Risk Assessment

1.1. Risk Assessment & Disaster Management Plan

The principal objective of the risk assessment study is to identify and quantify the major hazards and the risks associated with various operations of the proposed project, which may lead to emergency consequences (disasters) affecting the public safety and health. Based on this information, an emergency preparedness plan is to be prepared to mitigate the consequences. The approach involves hazards identification, hazards assessment and evaluation, developing Disaster Management Plan (DMP).

1.1.1. Risk Analysis

Risk analysis includes an estimate of the probability or likelihood that an event will occur. Estimation of random incidents totally uncorrected with plant activities may also be taken. Risk can be characterized in qualitative terms as high medium or low, or in quantitative terms using numerical estimates and statistical calculations. For practical purposes a risk analysis may be based on a subjective, common- sense evaluation. Both probability and consequences are extremely important in evaluating risk. A high risk situation can be the result of a high probability with severe consequences (e.g. irreversible health effects or death due to an airborne toxic dust, a fire or explosion with injuries or fatalities), whereas moderate risk situations can be a result of either high probability with mild consequences or low probability with more severe consequences. Diminishing the likelihood of an accident or minimizing the consequences will reduce risk overall.

A relative ranking of hazards requires extensive mathematical evaluations, application of statistics and extensive support from experts. Application of readily available information and common sense when combined with site-specific evaluations such as the vulnerability analysis, will complete much of the risk analysis process.

1.1.2. Evaluating Hazards

The need for the sophisticated techniques for evaluating hazards depends on the result of Preliminary Hazard Analysis. Various techniques for evaluation hazards are:

- Hazard and Operability Study (HAZOP)
- Accident Consequence Analysis

- Event Tree Analysis
- Fault Tree Analysis
- Failure Modes, Effects and Criticality Analysis.

In order to be in a state of readiness to face the adverse effects of accidents, an Emergency Preparedness Plan **(EPP)** has to be prepared. The possible hazardous situations in the locality and the causes, areas most likely to be affected, on-site and off-site plans, establishment of Emergency Control Centres **(ECC)**, location of emergency services and duties of officers/staff during emergency.

The EPP document for accidents is to be designed to provide for measures to contain the incident and for minimization of effects due to fire, explosives, release or escape of toxic gas, spillage of hazardous substances in storage, processing or during transportation. The necessary preventive and protective steps required to be taken before, during and after an accident need to be worked out in operational terms and detailed in the document.

1.2. Identification of Major Hazard Installations Based on GOI Rules, 1989 as amended in 1994 & 2000

By Studying accidents occurred in industries in India over a few decades, a specific legislation covering major hazard activities has been enforced by Government of India in 1989 in conjunction with Environment Protection Act, 1986. This is referred here as GOI rules 1989. For the purpose of identifying major hazard installations the rules employ certain criteria based on toxic, flammable and explosive properties of chemicals.

1.2.1. Identification of Toxic, Flammable, Explosive Chemicals

Toxic Chemicals: Chemicals having the following values of acute toxicity and which owing to their physical and chemical properties are capable of producing major accidents:

S.No	Toxicity	Oral toxicity LD50(mg/kg)	Dermal toxicity LD50(mg/kg)	Inhalation toxicity LC50(mg/l)
1.	Extremely toxic	1-50	1-200	0.1-0.5
2.	Highly toxic	51 – 500	201-2000	0.5 - 2.0

Flammable Chemicals: Flammable gases: Gases which at 20^0C and at standard pressure of 101.3 KPa are:-

- Ignitable when in a mixture of 13 percent or less by volume with air, or
- Have a flammable range with air of at least 12 percentage points regardless of the lower flammable limits.

Note: - The flammability shall be determined by tests or by calculation in accordance with methods adopted by International Standards Organization ISO Number10156 of 1990 or by Bureau of Indian Standards ISI Number 1446 of 1985.

- Extremely flammable liquids: chemicals which have flash point lower than or equal to 23^0C and boiling point less than 35^0C
- Very highly flammable liquids: chemicals which have a flash point lower than or equal to 23^0C and initial boiling point higher than 35^0C.
- Highly flammable liquids: chemicals which have a flash point lower than or equal to 60^0C but higher than 23^0C.
- Flammable liquids: chemicals which have a flash point higher than 60^oC but lower than 90^0 C.

Explosives: Explosives means a solid or liquid or pyrotechnic substance (or a mixture of substances) or an article.

- Which is in itself capable by chemical reaction of producing gas at such a temperature and pressure and at such a speed as to cause damage to the surroundings
- Which is designed to produce an effect by heat, light, sound, gas or smoke or a combination of these as a result of non-detonative self-sustaining exothermic chemical reaction

1.2.2. Applicability of Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 & subsequent amendments

A systematic analysis of the chemicals and their quantities of storage has been carried out to determine threshold quantities as notified by GOI Rules, 1989 and the applicable rules are identified. The results are summarized in **Table 1.**

Table 1. Description of applicable provisions of GOI rules'1989 as amended in 1994 & 2000

Applicable rules	Description
1	Short Title And Commencement These rules are called as Manufacture, Storage and Import of Hazardous Chemical Rules, 1989.
2	Definitions In these rules, unless the context otherwise requires
3	Duties Of Authorities
4	General Responsibility Of The Occupier During Industrial Activity Take adequate steps to prevent major accidents Provide information to persons working onsite Impart training, provide equipment and antidotes
5	Notification of major accidents to concerned authority If any major accident occurs, occupier to inform Concerned authority as listed in Schedule 5 and submit report as per the format in Schedule 6 (applies after commencing of the activity)
6	Industrial Activity To Which Rules 7 To 15
7	Notification of site to competent authority
8	Updating of site notification following changes in threshold quantity
9	Transitional provision for the existing activity
10	Preparation of safety reports for commencement of activity
11	Updating of safety reports based on modification
12	Provision of further information on safety reports to the authority
13	Preparation of onsite emergency plan by the occupier
14	Preparation of offsite emergency plan by the occupier
15	Information to be given to persons liable to be effected by a major accident
16	Disclosures of Information Where for the purpose of evaluating information notified under rule 5 or 7 to 15, the concerned authority discloses that information to some other person, that other person shall not use that information for any purpose, and before disclosing the information the concerned authority shall inform that other person of his obligations under this paragraph.
17	Collection, development and dissemination of information on hazardous chemicals employed by the occupier

Applicable rules	Description
18*	Import of hazardous chemicals
19	Improvement Notices If a person has contravened the provisions of these rules, the concerned authority shall serve on him a notice
20	Power Of The Central Government To Modify The Schedules
Occupier shall develop information in the form of safety data sheet as specified in Schedule 9. Every container of the hazardous chemical should be labelled with name of the manufacturer or importer of the hazardous chemical.	

