CHAPTER VIII

RISK ASSESSMENT AND MANAGEMENT

8.1 INTRODUCTION

Risk associated with the use of hazardous chemicals can be assessed and managed in terms of their effect on human health, environmental health, and business operations. When discussing a particular chemical, each of these categories should be examined to ensure a comprehensive understanding of the total risk and to provide the basis for an acceptable risk management programme.

Presence of a chemical commodity in the work place or the environment in general, generates some level of risk. Assessing the nature or severity of this risk is dependent upon a number of factors, all of which focus on one common element: exposure. In assessing a risk a number of questions must consistently be asked. Are personnel being exposed? Is there an exposure to the environment? What is the risk to continue success in business operations if there is an exposure to personnel and/or the environment? Therefore, risk assessment, which is the basis for risk management, is partially contingent upon an understanding of term 'Exposure'.

However, an exposure to chemical doesn't always mean that the results will be detrimental. If such exposure occurs (i.e. those with no detrimental or adverse effect to human health, the environment or business operation) then additional question must be asked – what is the nature of the risk associated with such exposure? Are these exposures hazardous or toxic? Hence, it is not always enough to have experienced an exposure to a chemical to accurately assess the risk posed by such. One must determine (assess) if the exposure was also hazardous before the level or nature of risk can be properly identified. In other words, the specific hazardous nature of an exposure that present risk to a person and/ or the environment must be examined. It becomes clear that the risk assessor or risk manager must understand the principals of hazard, exposure, and risk.

8.2 THE RISK EQUATION

Risk is the probability that the hazard will occur (i.e. that an adverse effect or/event will result from a given set of exposure condition). Since the risk is typically expressed as a mathematical probability, the range of risk can be stated as zero (having no possibility of adverse effect or event). One (having a certainty that an adverse effect or event will result) having established

this, it is important to note that risk is the mathematical product of hazard and exposure. This relationship can, be expressed in the following simple formula.

Risk = Hazard x Exposure

Simple Mathematics tells us that, multiplying any number by zero forces a product of zero. Therefore, the above equation means that an extremely hazardous substance can be present with little risk of adverse effect if it is handled with safe and proper conditions (i.e. when the exposure component of the risk equation is driven towards zero). Similarly, risk can be reduced towards zero by driving the hazard component of the equation towards zero (e.g. changing the process design, substituting less hazardous commodity, using a lesser amount of a chemical, etc.), even if there is still a high probability of exposure. Of course, the ultimate risk management solution would be driving both the exposure and the hazard components of the equation to as low probability as possible. Such measures would virtually guarantee a low or no risk scenario; however, in the real world of everybody, operations, it is not always practical, feasible, or possible to reduce the elements of risk to zero level or probability. For this reason, risk assessment and risk management have become extremely vital element to successful business operations in recent years. More importantly, the proper assessment and management of risks, which may be pose by the use, transport, storage, or disposal of hazardous chemical can be laterally save lives, prevent illness and injury and preserve the precious environmental resources.

8.3 HAZARD IDENTIFICATION

8.3.1 Mechanical Hazard

It mainly involves properties of machine parts or work pieces, such as:

a. Shape: It may cause injury to workman
b. Relative location: Confined location during repairs & maintenance
c. Mass and stability: May cause physical Injury
d. Inadequacy of mechanical strength
e. Accumulation of energy inside the equipment: steam/ air /water pressure cause injury to workman
f. During commissioning, Operation and Maintenance of plant- crushing hazard, shearing hazard, Cutting or severing hazard, Friction or abrasion hazard and High pressure fluid injection or ejection hazard can not ruled out

8.3.1.1 Mechanical injury to body parts

g. There are several places in an industry where workers are likely to be involved with accidents resulting in injury to body parts. The places are workshop, during mechanical repair work in different units, during construction work, road accidents due to vehicular movement, etc

h. Workers exposed to mechanical accident-prone areas will be given personal protective equipment. The non-respiratory PPE includes tight rubber goggles, safety helmets, welders hand shields and welding helmets, plastic face shields, ear plugs, ear muffs, rubber aprons, rubber gloves, shoes with non-skid soles, gum boots, safety shoe with toe protection.

i. All safety and health codes prescribed by the BIS will be implemented. Fire hydrants will be located at all convenient and strategic points along the major drains and checked for water availability on regular basis. Fire extinguishing equipment, sand buckets, water sprinklers, and water hoses will be provided at all convenient point. Fire, heat, smoke, and hydrocarbon detection alarms will be installed.

8.3.2 Electrical Hazard

Probable incidences for electrical hazards can be

a. Contact of persons with live parts (direct contact),
b. Contact of persons with parts which have become live under faulty conditions (indirect contact),
c. Approach to live parts under high voltage,
d. Electrostatic phenomena,
e. Thermal radiation or other phenomena such as the projection of any particles and chemical;
f. Effect of short circuits, overloads, etc identified during construction, production and maintenance

8.3.3 Thermal Hazard

Probable causes of thermal hazards can be -

a. Burns, scalds and other injuries by a possible contact of persons with objects or materials with an extreme high or low temperature, by flames or explosions and also by radiation of heat sources
b. Damage to health by hot or cold working environment

c. Thermodynamic Hazard such as over/under pressure, over/under-temperature need to be avoided by providing system management

8.3.4 Hazard generated by noise

In the proposed project probable source of noise are – boiler, motors and pumps, etc. Usually prolong exposure to high noise level, results into -

1. hearing loss (deafness), other physiological disorder (e.g., loss of balance, loss of awareness)
2. Interference with speech communication, acoustic signals, etc.

