N/A	N/A
	37.5	6	7	6	32	26	32	97	82	97	N/A	N/A	N/A
Maximum Distance at Overpressure Level (m)													
Overpressure (bar)	0.02068	N/A	N/A	N/A	35	32	34	127	129	123	417	359	327
	0.1379	N/A	N/A	N/A	16	16	16	55	63	54	411	134	114
	0.2068	N/A	N/A	N/A	15	14	15	49	57	48	412	121	97

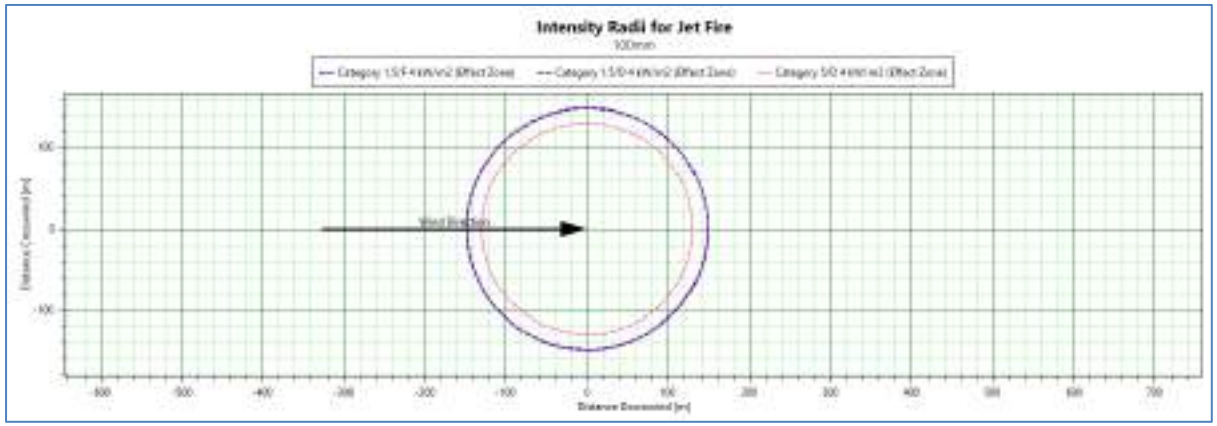
The results for 100mm leak and catastrophic case are superimposed on plot plan and presented in below figures. The results for only credible scenarios are presented.

