

CHAPTER – 7

ADDITIONAL STUDIES

7.1 PUBLIC CONSULTATION

Public hearing of the project was held on 15th July 2017 (at 11 AM) at Rajabari, Letekujan, M.E. School Campus, P.O. Letekujan, Mouza-Morongi, Dist.: Golaghat, Assam. Around 600 persons attended the public hearing and from them 31 persons have expressed their views. Major issues were related to employment, CSR activities and pollution. Majority of the local persons were in favor of the project. Detailed proceeding of public hearing is enclosed as annexure-XII.

7.2 RISK ASSESSMENT STUDIES

Industrial activities including process, production, storage, handling, transportation and operational practices presents levels of hazards to workforce, population and environment at large due to accidents, spills, leaks etc. These accidents results in personal and financial loss. The assessment of the threat posed, its control and prevention through good design, management and operational controls is of primal importance.

Events like the Bhopal tragedy have emphasized the need to address both on-site and off-site safety. It is against this background that the various Section and Rules under the Environment Protection Act, 1986, the Factories Act, 1948 and other Acts specify the requirements for a safe and reliable working of an industry. These require carrying out various studies and analysis to assess and mitigate hazards prevalent in the factory in line with the above goal of safe and reliable working. These are more commonly known as “Risk Assessment Studies”.

Risk assessment refers to the technical, scientific assessment of the nature and magnitude of risk and uses a factual base to define the health effects of exposure of individuals or populations or ecological receptors to hazardous contaminants and situations.

This chapter explains the basis of Risk Assessment and its objectives.

7.3 OBJECTIVE OF THE STUDY

The main objectives of the Risk Assessment Studies are as given below:

- 1) To identify the potential hazards and their sources.
- 2) To define various accident release scenarios with respect to the hazard.
- 3) To assess the damage caused by the source in the event of accidents
- 4) To devise strategies for the prevention of the accidents.
- 5) To define and assess emergencies, including risk impact assessment
- 6) To control and contain incidents.
- 7) To safeguard employees and people in vicinity.
- 8) To minimize damage to property and environment.
- 9) To inform the employees, the general public and the authority about the hazards / risk assessed, safeguards provided, residual risk if any and the role to be played in them in the event of emergency.
- 10) To ensure safety of the workers before personnel re - enter and resume work.
- 11) To work out a plan with all provisions to handle emergencies and to provide for emergency preparedness and the periodical rehearsal of the plan.

7.4 PHILOSOPHY AND METHODOLOGY OF RISK ASSESSMENT

Risk is defined as the probability of an adverse event due to disturbances in the environment. One can also describe risk with the following expression.

$$\text{Risk} = \text{Severity of event (Hazard)} \times \text{Exposure}$$

Major hazard installations have to be operated to a very high degree of safety; this is the duty of the management. In addition, management holds a key role in the organization and implementation of a major hazard control system. In particular, the management has the responsibility to,

- i. Provide the information required to identify major hazard installations;

- ii. Carry out hazard assessment;
- iii. Report to the authorities on the results of the hazard assessment;
- iv. Set up an emergency plan;
- v. Take measures to improve plant safety.

In order to fulfill the above responsibility, the Management must be aware of the nature of the hazard, of the events that cause accidents and of the potential consequences of such accidents. This means that in order to control a major hazard successfully, the Management must have answers to the following questions:

- a. Do toxic, explosive or flammable substances in our facility constitute a major hazard?
- b. Which failures or errors can cause abnormal conditions leading to a major accident?
- c. If a major accident occurs, what are the consequences of a fire, an explosion or a toxic release for the employees, people living outside the factory, the plant or the Environment?
- d. What can Management do to prevent these accidents from happening?
- e. What can be done to mitigate the consequences of an accident?

The most appropriate way of answering these questions is to carry out a hazard or risk assessment study, the purpose of which is to understand why accidents occur and how they can be avoided or at least mitigated. A properly conducted assessment will therefore

- i. Analyze the existing safety concept or develop a new one;
- ii. Identify the remaining hazards; and
- iii. Develop optimum measures for technical and organization protection in event of an abnormal plant operation.

7.5 DETAILS OF MANUFACTURING PROCESS

Detail of manufacturing process is given in chapter-2.

7.6 DETAILS OF STORAGE FACILITY

The list of hazardous materials with classification, state, storage and operational details are given in table-7.1.

TABLE - 7.1 LIST OF HAZARDOUS MATERIALS

S. No.	Name of the chemical	Type & Number of Storage's	Capacity & No. of Storage	Max. Storage Capacity (MT)	Place of storage
1.	Ethanol	Liquid tank	450 m ³ x 1 nos.	900	Tank farm
2.	Acetic Acid	Liquid tank	100 m ³ x 2 nos.	200	Tank farm
3.	Furfural	Liquid tank	115 m ³ x 2 nos.	330	Tank farm
4.	BioCoal	Solids silo	500 m ³ x 1 nos.	500	Silo, Biocoal
5.	Concentrated Stillage syrup	Liquid tank	70 m ³ x 1 nos.	70	Treatment of stillage
6.	Stillage cake	Slurry tank	70 m ³ x 1 nos.	180	Treatment of stillage

Note:

1. Fire fighting system as per OISD 117 norms.
2. Third Party safety audit to find out probable unsafe condition/ cause & to take remedial action.

7.6.1 SAFETY PRECAUTIONS FOR THE STORAGE OF MATERIALS

Following precautions shall be taken while storage of chemicals/products in tanks;

- The tanks shall be located and marked in the designated area for the chemical storage.
- Tanks of proper material of construction will be selected.
- The tanks shall be filled up to 90% of its capacity
- All tanks shall be uniformly tagged.
- Level indicators in tanks shall be provided.
- Industrial type electrical fittings shall be provided.

- Electrical installation shall be of flame proof type.
- Safe working place shall be provided in between all tanks/equipments.
- Proper colour coding shall be done to all pipe lines.
- Adequate fire fighting equipments shall be provided.
- Anti corrosive painting to be done.
- No smoking board shall be displayed.
- Safety instruction board shall be displayed.
- Standard Operating Procedure for the storage will be prepared.
- Proper earthing/bonding shall be provided.
- Lightning arrestor should be provided.

Precautions for storage in drums or bags;

- Separately stored with proper enclosures and marked, within premises in closed shed
- Proper ventilation shall be provided
- Sufficient fire extinguishers and PPE shall be provided
- Flame proof fittings will be provided
- Smoking will be prohibited

7.7 IDENTIFICATION OF HAZARDS

The first step in risk assessment is to identify the types of adverse health effects that can be caused by exposure to some agent in question, and to characterize the quality and weight of evidence supporting this identification.

7.7.1 MAJOR HAZARDS

M/s. Numaligarh Refinery Limited would be manufacturing Ethanol. Along with Ethanol other product will also be produce i.e. Acetic Acid, Furfural, Biocoal and Stillages. With the nature of product, organization will be handling hazardous materials during operation. A **hazardous material** is any item or agent (biological, chemical, physical) which has the potential to cause harm to humans, animals, or the environment, either by virtue of its intrinsic property or through interaction with other factors.

The potential hazard associated with the distillery industry are primarily classified into

- Chemical Hazard:
 - a. Toxicity
 - b. Flammable
 - c. Explosive
 - d. Corrosive
 - e. Carcinogen
 - f. Irritant

While hazards of other type along with safety measures, flood control measures and earthquake control measures are given in table-7.2, table-7.3 and table-7.4 respectively.

For existing refinery complex NRL has comprehensive Disaster Management Plans for both Onsite and Offsite emergencies based on Quantitative Risk Assessment carried out for the Refinery. NRL's Emergency Response and Disaster Management Plan is prepared as per Petroleum & Natural Gas Regulatory Board Regulations (NDMA Act, 2006); duly certified by M/s Bureau Veritas. As per the Factories Act & guidelines of Ministry of Petroleum and Natural Gas & MOEF Govt. of India, a detailed plan for Offsite Emergency has been developed, where cooperation from all Govt. agencies and district officials plays a pivotal role. The plan has also meets the clauses 13 & 14 of Manufacture, Storage and Import of Hazardous chemicals rules, 1989 of Environment Protection Act 1986. The Offsite Plan is approved by The Deputy Commissioner of Golaghat District. For the proposed project, same facility/management extended for safety of the plant.

TABLE - 7.2 HAZARDS AND ITS CONTROL

SR. NO	NAME OF THE POSSIBLE HAZARD & EMERGENCY	IT'S SOURCE & REASONS	IT'S EFFECT ON PERSONS PROPERTY & ENVIRONMENT	PLACE OF EFFECT	CONTROL MEASURES PROVIDED
1.	BOILER 1. Burning physical injury explosion	Over pressure in the boiler if safety valve not working. Water level indicator not working. Low water level indicator fail. High temp. system fail.	Minor/Major injury loss of human life loss of property (loss of Main/machine material)	Boiler House and surrounding places	Lower & upper level indication system provision. Safety valves for pressure control fixed temp. & pressure indicator provided. Blow down & blowing system provided for cleaning tube and shell. Soft water used. Inter locking provided on pumps, FD fan, ID fan. Periodical checking & inspection maintenance done. Yearly inspection done by boiler inspector.
2.	ELECRICITY (1) Burning (2) Fire (3) Shock	Loose contacts, weak earthing short circuit improper insulation	Burning, shock, Death	Surrounding the accident area	Proper Earthing, Periodical Checking of joints, proper insulations of Equipment, etc. flame proof fitting in solvent storage area, bounding and jumpers to all solvent barrier lines provided.
3.	HOUSE KEEPING (1) Physical (2) Burning (3) Fire (4) Chemical explosion	Bad House keeping	Physical / Chemical Thermal Burn injury (Major / Minor) In all surrounding areas i.e. storage	In all surrounding areas i.e. storage plants	Proper handling, regular cleaning, Proper placement of material.
4.	PIPELINE LEAKAGES Spillages etc. (1) Corrosion (2) Toxic gas release	Leaking of pipe line to corrosion. Loose contact etc.	Physical / Chemical Thermal Burn injury (Major / Minor)	Plant area	Proper maintenance, Proper selection of material for pipe lines, immediate attention, Earthing provided, flame proof fitting. NO SMOKING Boards displayed.
5.	Fire	Natural Disaster, Earthquakes, Lightning, war.	Production hindrance Trapping under debris, death Chemical burn Toxic chemical spillage	Whole factory & population nearby	<ul style="list-style-type: none"> Hydrant system First aid available Smoking prohibited inside the factory Security at all the time guarding important locations
6.	Fire & smoke	Fire in storage tank	Burns Storage tank catching fire Production hindrance	Tank area	<ul style="list-style-type: none"> Adequate earthing Tanker unloading permit Unauthorized person not allowed to enter Breathing Apparatus for rescue operations Alarm system for indicating unusual incidence

