7.3 POTENTIAL AND MAJOR HAZARDS IN SUGAR FACTORY

Process for manufacturing and refining sugar is a standard process. he risk assessment and hazard management study was done by Mr. Vinod Sahasrabude who is FAE for RH in respect of EEIPL. Areas of concern from hazard and risk points of view in the plant manufacturing of sugar are as follows-

7.4 OBJECTIVES AND SCOPE OF THE RH REPORT:

7.4.1 Objective of the Risk and Hazard analysis is to

1) Identify hazards and nature of hazard in the process, storage and handling of hazardous chemicals.
2) Carry out Qualitative risk analysis for the process and suggest mitigation measures.
3) Carry out Quantitative risk analysis of the storage of hazardous chemicals and estimate the threat zones for Most Credible and Worst case scenarios
4) Suggest mitigation measures to reduce the risk/probability of the accident to the minimum.
5) Incorporate these measures for ensuring safe operations and safe layout to mitigate hazard and for effectively encounter any accident reduce the damages to the minimum.
6) Help in preparation of preparation of On-site and Off-site emergency plans
7) Suggest Guidelines for on-site and off - site emergency plan

7.4.2 Methodology

7.4.2.1. Identify hazards based on

- Processes description received based.
- Identify Hazardous Chemicals handled and stored.
- Inventory of Hazardous chemicals
- Proposed storage facilities for hazardous chemicals
- Plant layout
- Safety measures to be adopted by the company

7.4.2.2. Hazard Assessment

- By Qualitative Risk Assessment
- By Quantitative Risk Assessment by Hazard index calculations and estimate threat zones by using ALOHO

7.4.2.3. Recommendations

- Recommend mitigation measures based upon the above
- Recommending guidelines for the preparation of On-site Emergency plan.

7.5 HAZARD IDENTIFICATION

7.5.1. Identification of types of Hazards in Distillery

Potential hazardous areas and the likely accidents with the concerned area have been enlisted below-

Table 7.1 Possible Hazardous Locations onsite

Sr. No.	Hazardous Area	Hazard identified	Mitigation measures	Mitigation measures in place /have to be in place for running plant	Comments/ Additional measures
1	Boiler Area	Explosion	IBR rules for design, maintenance and operation of boilers by certified boiler attendants in mandatory	These measures are in place as the boiler is in operation for the existing capacity.	Will be adopted for the additional boiler capacity
2	All over the plant	Lightening	To design and install adequate number of best available lightening arrestors.	These measures are in place as the boiler is in operation for the existing capacity.	If additional are required for increased area of operations these will be installed
3	Electrocution	Lose fitting	Regular maintenance, internal safety audit, and external safety audit at regular intervals.	These are in place for the operation of the existing capacity	
4	Electrical rooms	Fire and electrocution	Regular maintenance, internal safety audit, and external safety audit at regular intervals.	These are in place for the operation of the existing capacity	
5	Transformer area	Fire and electrocution	Regular maintenance, internal safety audit, and external safety audit at regular intervals.	These are in place for the operation of the existing capacity	
6	Cable tunnel	Fire and electrocution	Regular maintenance, internal safety audit, and external safety audit at regular intervals.	These are in place for the operation of the existing capacity	
9	Alcohol production area	Fire and Alcohol vapour release	HAZOP study is strongly recommended for the production as well as Alcohol		

Sr. No.	Hazardous Area	Hazard identified	Mitigation measures	Mitigation measures in place /have to be in place for running plant	Comments/ Additional measures
			Storage area. And adequate safety instrumentation with alarms and interlocks to be incorporated to make the design and plant operation intrinsically safe.		
10	Distillery (ethanol storage tank)	Fire	Detailed measures have been suggested in the report, in the later part. And QRA results and based on failure frequency risk has been calculated. Fire hydrant will be laid around with foam fighting arrangements.		

7.5.1.1. Mitigation Measures to avoid accidents:

(A) Preventive Measures for Electricity Hazard:

- All electrical equipment is to be provided with proper earthing. Earthed electrode are periodically tested and maintained.
- Emergency lighting is to be available at all critical locations including the operator's room to carry out safe shut down of the plant.
- Easy accessibility of fire fighting facilities such as fire water pumps and fire alarm stations is considered.
- All electrical equipments to be free from carbon dust, oil deposits, and grease.
- Use of approved insulated tools, rubber mats, shockproof gloves and boots, tester, fuse tongs, discharge rod, safety belt, hand lamp, wooden or insulated ladder and not wearing metal ring and chain.
- Flame and shock detectors and central fire announcement system for fire safety are to be provided.
- Temperature sensitive alarm and protective relays to make alert and disconnect equipment before overheating is to be considered
- Danger from excess current due to overload or short circuit is to be prevented by providing fuses, circuit breakers, thermal protection

(B) Fuel Storage:

- Workers to be trained to be vigilant and keep water hose with ready water supply to extinguish small fires during hot season.

- Fire fighting measures, alarm measures and fire hydrant line to be provided around the Baggase storage area to immediately and effectively deal with fire. This is already in place.
- Measures are taken to control the air pollution during loading/handling coal

7.6 ACCIDENTAL RELEASE MEASURES, SAFETY MEASURES FOR STORAGE & HANDLING

7.6.1 Distillery Plant

7.6.1.1. Alcohol Handling and storage -

Keeping away from heat, sparks and open flame, care will be taken for avoidance of spillage, skin and eye contact, well ventilation, Use of approved respirator if concentration of alcohol in air is above acceptable level will be promoted.

For Storage and handling following precautions will be taken:

- Keeping away from oxidizers, heat and flames.
- Cool, dry, & ventilated storage and closed containers.
- Grounding of the container and transferring of equipment to eliminate static Electric sparks.

7.6.1.2. Establishing a Fire Fighting Group

A small spark of fire may result into loss of lives, machines and the damage by fire may result in high economic losses. This type of losses can be avoided by preventing and controlling the fire instantly for which fire–fighting group will be established.

Fire fighting group would house and keep in readiness, the following types of equipment and arrangements.

- CO_2 extinguishers
- Dry powder chemical extinguishers
- Foam extinguishers
- 80 mm. spray hoses
- Fire brigade

7.6.2 Sugar Production Plant

Hazard Identification -

Following areas in Sugar Production are identified as hazard prone:

1. Bagasse Storage: For fire
2. Molasses storage: Environment hazard on leakage and likely fire and explosion
3. Sulphur Storage and SO2 production: Fire and toxic gas leakage affecting workers.

7.6.2.1. Bagasse Storage

The company has 23,000 Sq. M. of area reserved for the storage of Bagasse, used as fuel for the boiler.

Fire hazard

Bagasse is produced after crushing of sugar cane. In dried form it is used as fuel for boiler.

Small spark or ignition will cause fire and will spread rapidly leading to injury and loss of life, and damage to the property.

7.6.2.2. Mitigation Measures

Following mitigation measures to eliminate the fire hazard are in place and some additional measures are suggested as below:

1. It should be ensured while routing high tension voltage lines to avoid storage of bagasse storage below & near high voltage (H.T.) transmission lines.

Avoid routing of electric supply cables &cable trenches near to bagasse storage and if unavoidable locate these as far away from stored bagasse or bagasse heaps.

2. Always keep other raw materials & useful material far away from storage of bagasse area.
3. Installation of Fire Hydrant (self auto-mode fire fighting) system around the area of bagaasse yard. Fire hydrant has been/will be laid around the bagasse storage area as shown in the drawing mentioned above. Fire hydrant system will be designed as per_IS code and as per the applicable relevant code.
4. Creating awareness among workers about sudden bagasse fire and emergency action plan will definitely avoid risks of heavy fire. In this way we can save a valuable fuel & life of human being working near bagasse.
5. Posting of proper supervision staff with necessary communication facility.
6. Hot work, like welding, gas cutting should not be carried out near bagasse storage. Or only after issue of proper work permit and making necessary arrangements
7. Daily record of bagasse storage data must be maintained and proper review of storage conditions must be taken by higher authority.
8. Training of all the involved staff in firefighting in normal & emergency operating system.
9. Proper planning & installation of fire hydrant system around the bagaase storage yard and should not depend exclusively on fire tender for fire fighting.
10. Creating awareness among workers about sudden bagasse fire and emergency action plan will definitely avoid risks of heavy fire. In this way we can save a valuable fuel & life of human being working near bagasse.

7.6.2.3. Sulphur Storage

Storage and handling of Sulphur: Exposure to dust, dust explosion,

Hazard Identification

Sulphur 50 MT is MT is stored in a closed shed of area in a warehouse of 315 sq m area. It is transferred manually to the SO_2 production unit manually as per the requirement in bags. Following are the hazards in storage and handling Sulphur.

1. Dust Explosion
2. Fire

1. Dust Explosion

As Sulphur is stored and handled in granular form, there is always some dust formation, which can lead to dust explosion.
A dust explosion occurs when a fine dust in suspension in air is ignited, resulting in a very rapid burning, and the release of large quantities of gaseous products. This in turn creates a subsequent pressure rise of explosive force capable of damaging plant and buildings and injuring people. It is generally considered that a dust explosion can only be initiated by dust particles less than 500 microns diameter.

