Risk assessment

7.1 RISK ASSESSMENT

An industry with its complex nature of activities involving various plant machineries, raw materials, products, operations, intermediates and environmental discharge has a number of associated hazards. A minor failure can lead to major failure resulting into a disaster causing heavy losses to life, property and environmental. Risk assessment studies are being conducted to ensure safety and reliability of any new plant, through a systematic and scientific methods to identify possible failures and prevent their occurrences before they actually cause disasters and production loss.

7.1.1 Objective

The distillery involves storage and handling of large quantity of alcohol which is flammable under unfavourable situations. To ensure safe operation of the plant, it is proposed to carry out the Risk Analysis Study with the following objectives.

The main objectives of the Risk Assessment Studies are as given below:

1) To define and assess emergencies, including risk impact assessment.
2) To control and contain incidents.
3) To safeguard employees and people in vicinity.
4) To minimize damage to property and environment.
5) To inform the employees, the general public and the authority about the hazards/risk assessed, safe guards provided, residual risk if any and the role to be played in them in the event of emergency.
6) To be ready for mutual aid if need arises to help neighboring unit. Normal jurisdiction of an OEP in the own premises only, but looking to the time factor in arriving the external help or off - site emergency plan agency, the jurisdiction must be extended outside the extent possible in case of emergencies occurring outside.
7) To inform authorities and mutual aid centers to come for help.
8) To effect rescue and treatment of casualties. To count injured.
9) To identify and list any death.
10) To inform and help relatives.
11) To secure the safe rehabilitation of affected areas and to restore normalcy.
12) To provide authoritative information to the media.
13) To preserve records, equipments, etc., and to organize investigation into the cause of emergency and preventive measures to stop its recurrences.
14) To ensure safety of the workers before personnel re - enter and resume work.
15) To work out a plan with all provisions to handle emergencies and to provide for emergency preparedness and the periodical rehearsal of the plan.
16) To identify the major hazards relating to fire, explosion and toxicity due to storage and handling of Alcohol.
17) To visualize maximum credible accident scenarios

18) To analyze and quantify primary and secondary effects and damage potentials of the identified maximum credible accident scenarios using standard procedure.
19) To study the nature of exposures, pathways and consequences of maximum credible accident scenarios and characteristics of risk levels.
20) To provide guidelines for disaster management plan.

Risk analysis includes risk identification and risk assessment. Risk identification can be as simple as putting "what if" question at all designing reviews. Check list of normal process hazards associated with each and every equipments installed can also be prepared. Risk assessment can be done by many techniques such as Hazards and Operability Study (HAZOP), Fault Tree analysis, Monte Carlo Simulation, Safety Audits and Safety Indices, etc. all these techniques can identify all major hazards and also minor hazards associated with them. For effective Disaster Management Plan the industry should have the following details readily available with it:

- Description of various processes
- Process Engineering flow scheme
- Operation manuals for all machinery
- Plant and equipment layout
- Details on population density and related data on the surroundings of plant.
- Data on status of existing facilities for emergency preparedness
- Proposed fire fighting facilities.

Risk assessment studies have been carried out to assess the worst case scenarios of the plant operations to formulate an emergency management plan.

7.2 PRELIMINARY HAZARD ANALYSIS

Technical information on project including plant, process, and material is given in Chapter-2. Preliminary Hazard analysis is used to identify typical and often relatively apparent risk sources and damage events in a system. Hazards of significant nature whose consequence potential is of worth consideration, where in a specified area or where, more number of personnel likely to be present etc, is considered in identifying hazards. Alcohol being an organic solvent is flammable. Based on the preliminary hazard identification, the storage and handling facilities of alcohol has been recognized as distinctive and relatively evidential risk source. Loading and unloading from storage and forwarding of alcohol may lead to containment failure for various reasons. Such situation can cause fire or explosions depending upon the situation.

The distillery is relatively less hazardous plant. The main chemicals handled are alcohol, caustic soda and sulphuric acid. The quantities of these chemicals stored are too low to cause any disaster.

7.2.1 Alcohol

Alcohol is a clear liquid and burns in air with blue flame forming CO_2 and water. Vapour- Air mixture is explosive. Vapours are heavier than air and travel considerable distance. Potable alcohol is stored in warehouse to be matured, bottled and transported.

The material safety data sheets of Ethanol have been given Table No. – 7.1, to make oneself familiar with the physical and chemical properties of the materials, their effects and measures to be taken in case of exposure or fire.

Ethanol has a relatively low flash point (55deg. F) and boiling point (78.5 deg. C). It has also a lower NFPA flammability rating of 3. The evaporation rate of the vapour in air is 1.4. The burning rate of alcohol being lower heat radiated would be far lower. Hence the damage distance will be very small. The ethanol store on fire scenario can be discounted as it is stored at room temperature and has low flammability. All necessary precautions are applied.

7.2.1.1 Characteristics Of Alcohol

Rectified spirit (RS), Absolute Alcohol and Extra Neutral Alcohol (ENA) are basically ethanol of different grades and have the same hazard characteristics. Hence, all these products are considered as ethanol in hazard analysis. Alcohol is a clear, colorless and flammable liquid. It has the boiling point of 78 ^{0}C, ignition point of 365 ^{0}C and explosive limits of 3.3 % - 19.0 % by volume. The characteristics of ethanol are given

General Characteristics of Alcohol

Physical State	Liquid
Appearance	Clear
colour	Colourless
Physical form	Volatile Liquid
Odour	Alcohol Odour
Taste	Burning Taste
Molecular Weight	46.07
Molecular Formula	CH_3 CH_2OH
Boiling Point	173.07 0F (78.37 0C)
Freezing Point	-173 0F (-78.33 0C)
Vapour Pressure	40 mm Hg @ 19 °C
Vapour Density	1.59 kg/m^3
Specific Gravity	0.789 g/cm^3 (at 25 0C)
Water solubility	Soluble

volatility	100 %
Odour Threshold	5 – 10 ppm
Viscosity	1.22 – 1.41 cp @ 20 ^{0}C
Solvent solubility	Benzene, ether, acetone, chloroform, methanol, organic solvents.

7.2.1.2 Fire Hazard of Alcohol

Alcohol falls under flammable category of high intensity. The probable fire hazard in the plant is in the areas of alcohol storage and handling. In case of leaks, invisible vapours spread easily and are set on fire by ignition sources. Therefore, it is important to control or eliminate all potential ignition sources in areas that might lead to ignition of vapour. All forms and types of energy can be considered a potential ignition source. The management will exert close control over the storage and handling of the ethanol. This is best done by proper training of personnel, confinement of the liquids and associated vapours to selected areas, ventilation to prevent vapour build up, control of potential ignition sources, and protection of the area with an extinguishing system.

Potential Sources of Ignition

The potential sources of ignition are:

- Open flames
- Electrical wiring / devices
- Smoking
- Heat sources / Hot surfaces
- Welding and cutting
- Friction
- Sparks and Arcs
- Static sparks
- Gas Compression.
- Lightning effect

Precaution against Ignition

Following are some of the precautions that will be taken to minimize the probability of ignition:

- Electrical equipment and wiring should be suitable to avoid hazard.
- If a heating operation is necessary, use only indirect heating methods.
- Do not allow any open flames.
- Provide grounding and bonding for all equipment handling using these liquids.
- Maintenance program will be established to assure that all equipment and safety controls are functioning satisfactorily.

7.2.1.3 Health Hazards of Alcohol

The following acute health effects may occur

- Can affect when breathed in and by passing through skin
- May cause mutations
- Can irritate the skin. Repeated contact can dry the skin with cracking, peeling and itching
- Exposure can cause headache, nausea, a feeling if heat and drowsiness,
- Higher exposure can cause unconsciousness
- Exposure can irritate the eyes, nose, mouth and throat
- Breathing of alcohol can irritate the lungs causing coughing and/or shortness of breath.

Threshold limit value for Alcohol

Alcohol	OSHA	NIOSH	ACGIH
8 – hour exposure	1000 ppm	1000 ppm	1000 ppm

The Threshold limit value of the alcohol is 30 to 50 ppm it is well within the permissible exposure level as per ACGIH recommendation

7.2.1.4 Alcohol Storage Details

Details of storage conditions and hazardous nature of alcohol are given below.