Flash fire in case of 100mm leak of Phenol Tank

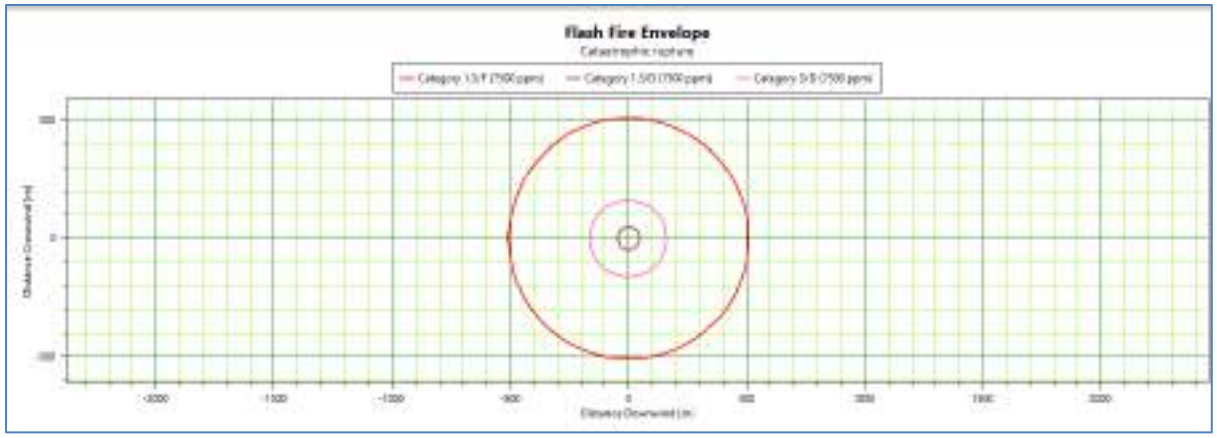


Intensity radii for late pool fire in case of 100mm leak of Phenol tank

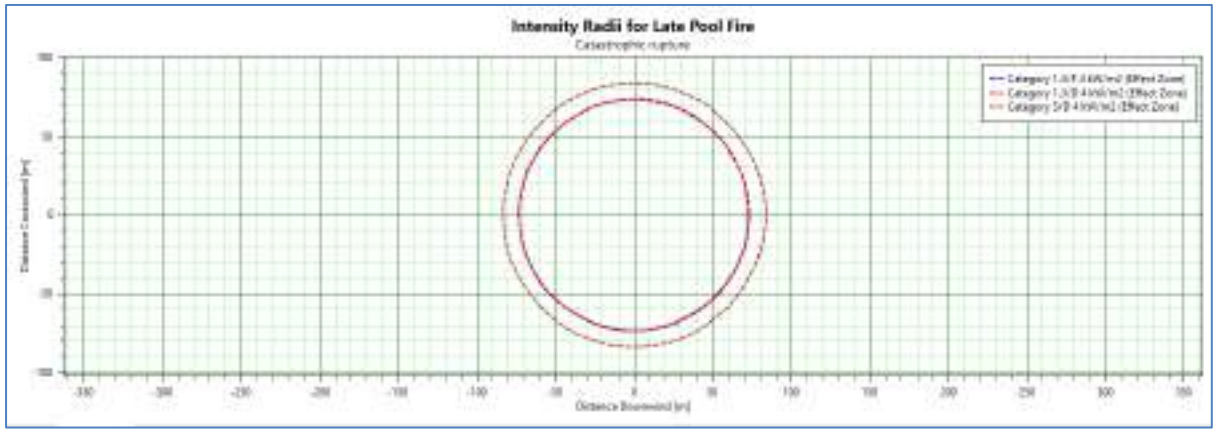
Intensity radii Jet fire in case of 100mm leak of Phenol tank



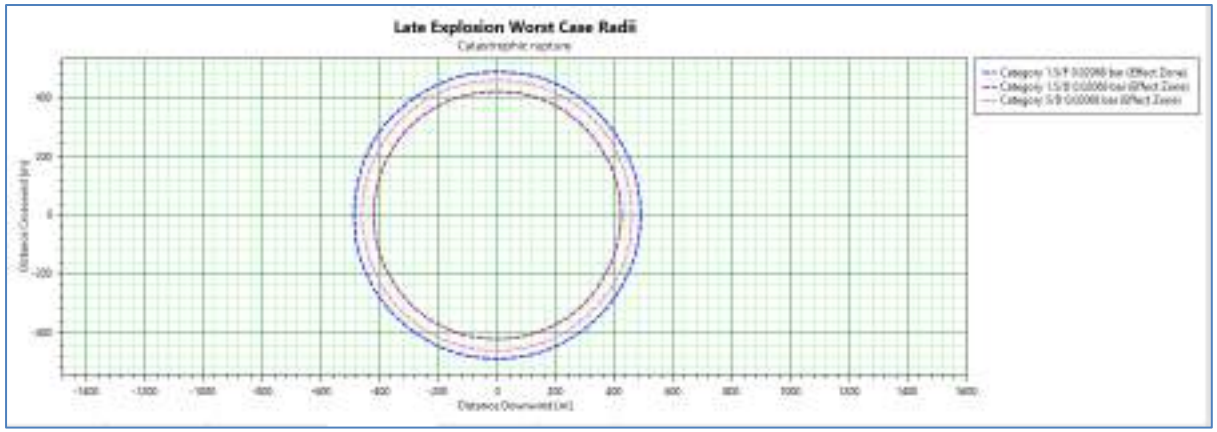
Flash fire in case of catastrophic rupture of Phenol Tank



Intensity radii for late pool fire in case of Catastrophic rupture of Phenol tank



