INDIAN OIL CORPORATION LIMITED

Risk Assessment Report for Ligno- Cellulosic based 100 KLPD capacity Ethanol Plant Gram Panchayat Baholi, Panipat Refinery Road, Panipat District, Haryana.

Category:-A, as per EIA notification dated 14/09/2006
[Schedule no. : 5(g) Distillery]

Prepared By:

Prepared By:

PRAJ INDUSTRIES LIMITED, PUNE

Corporate Office :

'Praj Tower', 274 & 275, Bhumkar Chowk-Hinjewadi Road, Hinjewadi, Pune-411057

Consultant appointed by Praj -

ABC TECHNO LABS INDIA PVT.LTD.

Corporate Office:

ABC Tower 400, 13th Street,SIDCO Industrial Estate (North Phase), Ambattur – 600 098, Chennai
Land Mark: Near National Productivity Council.
Ph: 9566187777

Mumbai Office:

A-355, Balaji Bhavan, Plot No. 42 A, Sector 11, CBD Belapur, Navi Mumbai – 400614. Maharashtra, India,
Tel: 022 27580044

www.praj.net abc@abctechnolab.com

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1. Introduction of Project :

1.1 Background of Project:

Panipat Refinery, a unit of Indian Oil Corporation Limited (IOCL) operates a 15.0 Million Metric Tons Per Annum (MMTPA) oil refinery at Panipat in Haryana. The refinery was commissioned in 1997-98 and started off with a crude oil processing capacity of 6.0 MMTPA (PR- Panipat Refinery). The refinery capacity was raised to 12.0 MMTPA with the addition of another crude unit and a full conversion hydrocracker as the secondary processing unit and Delayed Coker unit for bottom processing (PREP- Panipat Refinery Expansion Project). Through progressive revamps and addition of process units the refining capacity has been brought to the present operating capacity of 15.0 MMTPA (PRAEP- Panipat Refinery Additional Expansion Project).

IOCL has recently received EC for BS VI quality up gradation project and PX-PTA expansion in March'18.

The EC for expansion of its production capacities for Naphtha Cracker Unit (NCU), Mono Ethylene Glycol (MEG), High Density Polyethylene (HDPE) and Polypropylene (PP) Unit has been granted as per MOM dated 4th July'18.

IOCL (Panipat) proposes to install a biomass based ethanol second generation 100 KLPD capacity in its existing premises. This will attract Environmental Clearance under EIA notification 2006. In this regard, M/s ABC Techno Labs India Private Limited (ABC Techno Labs), NABET Accredited Environmental Consultant Organization, has been engaged by Praj Industries Ltd, Pune to carry out Environmental Impact Assessment studies for the proposed project at IOCL Panipat.

1.2 Purpose of the Project:

IOCL Panipat proposes to install new 100 KLPD cellulosic non-food biomass (Agri waste) based second generation advanced technology.

1.3 Market Scenario

1.3.1 Global Ethanol Scenario:

In 2015, countries made commitments toward a more environmentally balanced future through the Sustainable Development Goals (SDGs), and now seek to expand policies for low-carbon development after the agreement reached in Paris at COP-2. The year also marked a milestone in the bio-economy, as the point in time when the production of Second-Generation Biofuels (2G) finally took off at commercial scale. Historically, the United States of America (US) has had the largest installed capacity for cellulosic ethanol production of deployed second-generation biofuel facilities, followed by China, Canada, European Union (EU) and Brazil, respectively. Projects in these countries vary significantly in their technological approaches and feed stocks used for fuel Ethanol production, including the use of corn stover, sugarcane bagasse, Rice straw, wheat straw, cotton stalk municipal solid waste, and forestry residues, etc. 50% growth in the second-generation biofuels market has been forecast between 2014 - 2020 and its value in 2020 has been estimated to amount to US$ 23.9 billion (Allied Market Research,

2014). Navigant Research (2014) forecasts that global biofuel consumption in the road transportation sector will grow from more than 122.6 billion litres per year in 2013 to more than 193.41 billion litres

per year in 2022, which will increase demand for advanced biofuels. In the last ten years, an increase in ethanol production capacity in the US and Brazil, and biodiesel in Europe, has resulted in biofuels gaining an important position in the global market for liquid.

Despite the extensive use of biomass as a source of energy production, some developing countries still depend on oil imports to satisfy their energy demand, which makes them vulnerable to high and volatile oil prices. Some countries, such as China, Brazil, Thailand and India, developed a strong first-generation biofuel sector that led to a significant production capacity and infrastructure.

1.3.2 Indian Ethanol Scenario:

The Government of India (GOI) approved the National Policy on Biofuels on December 24, 2009. The policy encourages use of renewable energy resources as alternate fuel to supplement transport fuels and had proposed an indicative target to replace 20% of petroleum fuel consumption with biofuels by end of 12th Five - Year Plan (2017). To ensure implementation of ethanol blending program 'Cabinet Committee on Economic Affairs (CCEA)' recommended 5% mandatory blending of ethanol in gasoline in Nov-2012.

At present, the estimated production of ethanol in the country is in the range of 2,500- 3,000 TKL (Thousand Kilo Litres) which is primarily used for potable alcohol, chemical industries and ethanol blending. India's ethanol production is mainly based on sugarcane molasses, which is limited. Any improvement in ethanol production is directly proportional to increase in sugarcane production. However, considering available infrastructure & irrigation resources, it is very difficult to increase sugar cane production.

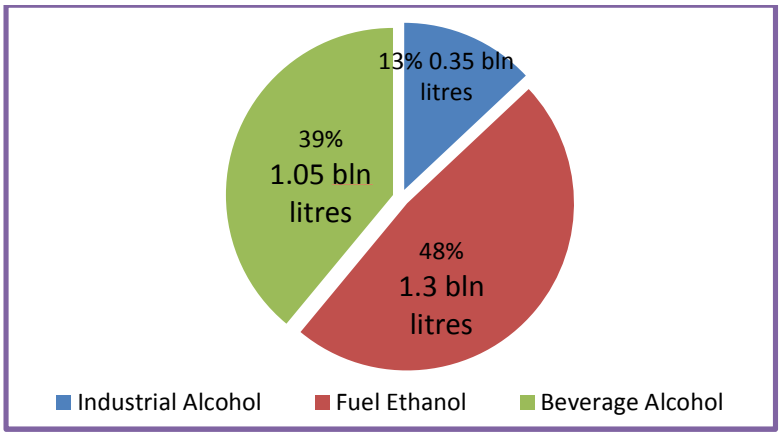

Figure 1.1: Pie Chart showing ethanol blending % in India

The Government of India (GOI) approved the National Policy on Biofuels on December 24, 2009. The policy encourages use of renewable energy resources as alternate fuel to supplement transport fuels and had proposed an indicative target to replace 20% of petroleum fuel consumption with biofuels by

end of Year 2022. To ensure implementation of ethanol blending program 'Cabinet Committee on Economic Affairs (CCEA)' recommended 5% mandatory blending of ethanol in gasoline in Nov-2012.