TABLE - 7.3 FLOOD CONTROL MEASURES

No.	Hazard	Safety Precautions	Emergency Control
1.	Electric shock	- All electric line cut off / switch off from main supply - Hand siren use to declare emergency - Shock proof hand gloves should be used if needed	Stop electric power Inform site main controller for outside help
2.	Slippery Surface	- Clean the working place - Keep away all persons at safe assembly points - Evacuate all persons through emergency exit door immediately	Start the emergency water tapping

TABLE - 7.4 EARTHQUAKE CONTROL MEASURES

No.	Hazard	Safety Precautions	Emergency Control
1.	Fire	- Minimum stock of Hazardous chemicals - Earthquake proof building	- Stop the leakage - Inform site main controller for outside help
2.	Mixing of incompatible chemicals	- Safe distance between chemicals - Dyke wall at all storage tank of chemicals	- Stop the leakage - Inform site main controller for outside help

7.8 PROCESS HAZARD AND SAFETY

Process Hazard Analysis (PHA) is a method to evaluate and identify credible hazardous scenarios. PHA is a thorough, orderly, systematic approach for identifying, evaluating, and controlling the hazards of processes involving hazardous chemicals. Proposed hazardous process details of plant are given in following table-7.5.

TABLE - 7.5 PROCESS HAZARD AND ITS CONTROL

No.	Particulars		Control Measure
01	Name of the Process	Ethanol Distillation	<ul style="list-style-type: none"> - Skill Supervisor - Process Safety Information - Operating Procedures - Fire proof electricity fitting - Earthing Bonding - Proper MOC selection - Transportation of raw materials & intermediates through fix piping - Mechanical seal in all pumps and reactors - Process automation with safety lock - CO₂ gas detector
	Material involved in process	Ethanol	
	Location	Within Plant	
	Hazard details	Raising in Temperature VOCs emission CO ₂ emission	

Process Hazard Safety Management:

Process Safety Management is a new discipline covering all aspects of risk and involving the identification, assessment and control of hazards in process facilities. The hazards most commonly considered include fires, explosions and release of hazardous substances.

Process Safety Management System integrates all aspects of risks in a facility and puts them under the control of a management system. By establishing a heightened awareness of the safety impacts of technology, personnel and the management, the system provides a dynamic environment for continual improvement.

7.9 SAFETY PRECAUTIONS FOR HANDLING AND TRANSPORTATION OF MATERIALS

Following safety precautions will be taken for handling and transportation of materials;

- PPE will be used
- Proper earthing bonding
- Flam arrestor will be used
- Contact with skin and eyes will be avoided

7.9.1 SAFETY PRECAUTION FOR HANDLING AND TRANSPORTATION OF ALCOHOL

Alcohol (Fuel grade Ethanol), is a volatile, flammable, colorless liquid. It burns with a smokeless blue flame that is not always visible in normal light. Mixtures of ethanol and water that contain more than about 50% ethanol are flammable and easily ignited. At room temperature, Ethanol is stable.

Ethanol produced shall be stored in MS tanks in a cool, dry well-ventilated location. Tanks will be bonded and grounded for transfers to avoid static sparks. Transfer of alcohol will be done using special flame proof pumps with CF8 grade make. The storage area shall be a smoke free zone. Use of non-sparking type tools and equipment, including explosion proof ventilation.

To prevent accidental release or leakage from tank following precaution shall be taken;

- A visual external inspection according to a checklist that includes markings, valves, manhole and cover and paint condition
- Through external examination including corrosion, dents or mechanical damage, missing or loose bolts, required markings and frame & support are in acceptable condition.
- Nuts & bolts are of SS material. Valve colour coding & identification is periodically checked.
- The examination shall be witnessed by third party competent person.

Receiving storage tank is normally equipped with load cell arrangement and/or level monitoring device, which display on line transfer.

7.10 FIREFIGHTING SYSTEM

NRL management shall take into consideration fire prevention measures at the project planning and during plant commissioning stage to avoid any outbreak of fire. But looking to the hazardous nature of process and the product Ethanol. Acetic Acid and Furfural that shall be handled and processed, the chances of outbreak of fire cannot be totally refuted. Hence to avoid such a scenario, a well laid fire protection system conforming OISD norm 117 will be provided in the factory. List of proposed fire fighting equipments are given in table-7.6.

Storage area shall be protected by hydrants system. A full flagged hydrant system (with hydrant lines and water spray system shall be provided covering storage areas and at different location within the premises. Water storage reservoir will be provided for hydrant system. Separate high capacity fire pumps preferably of CS will be provided to hydrant system.

Mobile/portable foam system shall be provided for suppression of pool fire in ENA storage area. Mobile system includes foam producing unit mounted on wheels towed by a vehicle or self propelled. Foams shall be supplied through foam towers to the burning surface.

A manually operated sirens located at strategic points shall be installed as fire alarm system in case of fire outbreak.

TABLE - 7.6 LIST OF PROPOSED FIREFIGHTING EQUIPMENTS

No.	Name of Equipment
1.	DCP type extinguishers (10 kgs., 75 kgs., etc)
2.	Foam type extinguishers (9 kgs., 45 kgs., etc)
3.	CO ₂ type extinguishers (2 kgs., 5 kgs., etc)
4.	Hydrant Post
5.	Hose Reel
6.	Hose Cabinet (MS)
7.	Nozzles
8.	Bucket Stand
9.	Water Reservoir

7.11 SAFETY FEATURES AND EMERGENCY CAPABILITIES TO BE ADOPTED

7.11.1 OBJECTIVES OF EMERGENCY PROCEDURES

Measures those are required to be taken during emergency are co-ordination of activities with many departments/ services and outside resources.

The objective of the procedure is to define role of key personnel of different services during major emergency to be effectively utilized to:

- 1) Safeguard lives
- 2) Contains of incident and bring it under control
- 3) Minimize damage to property & neighboring environment
- 4) Rescue & treatment of casualties & evacuation of persons to safe areas
- 5) Identification of affected persons, information to relatives and extending necessary assistance.
- 6) Preservation of information, records etc. which will help in investigation
- 7) Welfare assistance to casualties
- 8) Providing relevant information to police, district authorities and news media
- 9) Mobilizing inside resources
- 10) Initiating and organizing evacuation of affected persons

Collecting latest status, other information and requirement

7.11.2 BASIS OF PLAN AND HANDLING OF EMERGENCY

- 1) It is not possible to envisage and detail every action, which should be taken during an emergency. The basic philosophy is to get key personnel of necessary discipline who have the knowledge and background to assess the situation and give directions as per the objectives as quickly as possible.
- 2) The plan identifies the services / departments required to combat emergencies and also identifies the key persons to discharge the duties.
- 3) Key personnel have been identified for emergencies and are responsible for providing necessary assistance.
- 4) Any outside assistance, which company shall get, shall be co-ordinate by the MAIN SITE CONTROLLER on duty.
- 5) Messages via telephones are restricted to key personnel only. This is required to keep the telephones free for key personnel to contact for necessary feed-back.
- 6) Senior person who arrives on scene is automatically incharge for the service group. He should not leave the site without entrusting the charge to his deputy. All the key personnel should be available at the main control room. All key personnel of other services will report to main site controller, who will co-ordinate between various departments and outside agencies.

7.11.3 INFORMATION ABOUT EMERGENCY AND SUBSEQUENT ACTIONS

- 1) Any person noticing fire/explosion/re lease of hazardous gases should shout FIRE, FIRE or HELP, HELP and will activate the emergency bell
- 2) Inform respective control rooms
- 3) The Executive in-charge along with the concerned Dept. Head will immediately rush to the incidence site to assess and take immediate action required to control the source of incidence. They will also inform Security and Safety personnel to come to the place of disaster/emergency and assist them.
- 4) If he feels that the situation is likely to escalate and may lead to emergency will communicate following minimum information to all senior persons.
 - a) Brief description of incident.
 - b) Status & seriousness of the situation
 - c) Actions immediately taken.
 - d) Immediate assistance required.
 - e) All key personnel of respective services, depending on nature of emergency will arrive at site to take charge of positions.

7.11.4 INSTRUCTIONS TO EMPLOYEES

The plan assumes certain discipline at site during emergency as given below;

- 1) Do not get panicky
- 2) Do not approach the scene of disaster as a spectator
- 3) Do not engage phones / P.A. system unnecessarily
- 4) Non-essential personnel to gather at security gate after receiving instructions
- 5) Do not move here & there unnecessarily
- 6) Do not approach unnecessarily to get information or more inquiry
- 7) Remain at your working place unless called and be attentive to instructions
- 8) Ensure that all contract laborers working in the premises are immediately sent to main security gate. They will receive further instructions from main site controller

All non - essential staff members should gather at safe assembly point after assessing the wind direction (from the wind sock, stack of boiler chimney) and wait for further instructions which will be communicated through PA system or by other available means.

7.11.5 INSTRUCTIONS TO CONTRACTORS

The plan assumes certain discipline at site during emergencies as given below;

- 1) Do not get panicky
- 2) Do not approach the scene of disaster as a spectator
- 3) Do not engage phones / P.A. system unnecessarily
- 4) Non-essential personnel to gather at security gate after receiving instructions
- 5) Do not move here & there unnecessarily.
- 6) Do not approach unnecessarily for information or more inquiry.
- 7) Remain at your working place unless called and be attentive to instructions
- 8) Ensure that all contract laborers working in the premises are immediately sent to main security gate. They will receive further instructions from main controller. All should gather at safe assembly points after assessing the wind direction (from the wind sock, stack of boiler chimney) and wait for further instructions which will be communicated through PA system or by other available means.
- 9) All fabricator contractors should ensure that all welding machines are switched off and all cylinders are closed before leaving the working area.
- 10) All civil contractors should be gathered at assembly points after declared emergency.