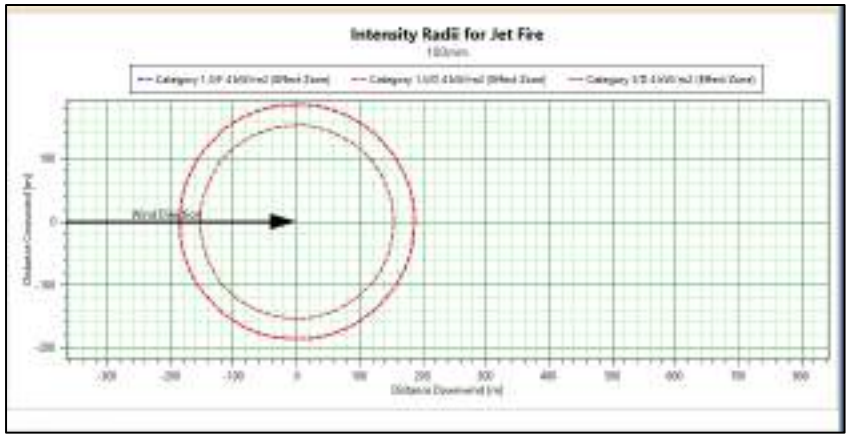
Intensity radii for late pool fire in case of Catastrophic rupture of Phenol tank



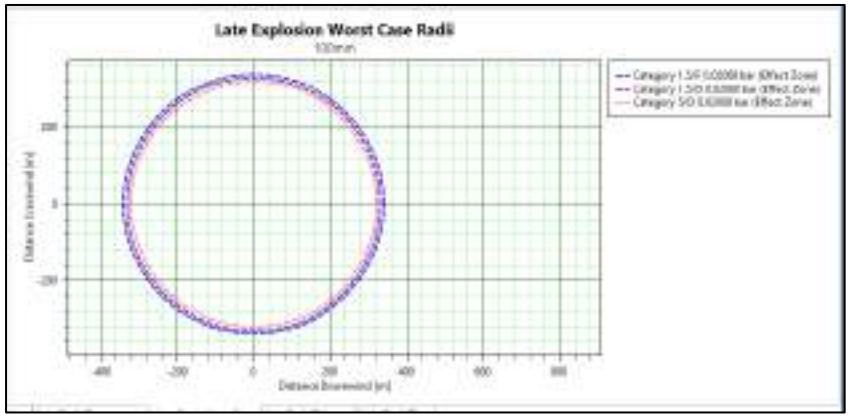
3. Acetic Acid Storage Tank

Scenario details		5 mm leak			25 mm leak			100 mm leak			Catastrophic Rupture		
Weather Category		1.5 F	5D	1.5D	1.5 F	5D	1.5D	1.5 F	5D	1.5D	1.5 F	5D	1.5D
Flash Fire Envelope (m)													
Conc. (ppm)	**27000**	16	4	15	89	51	93	163	162	190	40	50	32
	54000	8	3	4	71	34	70	123	126	145	25	33	22
Thermal Damage Distance by Pool Fire (m)													
Radiation Intensity (KW/m^2)	**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
Thermal Damage Distance by Jet Fire (m)													
Radiation Intensity (KW/m^2)	**4**	13	10	13	55	45	55	186	153	186	NH	NH	NH
	12.5	NR	8	NR	45	37	45	152	124	152	NH	NH	NH
	37.5	NR	NR	NR	NR	NR	NR	NR	103	NR	NH	NH	NH
Maximum Distance at Overpressure Level (m)													
Overpressure (bar)	**0.02068**	26	22	NA	238	115	202	339	320	330	239	241	242
	0.1379	13	12	NA	110	62	111	187	171	204	63	71	63
	0.2068	12	11	NA	103	59	106	180	166	198	54	60	52