This project would be a pioneering effort and first plant of its kind in India to demonstrate techno economic viability of producing bio-ethanol from agricultural crop residues. This technology gives India a formidable tool to reduce its GHG emissions and fulfill its responsibility towards protecting environment. As mentioned earlier the CII & AT Kearney joint report shows that, By 2020, a CO2 reduction of 3-4 %(over those that existed in 2000) creating an abatement of 10 million to 12 million tons of CO2 equivalent is possible.

IOCL Panipat has proposed to install a new 100 KLPD capacity biomass (Non Food) based second generation Ethanol production plant in the near IOCL Panipat Refinery at Panipat district, Haryana. Below mentioned are salient features of the Plant.
The project is proposed at existing IBP terminal which is decommsioned. Dismantling of existing tank related facilities will be done, however some basic facilities may be utilized

Table 1-Salient Features of the Project :

Salient features of the proposed new 100 KLPD Demonstration Pilot Plant:	
1	The project will implement advanced second generation ethanol producing/manufacturing techniques
2	Feedstock used are Agricultural residues like rice straw/wastes (Cellulosic,Non food Biomass) and thus adapt recycle concept reducing GHG emissions
3	Indigenous technology
4	No increase in pollution load
5	No increase in use of resources
6	Plant will be installed in premises

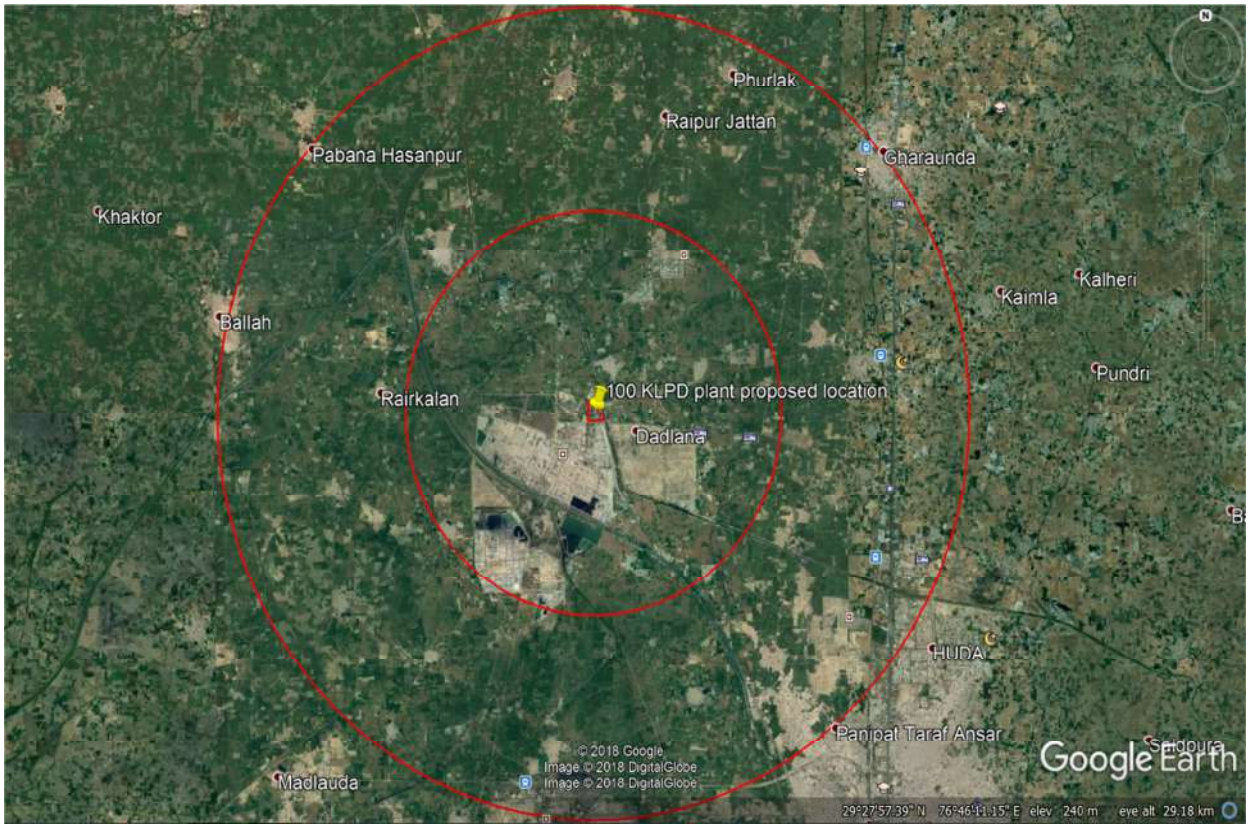

Figure 1: Satellite Imagery of Project Site

4.3 Environment Settings of the site:

Table 2: Environmental Settings of the Project Site

S.no.	Particulars	Details
1.	Latitude	29°28'55.89"N
2.	Longitude	76°53'21.74"E
3.	Site Elevation above MSL	242 m
4.	Topography	The project influenced study area is mostly plain terrain .
5.	Present land use at the site	Industrial use
6.	Nearest highway	NH 1 : 10 KM (approx)
7.	Nearest railway station	Panipat Railway station–23 km (approx)
8.	Nearest airport	Indira Gandhi International Airport-140 km (approx)
9.	Nearest town / city	Panipat – 23 km(approx)
10.	Hills / valleys	Nil in 5 Km radius
11.	Archaeologically important places	Nil in 5 Km radius
12.	National parks / Wildlife Sanctuaries	Nil in 5 Km radius
13.	Reserved / Protected Forests	Nil in 5 Km radius
14.	Seismicity	Seismic zone-IV
15.	Defense Installations	Nil in 5 Km radius

2.0 Process Description

4.4 Process Operations involved at the plant

The Project will comprise of following Sections/Process Operations:

I. BIOMASS PREPARATION SECTION:

- Biomass Storage
- Material Handling, Milling, Conveying and Wet washing.

