Risk Assessment

The Environmental risks are inherent in operation of any industry, or any human activity for that matter. Any system failure can lead to disaster.

These Organic Chemicals manufacturing is a simple three step process, as seen earlier. However Risk is posed by (1) Dust in various operational steps and (2) Fuel, which here is in the form of power and coal/bagasse.

Dust is generated in many steps from raw material handling, transfer, heating, cooling, transporting out and waste treatment. In order to reduce this risk, steps like capturing the same, conveying through ducts, and controlling by ESP are attempted. Conveying by smooth internal roads, watering the roads, regular and quick sweeping and monitoring the efforts, are the minimum actions to be taken.

Fuel used here is coal/ bagasse. Fuel can give rise to one Risks, namely Fire. As full fire protection and extinguishing gadgets are provided, any risk from fuel stands automatically covered. All motors are kept TEFC (totally enclosed fan cooled). Temperature and Carbon Monoxide control is undertaken by arranging carbon dioxide correct percent. This minimizes the Risk to a very great extent.

- Vehicles bringing in the materials are run at slow speed. It is neatly tied and secured to the vehicles. Guards patrol the entire length, throughout day and night. There is no public traffic here and warning signals are painted on boards.
- For other raw materials, it is a policy to bring the same in small doses and in closed containers. If sundry raw material comes in bags, hooks and other sharp equipment is not to be used on bags or unit loads. Cranes, tackles and forklift trucks are used for unloading and loading.
- Before storage all units are to be inspected for cleanliness and for damage.
- All bags are to be stacked on pallets. All damaged bags are to be repaired. a second impermeable bag which would be sealed properly and kept separately for use.
- Dyke walls, smooth sloping floors provided around storage tanks.
- Emergency Management Training

  The key personnel would undergo special courses on Emergency, Disaster management & Occupational Health. This may preferably be in-plant training. The Managers, Senior Officers & involved staff would undergo a course on the use of personal protective equipment also. In addition, special courses will be designed team-wise. In such training, outside government agencies also will be invited to be familiar with the plant layout.

7.2.1 Stocking at work place, loading and maintenance of floor area:

- The raw materials are to be placed very near to the feeding point.
- Housekeeping is most important of all dust control methods.
- Simply cleaning of all possible emission sources as quickly as possible.

7.2.2 Work Environment:

Dust and Heat free work environment is maintained in view of workers' safety, Health and Hygiene. The efforts taken in this respect are:

#	**Source**	**Attenuation by**
1.	Scrap Yard	Avoided by adopting smooth roads and yard.
2.	Plant	Avoided by adopting good foundation, good alignment, well lubricated.
3.	Generators	Fitted enclosure and tall stack
4.	Vibrations	Proper sturdy foundation provided for all the machines and equipments

		to avoid fugitive escapes.
5	fumes	Closed, covered and carried through ducts

Table No. 7.1: Work Environment Care.

7.3 Disaster Management Plan:

7.3.1 Objectives

- To localise the emergency
- To minimise the consequences
- To ensure that following concepts are considered, namely rescue, first aid, evacuation, rehabilitation, spreading the information

7.3.2 Elements of On-Site Plan:

- Assess the size of event
- Plan formulation and liason
- Action like: Raise alarm, communication within and outside
- Appoint key personnel and deploy. Appoint Controller.
- Emergency Control Center
- Action on site
- Action off-site.
- Alarm and visual signals at strategic point, first alert sent to Incidence Controller.