8.3.5 Hazard generated by Vibration

In the proposed project the hazard due to vibrations can be due to -

1. Use of hand-held machines resulting in a variety of neurological and vascular disorders
2. Whole body vibration, particularly when combined with poor postures

8.3.6 Hazards generated by materials/substances

1. Hazards from contact with or inhalation of harmful fluids such as: Anti rusting chemicals, Cleaning agents/acids/organic solvents gases, Superheated steam through leaks, bagasse dust, etc.
2. Fire hazard — dry bagasse, alcohol and molasses storage area, furnace
3. Biological or microbiological (viral or bacterial) hazards:-Workplace exposure to dusts from the processing of bagasse can cause the chronic lung condition pulmonary fibrosis.

8.3.7 Preliminary Hazard Analysis (PHA)

Preliminary hazard analysis (PHA) is a semi-quantitative analysis that is performed to identify all potential hazards and accidental events that may lead to an accident, rank the identified accidental events according to their severity, and identify required hazard controls and follow-up actions. This tool analysis is based on applying prior experience or knowledge of hazard to identify future hazards, hazardous situation. This can be used for product, process and facility design. This can be used in early development of a project where there is little information in detail is available.

8.3.8 Qualitative Risk Assessment

Table 8.1: Probability of occurrence of hazard

Probability No	Causes/ Incident
1	Very unlikely Once per 1000 years or more seldom
2	Remote Once per 100 years
3	Occasional Once per 10 years
4	Probable Once per year
5	Frequent Once per month or more often

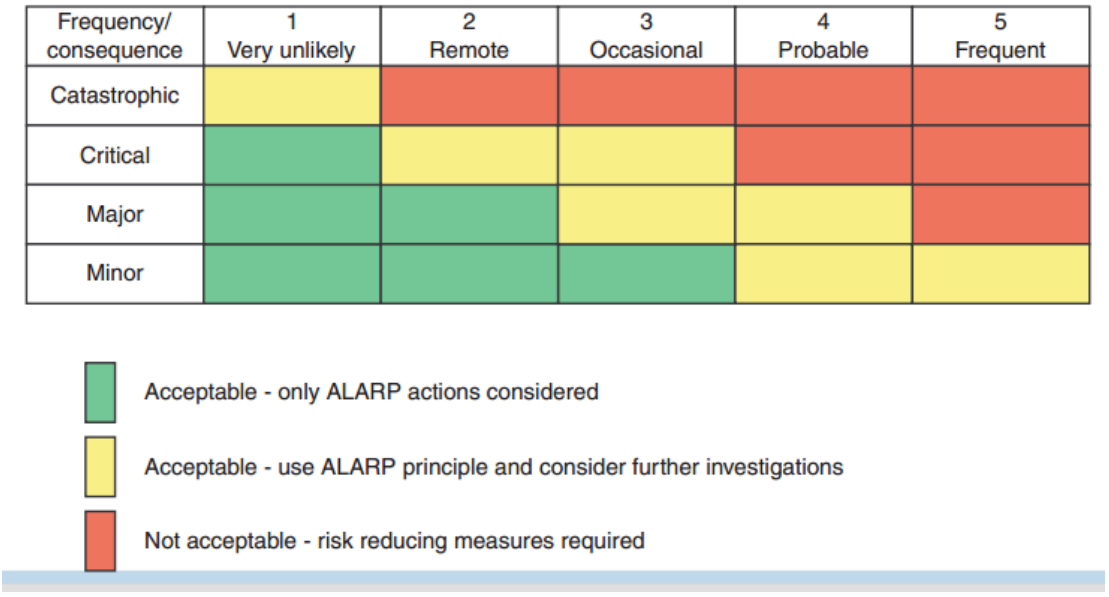

Table 8.2: Severity - Impact Intensity

1	Minor-Failure results in minor system damage but does not cause injury to personnel, allow any kind of exposure to operational or service personnel or allow any release of chemicals into the environment
2	Major-Failure results in a low level of exposure to personnel, or activates facility alarm system.
3	Critical --Failure results in minor injury to personnel, personnel exposure to harmful chemicals or radiation, fire or release of chemical to the environment
4	Catastrophic Failure results in major injury or death of personnel

Table 8.3 Risk assessment and mitigation measures

Sr. No	Hazard	Probability	Severity	Mitigation Measure
	Mechanical Hazard			
1.	Physical injury to hand/legs during process	Frequent Once per month or more often	Minor	Use PPE/PPA
2.	Boiler Explosion	Remote	Catastrophic	Layers of Protection area(LOPA)
3.	Fingers nipping in between moving part. E g Belt	Probable Once per year	Major	Fixed /Movable Guards at probable sites
4.	Steam pipe leakages	Frequent Once per month or more often	Major	Proactive Maintenance/PPE
5.	Working on height Impact /falling down	Probable Once per year	Critical	Work permit system Life belts/Helmet
6.	Water feeder pump failure	Occasional Once per 10 years	Critical	Alarming/communication arrangements
	Electrical Hazard			
7.	Contact of persons with parts which have become live under faulty conditions (indirect contact)	Occasional Once per 10 years	Major	PPE/PPA/Permits
8.	Approach to live parts under high voltage	Occasional Once per 10 years	Catastrophic	Guards/ authorization Enter Restriction
9.	Electrostatic phenomena	Remote	Major	Earthling, avoid Dust Explosion
10.	Thermal radiation or other Short circuits, overloads, etc.	Probable Once per year	Major	PPE/Checking /Inspection
	Thermal Hazard			