Conditions for a Dust Explosion

Following conditions are necessary before a dust explosion can take place.

(a) The dust must be combustible.
(b) The dust cloud must be of explosive concentration, i.e. between the lower and upper explosion limits for the dusts.
Sulphur is a flammable substance in both the solid and liquid states. The dust is characterized by a very low ignition point of 190°C compared to other combustible dusts, and dust clouds are readily ignited by weak frictional sparks. Dusts containing 25% or more elemental Sulphur may be almost as explosive as pure sulphur.
(c) There must be sufficient oxygen in the atmosphere to support and sustain combustion.
(d) A source of ignition must be present.
(e) The dust must be fine enough to support an explosion.

Mitigation Measures:

Explosion Prevention: Dust explosions can be prevented by ensuring that the following conditions are met:

• Formation and Suspensions of Sulphur dust in air are avoided.

a. To prevent dust formation during the storage and handling of Sulphur, it is necessary to take necessary precautions to avoid spillage and crushing of granular Sulphur during bulk loading and unloading in the storage area.
b. Storage shed should be constructed with a minimum number of horizontal surfaces to avoid dust must accumulation.
c. Bulk accumulations of fine Sulphur may also be removed using soft push brooms, having natural bristles and non-sparking scoops or shovels before vacuum cleaning equipment is used.
d. The use of compressed air to remove dust from any surface, vigorous sweeping or any other method of cleaning which may raise a dust cloud is prohibited.

e. All sources of ignition are excluded.
f. Presence of moisture helps in preventing dust explosion.

2. Fire in Sulphur storage:

There is a risk of fire in Sulphur storage as ignition temperature is low 190 deg C. Solid and liquid Sulphur will burn to produce Sulphur dioxide gas, which is extremely irritating and toxic. The effects of the fire hazard itself are slight.

Mitigation Measures:

- Smoking and the use of matches shall be prohibited in all areas where sulphur dust is likely to be present. Prominent NO SMOKING signs shall be placed around such areas.
- Naked flames or lights and the use of gas cutting or welding equipment is prohibited during the normal operation of the plant. Repairs involving the use of flames, heat, or hand or power tools in areas where sulphur may be present shall be made only after getting hot work permit from the authorities.
- Where this is not possible the sulphur shall be wetted down.

7.6.2.4. Safety and Fire Fighting Tips

- Always use Self Contained Breathing Apparatus (SCBA). Sulphur fires produce hazardous sulphur dioxide gas. Sulphur dioxide gas is heavier than air and will accumulate in the vapour spaces of the rail car.
- Automatic sprinkler systems which comply with relevant Indian Standards and provide a fine spray or mist are recommended as the most satisfactory extinguishing system for bulk stores. Fire hoses and extinguishers must be fitted with fine spray nozzles to ensure that Sulphur dust clouds are not raised, as these can explode on contact with the fire.
- Small Sulphur fires are easily extinguished by adding more sulphur on top of the burning Sulphur. This depletes the oxygen and smothers the fire.
- For larger Sulphur fires use a light water fog or CO2 to extinguish. Do not use heavy water streams as this may create Sulphur dust which could potentially explode.

7.6.3 Sulphur di oxide (SO_2) production and handling:

7.6.3.1. Hazard Identification

Company has standard SO_2 production facility. The description given below: is for standard plant normally operated in Sugar manufacturing plants.

Standard plant has Sulphur di oxide(SO_2) production unit. The existing production capacity is adequate to cater to the additional requirement of Sulphur di oxide(SO_2) for increased production. The unit produces required amount of Sulphur di oxide(SO_2) at the required rate by changing sulphur feed to the melter at a temp of 120 to 150 deg C , it is melted at and charged to the burner chamber, where in the air at controlled rate is fed to burner to produce Sulphur di oxide(SO_2). Gas at high temp of 400 to 600 deg C, secondary air is passed to secondary after burner at 250 -300 deg C. It is cooled to 70 to 80 deg C in secondary cooler and sent to the user unit through 100/150 mm piping at 1.5 to 1.7 atm pressure with approximate length of 20 meters.

This is unit designed for insitue production and use of Sulphur di oxide(SO_2). There is practically no inventory of gas in the Sulphur burner unit and the inventory of the gas is in the pipeline from the unit to the sulphiter only.

Major hazard is leakage, being toxic it can lead to serious injuries and health concerns.

7.6.3.2. Mitigation Measures suggested and measures which are in place

A. Safety Precautions in place

1) Handling.- Safety goggle &hand gloves used.
2) If SO_2 gas leakage first air stopped by manually and leakage attend.

PPEs including Self Breathing Apparatus and gas masks should be readily available at the operation site.
1) Eye – Contact with eye immedetely flush with clean water for 15 min. seek medical attention.
2) Skin – Remove contaminated clothing wash contaminated area by soap there may burn immediate medical attention.
Eye showers should be installed in the near vicinity.
3) Vomiting occurs medical attention.
4) Inhalation - Remove person to fresh air seek medical attention immediately.

B. Other additional mitigation measures suggested

1) Standard Operating Procedure (SOP) for the unit SHOULD BE available.
2) Emergency Shutdown procedure SHOULD BE available. Operators are trained.
3) Emergency Shutdown procedure, in local language should be displayed.
4) SO_2 leak detectors can be installed in the plant for early warning.

7.6.3.3. Hazard quantification

Following are the toxic properties of SO_2

NFPA rating N(H)=3, N(F)=0 and N(R)=0, TLV= 2 ppm

Toxicity Index

Toxicity Number: The toxicity number (Th) is derived from the NFPA health factor Nh. Nh is an integer number ranging from 0 to 4.

Table 7.2 Toxicity Number

Nh	0	1	2	3	4
Th	0	50	125	250	350

PENALTY FACTOR: The Penalty Factor (Ts) is the second toxicity parameter used to determine the TI. The Ts value is derived from the 'Threshold Limit Values (TLV)'.

The TLV-values are drawn up by the American Conference of Governmental Industrial Hygienists. TLV represents a time weighted average (TWA) air concentration to which workers can be exposed during a normal working week of 6 days at 8 hrs per day, without ill effects. The penalty factor is determined from the table below:

Table 7.3 TLV Level

TLV	<5	5-50	>50
Penalty factor Ts	125	75	5

Toxicity Index TI= Th+Ts/100 X (1+1.75+2.4) TI= 250+125/100 (5,15) = 3.75X 5.15, which is equal to **19.3**

Resulting TI values are ranked into three categories:

1-5 Light
6-9 Moderate
10-up High

Hence Toxicity index is in HIGH range. Sulphur di oxide is produced by oxidation of molten Sulphur in situ in a standard readymade unit as described above and is used in Sulfitation of Sugar cane juice. There is no storage of Sulphur di oxide, as it is produced at the consumption rate and when required.

7.6.3.4. Quantitative Risk Analysis (QRA)

Sr. No.	Name Of Chemical	Site Data	Chemical Data	Atmospheric Data	Source Of Chemical	Source Strength	Threat Zone
1.	**SULFUR DIOXIDE**	• Location: GANGAMAI INDUSTRIES AND CONS, INDIA • Building Air Exchanges Per Hour: 0.65(unsheltered single storied)	• Chemical Name: SULFUR DIOXIDE • Molecular Weight: 64.06 g/mol • Ambient Boiling Point: 11.2° C • Vapor Pressure at Ambient Temperature: greater than 1 atm • Ambient Saturation Concentration: 1,000,000 ppm or 100.0%	• Wind: 3 meters/second from NW at 10 meters • Ground Roughness: open country • Cloud Cover: 0 tenths • Air Temperature : 35° C • Stability Class: C • No Inversion :Height. • Relative Humidity: 5%	Gas flow through pipe	• Non-flammable gas is escaping from pipe • Pipe Diameter: 15 centimeters • Pipe Length: 30 meters • Unbroken end of the pipe is closed off • Pipe Roughness: smooth • Hole Area: 177 sq cm • Pipe Press: 2.7 atmospheres • Pipe Temperature: 50° C • Release Duration: 1 minute • Max Average Sustained Release Rate: 37.4 grams/sec (averaged over a minute or more) • Total Amount Released: 2.24kilograms	• Model Run: Heavy Gas • Red : 72 meters --- (100 ppm = IDLH) • Orange: 873 meters --- (0.75 ppm = AEGL-2 [60 min]) • Yellow: 1.45 kilometers --- (0.2 ppm = AEGL-1 [60 min])

Mitigation Measures suggested and based on QRA:

1. Before the plant start up and every six months, pressure test and thickness test of all the equipments and piping carrying Sulphur di oxide must be carried out to avoid leakage.
2. There must be alarm system, in case, SO_2 leakage is suspected and detected by smell, to warn all workers of the leakage.
3. SO_2 leak detectors may be installed.
4. All operators must be aware of Emergency Shutdown procedure and action to be taken to warn authorities to sound alarm.
5. Emergency Shutdown procedure and action to be taken should be displayed in the SO_2 production area in the local language.
6. It should form an important part of mock drill to be carried out as per on-site emergency plan.
7. In case of leakage as envisaged in MCA of flange joint leakage, area around SO_2 production unit and part of the main plant must be vacated immediately.
8. In case of major leakage as envisaged in first case, if there is sudden breakage of pipeline there will be Immediate Danger to Life and Health in the area within 50-60 meters area around 120 meters to 700 meters will be heavily affected and full onsite emergency plan for the entire plant will have to put in action and if necessary population around 1 to 1.5 km will have to be warned.
9. In case the leakage is through the 5 mm hole, and the action is not taken for 30 minutes the area affected is predicted in the second case.
10. The workers in the area should wear SCBA before taking action to plug the hole or any rectifying action. All workers in the vicinity of 300 meters should be evacuated.