7.11.6 MITIGATION OF CONSEQUENCES DURING MAJOR ACCIDENT

No major hazard installation can ever be absolutely safe. Even if a hazard assessment has been carried out, if the hazards have been detected and appropriate measures have been taken, the possibility of an accident cannot be completely ruled out.

So safety systems provide measures, which can mitigate the consequences of accident or emergency situation.

Other measures for mitigating the consequences of an accident deal mainly with the response to Alcohol. In order to be able to initiate counter measures in the event of an accident, company shall install various safety systems to mitigate the consequences during Major Accident are as under:

- (1) Emergency Control members available round the clock in all plants
- (2) ECC room with full equipped with Fire Fighting Equipment
- (3) Fire Men available in Fire Department round the clock
- (4) TAC approved Fire Hydrant system with electric motor and D.G. Set and water reserved for fire fighting
- (5) QRA to be done by competent party
- (6) Alarm System and method of reporting / declaring emergency
- (7) Regular rehearsal of emergency preparedness
- (8) Training to all employees regarding emergency preparedness
- (9) MSDS of all hazardous chemicals are available in safety department and in concerned department.

7.11.7 EMERGENCY CONTROL CENTER WITH LIST OF EQUIPMENT AND ACCESSORIES

Safety Office in front of Operation Building will act as Emergency Control Center. It is equipped with all necessary accessories as mentioned below and also given in table-7.7.

(A) DOCUMENTS

- Site Plan
- Disaster Control Plan copy
- List of essential telephone numbers
- List firefighting equipment
- Shift Schedule of Emergency Control members

(B) PERSONAL PROTECTIVE EQUIPMENT

- B. A. Sets (Breathing Apparatus)
- Face Masks
- Hand gloves
- Gum boots
- Goggles
- Helmets
- Safety belts
- Aprons
- Fire proximity suit

(C) EQUIPMENT LIST

- Internal / External Telephone
- Portable alarm
- Torches
- Emergency Cupboard with necessary PPE
- Artificial Respirator
- Racer watches (STOP WATCH)
- Gas Detector Tube
- Static Charge Meter

TABLE - 7.7 EMERGENCY CONTROL CENTERT WITH LIST OF EQUIPMENT AND ACCESSORIES

No.	Items Kept in Centre	Persons Who Will Handle / Operate This Items
1.	Safety helmet	Safety officer
2.	Safety hand gloves & shoes	
3.	Safety goggles	
4.	Self contained breathing apparatus	
5.	Gas mask with canister	
6.	Nose mask (dust)	
6.	Fire Extinguishers DCP (10 kg. Capacity) CO ₂ (3.2 kg Capacity) Foam type	
7.	Fire hose with branches	
8.	Intercom	
9.	Emergency Siren Switch	
10.	First Aid Box	

7.12 RISK ASSESSMENT AND CONSEQUENCE ANALYSIS

In a plant handling hazardous chemicals, the main hazard arises due to storage, handling & use of these chemicals. If these chemicals are released into the atmosphere, they may cause damage due to resulting fires or vapour clouds.

Blast Overpressures depend upon the reactivity class of material and the amount of gas between two explosive limits.

Operating Parameters

Potential vapour release for the same material depends significantly on the operating conditions. Especially for any liquefied gas, the operating conditions are very critical to assess the damage potential. If we take up an example of ammonia, if it is stored at ambient temperature, say 30°C, and then the vapour release potential of the inventory is much higher as compared to the case if it is stored at 0°C.

Inventory

Inventory Analysis is commonly used in understanding the relative hazards and short listing of release scenarios. Inventory plays an important role in regard to the potential hazard. Larger the inventory of a vessel or a system, larger the quantity of potential release. The potential vapour release (source strength) depends upon the quantity of liquid release, the properties of the materials and the operating conditions (pressure, temperature). If all these influencing parameters are combined into a matrix and vapour source strength estimated for each release case, a ranking should become a credible exercise.

Loss of Containment

Plant inventory can get discharged to Environment due to Loss of Containment. Certain features of materials to be handled at the plant need to be clearly understood to firstly list out all significant release cases and then to short list release scenarios for a detailed examination. Liquid release can be either instantaneous or continuous. Failure of a vessel leading to an instantaneous outflow assumes the sudden appearance of such a major crack that practically all of the contents above the crack shall be released in a very short time. The more likely event is the case of liquid release from a hole in a pipe connected to the vessel. The flow rate will depend on the size of the hole as well as on the pressure, which was present, in front of the hole, prior to the accident. Such pressure is basically dependent on the pressure in the vessel. The vaporisation of released liquid depends on the vapour pressure and weather conditions. Such consideration and others have been kept in mind both during the initial listing as well as during the short listing procedure. In the study, Maximum Credible Loss accident methodology is to be used, therefore, the largest potential hazard inventories have been considered for consequence estimation.

7.12.1 DAMAGE CRITERIA

In consequence analysis, use is made of a number of calculation models to estimate the physical effects of an accident (spill of hazardous material) and to predict the damage (lethality, injury, material destruction) of the effects. The calculations can roughly be divided in three major groups:

- a) Determination of the source strength parameters;
- b) Determination of the consequential effects.
- c) Determination of the damage or damage distances.

The basic physical effect models consist of the following.

Source strength parameters

- * Calculation of the outflow of liquid, vapour or gas out of a vessel or a pipe, in case of rupture. Also two-phase outflow can be calculated.
- * Calculation, in case of liquid outflow, of the instantaneous flash evaporation and of the dimensions of the remaining liquid pool.
- * Calculation of the evaporation rate, as a function of volatility of the material, pool dimensions and wind velocity.
- * Source strength equals pump capacities, etc. in some cases.

Consequential effects

- * Dispersion of gaseous material in the atmosphere as a function of source strength, relative density of the gas, weather conditions and topographical situation of the surrounding area.
- * Intensity of heat radiation [in kW/ m²] due to a fire or a BLEVE, as a function of the distance to the source.
- * Energy of vapour cloud explosions [in N/m²], as a function of the distance to the distance of the exploding cloud.
- * Concentration of gaseous material in the atmosphere, due to the dispersion of evaporated chemical. The latter can be either explosive or toxic.

It may be obvious, that the types of models that must be used in a specific risk study strongly depend upon the type of material involved:

- Gas, vapour, liquid, solid
- Inflammable, explosive, toxic, toxic combustion products
- Stored at high/low temperatures or pressure
- Controlled outflow (pump capacity) or catastrophic failure?

Selection of Damage Criteria

The damage criteria give the relation between extent of the physical effects (exposure) and the percentage of the people that will be killed or injured due to those effects. The knowledge about these relations depends strongly on the nature of the exposure. For instance, much more is known about the damage caused by heat radiation, than about the damage due to toxic exposure, and for these toxic effects, the knowledge differs strongly between different materials.

In Consequence Analysis studies, in principle three types of exposure to hazardous effects are distinguished:

1. Heat radiation, from a jet, pool fire, a flash fire or a BLEVE.
2. Explosion
3. Toxic effects, from toxic materials or toxic combustion products.

In the next three paragraphs, the chosen damage criteria are given and explained.

Heat Radiation

The consequence caused by exposure to heat radiation is a function of:

- The radiation energy onto the human body [kW/m²];
- The exposure duration [sec];
- The protection of the skin tissue (clothed or naked body).
- The limits for 1% of the exposed people to be killed due to heat radiation, and for second-degree burns are given in the table herein:

Damages to Human Life Due to Heat Radiation

Exposure Duration	Radiation for 1% Lethality (Kw/M ²)	Radiation for 2 nd Degree Burns (Kw/M ²)	Radiation for First Degree Burns, (Kw/M ²)
10 Sec	21.2	16	12.5
30 Sec	9.3	7.0	4.0

Since in practical situations, only the employees will be exposed to heat radiation in case of a fire, it is reasonable to assume the protection by clothing. It can be assumed that people would be able to find a cover or a shield against thermal radiation in 10 sec. time. Furthermore, 100% lethality may be assumed for all people suffering from direct contact with flames, such as the pool fire, a flash fire or a jet flame. The effects due to relatively lesser incident radiation intensity are given below.

Effects Due To Incident Radiation Intensity

Incident Radiation – kW/m ²	Type Of Damage
0.7	Equivalent to Solar Radiation
1.6	No discomfort for long exposure
4.0	Sufficient to cause pain within 20 sec. Blistering of skin (first degree burns are likely)
9.5	Pain threshold reached after 8 sec. second degree burns after 20 sec.
12.5	Minimum energy required for piloted ignition of wood, melting plastic tubing etc.

Explosion

In case of vapour cloud explosion, two physical effects may occur:

- * A flash fire over the whole length of the explosive gas cloud;
- * A blast wave, with typical peak overpressures circular around ignition source.

As explained above, 100% lethality is assumed for all people who are present within the cloud proper.

For the blast wave, the lethality criterion is based on:

- * A peak overpressure of 0.1 bar will cause serious damage to 10% of the housing/structures.
- * Falling fragments will kill one of each eight persons in the destroyed buildings.

The following damage criteria may be distinguished with respect to the peak overpressures resulting from a blast wave:

Damage Due To Overpressures

Peak Overpressure	Damage Type
0.83 bar	Total Destruction
0.30 bar	Heavy Damage
0.10 bar	Moderate Damage
0.03 bar	Significant Damage
0.01 bar	Minor Damage

From this it may be concluded that $p = 0.17 \text{ E}+5 \text{ pa}$ corresponds approximately with 1% lethality. Furthermore it is assumed that everyone inside an area in which the peak overpressure is greater than $0.17 \text{ E} + 5 \text{ pa}$ will be wounded by mechanical damage. For the gas cloud explosion this will be inside a circle with the ignition source as its centre.

Intoxication

The consequences from inhalation of a toxic vapour/gas are determined by the toxic dose.

This dose D is basically determined by:

- Concentration of the vapour in air;
- Exposure duration.

Furthermore, of course, the breathing rates of the victim, as well as the specific toxic mechanism unto the metabolism play an important role.

The dose is defined as $D = C^n \cdot t$, with:

- C = concentration of the toxic vapour, in [ppm] or [mg/m³];
- t = exposure duration, in [sec] or [min];
- n = exponent, mostly > 1.0; this exponent takes into account the fact that a high concentration over a short period results in more serious injury than a low concentration over a relatively longer period of exposure. The value of n should be greater than zero but less than 5.