Jet Fire Intensity radii in case of 100mm leak of Acetic Acid Storage Tank

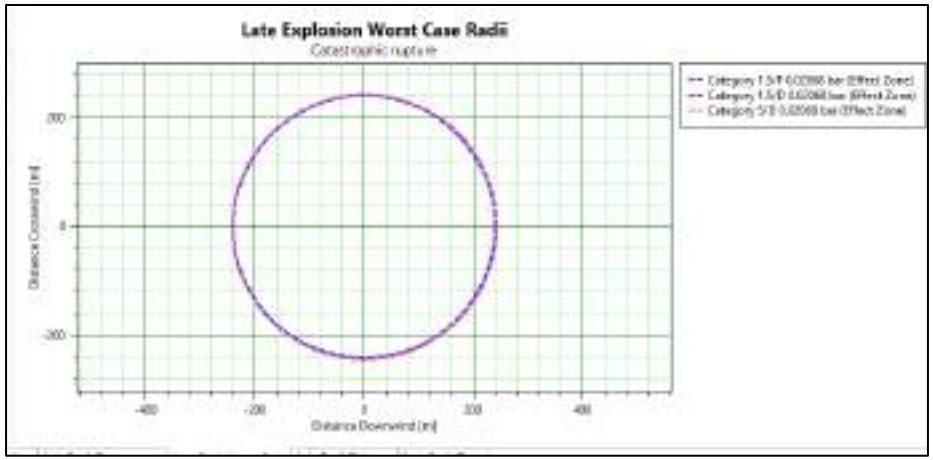


Late Explosion worst case radii in case 100mm leak of Acetic Acid Storage Tank

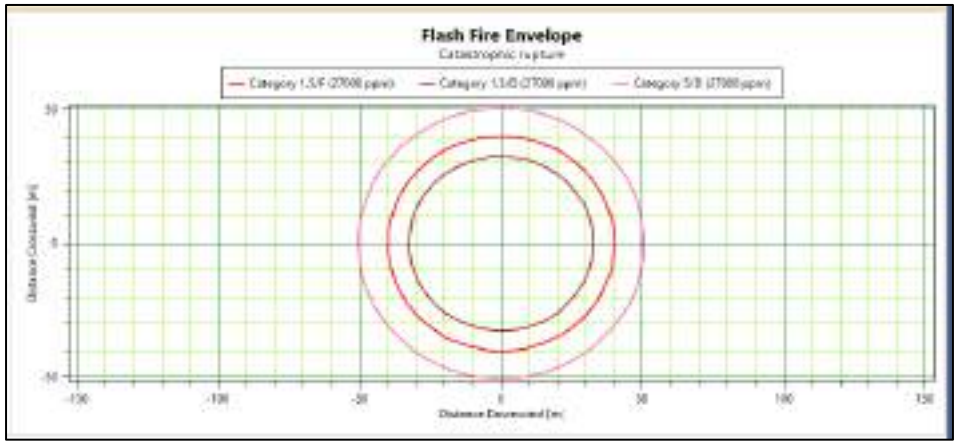


Flash Fire in case of 100mm leak of Acetic Acid Storage Tank

Late Explosion worst case radii in case catastrophic rupture of Acetic Acid Storage Tank



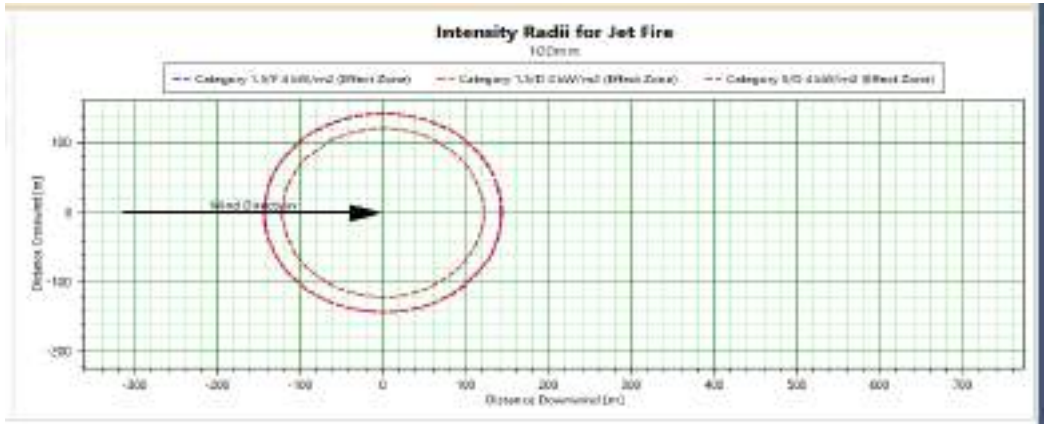
Flash Fire Envelope in case of Catastrophic Rupture of Acetic Acid Storage Tank