7.6.4 Co-generation plant

The company has 32 MW capacity Co-gen plant.

1. In distillery, steam will be taken from existing 8 TPH capacity boiler which is operated by using Biogas as fuel with normal operating pressure of 3.43 bar. Also, existing boiler from sugar factory having capacity 30 TPH and bagasse as fuel will be modified to 40 TPH under distillery expansion. Steam will be taken from this boiler too. Normal operating pressure of this boiler is 3.43 bar.

The boiler is as per IBR design standards, maintained and approved by IBR authority's rules and regulations.

The steam produced is used for power generation through turbine and the extracted steam is used for internal consumption for Sugar plant and Distillery operation. The boiler and Co-generation unit incorporates all the necessary instrumentation, alarms and interlocks and is operated through DSC system to ensure the safe operation.

Hazard identification: Heavy high pressure steam leakage, resulting in noise pollution, and in the worst case explosion involving boiler.

Mitigation measures should be place:

1. As mentioned above all the precautions and mitigation measures as per the statutory rule are in place and are strictly observed.

2. Important interlocks such as boiler water control, fans tripping on backfire, steam pressure, noise have been provided for boiler.
3. Turbine and power generation plan is PLC operated sequential start up and shutdown procedure built in. The plant is equipped with standard instrumentation, alarms, and interlocks, trips, such high speed trip, bearing vibration, bearing oil circulation, oil temperature, and turbine alignment.

Note: Detailed Alarm and interlock system for Boiler and Co-gen plant, which are standard features of Co-gen plant, is given in Appendix P

7.7 FIRE HAZARD

7.7.1. Sugar Factory – Molasses Storage

1. There are 5 molasses storage tanks and details of same are as follows –

No.	Description	Tank Details	Dimensions	Remark
1	Molasses Storage Tanks (In Sugar Factory)	Quantity: 2 Capacity: 10,000MT each	Diameter – 30 m Height -10 m	Existing Tanks
2	Molasses Storage Tanks (In Distillery)	Quantity: 2 Capacity: 7,000 MT	Diameter 25 m Height -10 m	Existing Tanks
3	Molasses Storage Tanks (In Distillery)	Quantity: 1 Capacity: 8,000 MT	Diameter –28 m Height -10 m	Expansion Tanks

Mitigation Measures:

It is necessary to take following mitigation measures to prevent bursting of tanks, and heavy leakage and loss of life.

Hazard Identification:

Areas of concern are -Molasses storage: Heavy leakage of Molasses, total breakage of tank, leading to loss of life and pollution.

Mitigation Measures- Storage of Molasses

1. Molasses should be stored in good quality and leak proof mild steel tanks.
2. Adequate safety factor should be incorporated into the design of wall thickness considering deterioration that will occur due to corrosion over a period of time.
3. Regular internal and external inspection should be scheduled for checking wall thickness of the tanks.
4. Dyke/ Bund walls should be constructed around the tank or tanks**.**
5. It must be ensured while finalizing the dyke dimensions and that thickness that clear volume inside the dyke walls is equal or more than 1.2 x volume of tank storage capacity.
6. Continuous mixing of molasses through external pump circulation should be done.
7. If there is increase in temperature beyond 30^0C external cooling of tanks shall be provided by heat exchanger in the circulation line.
8. Frequent Temperature monitoring, manually or by recorder is strongly advised.
   If there is leakage –

a. Leakage should be washed out and diluted and should be recycled as far as possible or must be properly treated in Effluent treatment plant.
b. Replacing of leaky gaskets, joints, should be done strictly by following work permit system.
c. Leakage of pipelines, welding repairs should be attended / carried out outside the plant. The necessary hot work permit should be issued after taking necessary precautions and fire fighting measures for onsite hot work, by the concerned authority before any hot work in undertaken
d. Leakage through pump gland shall be reduced to the minimum by installing mechanical seals.
e. To attend all major leakage in tanks the following procedure should be followed
   (i) Transfer the material to other tank.
   (ii) Prepare the tank for welding repairs by making sure that it is positively isolated with blinds from other vessels and ensuring that it is free of the chemicals and gases by purging air and carrying out air analysis before any hot work is undertaken and this should be done by skilled workers. For this purpose safety permit should be given.
f. During the shutdown Molasses tank are emptied for cleaning sludge and maintenance. General practice is to manually remove the sludge/tank bottoms and drain this in the open without treatment. If such practice is being followed, It is strongly recommended to discontinue this practice and use pump/suitable for pumping viscous sludge by diluting it and let out after proper effluent treatment.

7.7.2. Distillery – Alcohol Storage

The Company proposes to expand distillery capacity from 60 KLPD to 150 KLPD by increasing additional facility of 90 KLPD.

For this company proposes to achieve this by installing additional equipments. List of additional equipments in appendix - E , additional Alcohol storage tanks is given in chapter – 2

Hazard Identification

Major hazard identified in the production unit is release of alcohol vapours and fire.

It is recommended to eliminate the risk and hazard at the design stage of the expansion itself by carrying out detailed systematic HAZOP study of the entire process and make the process and operation intrinsically safe.

Major area of concern from Risk and hazard is Alcohol storage:

NFPA rating for Alcohol is NH (Helth Factor) NF (Fire Factor) NR (Reactivity)

NF= 3, NH = 2 and NR=0, indicating fire as the major hazard in handling and storage of Alcohol

Qualitative Risk analysis:

For the storage of alcohol Fire and Explosion index has been calculated to be 72 based on the Material Factor MF= 16 and storage conditions (Degree of Hazard is rated based on of Fire and explosion index as follows)

Table 7.4 Degree of Hazard and F&EI Index

F&EI Index Range	Degree of Hazard
1-60	Light
61-96	Moderate
97-127	Intermedite
128- 158	Heavy
MORE THAN 159	Severe

F&EI index is in the range of moderate

Mitigation Measures:

1. Based on standard recommendations for moderate hazard is it is recommended to have Alcohol storage tanks should be in open in dyke walls and must have spill collection and control (recycle) arrangement to pump into another tank.
2. As indicated the storage should be in open with dyke walls.
   It is indicated that the dyke wall with 25 M X 25 M and 0.25 M thick has been provided with drain pit valve and transferring the leakage through the pump.
3. Clear distance between tanks will be provided as per the requirement of Petroleum Rules Table 1 SCHEDULE II. Particularly for storage tanks mentioned in 8, 9, and 10 in the table given above.
4. Location of pumps, location of tank farm in the factory should be as per the requirements of Petroleum rules.
5. Proper firefighting system, inside the plant and around the storage tanks has been designed as per IS or international code. And is shown in the factory layout drawing. And Fire NOC will be obtained.
6. Fire fighting around Alcohol storage will be as per the accepted IS or international standard with sprinkler system and foam based fire fighting arrangement.
7. As the QRA reveals the distance between two tanks should be minimum ½ the tank diameter, as in case of even pool fire the tanks too close less than flame length of 4 meters will get heated directly leading to a bigger disaster of BELEV.
8. This also emphasizes the need for tank cooling as per acceted norms.
9. Quantitative Risk Analysis:
10. F&EI index can also be used for estimating the damage that would probably result from the accident/fire. And it is converted to radius of exposure by multiplying it by 0.84 to feet. Thus radius of exposure in this case will be 0.84X72= 60 feet or 18 meters

