RISK ASSESSMENT REPORT

Prepared for

"MODIFICATION & EXPANSION OF BULK DRUGS AND INTERMEDIATES"

At

Plot No 27, Raichur Growth Centre Industrial Area, Chicksugur Village, Raichur District, Karnataka

PROJECT BY

M/S. TRIMAX BIOSCIENCES PVT. LTD

Plot No. 27, Raichur Growth Centre Industrial Area, Chicksugur Village, Raichur District, Karnataka.

RISK ASSESSMENT STUDY REPORT

The proposed brown field project is for the manufacturing of Synthetic organics, Drugs & its Intermediates

Methodology:

The following parameters are considered to prepare Risk and Hazards Report

- Process equipments
- Manufacturing Process
- Unit Operations
- Chemical MSDS
- Consequence Analysis – ALOHA
- P& I Diagrams

INTRODUCTION TO RISK ASSESSMENT

M/s. Trimax Biosciences Pvt. Ltd handles various chemicals, some of which are hazardous in nature by virtue of their intrinsic chemical properties or their operating temperatures or pressures or a combination of them. Fire, explosion, toxic release or combinations of them are the hazards associated with industrial plants using hazardous chemicals. More comprehensive, systematic and sophisticated methods of Safety Engineering, such as, Hazard Identification and Qualitative /Quantitative Risk Assessment have been developed to improve upon the integrity, reliability and safety of industrial plants, the same has been discussed in detail under their respective headings.

OBJECTIVES OF RISK ASSESSMENT

Risk analysis follows an extensive hazard analysis. It involves the identification and assessment of risks the neighboring populations are exposed to as a result of hazards present. This requires a thorough knowledge of failure probability, credible accident scenario, vulnerability of population etc., much of this information is difficult to get or generate. Consequently, the risk analysis is often confined to maximum credible accident studies.

It provides basis for**:**

- The type and nature of its On-Site and Off-Site Emergency Plan and,
- The types of safety measures required.

IDENTIFICATION OF HAZARDS

- Hazard identification is carried out to ascertain the controls required and available in order to mitigate the risk of exposure to the hazards. This would substantially help in overcoming costly errors and prolonged delays that may be caused due to the design changes that may be required on a later date.
- Hazard assessment is carried out at the equipment design stage and the control / mitigation measures are put in place overcome them to avoid costly errors at a later stage.
- Hazard assessment in our plant is carried out examining the, material storage, type of operations, locations to find out the facilities in place to overcome the risks of exposure to the hazards.
- After a critical analysis of the chemicals used, stored, defined safe operating procedures and the different manufacturing processes, the following table lists the safety measures / installations in place and mitigation measures to overcome the hazards.

Following are the Hazards identified in proposed project activities**:**

- Fire Hazards
- Spillage of Hazardous chemicals which leads to Air pollution
- Explosion Hazards
- Toxic gas release
- Noise

TABLE: AREA WISE IDENTIFIED HAZARDS, PRECAUTIONS TAKEN WITH MITIGATION MEASURES.

S.NO	AREA	IDENTIFIED HAZARD	SEVERITY & NO. OF PERSONS EXPOSED	PRECAUTIONS TAKEN	MITIGATION MEASURES
1]	RM Storage area	Spillage of chemicals	Low to medium 2 persons	1. Approved layout as per legal requirements. 2. Flame proof electrical fittings installed 3. Chemicals stored in safe Containers with secondary containment to prevent spillages. 4. Storage quantity is limited 5. Storage area is well ventilated by a forced air ventilation system. 6. Material accessed only by authorized personnel using mechanized systems 7. Double door entry to ensure a clean atmosphere. 8. Body showers provided for decontamination.	1. Area will be cordoned off. 2. Information will be passed to Emergency control center is informed. 3. Information will be given to the declarer of emergency on the scale of Leakage. 4. Emergency Response teams will be kept on alert for swift response. 5. All hot works being carried out in the surrounding areas will be stopped 6. Personnel working in the area will be evacuated.

S.NO	AREA	IDENTIFIED HAZARD	SEVERITY & NO. OF PERSONS EXPOSED	PRECAUTIONS TAKEN	MITIGATION MEASURES
				9. Personnel are provided with full body protection suits and nose masks to prevent exposure to chemicals. 10.Fire hydrant system with hydrant points with hose reels and nozzles installed to mitigate fire hazards 11.Fire extinguishers deployed adequately 12. Fully fledged medical center /arrangements 13. Periodical occupational health checks to personnel working in the area to assess health effects, if any.	7. Spilled powders will be collected in vacuum cleaners. 8. The spillage will be cleared and the area is made fit work

S.NO	AREA	IDENTIFIED HAZARD	SEVERITY & NO. OF PERSONS EXPOSED	PRECAUTIONS TAKEN	MITIGATION MEASURES
2]	Chemical Tanks Storage area	Fire & Explosion	Medium to Low 2 persons	1. Storage facility located in isolated area 2. Natural ventilation for supply of fresh air 3. No electrical fittings in the area to prevent any fire hazard. 4. No electrical gadgets or items capable of generating static electric charges permitted inside the area. 5. Personnel are trained about Do's & Don'ts during emergency. authorized personnel only 6. No heat sources are permitted near the facility. 7. Hot work is controlled through a work permit system 8. Room kept under lock and key with access to authorized personnel only.	1. Area will be cordoned off. 2. Hot work being carried out in the vicinity will be stopped to prevent accidental spread of fire. 3. Personnel working in the area will be evacuated 4. Emergency control center will be informed 5. Information will be given to the declarer of emergency on the scale of Fire &Explosion. 6. Emergency Response teams will be kept on alert for swift response. 7. The spillage will be cleared and the area is made fit work

S.NO	AREA	IDENTIFIED HAZARD	SEVERITY & NO. OF PERSONS EXPOSED	PRECAUTIONS TAKEN	MITIGATION MEASURES
				9. Storage quantity is limited and material is handled by trained and authorized personnel. 10. Mechanical foam type fire is provided to mitigate fires 11. Fire hydrant system with hose reels are provided in the vicinity	

S.NO	AREA	IDENTIFIED HAZARD	SEVERITY & NO. OF PERSONS EXPOSED	PRECAUTIONS TAKEN	MITIGATION MEASURES
3]	Production Block	Spillages / Fire /Explosion	Low to medium 10 persons	1.Flame proof electrical fittings installed 2. Freight lift installed for movement of material 3. Material stored at production blocks in safe containers for batch charging with secondary containment to prevent Spillages. 4. Earthing and bonding carried out for all reactor vessels and pipelines 5.Nitrogen lines are provided to reaction vessel to create inert atmosphere inside the reactor to avoid fire and explosion 6. Work permit system implemented for hazard assessment in case of any hot work / height work . 7. Work permit system implemented for hazard assessment in case of any hot work / height work.	1. Area will be cordoned off. 2. Power supply will be cut off to the area to prevent accidental fire. 3. All hot work carried out in the vicinity will be stopped. 4. Emergency control center will be informed. 5. Information will be given to the declarer of emergency on the scale of Leakage / Accident. 6. Emergency Response teams will be kept on alert for swift response. 7. Personnel working in the area will be evacuated. .

S.NO	AREA	IDENTIFIED HAZARD	SEVERITY & NO. OF PERSONS EXPOSED	PRECAUTIONS TAKEN	MITIGATION MEASURES
				8. Manufacturing area is ventilated by a forced air ventilation system. 9. Fire hydrant system with hydrant points with hose reels and nozzles installed to mitigate fire hazards 10. Fire extinguishers deployed adequately 11. Emergency exit glass door with glass breaking hammer provided for safe escape in case of any emergencies. 12. Eye wash fountain / Body shower provided for decontamination.	

S.NO	AREA	IDENTIFIED HAZARD	SEVERITY & NO. OF PERSONS EXPOSED	PRECAUTIONS TAKEN	MITIGATION MEASURES
4]	Boiler House	Fire / Explosion	Low to medium Approx. 2	1. All requirements specified under Boiler Act and Boiler licensed is adhered to. 2. All electrical fittings are of flameproof type. 3. Entry restricted only to trained and authorized personnel to work in the area. 4. Fire extinguishers are positioned at different locations in case of any emergencies. 5. No material storage is permitted in the area.	1. Shutting down the plant, declaring the emergency. 2. Electrical supply will be isolated. 3. Type of emergency will be informed to the emergency declarer/ central authority. 4. Emergency response teams will be kept on alert for swift action. 5. Movement of personnel and vehicles will prohibited.

S.NO	AREA	IDENTIFIED HAZARD	SEVERITY & NO. OF PERSONS EXPOSED	PRECAUTIONS TAKEN	MITIGATION MEASURES
				6. Area is well ventilated and illuminated for safe working. 7. 24 x 7 manning of the area for monitoring the operation. 8. All maintenance /repair works are carried out after issuing work permits and under constant supervision of experts. 9. Periodical cleaning of soot in furnace to prevent formation of explosive mixtures. 10. Monitoring the boiler operational parameters and periodical cleaning 11. Checking of boiler internals to prevent accidents. 12. Sign boards are displayed to inform personnel about the hazards present in the area	6. Area is well ventilated and illuminated for safe working. 7. 24 x 7 manning of the area for monitoring the operation.

S.NO	AREA	IDENTIFIED HAZARD	SEVERITY & NO. OF PERSONS EXPOSED	PRECAUTIONS TAKEN	MITIGATION MEASURES
5]	Diesel Generator	Noise & Fire	Two	1. Noise abatement thru' modular acoustic paneling of D.G sets 2. Secondary containment to prevent Diesel leakage from day tanks. 3. Adequate no. of fire extinguishers is kept to handle emergency . 4. Entry access to the area controlled	1. Information will be given to Emergency control center. 2. Power supply will be cut off to the storage area to prevent accidental fire. 3. All hot work around the area will be stopped and the area will be cordoned off . 4. The concerned maintenance personnel will be carried repairs to mitigate the leakages. 5. Emergency Response Team will be kept on alert for swift response. 6. Periodical occupational health checks to personnel working in the area to assess exposure to noise.

S.NO	AREA	IDENTIFIED HAZARD	SEVERITY & NO. OF PERSONS EXPOSED	PRECAUTIONS TAKEN	MITIGATION MEASURES
6]	Electrical sub stations	Electric shock / fire	2 persons	1. Layout confirm to legal requirements specified under Indian Electrical Rules. 2. Entry restricted to licensed and authorized personnel only. 3. Earthing provided for leakage of stray currents. 4. Electronic mimic panels installed for fault indication at the entry of the sub-station. 5. Insulating rubber mats confirming to I S 15652:2006 provided in front of all electrical switchgear. 6. Periodical inspection and maintenance carried out to ensure good health of the equipment. 7. CO2 / DCP fire extinguishers deployed to handle emergency fires	1. Information will be given to Emergency control center. 2. Power supply will be cut off from incoming source. 3. Electricity supply company is alerted for cut off power supply in case of major risks 4. All hot work around the area will be stopped and the area is cordoned off. 5. The concerned maintenance personnel will be carried repairs to restore normalcy. 6. Emergency Response Team will be kept on alert for swift response

S.NO	AREA	IDENTIFIED HAZARD	SEVERITY & NO. OF PERSONS EXPOSED	PRECAUTIONS TAKEN	MITIGATION MEASURES
7]	Hazardous waste storage room	Fire	Low to medium 2 persons / Unmanned	1. Storage shed in an isolated location. 2. Conditions specified in hazardous waste authorization issued by SPCB implemented. 3. Compatible wastes are stored in separate enclosures. 4. Layout provides adequate ventilation and illumination 5. Secondary containment provided to prevent leakages / spillages. 6. Storage quantity is limited. 7. Periodical disposal of accumulated waste to Authorized landfills. 8. Flame proof electrical fittings installed to prevent fire / explosion hazards	1. Information will be given to Emergency control center. 2. Power supply will be cut off from incoming source. 3. All hot work around the area is stopped and the area is cordoned off. 4. The concerned maintenance personnel will be carried repairs to restore normalcy

