## 7.3 RISK ASSESSMENT

Proposed expansion project of distillery would be undertaken and implemented by management of HDPL in existing premises. Risk assessment and hazard management study was done by Mr. Vinod Sahasrabudde; FAE for Risk and Hazard (RH) in respect of EEIPL. Proposed expansion project would be formulated in such a fashion and manner, so that utmost care of safety norms and Environment Protection Act shall be taken care of.

### 7.3.1. Objective of the Risk and Hazard Analysis is to -

1. Identify hazards and nature of hazard in the process, storage and handling of hazardous chemicals.
2. Carry out Qualitative risk analysis for the process and suggest mitigation measures.
3. Carry out Quantitative risk analysis of the storage of hazardous chemicals and estimate the threat zones for Most Credible and Worst case scenarios
4. Suggest mitigation measures to reduce the risk/probability of the accident to the minimum.
5. Incorporate these measures for ensuring safe operations and safe layout to mitigate hazard and for effectively encounter any accident reduce the damages to the minimum.
6. Help in preparation of preparation of On-site and Off-site emergency plans
7. Suggest Guidelines for on-site and off - site emergency plan

### 7.3.2. Methodology

#### 7.3.2.1. Identify hazards based on

1. Processes description received based.
2. Identify Hazardous Chemicals handled and stored.
3. Inventory of Hazardous chemicals
4. Proposed storage facilities for hazardous chemicals
5. Plant layout
6. Safety measures to be adopted by the company

#### 7.3.2.2. Hazard Assessment

1. By Qualitative Risk Assessment
2. By Quantitative Risk Assessment by Hazard index calculations and estimate threat zones by using ALOHA

#### 7.3.2.3. Recommendations

1. Recommend mitigation measures based upon the above
2. Recommending guidelines for the preparation of On-site Emergency plan.

## 7.4 HAZARD IDENTIFICATION

### 7.4.1. Potential and Major Hazards in Integrated Complex of HDPL

Potential hazardous areas and the likely accidents with the concerned area have been enlisted below-

**Table 7.1 Possible Hazardous Locations Onsite**

| Sr. No. | Hazardous Area | Hazard identified | Mitigation measures | Mitigation measures in place | Comments/ Additional measures |
|---|---|---|---|---|---|
| 1 | Boiler Area | Explosion | IBR rules for design, maintenance and operation of boilers by certified boiler attendants in mandatory | These measures are in place as the boiler is in operation for the existing capacity. | Will be adopted for the additional boiler capacity |
| 2 | All over the plant | Lightening | To design and install adequate number of best available lightening arrestors. | These measures are in place as the boiler is in operation for the existing capacity. | If additional are required for increased area of operations these will be installed |
| 3 | Electrocution | Lose fitting | Regular maintenance, internal safety audit, and external safety audit at regular intervals. | These are in place for the operation of the existing capacity | -- |
| 4 | Electrical rooms | Fire and electrocution | | | |
| 5 | Transformer area | | | | |
| 6 | Cable tunnel | | | | |
| 7 | Storage yard for Coal | Fire | Constant supervision to extinguish small fires caused by heat by spraying water. Fire hydrant lines to be laid around the coal storage area. | Covered with fire hydrant system | -- |
| 8 | Alcohol production area | Fire and Alcohol vapour release | HAZOP study is strongly recommended for the production as well as Alcohol Storage area. And adequate safety instrumentation with alarms and interlocks to be incorporated to make the design and plant operation intrinsically safe. | Same will be followed for expansion. | -- |
| 9 | Distillery (ethanol storage tank) | Fire | Detailed measures have been suggested in the report, in the later part. And QRA results and based on failure frequency risk has been calculated. Fire hydrant will be laid around with foam fighting arrangements. | --- | -- |

### 7.4.2. Mitigation Measures to Avoid Accidents:

**A. Preventive Measures for Electricity Hazard:**

- All electrical equipment is to be provided with proper earthing. Earthed electrode are periodically tested and maintained.
- Emergency lighting is to be available at all critical locations including the operator's room to carry out safe shut down of the plant.
- Easy accessibility of fire fighting facilities such as fire water pumps and fire alarm stations is considered.
- All electrical equipments to be free from carbon dust, oil deposits, and grease.
- Use of approved insulated tools, rubber mats, shockproof gloves and boots, tester, fuse tongs, discharge rod, safety belt, hand lamp, wooden or insulated ladder and not wearing metal ring and chain.
- Flame and shock detectors and central fire announcement system for fire safety are to be provided.
- Temperature sensitive alarm and protective relays to make alert and disconnect equipment before overheating is to be considered
- Danger from excess current due to overload or short circuit is to be prevented by providing fuses, circuit breakers, thermal protection