Sr. No	Hazard	Probability	Severity	Mitigation Measure
11.	Burns, scalds and other injuries by steam	Occasional Once per 10 years	Major	Safe working distance/PPA/protective dress code
12.	Damage to health by hot working environment	Frequent Once per month or more often	Critical	Minimum exposure Ventilation /Humidity control
	Hazard generated by Noise			
13.	Belt movement. Pump/Motor Turbo generator	Frequent	Critical	Confinement of source Use Ear Muff/Plugs
	Hazard generated by Vibration			
14.	Whole body vibration, during working on feeder platform	Remote	Major	Engineering solutions

***Severity - Minor, Major, Critical, Catastrophic**

8.4 PROBABLE RISK FACTORS

Following scenarios feel under Maximum Credible Accident Scenario

- Fire in fuel yard (bagasse yard) or storage yard (molasses and alcohol storage tanks)
- Fire due to short circuits
- Injury to body and body parts (mechanical)

8.4.1 Fire: This is the most common accident known to occur in any plant, while storing and handling fuel. The most obvious safety concern in grain-handling facilities is the threat of dust fires and explosions. Therefore, good housekeeping is the single most important factor in reducing risk of grain dust explosion. Some grains, if damp or kept in storage for a long period, will generate heat, thus can become a source of fire hazard. Rotating the grain from bin to bin or well ventilated silos and adopting a "just-in-time" grain delivery procedure will eliminate this hazard. In case of existing distillery, there are two silos. One silo is used by adopting 'just-in-time' procedure where as the other silo is maintained as ~ 30 day reserve. Both the silos are well ventilated.

Since, such incident takes short time to get widespread. Quick response is required to evacuate the plant personnel. An elaborate fire hydrant network and fire fighting system comprising of

trained crew and facilities will mitigate the risk of such incidents. In addition, as per requirement fire alarm system and smoke detectors will be installed.

Table 8.4: NFPA (NATIONAL FIRE PROTECTION ASSOCIATION) RATING

Chemical	NFPA Ratings		
	Health Hazard	Fire	Reactivity
Ethanol	0	3	0

NFPA Classifications

Health Hazard	Definition
4	Materials which on very short exposure could cause death or major residual injury even though prompt medical treatment were given
3	Materials which on short exposure could cause serious temporary or residual injury even though prompt medical treatment 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 vaporise 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

8.4.1.1 Mitigation Measures For Fire Hazards

A. Storage

- Alcohol (RS, ENA or AA) will be stored in leak-proof MS tanks, gauges of MOC will be strictly as per IS or relevant standards;
- Storage area will be well ventilated with adequate spacing between units
- Provision of alcohol vapor condensation system
- Storage area will be strictly declared as 'No Smoking Zone' and prohibiting use of any ignitable material (e.g. even cell phones, etc.)
- Electrical fittings of good quality and complying with national or international standards will be used
- It will be mandatory for transport vehicle to use flame proof silencer
- Lightening arresting system

Product and storage details

#	Particulars	Production (KL/Day)	Make
1.	Rectified Spirit	190 KLPD	MS
	Impure Sprit	10 KLPD	MS
2.	E.N.A.	188 KLPD	MS
	Technical alcohol	12 KLPD	MS
3	Anhydrous alcohol	200.0 KLPD	MS
4.	Fusel oil	400 L per day	MS

B. Provisions of Fire fighting System will be as follows

a. Guidelines of OISD-STD-117 will be implemented

b. The fixed water spray system will be provided on all tanks, fire water flow rate will be calculated at a rate of 20.4 lpm/mPP^{2}PP as per OISD-STD-117

c. Fire water system will be designed for a minimum residual pressure of 7 kg/cm2(g) at hydraulically remotest point in the installation considering single largest risk scenario

d. Water for the fire fighting will be stored in easily accessible surface or underground tanks of RCC/steel with minimum four hours aggregate rated capacity of pumps. There will be one or two standby diesel engine driven pumps of the same type, capacity & head as the main pumps will be provided; Jackey pump (one in number - AC motor driven) for maintaining pressure

e. Hydrant system covering the entire plant including all important auxiliaries and buildings is proposed. The system will be complete with piping, valves instrumentation, hoses, nozzles and hydrants, valves etc.

f. High velocity water spray system near storage tanks

g. Portable extinguisher such as pressurized water type, carbon dioxide type and foam type will be located at strategic locations throughout the plant

h. The diesel engines will be quick starting type with the help of push buttons located on or near the pumps or located at a remote location.

i. Portable foam and/or water-cum-foam monitors will be provided for suppression of pool fire in tank farm area.

j. Fire water pumps & storage will be located at 30 m (minimum) away from equipment or where hydrocarbons are handled or stored

k. Fire water pumps will be exclusively used for firefighting purpose only

l. Fire water mains, hydrant & monitor stand posts, risers of water spray system will be painted with "Fire Red" paint as per IS: 5.

m. Hose boxes, water monitors and hydrant outlets will be painted with "Luminous Yellow" paint as per IS: 5

n. Electric audible fire siren will be to the farthest distance in the installation and also in the surrounding area up to 1 km from the periphery of the installation which wills different sound with respect to shift alarm with continuous power supply

o. Communication system like Telephone, Public Address System, etc. should be provided in non-hazardous areas of the installation

8.4.2 Gases

During the fermentation process, different gases may cause toxic and explosive risks. Therefore, adequate ventilation and strict maintenance are essential. Particularly significant are the risks of asphyxiation from the vapours of alcohol and carbon dioxide released by the fermentation process, especially when the liquids are transported and decanted into reservoirs, and in confined spaces where ventilation is inadequate.