S.NO	AREA	IDENTIFIED HAZARD	SEVERITY & NO. OF PERSONS EXPOSED	PRECAUTIONS TAKEN	MITIGATION MEASURES
				9. Eye wash / body shower is provided for decontamination in case of spillage on body parts. 10. PPE box is equipped with gum boots, splash proof safety goggles, aprons for use during handling of chemicals. 11. Access to the area restricted to authorize personnel only. 12. Fire hydrant point with hose reels provided for fire mitigation	5. Emergency Response Team will be kept on alert for swift response. 6. Support of external agencies will be sought in case situation poses major risks and is not controllable by in-house infrastructure

LIST OF SOLVENTS

S.NO	NAME OF THE SOLVENT	PHYSICAL STATE	MODE OF STORAGE	MAX. INVENTORY IN KL.	NATURE OF HAZARD	NFPA RATING
1	Toluene	Liquid	UG/Drum	25	Flammable	H: 2 F: 3 R: 0
2	Methanol	Liquid	UG/Drum	25	Flammable	H: 1 F: 3 R: 0
3	Iso propyl alcohol	Liquid	UG/Drum	25	Flammable	H: 1 F: 3 R: 0
4	Acetone	Liquid	UG/Drum	25	Flammable	H: 1 F: 3 R: 0
5	Ethyl Acetate	Liquid	UG/Drum	25	Flammable	H: 1 F: 3 R: 0
6	n-Butanol	Liquid	UG/Drum	25	Flammable	H: 2 F: 3 R: 0
7	Cyclohexane	Liquid	Drum	25	Flammable	H: 2 F: 3 R: 0
8	Acetonitrile	Liquid	Drum	10	Flammable	H: 2 F: 3 R: 0
9	Methyl tertiary butyl ether	Liquid	Drum	10	Flammable	H: 2 F: 3 R: 0
10	Hexane	Liquid	Drum	25	Flammable	H: 2 F: 3 R: 0
11	Dimethyl formamide	Liquid	Drum	10	Flammable	H: 2 F: 2 R: 0
12	Methylene chloride	Liquid	Drum	10	Flammable	H: 2 F: 1 R: 0
13	Tetrahydrofuran (THF)	Liquid	Drum	15	Flammable	H: 2 F: 3 R: 1
14	Ethanol	Liquid	Drum	25	Flammable	H: 1 F: 3 R: 0
15	Benzene	Liquid	Drum	10	Flammable	H: 2 F: 3 R: 0

HANDLING PRECAUTIONS

- Use in a closed system under argon or nitrogen.
- Do not get in eyes, on skin or clothing.
- Do not breathe vapors or mist.
- Store in a cool place. Keep container closed.
- Keep away from sources of ignition, water, air, acids and oxidizing agents
- In case of fire, do not use water or carbon dioxide

EMERGENCY PREPAREDNESS

- OSEP
- Training & Awareness

SAFE PRACTICES [HANDLING, STORAGE, TRANSPORTATION AND UNLOADING OF CHEMICALS]

Drums

Liquid Raw materials will be transferred from the drums to the day tank situated at the production block with the help of leak proof drum pumps / pumps /Vacuum through pipe lines from day tank to reaction vessel unloading by gravity.

Storage Tanks

Solvent will be transferred to the day tank situated at the production block with the help of mechanical seal pump through pipe lines from the tank, from day tank to reaction vessel unloading by gravity.

Tank is connected to chilled water circulated condenser with reflux system.

Measures to Avoid Evaporation

- Keep containers tightly closed.
- Keep away from heat, spark & flame
- Keep away from sources of ignition
- Store in a cool, dry, well-ventilated area away from incompatible substances.

Safety Systems

- Designated areas with proper indication & safety signs.
- Double earthling systems

- Flame arrestor to the vent
- Flame proof transferring pumps
- Handling precautions/SOP protocol
- Pressure Gauges
- Level indicators
- Flame proof lighting to storage yard

TRANSPORTATION / UNLOADING

Highly inflammable chemicals will be transported by road. Therefore, adequate safety precautions for transportation are followed. During transportation of hazardous chemicals, MSDS & TREM card will be provided to driver. As per Motor Vehicle Rules, PESO rules and Factory Rules all safety precautions will be followed during transportation of hazardous chemicals.

The following safety precautions are suggested during transportation of toxic, inflammable and corrosive chemicals in tankers, while loading and unloading, transportation and meeting the emergencies arising out of leakages and spillages of hazardous materials:

- Park the vehicle at designated place.
- Stop the engine.
- Check-up spark arrester.
- Provide earthing to tanker securely.
- Ensure that fireman is available near the place with proper equipment's.
- Connect the piping properly
- Before start unloading, check that, there should not be any leakage.
- In case of leakage, immediately attend the leakages & rectify it.
- After unloading is over, close the lid properly.
- Vehicle to be started only after removal of all pipelines connected with tanker.

SAFETY INSTRUCTIONS FOR TRANSPORTATION OF HAZARDOUS MATERIALS

- The name of the chemical along with pictorial sign denoting the dangerous goods should be marked on the vehicle and the packing material.
- The name of the transporter, his address and telephone number should be clearly written on the road tanker and on the vehicle.

- The tanker or vehicle should not be used to transport any material other than what is written on it.
- Only trained drivers and cleaners should transport hazardous chemicals.
- The transporter and the manufacturer must ensure the safe transportation of the material.
- The Tanker / Vehicle should be checked for its fitness and safe condition before loading.
- During loading and unloading, the tanker/vehicle should be braked and isolated against any movement, while loading/unloading, use safety appliances.
- The tanker / vehicle should not be overloaded beyond the weight permitted by R.T.O.
- Check for leakages from the line connections / containers before starting and Stopping the filling operations.
- Drive the vehicles carefully, especially in crowded localities and on Bumpy roads.
- Do not apply sudden break.
- The tanker / vehicle should not be parked for long time on the way and especially in crowded places. Park the vehicle away from residential areas

SPILL CONTROL

- For all plants spill control procedures will be displayed. Spillage shall be controlled as per concerned spill control procedure.
- Unprotected personnel up wind will be kept upwind.
- Like any spilled materials to contain. Absorb spilled liquid by dry absorbent clay or vermiculite.
- Collect most of the contaminated absorbent with shovel for further disposal/incineration.
- If spill of material directly on the ground, dig up and remove saturated soil for disposal/incineration.
- Inactivate poisonous chemical with suitable method.

EFFECT AND CONSEQUENCE ANALYSIS

- In a plant handling hazardous chemicals, the main hard due to storage, handling and use of these chemicals. If these chemicals are released into the atmosphere, they may cause damage due to resulting fires or vapor clouds last over pressures depend upon the reactivity class of material between two explosive limits.

OPERATING PARAMETERS

- Potential vapor release for the same material depends significantly on the operating conditions especially for any liquefied gas, operating conditions are very critical to assess the damage potential.
- If we take up an example of ammonia, if it is stored at ambient temperature say 30^0C, and then the vapor release potential of the inventory is much higher as compared to the case if it is stored at 0^0C.

INVENTORY

- Inventory analysis is commonly used in understanding the relative hazards and short listing of release scenarios.
- Inventory plays an important role in regard to the potential hazard.
- Larger the inventory of a vessel or a system, larger the quantity of potential release.
- The potential vapor release [source strength] depends upon the quantity of liquid release, the properties of the materials and the operating conditions [pressure, temperature].
- If all these influencing parameters are combined into a matrix and vapor source strength estimated for each release case, a ranking should become a credible exercise.

LOSS OF CONTAINMENT

- Plant inventory can get discharged to environment due to Loss of Containment.
- Certain features of materials to be handled at the plant need to the clearly understood to firstly list out all significant release cases and then to short list release scenarios for a detailed examination.
- Liquid release can be either instantaneous or continuous.
- Failure of a vessel leading to an instantaneous outflow assumes the sudden appearance of such a major crack that practically all of the contents above the crack shall be released in a very short time.
- The more likely event is the case of liquid release from a hole in a pipe connected the vessel. The flow rate will depend on the size of the hole as well as on the pressure, which was present, in front of the hole, prior to the accident. Such pressure is basically dependent on the pressure in the vessel.
- The vaporization of released liquid depends on the vapor pressure and weather conditions. Such consideration and others have been kept in mind both during the initial

listing as well as during the short listing procedure.

In the study, Maximum credible loss accident methodology is to be used, therefore, the largest potential hazard inventories have been considered for consequence estimation.

Damage Criteria

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

- Determination of the source strength parameters;
- Determination of the consequential effects;
- Determination of the damage or damage distances.

The basic physical effect models consist of the following.

Source strength parameters

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

Consequential effects

- Dispersion of gaseous material in the atmosphere as a function of source strength, relative density of the gas, weather conditions and topographical situation of the surrounding area.
- Intensity of heat radiation [in KW / m2] due to a fire or a BLEVE, as a function of the distance to the source.
- Energy of vapor cloud explosions [in KW / m2], as a function of the distance to the distance of the exploding cloud.
- Concentration of gaseous material in the atmosphere, due to the dispersion of evaporated chemical. The latter can be either explosive or toxic.

- It may be obvious, that the types of models that must be used in a specific risk study strongly depend upon the type of material involved:
- Gas, vapor, liquid, solid
- Inflammable, explosive, toxic, toxic combustion products
- Stored at high/low temperatures or pressure
- Controlled outflow (pump capacity) or catastrophic failure?

Selection of Damage Criteria

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

In consequence analysis studies, in principle three types of exposure to hazardous effects are distinguished:

- Heat radiation, from a jet, pool fire, a flash fire or a BLEVE.
- Explosion
- Toxic effect, from toxic materials or toxic combustion products.

Heat Radiation

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

- The radiation energy onto the human body [KW /M2]
- The exposure duration[sec]
- The protection of the skin tissue [clothed or naked body]

The limits for 1% of the exposed people to be killed due to heat radiation, and for second-degree burns are given in below:

TABLE:. DAMAGES TO HUMAN LIFE DUE TO HEAT RADIATION

EXPOSURE DURATION	RADIATION FOR 1% LETHALITY (KW/M^2)	RADIATION FOR 2ND DEGREE BURNS (KW/M^2)	RADIATION FOR FIRST DEGREE BURNS, (KW/M^2)
10 sec	21.2	16	12.5
30 sec	9.3	7.0	4.0

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

TABLE: EFFECTS DUE TO INCIDENT RADIATION INTENSITY

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

Explosion

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

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

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

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

- A peak over pressure of 0.1 bars will cause serious damage to 10% of the housing/structures.
- Falling fragments will kill one of each eight persons in the destroyed buildings.

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

TABLE: DAMAGE DUE TO OVERPRESSURES

PEAK OVERPRESSURE	DAMAGE TYPE
0.83 bar	Total destruction
0.30 bar	Heavy damage
0.10 bar	Moderate damage
0.03 bar	Significant damage
0.01 bar	Minor damage

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

INCIDENTS IMPACT

The identified failure scenarios in plant have been analyzed for the impact zones considering damage due to thermal, explosive and toxic impacts. Each incident will have Impact on the surrounding environment which in extreme case may cross plant boundary.

MAXIMUM CREDIBLE LOSS ACCIDENT SCENARIOS

A Maximum Credible Accident (MCA) can be characterized as the worst credible accident. In other words: an accident in an activity, resulting in the maximum consequence distance that is still believed to be possible. A MCA-analysis does not include a quantification of the probability of occurrence of the accident. Another aspect, in which the pessimistic approach of MCA studies appears, is the atmospheric condition that is used for dispersion calculations. The Maximum Credible Loss (MCL) scenarios have been developed for the Facility. The MCL cases considered, attempt to include the worst "Credible" incidents-what constitutes a credible incident is always subjective. Nevertheless, guidelines have evolved over the years and based on basic engineering judgment, the cases have been found to be credible and modeling for assessing vulnerability zones is prepared accordingly.