1.2.3. Storage facilities of hazardous chemicals

The storage capacities / details of the major hazardous chemicals proposed to be used in the project are given in **Table 2.**

Table 2 Details of Chemicals and Applicability of GOI rules

Solvent	Storage Type	Storage Capacity(Tons)	Listed in Scheduled	Threshold Quantity (Tons) for Application of Rules	
				5,7-9,13-15	10-12
Diesel	Tankers	5	Schedule 3 (part II)	5000	50000

From the above table it can be inferred that there would be no major Hazardous chemical stored at the proposed plant, which would attract the GOI rules 4 5,7-9 and 13-15, as the quantity likely to be stored at site lies below the stipulated threshold quantities.

Table 3 Nature of Possible Hazards

Hazard	Area	Probable Cause Of The Accident
Explosion	Boilers / Transformers / Receivers for the Air compressors.	Malfunctioning of the Safety Valve
	Flammable Petroleum Product Storage Tank / Drum Storage area	External fire causing pressure built up in the tanks / barrels
Fire	H.S.D. / FO Storage Area	Flammable vapor / air mixture and

Hazard	Area	Probable Cause Of The Accident
		source of ignition.
	Flammable Petroleum Product Storage Tank / Drum Storage Shed /Production Area	Formation on pool in the dyke wall and source of ignition.
		External fire →Built up of internal pressure →Failure of the top cover → Tank on Fire
Spillage	Acid / Alkali Storage Area	Spillage of Acid / Alkali due to rupture of the pipe line, collapse of the storage tank

1.2.4. Maximum credible accident analysis for diesel storage area

Identification of causes and types of hazards is the primary task for planning for risk assessment. Hazard can happen because of the nature of chemicals handled and also the nature of process involved. So for risk analysis first step is to identify the hazardous chemicals which are to be studied for risk analysis.

Identification of **Hazardous Chemicals** is done in accordance with **The Manufacture, Storage and import of Hazardous Chemical Rules, 1989.**

Schedule 1, of the Rule provides a list of the Toxic and Hazardous chemicals and the flammable chemicals. It defines the flammable chemicals based on the flash point and boiling point.

"**Major accident hazards (MAH) installations**" is defined as the isolated storage and industrial activity at a site handling (including transport through carrier or pipeline) of hazardous chemicals equal to or, in excess of the threshold quantities specified in Column 3 of Schedule 2 and 3 respectively Schedule 3 has classified hazardous substances in an operating plant into 5 groups and has provided the threshold quantities for application of above rules.

- Group1 & 2 – Toxic substances
- Group 3 – Highly reactive substances
- Group 4 – Explosive substance
- Group – 5 Flammable substances

The following **Table 4** shows the list of major chemicals which have been identified as hazardous chemicals in The Manufacture, Storage and import of Hazardous Chemical Rules, 1989 and which are to be considered as Major accident hazards (MAH) installations. 10 KL/month of diesel fuel is expected to be consumed at incinerator site.

Table 4 Hazardous Chemicals at Site

S.No	Chemical	Use	Nature of Chemical (Schedule 1 & 3)	Type of Storage & No's	Storage Quantity
1	Diesel	Supporting fuel for Vehicles	Highly Flammable	Vertical 1 No	5 KL

Table 5 Summary Table on the Inventories

Chemical	Codes/ Label	TLV	FBP	MP	FP	UEL	LEL
						%	
HSD (High Speed Diesel)	Flammable	800 mg/m^3TWA	215 - 376^0 C	NA	32^0 C	6.0	0.6

TLV : Threshold Limit Value FBP : Final Boiling Point
MP : Melting Point FP : Flash Point
UEL : Upper Explosive Limit LEL : Lower Explosive Limit

1.2.5. Fire Explosive Toxicity Index (FETI) for HSD

The application of FETI would help to make a quick assessment of the nature and quantification of the hazard in these areas.

Table 6 F&EI of fuels used for the proposed Industrial Area

Chemical/Fuel	NFPA Classification				GPH	SPH	*F&EI	F&E Category
	N_h	N_f	N_r	MF				
HSD	1	2	0	10	1.8	2.83	50.89	Light

FEI = MF *(1+GPH) * (1+SPH)

The F&EI values are ranked into following categories

Table 7 F&EI Category

S.No	F&EI	F&E Category
1	1-60	Low
2	60-90	Medium
3	90 and above	Severe

1.2.6. Nature of Hazard from Oil Storage:

Diesel is a petroleum product. It is a highly flammable liquid having flash point between 32 ^{0}C– 96 ^{0}C. However its auto ignition temperature is 256^{0}C. Its boiling point ranges between 150 ^{0}C – 400 ^{0}C. Furnace Oil is of similar characteristics having flash point above 66^{0}C. Major Hazards from oil storage can be fire. Maximum credible accidents from oil storage tank can be

a) Tank Fire
b) Pool / Dyke fire.

a) Tank Fire

Oil is stored in floating roof tank. Leak in rim seal leading to accumulation of vapour is a source of fire. Lighting can be a source of ignition and can cause tank fire. Overflow from tank leading to spillage may cause vapour cloud formation. This can catch fire and it can flash back to the tank to cause tank fire.

b) Pool / Dyke Fire

If there is outflow from the tank due to any leakage from tank or any failure of connecting pipes or valves, oil will flow outside and form a pool. Where the tank is surrounded by a dyke, the pool of oil will be restricted within that dyke. After sometime, the vapour from the pool can catch fire and can cause pool or dyke fire.

1.2.7. Heat Radiation and Thermal Damage Criteria

The level of damage caused by heat radiation due to fire is a function of duration of exposure as well as heat flux (i.e. radiation energy onto the object of concern). This is true both for the effect on building and plant equipment and for the effect on personnel. However the variation of likely exposures times is more marked with personnel, due to possibility of finding shelter coupled with protection of the skin tissue (clothed or naked body). Further, it is assumed that everyone inside the area by the pool fire will be burned

to death (100% lethality) or will asphyxiate. Radiation at various heat flux levels which are critical in risk analysis, are given in the **Table 8**.

Table 8 Effect of Heat Radiation

Exposure Time in seconds for % Fatality			
Radiation Level (Kw/m^2)	**1%**	**50%**	**99%**
1.6	500	1300	3200
4.0	150	370	930
12.5	30	80	200
37.5	8	20	50

The damage and fatality (percentage of the exposed people to be killed) due to the exposure time is very important in determining the degree of fatality and corresponding effect distance. It is observed that the exposed persons normally find shelter or protection from the heat radiation (e.g. against a wall) within 10 seconds. However, exposure time of 30 seconds is normally assumed for pessimistic calculation which applies if people do not run away immediately or when no protection is available. The variation of the effects on humans due to heat flux and duration of exposure have been developed in the form of a Probit Equation which gives following values for human fatality levels in **Table 9**.