Storage Conditions and Nature of Hazard

Hazardous Chemical	Physical State	Material of Construction	Storage Pressure	Hazardous Nature
Alcohol	Liquid	MS/SS	Atmospheric.	Flammable & Toxic

7.2.1.5 Hazard Rating of Alcohol

The rating of large number of chemicals based on flammability, reactivity and toxicity have been given in National Fire Protection Association codes 49 and 345 M. The NFPA rating for the ethanol is given below,

NFPA Hazard Rating

CHEMICAL	NH (Health Factor)	NF (Fire Factor)	NR (Reactivity)
Alcohol	2	3	0

(Least-0, Slight-1, Moderate-2, High-3, Extreme-4)

Explanation of NFPA Hazard Classifications

Health Hazard	Definition
4	Materials which on very short exposure could cause death or major residual injury even though prompt medical treatments were given.
3	Materials which on short exposure could cause serious temporary or residual injury even though prompt medical treatments were given.
2	Materials which on intense or continued exposure could cause temporary incapacitation or possible residual injury unless prompt medical treatment is given.

1	Materials which on exposure would cause irritation but only minor residual injury even if no treatment is given.
0	Materials which on exposure under fire conditions would offer no hazard beyond that of ordinary combustible material.
Flammability	**Definition**
4	Materials which will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature, or which are readily dispersed in air and which will burn readily
3	Liquids and solids that can be ignited under almost all ambient temperature conditions.
2	Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur.
1	Materials that must be preheated before ignition can occur.
0	Materials that will not burn.
Reactivity	**Definition**
4	Materials which in themselves are readily capable of detonation or of explosive decomposition or reaction at normal temperatures and pressures.
3	Materials which in themselves are capable of detonation or explosive reaction bur require a strong initiating source or which must be heated under confinement before initiation or which must be heated under confinement before initiation or which react explosively with water.
2	Materials which in themselves are normally unstable and readily undergo violent chemical change but do not detonate. Also materials which may react violently with water or which may form potentially explosive mixtures with water.
1	Materials which in themselves are normally stable, but which can become unstable at elevated temperatures and pressures or which may react with water with some release of energy but not violently.
0	Materials which in themselves are normally stable, even under fire exposure conditions, and which are not reactive with water.

7.2.2 Sulphuric Acid

Sulphuric acid is non-flammable, non combustible liquid. It is non-explosive and non-oxidizing material. It is highly corrosive in nature. It emits toxic fumes of SO_3 as combustion products.

Health hazards

(a) Routes of entry: Inhalation, ingestion, eyes, skin.

(b) Effects of exposure:

- Inhalation of vapours from hot concentrated acid may damage lungs and causes bronchitis.
- Swallowing may cause injury or death.

- Contact with skin or eyes cause severe burns.

Precaution and safety measures to be taken during exposure

1. Avoid contact with liquid.
2. Do not eat or drink at work place.
3. Provide safety shower, eye washbasins, safety goggles, face shield respiration, rubber shoes, rubber gloves and rubber apron to the workers at work place.
4. If inhaled, remove the victim to fresh air area and provide artificial respiration or oxygen, if required.
5. If eyes are affected wash with plenty of water for 15 minutes or more.
6. If skin is affected, remove contaminated clothes and shoes and wash the affected area with plenty of water and soap

7.2.3 Sodium Hydroxide

If comes in contact can cause irritation in nose, burning of eyes and skin and temporary loss of hair. The first aid is the same as that of phosphoric acid

7.2.4 Liquid fuel System and Onsite Storage Facility

HSD will be used for diesel generator. A rectangular fuel tank of 750 litres capacity will be provided for the storage of HSD. Tankers will supply HSD to the tank. The daily requirement of HSD would be 100 litres considering an average running of One DG set for 4 hours every day. HSD tank of fixed roof type will be provided. The material safety data sheet of Diesel have been given as Table- 7.2, for familiarity with the physical and chemical properties of the materials, their effects and measures to be taken in case of exposure.

The storage tank will be designed to conform to IS 2062 standards. Pumps of adequate capacity (one working and one stand-by) will be provided for forwarding the diesel oil from storage tank to the diesel generator. Diesel oil has a relatively high flash point (51.7deg.C) and boiling point range (232-338 deg. C). it has also a lower NFPA flammability rating of 2. The flammability range of the vapour in air is 1.3-6.0% v/v. it has negligible vapour pressure at the ambient temperature. The burning rate of HSD being lower at 0.05 kg/m^3 sec heat radiated would be far lower. Hence the damage distance will be very small. The diesel tank on fire scenario can be discounted as roof is a fixed type, quantity stored shall be too small and with a flash point of 40 deg. C to 55 deg. C.

7.3 IDENTIFICATION OF POSSIBLE HAZARDS

For the proposed distillery unit four categories of hazards are identified and listed below.

1. **Natural Hazard**

   Earthquake
   Flooding

2. **Man Made Hazard**

Fire & explosion
Explosive material
Chemicals
Short circuiting
Boiler
Diesel storage area
Process Area, Reactors

3. **Electrical**
   Electrical room
   Non insulated wires

4. **Mechanical/ Accident**
   Raw material Handling
   Equipmentȝs area
   Noise
   Transportation

5. **Thermal**
   Boiler

6. **Chemical**
   Chemical storage area
   Oil storage
   Leakage from process
   Reactors

In order to identify hazards the following two methods have been used.

- Identification based on storage and handling of Alcohol.
- Identification involving relative rating technique through Fire Explosion and Toxicity Index

7.3.1 Identification based on Manufacture, Storage and Import of Hazardous Chemical Rules, GOI Rules 1989

In order to determine applicability of GOI Rules 1989 to the notified threshold quantities, analysis of products and quantities of storage in the plant has been carried out.

Product	**Listed in Schedule**	**Total Quantity**	**Threshold Quantity**		**Applicable Rule**
			Rules 5,7-9 and 13-15	**Rule 10-12**	
Alcohol	1 (2)	45 KLPD	1000 t	50000 t	Rule 5, 7-9 and 13-15

Based on the above, it is noted that ethanol produced and stored in the plant attract the rules of GOI 1989.

7.3.2 Identification involving relative rating technique through Fire Explosion and Toxicity Index

Fire Explosion & Toxicity Indexing (FETI) is a rapid ranking method for identifying the degree of hazard. The basic objectives that characterize Fire Explosion and Toxicity Index are,

- Identification of equipment within the plant that would contribute to the initiation or escalation of accidents.
- Quantification and classification of the expected damage potential of fire
- Explosion n and toxicity index in relative terms.
- Determination of area of exposure.

In preliminary hazard analysis, alcohol is considered to have Toxic and Fire hazards. The application of FETI would help to make a quick assessment of the nature and quantification of the hazard in these areas. Before hazards index is applied, the installation in question is sub divided into logical, independent elements or units. The unit is logically characterized by the nature of the process that takes place in it.

Fire explosion and Toxicity Index is a product of Material Factor and Hazard Factor. Material factor represents the flammability and reactivity of the chemicals. The hazards factor itself is a product of general process and special process hazard. Respective Material Factor (MF), General Hazard Factors (GHF), Special Process Hazard factors (SPH) are computed using standard procedure of awarding penalties based on storage, handling and reaction parameters. Material factor is a measure of intrinsic rate of potential energy release from fire and explosion produced by combustion or other chemical reaction. General factor is a measure of intrinsic rate of potential energy release from fire and explosion produced by combustion or other chemical reaction.

General Process Hazard

The plant activities, which contribute to a significant enhancement of potential for Fire and Explosion, have been identified. The measured values of penalties have been added to obtain the value of General Process Hazard as given in DOW's Fire & Explosion Index Hazard classification guide.