7.3.3 Organization

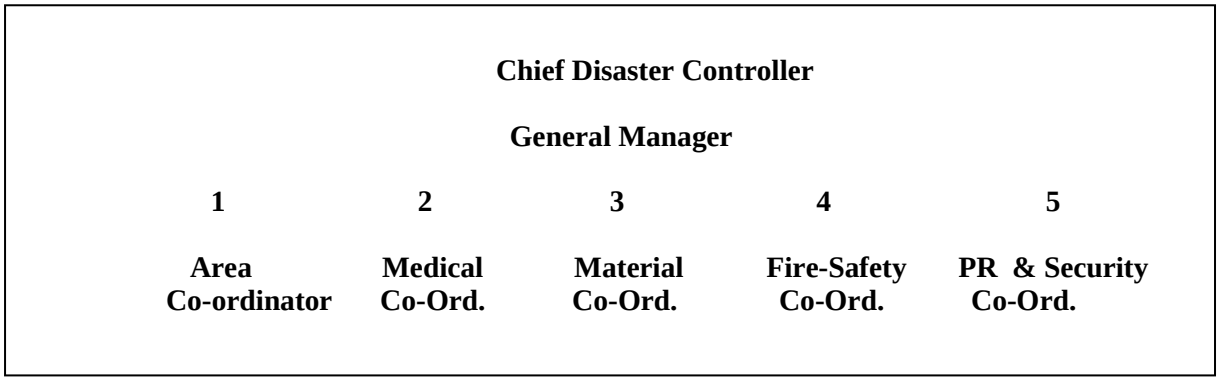

Fig.: Organization Chart

7.3.4 Duty Allocation

Chief Disaster Controller (General Manager)

- Take control and declare emergency
- Be there
- Contact Authorities

1 Area Co-Ordinator

- Take steps. Make Emergency shut-down of activities. Put everything in Safe condition.
- Evacuate.
- Commence initial fire-fighting, till Fire Department comes to take up.
- Identify materials requirements and call Material Manager.

2. Medical Co-ordinator

- Establish Emergency Center. Treat people, Transfer – Remove patients.
- Assign Deploy staff
- Arrange medical supplies
- Summon outside help

3. Material Co-ordinator:

- Despatch necessary supplies
- Arrange purchases

4. Fire-Safety Co-ordinator:

- Be Overall incharge for Fire and Safety.
- Coordinate with Area Coordinator and Direct the Operations
- Cordinate with City and Other Fire-tenderers.

5. PR & Security Co-Ordinator

- Remove Crowd
- Arrange Gate security
- Contact Police
- Arrange evacuation
- Contact outside Agencies if asked.
- Handle news media
- Mobilise vehicles
- Arrange Food, clothing to Officers inside.

6. Emergency Control Center

- Adequate Internal phones
- Adequate external phones
- Workers Tally
- Map showing hazardous storages, Fire horns, Safety equipments, Gates and side gates, Assembly points, List of persons.

7. Action on Site

- Evacuate. Non-essential people first at Assembly point
- Persons Accounting
- Record of Next-of-kins
- Public Relations

8. Post Disaster Analysis.

- Why happened
- How to avoid in future
- Whether on-site operations failed? In what respect?
- How to avoid such failure in future
- Report to be submitted in detail to Authorities
- Compensation arrangements if any, commenced?
- Call suggestions on shortfalls observed.
- Give rewards openly, pull defaulters individually

Hazard Analysis

Preliminary Hazard analysis is used to identify typical and often relatively apparent risk sources and damage events in a system. A characteristic of Alcohol is a clear, colorless and flammable liquid. It has the boiling point of 78^0 C, ignition point of 363 ^{0}C and explosive limits of 3.3 % - 19.0 % by volume. It is listed as hazardous substance by ACGIH, DOT, NFPA, MSIHC Rules and NIOSH and is regulated by OSHA.

It is important to control or eliminate all potential ignition sources in areas that might lead to ignition of vapour. 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. Following are the precautions that will be taken to minimize the probability of ignition:

- Electrical equipment and wiring should be suitable for the 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.

Characteristics of Ethanol

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. Ethanol is a clear, colorless and flammable liquid. It has the boiling point of 78^0 C, ignition point of 363 ^{0}C and explosive limits of 3.3 % - 19.0 % by volume. It is listed as hazardous substance by ACGIH, DOT, NFPA and NIOSH and is regulated by OSHA. The characteristics of ethanol are given below.