7.7.2.1. QRA for existing Alcohol storage tanks:

Sr. No.	Name Of Chemical	Site Data	Chemical Data	Atmospheric Data	Source Of Chemical	Source Strength	Threat Zone
1.	**ETHANOL**	• Location: GANGAMAI INDUSTRIES AND CONS, INDIA • Building Air Exchanges Per Hour: 0.65(unsheltered single storied)	• Chemical Name: Ethanol • Molecular Weight: 46.07 g/mol • Ambient Boiling Point: 77° **C** • Vapor Pressure at Ambient Temperature: 0.14 atm • Ambient Saturation Concentration: 144,032 ppm or 14.4%	• Wind: 5 meters/second from NE at 3 meters • Ground Roughness: open country • Cloud Cover: 0 tenths • Air Temperature: 35° C . • Stability Class: C • No Inversion :Height. • Relative Humidity: 5%	• Leak from hole in vertical cylindrical tank • Flammable chemical is burning as it escapes from tank	• Tank Diameter: 11 meters • Tank Length: 11.5 meters • Tank Volume: 1,093 cubic meters • Tank contains liquid Internal Temperature: 35° C • Chemical Mass in Tank: 749 tons Tank is 80% full • Circular Opening Diameter: 0.01 meters • Opening is 0.58 meters from tank bottom • Max Flame Length: 2 meters • Burn Duration: ALOHA limited the duration to 1 hour • Max Burn Rate: 3.61 kilograms/min • Total Amount Burned: 209 kilograms Note: The chemical escaped as a liquid and formed a burning puddle. • The puddle spread to a diameter of 1.7 meters.	• Threat Modeled: Thermal radiation from pool fire • Red : less than 10 meters(10.9 yards) --- (10.0 kW/(sq m) = potentially lethal within 60 sec) • Orange: less than 10 meters(10.9 yards) --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec) • Yellow: less than 10 meters(10.9 yards) --- (2.0 kW/(sq m) = pain within 60 sec)

7.8 FIRE FIGHTING DETAILS AS FOLLOWS:

The company has adequate water storage reserved for fire fighting, main fire hydrant pump, pump running on HSD, alarm system. Details are as follows -

1. Water storage for firefighting = 2500 M^3
2. Hydrant line pressure = 7.5 kg/cm^2
3. Number of hydrant point =5
4. Main hydrant pump capacity = 171M^3/hr
5. Jockey pump capacity = 10.8M^3/hr
6. Jockey pump starts at = after opening of Fire hydrant valve
7. Jockey pump starts at =
8. Main pump starts at = after start of jockey pump
9. Diesel pump starts at = in absence of power after start of jokey pump
10. Stops manually

IS Code or International code used for design of fire hydrant system is laid and will be modified before expansion. Foam based fire extinguisher system will be laid around the alcohol storage.

7.9 ON-SITE EMERGENCY PLAN

It was informed that that company has prepared on-site emergency plan for the existing facilities. This has to be implemented completely taking into consideration the safety audit report and conducting regular mockdrills. It is suggested to modify the same for the expanded capacity taking in to consideration Quantitative Risk analysis results given above and Mitigation measures and other suggested above.

7.9.1. Safety Measures during regular and shut-down:

It must be remembered that shutdown plant are also and sometimes more prone to accidents. Hence it is suggested that all workers, regular and contract workers should be issued proper PPE, like helmet, safety shoes etc. as necessary.
All work, hot work, working at height etc. during working and shutdown period should be carried out with proper work permit and under proper supervision.

7.9.2. DMP

It is part of On-site Emergency plan as it is stand alone industry and has to co-ordinate with local and nearest hospitals, police, fire brigade and Government officials.

7.10 OCCUPATIONAL HEALTH ASPECTS & MEDICAL PROVISION IN GIACL

7.10.1. Facilities available to workers

i) Full time medical officer.
ii) OHC with 2 rooms equipped all emergencies
iii) one compounder and one ward boy An ambulance with driver 24 by 7
iv) Regular medical check up of workers carried out, as per the requirements of Factory act and reports are available in the factory records

7.10.2. Effects of Alcohol on Health

Following is the additional information and suggestions with regard alcohol exposure –

It reacts vigorously with oxidizing materials. TLV for 8 hr. is 1000 ppm (ACGIH). Minimum identifiable concentration has been reported as 350 ppm. Exposure to concentrations of 5000 - 10000 ppm results in irritation of eyes and mucous membranes of the upper respiratory tract. Effects of exposure to higher concentration of Alcohol in the atmosphere are given in the following table

Table 7.5 - EFFECT OF ETHYL ALCOHOL

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

To prevent injury to workers, standard PPEs will be provided. In addition, sufficient number of Self-contained breathing apparatus will be provided to be used in case of major alcohol leakage to avoid exposure to higher levels of Alcohol.

All precautionary methods will be adopted by the company to reduce the risk of exposure of employees to occupational safety and health hazards.

7.10.3. Medical check-up

Pre & post medical check-ups will be done of all the employees. Employees will be regularly examined and the medical records will be maintained for each employee.

Pulmonary function test and periodical medical checkup shall be done once in every year.
The following tests will be conducted for each worker:

- Lung Function Test
- Radiology – X-ray
- Pulmonary Function Test
- Audiometric Test
- General clinical examination with emphasis on respiratory system
- Pre employment examinations
- Periodical medical examinations at the time of employment and after completion of employment.

The company will have OHC and other medical facilities at the site as per the factories act, and number of employees.

Some guide lines are given below:

Standard Medical facilities as required by Factory rule are expected to have been provided in the OHC for the existing plant, some important are illustrated below:

1. Well equipped First Aid Boxes will be provided in each Section of the factory.
2. Snake bite Lancet
3. In case of need, factory will be having dispensary to give effective medical facility to workers. In dispensary, sufficient stock of medicines will be available to provide to workers in case of any major emergent situation.
4. A vehicle will be always available to shift the sick/injured person to District Hospital.
5. Ambulance will be made available 24X7 in the factory to deal and take the injured workers to the district hospital.

7.11 EHS policy

The Company's EHS policy, if needed will be prepared (If not available) modified and displayed and known to the employees must inform district officials.

GANGAMAI INDUSTRIES AND CONSTRUCTION LIMITED, INDIA.
WORST CASE SCENARIO

Condition 1

Sr. No.	Name Of Chemical	Site Data	Chemical Data	Atmospheric Data	Source Of Chemical	Source Strength	Threat Zone
1.	**SULFUR DIOXIDE**	• Location: GANGAMAI INDUSTRIES AND CONS, INDIA • Building Air Exchanges Per Hour: 0.65(unsheltered single storied)	• Chemical Name: SULFUR DIOXIDE • Molecular Weight: 64.06 g/mol • Ambient Boiling Point: 11.2° C • Vapor Pressure at Ambient Temperature: greater than 1 atm • Ambient Saturation Concentration: 1,000,000 ppm or 100.0%	• Wind: 3 meters/second from NW at 10 meters • Ground Roughness: open country • Cloud Cover: 0 tenths • Air Temperature : 35° C • Stability Class: C • No Inversion :Height. • Relative Humidity: 5%	Gas flow through pipe	• Non-flammable gas is escaping from pipe • Pipe Diameter: 15 centimeters • Pipe Length: 30 meters • Unbroken end of the pipe is closed off • Pipe Roughness: smooth • Hole Area: 177 sq cm • Pipe Press: 2.7 atmospheres • Pipe Temperature: 50° C • Release Duration: 1 minute • Max Average Sustained Release Rate: 37.4 grams/sec (averaged over a minute or more) • Total Amount Released: 2.24kilograms	• Model Run: Heavy Gas • Red : 72 meters --- (100 ppm = IDLH) • Orange: 873 meters --- (0.75 ppm = AEGL-2 [60 min]) • Yellow: 1.45 kilometers --- (0.2 ppm = AEGL-1 [60 min])