**B. Coal/Fuel Storage:**

- The plant has adequate water supply through pipe/ surface water. Coal storage unit is to be ensured for stacking of coal in heaps and care shall be taken.
- Adequate dust suppression measures shall be provided to prevent fugitive emission and also risk of fire. Similar measures are also adopted for loading/unloading operations.
- Coal ash transported in tankers is to be covered and closed and so that there is no chance of spillage during transportation.
- Workers to be trained to be vigilant and keep water hose with ready water supply to extinguish small fires during hot season.
- Fire fighting measures, alarm measures and fire hydrant line to be provided around the coal storage area to immediately and effectively deal with fire. This is already in place.
- Measures are taken to control the air pollution during loading/handling coal

**C. Accidental Release Measures Safety Measures for Storage & Handling of Alcohol:**

**Handling and storage**

Keeping away from heat, sparks and open flame, care will be taken for avoidance of spillage, skin and eye contact, well ventilation, Use of approved respirator if concentration of alcohol in air is above acceptable level will be promoted.

For Storage and handling following precautions will be taken:

- Keeping away from oxidizers, heat and flames.
- Cool, dry, & ventilated storage and closed containers.
- Grounding of the container and transferring of equipment to eliminate static Electric sparks.

**D. Establishing a Fire Fighting Group**

A small spark of fire may result into loss of lives, machines and the damage by fire may result in high economic losses. This type of losses can be avoided by preventing and controlling the fire instantly for which fire–fighting group will be established. Fire fighting group would house and keep in readiness, the following types of equipment and arrangements.

- $CO_2$ extinguishers
- Dry powder chemical extinguishers
- Foam extinguishers
- 80 mm. spray hoses
- Fire brigade

## 7.5 POTENTIAL AND MAJOR HAZARDS IN HDPL

Normally alcohol plants sections are fully automated with PC control for maintaining recommended operating conditions and ensuring the product specifications, plant safety and achieving the plant capacity. Sufficient instrumentation, alarms and interlocks would be provided to minimize any risk of accident.

There are two areas of concern are:
1. Molasses storage: Heavy leakage of Molasses, total breakage of tank, leading to loss of life and pollution
2. Alcohol Manufacturing: Leakage leading to fire.
3. Alcohol Storage: Leakage leading to fire.
4. Grain Storage: Fire

**Table 7.2 Areas of Operation and Hazard in Distillery**

| No | Area of operation | Hazard |
|---|---|---|
| 1 | Molasses Storage | Leakage |
| 2 | Alcohol Manufacturing | Leakage and fire |
| 3 | Alcohol storage | Leakage and Fire |
| 4 | Grain Storage | Fire |

### 7.5.1 Hazard identification

Leakage of molasses can pose serious health hazard due to obnoxious odour. Uncontrolled rise in temperature leads to side reactions; this is exothermic and leads to further rise in temperature and polymerization. This can lead to serious accident. Carrying hot work near the tank or on the tank, even when empty, can lead to serious explosion and fatal injuries.

### 7.5.2 Mitigation Measures

- It is necessary to take following mitigation measures to prevent bursting of tanks, and heavy leakage and loss of life.
- It is recommended that the present storage arrangements should be reviewed and necessary modifications / operational procedure will be implemented.