8.4.3 Chemicals

Materials such as caustics, acids and many other solvents and cleaners are used for different purposes. Employees must be trained to handle these products safely. Workers must be educated on the use of material data safety sheets (MSDSs), which are information sheets available from suppliers, giving information on the contents of the hazardous product and the related health hazards, emergency action, first aid and so on. It is imperative that every worker who is exposed or likely to be exposed to a hazardous material be trained of handling of hazardous material. In addition to the training, first aid stations should be made available in the plant in order to control/minimize injuries to anyone who is accidentally exposed to a hazardous chemical.

8.4.4 Machinery

Conveyors are used commonly for transport and loading/unloading of materials; traps in the gearing between belts and drums can be avoided by efficient machinery guarding.

There should be an effective lockout/tagout programme for maintenance and repair. Where there are walkways across or above conveyors, frequent stop buttons should also be provided. In addition to this, adequate guards on the machinery and face guards, rubber gloves, rubberized aprons and non-slip boots for the workers can prevent injury.

8.4.5 Electricity

Owing to the prevailing damp conditions, electrical installations and equipment need special protection, and this applies particularly to portable apparatus. Ground fault circuit interrupters should be installed where necessary. Wherever possible, low voltages should be used, especially for portable inspection lamps. Steam is used extensively, that may causes burns and scalds; lagging and protection of pipes should be provided, and safety locks on steam valves will prevent accidental release of scalding steam.

8.4.6 Carbon dioxide

Carbon dioxide (CO_2) is formed during fermentation and is present in fermenting tuns, as well as vats and vessels that have contained beer. Concentrations of 10%, even if breathed only for a short time, produce unconsciousness, asphyxia and eventual death. Carbon dioxide is heavier than air, and efficient ventilation with extraction at a low height is essential in all fermentation chambers where open vats are used. In the existing unit the gas is collected, separated and filled in tanks under pressure i.e. using the gas as a by-product. The same practices will be followed in the expansion project and thus, such risk has been minimized.

8.4.7 Boiler Operations

1. Provision of adequate sets of personnel protective equipment
2. Pilot lights will be provided on electrical panel boards
3. Provision of hand operable fire fighting cylinders at strategic locations

8.5 Fire Fighting Strategy

1. In case of small fire, it can be extinguished with the help of DCP followed by water to prevent re-ignition.
2. If it is a major fire, cordon the area and restrict entry of any unauthorized personnel
3. Keep a safe distance if there is any possibility of explosion
4. In the event of any threat to the neighbouring residents, besides alerting those on the incident ensure that necessary precautions have been taken by them with the help of Civil Administration Authorities
5. Mutual aid to be activated and district authorities shall be contacted for activating off site emergency preparedness

6. Proper safety equipment should be used & back up of fire fighting/rescuing team to be provided.
7. Keep constant vigil on that particular spot and as well as on the neighbouring area.
8. Avoid directing heavy streams of water on the roof to avoid water stagnation.
9. Follow the instruction of Man-In-Charge during the entire fire fighting exercise.
10. Cooling water streams should be applied to the top of tank (excluding floating roof tank) so that the run-off down the sides of the tank will reduce the heat input to the tank.
11. Water must be applied on tank appurtenances, un-insulated supports and any porting of the tank shell above the liquid level where there is direct flame contact.
12. If the flames from vents are discharging onto the top of the shell of the tank, water must be directed on that area to keep it cool.
13. Cooling of tanks usually in needless unless there is direct flame contact or sufficient radiant heat to scorch the paint.
14. As a rule, ground fires around the tanks must be controlled or extinguished before attempting to extinguish the fire in the tank.

Table 8.5: Hazard Warning Information for Ethyl Alcohol

0B0B**SECTION I**						
PRODUCT NAME				Ethyl Alcohol,		
SYNONYMS				Anhydrous Ethyl Alcohol, Dehydrated Alcohol		
CHEMICAL FAMILY				Alcohol		
MOLECULAR WEIGHT				46.07		
FORMULA				CRR_2RRHRR_5RROH		
Health	**Fire**	**Reactive**	**Other**	**Degree of Hazard**	**Colour Coding**	**Other Codes**
0	3	0	-	0 = Minimum 1 = Slight 2 = Moderate 3 = Serious 4 = severe	Health = Blue Fire = Red Reactivity = Yellow Other = White	Ox = Oxidiser Acid = Acid Alk = Alkaline COR = Corrosive W = No use water

SECTION II – INGREDIENTS				
COMPOSITION	**CAS RN.**	**NOMINAL WT/WT%**	**PEL/TLV**	**HAZARD**
Ethyl Alcohol	64-17-5	100.0	**1000 ppm**	Flammable/Nervous System Depressant