The objective of the study is Emergency planning, hence only holistic & conservative assumptions are used for obvious reasons. Hence, though the outcomes may look pessimistic, the planning for emergency concept should be borne in mind whilst interpreting the results.

In Consequence analysis, geographical location of the source of potential release plays an

important role. Consideration of a large number of scenarios in the same geographical location serves little purpose if the dominant scenario has been identified and duly considered.

The Consequence Analysis has been done for selected scenarios by ALOHA [version 5.4.1.] of EPA. The details of software used for MCA analysis are described below.

- A computer based version ALOHA 5.4.1.2 is used to calculate toxic and explosive effect of the accidental release of liquid chemicals within the plant area.
- ALOHA (Areal Locations of Hazardous Atmosphere) is a computer program designed especially for use by people responding to chemical release as well as for emergency planning and training.
- ALOHA was jointly developed by the National Oceanic and Atmospheric Administration (NOAA) and the Environment Protection Agency[EPA]
- The mathematical model is based on the Emergency Response Planning Guidelines (ERPGs) which gives Toxic Levels of Concern (LOCs) to predict the area where a toxic liquid concentration might be high enough to harm people.
- ALOHA models key hazards-toxicity, flammability, thermal radiation (Heat), and over pressure (expansion blast force)-related to chemical releases that result in toxic gas dispersion, fire and/or explosion

CONSEQUENCE ANALYSIS

From the list mentioned below, all the Solvents are considered and have been taken for the consequences analysis considering their hazardous nature, Storage conditions and threshold values, other properties.

Sl No	List of Solvents	Maximum storage (KL)/Month	No of tanks	Physical status	Storage (Drum/Tanker)	Storage pressure & temp
1	Methanol	25 KL	2	Liquid	UG/Tank	Ambient
2	Toluene	25 KL	2	Liquid	UG/Tank	Ambient
3	Ethyl Acetate	25 KL	1	Liquid	UG/Tank	Ambient
4	Cyclohexane	25 KL	1	Liquid	UG/Tank	Ambient
5	n-Butanol	25 KL	2	Liquid	UG/Tank	Ambient
6	Isopropyl alcohol	25 KL	1	Liquid	UG/Tank	Ambient
7	Acetone	25 KL	1	Liquid	UG/Tank	Ambient
8	Hexane	25 KL	1	Liquid	UG/Tank	Ambient
9	Tetrahydrofuran	15 KL	2	Liquid	Drum/Tank	Ambient
10	Acetronitrile	10 MT	1	Liquid	Drum	Ambient
11	Methyl tertiary	10 MT	1	Liquid	Drum	Ambient

	butyl ether					
12	Dimethyl formamide	10 MT	1	Liquid	Drum	Ambient
13	Methylene chloride	10 MT	1	Liquid	Drum	Ambient
14	Ethanol	25 KL	1	Liquid	UG/Tank	Ambient
15	Benzene	10 MT	1	Liquid	Drum	Ambient

SITE DATA:

Location: RAICHUR, INDIA

1. **CHEMICAL DATA:**

Chemical Name: **METHANOL**

CAS Number: 67-56-1 Molecular Weight: 32.04 g/mol

AEGL-1 (60 min): 530 ppm AEGL-2 (60 min): 2100 ppm AEGL-3 (60 min): 7200 ppm

IDLH: 6000 ppm LEL: 71800 ppm UEL: 365000 ppm

Ambient Boiling Point: 63.4° C

Vapor Pressure at Ambient Temperature: 0.39 atm

Ambient Saturation Concentration: 408,698 ppm or 40.9%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 2 meters/second from NW at 3 meters

Ground Roughness: open country Cloud Cover: 5 tenths

Air Temperature: 42.5° C Stability Class: E

No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:

BLEVE of flammable liquid in horizontal cylindrical tank

Tank Diameter: 2.5 meters Tank Length: 5 meters

Tank Volume: 24.5 cubic meters

Tank contains liquid

Internal Storage Temperature: 42.5° C

Chemical Mass in Tank: 16000 kilograms

Tank is 84% full

Percentage of Tank Mass in Fireball: 100%

Fireball Diameter: 146 meters Burn Duration: 10 seconds

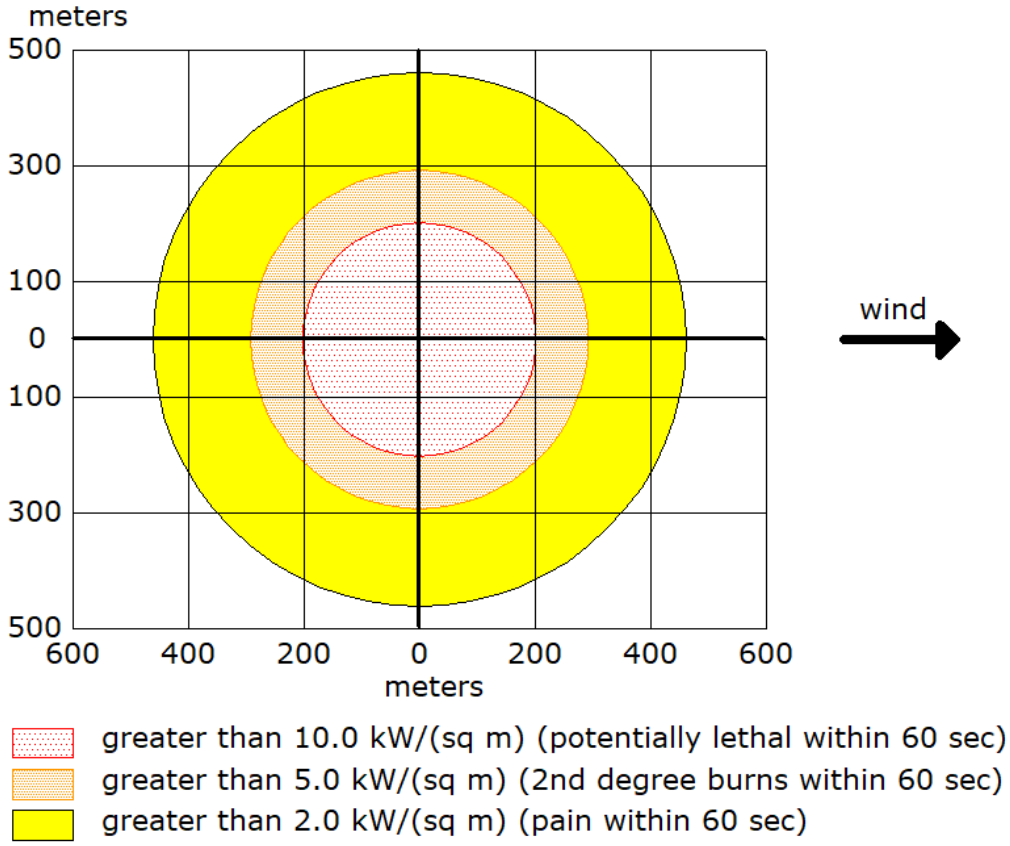
THREAT ZONE:

Threat Modeled: Thermal radiation from fireball

Red : 202 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)

Orange: 292 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

Yellow: 461 meters --- (2.0 kW/(sq m) = pain within 60 sec)



2. **CHEMICAL DATA:**

Chemical Name: **TOLUENE**

CAS Number: 108-88-3 Molecular Weight: 92.14 g/mol

AEGL-1 (60 min): 67 ppm AEGL-2 (60 min): 560 ppm AEGL-3 (60 min): 3700 ppm

IDLH: 500 ppm LEL: 11000 ppm UEL: 71000 ppm

Ambient Boiling Point: 109.2° C

Vapor Pressure at Ambient Temperature: 0.087 atm

Ambient Saturation Concentration: 90,860 ppm or 9.09%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 2 meters/second from NW at 3 meters

Ground Roughness: open country Cloud Cover: 5 tenths

Air Temperature: 42.5° C Stability Class: E

No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:

BLEVE of flammable liquid in horizontal cylindrical tank

Tank Diameter: 2.5 meters Tank Length: 5 meters

Tank Volume: 24.5 cubic meters

Tank contains liquid

Internal Storage Temperature: 42.5° C

Chemical Mass in Tank: 18000 kilograms

Tank is 87% full

Percentage of Tank Mass in Fireball: 100%

Fireball Diameter: 152 meters Burn Duration: 10 seconds

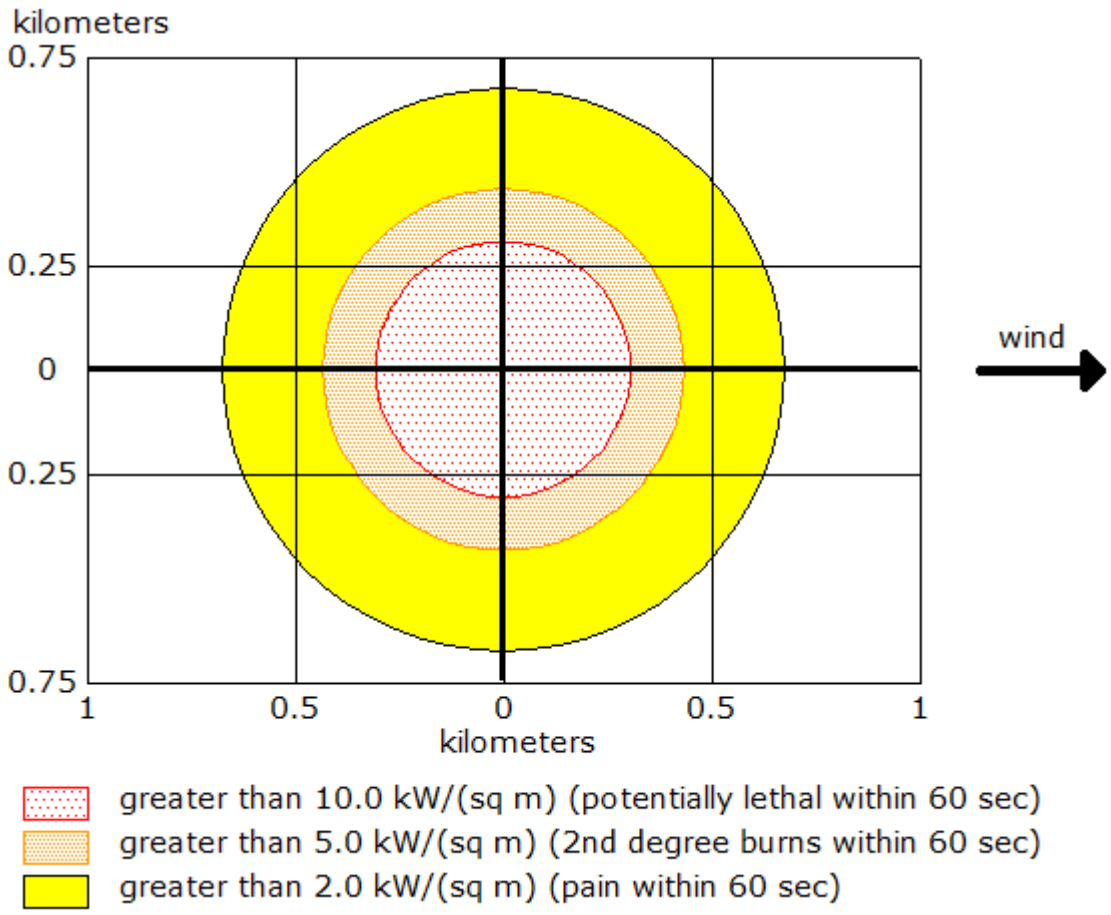
THREAT ZONE:

Threat Modeled: Thermal radiation from fireball

Red : 306 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)

Orange: 432 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

Yellow: 674 meters --- (2.0 kW/(sq m) = pain within 60 sec)



3. **CHEMICAL DATA:**

Chemical Name: **ETHYL ACETATE**

CAS Number: 141-78-6 Molecular Weight: 88.11 g/mol

PAC-1: 1200 ppm PAC-2: 1700 ppm PAC-3: 10000 ppm

IDLH: 2000 ppm LEL: 21800 ppm UEL: 115000 ppm

Ambient Boiling Point: 75.9° C

Vapor Pressure at Ambient Temperature: 0.27 atm

Ambient Saturation Concentration: 283,937 ppm or 28.4%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 2 meters/second from NW at 3 meters