II. MAIN PROCESS PLANT:

- Pretreatment
- Enzymatic Hydrolysis
- Co-Fermentation
- Distillation
- Dehydration

III. RESIDUE HANDLING SECTION:

- Solid Liquid Seperation

- Evaporation
- Process Condensate Treatment Plant

IV. UTILITIES & AUXILIARIES:

- Boiler
- Water Treatment Plant
- Chemical Storage
- Cooling Tower
- Air Compressor
- Product Storage
- Enzyme and ADY Storage
- Electrical System from grid to individual consumer
- Control System- DCS

V. OFF-SITE PACKAGES:

- Fire Fighting System
- Weigh Bridge

2.1 Material Handling, Milling & Wet Washing Section:

The purpose of this section is to outline the technical specifications for Feed Stock Handling System for conveying the feed stock, de-stoning and screening, magnetic particle separation, intermediate storage, necessary safety controls and instrumentation for automatic operation, weighing system, vibratory screen system with rated capacity as per layout and parameters mentioned in these specifications.
The Feed Stock handling system shall be designed for all feed stock materials mentioned in technical specifications and for the levels of moisture mentioned in the feed stock.

The complete installation will be outdoor type. All components in system, instrumentation, motors, gearbox, etc. shall be suitable for outdoor installation and necessary local canopies will be provided as per good engineering practices. A closed room will be provided for installation of M.C.C Panel only.

From storage, raw material will be fed to the feed conveyor of Feed Stock handling system with the help of front end loaders etc. for further processing of size reduction, stones separation, and removal of foreign particles, intermediate storage and further conveying. A Permanent Magnet type metal separator shall be installed to remove metallic foreign particles from the feed stock. A proper access will be provided to the magnetic separator for easy removal of separated metallic particles.

The milling unit will be supplied to crush biomass up to desired particle size and integrated with upward and downward conveying system including interconnecting chutes, bellows, hoods for Dust-Extraction system; etc. will be included in the handling system.

The controlled flow rate from the silo shall be fed to the wet washing system for further processing. Washing will be done at ambient conditions @ 3-3.5 % w/w solids. The wet biomass is further squeezed to increase solid up to 25 - 27 % w/w with the help of aqua separator and screw press. The wet washed, sized feed stock shall be conveyed from Wet Washing System to Pre-treatment section with Belt Conveyor and washed water will be sent to clarification section for recycle. The clarified water will be recycled back to washing section and clarifier bottom will be sent for further treatment in Evaporation section.

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2.2 Pre Treatment Section

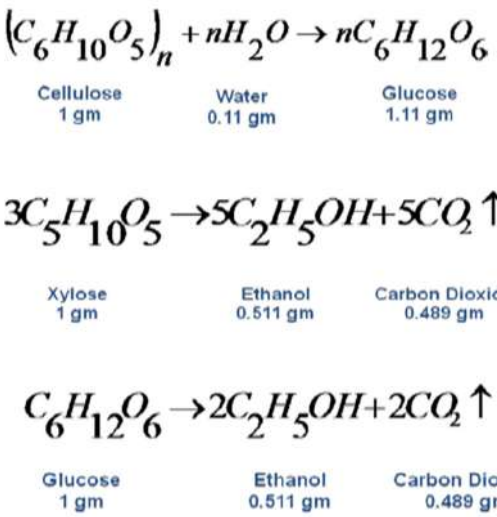
In this section, mainly C_5 hydrolysis is done (i.e. conversion of Xylan to Xylose) in a reactor, where a slurry concentration of about 18%-20% is maintained. The mixed acid solution is continuously fed as per the requirement. The slurry is treated at about 160 - 190 deg C and 10 - 12 bar pressure. The slurry from reactor is flashed in a Flash Vessel and then pumped to Enzymatic Hydrolysis section. Water from the steam flashing shall be recycled back to process.

$$(C_5H_8O_4)_n + nH_2O \rightarrow nC_5H_{10}O_5$$

Xylan 1 gm | Water 0.136 gm | Xylose 1.136 gm

2.3 Enzymatic Hydrolysis and Co Fermentation Section:

The pre-treated slurry is fed to the Pre-hydrolysis reactor. Reaction conditions maintained are pH in the range of 5.0 to 5.5, temperature of about 50 to 55 deg C at atmospheric Pressure before Enzyme addition. Enzyme shall be added to the reactor as per required dose. The reaction will continue in the Pre-hydrolysis reactor for few hrs and then the contents are transferred to main Hydrolysis reactor for further processing.



2.4 Co -fermentation Section:

Genetically Modified Organisms (GMO) type Activated Dry Yeast (ADY) will be mixed with water in Yeast slurry preparation tank and fed to Pre-fermenter for further propagation.

The sugar rich slurry from Hydrolysis reactor is then cooled to 32 – 34°C and fed to the Fermenter. Pre-fermenters are also provided for yeast propagation and different nutrients are added as per the required dosages. The Pre-fermenter volume is transferred to Main fermenter for fermentation process. Once the desired alcohol is achieved, fermented wash is transferred from fermenter to beer well and from beer well to distillation section. CO_2 evolved during fermentation shall be vented off at safe location through GMO filter.

2.5 Distillation Section:

The fermented mash from the Co-fermentation section is distilled and dehydrated to get Fuel grade ethanol.

"ECOFINE" Split Distillation consists of -

- **Stripping Section:** This section consists of following distillation columns.
- **Degasifying Column:** The primary function of Degasifying Column is to remove non-condensable gases and low boiling impurities from the fermented mash. Preheated Fermented mash is fed to Degasifying Column.

- **Split Mash Column:** The primary function of Mash Column is to strip off ethanol from Fermented mash. Split Mash Column helps in reduction of overall steam consumption in Distillation Section.

- **Rectification Section:** This section consists of following distillation columns.

- **Rectifier cum Exhaust Column:** The primary function of this column is to concentrate the ethanol. Ethanol is enriched at the top and is drawn out as hydrous ethanol and is fed to Dehydration Plant for further concentration.

2.6 Dehydration Section:

The process drives the rectified feed through a system of mole sieve beds. To allow for mole sieve bed regeneration in continuous operation, twin beds are provided of which one is in dehydration mode while the other is in regenerating mode. Depending on feed and product specifications, the dehydration-regeneration exchange takes place based on set time cycle. As the regeneration process releases the adsorbed water together with ethanol content, it is recycled back to system for reprocessing.