PEL = Personal Exposure Limit

TLV = Threshold Limit Value

SECTION III – HEALTH INFORMATION

INHALATION	Exposure to over 1000 ppm may cause headache, drowsiness, and lassitude, loss of appetite, and inability to concentrate. Irritation of the throat.
INGESTION	Can cause depression of central nervous system, nausea, vomiting, and diarrhea.
EYE CONTACT	Liquid or vapor may cause irritation.
SKIN CONTACT	May cause irritation and de-fatting of skin on prolonged contact
SECTION IV – OCCUPATIONAL EXPOSURE LIMITS	
PEL (OSHA Permissible Exposure Limit): Mixture	See Section II
TLV (ACGIH Threshold Limit Value): Mixture	See Section II
SECTION V – EMERGENCY FIRST AID PROCEDURE	
FOR OVEREXPOSURE BY SWALLOWING	If victim is conscious and able to swallow, have victim drink water or milk to dilute. Never give anything by mouth if victim is unconscious or having convulsions. **CALL A PHYSICIAN OR CHEM-TREC (POISON CONTROL) IMMEDIATELY**. Induce vomiting only if advised by physician (Poison Control)
INHALATION	Immediately remove victim to fresh air. If victim has stopped breathing, give artificial respiration, preferably mouth-to-mouth. **GET MEDICAL ATTENTION IMMEDIATELY**
CONTACT WITH EYES OR SKIN	Immediately flush affected area with plenty of cool water. Eyes should be flushed for at least 15 minutes. Remove and wash contaminated clothing before reuse. **GET MEDICAL ATTENTION IMMEDIATELY**
SECTION VI – PHYSICAL DATA	
BOILING POINT	173° F (78 PP^0PPC)
MELTING POINT	-173° F (-114 PP^0PPC)
VAPOR PRESSURE	44.6 mm Hg @ 68° F (20 PP^0PPC)
SPECIFIC GRAVITY	0.7940 @ 60°/60° F

VAPOR DENSITY (AIR = 1)	1.59
SOLUBILITY IN WATER	Complete in water, chloroform, acetone, ether, benzene and methanol
APPEARANCE AND COLOR	Clear and colorless, volatile liquid with a weak, vinous, alcohol odour and bitter taste. Odour threshold = 84 ppm
SECTION VII – FIRE AND EXPLOSIVE HAZARDS	
FLASH POINT	**56° F ASTM D-56 (Tag Closed Cup)**
AUTO-IGNITION TEMPERATURE	685° F
FLAMMABLE LIMITS IN AIR, % BY VOLUME	LOWER: 3.3 UPPER: 19
NFPA (National Fire Protection Association) RATING	HEALTH (0) FIRE (3) REACTIVITY (0)
FIRE FIGHTING PROCEDURES	**(Note: Individuals should perform only those fire-fighting procedures for which they have been trained.)** Use dry chemical, "alcohol" foam, or carbon dioxide; water may be ineffective, but water should be used to keep fire-exposed containers cool. If a leak or spill has not ignited, use water spray to disperse the vapors and to protect men attempting to stop a leak. Water spray may be used to flush spills away from exposures and to dilute spills to nonflammable mixtures.
	Firefighters should wear self-contained breathing apparatuses in the positive pressure mode with a full-face piece when there is a possibility of exposure to smoke, fumes, or hazardous decomposition products.
SECTION VIII – REACTIVITY	
STABILITY	Generally stable.
HAZARDOUS POLYMERIZATION	Not likely.
CONDITIONS & MATERIALS TO AVOID	Contact with acetyl chloride and a wide range of oxidizing agents may react violently.
SECTION IX – EMPLOYEE PROTECTION	
CONTROL MEASURES	Handle in the presence of adequate ventilation.

RESPIRATORY PROTECTION	Where exposure is likely to exceed acceptable criteria, use NIOSH/MSHA approved respiratory protection equipment. Respirators should be selected based on the form and concentration of contaminant in air and in accordance with OSHA (29 CFR 1910.134).
PROTECTIVE CLOTHING	Wear gloves and protective clothing, which are impervious to the product for the duration of the anticipated exposure if there is potential for prolonged or repeated skin contact.
EYE PROTECTION	Wear safety glasses meeting the specifications of ANSI Standard Z87.1 where no contact with the eye is anticipated. Chemical safety goggles meeting the specifications of ANSI Standard Z87.1 should be worn whenever there is the possibility of splashing or other contact with the eyes.
SECTION X – ENVIRONMENTAL PROTECTION	
ENVIRONMENTAL PRECAUTIONS	Avoid uncontrolled releases of this material. Where spills are possible, a comprehensive spill response plan should be developed and implemented.
SPILL OR LEAK PROCEDURES	Wear appropriate respiratory protection and protective clothing as described in Section IX. Contain spilled material. Transfer to secure containers. Where necessary, collect using absorbent media. In the event of an uncontrolled release of this material, the user should determine if the release is reportable under applicable laws and regulations.
WASTE DISPOSAL	All recovered material should be packaged, labeled, transported, and disposed off, or reclaimed in conformance with applicable laws and regulations and in conformance with good engineering practices.
SECTION XI HANDLING AND STORAGE	

Precautions Keep locked up. Keep away from heat. Keep away from sources of ignition. Ground all equipment containing material. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, acids, alkalis, and moisture.
Storage Store in a segregated and approved area. Keep container in a cool, well-ventilated area. Keep container tightly closed and sealed until ready for use. Avoid all possible sources of ignition (spark or flame). Do not store above 23°C (73.4°F).