Special Process Hazard

The Special Process Hazard includes the factor that contributes the probability and occurrence of accident. They are:

- Process temperature
- Low pressure
- Operation in or near flammable range
- Operation pressure
- Low temperature

- Quantity of Flammable and toxic material
- Corrosion and erosion
- Leakage, Joints

FEI (Fire Explosion Index) = MF x (1 + GPH) x (1 + SPH)

Classification of Hazards into Categories

By comparing the indices Fire and/or Toxicity to the criteria in the following table the unit in the question classified in one of the three categories established for this purpose.

Dows Fire and Explosion Index Hazard Classification, Degree of Hazard for F & E I

F & EI Range	Degree of Hazard
01-60	Light
61-96	Moderate
97-127	Intermediate
128-158	Heavy
159 and more	Severe

Based on the above, the degree of potential hazard based on DOW's classification for alcohol is given below.

Section	Material Factor	General Process Hazard	Special Process Hazard	Fire & Explosion Index	Category of Potential Hazard
Alcohol	16	3.00	2.24	107.52	Intermediate

Toxicity Index

Toxicity index is primarily based on the index figures for health hazards established by the NFPA in codes NFPA 704, NFPA 4 n and NFPA 325 m. NFPA Index figures of toxicity factor for Health Hazard index Nh are given below:

NFPA Index Toxicity Factor	NFPA Index Toxicity Factor
0	0
1	50
2	125
3	250
4	325

NFPA Health hazard index of ethanol is 2, which give toxicity factor of 125. In addition, the toxicity factor has to be corrected for the Maximum Allowable Concentration (MAC) values of the toxic substance by adding a penalty Ts. Ts values are arranged according to the following Criteria.

MAC (ppm)	Penalty Ts
< 5	125
5-50	75
> 50	50

MAC value for ethanol is 1000 ppm. Toxicity index is evaluated using the following Equation

$$\text{Toxicity Index} = \frac{Th+Ts\,(1+GPH+SPH)}{100}$$

By comparing the indices of FEI and Toxicity index, the unit under consideration is classified into one of the following three categories,

Classification of Toxicity Index

Category	Toxicity Index
Light	<6
Moderate	6-10
Severe	>10

Fire Explosion and Toxicity Index for Storage Facility

Fire explosion and Toxicity Index values obtained for fuel ethanol both combined through FETI are given below:

Fire Explosion and Toxicity Index for Storage Facility

Section	Quantity Processed per day	Material Factor	Fire Explosion Index	Toxicity Index
Alcohol	45 KLD	16	107.52	7.82

Degree of Hazard based on Fire explosion and Toxicity indices computed for the storage units is categorized as below:

Degree of Hazard

Section	Fire Explosion	Toxicity
Alcohol	Intermediate	Moderate

Minimum Preventive and Protective Measures for Fire and Explosion

Based on the categorization of Degree of Hazard, the following minimum preventive and protective measures are recommended.

Features	Light	Moderate	FE & I Rating		Severe
			Intermediate	Heavy	
Fire Proofing	2	2	3	4	4
Water Spray Directional	2	3	3	4	4
Area	2	3	3	4	4
Curtain Special Instr.	1	2	2	2	4
Temperature	2	3	3	4	4

Pressure	2	3	3	4	4
Flow Control	2	3	4	4	4
Blow down-spill	1	2	3	3	4
Internal Explosion	2	3	3	4	4
Combustible gas Monitors	1	2	3	3	4
Remote Operation	1	2	2	3	4
Dyking	4	4	4	4	4
Blast and Barrier wall separation	1	2	3	4	4
1= Optional 2=Suggested 3=Recommended 4= Required					

7.4 HAZARD ANALYSIS ON THE CONSIDERATION OF WORST CASE SCENARIO BY THE APPLICATION OF ALOHA MODEL

Hazard analysis is done on the consideration of worst case scenario that the hole is appeared in the vertical cylindrical storage tank of plant. Hazardous substance may be released as a result of failures or catastrophes, causing damage to the surrounding area. The physical effects resulting from the release of hazardous substances can be calculated by means of ALOHA model. The results thus obtained through modeling are used to translate the physical effects in terms of injuries and damage to exposed population and environment.

The probable fire hazard in the plant is in the area of ethanol and is due to storage and handling. The data of worst case scenario is flash on ALOHA text summary and the effect of this incident is shown in the form of Threat zone by considering the pool fire, and this model also shows the burn rate accordingly the source strength with respect of mass of fuel and time. Aloha models charts attached for reference.

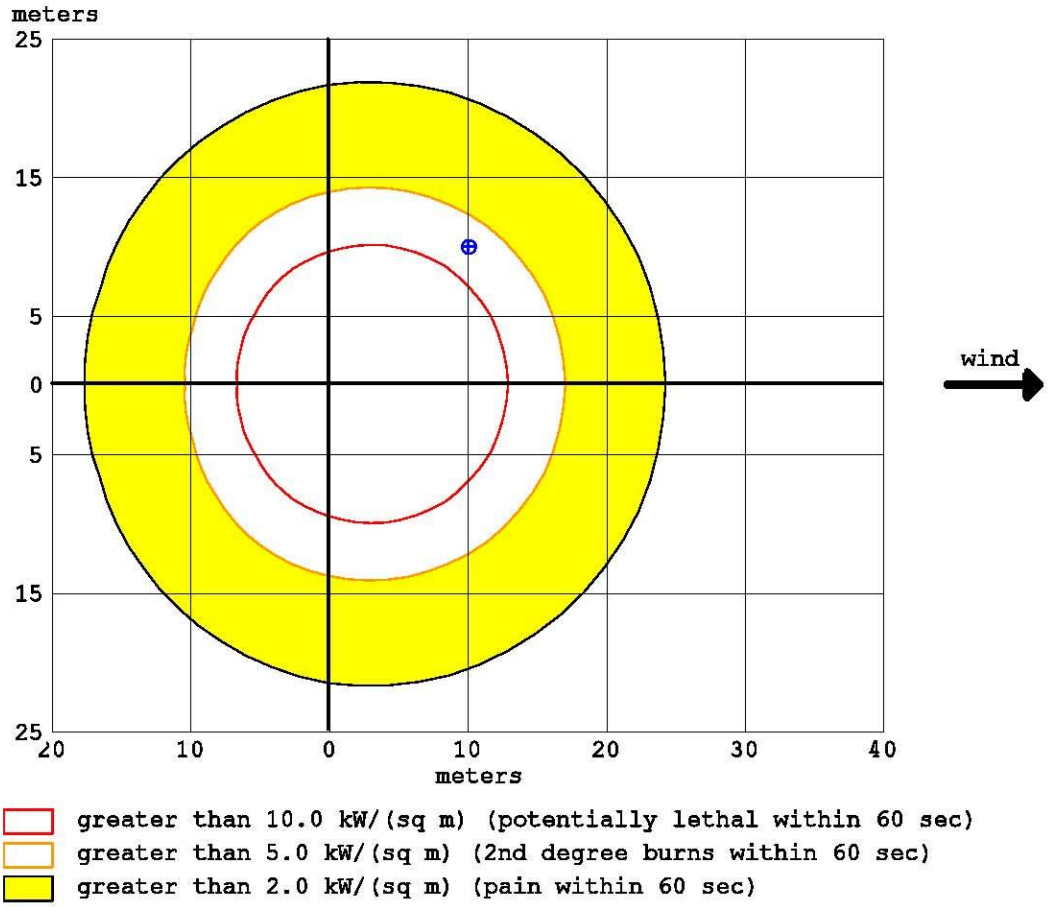
Thermal Radiation Threat Zone **ALOHA® 5.4.7**

```
Time: February 13, 2018  1747 hours ST (user specified)

Chemical Name: ETHANOL

Wind: 2.1 meters/second from NW at 3 meters

THREAT ZONE:
  Threat Modeled: Thermal radiation from pool fire
  Red    : 13 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
  Orange: 17 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
  Yellow: 24 meters --- (2.0 kW/(sq m) = pain within 60 sec)
```