Table 9 Heat Radiation and Fatality

Incident Radiation Intensity (KW/m^2)	**Type Of Damage**
37.5	Sufficient to cause damage to process equipment
25	Minimum energy required to ignite nearby wood at infinitely long exposure (non piloted)
12.5	Minimum energy required for piloted ignition of wood, melting plastic tubing etc. 1st degree burns for 10 seconds exposure.
4.5	Sufficient to cause pain to personnel if unable to reach cover within 20 seconds; however blistering of skin (1st degree burns) is likely.
1.6	Will cause no discomfort to long exposure

For the storage of HSD (Diesel), it is assumed that the complete liquid leaks due to tank failure or ruptures and develops into a pool and gets ignited. Hazards distances have been arrived due to effect of pool fires. For computing the damage distance from the tank

failure area ALOHA SOFTWARE is used. Full tank storage capacity has been considered. The out is given as **Table 10**

Table 10 Scenario (Pool Fire)

SITE DATA		
Location	NIMBUA, DERA BASSI MOHALI, INDIA	
Time	August 31, 2016 1221 hours ST (using computer's clock)	
CHEMICAL DATA		
Chemical Name	High Speed Diesel	Vapour Pressure at Ambient Temperature: 0.047 atm
Molecular Weight	114.23 g/mol	
IDLH: 1000 ppm	LEL: 9600 ppm	UEL: 65000 ppm
ATMOSPHERIC DATA		
Wind 2.29 meters/second	Wind Direction from NE	Air Temperature: 43° C
Stabiliy Class: D	Relative Humidity: 50%	Ground Roughness: open country
SOURCE STRENGTH		
Leak from hole in vertical cylindrical tank and Flammable chemical is burning as it escapes from tank		
Tank Diameter: 1.5 meters	Tank Length: 3 meters	
Tank Volume: 5.30 cubic meters	Chemical Mass in Tank: 3,646 kilograms	Tank is 100% full
Note: Per Day Fuel requirement is 360 liters maximum. Fuel storage capacity is for two week i.e 5 KL in vertical tank		
Risk scenario for Model run 1. The chemical escaped as a liquid and formed a burning puddle. 2. Circular Opening Diameter: 2.5 inches 3. Chemical Mass in Tank: 3,646 kilograms		
THREAT ZONE: Threat Modelled: Thermal radiation from pool fire		
Thermal radiation	Distance in meters	Remark
37.5 kW/(sq m)	less than 10 meters	Note: Thermal radiation from pool fire is within boundary limit of site.
25 kW/(sq m)	less than 10 meters	
12.5 kW/(sq m)	14 meters	
4.5 kW/(sq m)	24 meters	
1.6 kW/(sq m)	38 meters	

The risk contours are given below in **Figure 1 and 2**

Figure 1 Risk Contours with Pool Fire Threat Zone for HSD

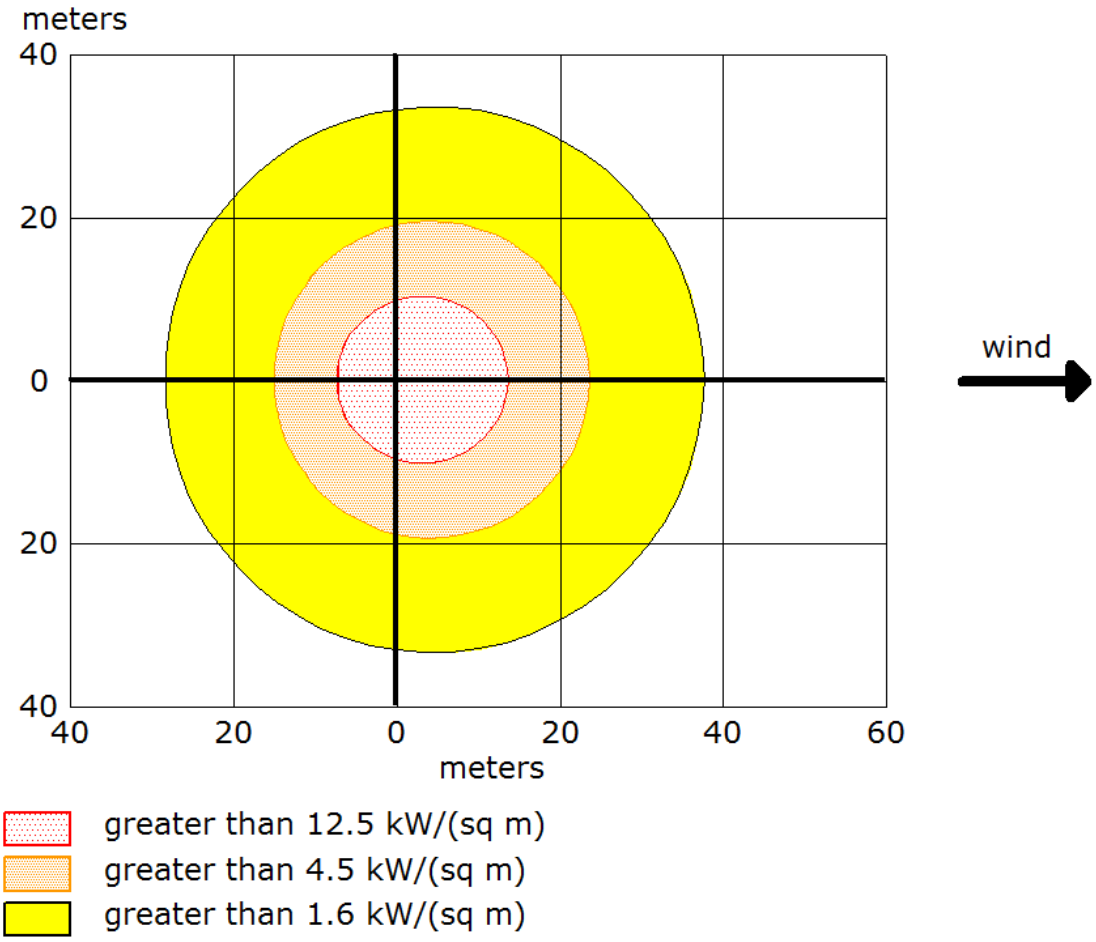
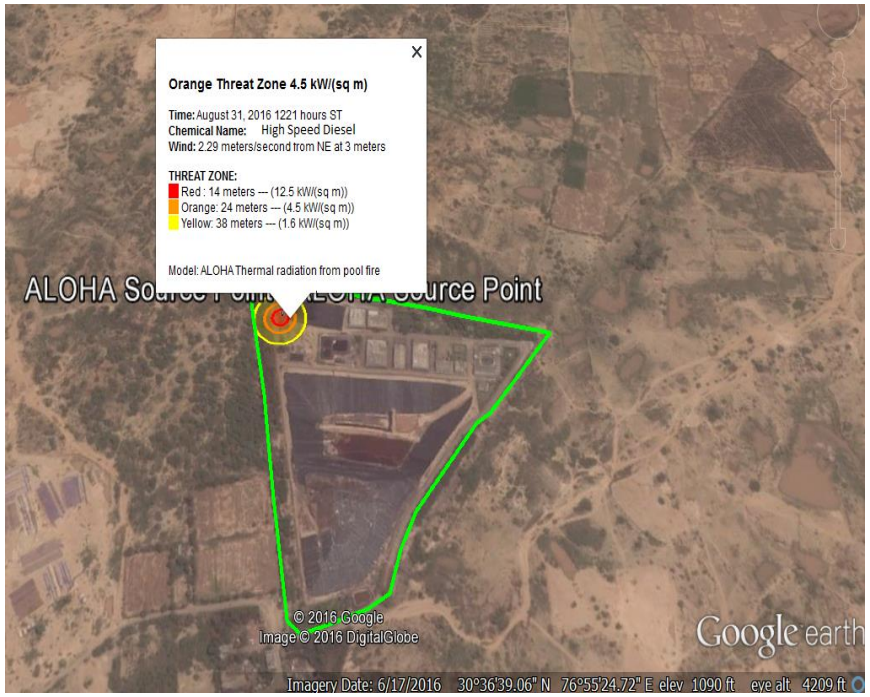
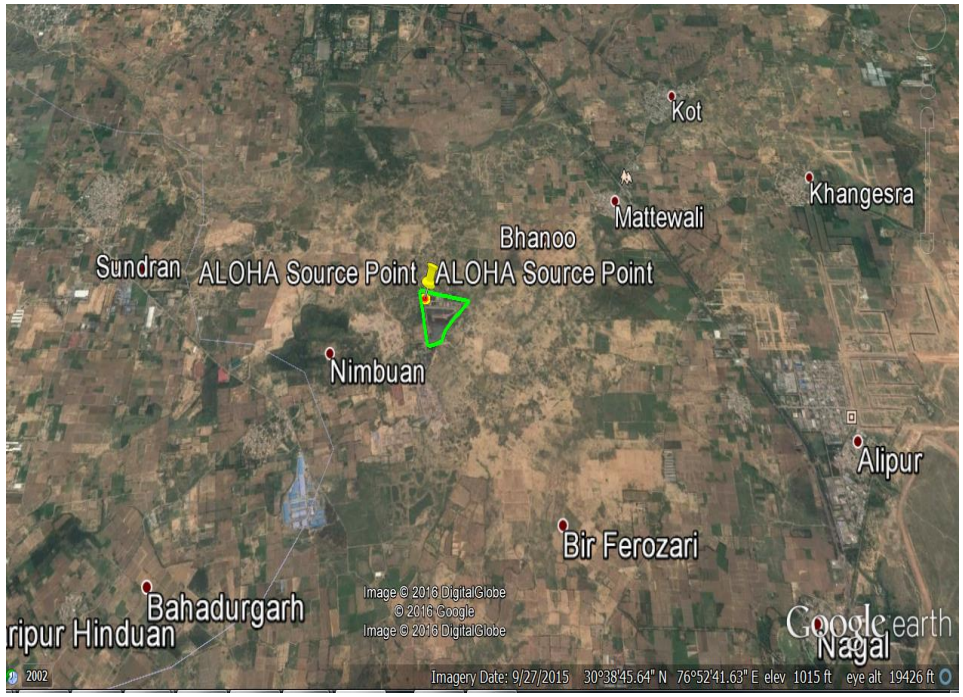