Properties of Ethanol

Physical State	Liquid
Appearance	Clear
Color	Colorless
Physical Form	Volatile Liquid
Odour	Alcohol odour
Taste	Burning taste
Molecular Weight	46.07

Molecular Formula	C – H3 – H2- O-H
Boiling Point	172^0F (78^0 C)
Freezing point	-179^0F (-117^0C)
Vapor Pressure	40 mm Hg @ 19 C
Vapor Density	1.59
Specific Gravity	0.789
Water Solubility	Soluble
Volatility	100 %
Odour Threshold	5 – 10 ppm
Viscosity	1.22 – 1.41 cp @ 20^0C
Solvent Solubility	Benzene, ether, acetone, chloroform, methanol, organic solvents

Hazard Rating of Alcohol is based on flammability, reactivity and toxicity as given in National Fire Protection Association codes 49 and 345 M as

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

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

Based on Manufacture, Storage and Import of Hazardous Chemical Rules, GOI Rules 1989, we find 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**	
Ethanol	1 (2)	2770 KL (2214 T)	1000 t	50000 t	Rule 5, 7-9 and 13-15

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

Degree of Hazard based on Fire explosion and Toxicity indices for the storages:

Section	**Fire Explosion**	**Toxicity**
Ethanol	Intermediate	Light

Thus, the following minimum preventive and protective measures are recommended.

Features	FE & I Rating	
	Light	Intermediate
Fire Proofing	2	3
Water Spray Directional	2	3
Curtain Special Instr.	1	2
Flow Control	2	4
Blow down-spill	1	3
Internal Explosion	2	3
Combustible gas Monitors	1	3
Remote Operation	1	2
Dyking	4	4
Blast and Barrier wall separation	1	3

(1= optional, 2= suggested, 3= recommended, and 4= required)

Maximum Credible Accident Analysis (MCA Analysis) is one of methodologies evolved to identify worst credible accident with maximum damage distance which is still believed to be probable.

The probable fire hazard in the plant is in the area of ethanol and is due to storage and handling. It is proposed to store about 60 day's production of both the products within a common dyke of 40x55 m. As a worst case it is assumed that the entire contents are leaked out. In the event of spilling its contents through a small leakage or due to rupture of the pipeline connecting the tank and on ignition fire will eventually forming pool of fire. In order to assess the radiation levels, Heat Radiation model has been used the algorithm of the models is based on the formulae published in the yellow book by the TNO, Netherlands.

Alcohol Storage is as Day receiver, IS Receiver, Fusel alcohol, Bulk receiver, IS Bulk Storage and DN Spirit, as totally 10 tanks with capacity of 2770 KL

With a dike area as 40 x 55 m., the results are computed for Pool Fire Scenarios and Distances and accordingly fire protection is designed.

Site Specific Consequences: In order to assess the site-specific consequences, information pertaining to the site such as nearest habitation, nearest industry etc was collected. The nearest village to the plant site is Baradgaon Sudrik village with a population of about a 3539 located at distance of 1.0 km from the plant site in the East direction. **Consequences of Heat Radiation** is also seen**.** As the project is located for away from any human habitation and surrounded by dry lands & hillocks with scrubs the offsite damage to the general public and property is negligible.

Fire Fighting Facilities In Ethanol Plant

1. **Possible Fire Hazards**

   i. Fire in fuel/bio-mass storage yard
   ii. Fire in Alcohol storage tanks Electric static electricity and consequent fire accident.

2. **Fire Fighting Facilities**
   Elaborate firefighting system will be made available in any corner of the plant. Fire detection is also envisaged.