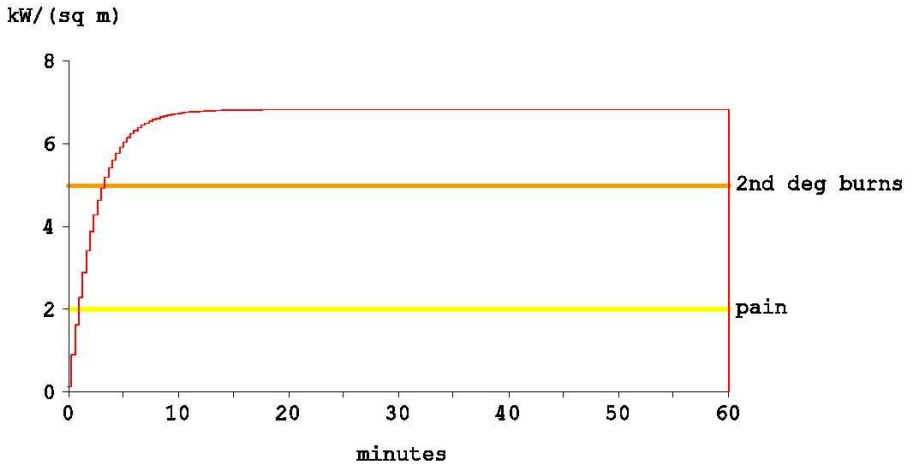
Thermal Radiation at Point **ALOHA® 5.4.7**

Time: February 13, 2018 1747 hours ST (user specified)

Chemical Name: ETHANOL

Building Air Exchanges Per Hour: 0.63 (unsheltered single storied)

THREAT AT POINT:
Model Run: No Model Given
Thermal Radiation Estimates at the point:
Downwind: 10 meters Off Centerline: 10 meters
Max Thermal Radiation: 6.82 kW/(sq m)



At Point: Downwind: 10 meters Off Centerline: 10 meters

Text Summary **ALOHA® 5.4.7**

```
SITE DATA:
  Location: VILLAGE MENDRANA, TEHSIL - S, INDIA
  Building Air Exchanges Per Hour: 0.63 (unsheltered single storied)
  Time: February 13, 2018  1747 hours ST (user specified)

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: 77.7° C
  Vapor Pressure at Ambient Temperature: 0.016 atm
  Ambient Saturation Concentration: 16,164 ppm or 1.62%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
  Wind: 2.1 meters/second from NW at 3 meters
  Ground Roughness: open country         Cloud Cover: 0 tenths
  Air Temperature: 32° F                 Stability Class: E
  Inversion Height: 250 meters           Relative Humidity: 17%

SOURCE STRENGTH:
  Leak from hole in vertical cylindrical tank
  Flammable chemical is burning as it escapes from tank
  Tank Diameter: 10.71 meters            Tank Length: 10 meters
  Tank Volume: 901 cubic meters
  Tank contains liquid                   Internal Temperature: 32° C
  Chemical Mass in Tank: 623,693 kilograms
  Tank is 89% full
  Circular Opening Diameter: 2 inches
  Opening is 0.5 meters from tank bottom
  Max Flame Length: 7 meters
  Burn Duration: ALOHA limited the duration to 1 hour
  Max Burn Rate: 93.2 kilograms/min
  Total Amount Burned: 5,392 kilograms
  Note: The chemical escaped as a liquid and formed a burning puddle.
  The puddle spread to a diameter of 8.4 meters.

THREAT ZONE:
  Threat Modeled: Thermal radiation from pool fire
  Red    : 13 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
  Orange: 17 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
  Yellow: 24 meters --- (2.0 kW/(sq m) = pain within 60 sec)

THREAT AT POINT:
  Thermal Radiation Estimates at the point:
  Downwind: 10 meters                    Off Centerline: 10 meters
  Max Thermal Radiation: 6.82 kW/(sq m)
```

7.5 IGNITION SOURCES OF MAJOR FIRES IN ALCOHOL INDUSTRY

- Electrical Wiring
- Smoking
- Friction-bearings/broken parts
- Overheated materials
- Hot surfaces-boilers-lamps
- Burner flame-torch
- Combustion sparks
- Spontaneous ignition
- Cutting, Welding

- Exposure fires
- Incendiaries
- Mechanical sparks
- Molten substances
- Chemical action
- Static charge
- Lightning
- Miscellaneous

7.6 TYPE OF HAZARDS IN ALCOHOL INDUSTRY

- Flammability (Fire) & Explosion Hazards
- Equipment rupture Hazards
- Combustible Dust Hazards
- Engulfment Hazards
- Noise Hazards
- Exposure of Hazardous substances
- Confined Space Hazards
- Motor Vehicle Hazards
- Hazards due to exposure of hazardous energy

1) **Flammability Hazards and Explosion Hazards:-** Flammability and Explosion hazards are the major hazard in the alcohol industry the exposure. of those hazards is occur When ethanol vapor combines with air in the presence of ignition sources, fires and explosions can result. The lower and upper explosive limits of ethanol are 3.3 percent and 19 percent, respectively, by volume in air. The major process unit operations in alcohol industry when the occurrence of those hazards is probable is as follows:-

   1) Distillation
   2) Storage
   3) Transportation

2) **Equipment Rupture hazards:-** Ruptures can occur in fermentation vessels, product storage tanks, or pipes for various reasons. For example, due to the

lack of safety systems or improperly functioning safety systems (e.g., failure of a rupture disk or pressure relief device on a fire protection line, failure of a safety valve to open when a heated storage tank is overheated). Ruptures may also be the result of fires; age deterioration; cracks (e.g., at the bottom and welding edges of storage tanks); corrosion (e.g., of a defective weld); or a lack of proper maintenance If hazardous substances (e.g., anhydrous ammonia, ethanol, gasoline, sulfuric acid) released during ruptures are not controlled and contained this may result in fires, explosions, and workers' exposure to hazardous air contaminants.

3) **Combustible Dust Hazards:-** Handling and size reduction of feedstock materials can generate combustible dusts. Combustible dusts are fine dust particles that when present in air at certain amounts and under the right conditions, Flash fires, deflagrations, and explosions are the primary hazards related to combustible dusts at ethanol manufacturing facilities and can result in death, injury, and substantial property damage. As shown in the combustible dust explosion pentagon above, five elements must be present for a combustible dust explosion to occur: fuel (i.e., combustible dust), an ignition source (e.g., heat), confinement (e.g., a building, a room, vessel, or process equipment), oxygen, and dispersion in sufficient quantity and concentration. Removing any of these elements prevents an explosion from occurring.

Many different types of combustible dusts can be found at ethanol manufacturing facilities. The largest quantities and accumulations of combustible dusts are expected to occur at facility locations that handle dry materials or processes that dry wet materials, such as in areas where feed stocks are received and processed and co-products are dried and loaded into trucks and railcars. Several different materials are expected to present combustible dust hazards at ethanol manufacturing facilities:

- Wood dusts from cellulosic materials, as wel as other dusts from cellulosic operations (e.g., agricultural residue, municipal solid waste) that may be combustible.

1) Cleaning area.
2) Bulk storage
3) Transfer points
4) Dryers
5) Dust collectors
6) Load-out and cooling areas.

4) Exposure of Hazardous substances:-

- **Enzymes-** enzyme alpha-amylase to the solution/slurry during liquefaction to convert corn starch into dextrins. Exposure to alpha-amylase is associated with increased risk for respiratory illnesses, such as occupational asthma, in exposed workers. Also reported are exposure-related symptoms in the eyes (e.g., itchiness) and nose (e.g., sneezing), as well as allergic reactions in those who are more sensitized to its effects
- **Gases.:-** carbon dioxide (CO2) may build up in stored material, CO2 is also produced during the fermentation process, and other gases can be produced from decomposing and fermenting, for example, hydrogen sulfide, ammonia, sulfuric acid, and methane.
- **Combustion by-products:-** For example, carbon monoxide can be generated when workers use machinery within or close to confined spaces.
- **PSM covered chemicals:-** Some hazardous chemicals that may be used in ethanol processing facilities in quantities that necessitate compliance with OSHA's PSM standard include: sulfur dioxide, ammonia, and anhydrous hydrochloric acid
- **Metallic catalysts:-** Metallic catalysts are used at facilities that thermo chemically convert syngas into ethanol. Potential worker exposures to the metal constituents will depend on the physical state of the catalyst, the extent of catalyst handling, and other parameters.