The given definition for D only holds if the concentration is more or less constant over the exposure time; this may be the case for a (semi) continuous source. In case of an instantaneous source, the concentration varies with time; the dose D must be calculated with an integral equation:

$$D = \int C^n \cdot dt$$

For a number of toxic materials, so-called Vulnerability Models (V.M.) have been developed. The general equation for a V.M. (probit function) is:

$$Pr = a + b \cdot \ln(C^n \cdot t), \text{ with}$$

Pr = probit number, being a representation of the percentage of people suffering a certain kind of damage, for instance lethality

Pr = 2.67 means 1% of the population;

Pr = 5.00 means 50% of the population;

a and b material dependent numbers;

$C^n \cdot t$ = dose D, as explained above.

The values for a and b are mostly derived from experiments with animals; occasionally, however, also human toxicity factors have been derived from accidents in past. In case only animal experiments are available, the inhalation experiments with rats seem to be best applicable for predicting the damage to people from acute intoxication. Although much research in this field have been done over the past decades, only for a limited number of toxic materials consequence models have been developed. Often only quite scarce information is available to predict the damage from an acute toxic exposition. Data transformation from oral intoxication data to inhalation toxicity criteria is sometimes necessary. Generally, in safety evaluations pessimistic assumptions are applied in these transformation calculations. The calculated damage (distance) may be regarded as a maximum. For the purposes of a response to a major incident, the IDLH value level has been chosen for the ‘wounded’ criteria. This type of injury will require medical attention.

7.12.2 MAXIMUM CREDIBLE LOSS ACCIDENT SCENARIOS

A Maximum Credible Accident (MCA) can be characterised as the worst credible accident. In other words: an accident in an activity, resulting in the maximum consequence distance that is still believed to be possible. A MCA-analysis does not include a quantification of the probability of occurrence of the accident. Another aspect, in which the pessimistic approach of MCA studies appears, is the atmospheric condition that is used for dispersion calculations. As per the reference of the study, weather conditions having an average wind speed of 1.0 m/s have been chosen.

The Maximum Credible Loss (MCL) scenarios have been developed for the Facility. The MCL cases considered, attempt to include the worst “Credible” incidents- what constitutes a credible incident is always subjective. Nevertheless, guidelines have evolved over the years and based on basic engineering judgement, the cases have been found to be credible and modelling for assessing vulnerability zones is prepared accordingly. Only catastrophic cases have been considered and not partial or small failures (as is the case in Quantitative Risk Assessment where contributions from low frequency - high outcome effect as well as high frequency - low outcome events are distinguished). The objective of the study is emergency planning, hence only holistic & conservative assumptions are used for obvious reasons. Hence though the outcomes may look pessimistic, the planning for emergency concept should be borne in mind whilst interpreting the results.

7.12.3 SELECTION OF INCIDENTS AND CONSEQUENCE CALCULATIONS

The Consequence Analysis has been done for selected scenarios. This has been done for weather conditions having wind speed 1.0 m/s. In Consequence Analysis, geographical location of the source of potential release plays an important role. Consideration of a large number of scenarios in the same geographical location serves little purpose if the dominant scenario has been identified and duly considered.

7.12.3.1 SOFTWARE USED FOR CALCULATIONS

1. ARCHIE (AUTOMATED RESOURCE FOR CHEMICAL HAZARD INCIDENT EVALUATION)

This software programme has been developed by Federal Emergency Management Agency (FEMA), U.S. Department of Transportation (USDOT) and U.S. Environmental Protection Agency (USEPA) for comprehensive hazard assessment including accident hazard assessment and consequence analysis procedures.

The core of the program is a set of hazard assessment procedures and models that can be sequentially utilized to evaluate consequences of potential discharges of hazardous materials and thereby assist in development of a basis for emergency planning.

2. ALOHA (AREAL LOCATIONS OF HAZARDOUS ATMOSPHERES)

Aloha is a computer program designed especially for use by people responding to chemical accidents, as well as for emergency planning and training. ALOHA can predict the rates at which chemical vapors may escape into the atmosphere from broken gas pipes, leaking tanks, and evaporating puddles. It can then predict how a hazardous gas cloud might disperse in the atmosphere after an accidental chemical release.

ALOHA is an air dispersion model, which you can use as a tool for predicting the movement and dispersion of gases. It predicts pollutant concentrations downwind from the source of a spill, taking into consideration the physical characteristics of the spilled material. ALOHA also accounts for some of the physical characteristics of the release site, weather conditions, and the circumstances of the release. Like many computer programs, it can solve problems rapidly and provide results in a graphic, easy-to-use format. This can be helpful during an emergency response or planning for such a response.

ALOHA provides output as amount of chemical discharged from the source as well as its concentration in air it takes in to account different levels of concentrations for a specified chemical. Different concentration levels are given below:

ERPG 1: is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odor.

ERPG 2: is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action.

ERPG 3: is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.

IDLH: The Immediately Dangerous to Life or Health (IDLH) level. A chemical's IDLH is an estimate of the maximum concentration in the air to which a healthy worker could be exposed without suffering permanent or escape-impairing health effects.

7.12.4 SCENARIOS (VULNERABILITY AREA IDENTIFICATION)

Possible accident scenarios at M/s. Numaligarh Refinery Limited are given in following table-7.8.

1. Maximum Credible Accident Scenario Ethanol – Leakage from flange
2. Maximum Credible Accident Scenario Ethanol – Leakage due to pump seal failure
3. Maximum Credible Accident Scenario Ethanol – Leakage due to rupture in pipeline of storage tank
4. Worst case Accident Scenario Ethanol – Catastrophic failure of storage tank
5. Maximum Credible Accident scenario for Acetic Acid – Leakage thorough flange joint
6. Maximum Credible Accident scenario for Furfural – Leakage thorough flange joint

TABLE - 7.8 POSSIBLE ACCIDENT SCENARIOS

No.	Short Description of Scenario	Capacity of The Tank	Type of Risk	Proba Bility	Severity	Concentration & Damage Distance from Source (Meters)
1.	Leakage from flange	450 m ³	Pool Fire	Very unlikely	Potentially lethal within 60 sec	10.0 kW, <10 m
					2nd degree burns within 60 sec	10.0 kW, <10 m
					Pain within 60 sec	2.0 kW, 11 m
2.	Leakage due to pump seal failure	450 m ³	Pool Fire	Very unlikely	Potentially lethal within 60 sec	10.0 kW, <12 m
					2nd degree burns within 60 sec	10.0 kW, 12 to 14 m
					Pain within 60 sec	2.0 kW, 14 to 18 m
3.	Leakage due to rupture in pipeline of Bulk Storage tank	450 m ³	Pool Fire	Very unlikely	Potentially lethal within 60 sec	10.0 kW, <22 m
					2nd degree burns within 60 sec	10.0 kW, 22 to 26 m
					Pain within 60 sec	2.0 kW, 26 to 34 m
4.	Catastrophic failure of storage tank Bulk Storage tank	450 m ³	Pool Fire	Very unlikely	Potentially lethal within 60 sec	10.0 kW, <49 m
					2nd degree burns within 60 sec	10.0 kW, 49 to 58 m
					Pain within 60 sec	2.0 kW, 58 to 78 m
5.	Leakage from Acetic Acid Bulk Storage tank	100 m ³	Toxic Effect	Very unlikely	ERPG-3	250 ppm, < 60 m
					ERPG-2	35 ppm, 61 to 313 m
					ERPG-1	5 ppm, 314 m to 1 km
6.	Leakage from Furfural Bulk Storage tank	115 m ³	Toxic Effect	Very unlikely	PAC-1	250 ppm, < 481 m
					PAC-2	35 ppm, 482 m to 1.3 km
					PAC-3	5 ppm, 1.3 km to 2.2 km

1. Maximum Credible Accident Scenario Ethanol – Leakage from flange

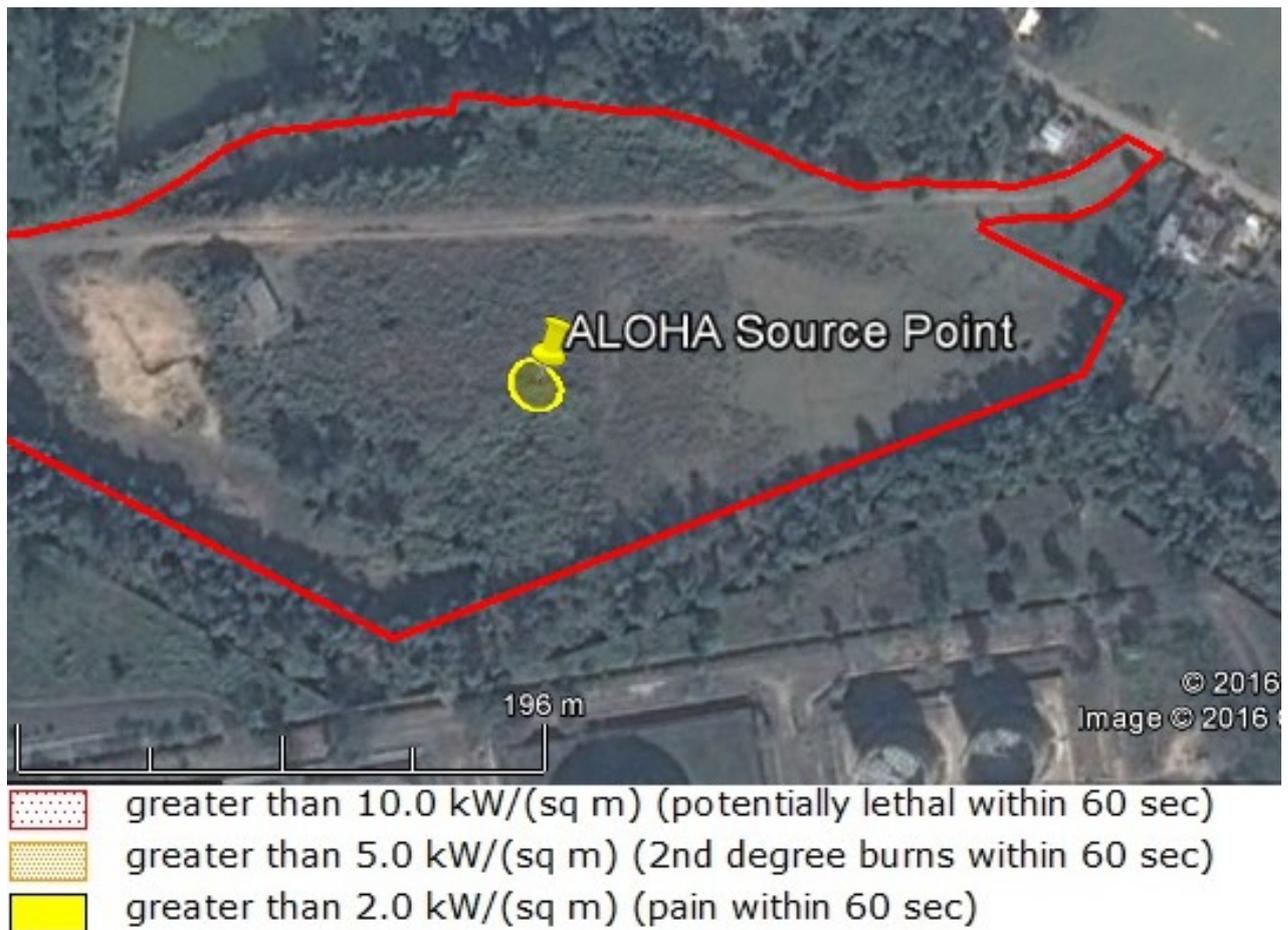
SOURCE STRENGTH:

Leak from short pipe or valve in vertical cylindrical tank
 Flammable chemical is burning as it escapes from tank
 Tank Diameter: 12 meters Tank Length: 5 meters Tank Volume: 565 cubic meters
 Tank contains liquid Internal Temperature: 32° C Chemical Mass in Tank: 387 tons
 Tank is 80% full Circular Opening Diameter: 3 centimeters
 Opening is 15.0 centimeters from tank bottom Max Flame Length: 4 meters
 Burn Duration: ALOHA limited the duration to 1 hour
 Max Burn Rate: 32.5 kilograms/min
 Total Amount Burned: 1,880 kilograms
 Note: The chemical escaped as a liquid and formed a burning puddle.
 The puddle spread to a diameter of 5.0 meters.

THREAT ZONE:

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: 11 meters --- (2.0 kW/(sq m) = pain within 60 sec)

FIGURE - 7.1 MCA SCENARIO: POOL FIRE – DUE TO LEAKAGE FROM FLANGE



2. Maximum Credible Accident Scenario Ethanol – Leakage due to pump seal failure.

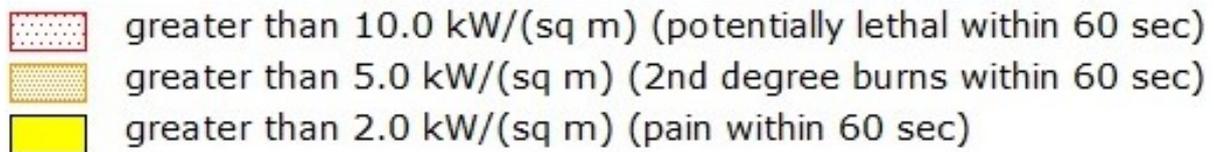
SOURCE STRENGTH:

Leak from short pipe or valve in vertical cylindrical tank
 Flammable chemical is burning as it escapes from tank
 Tank Diameter: 12 meters Tank Length: 5 meters
 Tank Volume: 565 cubic meters
 Tank contains liquid Internal Temperature: 32° C
 Chemical Mass in Tank: 387 tons Tank is 80% full
 Circular Opening Diameter: 5 centimeters
 Opening is 15.0 centimeters from tank bottom
 Max Flame Length: 6 meters
 Burn Duration: ALOHA limited the duration to 1 hour
 Max Burn Rate: 90.3 kilograms/min
 Total Amount Burned: 5,223 kilograms
 Note: The chemical escaped as a liquid and formed a burning puddle.
 The puddle spread to a diameter of 8.3 meters.

THREAT ZONE:

Threat Modeled: Thermal radiation from pool fire
 Red : 12 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
 Orange: 14 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
 Yellow: 18 meters --- (2.0 kW/(sq m) = pain within 60 sec)

FIGURE - 7.2 MCA SCENARIO: POOL FIRE – DUE TO LEAKAGE FROM PUMP SEAL FAILURE



3. Maximum Credible Accident Scenario Ethanol – Leakage due to rupture in pipeline of storage tank

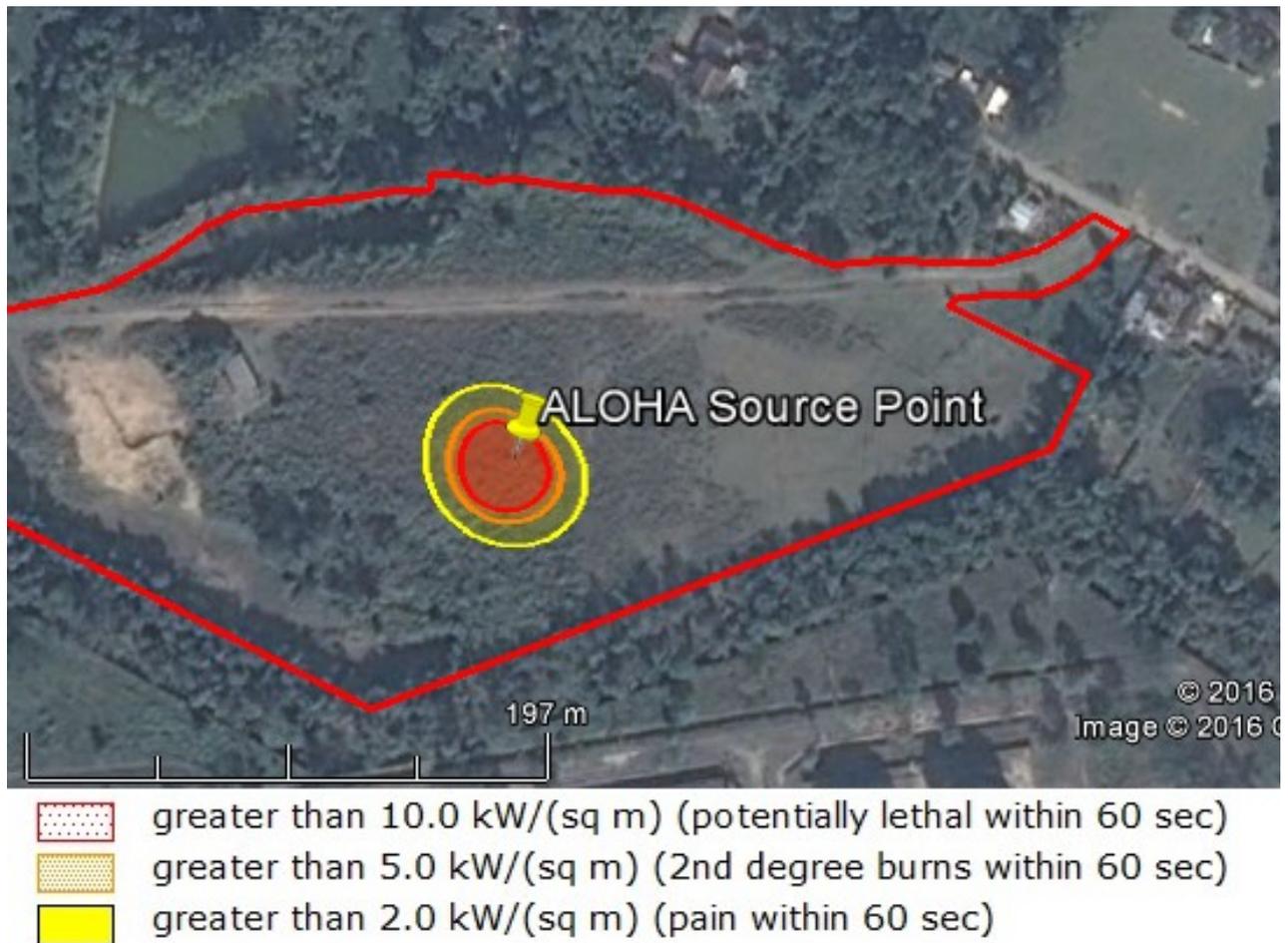
SOURCE STRENGTH:

Leak from hole in vertical cylindrical tank
 Flammable chemical is burning as it escapes from tank
 Tank Diameter: 12 meters Tank Length: 5 meters
 Tank Volume: 565 cubic meters
 Tank contains liquid Internal Temperature: 32° C
 Chemical Mass in Tank: 387 tons Tank is 80% full
 Circular Opening Diameter: 10 centimeters
 Opening is 15.0 centimeters from tank bottom
 Max Flame Length: 10 meters
 Burn Duration: ALOHA limited the duration to 1 hour
 Max Burn Rate: 361 kilograms/min
 Total Amount Burned: 20,893 kilograms
 Note: The chemical escaped as a liquid and formed a burning puddle.
 The puddle spread to a diameter of 16.6 meters.