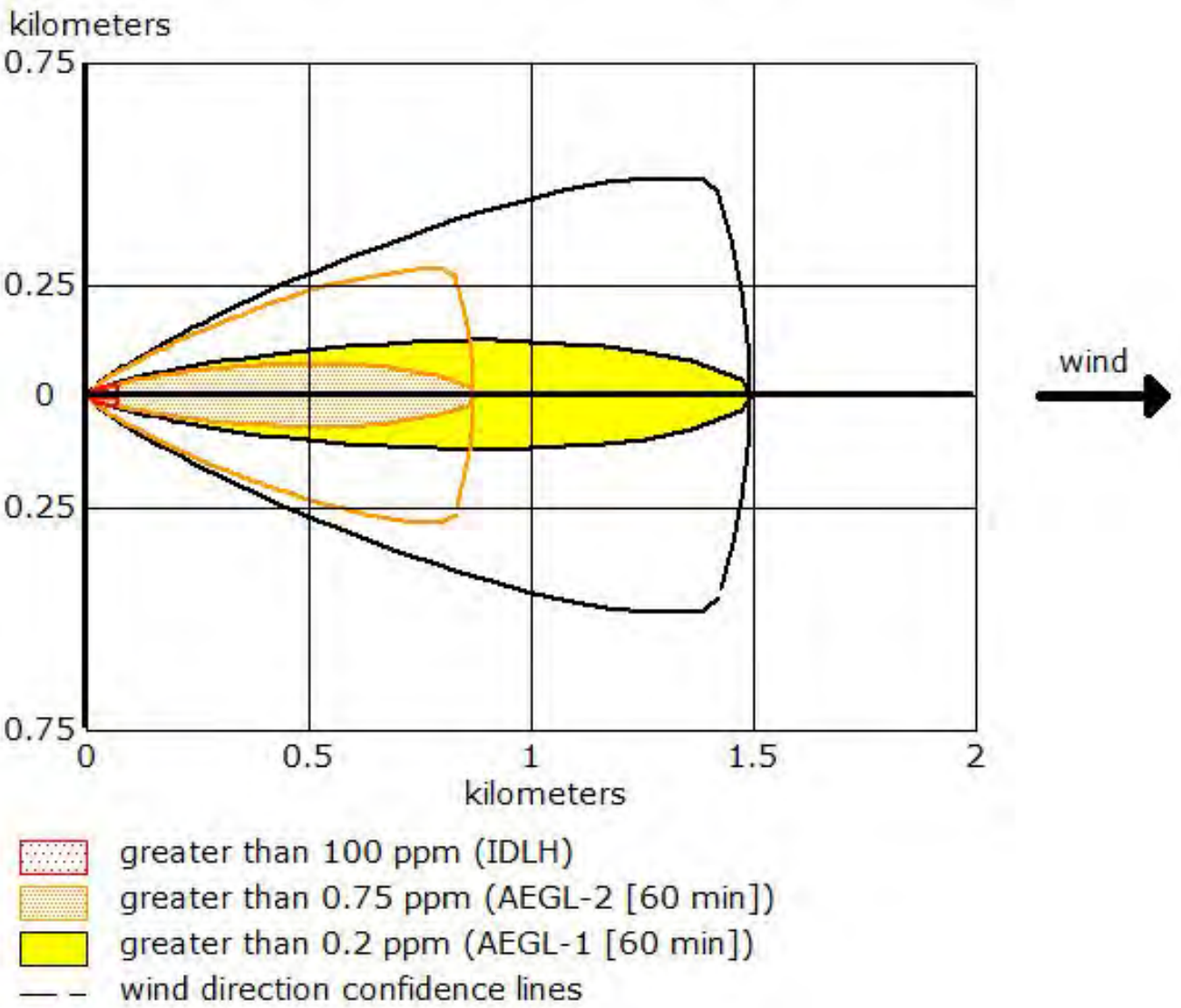

kilometers
0.75
0.25
0
0.25
0.75
0
0.5
1
1.5
2
kilometers
wind
greater than 100 ppm (IDLH)
greater than 0.75 ppm (AEGL-2 [60 min])
greater than 0.2 ppm (AEGL-1 [60 min])
wind direction confidence lines

Figure 2 Threat Zone at Point 1

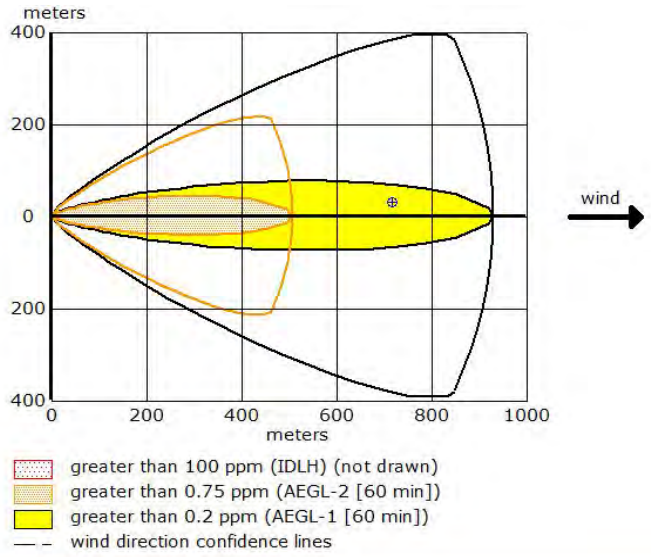


Figure 3 Strength at Point 1

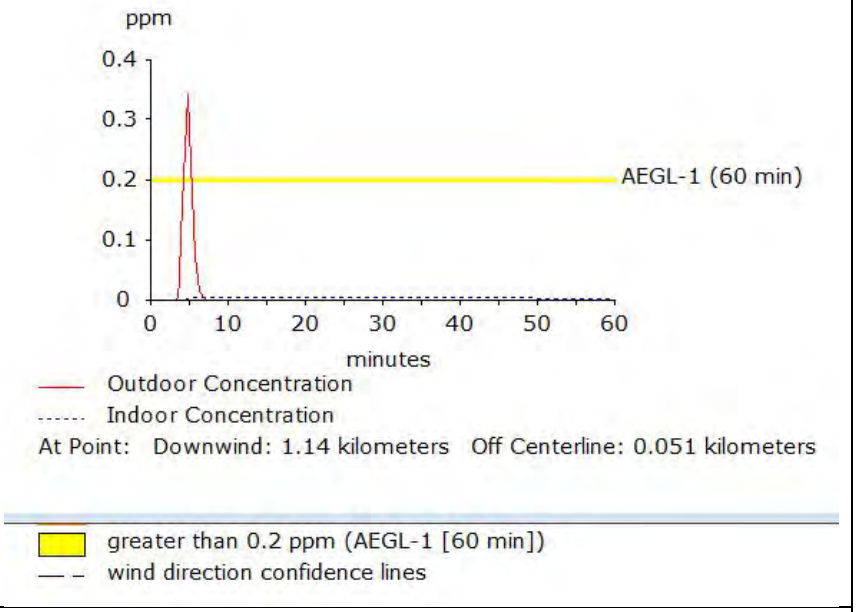
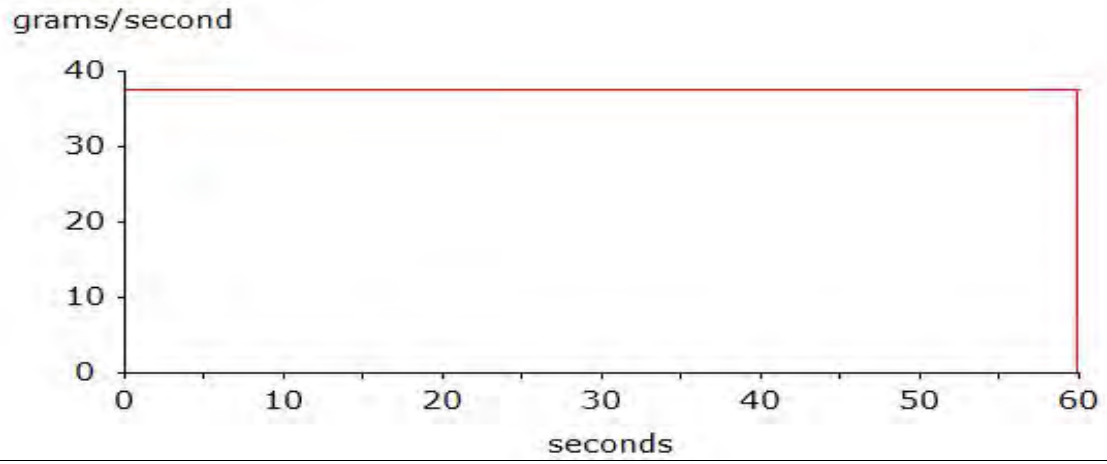
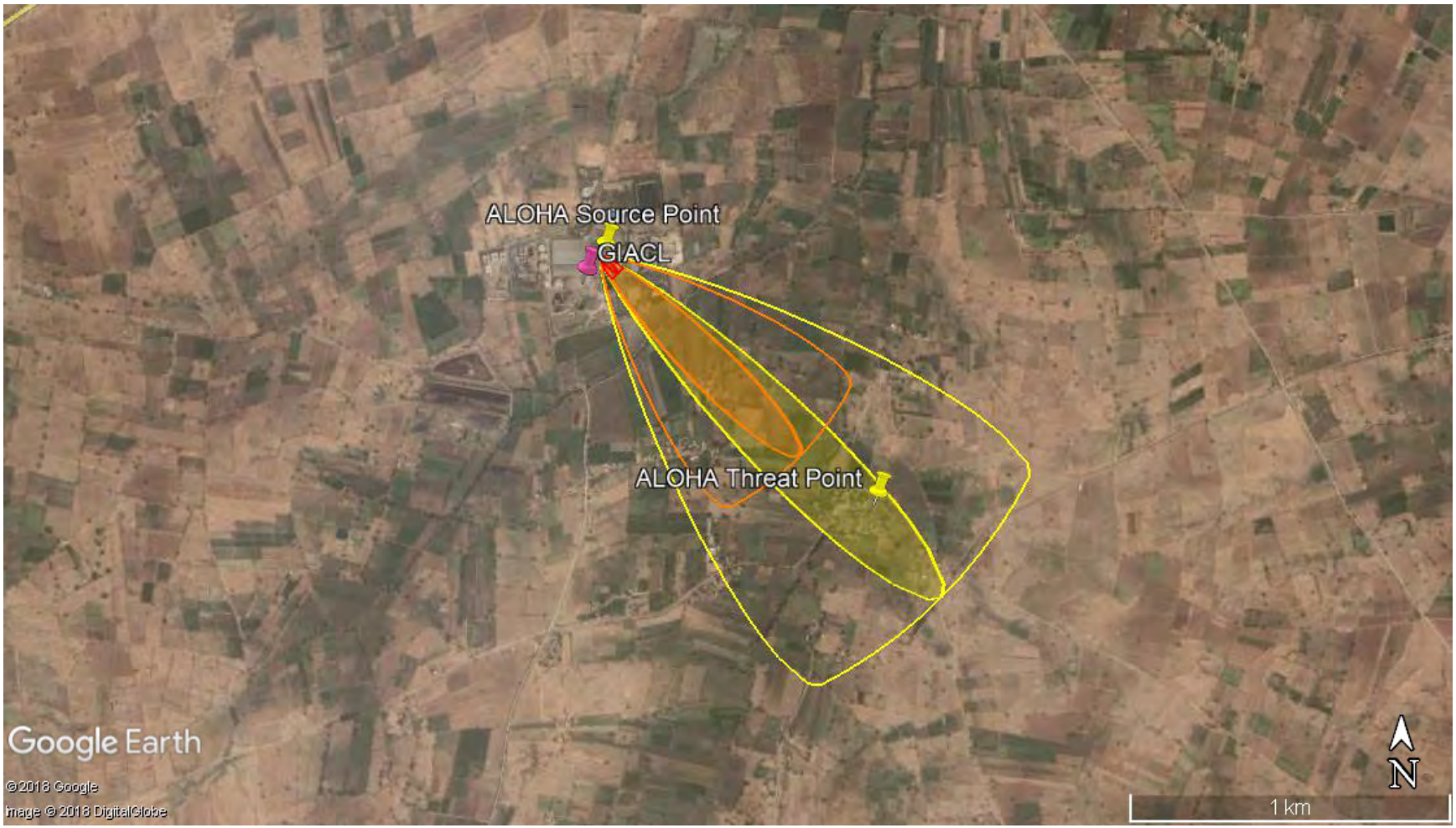