The feed is pumped to Vaporiser Tank. The overhead vapour of Vaporiser Tank is superheated in super heater to the required operating temperature and circulated to sieve bed 1 assumed in the description to be in dehydration mode. After passing through the molsieve, the vapor is condensed. The regeneration operation forces the release of the moisture from the molsieve, making the sieve bed 2 ready for the next cycle.

The condensed liquid is fed to simmering column to enhance the product quality by removal of low boiling impurity from fuel grade ethanol. The Bottom of simmering column is taken as Fuel Grade Ethanol and sent to storage after product cooler. The low boiling impurities removed from the top of the simmering column and send to technical alcohol storage tank as a by-product.

2.7 Solid -Liquid Separation

The Spent Mash generated in distillation shall be pumped to solid liquid separation section. The solid stream shall be used as a feed to boiler and the liquid stream (Thin Slop) shall be sent to evaporation section.

2.8 Thin Slop Evaporation

The Thin Slop is further concentrated by water evaporation in evaporators to produce the concentrated syrup which will be mixed with solid stream generated from solid liquid separation before feed to boiler. Evaporation (water evaporated) process condensate will be partially recycled back to process and remaining will be sent to polishing unit for further treatment.

2.9 Process Condensate Polishing Unit

The process condensate from evaporation plant will be treated through anaerobic followed by aerobic biological process in addition to separation in condensate polishing unit. The treated process condensate then will be sent OSBL (outside battery limit) for utility makeup. The sludge generated out of biological process will be send as manure for agricultural field

2.10 Output (Byproducts)

On the basis of design inputs the following outputs are expected from the plant: (Check table of EIA final report submitted by Praj)

Sr. No	Output Products – by products	Quantity
1.	Absolute Alcohol (AA)	100 KLPD Maximum (with 0.50% v/v moisture)
2.	Raw CO2	78TPD (It will be scrubbed with water and released to atm at safe location)
3.	Lignin rich cake (40% w/w)	467 TPD (The lignin rich wet cake shall be used as fuel for the boiler. It shall be mixed with the primary fuel and shall be incinerated in the boiler to generate steam
4.	Fuel Oils	Fuel Oils (a mixture of higher alcohols) removed from the system will be burn in Boiler.
5	Sludge from Process Condensate Treatment Plant	4.5-8.5 TPD Sludge is nothing but microorganisms based biological sludge. The sludge is generated from different biological processes carried out to treat Process Condensate coming from Evaporation Section of 2G Ethanol Plant. The collected sludge is subjected to dewatering action in solid/liquid separation unit to increase the suspended solid concentration. This sludge is then sent to farms as manure.
6	Ash	Ash generated (120- 130 TPD) Ash from the boiler is collected and conveyed into silo for the storage. This ash will be transported to Cement or Brick Manufacturing Unit by means of closed trucks . The ash analysis is shared to Ultra Tech Cement, Shree Cement, Ambuja Cement, Nirman Cement and under discussion.The logistics will be planned to avoid any stoppage of the plant.
7	Biogas:	Biogas generated (2400-3800 m3/day) in Process Biogas will be burned in the boiler as a fuel

3. Risk Assessment & Disaster Management Plan

Risk Assessment: Disaster is synonymous with 'emergency' as defined by the Ministry of Environment and Forests & Climate Change (MoEF & CC). An emergency occurring in the proposed project is one that may affect several sections within it and/ or may cause serious injuries, loss of lives, extensive damage to environment or property or serious disruption outside the plant. It will require the best use of internal resources and the use of outside resources to handle it effectively. It may happen usually as the result of a malfunction of the normal operating procedures. It may also be precipitated by the intervention of an outside force such as a cyclone, flood, earthquake or deliberate acts of arson or sabotage.

3.1 RISK ASSESSMENT

The output from the consequence analysis, and the frequency analysis, along with other supporting information are combined in a 'risk model'. The following data utilized for risk calculation are:

- Event frequencies
- Consequence data
- Ignition probabilities
- Population numbers and distribution in the plant.
- Local Weather data

- **Ignition Sources**

In order for a fire or explosion to start there must be an ignition source of sufficient heat intensity to cause an ignition. Ignition causes a release of flammable liquid or gas to become a fire (jet fire,flash fire, pool fire etc.) or explosion. There are many possible sources of ignition and those that are most likely will depend on the release scenario. Sources of ignition include electrical sparks, static electricity, naked flames, hot surfaces, impact, friction, etc. The following Ignition sources identified in a QRA under several categories including:

- **Current Electricity** – electrical equipment and cables can act as sources of ignition if sparks are generated at contact points or where wires overheat; e.g. Electrical equipment sparking.
- **Static Electricity** – static electricity can build up on any unearthed equipment and generate sparks. Static is commonly found on vehicles, vessels handling particulate solids and manned areas with nonconductive floor or footwear unearthed floors; e.g. Electrostatic discharges.
- **Naked Flames** – all naked flames (including cigarettes) are potential sources of ignition; this category also includes welding, flame-cutting and other hot work, fired furnaces and flares; e.g. Open flame heaters (boilers and flame heaters).
- **Population Data -** Population data of the Plant is mentioned in the following table. This data was utilized for two purposes, firstly to estimate the Individual Risk of fatality for a member of each onsite group, and also as the population input for calculating societal risk for site personnel.

Table- 2 Occupancy Data

Sr. No.	BUILDING	MANNING LEVEL
1	Material Handling	15
2	Milling	4
3	Pretreatment	4
4	Wet washing section	3
5	Hydrolysis and Fermentation	4
6	Distillation and Dehydration	3
7	Solid Liquid Separation	4
8	Evaporation	3
9	Boiler	7
10	WTP	3
11	WWTP	4
12	PCTP	3
13	Utility	4
14	QC	6
15	Others unskilled labors	20
16	Electrical, instruments and Maintenance	12
17	Administration (In-charge, HR, Finance, commercial)	9

3.2 Identification of Hazard

Details of major anticipated risks from the Hazards is given in Table below:

Table: Hazards of the proposed plant

Sr. No.	Name	Description	Severity	Hazard
1.	Transportations raw of material	Rice	None	-
		Coal	Minor	-
		Enzymes, Yeast, urea	Minor	Exposure & Inhalation
		Anti-bacterial agents, Sodium Hydroxide, Sulphuric Acid, Sulphamic Acid and Nitric Acid	Major	Exposure & inhalation
2.	Products by products and	Alcohol, fusel oil, Biogas	Major	Fire
3.	Manufacturing process	Distillation Unit	Major	Heat & fire
		Power Plant	Major	Heat fire & electrocution