8.6 RISK ASSESSMENT: HEALTH

8.6.1 General Assessment

The toxicity of ethyl alcohol is much lower in comparison to methanol or propanol. Ethyl alcohol is primarily toxic to humans by *ingestion.* While inhalation of its vapors can produce some toxic effects, its ability to enhance the effects of other chemicals poses a greater health risk for inhalation. Skin contact can cause topical damage and absorption is, therefore, not likely. It should be noted that most manufacturers of ethyl alcohol for use in industrial applications would normally mix it with a denaturant (a substance added to make it un desirable to drink). These include gasoline, acetone, formaldehyde, or methyl alcohol. Therefore, industrial exposures resulting from ingestion are very unlikely.

Inhalation can cause irritation of the eyes, nose, throat, upper respiratory tract, and associated mucosa. There may be headache, nervousness, tremors, dizziness, tearing, fatigue, nausea, somnolence, and narcosis with stupor and loss of consciousness. There are no reports of cirrhosis occurring as a result of inhalation exposures. However, chronic exposure to ethyl alcohol vapors caused brain damage in mice. Vapor exposure can also increase the toxic effects of other chemicals being inhaled. Also, the toxicity of ethyl alcohol is enhanced with the presence of compounds such as barbiturates, carbon monoxide, and methyl mercury.

Liquid contact with the eyes causes immediate burning and stinging with lachrymator and reflex closure of the lids. There may be injury to the corn epithelium and possible hyperemia

(excessive blood) the conjunctiva. Skin contact results in drying cracking, which can lead to secondary infections dermatitis.

Ingestion of ethyl alcohol is not likely to occur in the industrial environment. However, if it does, symptoms can include sleep disorders, hallucinations, distorted perceptions, ataxia, motor function changes, convulsions and tremors, coma, headaches, pulmonary changes, alteration of gastric secretions, menstrual cycle changes, glandular changes, nausea or vomiting, and decrease in body temperature.

8.6.2 Acute Health Effects

The following acute (short-term) health effects occur immediately or shortly after exposure to alcohol.

Skin	Causes dryness and cracking leading to dermatitis and possible infection.
Eye	Severe irritation with burning and possible damage to the cornea and conjunctiva.
Lung	Irritation of the eyes, nose, throat, and respiratory tract.
Central Nervous System (CNS)	High concentrations can cause depression the CNS with symptoms of sleepiness and I of concentration.

8.6.3 Chronic Health Effects

The following chronic (long-term) health effects occur at some time after exposure to ethyl alcohol can last for months or even years:

Cancer Hazards:	Ethyl alcohol is known to cause liver cancer in humans, primarily due to ingestion. Industrial exposures through ingestion are not likely but are certainly possible.
Reproduction:	According to the references, ethyl alcohol can affect human reproduction by ingestion. It causes changes in the female fertility index. Effects on newborns include changes in the apgar score, neonatal measures or effects, and drug dependence.
Other Chronic Effects:	Very high or prolonged expo- sure may result in mucous membrane irritation, head- ache, and depression of the CNS with symptoms of somnolence and lack of concentration. Prolonged skin contact can cause dermatitis.

8.6.4 Recommended Risk-Reduction Measures

Even though ethyl alcohol is a known carcinogen, this effect is primarily the result of ingesting large amounts of alcoholic beverages. Industrial exposures by this route are not likely to occur. The best risk reduction measure is to use a less toxic chemical as a substitute for an ethyl alcohol. However, based upon the fact that ethyl alcohol is one of the most widely used industrial solvents, substitution is usually not an alternative. Therefore, *engineering controls* are the most effective methods of reducing exposures. The best protection is to enclose operations' and/or provide local exhaust ventilation at the site of chemical release. While not always operationally feasible, isolating operations can also reduce exposure risk.

Using respiratory protection is less effective than the controls mentioned above, but is still advisable whenever working with or around ethyl alcohol. For concentrations over the Permissible Exposure Limit **(PEL** i.e. 1000 ppm), an air-purifying respirator with an organic vapor cartridge will suffice. For higher exposures, a supplied-air respirator with full face piece operated in positive pressure mode, or a self-contained breathing apparatus **(SCBA)** with full face piece and operated in pressure demand mode are the recommended respiratory protection methods of choice. If a full face piece is not available, then chemical goggles should be worn to protect the eyes. Whenever a chemical splash hazard exists, a face shield and a protective apron should be worn. To pre- vent hand and skin exposures, impervious gloves should be used.

Administrative controls should also be in place to minimize the potential for human exposures. These may include written procedures or policies, which specify the methods and techniques that will be practiced whenever personnel are to work with ethyl alcohol.

All personnel should receive training on- the use, hazards, protective measures, emergency actions, and other precautions per 29 CFR 1910.1200 (Hazard Communication), prior to the first assignment in an area where ethyl alcohol is used or stored. If symptoms develop or overexposure is suspected, the following medical tests are recommended

a. Liver function tests;
b. Skin testing with dilutes ethyl alcohol to help diagnose allergy (performed by a qualified allergist).

Any medical evaluation should include a careful history of past and present symptoms with an examination. Medical tests that look for existing damage are not a substitute for controlling exposures. Also, since consuming large quantities of alcoholic beverages can lead to liver dysfunction and even cancer, persons with alcohol addiction who arc exposed to ethyl alcohol

on the job may develop symptoms much quicker and with greater intensity than those who do not drink under identical exposure conditions. Prudent risk management requires careful consideration of *all* possible factors that may be causing the appearance of exposure symptoms.