4. Formaldehyde Storage Tank

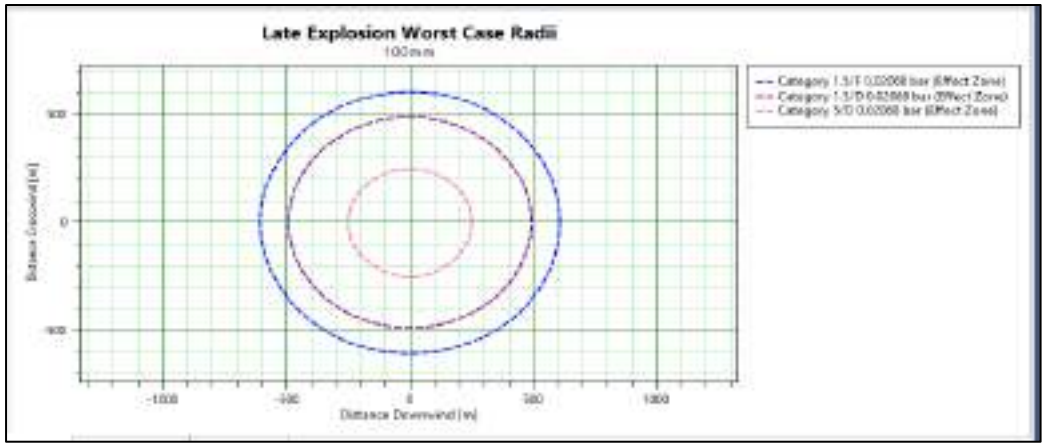
Scenario details		5 mm leak			25 mm leak			100 mm leak			Catastrophic Rupture		
Weather Category		1.5 F	5D	1.5D	1.5 F	5D	1.5D	1.5 F	5D	1.5D	1.5 F	5D	1.5D
Flash Fire Envelope (m)													
Conc. (ppm)	35000	14	4	10	73	42	74	214	103	207	218	168	216
	70000	5	3	4	47	23	39	149	63	126	141	106	136
Thermal Damage Distance by Pool Fire (m)													
Radiation Intensity (KW/m^2)	4	12	12	11	64	61	63	153	152	152	167	173	165
	12.5	8	7	7	41	43	41	100	107	99	106	120	105
	37.5	NR	NR	NR	25	23	25	59	58	58	59	64	58
Thermal Damage Distance by Jet Fire (m)													
Radiation Intensity (KW/m^2)	4	12	10	12	48	40	48	143	121	143	NA	NA	NA
	12.5	NR	8	NR	39	33	39	118	98	118	NA	NA	NA
	37.5	NR	NR	NR	NR	NR	NR	NR	78	NR	NA	NA	NA
Maximum Distance at Overpressure Level (m)													
Overpressure (bar)	0.02068	22	NA	21	190	95	142	606	249	490	567	539	565
	0.1379	12	NA	12	93	50	84	287	129	256	267	171	238
	0.2068	11	NA	11	87	48	80	267	121	242	250	160	227

Jet Fire Intensity radii in case of 100mm leak of Formaldehyde Storage Tank

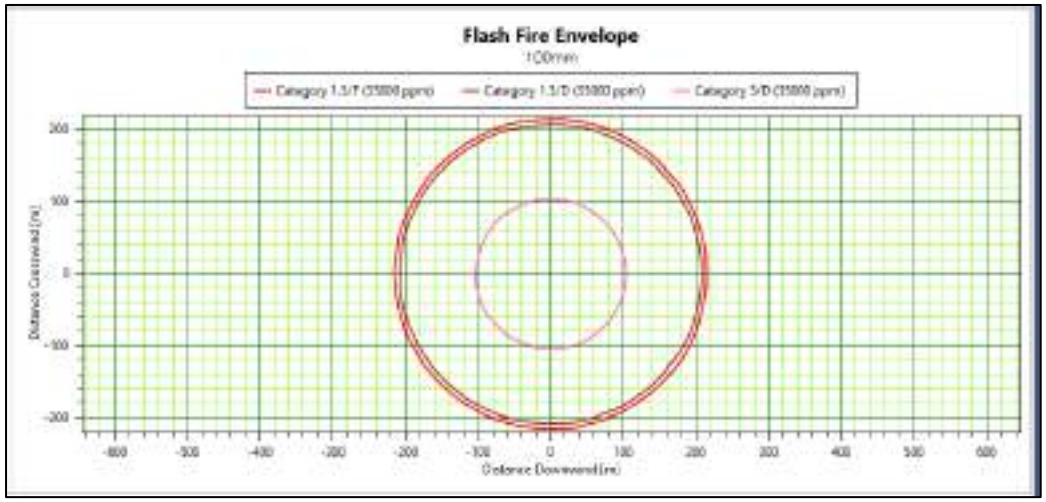


Intensity radii of Late Pool Fire in case of 100mm leak of Formaldehyde Storage Tank