5) Confined space Hazard:- Examples of confined spaces at ethanol manufacturing facilities include silos, process vessels, storage tanks, and feed hoppers. Adverse health effects are possible if workers enter confined spaces containing toxic atmospheres. These are atmospheres containing gases, vapors, or fumes known to have poisonous physiological effects

- **Hazardous chemicals:** Employers must prevent workers exposure to concentrations of toxic and other hazardous substances, capable of causing acute health effects (e.g. within seconds or minutes) that can prevent workers from effecting self-rescue or being able to request help when working in a confined space

- **Oxygen-deficiency:** Some confined spaces can be oxygen-deficient, especially when oxygen is displaced by other gases (e.g., CO2) formed by the decomposition or other processes in the confined space.
- **Physical hazards:** These include: falls from heights; drowning; pipes that could cause workers to trip and fall; crushing or laceration injuries from moving mechanical parts, for example, sweep augers capable of causing severe laceration or crushing injuries or death; and, exposure to hazardous energy

6) **Motor Vehicle Hazards:-** Heavy-duty trucks and railcars have a ubiquitous presence at ethanol manufacturing facilities. At larger facilities, a nearly constant stream of truck traffic delivers corn to receiving areas, and a separate set of trucks and railcars are routinely filled with denatured ethanol at product load-out areas. Hazards that could affect safe transportation and safe loading and unloading of motor vehicles include: a flammable atmosphere; static electricity which could act as a source of ignition during loading and unloading of flammable substances or combustible dust; poorly maintained roads (e.g., pot holes, uneven road surfaces); severe weather conditions (e.g., lightning, snow storm); unsafe driving; and, operating motor vehicles in poor working condition. Unsafe driving habits and/or improperly planned routes may also result in motor vehicle collisions with pedestrians, equipment, pipes, etc. Safety measures must be implemented to preclude motor vehicle incidents.

7) **Exposure to hazardous Energy:-** Sources of hazardous energy include mechanical, electrical, hydraulic, and pneumatic equipment, which present a danger to workers if the energy isolating source (e.g., circuit breaker, disconnect switch) is not properly shut down and if appropriate measures are not taken to prevent the equipment from starting up unexpectedly while employees are still working.

7.7 IDENTIFICATION OF OTHER HAZARDS

Potential Health Effects:

Eye Contact:

Airborne dust may cause immediate or delayed irritation or inflammation. Eye contact with large amounts of dust particles can cause moderate eye irritation, chemical burns and blindness. Eye contact with large amounts of gypsum can cause moderate eye irritation, redness, and abrasions. Eye exposures require immediate first aid and medical attention to prevent significant damage to the eye.

Skin Contact:

Dust of coal, may cause dry skin, discomfort, irritation, severe burns and dermatitis. These dusts are capable of causing dermatitis by irritation. Skin affected by dermatitis may include symptoms such as, redness, itching, rash, scaling and cracking.

Inhalation (acute):

Breathing dust may cause nose, throat or lung irritation, including choking, depending on the degree of exposure. Inhalation of high levels of dust can cause chemical burns to the nose, throat and lungs.

Ingestion:

Internal discomfort or ill effects are possible if large quantities are swallowed.

Following First Aid Measures

First aid measures shall be taken.

Eye Contact:

Rinse eyes thoroughly with water for at least 15 minutes, including under lids, to remove all particles. Seek medical attention for abrasions and burns.

Skin Contact:

Wash with cool water and a pH neutral soap or a milk skin detergent. Seek medical attention for rash, burns, irritation and dermatitis.

Inhalation:

Move person to fresh air. Seek medical attention for discomfort or if coughing or other symptoms.

Ingestion:

Do not induce vomiting. If conscious, have person drink plenty of water. Seek medical attention.

7.8 PREVENTION PROCEDURES TO AVOID THE HAZARDS & RISKS

Besides the operating Emergency, Fire or Disaster Handling Procedures have to be implemented to handle the emergency situations. Additional safety procedures to be followed are as given below:

7.8.1 Procedure for Preparation of Equipment for Repairs or Maintenance (Hot or Cold Work)

This procedure is to assure safe condition of equipment, pipelines, vessels, pumps, and compressors etc., which have previously held flammable, explosive, toxic or corrosive substance before permitting repairs or maintenance work (Hot or Cold).

7.8.2 Work Permit Procedure

The "Work Permit Procedure" is to ensure that the equipment and conditions of a proposed job are made safe for the person(s) who may be required to carry out the job and to observe and maintain conditions required for safe completion of the job.

7.8.3 Fire & Safety Permit Procedure

This procedure is primarily to ensure avoidance of any potential life or fire hazard by establishing uniform measures to control and safe-guard operation involving source of ignition or hazard of personnel or installation or combination of both.

7.8.4 Tagging Procedure

This procedure is to prescribe the use of "TAGS" to caution, notify or instruct employees of any hazard or condition of equipment on temporary basis as a safety measure.

7.8.5 Locking & Unlocking Procedure

a) Equipment powered by Electricity

ii) Equipment powered by Hydraulic, Pneumatic & Steam.

This procedure is to prevent any injury to any person who has been authorized to carry out any work in, on or around equipment or vessel connected with power, e.g. electricity, hydraulic, pneumatic or steam.

7.8.6 Accident Reporting and Investigation Procedure

This procedure is to outline the actions for immediate notification of accidents and investigation both orally and in writing to ensure that:

- Cause is revealed for corrective action to prevent similar accidents,
- Government authorities are informed as required under different statutory rules.

7.8.7 Procedure of Medical Treatment

This procedure is to enable every employee to avail medical facilities in the plant at all hours while on duty.

7.8.8 Operating Emergency, Fire or Disaster Inspection Procedure

This procedure is primarily to assign duties and responsibilities to all employees to handle the emergency situations in an organized and effective manner to control and eliminate the risk quickly.

7.8.9 Vent Header Purging, checking and Inspection Procedure

This is to ensure that the vent lines and headers in the plant, which are likely to get choked or plugged, are maintained free with adoption of continuous/ intermittent flushing with fluids capable of dissolving the substance which cause plugging/ choking.

7.8.10 Procedure on Inspection, test and Record of Pressure Relieving Devices (Safety and Relief Valves)

This is to ensure that the safety and relief valves are capable of providing design operating condition, through inspection and test for the safety of equipment and personnel.

7.8.11 Procedure on Safety Meetings

This is to involve all employees in the business of safety as employee participation is essential to the success of any safety program.

7.8.12 Boiler Charging

This procedure is to prevent fire or explosion hazard while charging and shutting down of boiler.

7.9 PREVENTIVE MEASURES

Lightening protection system:- A lightning protection system has been provided as per IS:2309 and Indian Electricity Rules. The protections consist of roof conductors, air terminals and down-comers, and would be provided for high-rise (of more than 10 m height) structures.

Safety earthing system:- A safety earthing system consisting of a buried mild steel conductor earthling grid has been provided for the power plant transformer yard, switchyard and other outlying areas. These are connected to the earth grids in various buildings. The buried earthling grid are further connected to earthling

grid are further connected to earthling electrodes buried under ground and located at representative points.

Communication system:- Adequate provision of inter-communication telephones, public address system, and walkie-talkie sets along with cellular phone based communication have been made to ensure that communication works fail safe during emergency response planning.

Training and information system:- While technical measures are essential for the safety, the role of people in management of disasters cannot be ignored. The people can have a negative as well as a positive influence on the safety.