Figure 2 ALOHA Source point on the layout





1.3. On-Site Emergency Plan

An on-site emergency is caused by an accident that takes place in plant itself and the effects are confined to the factory premises involving only the people working in the factory. On-site emergency plan to deal with such eventualities is the responsibility of the occupier and is mandatory. An on-site emergency plan should contain the following key elements:

- Basis of the plan: Hazard analysis
- Accident prevention procedure/measures;
- Accident/emergency response procedure/measures and
- Recovery procedure.

1.3.1. Elements of Planning

The charts and maps should highlight the accident-prone areas of the industry so that in case of an emergency, it provides a basis for taking any action.

1.3.1.1. Emergency Personnel's Responsibility during Normal Office Hours

Site Controller: The Project Head (however called) or his nominated depute will assume overall responsibility for the plant / storage site and its personnel. His duties will be to:

- Assess the magnitude of the situation and decide if staff needs to be evacuated from their assembly points to identify safer places;
- Exercise direct operational control over areas other than those affected;
- Undertake a continuous review of possible developments and assess in consultation with key personnel as to whether shutting down of the plant or any section of the plant and evacuation of personnel are required;
- Liaise with senior officials of Police, Fire Bridge, Medical and Factories Inspectorate and provide advice on possible effects on areas outside the factory premises:
- Look after rehabilitation of affected persons on discontinuation of emergency;
- Issues authorized statements to news media, and ensure that evidence is preserved for enquiries to be conducted by the statutory authorities.

Fire & Security Officer: The Chief Fire and Security Officer, will be responsible for firefighting. On hearing the fire alarm, he shall reach the fire station immediately and advise fire and security staff in the factory of the incident zone and cancel the alarm. He will also announce on PAS or convey through telephones or messengers to the

Communication Officer, Incident Controller and Site Controller about the incident zone. He will open the gates nearest to the incident and stand by to direct the emergency services.

Telephone Operator: On hearing the emergency alarm, he will immediately contact Site Controller and on his advice, call the local fire bridge or mutual-aid scheme members. In case the PAS internal/external telephone system becomes inoperative, he shall inform the Communication Officer through a messenger. In case, fire has been detected and the alarm is not in operation, he shall receive information about location from the person who detected the fire and thereafter immediately consult the Incident Controller and make announcement on PAS or telephone telling the staff about location of the incident and to evacuate to their assembly points. He will continue to operate the switch board advising the callers that the staff is not available and pass all calls connected with the incident to the Communication officer

Departmental Heads: The Departmental Heads will report the incident to the Incident Controller and provide assistance as required. They will decide the staff required at the incident site.

Fire Pump Attendant: Two persons identified in each shift will work as fire pump attendants. On hearing the fire alarm, they will immediately proceed to pump house to ensure that pumps are operating and standby to maintain them. At the end of emergency, they will be relieved of their duty by the Fire and Security Officers.

1.4. Infrastructure

Emergency Control Room- Emergency Control Room is to be set up and marked on the site plan. The Control Room will be the focal point incase of an emergency from where the operations to handle the emergency are directed and coordinated. It will control site activities and should be furnished with external and internal telephone connections, list of essential telephone numbers, list of key persons and their addresses.

Assembly Points- Assembly points are to be set up farthest from the location of likely hazardous events where pre-designated persons from the works, contractors and visitors would assemble in case of emergency. Up-to-date list of pre-designated employees of various departments (shift-wise) must be available at these points so that roll call could be taken. Pre-designated persons would take charge of these points and mark presence as the people come into it.

