Risk Assessment

Hazard Identification & Risk Assessment

Hazards identification involves the identification & quantification of the hazards that exist in the plant. On other hand, risk analysis deals with the identification and quantification of the risk. The plant equipment and personnel are exposed to accident resulting from the hazards present in plant. Risk analysis involves the identification & assessment of risk to the population exposed to as a result of hazards present.

An industry with its complex 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 environment. Risk assessment studies are conducted to ensure safety and reliability of any plant, through systematic and scientific methods to identify possible failures and prevent their occurrence before they actually cause disasters and production loss.

Methodology

Risk assessment is most essential before preparing any on site or off site emergency plan. Hazards identification involves hazard prone areas, transportation risk, storage risks, pollution risks and air and water pollution etc. Catastrophic risks are due to natural calamities, earthquake, landslide, storm, high wind, flood, scarcity, heavy rain, lightening. Massive infection, heavy fire, heavy explosion, heavy spill, toxic exposures are other areas where risk analysis must be address to minimize the damages. Risks from social disturbances, risks from the past accidents must be considered while carrying out risk assessment for a particular area (district) from which the off-site emergency plan is to be prepared.

Identification of hazard areas

Risk analysis deals with the identification and quantification of the risk, the plant equipment and personnel are exposed to accidents resulting from the hazards present in the plant. Risk analysis involves the identification and assessment of risks to the population is exposed to as a result of hazards present. This requires an assessment of failure probability credible accident scenario, vulnerability of population etc. Much of this information is difficult to get or generate consequently, the risk analysis in present case is confined to maximum credible accident studies and safety and risk aspect related to Molasses based Distillery. Activities requiring assessment of risk due to occurrence of most probable instances of hazard and accident are both onsite and off-site. Activities requiring assessment of risk due to occurrence of most probable instances of hazard and accident are both onsite and off-site.

Detail Risk analysis is carried out for the operation of the plant, raw material, production process, and packing. Various scenarios are considered ensuring related protective measures provided and their effectiveness. Methods are suggested to decrease the hazards potential.

The emergency considered in this plant refer to the occurrence of one or more of the following

- Fire in Oil room and alcohol storage and bagase storage
- Leakage of alcohol/Molasses from storage tank
- Release of toxic gases.
- Release of chemicals.
- Explosion in Boiler house and other accidents due to plant operation

Identification of hazards areas and likely hazards are summarized in **Table 1**

Table 1: Hazardous area & its hazards

Sr. No.	Hazardous Area	Likely Accident
1.	Boiler Area	Explosion
2.	Turbine room	Explosion
3.	Electrocution	Lose fitting
4.	Electrical rooms	Fire and electrocution
5.	Transformer area	Fire and electrocution
6.	Cable tunnel	Fire and electrocution
7.	Storage yard (Bagasse)	Sliding, fall of material
8.	Coal/Bagasse storage area	Fire and spillage
9.	Distillery (alcohol storage tanks)	Fire
10.	Biomass storage, Biomethanation	Odor/Fire

On Site Emergency Plan

A major emergency in a work place is one, which has the potential to cause serious injury and loss of life. In addition, it may cause extensive damage to property and environment. The rapid growth in the use of hazardous chemicals in industry and trade has brought about a very significant increase in the number of people, both workers and members of general public, whose life could be endangered at any one time by an accident involving these chemicals.

Objectives: The overall objectives of an emergency plan are to

(1) Locate the emergency, if possible and eliminate it
(2) Minimize the effects of the accident on the people and property

Elimination: It requires prompt action by operators/workers, emergency staff, e.g. firefighting equipment, emergency shut off valves, water sprays. Minimizing the effects may include rescue, first aid, evacuation, rehabilitation and giving information promptly to people being nearby

Identification and assessment of Hazards:

- Fire & Explosion possibilities in Storage and Handling of Ethanol
- Fire & Explosion possibilities in Boiler Section
- Fire possibilities in bagasse/Coal yard

Emergency control center

Security Main Gate Office is chosen as the "EMERGENCY CONTROL CENTRE". The emergency control center is the place from where the operations related to emergency are coordinated. The Emergency control center is suitably equipped to receive and transmit information and directions from the incident site and furnish useful data to other affected areas inside & outside works. The center shall contain the following information and facilities.