- Fire water storage tanks
- Fire water pump house containing combination of diesel & electrically driven pumps.
- Hydrant system with piping, valves, instrumentation, hoses, nozzles etc.
- Foam injection system for fuel oil tanks of foam concentrate tanks, foam pumps, in- line inductors, valves, piping & instrumentation
- Automatic high velocity water spray system consisting of detectors. Deluge valve projectors, valves, piping & instrumentation
- Automatic medium velocity water spray system consisting of QB (Quartzoid Bulb)
- Linear heat sensing cable detectors, deluge valves, isolation valves, nozzles, piping & instrumentation
- Suitable 'Halon Substitutes' such as INERGEN or FM:200 or AGGONITE for protection of Control-equipment-computer – electronic equipment rules
- Early warning fire detection & alarm system
- Portable & mobile extinguishers of type –Pressurized water, Co2, foam, DCP (Dry Chemical Powder) at strategic locations throughout the plant.

a. Water Hydrant System

Fire hydrant system with hose pipe of 7 kg/cm^2 pressure with hydrants are located at in bio-mass yard, distillery house, ethanol storage area

- A jockey pump and accessories. 50 m^3/hr at 90 m head
- Corrosion protected M.S. underground piping 150 mm dia. and 100 mm and around the plant as closed loop
- 8 nos. single headed hydrants distributed around the plant at about 30 m spacing to supply pressurized water for fire fighting.
- 10nos. m. s. hydrant nose cabinet adjacent to each cabinet.

b. Fire Extinguishers

Type	**No.**	**At**
Foam water	2 each	Main office and store.
CO_2 type	6 each	Departmental office and electrical installations.
DCP type	8 each	Distillery plant and power plant.
Sand buckets	various	Different locations

c. Fire Protective Appliances

Two sets of fire safety appliances each consisting of following units are located at store and alcohol storage, respectively, such as Face masks & gas masks (2), Face shield (2), Helmet (6), Safety belts (2) and Safety ladder (1)

d. Fire Brigade

Fire brigade facilities available at Daund and Ahmadnagar shall be utilized whenever need arises. Contacts are already established.

On site emergency plan is in place. **Emergency Organization** is constituted.

#	**Designation**	**Person**	**Alternate person**
1	Declarer of Emergency	General Manager(Prod)	General Manager (Adm.)
2	Incidence Controller	Manager Engineering	Manager (Prod)
2.1	Evacuation and Rescue Team	Production Manager	Production
2.2	Repair Team	Boiler Supervisor	Plant Supervisor
2.3	Essential Service Team	Lab. Chemist	Electrical Supervisor
3.0	Emergency coordinator	Boiler Supervisor	Power plant Supervisor

3.1	Transportation Vehicle Team	Personal Officer	Office Clerk
3.2	Medical Services Team	Environmental Manager	Digester Supervisor
3.3	Security	Security Officer	Security Supervisor
3.4	Communication	Gen. Manager (Adm.)	Gen. Manager (Prod.)

Safety Equipments And Appliances will be kept at administrative building/stores building and are under the control of emergency Co-ordinator, namely First AID medical units, 4 units at store and 4 units at ECR, Safety belts, Ear muffs, Noise muffs, against dusts, Aprons against chemical spillage, Shock proof gloves and mats, Leather Aprons, and Leather gloves, Safety items against chemicals like gum shoes, hand gloves, helmets, goggles, Safety ladder, Breathing apparatus, Stretchers and oxygen cylinder, Emergency lighting facilities and Air life line for working in vessels and tanks.

As **Emergency Transport Vehicle,** One vehicle along with driver is always made available at the factory premise for emergency needs. Ambulance facilities available at general hospitals of Daund will be made use whenever necessary.

Assistance of District Fire Brigade and Central Labour Institution shall be utilized for conducting training programmes arranged every year.
Once the emergency is controlled the Declarer of Emergency assesses the situation along with other team heads. If he is satisfied that normalcy is regained and no further hazards involved, he shall arrange **all clear signal** by giving one minute continuous siren at high pitch. All Authorities will be informed about this episode including Police Station, Revenue Department, Factory Inspectorate, SPCB and others. The incidence will be reviewed. After emergency situation is over, the Declarer of Emergency should appoint an expert committee of two to three members to,

i. Identify the causes lead to the emergency situation.
ii. Preventive measures to avoid recurrence of such situations in future.
iii. Identifying the areas of lapses in implementation emergency plan so that the same can be improved in future.
iv. Recommendation for further strengthening of EMP