### 7.5.2.1. Storage of Molasses

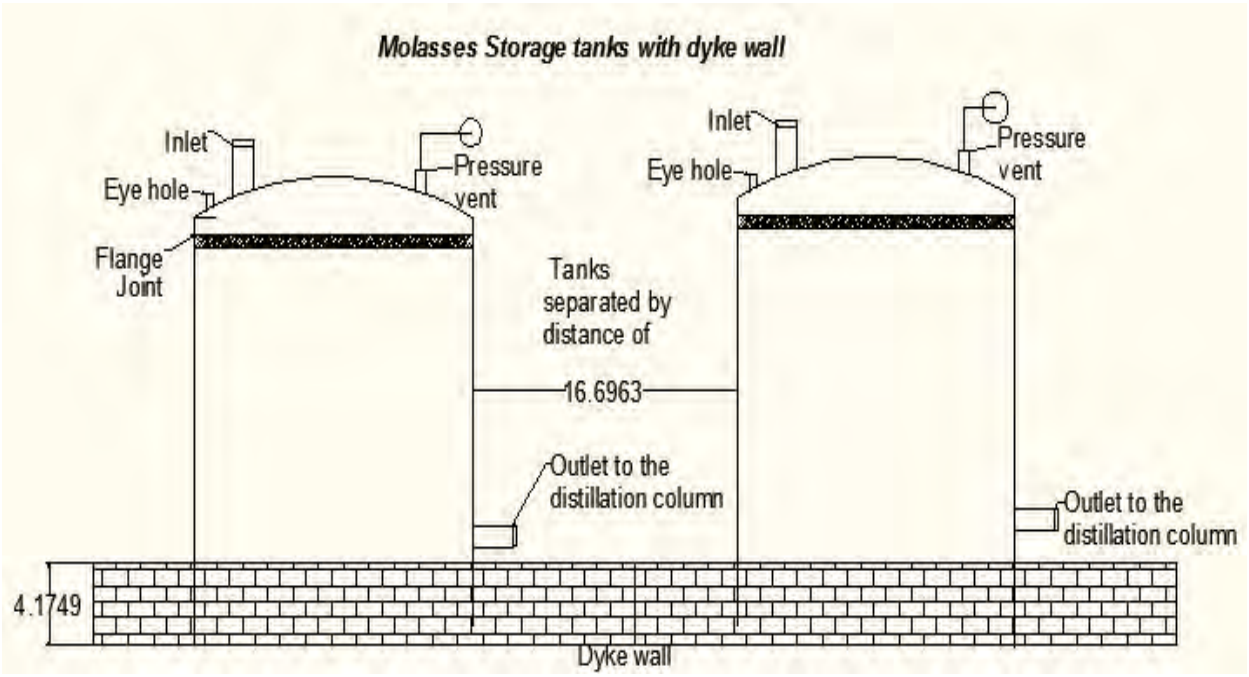
1. Under expansion, additional increase in capacity by 200 KLPD, consumption of Molasses will increase from 1200 MT/month to 2400 MT/M.
2. Molasses should be stored in good quality and leak proof mild steel tanks.
3. Adequate safety factor should be incorporated into the design of wall thickness considering deterioration that will occur due to corrosion over a period of time.
4. Regular internal and external inspection should be scheduled for checking wall thickness of the tanks.
5. Dyke/ Bund walls should be constructed around the tank or tanks.
6. It must be ensured while finalizing the dyke dimensions and that thickness that clear volume inside the dyke walls is equal or more than 1.2 x volume of tank storage capacity.
7. Continuous mixing of molasses through external pump circulation should be done.
8. If there is increase in temperature beyond 300C external cooling of tanks shall be provided by heat exchanger in the circulation line.
9. Frequent Temperature monitoring, manually or by recorder is strongly advised.

If there is leakage following measures will be followed –

a. Leakage should be washed out and diluted and should be recycled as far as possible or must be properly treated in Effluent treatment plant.
b. Replacing of leaky gaskets, joints, should be done strictly by following work permit system.
c. Leakage of pipelines, welding repairs should be attended / carried out outside the plant. The necessary hot work permit should be issued after taking necessary precautions and fire fighting measures for onsite hot work, by the concerned authority before any hot work in undertaken
d. Leakage through pump gland shall be reduced to the minimum by installing mechanical seals.
e. To attend all major leakage in tanks the following procedure should be followed
   (i) Transfer the material to other tank.
   (ii) Prepare the tank for welding repairs by making sure that it is positively isolated with blinds from other vessels and ensuring that it is free of the chemicals and gases by purging air and carrying out air analysis before any hot work is undertaken and this should be done by skilled workers. For this purpose safety permit should be given.
   (iii) While emptying the tank completely for regular or breakdown maintenance, the thick slurry from the tank bottom should be pumped out by using suitable high viscosity pump. The pumped slurry should be diluted and treated in ETP. Should not be let out in the drain. For storage of molasses refer Chapter 2

Representation of Storage tanks of molasses with dyke wall is given as follows.