Compile the following information for the on-site emergency plan

- Master plan of the works showing different locations, where hazardous materials are stored / processed
- Sources of Personal Protection Equipment, portable fire extinguishers, and other safety material
- Fire fighting system and sources of water.
- Plan of the works with safe distance areas, escape routes, assembly points
- List of key personnel and their telephone numbers
- List of Government officials, other areas of help – their telephone numbers
- Updated Nominal roll of the employees and other visitors
- Communication facilities like phones, mobile phones, walkie-talkie sets etc
- Standby power arrangements like- Generator sets

Responsibility of work's manager

(1) Prepare on-site emergency plan and revise it from time to time (once in 6 months)
(2) Conduct regular mock drills
(3) Educate / train all the employees regarding on-site emergency plan
(4) Submit copy of "on-site emergency plan" and mock drill to Chairman / District Disaster Plan, Deputy Chief Inspector of factories Office
(5) Stock necessary PPE for fire fighting.

(6) Device data collection forms for collecting data during emergency
(7) Ensure the details giving in displayed / kept in Emergency Control Centre

Emergency Siren:

An emergency siren of 500 meter Capacity is installed for the purpose of alarming employees on emergency. It is located near the Security Main Gate or Emergency Control Room. The "Chief incident controller" will decide the operating controls at appropriate time.

The identification of various signals of the siren to the employees is given in **Table 2**

Table 2: Information about Siren

Sr.no	Type of siren	Duration
1.	Factory shift siren	Continuous for 30 seconds
2.	In case of fire	Special Hooter Siren
3.	Emergency siren of heavy toxic Gas leakage (Probability from neighboring industries)	Special Hooter Siren repeating TWICE.
4.	All clear siren	Continuous siren for three minutes.

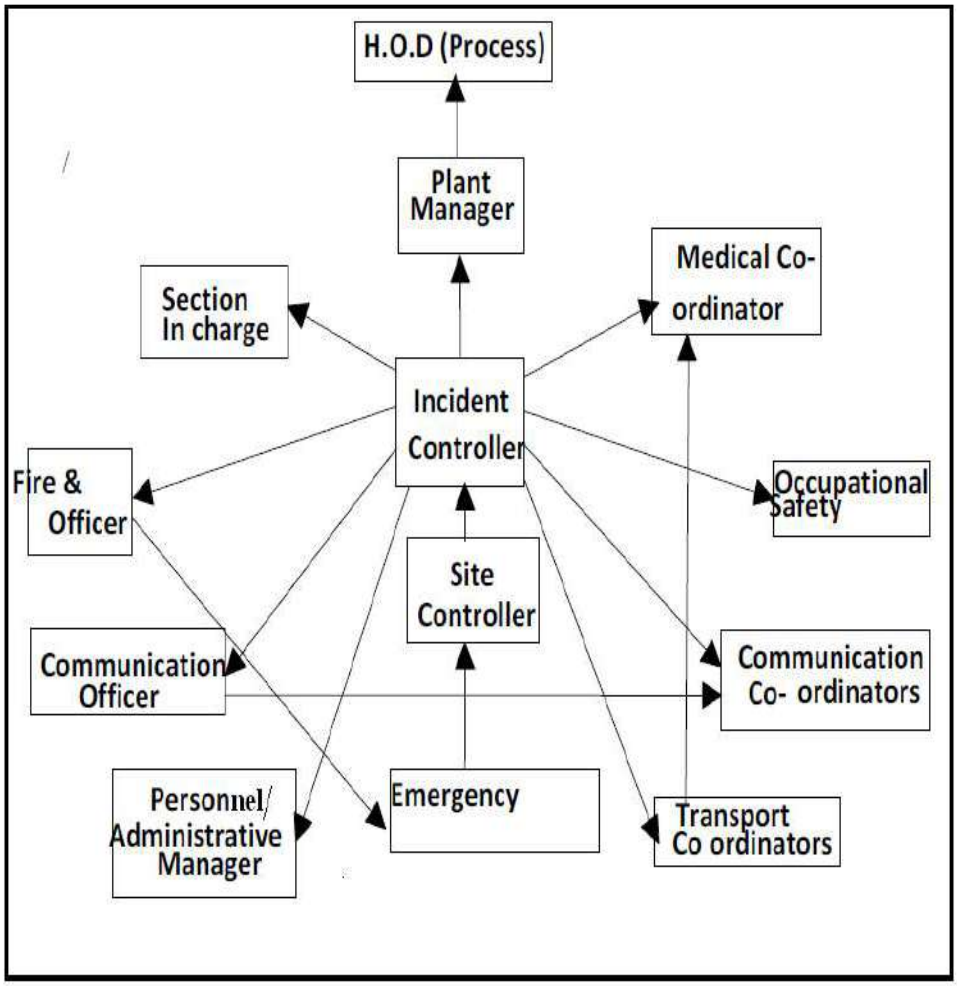
Origination chart suggested for safety persons dealing with emergencies is given in **Fig 1.** And there responsibilities and duties are summarized hereunder.