THREAT ZONE:

Threat Modeled: Thermal radiation from pool fire
 Red : 22 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
 Orange: 26 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
 Yellow: 34 meters --- (2.0 kW/(sq m) = pain within 60 sec)

FIGURE - 7.3 MCA SCENARIO: POOL FIRE DUE TO RUPTURE IN PIPELINE OF STORAGE TANK



4. Worst case Accident Scenario Ethanol – Catastrophic failure of storage tank

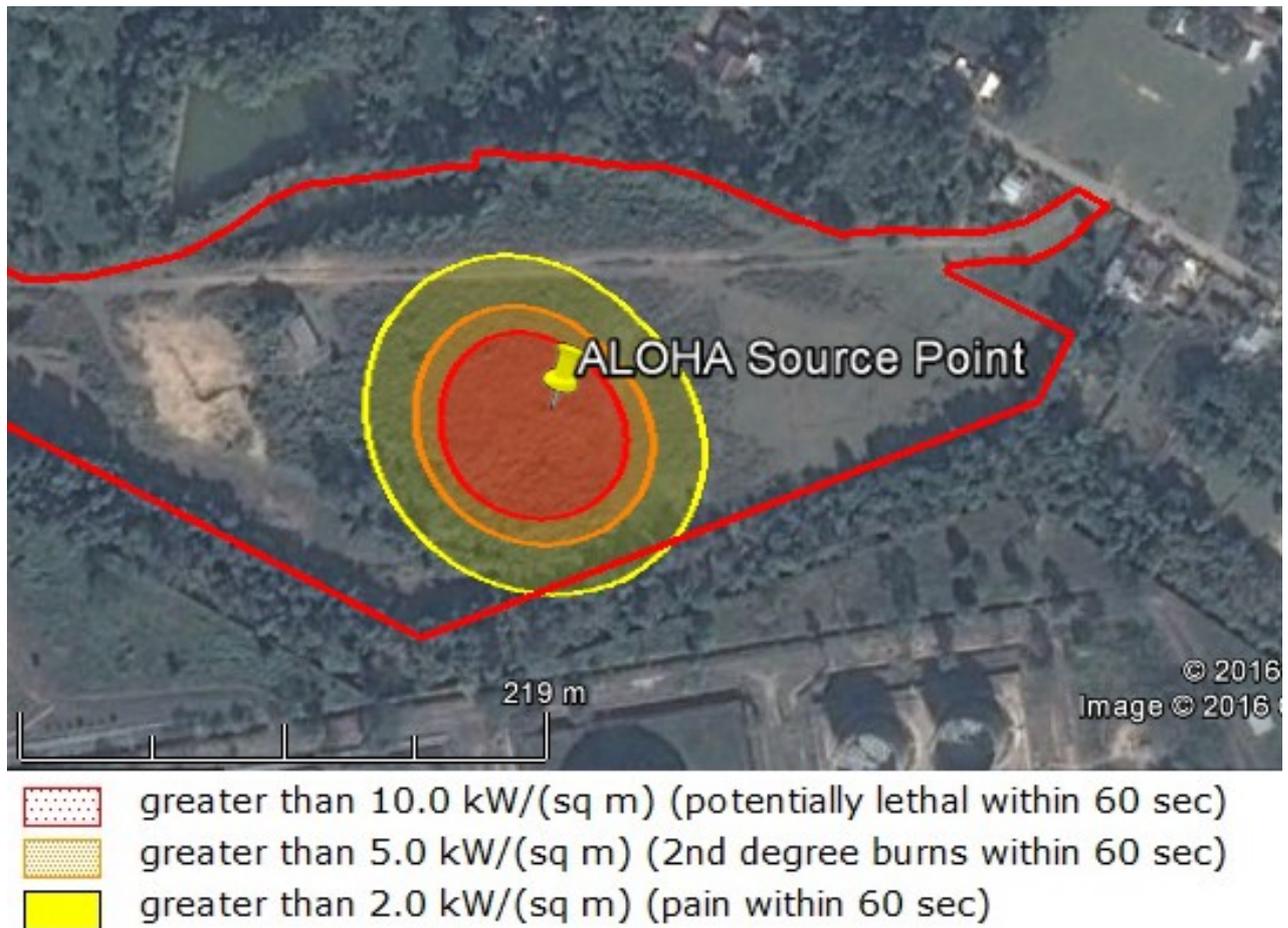
SOURCE STRENGTH:

Burning Puddle / Pool Fire
 Puddle Area: 1230 square meters Puddle Volume: 450 cubic meters
 Initial Puddle Temperature: Air temperature
 Flame Length: 18 meters
 Burn Duration: ALOHA limited the duration to 1 hour
 Burn Rate: 2,050 kilograms/min
 Total Amount Burned: 122,881 kilograms

THREAT ZONE:

Threat Modeled: Thermal radiation from pool fire
 Red : 49 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
 Orange: 58 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
 Yellow: 78 meters --- (2.0 kW/(sq m) = pain within 60 sec)

FIGURE - 7.4 MCA SCENARIO: POOL FIRE DUE TO CATASTROPHIC FAILURE OF STORAGE TANK



5. Maximum Credible Accident scenario for Acetic Acid – Leakage thorough loose flange joint.

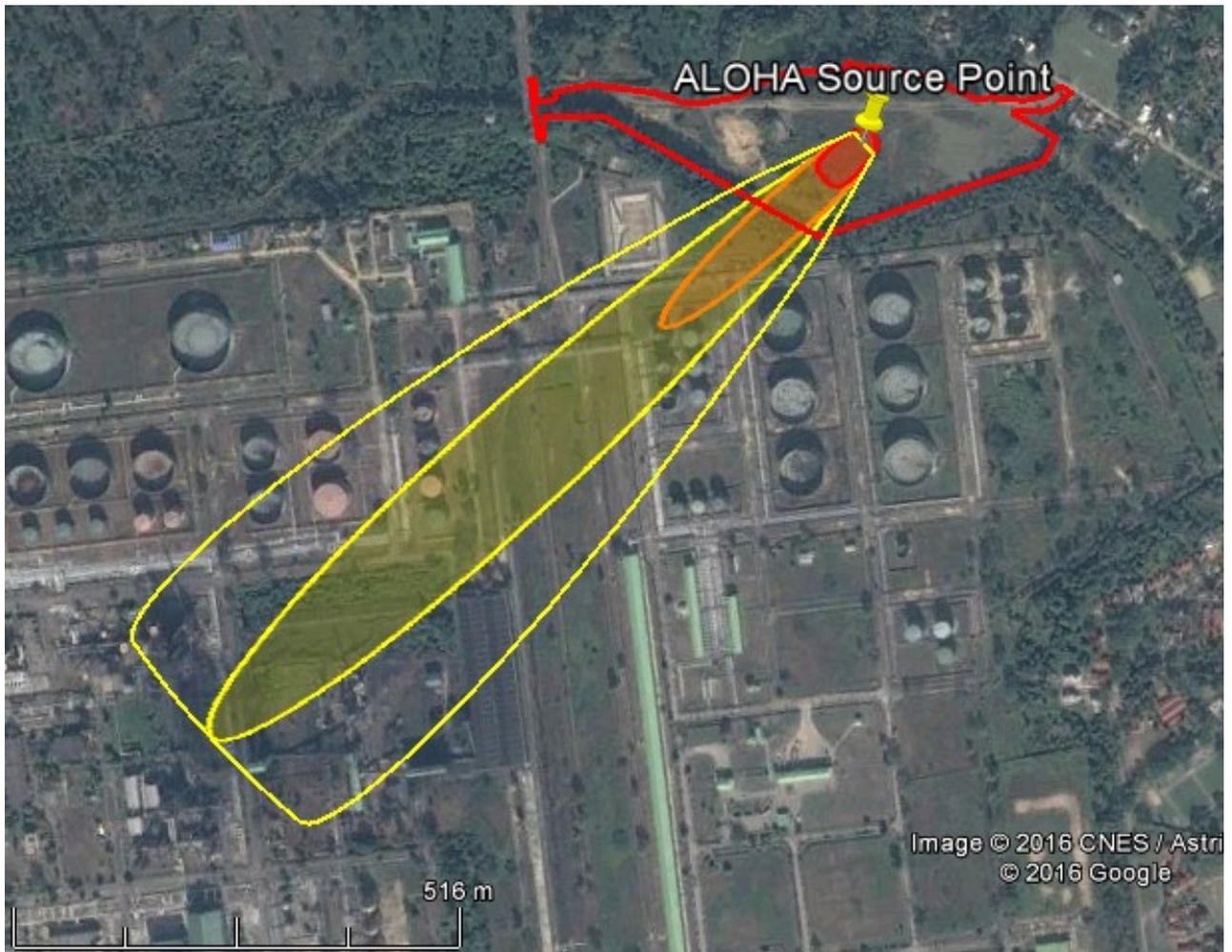
SOURCE STRENGTH:

Evaporating Puddle (Note: chemical is flammable)
 Puddle Area: 1000 square meters Puddle Mass: 50 metric tons
 Ground Type: Concrete Ground Temperature: 32° C
 Initial Puddle Temperature: Ground temperature
 Release Duration: ALOHA limited the duration to 1 hour
 Max Average Sustained Release Rate: 68.4 kilograms/min
 (averaged over a minute or more)
 Total Amount Released: 4,090 kilograms

THREAT ZONE:

Model Run: Gaussian
 Red : 60 meters --- (250 ppm = ERPG-3)
 Orange: 313 meters --- (35 ppm = ERPG-2)
 Yellow: 1.0 kilometers --- (5 ppm = ERPG-1)

FIGURE - 7.5 MCA SCENARIO: POOL FIRE OF 100 M3 ACETIC ACID BULK STORAGE TANK



-  greater than 250 ppm (ERPG-3)
-  greater than 35 ppm (ERPG-2)
-  greater than 5 ppm (ERPG-1)
-  wind direction confidence lines