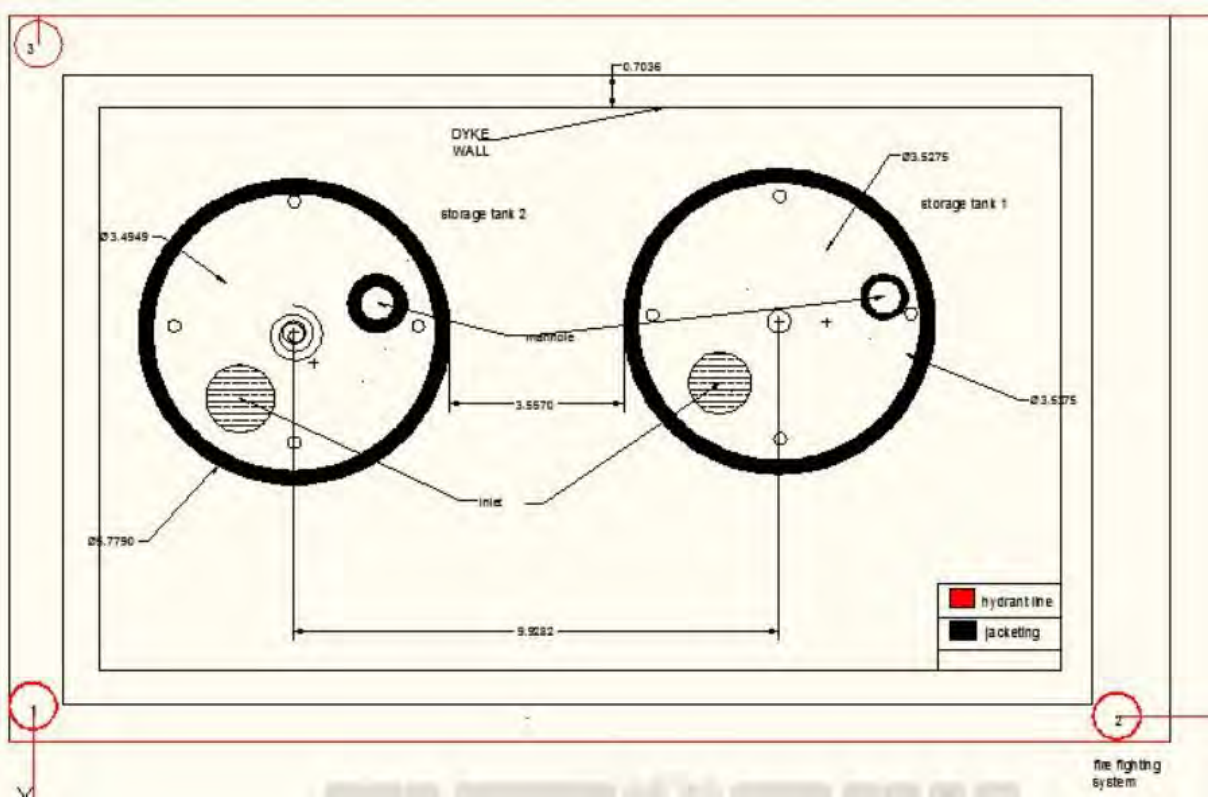
**Figure 7.1 Front views of Molasses storage tanks**




## 7.6 Alcohol manufacturing unit

Main hazard is the alcohol storage tanks where the hazard is release of alcohol vapiur and fire. For improvisation of safety near storage tanks, the storage tanks will be separated with the distance half of the diameter of the nearby tanks. Refer Table 2.15 for details of alcohol storage.

**Figure 7.2 Top view of Alcohol storage tank**



- **Major area of concern from Risk and hazard is Alcohol storage:**

NFPA rating for Alcohol is NH (Health Factor) NF (Fire Factor) NR (Reactivity)
NF= 3, NH = 2 and NR=0, indicating fire as the major hazard in handling and storage of Alcohol

- **Qualitative Risk analysis:**

For the storage of more than 3000 $M^3$ of alcohol Fire and Explosion index has been calculated to be 72 based on the Material Factor MF= 16 and storage conditions (Degree of Hazard is rated based on of Fire and explosion index as follows

**Table 7.3 Degree OF Hazard and F&EI Index**

| F & EI Index Range | Degree of Hazard |
|---|---|
| 1-60 | Light |
| 61-96 | Moderate |
| 97-127 | Intermedite |
| 128- 158 | Heavy |
| More Than 159 | Severe |

- **Mitigation Measures for the existing & proposed expansion installation of Alcohol storage tanks:**

1. Based on standard recommendations for moderate hazard is it is recommended to have Alcohol storage tanks will be in open in dyke walls and should have spill collection and control (recycle) arrangement to pump into another tank.
2. As indicated the storage will be in open with dyke walls.
3. Clear distance between tanks will be provided as per the requirement of Petroleum Rules.
4. Location of pumps, location of tank farm in the factory should be as per the requirements of Petroleum rules.
5. Necessary approval from Chief Controller of Explosives will be obtained for the alcohol storage and factory lay out.