Figure 4 Source Strength



Google Image



Condition 2

Sr. No.	Name Of Chemical	Site Data	Chemical Data	Atmospheric Data	Source Of Chemical	Source Strength	Threat Zone
2.	**SULFUR DIOXIDE**	• Location: GANGAMAI INDUSTRIES AND CONS, INDIA • Building Air Exchanges Per Hour: 0.65(unsheltered single storied)	• Chemical Name: SULFUR DIOXIDE • Molecular Weight: 64.06 g/mol • Ambient Boiling Point: -11.3° C • Vapor Pressure at Ambient Temperature: greater than 1 atm • Ambient Saturation Concentration: 1,000,000 ppm or 100.0%	• Wind: 3 meters/second from NW at 3 meters • Ground Roughness: open country • Cloud Cover: 0 tenths • Air Temperature: 35° C . • Stability Class: C • No Inversion :Height. • Relative Humidity: 5%	Gas flow through pipe	• Non-flammable gas is escaping from pipe • Pipe Diameter: 15 centimeters Pipe Length: 30 meters • Unbroken end of the pipe is closed off • Pipe Roughness: smooth • Hole Area: 0.19625 sq cm • Pipe Press: 2.7 atmospheres • Pipe Temperature: 35° C • Release Duration: 31 minute • Max Average Sustained Release Rate: 580 grams/min • (averaged over a minute or more) • Total Amount Released: 2.24 kilograms	• Model Run: Heavy Gas • Red : 35 meters --- (100 ppm = IDLH) Note: Threat zone was not drawn because effects of near-field patchiness make dispersion predictions less reliable for short distances. • Orange: 453 meters --- (0.75 ppm = AEGL-2 [60 min]) • Yellow: 865 meters --- (0.2 ppm = AEGL-1 [60 min])

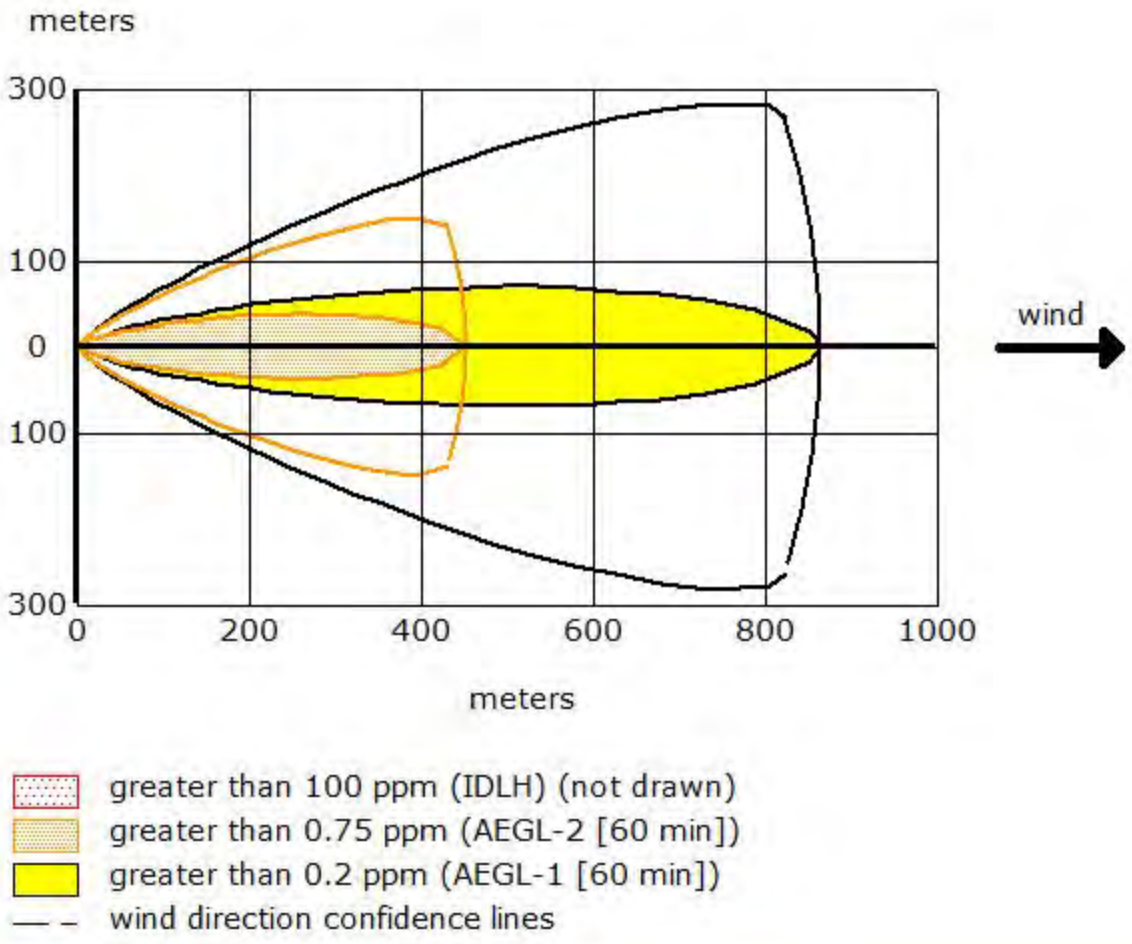

meters
300
100
0
100
300
0
200
400
600
800
1000
meters
wind
greater than 100 ppm (IDLH) (not drawn)
greater than 0.75 ppm (AEGL-2 [60 min])
greater than 0.2 ppm (AEGL-1 [60 min])
wind direction confidence lines