6. Maximum Credible Accident scenario for Furfural – Leakage through loose flange joint:

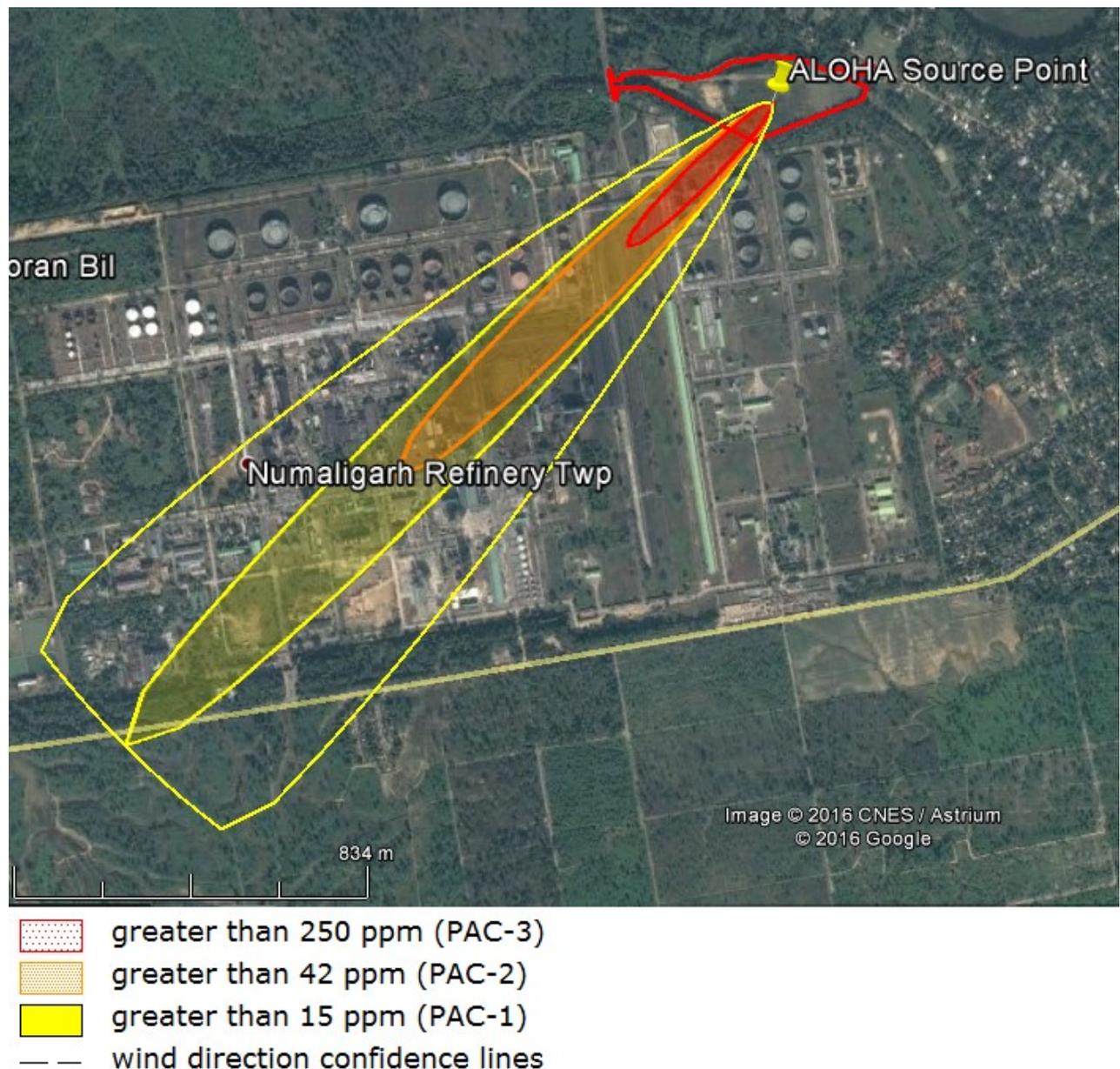
SOURCE STRENGTH:

Direct Source: 50 tons/hr Source Height: 0
 Release Duration: 60 minutes
 Release Rate: 756 kilograms/min
 Total Amount Released: 45,359 kilograms

THREAT ZONE:

Model Run: Heavy Gas
 Red : 481 meters --- (250 ppm = PAC-3)
 Orange: 1.3 kilometers --- (42 ppm = PAC-2)
 Yellow: 2.2 kilometers --- (15 ppm = PAC-1)

FIGURE - 7.6 MCA SCENARIO: POOL FIRE FOR 115 M3 BULK STORAGE TANK OF FURFURAL



7.12.5 RECOMMENDATIONS ON THE BASIS OF RISK ASSESSMENT DONE

- At Ethanol storage and handling area fire fighting facility will be provided as per OISD 117 norms.
- CO₂ detection system at fermentation section must be provided if CO₂ not collected.
- Top Guard rail, middle guard rail & Toe guard must be provided at all working platform including stair case to avoid fall of materials or person.
- Integrity of flam proof fitting must be check after every two years from competent agency.
- Cable trench must be provided to protect cables.
- Double earthing must be provided.
- To avoid losses due to corrosion regular painting must be done.
- Trailer driven pump with sufficient length of hose pipe must be available for fire fighting,
- Fix guard must be provided at all the rotating parts.
- Permit system must be implemented for Hot working, working at height (Distillation Colum and tank), working in confined area and tanker loading and unloading.

7.13 DISASTER MANAGEMENT PLAN

7.13.1 INFORMATION REGARDING KEY PERSONS AND THEIR RESPONSIBILITIES DURING EMERGENCY

7.13.1.1 SITE MAIN CONTROLLER

After getting information of emergency, the site main controller will be rushed to the Emergency Control Center immediately.

- 1) On reaching he will assess the magnitude of the situation in consultation with Incident Controller and decide whether inside or outside help are to be called (i.e. Fire Service, Police, Ambulance etc.).
- 2) Ensure that key persons are called in.
- 3) Give guidance and direction in vital and important activities to control the emergency situation.
- 4) Direct to close down and evacuation of the plants in consultation with Incident controller and key personnel.
- 5) If necessary arrange for evacuation of neighboring population.
- 6) Inform the Government authorities such as Collector, MC, Factory Inspector, Health Officer & medical Officer and request them for their help as situation demands.
- 7) Give prime importance to human life and guidance in organizing the rescue operations as well as ensure whether injured people getting proper medical attention in time.
- 8) Always be in touch with the Incident Controller to get further progress and decide further plan.
- 9) On completion of emergency situation declare the normalcy through Administrative Officer.
- 10) Control the re-occupation of the affected areas on discontinuation of emergency.
- 11) Do not permit to re-start the plant unless it is safe.
- 12) Give authentic statement of the incident to News Media & Government Authorities.

7.13.1.2 INCIDENT CONTROLLER

- 1) Take the charge of situation and assess the magnitude of the event
- 2) Control and guide all the operations with priorities to the Safety of Personnel, minimize pollution, loss of material and loss to the plant equipment and property.
- 3) Provide advice and guide to the Fire Fighting and Rescuing squad and Fire Brigade while they arrive.
- 4) Establish communication with emergency control center.
- 5) Report on all significant developments to the emergency control center through phone/Messenger.
- 6) Ensure that evacuation of the areas in the factory getting affected is complete.
- 7) After the emergency situation is brought under control, assure that the necessary evidence for further investigation in the incident is preserved and inform Site Controller regarding control of emergency.

7.13.1.3 TECHNICAL STAFF / DEPARTMENT HEAD

- 1) As soon as informed, rush to the spot and take charge of the situation till senior group arrives.
- 2) Ensure that emergency siren is raised which gives information to Security, Safety, Administration Staff and Technical Staff.
- 3) On arrival of Incident Controller, inform him about the gravity of the situation and then to work under his guidance to control the situation.
- 4) Ensure that only experienced and essential people remains at the location for controlling, while others to be evacuated from the scene.

7.13.1.4 EMPLOYEES NEAR THE SPOT (INCIDENT AREA)

The employees near affected area, under the guidance of the **Incident Controller** shall

- 1) Tackle the emergency as per laid down procedures for the area bearing in mind the requirements of the situation called for by the progress of the emergency.
- 2) Remove all non-essential employees (who are not assigned any emergency duty) shall evacuate the area and gather at the specified assembly points.
- 3) Stop the operations as per the information of the Incident Controller.

7.13.1.5 EMPLOYEES OF OTHER DEPARTMENTS

- 1) On getting information of incident, take permission of superior and confirm own plant, department, safety and then after trained and skill persons will rush to incident spot with necessary personnel protective equipment.
- 2) Approach the spot from up wind direction and assemble at safe place near to the spot taking in to consideration the wind direction.
- 3) Extend help to control the situation as per the instruction and guidance given by the senior persons controlling the operation.

7.13.1.6 PERSONNEL OFFICER

- 1) When emergency declared immediately rushed to emergency control center.
- 2) Basically he will work as a Liaison Officer and will stationed at emergency control center during emergency. He will work under the direction of Site Controller.
- 3) To ensure that the casualties receives adequate attention at first aid center, also ensure additional help if require from Government authorities or outside agencies.
- 4) Arrange transport facility for injured personnel to get timely medical help.
- 5) He will also arrange for head count at assembly points and will inform Site Controller.
- 6) Also be in touch with the Security and Other Departments for help.
- 7) Will check the Roll call from Time Office for availability of trained personnel during emergency situation at the site.
- 8) Determine the need to inform statutory authorities of the accident and fill the necessary forms for submission with consultation of the Site Controller.
- 9) When emergency is prolonged, arrange for the relief of personnel as well as inform the families of injured persons and organize refreshments / catering facility.

7.13.1.7 ADMINISTRATIVE OFFICER

- 1) When emergency declared, immediately rushed to the emergency control center and establish contact with Site Main Controller.
- 2) Ensure the communication between site controller and incident controller. Keep messenger for communication.
- 3) Make arrangement to send portable megaphone and torches to the Incident Controller if required.
- 4) On receiving instructions from Site Controller, organize transportation for the evacuation of people from the assembly points.
- 5) As per instructions from Site Controller will inform to Head Office, Insurance Surveyor, other relevant authorities and neighboring areas.
- 6) On getting instructions from Site Controller / Incident Controller, he will be in touch with other Industries for help in emergency.
- 7) Will arrange to announce necessary instructions for all personnel.
- 8) Ensure that telephone operator keeps the EPABX free to extend possible for in coming calls.
- 9) Ensure that Press and other Media do not publish unauthentic news.

7.13.1.8 ENGINEERING SERVICES KEY PERSONNEL

- 1) When emergency declared, immediately proceed to Emergency Control Center.
- 2) Ensure the availability of electrical wiremen, utility, maintenance employees and drivers.
- 3) Ensure the water supply & electric power generator in case of power failure.
- 4) Be in touch with the Site controller / Incident Controller to extend help as and when required.
- 5) Ensure availability of Light Motor Vehicles as well as Fork Lifts, JCBs etc.
- 6) Arrange the vehicle as per required by Administrative / Personnel Officer.

7.13.1.9 SECURITY & FIRE IN-CHARGE

- 1) When emergency declared, ensure that the Fire man in the fire station and Security guards at the main gate are sufficient.
- 2) On getting instruction from Site Controller/Incident controller, cordon the affected area to maintain law and order.
- 3) As per instruction from Site Controller/ Incident controller, arrange to start the fire hydrant pump.
- 4) Ensure the following duties by Security Guards;
 - Stop all vehicles and visitors entering into the factory, except any Government authorities such as Fire Brigade, Police, Factory Inspector, Medical Staff and inform the Administrative Officer on their arrival.
 - If any press reporter and local Leader comes at the main gate, take them to the Administration Office.
 - Do not allow any vehicle to park at the main gate or nearby at main road.
 - Assure that the entrance of the gate is clear for thorough fare. In Similar way control/ guide internal traffic for smooth operations.
 - Act according instructions given by Personnel and Administrative Officer.
 - Ensure that all essential personnel evacuated and assembled at Assembly points.
 - Arrange effective security nearby the incident place.