Responsibilities of Safety personnel

Responsibility of chief incident officer

- Declares emergency.
- Rushes to emergency control centre.
- Controls emergency by coordinating with site-incident controller.
- Communicates to external agencies through liaison team.
- Declares lifting of emergency.
- Gives guidelines to liaison team on sharing information to Government officials, press and general public.
- Time to time interaction with site incident controller on dealing of emergency.

Fig.1 Organization chart for dealing with emergencies



Site Incident Controller

- Receives a call from security supervisor.
- After a brief visit to incident site, decides and advises chief incident controller to declare emergency.
- Controls the emergency by coordinating various activities through his teams.
- Advises to chief incident controller lifting of emergency.
- Reviews and prepares a detailed report on the incident and submits to “Chief Incident Controller”.

Safety & emergency team:

- Device methods to isolate emergency and movement of people.

- Provide necessary safety data to site controller.
- Provide required PPE.
- Provide time to time information to site incident controller.
- Shift/cordon off flammable materials from the danger zone.
- Put off power supply wherever not required.

First aid team:

- Provide first aid / medical care to persons injured inside factory
- Keep a list of people sent for outside treatment and other welfare measures undertaken.
- Maintain the list of people inside premises and sent out including visitors.
- Provide time to time information to site incident controller.
- Act as per the instructions of site incident controller.
- Keep a list of essential staff required to assist during emergency.

Fire team & Security team:

- Control the emergency by fire fighting. Give a call to mutual aid if required.
- Move people to safe areas specified by safety and engineering teams.
- Control the movement of traffic at Gate.
- Provide time to time information to site incident controller.

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Fire & Risk Management

Fire Fighting System

Fire fighting facility is available and is under renovation within the plant premises. The fire protection system for the unit is to provide for early detection, alarm, containment and suppression of fires. The fire detection and protection system should be planned to meet the above objective an all–statutory and insurance requirement of Tariff Advisory Committee (TAC) of India. The complete fire protection system will comprise of the following.

System Description of Fire Fighting System

The entire fire safety installation shall be complied with the most stringent codes /standard for the entire complex to ensure the highest safety standard and uniformity of system. Further, the fire protection shall be fully operated and tested under simulated conditions to demonstrate compliance with the most stringent standards, codes and guidelines.

Fire & Safety Coordinator

The security officer will be the fire and safety coordinator. He will assume full responsibility for all activities including organizing fire fighting manpower, equipment and appliances to control and extinguish fire/ mitigate emergency in consultation with site coordinator. He has to assess the situation and decide on the assistance required from state/ municipal/ neighbor fire services. In consultation with store coordinator and safety officer, he has to update the inventory of all fire fighting / safety equipments.

The coordinator has to preserve all possible evidences that would facilitate the subsequent investigation in to the cause of disaster. Emergency Plan Prepared for Fire Protection.
The Safety officer prepared the plan when an emergency occurred He will assist other safety precautions such as

- Arrange to cordon off the area of emergency.
- Arrange for search and rescue operation.
- Guide the fire and safety coordinator in mitigating the emergency.
- Ensure that non-concerned personnel evacuated from the scene of emergency.
- Will execute all jobs to control the emergency such as isolation, diversion of the process to other areas, arrange for removal of comestible /inflammable /explosive toxic chemicals, drums, bags etc. from the emergency.
- Will shutdown process of plant, if necessary.
- Will direct the fire and rescue team.

Off Site Management Plan
The main objectives of the off-site emergency plan are:-

a. To save lives and injuries.

b. To prevent or reduce property losses and

c. To provide for quick resumption of normal situation or operation.

Legal Provisions

Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996 prescribes for the constitution of the State Crisis Group as apex body at the State Level to deal with major chemical accidents and to provide expert guidance for handling major chemical accidents. Schedule 7 and Schedule 8 of the Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996 prescribes for the constitution of District and Local Crisis Groups.