Occupational Health & Safety

During operation stage, dust, gas cutting, welding may cause hazards, micro-ambient conditions near border, platforms etc. Periodical examination of workers' occupational health is necessary.
Health evaluation should do:

#	Occupation	Type of Evaluation	Frequency Pre-placement & Thereafter		
			For Age <30 every (years)	For Age 30-40 every (Years)	For Age 41-50 every (years)
1	Cane crushing area	Chest X-ray, Spirometry & vision testing	5	4	2
2	Sugar Process area & Co-generation Area	Chest X-ray, Spirometry & vision testing	5	4	2
3	Main Control Room	Far & Near Vision, colour vision and hearing test	5	4	2
4	Ash & Bagasse handling area	Chest X-ray, Spirometry, vision & Hearing testing	5	4	2
5	Noise prone area	Audiometry	Annually		

Note: All workers engaged in material handling system will be regularly examined for lung diseases such as PFT (Pulmonary Function Test).

Heat Radiation

As a worst case, it is assumed that the entire contents are leaked out & on ignition, fire will eventually form a pool of fire. The resultant radiation has to be assessed of the pool fire.

The heat load on objects outside the burning pool of liquid can be calculated with the heat radiation model. This model uses an average radiation intensity which is dependent on the liquid. Account is also taken of the diameter to height ratio of the fire, which depends on the burning liquid. In addition, the heat load is also influences by the following factors:

Distance from the fire

The relative humidity of the air (water vapour has a relatively high heat absorbing capacity)

Visualization and Simulation of Maximum Accidental Scenarios

The worst case scenario which is considered for MCA analysis is Pool fire due to failure of storage of ethanol storage tanks in the farm area. The proposed industry will provide 15 days storage of the final product within the plant premises. The following table provides the storage details of ethanol and Rectified spirit.

Ethanol Storage Details

#	**Tank**	**Capacity ,m^3**
1	Day receiver	80 X 3
2	IS Receiver	20 x 1
3	Fusel alcohol	20 x 1
4	Bulk receiver	600 x 3
5	IS Bulk Storage	600 x 1
6	DN Spirit	90 x 1
	Total , 10 No.s	2770 KL

As a worst case it is assumed that the entire contents are leaked out. In the event of spilling its contents through a small leakage or due to rupture of the pipeline connecting the tank and on ignition fire will eventuate forming pool fire. As the tanks are provided within the dyke the fire will be confined within the dyke wall.

Fires affect surroundings primarily through radiated heat, which is emitted. If the level of heat radiation is sufficiently high, other objects, which are inflammable, can be ignited. In addition, any living organism may be burned by heat radiation. The damage caused by heat radiation can be calculated from the dose of radiation received, a measure of dose is the energy per unit area of surface exposed to radiation over the duration of exposure.

Effects of Pool Fire

Pool fire may result when bulk storage tanks will leak/burst, and the material released is ignited. As 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. However, the effects of radiation may be felt to larger area depending upon the size of the plant and quantity of material involved.

Thermal radiation due to pool fire may cause various degrees of burns of human bodies.

More ever, their effects on objects like piping, equipment are severe depending upon the intensity. The heat radiation intensities due to the pool fire of the above tank farms are computed using the pool fire model. The results obtained are presented in the following Table.

Pool Fire Scenarios and Radiation Distances

Ethanol Storage Tanks Farm	**Quantity of Storage : 2770 KL**
	Dyke area : 40 m x 50 m
Damage Criteria	**Damage Distance (m)**
100 % Leathality (35.5 kW/m^2)	5.0
50% Lethality (25.0 kW/m^2)	25.0
1 % Lethality (12.5 kW/m^2)	65.0
First Degree burns (4.5 kW/m^2)	140
Normal Intensity with no discomfort (1.6 kW/m^2)	170