4.	Utilities	D.G set, Boiler,	Major	Heat, fire & electrocution
5.	Other accidents	Leakages From the vessels, Catastrophic of rupture pressure and vessels Storage Tanks	Major	Exposure & fire

3.3 Risk Assessment and mitigation measures

Risk during Boiler operation

Table: Impact matrix for Boiler operation

Sr. No.	Activity	Associated Hazards	Health impact	Risk rating	Proposed mitigation and control measures
1.	Working near Boiler	High noise	Noise induced hearing loss	M	Required PPEs need to be used
2.	Boiler maintenance	Mechanical hazard	Physical injury	M	• PPEs • Regular monitoring for checking leakages • Individual vigilance and proper training to worker for proper handling • Provision of First aid box
3.	High Pressure Steam	Explosion	Risk of severe injury, damage to equipment	H	• Required PPEs • Good housekeeping • Regular monitoring of the storage facility • Flammable chemicals stored away from the source of ignition • Firefighting facility • Provision of First aid Box
4.	Incomplete Combustion	Asphyxiation from carbon monoxide	Possible fatality	H	• Online CO monitors • Regular checking of workplace • Individual alertness and precaution
5.	Maintenance work	Slips, Trips and Falls	Physical injury	M	• PPEs • Individual alertness and precaution
6.	Electrical maintenance work	Electricity	Electric shock, Possible burns	H	• Regular checking and maintenance of electrical units • PPEs • Provision of First aid box

7.	Maintenance of burner	Burn injury	Severe Physical injury or burn	M	• PPES will be provided. • Work will be carried out under proper supervision. • Follow of SOPs. • Individual alertness and precaution is important Provision of First aid box

(Note: M: Moderate, H: High)

3.4 Risk during D.G. set operation

Table: Impact matrix of risk during D.G set operation

Sr. No.	Activity	Associated Hazards	Associated Risk /Health impact	Risk rating	Proposed mitigation measures
1.	Working near DG	High noise	Noise induced hearing loss	M	• Use of PPEs • Acoustic enclosure
2.	Maintenance	Fire	Burns, Serious injury	H	• Restricted Entry • Use of flame proof fittings • Use of PPEs
3.	HSD Storage	Leakage / Fire	Risk of severe physical injury and burn	H	• Storage will be away from ignition source • Regular monitoring to check the leakages and spillages • Firefighting facility will be provided • PPEs will be provided • First aid box
4.	DG set maintenance	Mechanical Hazard	Physical injury	M	• PPEs • Leakage and heat in the joint will be checked before maintenance • First aid box at approachable place

(Note: M- Moderate, H- High)

3.5 Hazard & associated Risk of storage and handling of Raw material

Impact matric for risk associated with storage and handling of material is given in Table 7.4.

Table : Impact matrix of Storage and handling of raw material

Sr. No.	Activity	Associated Hazards	Associated Risk / Health impact	Risk rating	Proposed mitigation measures
1.	Storage, handling, loading & Unloading of material	Exposure, leakage, Fire, Explosion	Physical Injury, burn, Eye irritation and respiratory problem	H	• Provision of Eye wash • Inspection and regular monitoring of storage area • Training to Workers for proper handling • PPEs will be provided as Nose mask, Hand gloves. • Proper system for loading operation to prevents spillage • Provision of level indicators for storage Tanks • Spill kit for Acid and other chemicals • Proper ventilation • First Aid boxes
2.	Transportation	Fire, Accident, leakage	Burns, serious injury	H	• Firefighting facility • Training to Driver • Study of MSDS • TREM Card • First Aid Box

(Note: H- High)

3.6 Risk associated with alcohol storage and its mitigation measures

Material Safety Data Sheet (MSDS) for ethyl alcohol is enclosed as Annexure. Impact matric of risk associated with storage and transportation of alcohol along with control and mitigation measures are given below table:

Sr. No.	Activity	Associated Hazards	Health impact	Risk rating	Proposed Control and mitigation measures
1.	Storage of Alcohol	Exposure, inhalation, ingestion & Fire	• Exposure to over 1000 ppm may cause headache, drowsiness and lassitude, loss of appetite, and inability to concentrate. Throat Irritation • Ingestion causes depression of central nervous system, nausea, vomiting, and diarrhea • Liquid or vapor may cause eye and skin irritation • Burn injury	H	**Storage** • Storage will be away from process area with well-ventilation. Avoid all possible sources of ignition like spark or flame. • Use spark/flame proof hand tools • Electrical wiring will be flame proof type • Based on the leakage quantity, wiped out with or dilute by spraying the water to suppress the vapors **Control measures in case of over exposure** • If victim is conscious and able to swallow, then give water or milk to drink to dilute the contents in the stomach • Look out for medical help **Skin or Eye exposure** • Immediately flush affected area with plenty of water. Eyes should be flushed for at least 15 minutes with water • PPEs will be provided to avoid exposure

3.7 Risk associated with work area of distillation:

Sr. No.	Activity	Associated Hazards	Health impact	Risk rating	Proposed Control and mitigation measures
1.	Working near Distillation column	Heat & Fire	Physical injury & burning	H	• PPEs • Firefighting facility • First aid box • Periodic checking of all parts

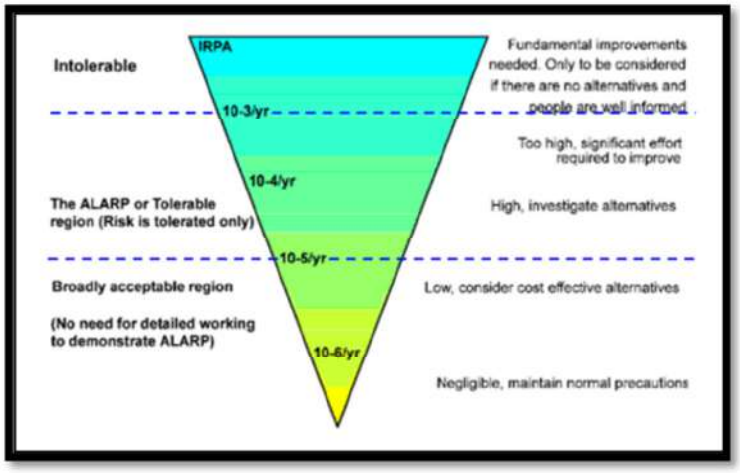
Location Specific Individual Risk (LSIR)

Location Specific Individual Risk (LSIR) is a commonly used risk assessment tool and is defined as the frequency per year at which an individual, who stays unprotected for 24 hours per day and 365 days per year at specific location, is expected to sustain fatal harm due to exposure to hazards induced by the project facility. From the LSIR value, the Individual Risk Per Annum (IRPA) to the personnel based on their exposure within the project facility.