The composition of the District Crisis Group has been prescribed under the chairpersonship of District Collector and Local Crisis Group under the Chairpersonship of Sub-Divisional Magistrate. The District Crisis Group shall meet every forty five days and send a report to the State Crisis Group. The Local Crisis Group shall meet every month and forward a copy of the proceedings to the District Crisis Group.

Functions of the Local Crisis Group

The Local Crisis Group shall -

a) Ensure dovetailing of the local emergency plan with the district off-site emergency plan;
b) Train personnel involved in chemical accident management;
c) Educate the population likely to be affected in a chemical accident about the remedies and existing preparedness in the area;
d) Conduct at least one full scale mock-drill of a chemical accident at a site every six months and forward a report to the District Crisis Group; and
e) Respond to all public inquiries on the subject.

Mock drills

The success of the plan is dependent on planned and unplanned mock drills. Mock drills help to familiarize employees with their roles, and prove the current accuracy of the details of the OEP. As per the Industrial Major Accident Hazard Rules,

- Mock drills of the on-site emergency plan are conducted periodically.
- A detail report of the mock drill conducted is to be made immediately available to the concerned authority.
- Also, Major Fire and Minor Fire mock drills are conducted once in three months and one month respectively.
- Inform site incident controller the incident and call him to site of incident.
- Act as per the directive of Site incident controller
- Rush fire-fighting team to site of incident and start fire-fighting operation.
- Rush security team to cordon off the incident site.
- Move non-essential employees to assembly point.
- Regulate the traffic at gates.
- Keep the escape routes and roads free from obstruction.
- Make transport facilities for transporting non-essential employees.
- Keep list of essential staff needed during emergency.

Process Hazards and its control measures

Following hazards may occur in industry.

- Fire Electric Panels
- Bagasse, Coal, Oil room and alcohol storage
- Fall of material
- Fire hazards

The potential mitigation measures of hazards with the concerned area have been enlisted below.

Preventive Measures for Electricity Hazards

- All electrical equipment is to be provided with proper earthling. 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 are 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.

Coal & Bagasse Storage

- The unit has adequate water supply through pipe/ surface water before selection of the site. Coal storage unit is to be ensured for stacking of coal/Bagasse in heaps.

- Adequate dust suppression measures are 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.
- Fire fighting measures are provided to avoid any fire case.
- Measures are taken to control the air pollution during loading/handling coal.
- It should be ensured while routing high tension voltage lines to avoid storage of bagasse storage below & near high voltage (H.T.) transmission lines.
- Avoid route of electric supply cables &cable trenches far away from stored bagasse or bagasse heaps.
- Keep raw & useful material far away from storage of bagasse area.
- Installation of Fire Hydrant (self auto-mode fire fighting) system around the area of bagasse yard.
- Posting of proper supervision staff with necessary communication facility
- Hot work, like welding, gas cutting should not be carried out near bagasse storage.
- Daily record of bagasse storage data, proper review of conditions taken by higher authority.

Precautionary Measures for Falling material

- Safety helmets to be used to protect workers below against falling Material,
- Barriers like a toe boards or mesh guards are to be provided to prevent items from

  Slipping or being knocked off the edge of a structure.
- An exclusion zone is to be created beneath areas where work is taking place.
- Dangerous areas are to be clearly marked with suitable safety signs indicating that access is restricted to essential personnel wearing hard hats while the work is in progress.

Safety measures for storage & handling of alcohol

Major hazard of alcohol release vapors and fire so proper handling and storage of alcohol shall be done as per prescribed norms. The alcohol is directly fed to the storage tank through pump

and no manual handling will be involved which will reduce the risk of spillage in the storage area. Following precautionary measures would be taken for safety. It is recommended to eliminate the risk and hazard at the design stage itself by carrying out detailed systematic HAZOP study of the entire process and make the process and operation intrinsically safe.

a) 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 air contamination is above acceptable level will be promoted.