For worst case scenario mapping refer Appendix – I

### 7.6.1. Fire fighting system design around alcohol storage

- Fire hydrant system, with necessary alarm systems, piping, with required number of hydrant points, hose boxes, pump, auxiliary pump to operate, auxiliary power generator/backup will be designed as per relevant IS standards.
- The static fire fighting pumps will conform to the requirements given in IS 12469: 1988. The capacity of pumps would be worked out based on requirements of output and pressure for the system.
- Fire fighting hydrant system in the entire plant will be laid as per IS 909: 1975 Standard with hose reels

## 7.7 FIRE TRIANGLE

The triangle illustrates the three elements a fire needs to ignite: Fuel, Heat, and an oxidizing agent (usually oxygen) A fire naturally occurs when the elements are present and combined in the right mixture, meaning that fire is actually an event rather than a thing.

**Figure 7.3 Fire Triangle**


A fire can be prevented or extinguished by removing any one of the elements in the fire triangle. For example, covering a fire with fire blanket removes the oxygen part of the triangle and can extinguish a fire. This type of representation will be displayed in the fire prone areas.

### A. Mitigation Measures for Leakages And Fire

- Approval from Chief Controller of Explosives CCOE' will be procured in addition to regular factory inspector's approval and other statutory approvals.
- With respect to the Petroleum Act, Petroleum rules, 2002 following important measures with respect to tank layout and factory layout will be followed though these are recommended for storage above 5000 $M^{3.}$
- Minimum Clear distance between two tanks will be 0.5 D or d or 15 meters D= tank diameter in meters, d= diameter of small tank in meters. Or (D+d)/4
- Tanker vehicle loading/unloading center of the bay area will be minimum 15 meters away from the tanks storage periphery.
- Boundary fencing will be minimum 20 meters away from periphery
- All the tanks will be placed within the area surrounded by dyke wall, constructed as per standard design and construction norms.
- Volume of the within the dyke wall will be more than the largest storage tank inside the dyke wall.
- Provision will be made for spare tank of for pumping large alcohol spillage or leakage by proving sump and pump connection.
- In case, spare tank is not provided pump piping will be provided such that large leakage can be pumped to a suitable process tank.
- All pump motors and other electrical fittings will be flame proof of suitable class.
- Chilled water condenser will be provided over the tanks to avoid alcohol loss.
- Suitable and proper safety measures shall be installed on the tanks.
- Tanks will be provided with level indicating instruments with high and low alarms.

### B. Details On Fire Fighting System to be Provided Around Alcohol Storage Area

- Guidelines in OISD 117 will be followed, while designing firefighting system around the alcohol storage area.

- The main components of the fire system are Fire Water Storage, Fire Water Pumps and Distribution Piping Network.
- The fire water system installation will be designed to meet the fire water flow requirement to fight single largest risk at a time.
- Fire water flow rate for a tank farm will be aggregate as following :-

1. Water flow calculated for cooling a tank on fire at a rate of 3 lpm/m² of tank shell area.
2. Water flow calculated for exposure protection for all other tanks falling within a radius of (R +30) meters from centre of the tank on fire (R-Radius of tank on fire) and situated in the same dyke at a rate of 3 lpm/m² of tank shell area.
3. Water flow calculated for exposure protection for all other tanks falling outside a radius of (R+30) m from centre of the tank on fire and situated in the same dyke at a rate of 1 lpm/m2 of tank shell area.
4. Foam water requirement required will be calculated based on 5 lpm/$m^2$ of tank area
5. For water flow calculations, all tanks farms having class A or B petroleum storage shall be considered irrespective of diameter of tanks and whether fixed water spray system is provided or not.
6. Water flow required for applying foam on a single largest tank by way of fixed foam system, where provided, or by use of water/foam monitors.
7. Various combinations will be considered in the tank farm for arriving at different fire water flow rate and the largest rate to be considered for design.
8. Fire water flow rate for supplementary streams will be based on using 4 single hydrant outlets and 1 monitor simultaneously.
9. Capacity of each hydrant outlet as 36 $m^3$/hr and each monitor as 144 $m^3$/hr minimum will be considered at a pressure of 7 kg/$cm^2$g.