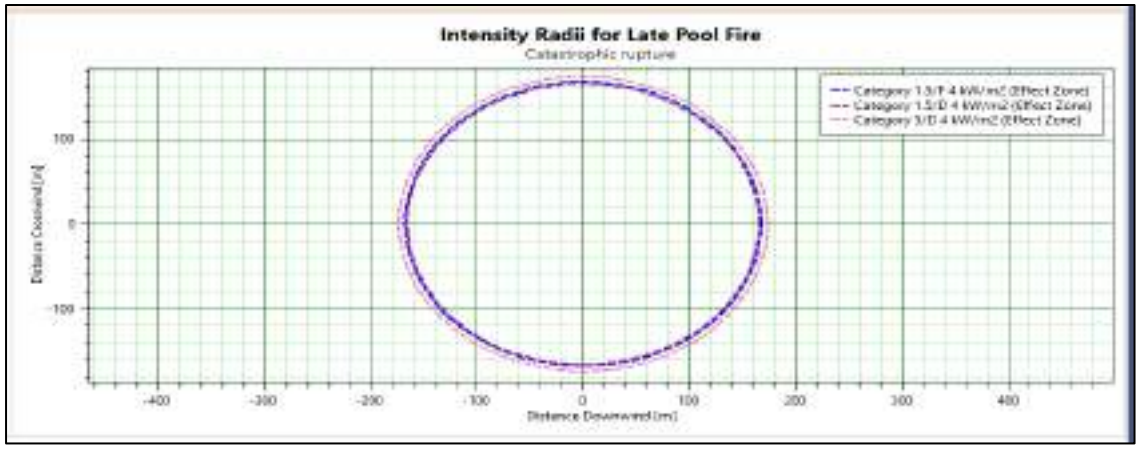
Late Explosion worst case radii in case 100mm leak of Formaldehyde Storage Tank



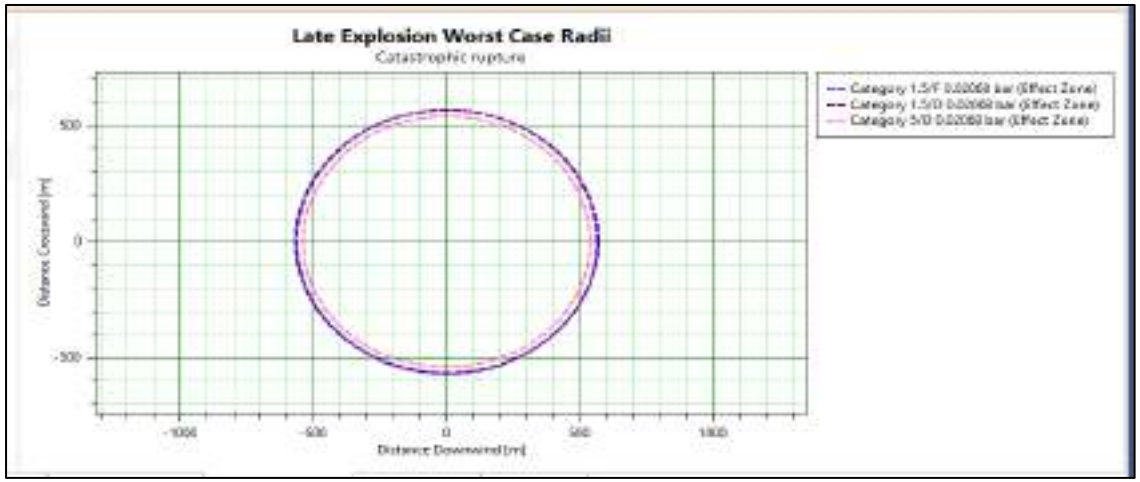
Flash Fire Envelope in case of Catastrophic Rupture of Formaldehyde Storage Tank