For storage and handling following precautions will be taken:

- Keeping away from oxidizers, heat and flames.
- Avoidance of plastics, rubber and coatings in the storage area.
- Cool, dry & ventilated storage and closed containers.
- Grounding of the container and transferring of equipment to eliminate static electric sparks.

b) Fire Fighting Measures

- Use of extinguishing media surrounding the fire as water, dry chemicals, CO_2, Sand, dolomite, etc.
- Foam System for fire fighting has been provided to control fire from the alcohol storage tank. The foam thus produced is suppressed fire by separating the fuel from the air (oxygen), and hence avoiding the fire & explosion to occur in the tank. Foam would blanket the fuel surface smothering the fire. Then the fuel also be cooled by the water content of the foam.
- The foam blanket suppresses the release of flammable vapors that can mix with the air.
- Special Fire Fighting Procedures; Keeping the fire upwind. Shutting down of all possible sources of ignition, keeping of run-off water out of sewers and water sources. Avoidance of water in straight hose stream which will scatter and spread fire. Use of spray or fog nozzles, cool containers is exposed to flames with water from the side until well after the fire is out.
- Hazardous Decomposition Products: gases of Carbon monoxide (CO) & Carbon dioxide (CO_2).

c) Accidental Release Measures

For spill cleanup well ventilation, shutting off or removal of all possible sources of ignition, absorbance of small quantities with paper towels and evaporate in safe place like fume hood and burning of these towels in a safe manner, use of respiratory and liquid-contact protection by the cleanup personnel will be promoted.

Fire Fighting Facility

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 shall conform to the requirements given in IS 12469: 1988. The capacity of pumps should be worked out based on requirements of output and pressure for the system. 171 m3 / Hr, @ 7.kg / Cm2. Provision shall be made for standby pumps fed from different source of power at the rate of 50 percent of aggregate number of pumps, subject to minimum of one and maximum of two. Where pumps are of different capacities as per DBR they require Main Electric Pump, Stand by Pump Electric or DG, Sprinkler Pump if Further applicable and Jokey Pump. Fire fighting hydrant system in the entire plant will be as per IS 909: 1975 Standard with Hose Reels.

Special fire fighting arrangement around RS and AA, ENA tank farm will have

1. Medium velocity water spray system configured with deluge valve System.
2. Automatic Smoke Detection System with Multisensory Detectors with manual call point and hooter
3. Automatic sprinkler system or internal hydrant & Hose reel with Foam ratio controller. NFPA 13 & 15 + Foam Monitor Nozzle. NFPA 13 & 15
4. Foam sprinkler system, configured with AFFF foam tank NFPA 16

A) Fire pumping system

The fire pumping system comprises independent electrical pumps for hydrant and sprinkler system, diesel engine driven pump & jockey pump for hydrant & sprinkler system.

Electrical pump has to be provided adequate flow for catering requirement of hydrant system. Diesel engine driven fire pumps provided for ensuring operation & performance of the system in case of total electrical power failure. Provision of PRS/orifice plate shall be made in sprinkler riser to restrict pressure on sprinkler system. Individual suction lines are drawn from the fire reserve tanks at the basement level and connected to independent fire suction header. The electric fire pumps, diesel engine driven fire pumps and the jockey pumps all draw from this suction header.

Delivery lines from various pumps also be connected to a common header in order to ensure that maximum standby capacity is available. The sprinkler pump is isolated from the main discharge header by a non return valve so that the hydrant pump can also act as stand by for the sprinkler system. The ring main shall remain pressurized at all times and Jockey pumps shall make up minor line losses. Automation required to make the system fully functional shall be provided.

B) Fire hydrant system

Internal and external stand pipe fire hydrant system has been provided with landing valve, hose reel, first aid hose reels, complete with instantaneous pattern short gunmetal pipe in the complex. The internal diameter of inlet connection is 80 mm. The outlet shall be of instant spring lock type gunmetal ferrule coupling of 63 mm dia. for connecting to hose pipe. Provision of flow switch on riser shall be made for effective zone monitoring. The flow switch shall be wired to FAP and it indicates water flow on hydrant of the identified zone. Recessed cupboard/ fire hydrant cabinet shall be strategically located for firefighting requirement. Location of cabinets accessed as per compartment plan in consultation with the Architect. Provision of fire man's axe shall be made for internal hydrant. External hydrant has been located within 2 m to 15 m from the building to be protected such that they are accessible and may not be damaged by vehicle movement. A spacing of about 45-50 m between hydrants for the building shall be adopted. Details of fire hydrant system are as follows:

Piping: Mild Steel pipes (heavy class) as per IS: 1239 shall be provided throughout the complex. Pipes buried below ground shall be suitably lagged with 2 layers of 400 micron polythene sheet over 2 coats of bitumen.