**C. Header Pressure**

Fire water system will be designed for a minimum residual pressure of 7 kg/$cm^2$ (g) at hydraulically remotest point in the installation considering single largest risk scenario.

**D. Storage**

Sufficient quantity of water required for fire fighting is being stored onsite; the same shall also be utilized during expansion.

**E. Other mitigation measures to avoid leakage and fire**

- Regular mock drills and trainings are being carried out in the existing premises of HDPL. This practice shall also be followed after expansion.
- Safety policy, Environment, Health and Safety policy has already been formulated, displayed and implemented in HDPL.
- Frequent checking of pipe lines and storage units is being followed and shall be continued after expansion.
- Disaster/ emergency response plan is prepared as per the guidelines and rules laid down in Factory's act.

## 7.8 OCCUPATIONAL HEALTH ASPECTS AND MEDICAL PROVISION IN THE FACTORY

- Effects of Alcohol on health**:** It reacts vigorously with oxidizing materials. TLV for 8 hr. is 1000 ppm (ACGIH). Minimum identifiable concentration has been reported as 350 ppm.
- Exposure to concentrations of 5000 - 10000 ppm results in irritation of eyes and mucous membranes of the upper respiratory tract.
- Effects of exposure to higher concentration of alcohol in the atmosphere are given in the following table.

**Table 7.4 Effect of Ethyl Alcohol**

| Sr. No | Concentration in mg/l | Concentration in ppm | Effects |
|---|---|---|---|
| 1 | 10-20 | 5300 – 10,640 | Some transient coughing and smarting of eyes and nose, not tolerable. |
| 2 | 30 | 15,960 | Continuous lacrimation and marked coughing; could be tolerated with discomfort. |
| 3 | 40 | 21,280 | Just tolerable for short period |
| 4 | > 40 | > 21,280 | Intolerable |

To prevent injury to workers, standard PPEs are provided. In addition, sufficient numbers of Self-contained breathing apparatus are provided to be used in case of major alcohol leakage to avoid exposure to higher levels of Alcohol. All precautionary methods are adopted by the company to reduce the risk of exposure of employees to occupational safety and health hazards. The same will be followed after expansion.

### 7.8.1. Medical check-up

Pre & post medical check-ups will be done of all the employees. Employees will be regularly examined and the medical records will be maintained for each employee.

Pulmonary function test and periodical medical checkup shall be done once in every year. Following tests for each worker are conducted regularly.

- Lung Function Test
- Radiology – X-ray
- Pulmonary Function Test
- Audiometric Test
- General clinical examination with emphasis on respiratory system
- Pre employment examinations
- Periodical medical examinations at the time of employment and after completion of employment.

### 7.8.2. Occupational Health Center (OHC)

In existing unit, about 65 skilled and 88 unskilled workers are employed. Under expansion, about 65 skilled and 88 unskilled workers will be employed.
OHC will be as per the factory’s act, depending upon the number of workers employed.

- Guidelines are given below-

Under rule 73 W All factories carrying out hazardous processes must have OHC with services and facilities

A) For factories employing up to 50 workers: i) Medical officer on retainership basis, ii) minimum 5 workers trained in first aid, at least one shall be available during all working hours. iii) Fully equipped first aid box (What it should contain is also specified later)
B) For factories employee 51 to 200 workers
   i) OHC with min. floor space of 15 sq. meters
   ii) Part time medical officer
   iii) One qualified and trained dresser-cum- compounder throughout all working hours.
   iv) Equipped first aid box
C) For factories employing more than 200 workers,
   i) Full time medical officer up to 500 workers, and one more full time medical officer for every additional 1000 workers or part thereof
   ii) OHC with 2 rooms
   iii) one compounder and one ward boy 24 by 7
   iv) OHC to be equipped all emergencies

Requirement of Ambulance van for any factory carrying on hazardous process shall be provided and maintained is defined under 73-X.

Standard Medical facilities as required by Factory rule are expected to have been provided in the OHC for the existing plant, some important are illustrated below:

1. Well equipped First Aid Boxes will be provided in each Section of the factory.
2. Snake bite Lancet
3. In case of need, factory will be having dispensary to give effective medical facility to workers. In dispensary, sufficient stock of medicines will be available to provide to workers in case of any major emergent situation.
4. A vehicle will be always available to shift the sick/injured person to District Hospital.
5. Ambulance will be made available 24X7 in the factory to deal and take the injured workers to the district hospital.