Ground Roughness: open country Cloud Cover: 5 tenths

Air Temperature: 42.5° C Stability Class: E

No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:

BLEVE of flammable liquid in horizontal cylindrical tank

Tank Diameter: 2.5 meters Tank Length: 5 meters

Tank Volume: 24.5 cubic meters

Tank contains liquid

Internal Storage Temperature: 42.5° C

Chemical Mass in Tank: 19000 kilograms

Tank is 89% full

Percentage of Tank Mass in Fireball: 100%

Fireball Diameter: 155 meters Burn Duration: 11 seconds

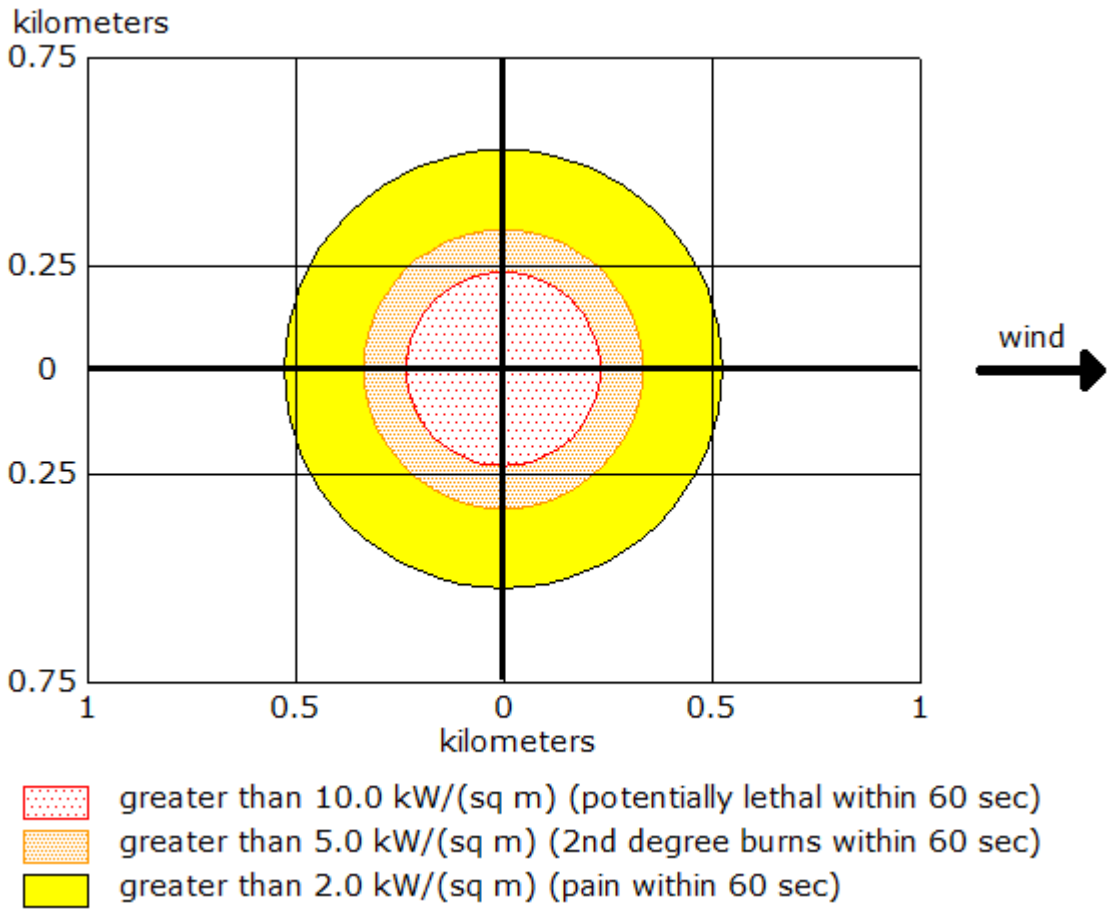
THREAT ZONE:

Threat Modeled: Thermal radiation from fireball

Red : 233 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)

Orange: 334 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

Yellow: 526 meters --- (2.0 kW/(sq m) = pain within 60 sec)



4. **CHEMICAL DATA:**

Chemical Name: **CYCLOHEXANE**

CAS Number: 110-82-7 Molecular Weight: 84.16 g/mol

PAC-1: 300 ppm PAC-2: 1700 ppm PAC-3: 10000 ppm

IDLH: 1300 ppm LEL: 13000 ppm UEL: 78000 ppm

Ambient Boiling Point: 79.4° C

Vapor Pressure at Ambient Temperature: 0.27 atm

Ambient Saturation Concentration: 279,588 ppm or 28.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 2 meters/second from NW at 3 meters

Ground Roughness: open country Cloud Cover: 5 tenths

Air Temperature: 42.5° C Stability Class: E

No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:

BLEVE of flammable liquid in horizontal cylindrical tank

Tank Diameter: 2.5 meters Tank Length: 5 meters

Tank Volume: 24.5 cubic meters

Tank contains liquid

Internal Storage Temperature: 42.5° C

Chemical Mass in Tank: 16000 kilograms

Tank is 86% full

Percentage of Tank Mass in Fireball: 100%

Fireball Diameter: 146 meters Burn Duration: 10 seconds

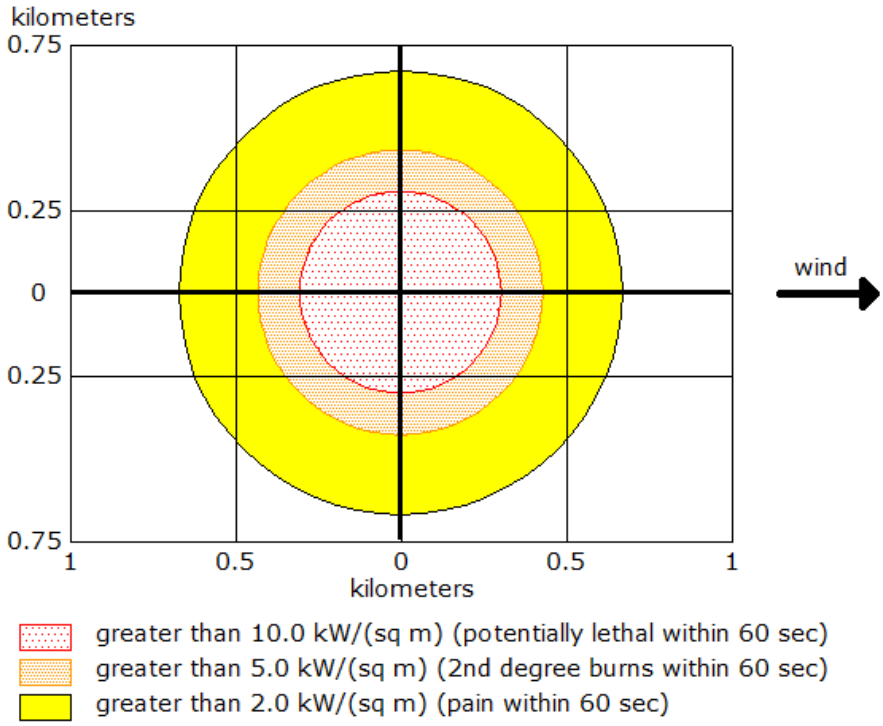
THREAT ZONE:

Threat Modeled: Thermal radiation from fireball

Red : 305 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)

Orange: 431 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

Yellow: 671 meters --- (2.0 kW/(sq m) = pain within 60 sec)



5. **CHEMICAL DATA:**

Chemical Name: **N-BUTYL ALCOHOL**

CAS Number: 71-36-3 Molecular Weight: 74.12 g/mol

PAC-1: 60 ppm PAC-2: 800 ppm PAC-3: 8000 ppm

IDLH: 1400 ppm LEL: 17000 ppm UEL: 113000 ppm

Ambient Boiling Point: 118.7° C

Vapor Pressure at Ambient Temperature: 0.029 atm

Ambient Saturation Concentration: 29,963 ppm or 3.00%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 2 meters/second from NW at 3 meters

Ground Roughness: open country Cloud Cover: 5 tenths

Air Temperature: 42.5° C Stability Class: E

No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:

BLEVE of flammable liquid in horizontal cylindrical tank

Tank Diameter: 2.5 meters Tank Length: 5 meters

Tank Volume: 24.5 cubic meters

Tank contains liquid

Internal Storage Temperature: 42.5° C

Chemical Mass in Tank: 16000 kilograms

Tank is 83% full

Percentage of Tank Mass in Fireball: 100%

Fireball Diameter: 146 meters Burn Duration: 10 seconds

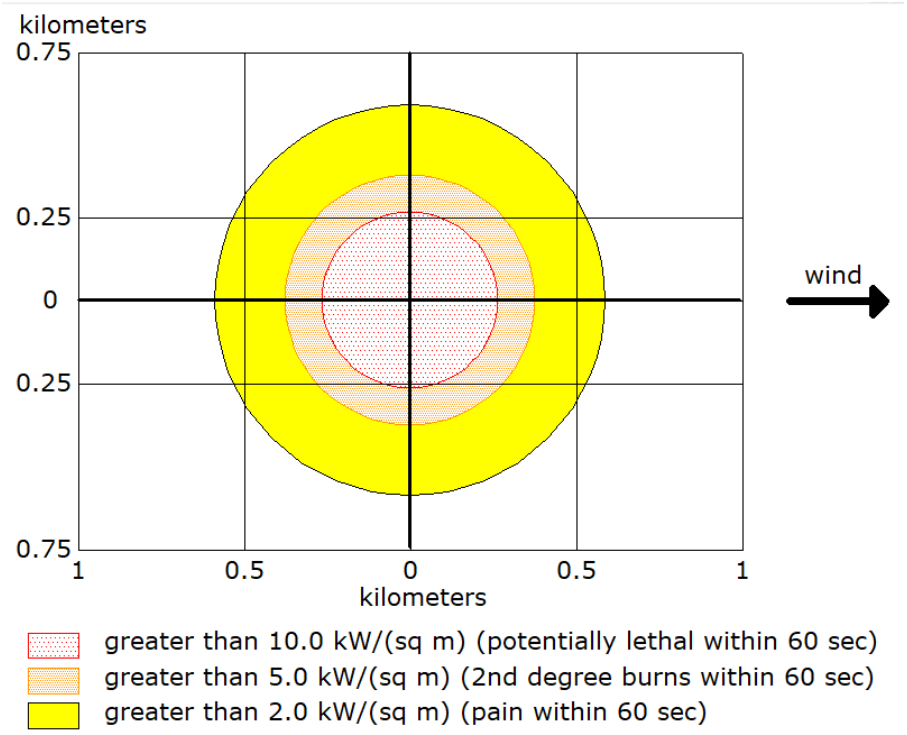
THREAT ZONE:

Threat Modeled: Thermal radiation from fireball

Red : 265 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)

Orange: 377 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

Yellow: 589 meters --- (2.0 kW/(sq m) = pain within 60 sec)



6. **CHEMICAL DATA:**

Chemical Name: **ISOPROPANOL**

CAS Number: 67-63-0 Molecular Weight: 60.10 g/mol

PAC-1: 400 ppm PAC-2: 2000 ppm PAC-3: 12000 ppm

IDLH: 2000 ppm LEL: 20000 ppm UEL: 127000 ppm

Ambient Boiling Point: 81.1° C

Vapor Pressure at Ambient Temperature: 0.16 atm

Ambient Saturation Concentration: 165,242 ppm or 16.5%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 2 meters/second from NW at 3 meters

Ground Roughness: open country Cloud Cover: 5 tenths

Air Temperature: 42.5° C Stability Class: E

No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:

BLEVE of flammable liquid in horizontal cylindrical tank

Tank Diameter: 2.5 meters Tank Length: 5 meters

Tank Volume: 24.5 cubic meters

Tank contains liquid

Internal Storage Temperature: 42.5° C

Chemical Mass in Tank: 17000 kilograms

Tank is 91% full

Percentage of Tank Mass in Fireball: 100%

Fireball Diameter: 149 meters Burn Duration: 10 seconds

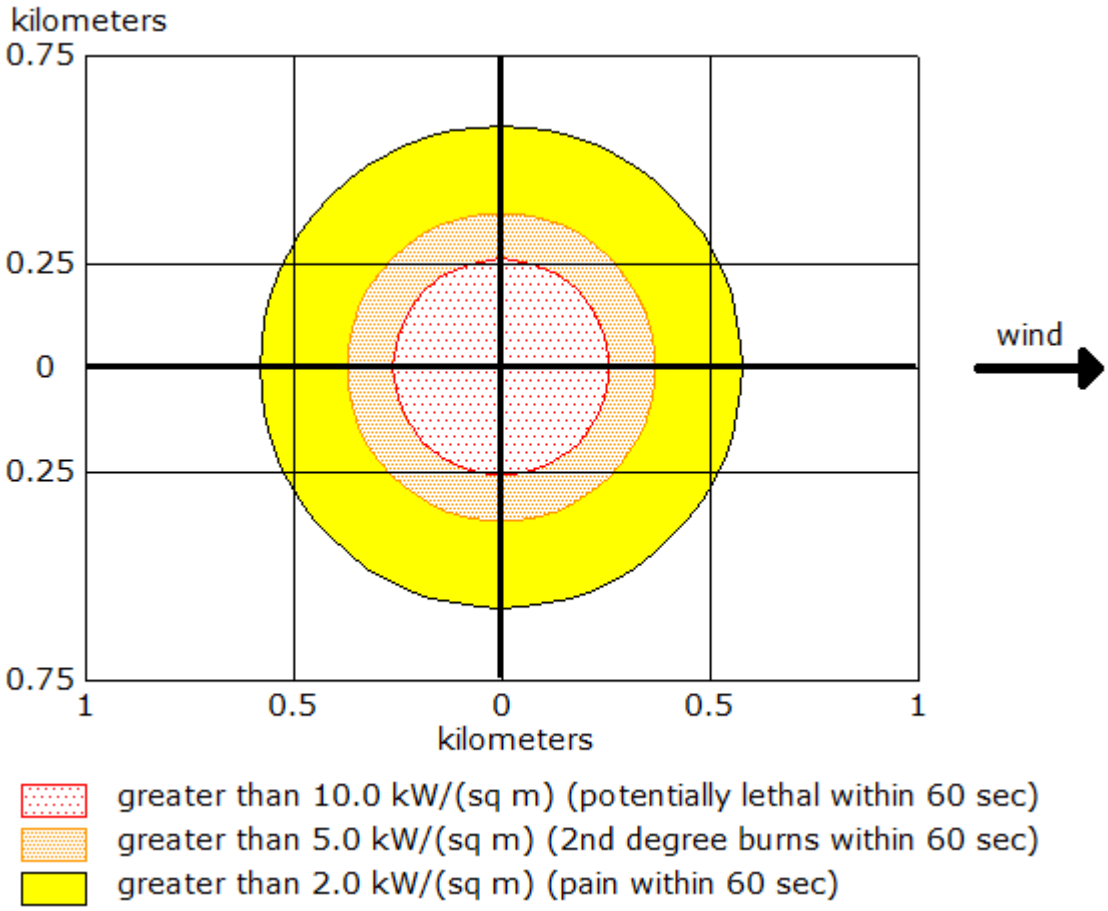
THREAT ZONE:

Threat Modeled: Thermal radiation from fireball

Red : 259 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)

Orange: 369 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

Yellow: 577 meters --- (2.0 kW/(sq m) = pain within 60 sec)



7. **CHEMICAL DATA:**

Chemical Name: **ACETONE**

CAS Number: 67-64-1 Molecular Weight: 58.08 g/mol

AEGL-1 (60 min): 200 ppm AEGL-2 (60 min): 3200 ppm AEGL-3 (60 min): 5700 ppm

LEL: 26000 ppm UEL: 130000 ppm

Ambient Boiling Point: 54.9° C

Vapor Pressure at Ambient Temperature: 0.61 atm

Ambient Saturation Concentration: 639,451 ppm or 63.9%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 2 meters/second from NW at 3 meters

Ground Roughness: open country Cloud Cover: 5 tenths

Air Temperature: 42.5° C Stability Class: E

No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:

BLEVE of flammable liquid in horizontal cylindrical tank

Tank Diameter: 2.5 meters Tank Length: 5 meters

Tank Volume: 24.5 cubic meters

Tank contains liquid

Internal Storage Temperature: 42.5° C

Chemical Mass in Tank: 16000 kilograms

Tank is 85% full

Percentage of Tank Mass in Fireball: 100%

Fireball Diameter: 146 meters Burn Duration: 10 seconds

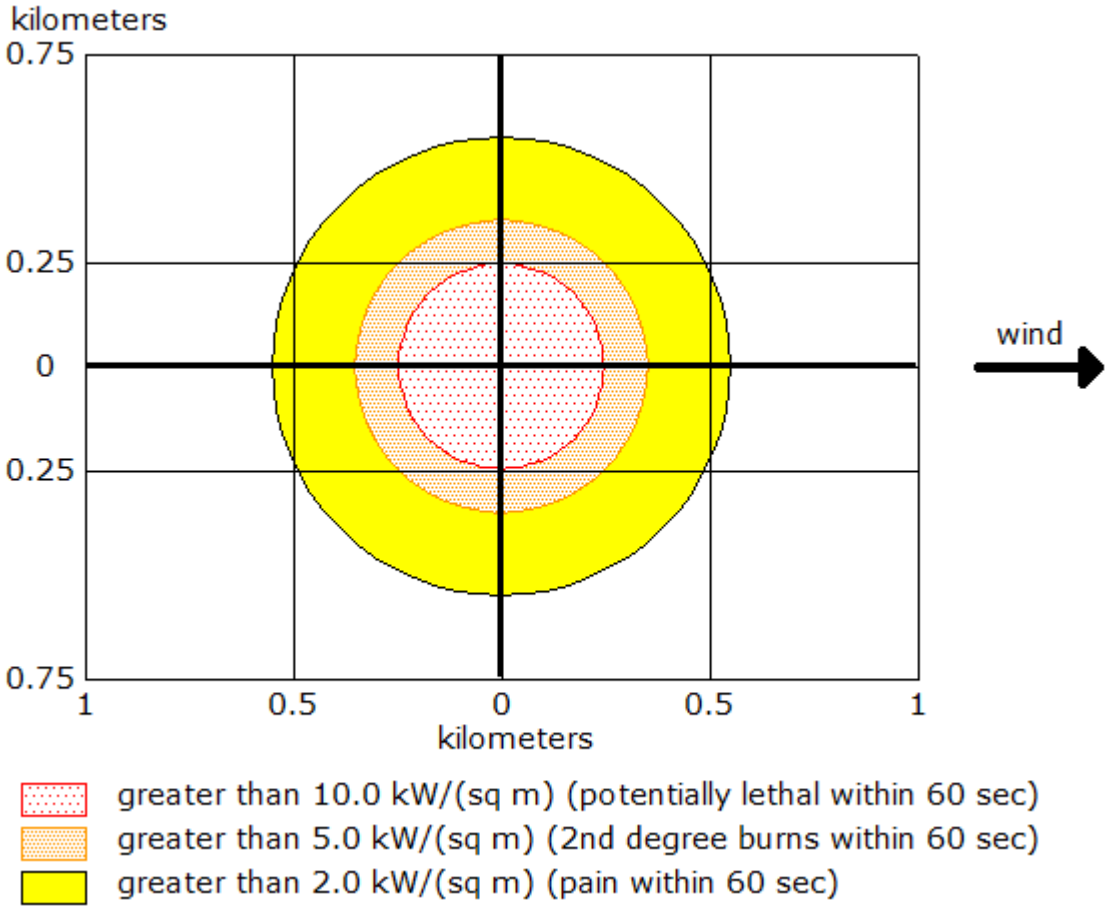
THREAT ZONE:

Threat Modeled: Thermal radiation from fireball

Red : 245 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)

Orange: 350 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

Yellow: 549 meters --- (2.0 kW/(sq m) = pain within 60 sec)



8. **CHEMICAL DATA:**

Chemical Name: **N-HEXANE**

CAS Number: 110-54-3 Molecular Weight: 86.18 g/mol

AEGL-1 (60 min): N/A AEGL-2 (60 min): 2900 ppm AEGL-3 (60 min): 8600 ppm

IDLH: 1100 ppm LEL: 12000 ppm UEL: 72000 ppm

Ambient Boiling Point: 67.4° C

Vapor Pressure at Ambient Temperature: 0.41 atm

Ambient Saturation Concentration: 423,987 ppm or 42.4%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 2 meters/second from NW at 3 meters

Ground Roughness: open country Cloud Cover: 5 tenths

Air Temperature: 42.5° C Stability Class: B

No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:

BLEVE of flammable liquid in horizontal cylindrical tank

Tank Diameter: 2.5 meters Tank Length: 5 meters

Tank Volume: 24.5 cubic meters

Tank contains liquid

Internal Storage Temperature: 42.5° C

Chemical Mass in Tank: 14000 kilograms

Tank is 89% full

Percentage of Tank Mass in Fireball: 100%

Fireball Diameter: 140 meters Burn Duration: 10 seconds

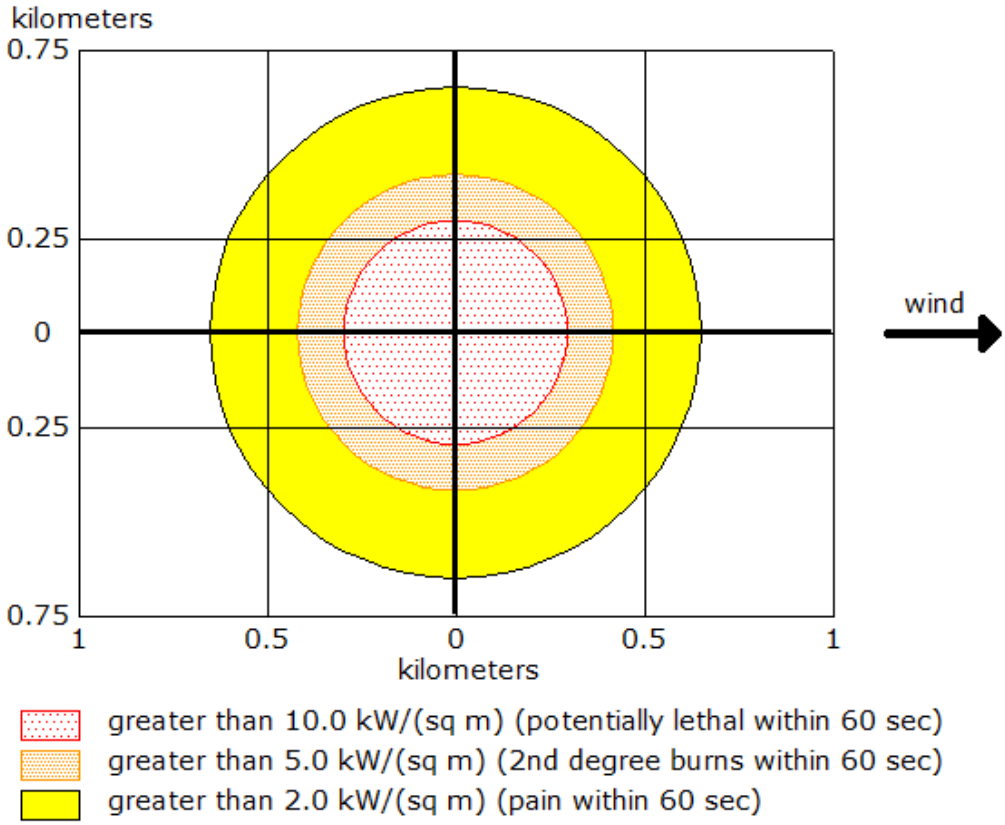
THREAT ZONE:

Threat Modeled: Thermal radiation from fireball

Red : 297 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)

Orange: 419 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

Yellow: 653 meters --- (2.0 kW/(sq m) = pain within 60 sec)



9. **CHEMICAL DATA:**

Chemical Name: **ETHANOL**

CAS Number: 64-17-5 Molecular Weight: 46.07 g/mol

ERPG-1: 1800 ppm ERPG-2: 3300 ppm ERPG-3: N/A

IDLH: 3300 ppm LEL: 33000 ppm UEL: 190000 ppm

Ambient Boiling Point: 77.2° C

Vapor Pressure at Ambient Temperature: 0.20 atm

Ambient Saturation Concentration: 210,472 ppm or 21.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 2 meters/second from NW at 3 meters

Ground Roughness: open country Cloud Cover: 5 tenths

Air Temperature: 42.5° C Stability Class: B

No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:

BLEVE of flammable liquid in horizontal cylindrical tank

Tank Diameter: 2.5 meters Tank Length: 5 meters

Tank Volume: 24.5 cubic meters

Tank contains liquid

Internal Storage Temperature: 42.5° C

Chemical Mass in Tank: 16000 kilograms

Tank is 85% full

Percentage of Tank Mass in Fireball: 100%

Fireball Diameter: 146 meters Burn Duration: 10 seconds

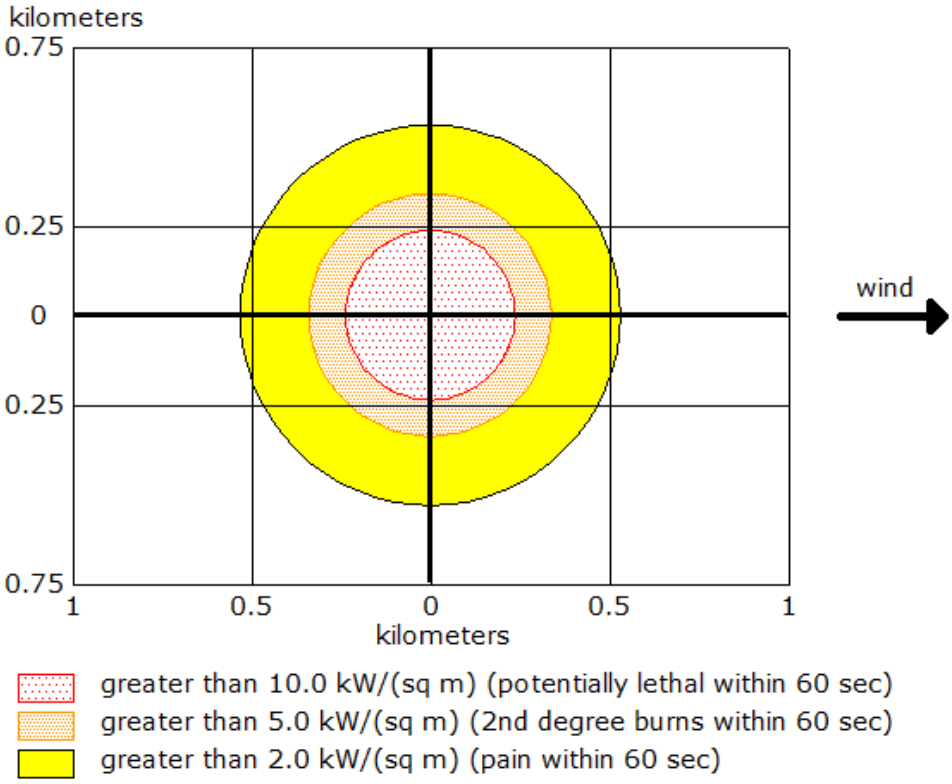
THREAT ZONE:

Threat Modeled: Thermal radiation from fireball

Red : 237 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)

Orange: 339 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

Yellow: 532 meters --- (2.0 kW/(sq m) = pain within 60 sec)



10. **CHEMICAL DATA:**

Chemical Name: **TETRAHYDROFURAN**

CAS Number: 109-99-9 Molecular Weight: 72.11 g/mol

ERPG-1: 100 ppm ERPG-2: 500 ppm ERPG-3: 5000 ppm

IDLH: 2000 ppm LEL: 20000 ppm UEL: 118000 ppm

Ambient Boiling Point: 64.7° C

Vapor Pressure at Ambient Temperature: 0.44 atm

Ambient Saturation Concentration: 455,032 ppm or 45.5%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 2 meters/second from NW at 3 meters

Ground Roughness: open country Cloud Cover: 5 tenths

Air Temperature: 42.5° C Stability Class: B

No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:

BLEVE of flammable liquid in horizontal cylindrical tank

Tank Diameter: 2.5 meters Tank Length: 3 meters

Tank Volume: 14.7 cubic meters

Tank contains liquid

Internal Storage Temperature: 42.5° C

Chemical Mass in Tank: 11000 kilograms

Tank is 87% full

Percentage of Tank Mass in Fireball: 100%

Fireball Diameter: 129 meters Burn Duration: 9 seconds

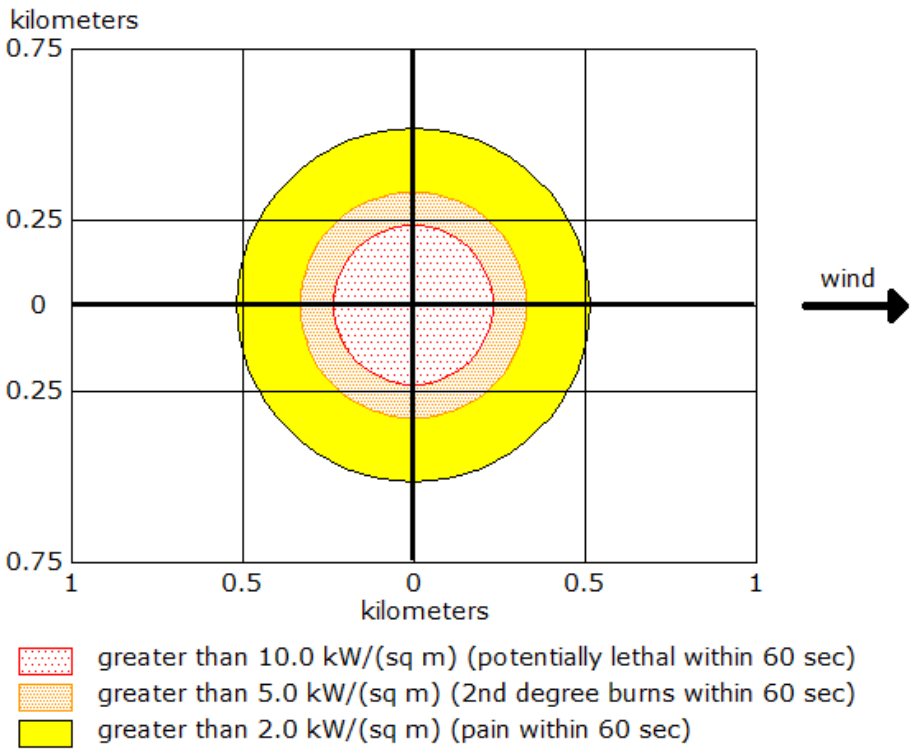
THREAT ZONE:

Threat Modeled: Thermal radiation from fireball

Red : 232 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)

Orange: 330 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

Yellow: 517 meters --- (2.0 kW/(sq m) = pain within 60 sec)



11. **CHEMICAL DATA:**

Chemical Name: **ACETONITRILE**

CAS Number: 75-5-8 Molecular Weight: 41.05 g/mol

AEGL-1 (60 min): 13 ppm AEGL-2 (60 min): 50 ppm AEGL-3 (60 min): 150 ppm

IDLH: 500 ppm LEL: 30000 ppm UEL: 170000 ppm

Ambient Boiling Point: 80.3° C

Vapor Pressure at Ambient Temperature: 0.25 atm

Ambient Saturation Concentration: 259,139 ppm or 25.9%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 2 meters/second from NW at 3 meters

Ground Roughness: open country Cloud Cover: 5 tenths

Air Temperature: 42.5° C Stability Class: B

No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:

Leak from hole in vertical cylindrical tank

Flammable chemical is burning as it escapes from tank

Tank Diameter: 2 meters Tank Length: 3 meters

Tank Volume: 9.42 cubic meters

Tank contains liquid Internal Temperature: 42.5° C

Chemical Mass in Tank: 6000 kilograms

Tank is 84% full

Circular Opening Diameter: 3 inches

Opening is 0.3 meters from tank bottom

Max Puddle Diameter: Unknown

Max Flame Length: 12 meters Burn Duration: 36 minutes

Max Burn Rate: 207 kilograms/min

Total Amount Burned: 5,320 kilograms

Note: The chemical escaped as a liquid and formed a burning puddle.

The puddle spread to a diameter of 11.4 meters.

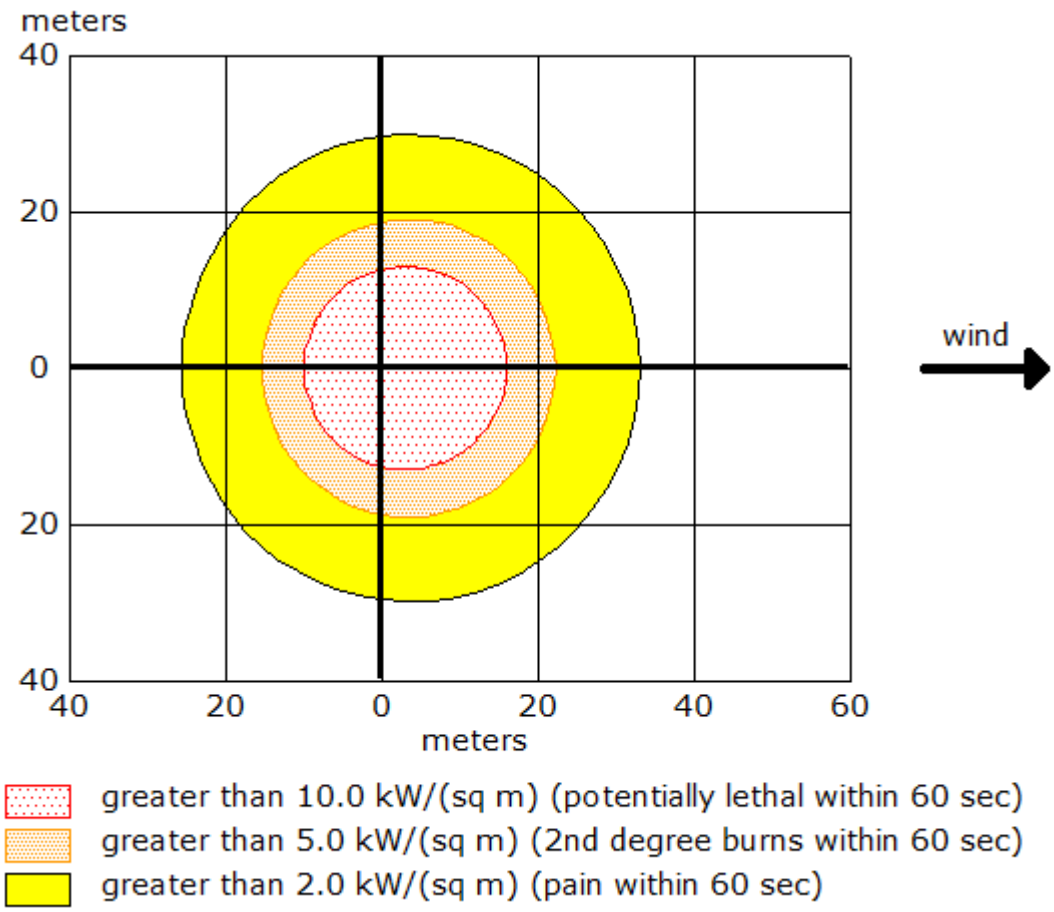
THREAT ZONE:

Threat Modeled: Thermal radiation from pool fire

Red : 16 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)

Orange: 22 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

Yellow: 33 meters --- (2.0 kW/(sq m) = pain within 60 sec)



12. **CHEMICAL DATA:**

Chemical Name: **METHYL TERT-BUTYL ETHER**

CAS Number: 1634-4-4 Molecular Weight: 88.15 g/mol

AEGL-1 (60 min): 50 ppm AEGL-2 (60 min): 570 ppm AEGL-3 (60 min): 5300 ppm

LEL: 12300 ppm UEL: 84000 ppm

Ambient Boiling Point: 53.8° C

Vapor Pressure at Ambient Temperature: 0.65 atm

Ambient Saturation Concentration: 676,087 ppm or 67.6%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 2 meters/second from NW at 3 meters

Ground Roughness: open country Cloud Cover: 5 tenths

Air Temperature: 42.5° C Stability Class: B

No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:

Leak from hole in vertical cylindrical tank

Flammable chemical is burning as it escapes from tank

Tank Diameter: 2 meters Tank Length: 3 meters

Tank Volume: 9.42 cubic meters

Tank contains liquid Internal Temperature: 42.5° C

Chemical Mass in Tank: 6000 kilograms

Tank is 89% full

Circular Opening Diameter: 3 inches

Opening is 0.3 meters from tank bottom

Max Puddle Diameter: Unknown

Max Flame Length: 18 meters Burn Duration: 38 minutes

Max Burn Rate: 201 kilograms/min

Total Amount Burned: 5,360 kilograms

Note: The chemical escaped as a liquid and formed a burning puddle.