7.13.1.10 FIRST AID ATTENDANTS

- 1) As per the instructions given by the Incident Controller, arrange the supply of additional emergency related equipment to the incident place. Give necessary First Aid treatment to the affected persons immediately.
- 2) Inform the Personnel and Administration Officer regarding the severity of injury and advise for further medical help if necessary.
- 3) Ask for additional trained First-Aider, if required.
- 4) On arrival of Doctor, assist him to give medical treatment to the affected people.

7.13.1.11 SAFETY OFFICER

- 1) On hearing emergency siren rush to the spot and assume the position of incident controller and take care of the situation till a senior personnel arrives and on their arrival work with them in team, extending their own expertise.
- 2) Give instructions and guideline to the people involved in control measures. As well as help in providing required PPE
- 3) Give instructions to the safety attendants.
- 4) Brief the Site Main Controller about the progress of control measures.
- 5) Advise site controller regarding type of help required from outside.
- 6) Give instructions to other department through internal phones /Communication Officer.
- 7) Make arrangement to carry out monitoring whenever necessary and appraise results to the concerned seniors

7.13.1.12 ESSENTIAL EMPLOYEES AND THEIR DUTIES

[A] Fireman:

- 1) On getting information, check the water level in emergency tanks and overhead /under ground storage tanks. Maintain the emergency tank water level to its fullest capacity.
- 2) Start fire hydrant pump as per the instruction from Security & Fire incharge.
- 3) Ensure continuous water supply to the incident place.
- 4) Do not leave the Fire Hydrant pump house till further instruction

[B] Driver:

- 1) On getting information from Communication Officer remain alert and wait for further instructions along with Ambulance van to meet with emergency.
- 2) Extend help to shift the injured people from site of incident to First-Aid and if required to hospital through Ambulance / Other vehicle.
- 3) For material handling take Fork-lift / JCB to the spot if required.

[C] Electrical / Utility Personnel:

- 1) After getting the information rush to the spot with necessary personal protective equipment and if instructed by incident controller cut off the power supply to the affected area.
- 2) Ensure that the D.G. Set is in running condition.
- 3) Extend help to the Utility Operator in maintaining adequate supply of water and others under guidance of Supervisors.
- 4) Water in water hydrant storage tank is in full capacity or not

7.13.2 EMERGENCY ORGANIZATION FOR IDLE HOURS

1. Security:-

- i) After getting information through emergency hooter inform at least two senior persons at their residence by telephone/messenger.
 - (a) Site controller
 - (b) Safety Officer
 - (c) Incident controller.
 - (d) Technical Staff/Senior Staff
- ii) Assure that the front side of the gate is clear for thoroughfare.
- iii) Act according to the instructions of Incident Controller/Senior Officers
- iv) Inform Emergency Control Center for emergency.

2. SAFETY/FIRST AID ATTENDANT:

One attendant remains present around the clock.

Duties:

- 1) On hearing emergency hooter does not leave the Occupational Health Center.
- 2) As per the instructions given by the person In charge of the emergency operation or Incident Controller arrange the supply of additional emergency safety equipment to incident place.
- 3) Give necessary first aid to the affected person immediately. Inform the site controller about the severity of the Injury and advice for further medical help if required. On arrival of doctor, assist him for medical treatment offered to the affected people.

7.13.3 LIST OF IMPORTANT AUTHORITIES WITH THEIR ROLE IN EMERGENCY AND TELEPHONE NUMBERS

List of important authorities with their role in emergency and telephone numbers will be prepared and placed wherever required.

7.13.4 INFORMATION ABOUT EXTERNAL COMMUNICATION SYSTEM**(1) Communication will be through Emergency Central Alarm System**

(2) Telephones: An EPABX unit will be installed to connect all departments internally. Company will also provide mobile connections to all important personnel at site.

(3) STD PHONE & FAX/TELEX: Will be provided at IMP places

(4) IN THE EVENT OF FAILURE OF TELEPHONE SYSTEM:

Communication officer will arrange special messengers for communication. Minimum one vehicle with driver/trained security personnel are available in the company premises round the clock.

We will communicate through our Administration department by our vehicle to nearby community.

7.13.5 ANNOUNCEMENT SYSTEM DETAILS

During emergency it is necessary that the alarm should be heard by all employees wherever they work, for that speakers will be placed at various locations within plant.

7.13.6 OUTSIDE IMPORTANT ADDRESSES AND PHONE NUMBERS

List of Important addresses in the nearby area such as hospitals, ambulance services, fire fighting services, Government personnel (Municipal Commissioner, district collector, zilla panchayat, police station and emergency control services and their telephone numbers will be prepared and will be displayed outside emergency control room.

7.13.7 REHEARSAL AND UPDATION OF PLAN

- 1) Every year mock drills will be organized. Shortfalls in actions observed during drill will be explained to participants and will be corrected accordingly.
- 2) Any shortcomings regarding On-Site Emergency Plan observed during such drills will be corrected and incorporated in On-Site Emergency Plan and same will be communicated to all.
- 3) The On-Site Emergency Plan will be updated after any significant development in factory or change in the law.

7.14 OCCUPATIONAL HEALTH AND SAFETY PROGRAM FOR THE PROJECT

Health hazards associated with the occupation are called occupational hazards. In chemical industry due to handling of toxic and hazardous chemicals there are possibilities of developing occupational diseases. Company shall carry out the following checks to curb the problem:

- i) Pre - employment medical check up at the time of employment.
- i) Annual medical check up shall be done for all employees.
- iii) First aid training shall be given to the employees.
- iv) Monitoring of occupational hazards like noise, ventilation, chemical exposure shall be carried out at frequent intervals, the records of which shall be documented.

All precautions shall be taken to avoid foreseeable accidents like spillage, fire and explosion hazards and to minimize the effect of any such accident and to combat any emergency at site level. Some of the preventive safety measures shall be taken to minimize the risk of accident with respect to Technical Safety, Organizational Safety and Personal Safety are listed below:

- ◆ The factory shall take all reasonably practicable measures to minimize the risk of such accident in compliance with the legal obligation under the relevant safety.
- ◆ All building plans and installations shall be as per relevant acts and duly approved by competent government authorities.
- ◆ Process and Equipment shall be designed by qualified and experienced professionals and fabricated to applicable national / international codes with stage wise inspection.
- ◆ Hazardous processes shall be operated by trained workers and shall be looked after by qualified & experienced supervisors.

- ◆ Safety features such as fire extinguishers, fire hydrant system and suitable Personal Protective Equipment (PPE) shall be provided. Regular operations and testing of fire hydrant system and fire extinguishers shall be carried out.
- ◆ Suitable provisions for control of critical process / storage parameters within specified safe limits (use of pressure relief valves, rupture discs, safety valves, trip circuits, wherever necessary) shall be done.
- ◆ Use of flameproof electrical equipment, flame arresters and breather valves shall be done.
- ◆ Provision of Earthing and lightning arrestor to prevent electrical fires and explosions in flammable / explosive chemicals storage / processing areas shall be done.
- ◆ Drums storing hazardous liquid chemicals shall be placed separately to confine any spillage and facilitate easy collection. Necessary separation distance shall be maintained.
- ◆ Periodic inspection and testing of pressure vessels, equipment, machineries and equipment handling hazardous substances shall be done.
- ◆ Training of workers and Staff shall be given for fire fighting, work permit system, first aid, safe handling of hazardous chemicals and integrating safety, in all activities.
- ◆ Adequate scrubber system shall be provided to control air pollution.
- ◆ Good housekeeping in factory premises shall be ensured.
- ◆ Accident / Incident reporting system and information of employees about the same shall be done for better awareness.
- ◆ Suitable notices / boards shall be displayed at several locations indicating appropriate hazards warning as well as DOs and DON'Ts for ensuring operational and personal Safety for information of workers / staff and visitors.
- ◆ Details of the Evacuation plan shall be distributed among the workers.

Personal Protective Equipment (PPE) like goggles, safety shoes, helmet, apron, earplugs, facemask & clothing shall be provided to employees as per the job requirements. The company shall prepare a comprehensive on - site emergency plan with well-defined responsibilities to face any eventuality caused under adverse circumstances and unforeseen reason.

Company shall adequately install fire-fighting system in different sections of the plant.

Some of the safety precautionary measures shall be taken for manufacturing process are listed below:

- ◆ Safety Relief Valve, Rupture disk, temperature scanner, pressure indicator, and flow meter shall be installed to vessel wherever required.
- ◆ Cooling / Chilling water circulation arrangement shall be provided to avoid abrupt increase of pressure.
- ◆ Pressure controller at the process lines shall be provided and vent shall be connected with scrubber as per the requirement.
- ◆ PPE shall be provided to workers during charging of various raw materials and exhaust ventilation lines shall be provided as per requirement.
- ◆ Local Foam based fire extinguisher along with fire hydrant system shall be installed.
- ◆ Necessary interlocking and alarm system shall be installed wherever required.
- ◆ Gas detection system shall be installed in the plant wherever required

7.14.1 INFORMATION OF ASSEMBLY POINTS

At the time of emergency, non - essential workers, casual workers, visitors and others are to be placed to Assembly Points and separate in charge are nominated. No. of assembly points and location will be decided based on the layout of the plant.

In case of an emergency, the visitors, contract persons and factory employees will gather at nearby assembly point. Pre-designated persons will take their roll call. If needed, they can be evacuated easily through any gate in a short period as per instruction of site main controller.

MEDICAL AID SCHEME

For outside help, company authority will make a mutual understanding with the following authorities to extend their help whenever an emergency occurs;

- (1) Nearest Medical Hospital
- (2) Police Station
- (3) Fire Brigade

Time to time company shall inform/impart training to concerned employees for awareness about chemicals and its hazards and the precautionary measures on their part. An emergency guide will be provided to each employee, which gives guidance to him or her during an emergency.