### 7.8.3. EHS policy

Factory will be followed EHS policy for the existing as well as expansion unit

## 7.9 ONSITE & OFFSITE EMERGENCY PLAN

Industry will be prepared standard on site emergency plan as per the factories act for the existing plant as well as expansion unit.

# Appendix I

# Worst Case Scenario

## Worst case Scenarios

### 1.ETHYL ALCOHOL

The following Scenario have been generated using ALOHA software

**A. Pool Fire (tank is 80% full)**

**a. SITE DATA:**

Location: HERMES DISTILLARY PVT. LTD., INDIA

Building Air Exchanges Per Hour: 0.49 (sheltered single storied)

Time: March 3, 2018 1317 hours ST (using computer's clock)

**b. CHEMICAL DATA:**

Chemical Name: ETHANOL 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: 76.6° C

Vapor Pressure at Ambient Temperature: 0.098 atm

Ambient Saturation Concentration: 105,018 ppm or 10.5%

**c. ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)**

Wind: 2.89 meters/second from E at 10 meters

Ground Roughness: open country Cloud Cover: 0 tenths

Air Temperature: 29° C Stability Class: B

No Inversion Height Relative Humidity: 5%

**d. SOURCE STRENGTH:**

Leak from hole in vertical cylindrical tank

Flammable chemical is burning as it escapes from tank

Tank Diameter: 10.5 meters Tank Length: 14.8 meters

Tank Volume: 1,282 cubic meters

Tank contains liquid Internal Temperature: 29° C

Chemical Mass in Tank: 884 tons Tank is 80% full

Circular Opening Diameter: 2.5 centimeters

Opening is 4.44 meters from tank bottom

Max Flame Length: 5 meters

Burn Duration: ALOHA limited the duration to 1 hour

Max Burn Rate: 22.6 kilograms/min

Total Amount Burned: 1,308 kilograms

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

The puddle spread to a diameter of 4.2 meters.

**e. THREAT ZONE:**

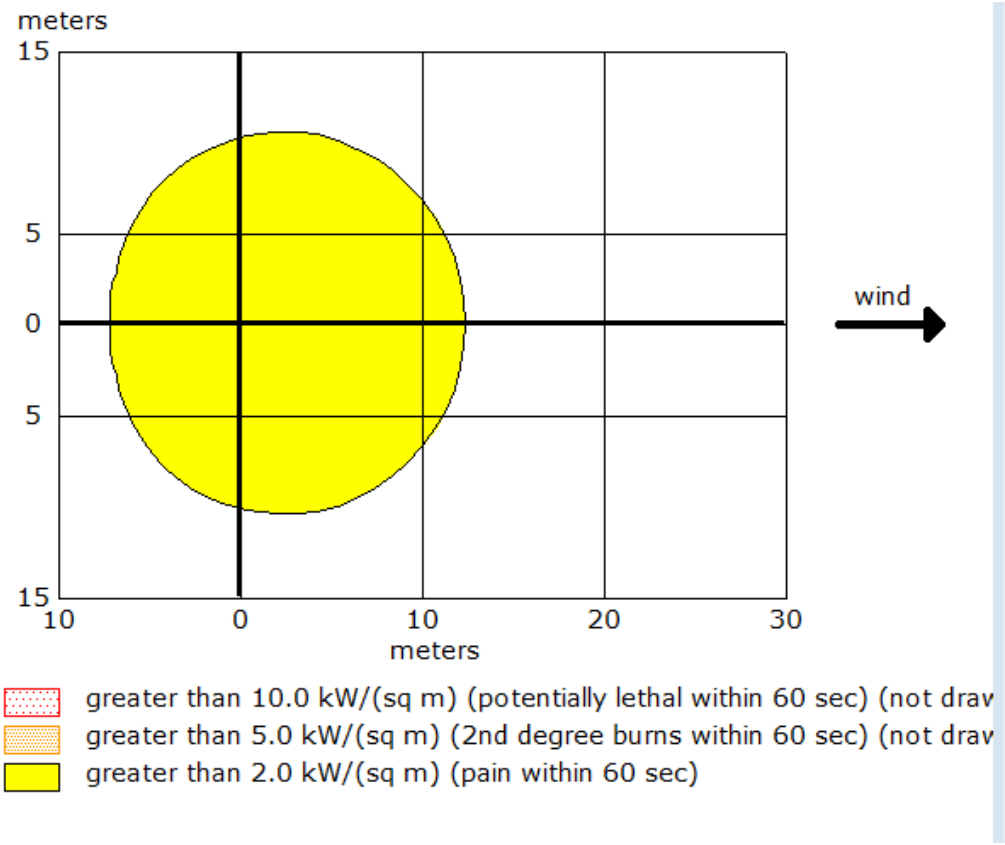
Threat Modeled: Thermal radiation from pool fire