The puddle spread to a diameter of 6.5 meters.

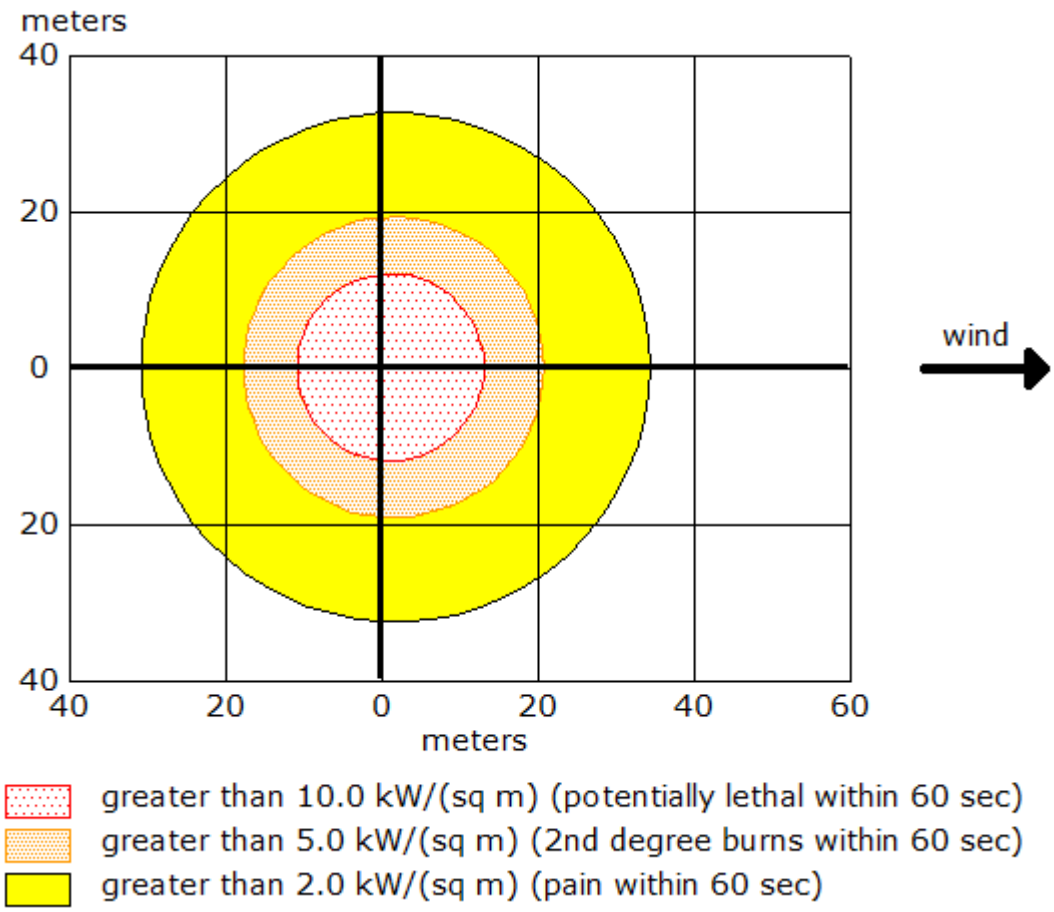
THREAT ZONE:

Threat Modeled: Thermal radiation from pool fire

Red : 13 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)

Orange: 21 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

Yellow: 34 meters --- (2.0 kW/(sq m) = pain within 60 sec)



13. **CHEMICAL DATA:**

Chemical Name: **N,N-DIMETHYLFORMAMIDE**

CAS Number: 68-12-2 Molecular Weight: 73.09 g/mol

AEGL-1 (60 min): N/A AEGL-2 (60 min): 91 ppm AEGL-3 (60 min): 530 ppm

IDLH: 500 ppm LEL: 23000 ppm UEL: 160000 ppm

Ambient Boiling Point: 150.2° C

Vapor Pressure at Ambient Temperature: 0.015 atm

Ambient Saturation Concentration: 15,522 ppm or 1.55%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 2 meters/second from NW at 3 meters

Ground Roughness: open country Cloud Cover: 5 tenths

Air Temperature: 42.5° C Stability Class: B

No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:

BLEVE of flammable liquid in vertical cylindrical tank

Tank Diameter: 2 meters Tank Length: 3 meters

Tank Volume: 9.42 cubic meters

Tank contains liquid

Internal Storage Temperature: 42.5° C

Chemical Mass in Tank: 7000 kilograms

Tank is 80% full

Percentage of Tank Mass in Fireball: 100%

Fireball Diameter: 111 meters Burn Duration: 8 seconds

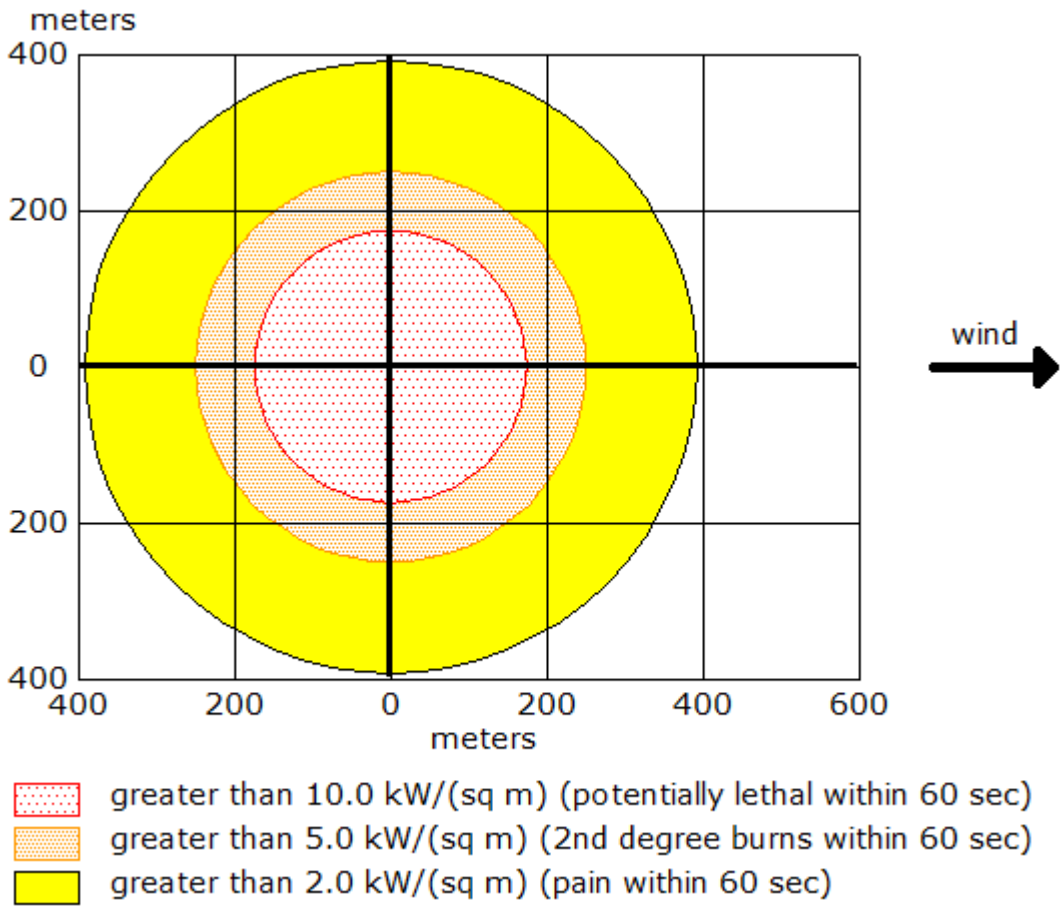
THREAT ZONE:

Threat Modeled: Thermal radiation from fireball

Red : 174 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)

Orange: 249 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

Yellow: 392 meters --- (2.0 kW/(sq m) = pain within 60 sec)



14. **CHEMICAL DATA:**

Chemical Name: **BENZENE**

CAS Number: 71-43-2 Molecular Weight: 78.11 g/mol

AEGL-1 (60 min): 52 ppm AEGL-2 (60 min): 800 ppm AEGL-3 (60 min): 4000 ppm

IDLH: 500 ppm LEL: 12000 ppm UEL: 80000 ppm

Carcinogenic risk - see CAMEO Chemicals

Ambient Boiling Point: 78.8° C

Vapor Pressure at Ambient Temperature: 0.27 atm

Ambient Saturation Concentration: 276,883 ppm or 27.7%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 2 meters/second from NW at 3 meters

Ground Roughness: open country Cloud Cover: 5 tenths

Air Temperature: 42.5° C Stability Class: B

No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:

Leak from hole in vertical cylindrical tank

Flammable chemical is burning as it escapes from tank

Tank Diameter: 2 meters Tank Length: 3 meters

Tank Volume: 9.42 cubic meters

Tank contains liquid Internal Temperature: 42.5° C

Chemical Mass in Tank: 7000 kilograms

Tank is 87% full

Circular Opening Diameter: 3 inches

Opening is 0.3 meters from tank bottom

Max Puddle Diameter: Unknown

Max Flame Length: 18 meters Burn Duration: 30 minutes

Max Burn Rate: 220 kilograms/min

Total Amount Burned: 6,207 kilograms

Note: The chemical escaped as a liquid and formed a burning puddle.

The puddle spread to a diameter of 7.3 meters.