1.5. Operational Systems during Emergency

1.5.1. Communication System

There are different types of alarms to differentiate one type of an emergency from other as described below:

Fire or Gas	:	Normal Fire Siren
Emergency/Evacuation	:	High-pitched wailing Siren

Alarms should be followed by an announcement over Public Address System (PAS). In case of failure of alarm system, communication should be by telephone operator who will make announcement in industrial complex through Public Address System which should be installed. If everything fails, a messenger could be used for sending the information.

1.5.2. Warning System & Control

The Control centres should be located at an area of the minimum risk or vulnerability in the premises concerned, taking into account the wind direction, areas which might be affected by fire/explosion, toxic releases, etc.

For promptness and efficiency, the factory premises/storage sites may be divided into 'X' number of zones, which should be clearly marked on the site plan.

- **Emergency Services -** Under this, each factory should describe the facilities of fire-fighting, first-aid and rescue. Alternate sources of power supply for operating fire pumps, communication with local bodies, fire brigade, etc. Should also be clearly indicated.
- An adequate number of external and internal telephone connections should be installed.

A plan or plans of the works to illustrate-

- Areas with large inventories of hazardous material.
- Sources of safety equipment.
- Fire-hydrant system and alternate supply sources.
- Stock of other fire-fighting materials.
- Assembly points, first-aid centres.
- Surrounding habitation within 1/ 2 km distance.
- Availability of first-aid equipment.

1.5.3. Mutual Aid

It is essential to have mutual aid arrangements as it is useful in cases of major fire and other emergencies. Mutual aid arrangements have to be worked out in the plan to facilitate additional help in, fire-fighting or medical attention which might be beyond the capacity of an individual factory/unit. To make the mutual aid plan a success, the following are considered essential:

- Written procedure which spells out how call for help will be made and how it will be responded.
- The type of equipment which would be used and procedure for making replacement.
- A quick hot-line method of communication.
- A brief mention of the type of hazard in each plant and fire-fighting measures.
- Orientation and joint training program for staff.
- Joint inspections and drills.

1.6. Disaster Management Plan

Emergency prevention through good design, operation, maintenance and inspection are essential to reduce the probability of occurrence and consequential effect of such eventualities. The overall objective of the DMP/Emergency Response Plan (ERP) is to make use of the combined resources at the site and outside services to achieve the following.

- Localize the emergency on property and people
- Minimize effects on property and people
- Effective rescue and medical treatment
- Evacuation.

A disastrous event strikes suddenly, violently and without warning. Identifying the potential hazards ahead of time and advance planning can reduce the dangers of serious injury, loss of life and damage to environment in the event of an incident occurrence.

The first response to a disaster is the job of the local government's emergency services with the help from the nearby municipalities and the volunteer service agencies. In a catastrophic disaster only the govt. can provide the rescue search on the disaster site, resumption of electric power, food, water, medicines, cloths, shelter and other basic human needs. It is the long term recovery phase of disaster which places the most severe financial strain to govt. in-addition to damage to public facilities and infrastructure. It takes longer time to get aid from the govt. for rescue work when there is a natural

calamity because of various constraints such as reaching the site, priority of personnel involved, availability of material, equipment and rescue team personnel etc. It is always advisable to develop teams within the organization for taking immediate rescue action if possible. Industry has to prepare a detailed disaster control measures and give information such as the quantity of hazardous material stored, the location of storage, the approximate population living in the vicinity and the detail of the hazardous characteristic of the material to the Employees, District Collector, Police, Fire service department, Director of Factories, State Pollution control Board and the Public living in the vicinity regularly to enable the government to prepare the disaster management plan. Educate employees and the public living in the vicinity the safety measures required to be taken in the event of an accident taking place.

What are the types of disasters that can occur in a hazardous waste management site?

- An earth quake leading to damage of liner and contamination of soil and ground water due to leakage of chemicals, waste material and leachate.
- Cyclone leading to flood water entering landfill site contamination of ground water and soil.
- Major explosion of chemicals fire and toxic gas release.
- Contamination of soil and water sources due to leakage of contaminants from the landfill waste or due to leakage of leachate.
- Release of dangerous gases from the incinerator affecting the public in the vicinity.

1.6.1. An earthquake.

During site selection stage based on the past seismic metrological data / reports earth quake prone areas have to be avoided. Cover the site with public liability insurance as per the advice of government. Design building to withstand minor shocks of earth quake without damage to structures.

Maintain inventory of material and the location of stock on day today basis and submit the report to disaster management authority (district collector) and the state pollution control board weekly / monthly also maintain parallel record at H.O.

Maintain MSDS of stored materials toxicity of gases that can emanate due to reactions of stored materials including the landfill material. Provide communication facilities internal and with people living in the vicinity. Educate the employees and the surrounding peoples about the possible dangers in case of an earthquake and the safety measures required to be taken.

Take preventive action of stopping work activities, informing and evacuating employees and the public living in the vicinity to safe location as per the advice of government agency if there is an advance earth quake warning from the agencies.

After an earth quake (if the site is affected), Inform disaster management authorities and state pollution control board authorities over phone, e-mail or through messenger. Display Phone Numbers of: District Collector, Police S.P, Fire Service Department, Factories Inspectorate and nearby Hospitals. Inform company authorities through phone: Phone numbers: Project Head, EHS Head, HR Head. Inform the insurance authorities about the incident. Phone Numbers: Local Insurance officer and Divisional Manager

Test the nearby water sources and soil for contamination and the extent of damage and compare data with the base data. If found contaminated, Inform public of the affected area not to use water from the wells or bore wells through mobile public announcement system and by using media like radio and TV. Arrange supply of drinking water from outside till the condition is normalized.

Use the services of the lab and expertise of pollution board and find solutions to arrest the leakage of material and leachate and start remedial measures.

Divert material required for lining and transfer skilled employees for new pit construction from other site along with additional number of equipment. Construct new pit and start transfer landfill material / leachate in to the new pit. Test the soil contamination level and find out the level of damage and treat the soil if required or remove the contaminated soil and safely transfer it in the new land fill.

Check the water contamination level and advise authorities and public about the usability of water.

Asses the expenditure required for implementation of required remedial measures. Prepare cost estimate of the total loss including the transport and remediation cost. Make insurance claim and pay compensation if any advised by the govt. authorities to the affected victims.

1.6.2. Cyclone leading to land fill flood

Control measures during planning and operation:

During site selection and approval of the site for hazardous waste disposal and should highlight the history / possibility of cyclone / Floods, Tsunami in the particular area. If it

falls in any of the above better avoid usage of that site, for hazardous waste handling and storage.

Maintain base line data of quality of water and soil at least one year before start of site activities.

Check the possibility of breach of an upland water pond / tank or dam which can cause flood before finalizing the location. Design buildings as per national building code to withstand for the maximum wind speed experienced by the region without damage.