Red : less than 10 meters(10.9 yards) --- (10.0 kW/(sq m) = potentially lethal within 60 sec)

Orange: less than 10 meters(10.9 yards) --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

Yellow: 12 meters --- (2.0 kW/(sq m) = pain within 60 sec)

**Figure 1 Threat zone of Ethyl Alcohol**



f. THREAT AT POINT:

Thermal Radiation Estimates at the point:

Downwind: 5.51 meters Off Centerline: 2.43 meters

Max Thermal Radiation: 2 kW/(sq m)

**Figure 2 THREAT AT POINT**

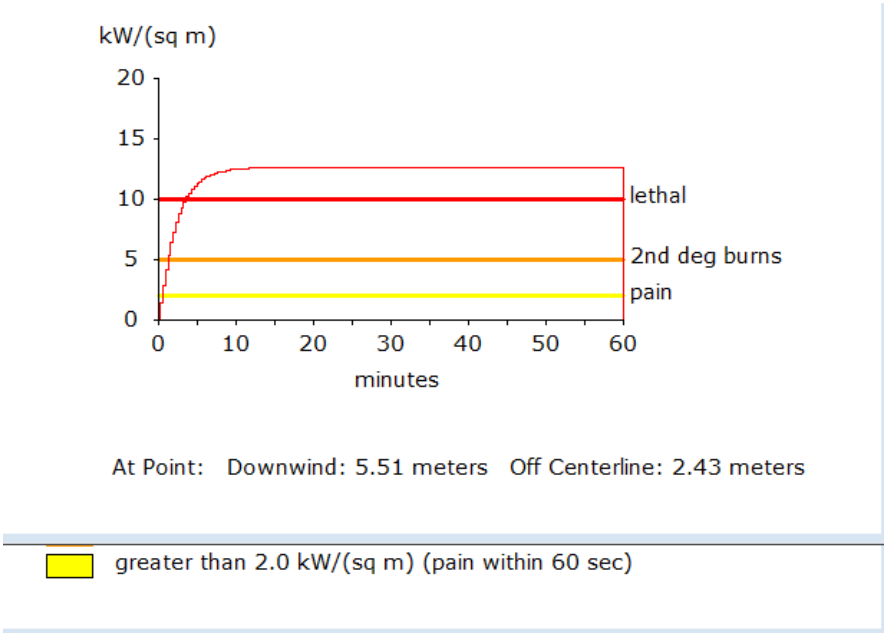



**Figure 3 Source Strength**

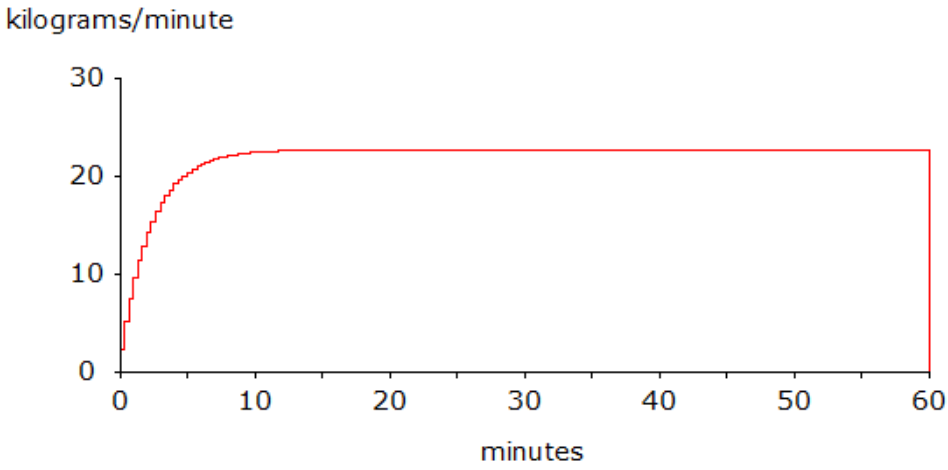


**Figure 4 Google Image**