It is important to train not only the persons directly involved by the virtue of official authority or institutional affiliations (including NGOs), but also the general public by appropriately disseminating information on;

a) Possible disaster prone situations and extent of impact
b) Experience in similar situations elsewhere
c) Expected response and measures
d) Role of various constitutional authorities

In addition to the above, other preventive measures to be taken are:

a) Periodical checking of wiring, fittings, and equipment. Immediate removal of all combustible and flammable material from the vicinity of sources of ignition.
b) All welding/cutting operations shall be carried out taking suitable precautions under permit procedure in consultation with the officer-in-charge of the Plant and the Fire and Safety Division.
c) All plant equipment, lines, vessels and storage shall be inspected in all shifts for leakage and release of inflammable liquid/gases. All such leakage if found should be stopped and attended to at once.
d) Areas where spontaneous combustion is possible due to storage of material or in scrap yard to be inspected regularly for immediate control of fire on its outbreak.
e) Internal combustion engines not to be permitted to operate in hazardous plant/areas. Whenever permitted, authority and under permit procedure.
f) Housekeeping should be done in all shifts to remove cotton/jute soaked in oil, grease; oil kept in trays etc. and removed for safe disposal.
g) Stacked material, which can generate heat or can spontaneously ignite, should be inspected regularly to detect any fire. Material should be stacked with sufficient space in between the rows to permit free circulation of air and remove any heat, if generated.
h) Plant or machine/equipment should be operated under close supervision. Any malfunction should be attended to at once before it can lead to breakdown, fire or any such dangerous occurrence.
i) Air- conditioning equipment should be inspected regularly and defects attended to at once.
j) Dry grass and vegetation should be cut as and when required.

k) Smoking should be prohibited in the Plant premises. It may be allowed in the safe locations outside the plant area. All persons should be checked at plant gate for matches, lighter, beedi, cigarettes and other smoking materials.
l) No source of ignition should be permitted in the area near a fire hazard installation. Sources of ignition should be regularly inspected for correction.
m) For storing chemicals and other materials, the following measures should be adapted:
    ii) All racks in stores should be anchored together at top to provide maximum stability.
    iii) The materials should always be stored from bottom upward and not the other way.
    iv) Since there could be a possibility of some of the chemicals being mutually reactive, those should be carefully segregated and separately stored. All chemicals should be labelled with some colour coding indicating their quality from the point of view of in-flammability, corrosively etc.

7.10 FIRE FIGHTING AND MANAGEMENT

The design features of the plant already include all safety and emergency features as outlined in this report.

Adequate fire fighting facilities, equipment and trained personnel shall be available round the clock to fight any type of fire or spillage. Persons trained in first-aid, medical and rescue operations shall also be available on 24 hours call basis. All fire fighting equipment will be tested and checked regularly.

7.10.1 Necessary fire fighting facilities required in alcohol plant to prevent fire hazards

1. **Possible fire hazards**
    - Fire in fuel/bio-mass storage yard
    - Fire in Alcohol storage tanks Electric static electricity and consequent fire accident.
2. **Fire fighting facilities**

The following systems of fire protection are proposed to be provided for the Plants:

a. Fire alarm system
b. Fire containment
c. Hydrant system for the entire plant
d. High velocity water spray (HVWS) system
e. Carbon dioxide flooding system
f. Portable fire extinguishers.

a) **Fire alarm system:-** A fire alarm system has been installed to provide visual and audible alarm in the plant for fire detection at the incipient stage. This system comprise manual call points located at strategic locations in areas which are normally manned, and automatic smoke and heat detectors located at important points such as the cable vault, the

control room, switchgear room etc., to detect fire at an early stage, and provide visual and audible alarm.

b) **Fire containment:-** Strategic areas in the plant have been separated by adequately rated firewalls. All openings for switchgears and cable entry have been sealed by fireproof seals to prevent spread of fire from one area to another.

c) **Reserve water storage for fire demand:-** Reserve storage of 500 m^3has been provided in the treated effluent storage tank with a suitable partition to cater to the water requirements of the fire protection system.

d) **Hydrant system:-** The hydrant system comprise the following:
   - Four pumps, two motor driven and two diesel engine driven, each of 10m3/hour, capacity have been provided to keep both the hydrant and HVWS system mains pressurized. These pumps will take the suction from the water storage tank.
   - External as well as internal fire hydrants in all areas of the industry.

e) **High velocity water spray system:-** The HVWS system has been provided for the fuel storage area. Since the parameters for the HVWS system will be identical to that of the hydrant system, the diesel engine driven pump described in the hydrant system serve as a common standby for both HVWS system and hydrant system. The HVWS system consists of a number of high velocity water projectors. Smoke and heat detectors have been used strategically.

f) **Portable fire extinguishers:-** The fire protection system for the units is to provide for early detection, alarm, containment and suppression of fires. An adequate fire protection system shall be installed to meet the above objective and also to meet all statutory requirements and insurance requirements of Tariff Advisory Committee (TAC) of India. These are intended as a first line of defence, and hence will be located at strategic locations in different buildings and also for outdoor facilities. Portable fire extinguishers will be of foam type, carbon dioxide type and multipurpose dry chemical (MPDC) type. Various areas in the plant will be have one or more of the above system depending upon the particular nature of risk involved in that area. The shifting of acid to the process shall not be manual. It is proposed to feed acid through a PVC pipeline. Regular check up of the leakage, if any, in the pipeline joint should be carried out.

   Other provisions include the following

   1. A direct communication line between the unit and nearest medical center.
   2. A windbag type wind direction indicator to be installed to show wind speed flow, direction and approximate strength.
   3. Some of the operating personnel shall be given first aid training particularly against fire hazard & acid exposure. In addition a fully equipped first aid center shall be set up, including sufficient storage of medicines.

4. A green belt consisting of tall plants and shorter shrubs of fast growing variety shall be installed thus reducing the concentration and dispersion of emission in the surrounding area

7.11 ON-SITE EMERGENCY PLANNING

A major emergency is defined as one, which may affect one or several sections of project and may extend beyond the factory premises. It may cause euforia, loss of life and extensive property damage. It may require the help of outside agencies in addition to own handle it effectively.

Type of Emergency

1. Large fire
2. Sudden Short Circuiting
3. Flooding (Remote possibility)

Objectives

1. Rescue victim of treatment suitability in shortest possible time.
2. Safeguard of others (Evacuate them to safer places)
3. Control the incident with minimum damage of property/ human life.
4. Identify of personnel affected and provide medical help.
5. Information to the relatives of causalities.
6. Provide authoritative information to media/others.
7. Preserve relevant record and equipment needed as evidence in any subsequent inquiry.
8. Restoration of the effected area.

Identification of Major Hazard

1. Fire and around raw material/Finished goods area.
2. Fire in LT HT Panels.
3. Flooding of premises leading to damages of equipment or harm to personnel.

The main objectives of this plan are as follows:

1. To minimise the loss of human life by quick response.
2. To minimise loss of property in the plant & surrounding area.

Scope of plan:

a) Indicate clearly the responsibility of each individual in factory at time of emergency.
b) To seek help at the earliest possible time.
c) Evacuation of surrounding area, if required.

Action Plan

(A) Operation

1. Stop electric supply immediately to the point of fire keeping him safe.
2. Use fire-fighting Equipment.
3. Use required safety appliances.
4. Stand by the instructions of shift supervisor.
5. Evacuate person(s) affected.

Shift Supervisor

1. Alert all sections.
2. Send message to the fire station.
3. Inform the Sr. Engineer/ Plant Manager.
4. Take action to shutdown plant.
5. Isolate sources of Flammable materials.
6. Direct fire fighting rescue operation.
7. Direct all activity till the arrival of Plant manager.

First who notices the emergency

1. Anyone who first notices or gets information of any type of emergency should inform immediately the concerned shift engineer about the details of the emergency.
2. Shift engineer of respective area should immediately inform the department officer and production manager giving full details of emergency and inform security department if required.
3. Respective duty officer should reach the spot immediately and check the gravity of the emergency. In consultation with the production manager he will take immediate steps for closing/shutting down the plant or that area. He will give full assistance to production manager.
4. Production manager has to play the important role in controlling the disaster/emergency. He has to act as a site controller. He should be available all the time. He will instruct all his assistants for asking help from security/ fire fighting/medical safety/ maintenance or any other agency. He will also instruct for audio alarm (Siren) sounding if needed. He may visit the emergency/ disaster site for assessing the gravity of the situation, but most of the time he will decide whether to call for outside help or not and in turn he will inform the security department for asking outside help i.e. police station/ medical services/ fire services/ traffic police etc.