Cover the site with public liability insurance as per government advice. Check the maximum rainfall in the location and the possibility of rain water entry from outside in to the site. Arrest the outside water entry by raising the ground level or by constructing bund wall / compound wall and providing proper drains along the boundary.

Ensure the storm water drainage system is well designed and maintained to drain storm water from the site to outside drains and is sufficient to drain rain or flood water without allowing it to accumulate near landfill. Maintain waste storage and landfill level above the drain level.

Ensure the leachate ponds capacity is sufficient and will not over flow due to rain water collection. Get the warning advice from the weather forecasting department regularly. Stop all activities of land fill and cover the land fill with liners regularly to prevent rain water contact with the waste material before the start of rain fall. If possible provide temporary bund wall with sand bags to reduce the damage to landfill bund due to the flowing water. Evacuate the place and move to safe location as per the advice.

After the occurrence

Check the extent of contamination and damage to ground water source and the soil after the flood and compare data with base data. Inform disaster management authorities and state pollution control board authorities if contamination is detected through phone or through messenger. Inform company authorities over phone. Phone numbers: Project Manager, HR manager, EHS manager. Inform public of the affected area not to use water from the wells or bore wells through mobile public announcement and by using media like radio and TV. Arrange supply of drinking water from outside till the condition is normalized. Continuously test and monitor the soil and ground water sources and advise public the condition regularly.

Check the soil contamination level if necessary start remedial action as per the advice of pollution board. Plan for removing the contaminated soil and fill it in a new land fill pit.

Inform insurance company over phone. Phone Numbers: Assess the damage, prepare and submit estimate of damage and claim insurance. If necessary relocate the affected public to an unaffected site.

1.6.3. Major explosion of chemicals / fire and toxic gas release in landfill or Stores

Control measures during planning

Analyze material samples before accepting the materials for disposal. Ensure material samples collected and analyzed before taking the material inside the premises. Explosive materials should not be accepted without treatment and check the incoming materials using an explosive meter.

Ensure good covered storage space available for incinerable waste material. Storage is well ventilated to prevent accumulation and concentration of gases below explosive and flammable limit. Install gas detectors and explosive level meters with early warning alarm. Avoid electric fittings in flammable material storages use flame proof materials if felt essential.

Compartmentalize storage to limit the stock quantity and risk of fire spread. Locate incinerable waste storages away from heat source and hot furnace areas.

Provide communication facility and sufficient number of security personal for 24 hours manual watching.

Installation of smoke detection and warning and automatic fire hydrant with foam monitors, automatic sprinklers, mist sprays and CO_2 flooding system in incinerable waste storage will help a lot in early detection and automatic fire fighting. Provide separate storage for reactive chemicals. Provide spark proof equipment to handle solvent waste containers.

Ensure sufficient gap between storage sheds are maintained as per national building code to prevent fire spread and easy movement of fire vehicles around the storage during an emergency.

Wind socks with wind speed indicators are installed in the site to see the wind direction from any location. Lightning arrestors are installed to cover the whole site. Employ only qualified and trained employees to supervise the storage activities.

Operation:

Ensure public liability insurance cover is in force for the site. Plan for the disposal of Low flash point material immediately on arrival and minimize inventory of low flash point materials and flammable materials. Reactive materials are separated and stored away from the flammable materials store. Display No smoking warning boards around the waste material storages. Do not allow any source of heat or spark in material storage.

Ensure static electricity is discharged from material containers by bonding the containers. Maintain sufficient gap between stack for inspection and also for better ventilation. Do not use mechanical handling equipments which produce sparks or static electricity.

Use spark proof equipment while handling low flash point and waste containing solvents. Ensure good housekeeping is maintained in and around storage. Maintain record of quantity of material stock and the MSDS of material in each shed for giving required information to disaster management team on arrival at site. Install and maintain sufficient number of appropriate first aid fire appliances and ensure the approach way is not blocked.

Train all the employees in first aid, firefighting and the procedures to be followed in case of an emergency. Replace leaky containers and clean spillage immediately. Remember inhaling gas generated due to a fire or explosion is dangerous. Use of Self-contained breathing apparatus (SCBA) is mandatory for all rescue and firefighting work in case of an explosion or fire. Check the wind direction and inform everyone to stand on the upwind direction through public address system or through phones. Advice evacuation of people at site and surrounding if found necessary.

Try and put off fire with the help of available hand appliances, fire hydrant water using internal trained employees. Bring all available firefighting appliances and also get help from nearby industries in control and rescue operations only if they are trained and have the required PPE to carry out the work safely. Phone Numbers of nearby industries: If the fire is found very major leave it to professionals to deal with it.

Inform state fire and police department about the disaster through phone or through messenger. Display Phone Numbers: Nearby Fire station, Police station at many locations. Inform company authorities through phone. Phone Numbers: Use SCBA and rescue

affected employees to safe location and if necessary give first aid with the help of trained first aider.

Remember to wash with cool water in case of burn injury or chemical spills on human body and eye at least for 15minits before shifting the victim to hospital. Measure the gas pollution level in the environment and advice concerned. Inform disaster management authorities and state pollution control board authorities through phone or through messenger or phone calls inform nearby hospitals the possible gas that can release from the incident for quick treatment.

Call additional ambulance if felt necessary the site controller will direct concerned department to arrange without delay. Provide FIRST AID to the affected victim before moving them to hospitals. Send the victims to hospital with their personal data and their medical history while sending for treatment. Measure the contamination level of air and soil and report to authorities. Initiate remedial measures such as supply of drinking water and measure air contamination level regularly till the condition normalizes.

If felt necessary, Inform public living near the affected area to evacuate through public announcement and by using media like radio and TV the direction of escape route and advise them to use wet cloth to cover the nose while moving. Put off fire using the fire hydrant water and foam compound or with the help of fire extinguisher.

Use Self Contained Breathing Apparatus and Collect gas samples analyze the type of gas emanated and the toxicity level.

Inform Fire service and police personnel about the potential of the gas emanated due to the reaction promptly. Block the road traffic at least 5 km distance depending on the toxicity of the gas and the wind speed to prevent exposure of more number of public.

Provide first aid to burn injuries by pouring cool water before shifting the victim to hospital: Phone Number of Hospitals: Shift the gas affected victims to well ventilated area and provide breathing oxygen. Transport the affected to the hospitals with the advice of the possible name of gas inhaled by the victim.

Check the extent of damage to the liners if any and arrange for immediate repair based on the need. Prepare report of the incident and investigate and find out the root cause of accident. Inform insurers about the incident. Estimate the loss incurred and make the insurance claim and pay for the actual expenses inquired for treatment and compensation for the victim or the family members of the victim.

1.6.4. Contamination of soil and water sources due to leakage of contaminants Control measures:

First and the foremost is to collect soil and water samples from the site before starting operations and establish the base line data. Cover the site with public liability insurance.