External Hydrants: An external hydrant has been provided all around the complex. The hydrants shall be controlled by a cast iron sluice valve or butterfly valve. Hydrant has instantaneous type 63 mm diameter outlets. The hydrants double outlet with CI duck foot bend and flanged riser or required height to bring the hydrant to correct level above ground. For each external fire hydrant two numbers of 63 mm diameter 15m long controlled percolation hose pipe with gunmetal male and female instantaneous type couplings machine wound with GI wire, gunmetal branch pipe with nozzle provided. Each external hydrant hose cabinet has been provided with a drain in the bottom plate.

Internal Hydrants

Internal hydrant provided on each landing and other locations as required by NBC with double headed gunmetal landing valve with 100 mm dia inlet, with shut off valves having cast iron wheels. Landing valve have flanged inlet and instantaneous type outlets.

- Instantaneous outlets for fire hydrants are standard pattern and suitable for fire hoses.
- For each internal fire hydrant station two numbers of 63 mm dia. 15 m long rubberized fabric lined hose pipes with gunmetal male and female instantaneous type coupling machine with GI wire, fire hose reel, gunmetal branch pipe with nozzle shall be provided.
- Standard fire hose reels of 20 mm dia high pressure rubber hose 36.5 m long with gunmetal nozzle, all mounted on a circular hose reel of heavy duty mild steel construction having cast iron brackets are provided. Hose reel is connected directly to the wet riser with an isolating valve. Hose reel shall be mounted vertically.
- Each internal hydrant hose cabinet has provided with a drain in the bottom plate. The drain point shall be led away to the nearest general drain.
- Each internal hydrant hose cabinet containing items as also be provided with a nozzle spanner and a Fireman's Axe. The cabinet shall be recessed in the wall.
- Each hose cabinet conspicuously painted with the letters "FIRE HOSE".

Hose Reel

Hose reel shall be heavy duty, 20 mm dia, length 36.5m long fitted with gun metal chromium plated nozzle, mild steel pressed reel drum which can swing up to 170 degree with wall brackets of cast iron finished with red and black enamel complete.

C) Sprinkler system

Elaborate automatic sprinkler system is provided. The system is suitably zoned for its optimum functional performance. The sprinkler system provided with control valves, flow and tamper switches at suitable location and connected to control module of the fire alarm system for its monitoring and annunciation in case of activation.

Sprinkler type along with its quartzite bulbs rating shall be selected based on the requirement of the space and shall be specified accordingly. Inspector's test valve assembly with sight glass shall be provided at remote end with discharge piped to drain pipe.

D) Fire Extinguishers

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. The 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
- Fire hydrant
- Protocol (chemical to combat oil fires).

E) Fire Pump

The fire pump shall be horizontally mounted, variable speed type. It has a capacity to deliver and developing adequate head so as to ensure a minimum pressure at the highest and the farthest outlet. The pump has capable of giving a discharge of not less than 150 per cent of the rated discharge, at a head of not less than 65 per cent of the rated head. The shut off head shall be within 120 per cent of the rated head.

The pump casing of cast iron and parts like impeller, shaft sleeve, wearing ring etc. shall be of non-corrosive metal like bronze/brass/gun metal. The shaft is of stainless steel. Provision of mechanical seal shall also be made. Bearings of the pump effectively sealed to prevent loss of lubricant or entry of dust or water. The pump has provided with a plate indicating the suction lift, delivery head, discharge, speed and number of stages. The pump casing shall be designed to withstand 1.5 times the working pressure.

F) Foam System

For Fire Fighting Aqueous Film-Forming Foams (AFFF) based on combinations of fluoro-chemical surfactants, hydrocarbon surfactants, and solvents will be used as foam agent. These agents require a very low energy input to produce a high quality fire fighting foam. Foam concentrate stored in a bladder tank system. In AFFF system a bladder tank containing nylon reinforced elastomeric bladder is used to store the foam concentrate. System water pressure is used to squeeze the bladder providing fire fighting foam concentrate, at the same pressure, to the proportioner. An aqueous film has formed on the surface of the alcohol by the foam solution as it drains from the foam blanket. This film is very fluid and floats on the surface of most alcohol. This gives the AFFF unequaled speed in fire control and control the spill fire.

Occupational Health & Safety and EHS Policy

Production of Ethanol involves storage handling and use of several chemicals. Some of these chemicals are toxic and hazardous in nature. Information about these chemicals is therefore important for the safety of the employees and the plant. Occupational health programme would be taken as a regular exercise for all the employees and their records maintained. In order to ensure good health of workers, regular health check-up of the plant workers would be carried out. Occupational health surveillance programme will be taken as a regular exercise for all the employees and their record will be maintained.