Individual Risk Criteria

Individual risk criteria are well established both within industry and by regulatory bodies. The criteria adopted by the UK HSE, which are widely used and considered most appropriate to this study are:

Figure 2: Individual Risk acceptance criteria



The "ALARP region" (1X10-3 to 1X10-5) lies between unacceptably high and negligible risk levels.

Even if a level of risk for a "baseline case" has been judged to be in this ALARP region it is still necessary to consider introducing further risk reduction measures to drive the remaining, or "residual", risk downwards.

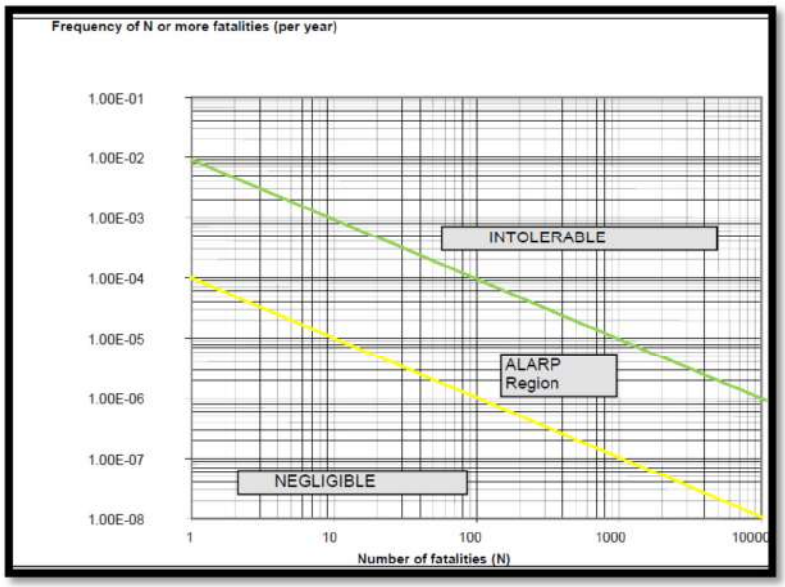
The individual risk contours will not be affected by the number of persons living or working in the area around the facility. Thus, a person located on the 1.0 x 10-6 individual risk contour for one year has one chance in a million of being fatally injured by the hazards associated with releases of hazardous fluids, regardless of how many other persons are located in the same area.

3.8 Risk criteria for Societal Risk:

Societal risk is defined as the relationship between the frequency and the number of people suffering a given level of harm from the realization of specified hazards. It is usually taken to refer to the risk of death, and usually expressed as a risk per year. In the same way as for individual risk, maximum tolerable and broadly acceptable criteria are set a upper and lower limits, where between these levels (termed the ALARP region) risks should be reduced wherever possible.

Societal risk criteria are more judgmental, and therefore less well established, than those for individual risk. The general aim of such criteria is to balance the risk to population groups from a facility with the benefits that the group, or society as a whole, receive. The criteria, therefore, mayvary according to the type and value of facility being assessed (where value is not necessarily defined in monetary terms) and the type of population that may be affected, as well as according to the country and regulatory authority.

Figure 3: Social Risk Acceptance criteria



3.9 Conclusions & Recommendations:

3.9.1 The study team identified various scenarios for the RA study. Considering the risk contours and FN curve for combination of all scenarios, DNV- PHAST RISK (SAFETI) software has been used for estimating the risk.

The following interpretations are derived from the risk results of this study:

- Individual risk is in the ALARP region of the UK HSE Individual risk acceptance criteria.
- The societal risk is in the ALARP region of the UK HSE Societal risk acceptance criteria.

The conclusions based on the QRA study outcome are listed below:
Individual Risk Values at control room, electrical sub-station, workshop, fire station, PSA, security barrack, medical building, administration building, security building are found to be in ALARP region.

This QRA report represents the worst case scenario for all the consequences. Maximum inventory and maximum pressure have been considered as an initial cause for worst case scenario. It has been observed that the consequence results are not having any adverse effects on the facilities.

Risk Contours of the proposed new 100 KLPD plant are limited to vicinity of the Petrochemical Complex, It will not affecting the Refinery or Marketing complex directly. Risk is combination of consequence and failure frequency of the scenario. Consequences are found to be higher because of the availability of flammable gas/liquid and high pressure in the process. However the probabilities of the failure are in the acceptable range (1E-4 to 1E-7). Hence the risk falls under As Low As Reasonably Practicable (ALARP) region.

IR Curve presents the combined risk hazards modelled for facility. The risk is expressed as risk of death on average per year. The largest contour as shown in Dark Green colours represents a risk level of 1E-9 per year while the smallest contour shown in red colour represents an individual risk of 1E-3. Pump Seal Failure scenarios are the major contributors to this level of risk to the individual and is mainly attributed to the very high failure frequency of pump seal year restricted to isolated sections within the respective units.
The societal risk (F-N Curve) from facility presented in figure shows that societal risk falls in broadly acceptable and ALARP region as per the UKHSE.

3.9.2 Technical Recommendations:

1. When the Plant is in Operation, Permit system should be introduced for outside visitors' entry. Also the number of outside persons at any time within facility should be well regulated.

2. Appropriate Personal Protective equipment (PPE) as per standards shall be used by the personnel working in the area.

3. To maintain the seals with utmost care and diligence and preventive maintenance of the same to be planned extensively. It is to be ensured that good quality pump seals / seal systems, having low failure frequency to be used for pumps.

4. Emergency procedures, SOP shall be maintained and followed accordingly.

5. Safety Audits shall be regularly done as per norms and recommendations of OISD. Risk Analysis Study in future shall be required if there is any change in the plant facility.