Figure 2 Threat Zone at Point 1

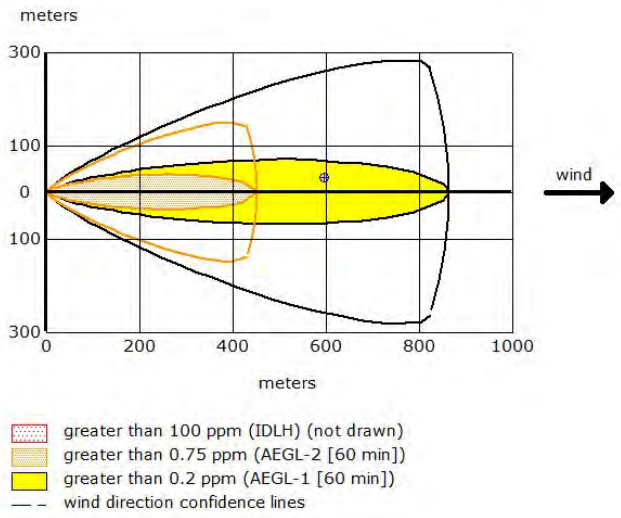


Figure 3 Strength at Point 1

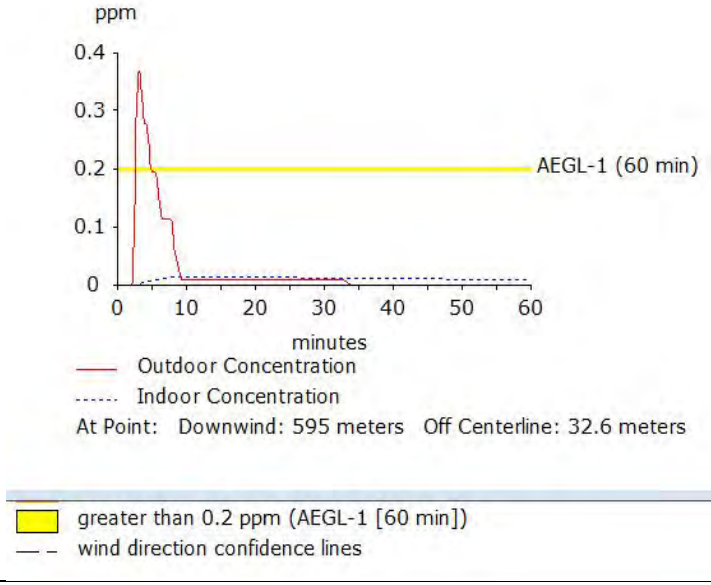
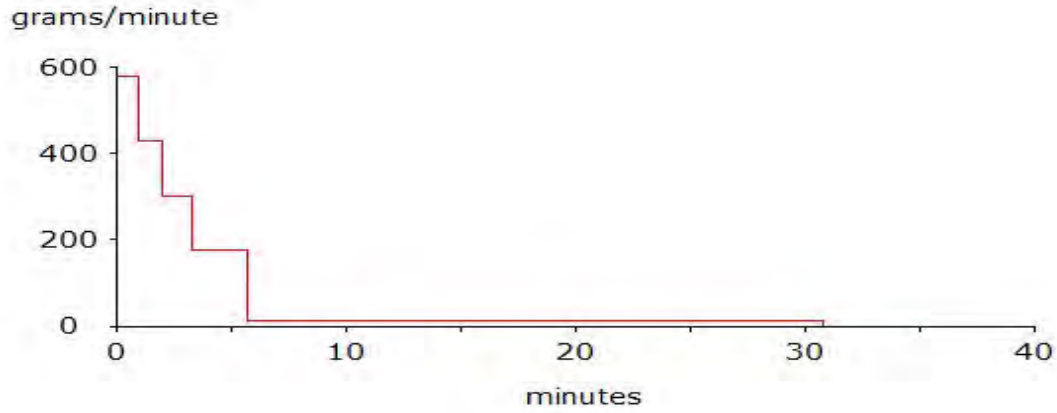


Figure 4 Source Strength

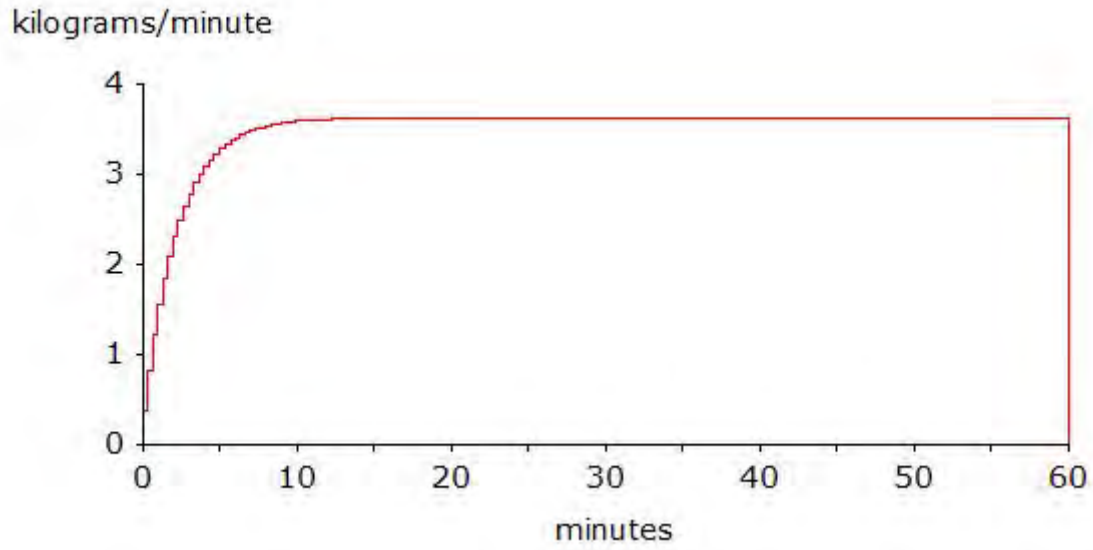


Condition 3

Sr. No.	Name Of Chemical	Site Data	Chemical Data	Atmospheric Data	Source Of Chemical	Source Strength	Threat Zone
3.	**ETHANOL**	• Location: GANGAMAI INDUSTRIES AND CONS, INDIA • Building Air Exchanges Per Hour: 0.65(unsheltered single storied)	• Chemical Name: Ethanol • Molecular Weight: 46.07 g/mol • Ambient Boiling Point: 77**° C** • Vapor Pressure at Ambient Temperature: 0.14 atm • Ambient Saturation Concentration: 144,032 ppm or 14.4%	• Wind: 5 meters/second from NE at 3 meters • Ground Roughness: open country • Cloud Cover: 0 tenths • Air Temperature : 35° C . • Stability Class: C • No Inversion :Height. • Relative Humidity: 5%	• Leak from hole in vertical cylindrical tank • Flammable chemical is burning as it escapes from tank	• Tank Diameter: 11 meters • Tank Length: 11.5 meters • Tank Volume: 1,093 cubic meters • Tank contains liquid Internal Temperature: 35° C • Chemical Mass in Tank: 749 tons Tank is 80% full • Circular Opening Diameter: 0.01 meters • Opening is 0.58 meters from tank bottom • Max Flame Length: 2 meters • Burn Duration: ALOHA limited the	• **Threat Modeled: Thermal radiation from pool fire** • **Red : less than 10 meters(10.9 yards) --- (10.0 kW/(sq m) = potentially lethal within 60 sec)** • **Orange: less than 10 meters(10.9 yards) --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)** • **Yellow: less than 10 meters(10.9 yards) --- (2.0**

Sr. No.	Name Of Chemical	Site Data	Chemical Data	Atmospheric Data	Source Of Chemical	Source Strength	Threat Zone
						duration to 1 hour • Max Burn Rate: 3.61 kilograms/min • Total Amount Burned: 209 kilograms Note: The chemical escaped as a liquid and formed a burning puddle. • The puddle spread to a diameter of 1.7 meters.	**kW/(sq m) = pain within 60 sec)**

Threat Modeled: Thermal radiation from pool fire
Red : less than 10 meters(10.9 yards) --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
Orange: less than 10 meters(10.9 yards) --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
Yellow: less than 10 meters(10.9 yards) --- (2.0 kW/(sq m) = pain within 60 sec)



Boiler Interlock

Fuel Handling System:-

1) Excess Bagasse Carrier stopped or tripped then MBC, CCSC and RBC tripped.
2) MBC stopped or tripped then CCSC and RBC tripped.
3) CCSC stopped or tripped then RBC tripped.
4) Pole cord switch or belt swa switch act then RBC tripped.

Ash Handling System:-

Ash Belt elevator stopped or tripped then all ash belt conveyer and ESP and APH RAV tripped.

FAN Interlock System:-

1) ID FAN stopped or tripped then FD FAN, SA FAN and fuel handling System are tripped.
2) FD FAN stopped or tripped then SA FAN and fuel handling System are tripped.
3) SA FAN stopped or tripped then fuel handlings System are tripped.

Drum Level Interlock:-

Drum level greater than 80% or less than 20% then FD Fan tripped.

Bagasse Feeder interlocks:-

1) Screw feeder stopped or tripped then bagasse feeder tripped.
2) SA FAN air pressure for fuel feeding less than 350 mmWc or both SA Fan stopped or tripped.

Feed Pump Interlock :-

Deareator level less than 30% or suction pressure less than 1kg/cm^2 or suction valve close or in between feedback or motor bearing temperature 90 ^{0}C or winding temperature greater than 110 ^{0}C or feed pump cooling water pressure less than 2 kg/cm^2 . All any above conditions or any one of above conditions occur then feed pump tripped.

ESP Interlock System:-

Any of ESP RAV stopped or purge air blower stopped or tripped or ESP inlet flue gas temperature less than 130 ^{0}C or ESP hopper level hi hi alarm then ESP TRCC tripped.

Boiler Alarm

1) ID, FD, SA and BFW bearing temperature greater than 80 ^{0}C .
2) ID, FD, SA and BFW winding temperature greater than 90 ^{0}C .
3) Fuel feeding air pressure for bagasse less than 450 mmWc.
4) ESP inlet Temperature 140 ^{0}C .
5) Main steam pressure less than 80 kg/cm^2 .
6) Main steam Temperature 500 ^{0}C .
7) Main steam pressure greater than 90 kg/cm^2 .
8) Main steam Temperature 529 ^{0}C .
9) Deareator level less than 60%
10) Deareator level greater than 90%
11) Deareator Temperature less than 105 ^{0}C .
12) Deareator Temperature greater than 112 ^{0}C .