Health status of the employees is also important which may be affected due to exposure to these chemicals. The exposures may be sudden and accidental or for a long period. In both the cases there will be different health effects. Therefore safety measures dealing with these chemicals are of vital importance.
The following control measures will be taken up under occupational health surveillance programme is under EHS policy.

- Occupational Health Surveillance (OHS) shall be under taken as regular exercise for all the employees specifically for those engaged in handling hazardous substances.
- Change in Method of work.
- Proper Information, Instruction & Training.
- Regular use of Personal Protection Equipment.
- Regular Monitoring.
- Proper Recovery Measures (Emergency Plan) will be prepared.
- All the first aid facilities, ambulance facility, dispensary etc are provided in the Occupational Health Centre.
- The medical records of each employee shall be maintained separately.
- Occupational health center for medical examination of employees with all the basic facilities will be established with in the plant.
- The noise levels in critical area shall be monitored regularly and the workers at high noise level generating areas will undergo audiometric tests once in six months.
- To ensure proper implementation of fire preventive methods and an appropriate firefighting service together training facilities for personnel involved in this service.

- To publish notify regulations, instructions and notices in the common language of employees.
- To keep all operations and methods of work under regular review for making necessary changes from the point of view safety in the light of experience and up to date knowledge.
- To provide appropriate facilities for first aid and prompt treatment of injuries and illness at work.
- To take steps to ensure that all known safety factors are taken into account in the design, construction, operation and maintenance of plants, machinery and equipment.
- To allocate sufficient resources to maintain safe and healthy conditions to work.
- To ensure that adequate safety instructions are given to all employees.

Site specific Qualitative Risk Analysis (QRA)

For the storage of 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 given in **Table 3**

Table 3: Degree of Hazard and F& EI Index

DEGREE OF HAZARD AND F & EI INDEX	
F&EI INDEX RANGE	**DEGREE OF HAZARD**
1-60	LIGHT
61-96	MODERATE
97-127	INTERMEDIATE
128- 158	HEAVY
MORE THAN 159	SEVERE

Mitigation Measures

1. Based on standard recommendations for moderate hazard is it is recommended to have Alcohol storage tanks should be in open in dyke walls and must have spill collection and control (recycle) arrangement to pump into another tank.

As indicated above the storage will be in open with dyke walls and with clear distance between tanks will be minimum 4 m as per the requirement of Petroleum Rules This

will be provided and approval from Chief Controller of Explosives has obtained for the alcohol storage and factory lay out.

2. F & EI index can also be used for estimating the damage that would probably result from the accident/fire. And it is converted to radius of exposure by multiplying it by 0.84 to feet. Thus radius of exposure in this case will be 0.84X72= 60 feet or 18 meter.

Quantitative Risk Analysis

For the alcohol storage of 3000M^3 in five tanks, each of 500M^3 capacity and 8 meter diameter and 10 meter height. Keeping distance between two tanks to be minimum half the tank diameter, distance between two tanks is 5 meters (with tank diameter= 4 meters), giving allowance for the base etc. as 1 meter from the dyke wall, and keeping these tank 3 in 1 line and 3 in another parallel line inside the dyke wall provision has been made for dyke wall of 45X25X1 meter tank farm with dyke walls

Quantitative risk analysis for the worst case scenario

Conditions assumed for the worst case scenario include one of the 6 Alcohol storage tanks of 500 m^3 capacity, tank is 90% full and there is leakage through a hole of 25 mm at a distance 2 meters from the bottom and the alcohol leakage forms a pool within the dyke wall catches fire. And there is a pool fire.

Pool fire may result when bulk storage tanks will leak/burst, and the material released is ignited. As of these tanks are provided with dyke walls to contain the leak and avoid spreading of flammable material, the pool fire will be confined to the dyke area only.

Using ALOHO soft ware and applying normal site conditions, threat zones predicated are

1. Max Flame Length: 4 meters
2. Burn Duration: ALOHA limited the duration to 1 hour
3. Max Burn Rate: 22.6 kilograms/min
4. Total Amount Burned: 1,307 kilograms. The puddle spread to a diameter of 4.2 meters.