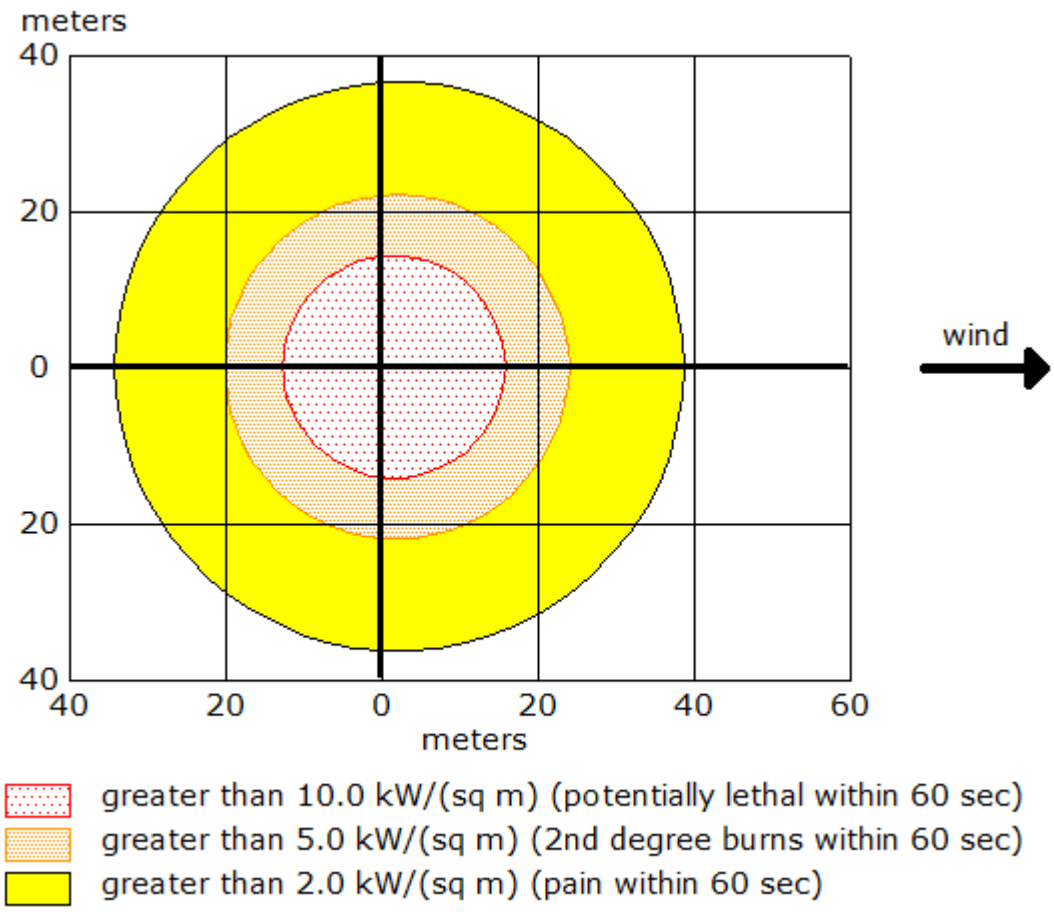
THREAT ZONE:

Threat Modeled: Thermal radiation from pool fire

Red : 16 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)

Orange: 24 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

Yellow: 39 meters --- (2.0 kW/(sq m) = pain within 60 sec)



Common Hazards

- Physical such as ventilation, poor illumination, noise, extreme temperature, humidity and radiation.
- Biological such as variety of pathogenic bacteria and parasites.
- Chemical due to hazardous gases and dusts.
- Ergonomic.

Industrial Hygiene Monitoring

- Industrial hygiene monitoring is to be located and identify source of exposure in the workplace so that they can be corrected and to quantify the exposure of employees to chemicals in the air.

Occupational Health Monitoring System

Air samples

Locations of samples – air samples are generally collected in one or three locations:

- At the breathing zone of the worker [Personal sample]
- In the general room air [Areas ample]
- At the operation which is generating the hazardous substance [Area sample]

Lengths of samples – Air samples are generally collected for two lengths of time.

- Grab samples [instantaneous] measure conditions at one moment in time and can be likened to a still photograph. They give only a picture of conditions at one place at one instant in time.
- Continuous Samples [range from twenty minutes to 8 – 10 Hours].These is used to evaluate all day exposure by a series of continuous samples. Continuous samples may be thought of as like a motion picture since they record activity taking place in various places over a period of time. They provide an average of conditions over a period samples.

Other sampling methods

Bulk samples

Bulk samples will be collected from settled dust in the work place or from drums or bags of chemicals. Their purpose is to analyze and identify the substances present. For example, bulk samples are used to analyze the percent of asbestos in insulation or dust. Usually, a substance which is greater than one percent of bulk sample is considered a concern.

Wipe Samples

Wipe samples will be used when skin absorption or ingestion is a suspected rote of exposure. The purpose is to show whether skin, respirators, clothing, lunch rooms, lockers, etc. are contaminated.

It can show which surfaces are clean and which are contaminated. It can also show if some surfaces are more contaminated than others.

Sampling Devices

The general principle of sampling is to collect an amount of a contaminant onto a medium from a known quantity of air.

Air samples will be collected using small pumps to suck air from the workroom. The pump

is attached by tubing to a sampling device which contains the sampling medium; for example a glass tube containing charcoal.

The sampling method will be used depends on the physical form of the substance:

- DUSTS –The sampling device is a filter of plastic or paper in sholder:
- VAPORS –The sampling device is a glass tube containing activated charcoal as a medium.
- GASES –The sampling device is a bubbler containing a fluid medium to dissolved or react with the gas

The collected samples will be sent to a laboratory where the amount of the substance on the sampling medium [filter, tube, etc.] is measured.

In some cases air monitoring will be conducted by using direct reading instrument such as a monitoring for carbon monoxide these instruments can measure the amount of a contaminant in the air immediately without being sent to a laboratory.

- **PELs** [Permissible Exposure Limits] – these are legal limits which have been established by OSHA.
- Recommended PELs – also reference to as **RELs** [Recommended Exposure Limits] often these values are based on more recent scientific information than the legal PELs enforced by **OSHA**.
- **TLVs** [Threshold Limit Values] – These are exposure limits put out by a nongovernmental group, the **ACGIH** [American Conference of Governmental Industrial Hygienists]. Many of these were adopted as legal requirements.
- Revised **TLVs** are often based on the most recent and accurate scientific information.
- Permissible Exposure Limits by **OSHA** [Occupational Safety and Health Administration] when it started back in1970.
- **IDLH** [Immediate Dangerous to Life or Health] limits are prescribed by **NIOSH** [National Institute of Occupational Safety and Health]

CHEMICAL EXPOSURE LIMITS & EMP FOR THE OCCUPATIONAL SAFETY & HEALTH HAZARDS

TABLE: CHEMICAL EXPOSURE LIMITS

S. No	SOLVENT NAME	Exposure Standards		
		ACGIH [TLV]	OSHA [PEL]	NIOSH [IDLH]
1	Methanol	200	200	6000

2	Iso propyl alcohol (IPA)	200	400	500
3	Acetone	500	750	2500
4	Ethyl Acetate	250	250	2000
5	Acetonitrile	60	60	20
6	Hexane	50	500	50
7	Tetrahydrofuran (THF)	50	200	2000

Notes:

- All the above Values are in **ppm**
- PPE Means Personal Protective Equipment like Helmets, Safety Google, Breathing apparatus, Nose Masks, Gloves, Gum Shoes etc.,

NOTE: Medical testing reports of the Employees will be available at the time of industry in operation

EMP for the Occupational Safety & Health Hazards so that such exposure can be kept within permissible exposure level (PEL) / Threshold Level value (TLV) so as to protect health of workers.

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

2. It is proposed that this EMP be formulated on the guidelines issued by Bureau of Indian Standards on OH&S Management Systems: IS 18001:2000 Occupational Health and Safety Management Systems.

3. Proposed EMP will be incorporated in Standard Operating Procedure also

4. The proposed EMP will also include measure to keep air-borne concentration of toxic and hazardous chemicals below its PEL and TLV, like…

- Leak Surveys
- Separate storage for toxic chemicals

- Exhaust Ventilation
- Proper illumination
- On-line detectors toxic chemical like Anhydrous Ammonia
- Close processes to avoid spills and exposures
- Atomization of process operations to hazards of manual handling of chemicals
- 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
- Decontamination procedure for empty drums and carboys.
- Regular maintenance program for pumps, equipment, instruments handling toxic and corrosive chemicals
- Display of warning boards
- Training to persons handling toxic and corrosive chemicals

Workplace Monitoring Plan

- It is proposed that a Workplace Monitoring Plan to be prepared & implemented accordingly.
- 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 records 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 been proposed to study the exposure data when the plant is operative.

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

  1. Liver Function tests,
  2. Chest X-ray,
  3. Audiometry,

4. Spirometer Vision testing (Far & Near vision, color vision and Any other ocular defect)
5. ECG, etc. will be carried out.

However, the parameters and frequency of such examination will be decided in consultation with Factory Medical Officer.

- 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. Plan of monthly and yearly report of the health status of workers with special reference to Occupational Health and Safety, will be maintained.

TREATMENT OF WORKERS AFFECTED BY ACCIDENTAL SPILLAGE OF CHEMICALS

[Interim First Aid for General Injuries & Wounds]

Interim First Aid is essential in many injuries while injured waits for trained personnel to arrive.

BLEEDING

- Apply direct pressure on the wound with a clean dressing.
- If bleeding continues and you do not suspect a fracture, elevate the wound above the victim's heart and continue to apply direct pressure.
- If bleeding continues, apply pressure at a pressure point.
- Maintain body temperature.
- Do not use a tourniquet unless this is a serious amputation.

BREATHING PROBLEMS

- Move victim to fresh air if smoke or dangerous gases are present.
- Otherwise, do not move victim.
- If victim loses consciousness, call doctor
- Never enter into a room with toxic gases released -call without protection

UNCONSCIOUS VICTIM

- Move victim to fresh air if smoke or dangerous gases exist.
- Begin rescue breathing- is First Aid trained ahead of time! Instead.
- Never enter into a room with toxic gases released- call without protection

CHEMICAL BURNS

- Have victim remain under a safety shower or flush skin with an available water source for 15-30 minutes.
- Remove all contaminated clothing and jewelry.
- Cover burns with dry, loose dressings.
- Wash all clothing thoroughly before wearing it again.

ACID BURNS

- In case of acid burn, the operator should with all possible speed get under a safety shower and use the full flow of water - the more water the better. A small amount of water will incase severity of the burn Water should be used until all traces of acid have been washed from the burn. Alkaline solutions are not needed; if used at all they should be used only after all acid has been washed from the burn, it may to treat in the same manner as a heat burn.

CHEMICAL INGESTIONS

- Never enter into a room with toxic gases released without protection
- Do not give victim any food or liquids without specific advice from physician.

EYE INJURIES FROM CHEMICALS

- Get victim to a safety shower or eye wash immediately.
- Never enter into a room with toxic gases released- call without protection
- Flush eye for 15-30 minutes with both lids held open. Keep the injured eye lower than the uninjured eye.
- Keep the eyelids open hold fingers at top and bottom of the eyeball. Wrap a bandage loosely around both eyes.

SAFE OPERATING PROCEDURES

- Safe operating procedures will be available for all materials, operations and equipment.

- The workers will be informed of consequences of failure to observe the safe operating procedures.
- Safe operating procedures will be formulated and updated, specific to process & equipment and distributed to concerned plant personnel.
- Safety procedures will be prepared and displayed meticulously in Kannada and English languages.

FIRE PROTECTION

- Well-designed pressured hydrant system comprising with jockey pump, electrical & diesel pumps, hydrant, monitor etc. will be installed at the plant.
- The firefighting system and equipment will be tested and maintained as per relevant standards.
- Heat and smoke detectors will be provided at the plant and calibrated and maintained properly.

STATIC ELECTRICITY

- All equipment and Storage tanks / Containers of flammable chemicals are will be bounded and earthed properly.
- Electrical pits will be maintained clean and covered.
- Electrical continuity for earthing circuits shall be maintained.
- Periodic inspections shall be done for earth pits and record will be maintained.

COMMUNICATION SYSTEM

Communication facilities will be checked periodically for its proper functioning.

SAFETY INSPECTIONS

The system will be initiated for checklist based routine safety inspection and internal audit of the plant. Safety inspection team will be formed from various disciplines and departments.

PREDICTIVE AND PREVENTIVE MAINTENANCE

Predictive and preventive maintenance schedule will be followed in religious manner.

ELECTRICAL SAFETY

- Insulation pad at HT panels will be replaced at regular interval.
- Housekeeping in MCC room will be kept proper for safe working conditions.

COLOUR CODING SYSTEM

Color coding for piping and utility lines are will be followed in accordance with IS: 2379:1990.