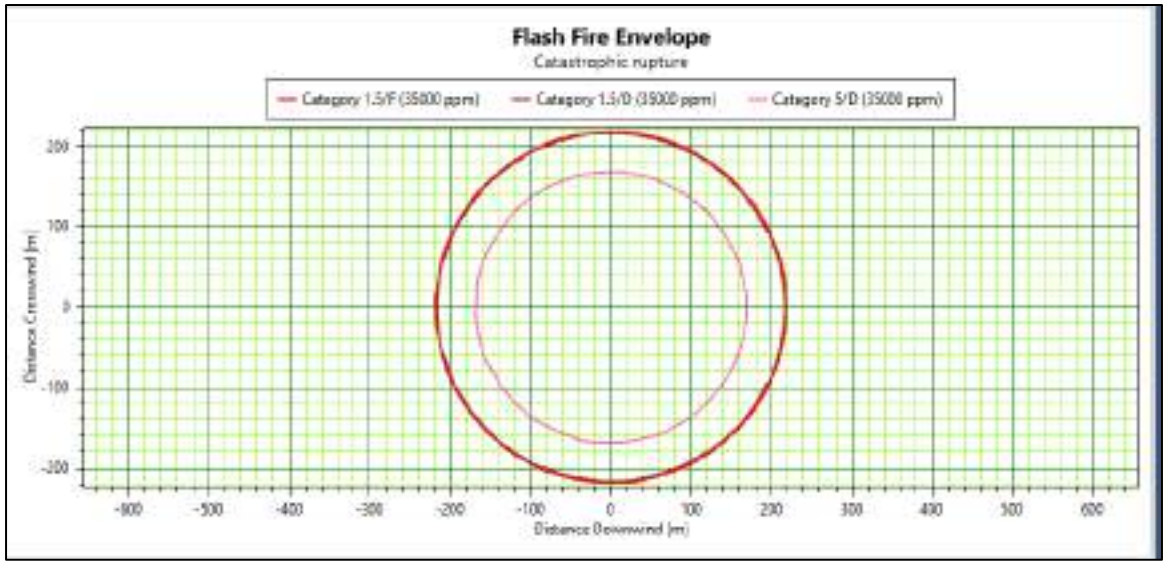
Intensity radii of Late Pool Fire in case of Catastrophic Rupture of Formaldehyde Storage Tank



Late Explosion worst case radii in case of Catastrophic Rupture of Formaldehyde Storage Tank



Flash Fire Envelope in case of Catastrophic Rupture of Formaldehyde Storage Tank



6.10. Conclusion

In above QRA study we found that this industry stored hazards material like corrosive and toxic acids and flammable chemicals etc. In case of 100 mm leakage in formaldehyde storage tank the damage distance and affected area around **606 m** from the object during worst case.

Proposed control measures on the basis of consequeses analysis.

Follow disaster management plan/procedure in case of any spillage, release and fire of hazardous material. Provide specific active and passive fire fighting system.

6.11. Proposed Control Measures

To prevent fatalities, injuries and to reduce damage to buildings and contents follow Workplace Emergency Planning & Preparedness procedure:

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

6.12. MITIGATION MEASURES

General

Measures and Recommendations are as follows:

- Storage areas shall be free from accumulation of materials.
- Non-freeze safety showers and eyewash fountains shall be provided, clearly marked, well lit and with unobstructed access.
- Periodic on site emergency Mock Drills and occasional Off Site Emergency Mock. Drills to be conducted, so those staffs are trained and are in a state of preparedness to tackle any emergency.
- Safe operating procedure to be prepared for hazardous process and material handling process.
- Safety devices and control instruments to be calibrated once in a year.
- Proper colour work as per IS 2379 to plant pipeline and tank, equipments to be done once in a six month to protect from corrosion.
- Preventive maintenance schedule to be prepared for all equipments.
- Permit to work system to be implemented for hazardous work in the plant.
- Safe handling of solvent drum procedure should be defined.
- It is recommended to store the drums having flammable material at low height to avoid accidental damage and fire hazards during the transfer of drums using forklifts

6.13. REFERENCES

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