3.10 Main Findings of Consequence Analysis :

Analysis for the ten scenarios arising out of the proposed additional storage units was carried out. The impacts of the storage in individual tanks on life and property are summarized below. 1. Impacts of introducing ethanol tanks in the site: a. Dyke fire in Tank farm D: The impacts of critical radiation levels from spill and fire from the new horizontal tank for ethanol to be located within the new tank farm TF D are described o Radiation corresponding to severe damage (37.5 kW/m2) will be experienced up to a distance of 57m from the dyke. radiation levels from Ethanol pool fires are of the order of 70 kW/ m2 and have the potential to trigger secondary/ cascade events. While no activities are observed to be within this zone, the HVLR lines to TF A and TF C will be damaged. The radiation level of 12.5KW (corresponding to 1% fatality) extends to the neighbouring dykes and tank T02 within the site towards the north. b. Pool fire at TLF pumphouse: The effects of leak and spill of ethanol during pumping was considered at the TLF pump house. o The radiation corresponding to 100% fatality will be experienced at the TLF pumphouse. There is potential for cascade effects. o Radiation levels from Ethanol pool fires are of the order of 72 kW/ m2 and have the potential to trigger secondary/ cascade events. In addition to the pump house, the additive and sealing shed, tanks T10 ethanol tank, T6, T7, T8, T9 manifold fromgantry to storage, and fire fighting equipment along the western dyke wall of TFB are exposed to this high level of radiation. The radiation corresponding to 1% fatality was found to extend 15m beyond the northern boundary. The presence of the boundary wall may attenuate the impact beyond the boundary. Pool fire at the TLF gantry: Thermal radiation leading to severe damage and up to 1% fatality will be localized and restricted to the immediate surroundings. 2. Impacts of introducing biodiesel in the site Biodiesel has low flammability

3.11 Disaster Management Plan / Emergency Response Plan :

IOCL Panipat (Ligno-celluosic 2G Ethanol Plant) will be a new growth oriented centre around district. Such unit can pose threat of danger / hazard due to storage of hazardous materials. Distillery plant also poses electrocution, fire, and explosion hazards. When the full fledge activity of Ethanol Plant will gear up it will have to follow Factories Act 1948 & Haryana Factories Rules 1963 with all amendments till today and any directives from Director Safety, Health & Environment [SHE] will automatically be binding on IOCL Panipat . In such condition to appoint a qualified Safety Officer is a must & will be an adequate, wise step in such direction. On site and off site disaster control plans and their perfect implementation will be part and parcel of the management & such safety officer. To lessen the probability of hazard to occur & avoid the consequent damage, a disaster management and control plan has to be worked out for whole complex in anticipation to the threat.

3.11.1 Type of Disaster at IOCL Panipat (Ligno-celluosic 2G Ethanol Plant) complex

Disaster can occur as on site or off site variety i.e. disaster on campus or disaster in nearby area causing indirect damage to site area & the complex. Disaster may occur due to two categories, natural and

manmade calamities. Natural calamities cover Flood, Storm / typhoon, Earthquake, Tsunami, Heavy mist, fog, hail storm, Land slide.
Manmade calamities involve Fire & Explosion, All types of leakages & spillage, Electrocution, excavation, construction, erection, Sabotage, rail & road accidents, Mass agitation, Looting, Morcha, war.
The identified hazardous areas in the complex are:

1. Chemical Storage Area: Fire and Explosion.
2. Boiler area - Explosion
3. Electrical rooms - Fire and electrocution
4. Transformer area - Fire and electrocution
5. Cable - Fire and electrocution
6. Storage facilities – Fire / spillage for fuel and alcohol
7. Biomass Storage Area : Fire

Considering various probabilities the management & safety department has to create safety awareness & preparedness in all employees and people in vicinity area in case of any sort of emergency to occur & a chalked out attempt to surely overcome the disaster in time. This includes preparation of on site and off site disaster control plans, their mock drills at least 2 times in a calendar year, reports for the same to DISH & due amendments for the perfect implementation.

3.11.2 Level of accident

If there is any disaster in any part of plant/work place due to any reason the level of accidents from damage point of view may vary. Accordingly accident prevention program will have to be initiated by safety department simultaneously.

3.11.3 Critical Targets during Emergency

Level - I Accidents

Under this level disaster may happen due to electrocution, fire explosion, ~~oil spillage~~ and spontaneous ignition of combustible material. This level has probability of occurrence affecting persons inside the plant. Various hazardous areas identified in section 6.3 are potential areas to be affected due to level – I accidents.

Level - II Accidents

Disaster of this level can occur in case of sabotage and complete failure of all automatic control / warning systems, or in case if fires at Biomass storage area and Ethanol Storage Tanks.

However, probability of occurrence of this is very low due to the proposed adequate security training, and education level of plant personnel for the captive power plant.

3.12 Site Emergency Control Room (SECR) & Site main controller

In each segment of work from domestic level to war fighting team level approach always helps.
If concerned man is aware of his duty at his place & need of the time he can complement to huge task of lessening the damage of the disaster. To overcome the emergency in its occurrence it is the strategy to get prepared in advance, plan for the team effort, educate others and reduce all effects of disaster.

In case of any disaster main responsibility lies with the Chairman and Board of Directors, where they can nominate one fellow to be responsible person who will be Chief incidence controller. In case of disaster key person like Chief engineer, Chief chemist, Distillery manager will be the site main incidence controller and will commence respective duties in that capacity to curtail the emergency & minimize the losses may be occurring.

People in all departments can assist to contact external persons, district, state & central authorities, hospital & ambulance contact, evacuation if needed for people in the vicinity with assistance of state transport buses. People from maintenance department can help to rectify the fault in system. Security persons assist in fire fighting & material movement operation to avoid losses. It is utmost necessary to plan the control plan & to involve all staff in factory to get any sort of external help / assistance in time to lessen all sorts of damage.

To assist the disaster control more effectively a site emergency control room (SECR) will be established at the plant site. The SECR may be provided with following sections:

- All site plant layout
- List of important telephone numbers of Chairman & Directors IOCL Panipat , Chief Engineer, Chief Chemist, Distillery Manager, Administration Manager.
- Telephone numbers of near by Gram Panchayat, & District collector, State transport depot office, District & local fire brigade station, home guard, civil defence, N.C.C. unit, State crisis group, , CGO complex, MoEF, New Delhi
- All material handling & incoming vehicle traffic to be stopped temporarily.
- All out going lines to be used to contact above authorities.
- Captive power plant layout showed with inventories and locations of fuel.
- Fire Fighting systems at Biomass storage area
- Hazard identification chart, maximum number of people working at a time, assembly points etc
- List of village and their population in the vicinity of proposed Distillery plant
- Public address system like loud speaker, battery operated speaker, sirens,
- Whistles, batteries, signaling flags etc.
- Rechargeable and battery operated torch lights and invertors.
- Tie up with nearest hospital for medical assistance and facility for stretchers, chairs etc.
- List of registered medical practitioners in vicinity.

- Study map showing various villages and towns in the vicinity of distillery plant.
- Muster Roll of all present employees.
- Note pads and ball pens to record message received and instructions to be passed to concerned persons
- The blow up copy of Layout plan showing areas where accident could occur.
- Accident mock drill for at least 2 times in a calendar year is to be a part of routine exercise. The report bf such drill has to be submitted to DISH for his information & approval.