Make sure that the preparation of landfill pits done as per the laid out standard. Special care is taken while laying the liners such as visual check for damage of liner material and proper welding of joints to ensure that the leakage of leachate from the liner is absolutely nil also by conducting leak proof tests ultrasonic or X-ray tests.

Avoid damage of liners during land fill operation by the use of sharp edged objects such as cutting knives, dropping of crow bars and by moving heavy vehicle on the liners. Contamination of water and soil due to leakage of leachate from the liners / due to over flowing from leachate ponds especially during rainy season spillage while pumping or spillage during handling operation to be avoided.

Flooring of material stores should not have cracks and should not allow seepage of material. The floor should be provided with bund wall and collection pit.

Periodic checking of soil and water samples and compare data with base line data at least once a month. If any adverse increase in parameters noticed increase the frequency of tests. Prepare comparative analysis data if found more, than the base line data inform the pollution board authorities.

After the incident:

If the operation is continued the condition is going to be disastrous after some time. Hence it is necessary to initiate corrective measures as per the advice of the pollution control board. Follow the corrective measures mentioned after an earth quake and flood.

1.6.5. Release of toxic gases from incinerator

Control Measures:

Ensure public liability insurance cover is taken for the site. Analyze the combination of waste material that is proposed to be burned and check the possibility of toxic gas generation and get the written report from lab before start feeding the waste material in the incinerator.

Install wind socks and wind speed monitor at site visible from all points. Employ qualified and well trained operators to operate the incinerator. Maintain the temperatures of gases at locations as per the incinerator operation instruction. Install instruments to detect and warn operators before the toxicity level reaches higher than the statute limit.

Monitor the toxic content levels at the chimney exhaust continuously during the operation. If any changes in parameters of gases noticed during the operation stop feeding the material and inform the lab manager immediately and take corrective measures. Reanalyze the sample and decide the combination of materials before restart.

Maintain the record of changes made for future reference. Inform the employees and the public living in the vicinity about the safety measures required to be taken in case of an accidental release.

After an incident:

Evacuate everyone from the site and the vicinity to safe place. Additional care to be taken while evacuating, sick, old, infants and physically challenged persons. Detect the gas that is generated by analyzing the gas and its toxicity level. Provide first aid to victims by removing them to safe and well ventilated area. If necessary send the victim for treatment with information of the type of gas victim is exposed to.

If necessary make insurance claim and meet the expenses.

1.7. Hazard Control Measures

1.7.1. Fire

To increase the level of safety in proposed project, installation of smoke alarms or automatic fire detection /alarm systems will be proposed at strategic locations as an early warning of fire to the occupants.

To prevent fire mishaps and to manage the emergency situation during fire in the proposed project the following activities and precautions are proposed.

- Emergency evacuation plan is important for all projects, and the same will be prepared as per Fire & Safety rules.
- Regular mock drills will be carried out to create awareness on procedures to be followed in times of emergency situation/evacuation

- It will be advised to keep oxygen cylinders, medical kits and masks to prevent smoke inhalation especially for those with respiratory disorders for whom smoke inhalation can be very dangerous.
- Plant manager will be advised to ensure that the firefighting equipments are in good working conditions.
- The plant will be provided with sufficient firefighting gadgets (water, soil, cylinders, etc).

Simple steps to be followed during emergency are as follows.

Call the fire rescue department: During fire in plant, leave the premises by nearest available exit. Call fire department and do not assume anyone else has called the fire department. If your cloth catches fire, do not get panic or run, stop, drop and roll.

Cover your nose and mouth with a wet clean cloth: Stay calm cover your nose and mouth with a wet, clean cloth to prevent smoke inhalation injury and choking. Never jump off or attempt to climb down the side of a tall structure as it will mean certain death.

Do not run: During a fire, smoke containing poisonous gases such as CO tends to rise up. When you run in a smoke filled room, you tend to inhale the smoke faster. CO dulls the senses and prevents clear thinking, leading to panic. To prevent being asphyxiated, dip tissues or cloth in water and cover your noise with it.

Head-count of the occupants: During an emergency, make good use of the evacuation procedure and help each other to reach out of plant/building safely. Ensure nobody is left behind by doing a head-count of occupants. Visitors should read and understand the evacuation plan before going into the plant/building area and ensure their safety.

1.7.2. Natural Disasters

Disasters occur without notice. Most disasters are natural such as earthquake, floods, hurricanes, sandstorms, landslides, tsunamis and volcanoes. We have no way of stopping them, but we can learn to deal with the difficult situations that arise due to them. During disasters like floods, fire, earth quake, landslides, rescue beings at site. Even before external help arrives, people affected by the disasters help each other. The government and many voluntary organizations send teams of workers trained in rescue operations to disaster-affected areas. These teams join hands with the local community helpers such as doctors, nurses, social workers and policemen.

Temporary shelters are built for displaced people. Doctors and nurses provide medical aid. They treat the wounded and work to control epidemics. Social workers collect food and cloth from all over the country for the disaster-affected people. The police maintain law and order. Media –persons help in spreading news about the victims and their conditions. They also post advertisements that urge people to donate for victims.

In extreme conditions, the army and Air force organize rescue operations. They clear roads, send medical teams and help to move people to safer places. The air force drops food, water and clothes in the affected areas. Organization like UN helps in providing aid during massive disasters.

Individually, people from all over the world also come forward to help during a disaster. They donate blood while many donate money. Some even reach the disaster affected places to give an extra hand in the rescue operation. Families adopt children who have lost their parents and thus give them a new home.

Some of the points we can keep in mind when disaster happens

- If there is a tornado, take shelter in a place without windows.
- In an earthquake, remember to crouch under some heavy furniture or stand under the doorframe for cover.
- In case of a fire in the building, leave the building by nearby exit
- If the site is flooded, then climb up to the roof.
- Do not use the telephone, except to call for help, so as to leave telephone lines free for the organization of response
- Listen to the messages broadcast by radio and the various media so as to be informed of development
- Carry out the official instructions given over the radio or by loudspeaker
- Keep an emergency kit ready. In all the different types of emergency, it is better to be prepared than to get ready, to get information so as to get organized, to wait rather that act too hastily
- During floods turn off electricity to reduce the risk of electrocution
- As soon as flood begins, take vulnerable people (old, children, sick, etc) to upper floor
- Beware of water contamination, wait until the water is declared safe before drinking or boil the water before drinking
- Clean and disinfect the room that is flooded
- During storms and hurricanes do not go out in a car or a boat once the storm has been announced

- If caught outside in a storm, take refuge as quickly as possible in shelter (never under a tree), if there is no shelter, lie down flat in a ditch.
- In a thunderstorm keep away from doors, windows, and electrical conductors, unplug electrical appliances and aerials. Do not use any electrical appliances or the telephone
- During earthquake keep calm, do not get panic, People who are indoors should stay there but move to the central part of the building, people who are outside should stay there, keeping away from buildings to avoid collapsing walls and away from electrical cables. Anyone in a vehicle should park it, keeping away from bridges and buildings
- During spread of clouds of toxic fumes, close doors and windows, seal any cracks or gaps around windows and doors with adhesive tape. Organize a reserve of water (by filling wash basins, baths, etc. Turn off ventilators and air conditioners.