Turbine Interlock System

Turbine Tripping Interlock:-

1) Lube oil pressure less than 1.8 kg/cm$^{2.}$
2) Control oil pressure less than 7.8 kg/cm$^{2.}$
3) Oil tank level less than 36.5%.
4) Turbine inlet pressure less than 41.5 kg/cm$^{2.}$
5) Turbine inlet temperature less than 485 ^{0}C.
6) Turbine inlet pressure greater than 99 kg/cm$^{2.}$
7) Turbine inlet temperature greater than 543 ^{0}C.
8) Exhaust steam temperature less than 120^{0}C.
9) Exhaust steam Temp. between 105 ^{0}C and 120 ^{0}C. more than 1hr.
10) Exhaust steam pressure less than -0.763 kg/cm$^{2.}$
11) Hotwell level greater than 92.5%.
12) OHT level less than 94%.
13) Turbine no load more than 1hr.

Pressure Timer:-

Timer T1:

TG inlet pressure in between 87.12 kg/cm$^{2.}$ And 99.56 kg/cm$^{2.}$ Then timer start for counting 12 hr (paused timer). After completion 12 hr then turbine trip.

Timer T2:

Turbine running time 1year after that turbine Trip.

Temperature Timer:

Timer T1 (Retentive Timer):

TG inlet Temp. in Between 523 ^{0}C to 529 ^{0}C then timer start counting 16 day 16 hr (paused timer) after completion 16 day 16 hr then turbine trip.

Timer T2 (Retentive Timer):

Turbine running time 1year after that turbine Trip.

Timer T3 (Retentive Timer):

TG inlet Temp. in Between 529 ^{0}C to 543 ^{0}C then timer start counting 3 day 8 hr (paused timer) after completion 3 day 8 hr then turbine trip.

Timer T1:

TG inlet Temp. in Between 529 ^{0}C to 543 ^{0}C continuously timer start for 15 min (reset timer) after completion 15 min then turbine trip.

Vibration Alarm and Trip Condition(Turbine, gearbox and Alternator):-

SR NO	TAG	Service Name	Alarm H	Trip HH	Alarm L	Alarm LL
1	ZI-801	Axial Displacement	0.4 mm	0.6 mm	-0.4mm	-0.6mm
2	ZI-802	Axial Displacement	0.4 mm	0.6 mm	-0.4mm	-0.6mm
3	YI-801	Turbine Front Bearing Vibration X-axis	76 µ	99 µ		
4	YI-802	Turbine Front Bearing Vibration Y-axis	76 µ	99 µ		
5	YI-803	Turbine Rear Bearing Vibration X-axis	76 µ	99 µ		
6	YI-804	Turbine Rear Bearing Vibration Y-axis	76 µ	99 µ		
7	YI-805	GB High Speed DE Vibration X-axis	65 µ	125 µ		
8	YI-806	GB High Speed DE Vibration Y-axis	65 µ	125 µ		
9	YI-807	GB High Speed NDE Vibration X-axis	65 µ	125 µ		
10	YI-808	GB High Speed NDE Vibration Y-axis	65 µ	125 µ		
11	YI-809	GB Low Speed NDE Vibration X-axis	90 µ	150 µ		
12	YI-810	GB Low Speed NDE Vibration Y-axis	90 µ	150 µ		
13	YI-811	GB Low Speed DE Vibration X-axis	90 µ	150 µ		
14	YI-812	GB Low Speed DE Vibration Y-axis	90 µ	150 µ		
15	YI-813	Alternator Front Vibration X-axis	178 µ	232 µ		
16	YI-814	Alternator Front Vibration Y-axis	178 µ	232 µ		
17	YI-816	Alternator Rear Vibration X-axis	178 µ	232 µ		
18	YI-817	Alternator Rear Vibration Y-axis	178 µ	232 µ		
19	-	Exciter Field Volt	200 V	200 V		
20	-	Exciter Field Current	25 A	25 A		

Bearing Temperature, Alarm and Trip Condition(Turbine, gearbox):-

SR NO	SENSOR	ALARM	TRIP
1	Turbine Thrust active top bearing Temp.	95 ^{0}C.	100 ^{0}C.
2	Turbine Thrust non active top bearing Temp.	95 ^{0}C.	100 ^{0}C.
3	Turbine Front Bearing Temp.	110 ^{0}C.	120 ^{0}C.
4	Turbine Rear Bearing Temp.	110 ^{0}C.	120 ^{0}C.
5	Turbine active bearing Bottom Temp.	95 ^{0}C.	100 ^{0}C.
6	Turbine non active bearing Bottom Temp.	95 ^{0}C.	100 ^{0}C.
7	Gear box High speed front bearing Temp.	100 ^{0}C.	107 ^{0}C.
8	Gear box High speed rear bearing Temp.	100 ^{0}C.	107 ^{0}C.
9	Gear box low speed front bearing Temp.	85 ^{0}C.	90 ^{0}C.
10	Gear box low speed rear bearing Temp.	85 ^{0}C.	90 ^{0}C.

Bearing Temperature, Alarm and Trip Condition(Alternator):-

SR NO	SENSOR	ALARM	TRIP
1	Alternator Front Bearing Temp.	85 ^{0}C.	95 ^{0}C.
2	Alternator Rear Bearing Temp.	85 ^{0}C.	95 ^{0}C.
3	Alternator Winding Temp. (U1)	125 ^{0}C.	130 ^{0}C.
4	Alternator Winding Temp. (V1)	125 ^{0}C.	130 ^{0}C.
5	Alternator Winding Temp. (W1)	125 ^{0}C.	130 ^{0}C.
6	Alternator Winding Temp. (U2)	125 ^{0}C.	130 ^{0}C.
7	Alternator Winding Temp. (V2)	125 ^{0}C.	130 ^{0}C.
8	Alternator Winding Temp. (W2)	125 ^{0}C.	130 ^{0}C.
9	Inlet air Temp.-1 (Not Trip)	50 ^{0}C.	55 ^{0}C.
10	Outlet air Temp.-1 (Not Trip)	80 ^{0}C.	85 ^{0}C.
11	Inlet air Temp.-2 (Not Trip)	50 ^{0}C.	55 ^{0}C.
12	Outlet air Temp.-2 (Not Trip)	80 ^{0}C.	85 ^{0}C.
13	Alternator Core-1 Temp.	125 ^{0}C.	130 ^{0}C.
14	Alternator Core-2 Temp.	125 ^{0}C.	130 ^{0}C.
15	Alternator Core-3 Temp.	125 ^{0}C.	130 ^{0}C.
16	Exciter Field Temp.	125 ^{0}C.	130 ^{0}C.

CEP Interlock System:-

1) Condensate discharge header pressure less than 3.5 kg/cm^2 then CEP auto start.
2) Hotwell level Greater 84.40% then auto start.

3) Hotwell level less than 20% then CEP Pump tripped.

Barring Gear Motor Interlock System:-

1) Lube oil pressure greater than 1.95 kg/cm^2 then barring gear motor start permissive.
2) Turbine RPM less than 250 RPM then barring gear motor start permissive.
3) EOP ready or HOT level greater than 94% barring gear motor start permissive.
4) Turbine speed greater than 350 RPM then barring gear motor auto stopped.

Hood Spray Valve Interlock System:-

1) Exhaust temperature greater than 80 ^{0}C then auto open valve.
2) Exhaust temperature less than 55 ^{0}C then auto close valve.
3) Hood spray valve continuously 1 hr open then auto valve closed.

Vacuum Breaker Valve Interlock System:-

1) Lube oil header pressure less 1.95 kg/cm^2 then auto open.
2) Generator differential relay operated than auto open.
3) Turbine rotor axial movement hi hi.
4) Turbine RPM less than 70% then open.

Turbine Extraction QCNRV Interlock System:-

1) Active Power greater than 6.6 MW then valve open permissive.
2) Active Power less than 5.5 MW then valve auto closed.
3) Turbine Trip then valve auto closed.

Turbine Bleed QCNRV (HP Heater)Interlock System:-

1) TG inlet Steam flow greater than 40 TPH then open permissive.
2) TG inlet Steam flow less than 35 TPH then valve auto closed.
3) Turbine Trip then valve auto closed.

Turbine Bleed QCNRV (MP Process)Interlock System:-

1) TG inlet Steam flow greater than 40 TPH then open permissive.
2) TG inlet Steam flow less than 35 TPH then valve auto closed.
3) Turbine Trip then valve auto closed.

Wonder Bleed Control Valve 101 Interlock System:-

1) TG Steam Flow greater than 40 TPH then valve open permissive.
2) TG Steam Flow less than 35 TPH then valve auto closed.

3) TG Steam Flow greater than 65 TPH then valve auto closed slowly and wonder valve 102 slowly simultaneously opened.
4) Turbine Trip then valve auto closed.

Wonder Bleed Control Valve 102 Interlock System:-

1) TG Steam Flow greater than 65 TPH then valve open permissive.
2) TG Steam Flow less than 60 TPH then valve auto closed.
3) TG Steam Flow greater than 60 TPH then valve auto closed slowly and wonder valve 101 slowly simultaneously opened.
4) Turbine Trip then valve auto closed.