He will command over all the emergency operations from first line/ second line ECR. He will keep a close contact with factory Director and GM. Immediately after getting the information of the disaster emergency. Security officer/ incharge should give necessary instructions to their team and rush to the emergency site. Instruction may be as under:

a) In case of fire, team should reach with fire fighting readiness.
b) In case of toxic gas release and other natural calamities, team should reach with necessary arrangements.

5. Designated Safety officer will reach at once at the site and check the gravity of the emergency. He will help in fire/medical and other operations and will keep close liaison with the production manager. He will also assist/ advice production manager in all emergency operations. Due to his expertise in the field, he can suggest best way and means for controlling the emergency. He will also help in arrangement of proper Personnel/perfect Equipment required at emergency site. Safety officer will ensure that all related legal authorities such

as factories and boilers inspection department, pollution control department, explosive department, electrical inspector etc. are informed at once.

6. The medical officer/ assistant will be ready for extending first aid treatment to any type of victims. He can suggest to production manager for shifting victims to nearby hospital or ask for medical help from these places. He will brief the type and quantum of help needed. If instructed by production manager, medical officer/assistant will rush to the scene with all required first aid arrangements at emergency/site.
7. All the employees of respective departments/plant will be attentive at their duty spots and will act as per the directives of the departmental officers.
   The employees will be attentive at their duty spot and will act as per the directives of the department officer/ production manager. They may be asked to help in emergency operation/ shifting of victims any other maintenance.
8. Public relation officer will work as communication officer. He will work as per the directives of site controller. He will help in contacting outside agencies for necessary help. He will also contact press men/news men/ photographers and ensure that they publish the realistic situation as false information can misguide the community/ public.
9. The security mar at main gate will work as traffic controller and work as per the instructions of Site Controller / communication officer. He will guide the outside agencies like fire brigade/ambulance. Local administration site at the earliest possible.
   He will not allow unnecessary movement to the emergency site. All correct telephone numbers should be displayed and should be made available to all concerned persons.
10. Control room of respective department will be the emergency control center. From there the site controller will direct all the operations.

    Each such control room should contain the following:

    a) Site Plan
    b) External and internal telephone connections.
    c) List of key persons with telephone numbers and home address.
    d) A copy of chemical facts sheet.
    e) F.F.E
    f) Torches

In case 1st line emergency control centre is involved in emergency/disaster then G.M office will be the 2nd line emergency control centre. G.M who has to work as site controller will govern all the function from here. It contains the following

1. Site Plan
2. External and internal telephone connections.
3. List of key persons with telephone numbers and home address.
4. A copy of chemical fact sheet.

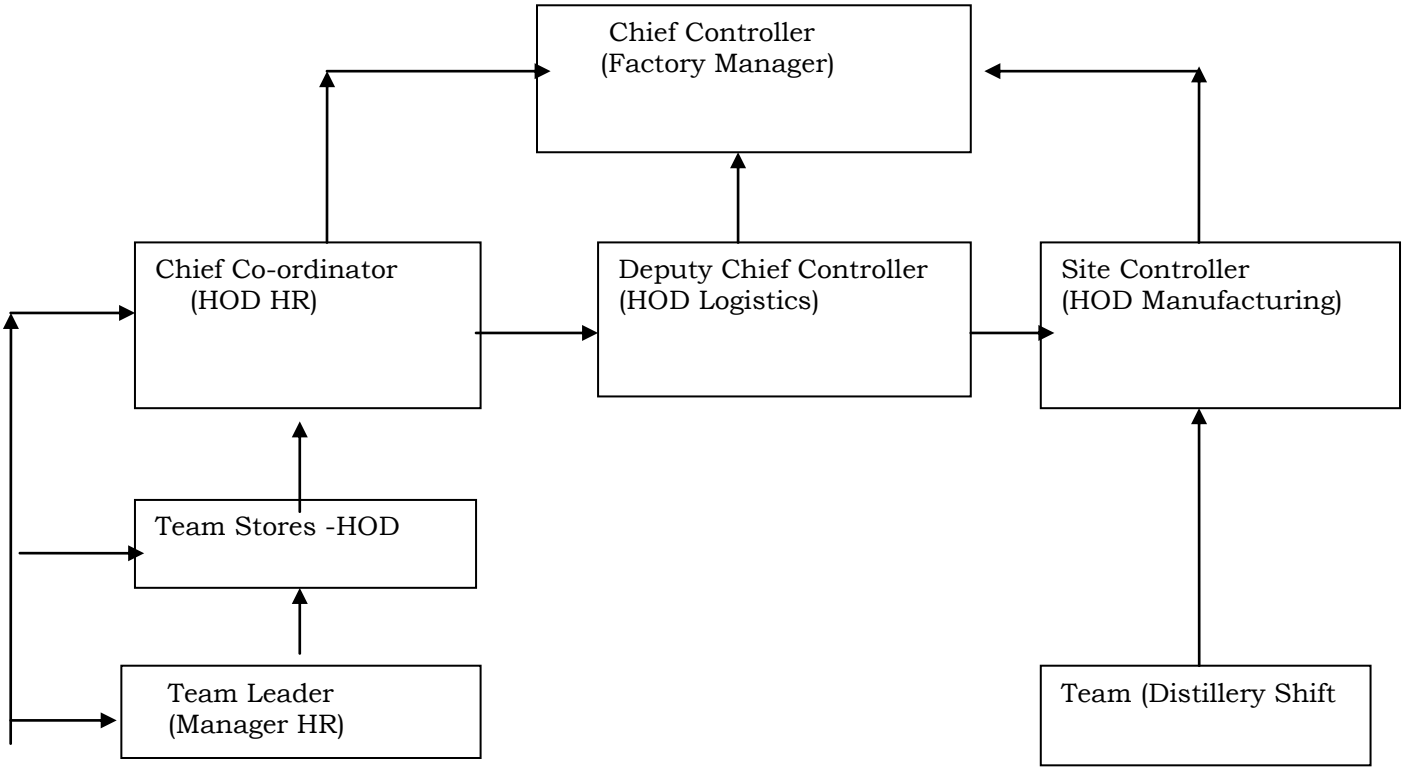
11. Time office, which is away from work place, will be assembly point where employees, visitors and contractors would assemble in case of some major

emergency. Here the list of person at works at the time of emergency will be available and accordingly the Time Officer may take roll call of personnel.

Training

- Disaster plan as drawn up in writing would be circulated and explained to all persons about agencies.
- All concerned at the plant communication /mobilization / law –order would be practiced once a year in beginning and later on once in two year.

Emergency Management Organization Chart



7.12 OFF-SITE EMERGENCY PLANNING

The Off-Site disaster management plan is as per the requirement of Schedule 12 of MSIHC Rules, 2000. Organizations involved, their responsibilities and liaison arrangements between them are discussed in following paragraphs.

7.12.1 City fire services

It is to combat fire and carry out other emergency operations as per the need. In case of fire, the fire brigade is the best help from outside. Even in a disaster not involving fire, the fire brigade could be of good help, inside the plant and outside, in view of their specialized equipments and expertise in rescue and relief.

Responsibilities;

- To reach the accident spot as soon as possible with all necessary equipments to extinguish the fire
- To provide all other necessary help depending on nature of emergency

7.12.2 Police

Police is required to manage and control the mob, violence, sabotage or outbreak, if any, cordoning of the area and help in fire fighting and other emergency operations. In case of emergency the police department has a number of functions to perform.

Responsibilities;

- Maintain law and order situation around the premises
- To control the traffic to facilitate the victims to reach hospitals as early as possible
- To restrict entry of any unauthorized persons
- To set up communication to assist in disaster management operation
- To take control of surrounding transport facilities and assist in disaster management operation by shifting injured persons and causalities to nearby hospitals
- Shifting injured persons and causalities to nearby hospitals
- To assist in fire fighting and other emergency operations

7.12.3 Hospitals: - Hospitals are required to provide first aid, treatment, and also to arrange for removal of victims/casualties. Prompt and efficient medical aid is important in an emergency situation. The first centre, inside the industrial premises, cannot cope up with all the treatment requirements. The right approach to this problem is to have arrangements with nearby hospitals so that in case of an emergency, services and facilities available with the nearby hospitals can be utilized.