8.6.5 Other Methods to Reduce Exposure

1. Where possible, enclose operations and use local exhaust ventilation at the site of chemical release. If local exhaust ventilation or enclosure is not used, respiratory protection should be mandatory.
2. Always ensure that proper protective clothing is worn when using chemical substances.
3. Wash thoroughly immediately after exposure to ethyl alcohol and at the end of the work shift or before eating, drinking, or smoking.
4. Hazard warning information should be posted in the work area. In addition, as part of an on-going education and training program, all information on the health and safety hazards of ethyl alcohol should be communicated to all potentially exposed workers.

8.7 RISK ASSESSMENT: ENVIRONMENT

8.7.1 General Assessment

The environment is at risk of exposure during transportation, storage, disposal, or destruction of ethyl alcohol. In almost every scenario, the threat of environmental exposure is contingent upon the proper handling of the chemical substance. Accidental spills, large or small, can result in fire, explosion, and possible contamination of the surrounding environmental mediums (water, soil, and air).

Ethyl alcohol is considered a class IB flammable liquid (according to OSHA 29 CFR 1910.106)**.** Its low flash point and relatively low boiling point present a serious fire and explosion hazard concern. Also, because it is incompatible with a number of common materials, especially strong oxidizers and many metal nitrates, contact can result in violent and explosive reactions. It can form explosive mixtures in air and can ignite on contact with heat, fire, or sparks. It will react and then explode in contact with acetic anhydride + sodium hydrogen sulfate. It also reacts violently with acetyl bromide (evolves hydrogen bromide). These characteristics require special consideration during any emergency situation involving a leak or spill of ethyl alcohol.

Ethyl alcohol can enter the environment through unchecked industrial discharges into effluents and through spills.

8.7.2 Acute Ecological Effects

Acute (short-term) toxic effects may include the death of animals, birds, or fish, and death or low growth rate in plants. Acute effects are seen 2 to 4 days after animals or plants are exposed to ethyl alcohol. This chemical has moderate acute toxicity to aquatic life. Insufficient data are available to evaluate or predict the short-term effects of ethyl alcohol to plants, birds, or terrestrial animals.

8.7.3 Chronic Ecological Effects

Chronic toxic effects may include shortened life span, reproductive problems, lower fertility, and changes in appearance or behavior in exposed animals. These effects can be seen long after first exposure(s) to toxic chemicals. Ethyl alcohol has moderate chronic toxicity to aquatic life. Insufficient data are available to evaluate or predict the long-term effects of ethyl alcohol to plants, birds, or land animals.

Water Solubility: Ethyl alcohol is highly soluble in water. Concentrations of 1000 milligrams and more can be expected to mix with a liter of water.

8.7.4 Persistence in the Environment

Ethyl alcohol is slightly persistent in water, with a half- life of between 2 to 20 days. The half-Life of a pollutant is the amount of time it takes for one-half of the chemical to be degraded. About 90% of ethyl alcohol will eventually end up in the air; the remainder will end up in water.

8.7.5 Bioaccumulation in Aquatic Organisms

Some substances increase in concentration, or *bioaccumulate,* in living organisms as they breathe contaminated air, drink contaminated water, or eat contaminated food. These chemicals can become concentrated in the tissues and internal organs of animals as well as humans. The concentration of ethyl alcohol found in fish tissues is expected to be about the same as the average concentration of ethyl alcohol in water from which the fish was taken.

8.7.6 Recommended Risk-Reduction Measures

Proper training of all transporters will reduce the likelihood of a mishap or accident resulting in a leak or spill to the environment. The correct labeling while transportation on all transporting vehicles should be enable emergency responders to react properly and quickly to any disaster thereby reducing the potential risk to the environment and to personnel.

Storage of ethyl alcohol should be segregated from incompatible chemicals to minimize the risk of cross contamination or contact. Buildings designated for storage should be equipped with

appropriate fire protection systems (alarms, sprinklers, emergency lighting, portable extinguishers). Equipment should be designed to meet explosion-proof standards.

If a spill or leak to the environment has occurred, fire department, emergency response, and/or hazardous materials spill personnel should be notified immediately. Cleanup should be attempted only by those trained in proper spill containment procedures. Contaminated soils should be removed for incineration and replaced with clean soil. If ethyl alcohol should contact the water table, aquifer, or navigable waterway, time is: of the essence. It is highly soluble in water and, therefore, total containment and remediation may not be entirely possible. When such spills occur, the local and/or state emergency response authorities must be notified. A comprehensive emergency response of disaster preparedness/recovery plan should be in place prior to any operations involving the use, transportation, storage, or disposal of ethyl alcohol. If ethyl alcohol is spilled or leaked, the following specific steps are recommended:

a. Restrict persons not wearing protective clothing from area of spill or leak until cleanup is complete and area can be opened for normal work.
b. Ventilate area and remove ignition sources.
c. Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers. Use non-sparking tools.
d. It may be necessary to dispose of ethyl alcohol as a hazardous waste. The state PCB should be contacted for specific recommendations.

8.8 RISK ASSESSMENT: BUSINESS

8.8.1 General Assessment

Accidents or mishaps involving ethyl alcohol can present a moderate threat to business operations. The loss or damage of equipment or facilities can significantly affect fiscal viability. Lawsuits that may result from personnel injury/death, public exposures, and/or environmental contamination will also require a serious expenditure of resources. Media attention surrounding an injury, death, or environmental damage can also result in a loss of profits and loss of current as well as future business.