THREAT ZONE: Predicted is given in **Table 4**

Threat Modeled: Thermal radiation from pool fire

Red : (12.7 kW/(sq m)) less than 10 meters(10.9 yards)

Orange: (5.0 kW/(sq m) less than 10 meters(10.9 yards)

Yellow: (1.6 kW/(sq m)) 13 meters

Table 4: Thermal Radiation & its Predicted Distance

Thermal radiation	Predicted distance
12.7 kW/sq m	less than 10 meters
(5.0 kW/(sq m)	less than 10 meters
(1.6 kW/(sq m)	13 meters

Conclusion: Serious threat zone remains with the confines of the dyke wall. And fire fighting piping when laid 10 meters away from the dyke wall, fire can be extinguished from the safe distance, which has to be more than 13 meters where thermal radiation will not cause serious discomfort**.** There is no threat to the population outside the plant. The criterion chosen for calculating thermal radiation effects for the above values is based on the following information.

Thermal radiation due to pool fire may cause various degrees of burns of human bodies. **(Table 5)** Exposure at different incident levels of thermal radiation on human with exposed skin

Table 5: Thermal Radiation Exposure on Human Bodies

Radiant Heat (kW/m^2)	Effect on human with exposed skin	
37.5 kW/m^2	100% lethality in 1 min	1% lethality in 10 seconds
25.0 kW/m^2	100% lethality in 1 min	significant injury in 10 seconds
12.7 kW/m^2	1% lethality in 1 min	first degree burns in 10 seconds
9.5 kW/m^2	Pain threshold reached after 8 seconds	second-degree burns after 20 seconds
4.0 to 5.0 kW/m^2	Sufficient to cause pain to personnel after 20 seconds and blistering of skin	
1.6 kW/m^2	Causes no discomfort for long exposure	

It is observed that the exposed persons normally find shelter or protection from the heat radiation (e.g. against a wall) within 10 seconds. However, exposure time of 30 seconds is normally assumed for pessimistic calculation which applies if people do not run away immediately or when no protection is available.

Effect on equipments and buildings

Thermal radiation affects on objects like piping, equipment and can be severe depending upon the intensity of radiations as shown below.

Table 6: Heat Radiation & its Effect

Heat Radiation	Effect
37.5 kW/m^2	Damage to equipment
30.0 kW/m^2	Limit for Class 1 building materials

Health and Safety aspects of the Chemical

Ethyl Alcohol: Ethyl Alcohol is a flammable liquid requiring a red label by DOT. Its flash point 12°C (closed cup). Vapor concentration between 3.3% and 19.0% by volume in air is explosive. 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 as presented in **Table 7**

Table 7: Effect of Ethyl Alcohol

mg/l	Ppm	Effects in human
10-20	5300 – 10,640	Some transient coughing and smarting of eyes and nose, not tolerable
30	15,960	Continuous lacrimation and marked coughing; could be tolerated with discomfort.
40	21,280	Just tolerable for short period
> 40	>21,280	Intolerable

There is no evidence that inhalation of ethyl alcohol vapour can cause drunkenness or Cause cirrhosis. In order to prevent the workers of the industrial unit for any kind of accident, following Personnel Protective Equipments would be provided to them;

- Industrial Safety helmets
- Crash helmets
- Face shield with replacement acrylic vision
- Zero power plain goggles with cut type filters on both ends

- Zero power goggles with cut type filters on both sides and blue colour glasses
- Welders equipment for eye and face protection
- Cylindrical type earplug
- Ear plugs
- Canister gas masks
- Self-contained breathing apparatus
- Leather apron
- Boiler suit
- Safety belt / line man's safety belt
- Leather hand gloves
- Asbestos hand gloves
- Canvas cum leather hand gloves with leather palm
- Industrial safety shoes with steel toe
- Electrical safety shoes without steel toe and gum boots

Medical Facilities: The Factory will be provided with the following medical facilities to handle any emergency:

1. Well equipped First Aid Boxes will be provided in each Section of the factory.
2. The First Aid Boxes will be distinctively marked with a Red Cross on green background and contain the following equipment/accessories:

a. Small sterilized dressings.
b. Medium size sterilized dressings
c. Large size sterilized dressings
d. Large size sterilized burn dressings
e. Packets sterilized cotton
f. Snake bite Lancet
g. Pair of scissors
h. Bottle of Potassium Permanganate
i. Bottle containing 2% of alcoholic solution of iodine.
j. Bottle of Sol. Volatile having the dose and mode of administration indicated on the label
k. One copy of first aid leaf-let
l. Bandages

m. Adhesive plaster
n. Triangular bandage
o. Packets of safety pins
p. Supply of suitable splints
q. One tourniquet

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.

A vehicle will be always available to shift the sick/injured person to District Hospital.