1.7.3. Electrical Accidents

Electrical hazards can cause burns, shocks, and electrocution which can lead to serious injury and even death. When dealing with potentially serious electrical hazards stop and think! Instead of taking a chance and risking your personal safety, call trained professionals to handle problems.

Many times people prefer to take electrical matters into their own hands. Other small aspects of electrical repair in a business setting may be taken care of without needing professional service technicians. If you do decide to take matters into your own hands, safety precautions can avoid injuries and other losses.

1.7.3.1. Prevention of Electrical Accidents

Flexible cords connected to appliance should be wired to confirm to the international color code. Color of insulation wire is

- Brown represents live wire,
- Blue represents neutral wire and
- Green/yellow stripes represent earth wire.

What you should look for when selecting an electrical appliance are given below

a. The appliance should be suitable for operation on local electrical supply of 240 volts AC and frequency of 50 Hz.

b. The appliance should preferably be tested and certified by a national or reputed standards testing authority
c. Look for certified plugs on the flexible cords connected to the appliances. If the appliance is double insulated and has a 2-pin plug, then it should be fitted with a suitable certified plug.
d. An essential formality when buying any appliances is a duly completed guarantee card with the dealers/retailer's official stamp and details of the appliance (serial number, etc.).

Safety precautions to be taken when using electrical appliances

a. Avoid using handheld appliances when your hand and/or body is wet.
b. Do not use or leave appliances where liquid can splash onto them
c. Flexible cords connecting the appliance and the plug should be in good condition, if the cord is frayed, chaffed, cut or melted, have the entire cord replaced by a competent person.
d. Check accessories such as plugs attached to appliances for cracks and burnt marks and have them replaced. If undue overheating occurs or burnt marks appear in any electrical appliance, have it checked.

Some common causes of electrical accidents in the house

a. Faulty wiring: This usually occurs when unauthorized extension or rewiring is done by unqualified persons. Some of the usual faults are the omission of earth wires and the reversing of the live and neutral wires. Without an earth wire, the exposed metal parts of appliances may deliver a lethal shock to the user when a fault develops.
b. Improper flexible cords: This can be caused by connecting the flexible cord wrongly to the plug. In the case of appliances which have exposed metallic parts, a 2-core instead of a 3-core flexible cord is used. When the appliance is faulty, the exposed metal parts may become live and a fatal accident could result.
c. Faulty appliance: Attempts to repair faults in electrical appliances by people not trained to do so can result in accidental shock.

To prevent Electrical accidents, the following points should be kept in mind:

- All electrical wiring, rewiring or extension work must be carried out by licensed electrical contractors. On completion, the contractors should test before electricity supply is connected.
- Repair of appliances and replacement of flexible cords should be carried out only by competent persons.

- To ensure electrical safety in the facility, a current-operated Earth Leakage Circuit Breaker (ELCB) or Residual Current Circuit Breaker (RCCB) set to operate at a very small leakage current is recommended. (This is usually marked 100mA or 0.1A on the label). In case of dangerous electrical leakage to earth, it should automatically cur off the supply of electricity.
- DO NOT use multi-way adaptors. Over loading can cause fire. One socket outlet is for one appliance only.
- DO NOT carry out wiring extension, Engage a licensed wiring contractor for the work.
- DO NOT use a two-way lighting adaptor for any extension.
- DO NOT connect any electrical appliance to lighting outlets. A lighting outlet does not have an earth wire to prevent danger.
- ENSURE the switch is in "OFF" position before changing bulbs.
- DO NOT make joints to lengthen the lead of the electrical appliances. If the lead wire is worn out or too short, replace it with a new wire.
- DO NOT drive nails carelessly on the wall. There may be concealed wiring.
- USE individual socket outlet for every electrical appliance.
- KEEP AWAY from danger areas such as a substation for whatsoever reasons.
- CHECK before carrying out excavation work to prevent damaging any underground cable. The operator may receive severe electric shock or even be electrocuted.
- TAKE PRECAUTION when working in the vicinity of overhead lines to avoid any unforeseen incident.
- DO NOT meddle with any broken overhead wire. Report the matter immediately to the nearest electric office.
- DO NOT climb any electric pole. You may receive an electric shock or get electrocuted.
- DO NOT throw anything onto the overhead lines.
- NEVER attempt to retrieve anything stuck to overhead lines by whatever means.
- DO NOT climb transmission line towers. No one is safe from its high voltage shock.
- DO NOT erect any structure close to transmission lines.
- DO NOT fly kites close to overhead lines.
- TAKE PRECAUTION when working in the vicinity of overhead lines to avoid any unforeseen incident.
- NEVER stand on a damp or wet surface when using electrical equipment.
- USE a portable electrical tool, which is properly earthed.
- DO NOT tap electrical power without a proper plug.
- DO NOT use any electrical tool which has a damaged casing, cap, switch, lead or plug.

1.7.3.2. First Aid and Emergency Procedures

Burns can cause due acid spillage and leakage of electricity. Curative measures for any issues of burns and First Aid procedures are given below:

Table 11 -First Aid for Burns

Burns Covering Small Area	Burns Covering Extensive Area
i. Allow cold tap water to run gently over the area or immerse in cold water. ii. It may be necessary to cover with gauze or a clean handkerchief, and bandage.	i. Allow person to lie down. ii. Cover burned areas with sterile dressing or clean cloth and lightly bandage. iii. If clothing is adhering, do not disturb; leave the clothing alone. iv. Keep person warm. If person is not nauseated, he may have sips of water. v. Arrange for immediate medical care.
Note: Do not user ointments, greases, pastes or powder on burned area. Do not prick the blisters caused by burns. Tetanus immunization - Protection against tetanus should be considered whenever the skin is broken by injuries	

1.8. Full Mock Drill Monitoring

The mock drills are to be conducted at regular intervals. For conducting mock drills a committee has to be organized. The committee may invite any other official/expert, if considered necessary.

1.8.1. Steps of Mock Drills

The Mock Drills should be carried out step by step as stated below.

First Step : Test the effectiveness of communication system
Second Step : Test the speed of mobilization of the emergency teams.
Third Step : Test the effectiveness of search, rescue and treatment of casualties.
Fourth Step : Test Emergency isolation and shut down and remedial taken on the system.
Fifth Step : Conduct a full rehearsal of the actions to be taken during an emergency.

The Disaster Management Plan should be periodically revised based on experience gained from the Mock Drill.