Responsibilities;

- Depute doctors and nurses to site with ambulance
- To provide immediate medical relief to casualties
- Augmentation of equipments, drugs and doctors
- To provide first aid on the spot to casualties
- To take all out efforts on war-footing to save maximum lives
- To continue treatment to casualties till all of them are attended and properly shifted to medical centers

7.12.4 District administration:- Civil administration is meant to provide overall supervision of all off-site emergency operations including order to evacuate off-site population. Local administration means those who are responsible for administration of the geographical area where the industrial facility is located.

Responsibilities;

- To protect the citizens
- To assess the situation for overall control

- To monitor the functioning and need of various agencies in rescue operation at site
- To requisite and make available the services and facilities available in the area like additional fire tenders, hospitals, doctors, transport, police, fire brigade, requisition of army and so on.
- To coordinate the activities outside the industrial facility in view of their authority and experience in coordinating rescue and relief operations.

7.12.5 Regional transportation office:- RTO services may be needed to clear all approach roads to and from accident area for free flow of vehicular traffic, which is engaged in combating the emergency, and demarcate parking area for vehicles to evacuate population.

7.12.6 Controller of Explosives and Factory Inspectorate:-

These authorities are meant to provide expert advice and help in coordinating emergency operations with government agencies. The inspector of factories is expected to be friend and a guide to industrial establishments. His involvement is a matter of course since he would be officially connected with inquiries after the disaster.

Responsibilities;

- To coordinate with local government body e.g., civil administration, civil hospital, police department, etc., as well as surrounding voluntary organizations
- To act as off-site emergency controlling authority
- To inform public for precautionary measures

7.12.7 Voluntary organizations

Voluntary organizations should help in relief and humanitarian services to victims in case of any emergency.

Responsibilities;

- To assist in rescue operations and first aid to the victims.
- To arrange transport, refreshment and shelter
- To take necessary assistance from social organizations like Red Cross Society, Scouts, NCC, Rotary, Lions clubs, etc.,

7.12.8 Other industrial installation in the vicinity:-

Industrial installations present near the site should help to combat the emergency with the available equipment/infrastructure present in their locations.

Responsibilities;

- To provide the strongest possible support and resources to the plant managers so that the best accident prevention and emergency preparedness procedures are in place in the industrial facility
- To encourage their facility managers to commit themselves fully to the awareness and preparedness for emergencies at local level process.

7.13 HEALTH & SAFETY POLICY

Preparation of (Occupational) Health and Safety policy

Preparation of (Occupational) Health and Safety policy for the Safety of the workers at work in the factory and the organization itself is solely an obligatory duty of the Occupier in general under the statutory provisions of statutory legislation (Medical Provision) prescribed in the factories Act 1948 and also under section 41B (2) ibid. in case of hazardous process industries as listed in the first schedule of the factories Act. it is the legal responsibility of the Occupier to make this Health and Safety policy know his workers local authority and the chief Inspector of the Factories as well. This Health and Safety plan followed by the factory in accordance with the guidelines embodied in the licit provisions of Rule 63B of Factories Rules 1958 amended w.e.f. 27/11/1991 and include the following features:

Main Features

- It is policy of the company that every reasonable effort shall be made to provide and maintain safe and healthy working condition of equipment and system of work for all employees.
- The prevention of accidents or accident hazard leading to personnel injury or damage of equipment/property is recognized as essential and integral part of efficient operation.
- It shall also be the endeavour of the factory to ensure that surrounding environment is not adversely effected.
- Every employee shall follow safety rules/regulation, operating procedures/ safe work method design to protect people and equipment from risk of injury or damage to property.
- The factory shall endeavour to adequately train all employees suitably to equip them to perform their duties in a safe and effective way.
- Every employee shall discharge his personal responsibility and shall co-operate and actively participate in maintaining and improving safety standards.
- A health policy will be framed in consultation with the workers and the policy will be distributed amongst workers. The heath policy will be displayed at prominent places so that every worker is aware of it.
- All necessary safety equipment's /tool will be provided to workers.
- Adequate supply of clean drinking water, near and clean toilets and washing facilities will be provided in the factory.
- Proper ventilation and exhaust fans will be provided in the workshop.
- Proper protections, steps, guards, will be provided at all required places.
- Fire fighting equipment like sand buckets and fire extinguishers will be placed at handy places.

Fire Fighting Equipments

Sr. No.	Type	Capacity
1.	CO_2	4.5 kg
2.	Dry Chemical powder	5.0 kg
3.	Foam	9 liter
4.	Heavy duty extinguishers (Trolley mounted)	Standard

Medical Facilities

1. First- aids kits will be kept ready and available to the workers.
2. A registered medical practitioner shall be arranged for looking after the health of the workers.
3. An ambulance will be provided in the factory premises for transferring the patient to hospital in case of an emergency.

Table – 7.1
Material Safety Data Sheet
Ethanol

Physical Properties		**Other Characteristics**
Molecular Wt. Boiling point Heat of combustion Flash Point (CC) Sp. Gr. Explosion limits Volatibility TLV/MAC VALUE:	46.08 78.5 deg. C, 351.5 deg. K 452 x 17 J/kg 55 deg. F 0.7893 Lower – 3.3%, Upper – 19% 100% PPM 200 Mg/m3 -	Clear liquid Sweet smell Miscible with water Float on water Combustible
Hazards	**Precautions**	**Extinguishing Agents**
Combustible. Harmful if ingested in excess. Mild redness, burning and irritation of skin & eyes	Remove to free air. Keep away from ignition source & call Fire Dept. Cool exposed containers with water.	Extinguish with dry chemical foam or carbon dioxide or water spray or alcohol foam.
Symptoms	**Precautions**	**First Aid**
Inhalation Causes irritation to upper respiratory tract & coughing. Ingestion cause Emotional liability and decreases inhibition, visual impairment, muscular in coordination, etc.	Use protective equipment for skin, eyes & nose.	Call a doctor. Remove contaminated clothing and shoes. Wash affected area with mild soap. Inhalation: Remove from exposure area to fresh air. Ingestion: if person is conscious and not convulsing remove by thorough gastric lavage under medical supervision

Disposal	Storage	Packing
Additional Information: NEPA RATING : IDLH value Nh 0 Nf 3 Nr 0	Stable in transport store at ambient temperature Venting: Open	

Table – 7.2

Material Safety Data Sheet

Diesel

Physical Properties		Other Characteristics
Molecular Wt. Boiling point Heat of combustion Flash Point (CC) Flammability limits TLV/MAC VALUE:	114.24 282-338 deg.C, 555-661 deg. K 452 x 17 J/kg 51.7 deg. C 1.3-6.0 % v/v PPM – 200 Mg/m3 -	Liquid Yellow – brown Gasoline like odour Float on water Combustible

Hazards	Precautions	Extinguishing Agents
Combustible Harmful if swallowed irritating to skin & eyes	Stop discharge if possible & keep people away. Away from ignition sources & call Fire Dept. cool exposed containers with water	Extinguish with dry powder keep chemical foam or carbon dioxide. Water may be ineffective on fire

Symptoms	Precautions	First Aid
Inhalation Causes irritation to nose and eyes Aspiration causes severe lung irritation, coughing, and pulmonary oedema: Exciter net followed by depression: Ingestion cause nausea, vomiting & cramping: depression of nervous system ranging from mild headache till anaesthesia, coma & death.	Use protective equipment for skin, eyes & nose.	Call a doctor. Remove contaminated clothing and shoes. Inhalation: maintain respiration give oxygen if needed. Aspiration: enforce bed rest give oxygen if needed. Ingestion: DO NOT induce Vomiting: if conscious. Have victim drink plenty of water or milk

		Exposure: flush eyes with water, wipe off, and wash skin with soap & water.
Disposal	**Storage**	**Packing**
Additional Information: NEPA RATING: IDLH value Nh 0 Nf 2 Nr 0	Stable in transport store at ambient temperature Venting: Open (flame arrester)	