3.13 Disaster Preventive Measures

The proposed power plant will have following preventive measures to avoid occurrence of disasters:

(i) Specification & marking of safe area to gather in emergency.

(ii) Design, manufacture and construction of plant, machineries and buildings will be as per national and international codes as applicable in specific cases and laid down by statutory authorities.

(iii) Provision of adequate access ways for movement of equipment and personnel shall be kept.

(iv) Minimum two numbers of gates to escape during disaster shall be provided.

(v) Fuel oil storage shall be in protected and fenced. The tank will be housed in a dyke wall. As per regulations of CCOE its testing & certification will be performed each 5 years regularly.

(vi) Proper colour coding for all process water, air & steam lines will be done.

(vii) Proper insulation for all steam & condensate, hot water lines will be done.

(vii) Provision of circuit breakers, isolation switches, signals will be provided as per electricity act & rules.

(ix) Proper & rigid bonding and earthing to all equipment will be arranged.

(x) Meager value of earthing connections will be checked each 6 months and the same record will be available.

(xi) System of fire hydrants comprising, of electrical motor driven fire pumps is planned. The fire hydrant system will have electrical motor and a generator driven jockey pump to keep the fire hydrant system properly pressurized.

(xii) Automatic water sprinkling system is planned for all transformers.

In addition to the existing Fire Fighting System, separate Fire safety system is planned to be installed for 100 KLPD commercial Pilot Plant, which will cover its following sections :

1. Feed stock storage & Material Handling & Milling
2. Wet Washing & Pretreatment Section
3. Enzymatic Hydrolysis
4. Co- Fermentation
5. Distillation
6. Solid Liquid Separation
7. Effluent Treatment section

8. RS Storage Tank (In existing Alcohol storage section)
9. Fire Fighting System
10. Cooling Towers
11. Labs and Control room.
12. Office and Admin Buildings

Fire system will be designed primarily as per TAC guidelines. Fire safety system includes:

a) Hydrant System with water cum foam monitor for the Complete Plant
b) Wet Riser System for Milling, Pre-treatment, Solid Liquid Separation/Filter Press, Fermentation and Distillation
c) Suitable Fire Alarm & Detection system for the Complete Plant

3.14 Location Type Of Fire Extinguishers

- Turbo-generator area: CO_2 Type, Foam Type Dry chemical powder
- Cable galleries: CO_2 Type, Foam Type Dry chemical powder
- High voltage panel: CO_2 Type, Foam Type Dry chemical powder
- Control rooms: CO_2 Type, Foam Type Dry chemical powder
- MCC rooms: CO_2 Type, Foam Type Dry chemical powder
- Pump houses: CO_2 Type, Foam type dry chemical powder
- Fuel tank Area: CO_2 type, Foam Type Dry chemical powder Sand Basket
- Offices & Godowns: Foam or Dry chemical powder Type
- Crushers house: CO_2 Type, Foam Type dry chemical powder

3.15 Offsite Emergency Plan

In case the hazard spreads out-side the premises Team A under the instruction of DMC will communicate to the District Magistrate, Commissioner of the Police and inform the situation as Off-Site Emergency. Types of emergency facilities/actions required from outside bodies are,

- Firefighting facilities required: Factory will have its own firefighting facilities but during emergency, fire brigade may be called from nearby areas or other establishments
- Police help shall be required during emergency for control of people, traffic and security arrangements
- Medical help required: seriously injured personnel may be referred to the Hospital/Primary Health Centre depending upon injuries

Information to authorities

- Emergency situations will be informed to the local Panchayat official regarding the likely hazards from the industry and the steps to be taken when there is an Off-Site Emergency. It is preferable that the Local Panchayat Officials are also trained on simple protective methods through demonstrations and practice
- District Magistrate, Commissioner of the Police and District Control Room if exists

3.16 General Natural Disaster Management Measures

- Factory Management shall train their staff to manage emergencies arises from fire, storms & cyclones, lightning and leakages.
- As soon as the cyclone or flood warning receives from District Disaster Management Authority, the raw material as well as finished products shall be kept to a minimum to avoid spillage or misuse
- All the material and products shall be stored properly to avoid the damage or mixing with other
- All the employees will have the list of important phone numbers and contact details to help in getting the required help in time. These numbers shall be displayed at distinct location within Factory premises
  - Company's designated safety personnel will be main contact person for all the employees for any type required help from outside
  - District level disaster management units
  - Nearest Fire station
  - Nearest Doctors & Ambulance
  - Forest & Environment department.
  - Company's Emergency Management Cell Members
  - Police Station
  - Village heads & Panchayat
  - Substation details from where Company takes power

3.17 Recommendations

The fire tender, which will be part of project with following minimum fire-fighting arrangements, shall be procured:

- Water tank – 2,800 m^3
- Foam tank - 45 litres
- Fire extinguishers – 45 nos

3.18 Alarm System to be followed during disaster

On receiving the message of 'Disaster from Site Main Controller, fire station control room attendant will sound Siren 'WAVING TYPE' for 5 minutes. Incident controller will arrange to broad cast disaster message through public address system. On receiving the message of "Emergency Over" from incident Controller the fire station control room attendant will give "All Clear Signal" by sounding alarm straight for two minutes. The features of alarm system will be explained to one and all to avoid panic or misunderstanding during disaster. It is necessary to take one trial for perfect functioning of the siren at least once in one week with prior intimation to Panipat District Collector.

3.19 Summary & Conclusion:

Project proponent will implement all preventive measures to tackle all type of emergencies arising out of operation or malfunction of individual unit's. The required resources for Onsite and offsite emergency management plan will be properly planned and provided to implement the plan effectively. The Company shall give highest priority towards Health and safety of the employees and people residing nearby areas. Management shall conduct the training to the nearby villagers to appraise them about their role during emergency. All nearby people shall be given training on do's and don'ts during emergency situation.

As the hazards involved during operation and production activities will be known to the Management, all required mitigation measures shall be implemented in time to avoid the emergency situation from the arising. Unfortunately, if there is any emergency onsite of offsite, it will be tackled effectively due to availability of required resources at the site. Similarly, all the concern staff and members of the Teams shall be trained appropriately to tackle the emergencies in the plant. By knowing the type of emergency situation that may arise during operation of the plant, appropriate control measures will be implemented to reduce the gravity of the emergencies. Similarly, to avoid the emergency situation, all required mitigation measures will be implemented as recommended.

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