Recommended Risk-Reduction Measures

Company attorneys, safety and health professionals, and environmental specialists should be involved in the development of any procedures or policies intended to manage the use of chemicals in the workplace. A company official should be pre-designated as a public relations officer with specific training in dealing with the press. Corporate plans and policies should be developed, approved, and implemented long before any need for such arises.

Safety Provisions Proposed: Others

1. Frequent checking of pipelines and storage units will be done.
2. Prohibiting welding or similar maintenance activities near combustible material storage
3. Pumps of reliable quality will be installed.
4. Lightening protecting system as per Indian electricity rules
5. keep safe distance between fuel storage area and main unit
6. Corrosion protection methods for pipelines
7. All locations where the above ground pipelines are close to traffic movement, protection like crash guards will be provided
8. 'Flame arresters' will be provided in gas lines to protect the digester from back fire from the flame and / or the boiler burner.
9. Over / under pressure release device will be provided on biogas digester for its safety from over pressure / vacuum.
10. Transfer of alcohol only mechanically

Table 8.6: Summary of risk assessment and damage control

High risk equals 16 to 25	High Risks activities should cease immediately until further control measures to mitigate the risk are introduced
Medium risk equals 9 to 15	Medium Risks should only be tolerated for the short-term and then only whilst further control measures to mitigate the risk are being planned and introduced, within a defined time period. Note: Medium risks can be an organizations greatest risk, its achilles heel, this due to the fact that they can be tolerated in the short-term.
Low risk equals 1 to 8	Low Risks are largely acceptable, subject to reviews periodically, or after significant change etc.

General Risk Assessment

1. **Responsibility**

Site Controller: Head- Production
Incident Controller: Shift- In charge
Emergency Coordinators: Departmental Heads

Hazards and details	**Persons at risk**	**Control measures**	**Action recommended in case of emergency**	**Risk**		
				Likelihood	**Severity**	**Risk rating**
				L	**S**	**RR=LxS**
Furnace/boiler- or storage area Fire hazard caused by	Persons working near the furnace or storage area- Burns	• Emergency alarm to be put on to signal the emergency • Emergency kit will be kept ready near the plant • Fire fighting equipments	• Switch off the system. • Fire extinguishers are to be used immediately • Water hose to be operated to set out the fire depending on	2	5	10

fuels/ ignitable substances	may be possible if directly come in contact	power/ foam type extinguishers on vehicles and mounted on walls will be kept readily available • Provision of water hose • Strictly 'No smoking zone' and prohibition of ignitable activities • Plant workers will be trained to fight fire	the situation • Outside fire brigade is to be called if the fire cannot be extinguished immediately • Inform the occupier/ manager and activate the onsite emergency plan • Immediate first aid to victims and sent to hospital for treatment			

2. Responsibility

Site Controller: Head- Electrical
Incident Controller: Shift- In charge
Emergency Coordinators: Departmental Heads

Hazards and details	**Persons at risk**	**Control measures**	**Action taken in case of emergency**	**Risk**		
				Likelihood	**Severity**	**Risk rating**
				L	**S**	**RR=LxS**
Electrical Transformer- Electrical shock and fire	Person near the transformer	Shock proof insulated PCC platform	• Cut off power supply. • Treat the injured for electrical shock • If fire is caused, immediately fight fire with available resources, summoning outside help if necessary	2	3	6

3. Responsibility

Site Controller: Head- Laboratory
Incident Controller: Shift- In charge
Emergency Coordinators: Departmental Heads

Hazards and details	Persons at risk	Control measures	Action recommended in case of emergency	Risk		
				Likelihood	Severity	Risk rating
				L	S	RR=LxS
Lab chemicals- in case of bottle breakage, causes burns and damage to respiratory systems due to inhalation.	Persons working in the lab	• Proper care should be taken while handling the chemicals. • First aid box should be available at site with all required medicines and devices • Fire fighting equipments like fire extinguishers, sand buckets should be always available • Instruction boards to be displayed for knowledge of other workers to care of the situation in the event of occurrence	• Immediately treat the persons as guided in the MSDS • Hospitalize the affected person if necessary	3	2	6

4. Responsibility

Site Controller: Manager- Services
Incident Controller: Shift- In charge
Emergency Coordinators: Departmental Heads

Hazards and details	Persons at risk	Control measures	Action taken in case of emergency	Risk		
				Likelihood	Severity	Risk rating
				L	S	RR=LxS
Cooling Tower- Burns from returning hot water	Persons operating cooling tower	• Issue work permits to work near the tank and hot water line. Railing is to be provided all around the tank • Always precautionary measures should be taken and adopted	• Victims are first aided by trained persons and then referred to doctor/ hospital for further treatment	2	3	6

5. Responsibility

Site Controller: Manager
Incident Controller: Shift- In charge
Emergency Coordinators: Departmental Heads

Hazards and details	Persons at risk	Control measures	Action taken in case of emergency	Risk		
				Likelihood	Severity	Risk rating
				L	S	RR=LxS
Water tank- Drowning of personnel	Persons near the water tank	Water tank are fenced/ covered The tank will not be permitted for domestic utility	Drowned person should immediately be given first aid	1	3	3

6. Responsibility

Site Controller: Head- Production
Incident Controller: Shift- In charge
Emergency Coordinators: Departmental Heads

Hazards and details	Persons at risk	Control measures	Action taken in case of emergency	Risk		
				Likelihood	Severity	Risk rating
				L	S	RR= LxS
Control rooms-electrical shocks	Persons working in the control room	Earth leakage circuit breaker installed.	Main supply will be immediately shut off	1	4	4