Risk Assessment and Disaster Management Plan

1.1 Risk assessment and disaster management plan

The principal objective of risk assessment is to identify and quantify the major hazards and risk associated with various operations of the proposed project, which may lead to emergency consequences (disasters) affecting the public health and safety. Based on this information, an emergency preparedness plan has to be prepared to mitigate the consequences. The approach involves hazards identification, hazards assessment, evaluation and developing a 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 in to account. Risk can be characterized in qualitative terms as high, medium or low or in quantitative terms using numerical estimates and statistical calculations. Diminishing the likelihood of an accident or minimizing the consequences will reduce overall risk.

1.1.2 Evaluating hazards

The need for sophisticated techniques for evaluating hazards depends on the result of preliminary hazard analysis. Various techniques for evaluating hazards are as follows:

- 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. Such a plan must cover the possible hazardous situations in the locality and the causes, areas most likely to be affected, on-site and off-site emergency plans, establishment of Emergency Control Centre (ECC), location of emergency services and duties of officers/staff during an emergency.

The EPP protocol should be designed to provide measures to control the incident and minimizing the effects due to fire, explosives, release or escape of toxic gas, spillage of hazardous substances during storage, processing or 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 Risk assessment and hazard identification

The past disastrous events in India over a few decades have enlightened the need for a specific legislation covering major hazard activities. This has been enforced by Government of India in 1989 in conjunction with Environment Protection Act, 1986, amended in 2000. For the purpose of identifying major hazard installations, the rules employ certain criteria based on toxicity, flammability and explosive properties of chemicals which are outlined below.

1.2.1 Identification of toxic, flammable, explosive chemicals

Toxic Chemicals: Chemicals having acute toxicity values, owing to their physical and chemical properties are capable of producing major accidents. The details are given in **Table 1.**

Table 1 Toxicity values of chemicals

S. No	Toxicity	Oral toxicity LD_{50} (mg/kg)	Dermal toxicity LD_{50} (mg/kg)	Inhalation toxicity LC_{50} (mg/l)
1.	Extremely toxic	>5	<40	<0.5
2.	Highly toxic	>5-50	>40-200	<0.5-2.0
3.	Toxic	>50-200	>200-1000	>2-10

Flammable Chemicals:

Flammable gases: Gases which at 20°C and at standard pressure of 101.3 kPa are:-

- Ignitable when in a mixture of 13 % or less by volume with air, or
- Have a flammable range with air of at least 12 % points regardless of the lower flammable limits.
    - **Extremely flammable liquids:** chemicals which have flash point lower than or equal to 23°C and boiling point less than 35°C
    - **Very highly flammable liquids:** chemicals which have a flash point lower than or equal to 23°C and initial boiling point higher than 35°C.
    - **Highly flammable liquids:** chemicals which have a flash point lower than or equal to 60°C but higher than 23°C.

Flammable liquids: chemicals which have a flash point higher than 60°C but lower than 90°C.
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.

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;

- 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 Storage of hazardous chemicals and nature of possible hazards

The details of storage facilities and capacities of hazardous chemicals proposed to be used in the project are given in **Table 2** and the nature of possible hazards is listed in **Table 3**.

Table 2 Details of chemicals and applicability of GoI rules

Solvent	Storage Type	Listed in Scheduled	Threshold Quantity (Tons) for Application of Rules	
			4,5,7-9,13-15	10-12
High Speed Diesel (HSD)	Tank	Schedule 1 (part I)	5000	50000
Isopropyl alcohol		Schedule 1 (part III)	7000	7000
Butanol		Schedule 1 (part IV)	10000	10000
Toluene		Schedule 1 (part III)	7000	7000
N,N-dimethyl formamide		Schedule 1 (part V)	5000	50000
O-dichlorobenzene		Schedule 1 (part V)	5000	50000

From the above table, it can be inferred that there would be no major hazardous chemicals stored at the proposed plant which would attract the GoI rules 4, 5, 7-9 and 13-15. Further, as the quantities likely to be stored at site lie below the stipulated threshold quantities major hazards are not anticipated.

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 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

1.2.3 Maximum credible accident analysis (MCA) for diesel storage area

Identification of causes and types of hazards is the primary task for assessing risk. Hazards can happen because of the nature of chemicals handled and also the nature of processes involved. A pre-requisite for risk analysis is to identify and study the hazardous chemicals associated with risk.

Identification of hazardous chemicals is done in accordance with **Manufacture, Storage and Import of Hazardous Chemical (MSIHC) Amendment Rules, 2000.** Schedule 1, of the Rule provides a list of toxic and hazardous chemicals and the flammable chemicals. It defines flammable chemicals based on 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.

- Group 1 and 2 – Toxic substances
- Group 3 – Highly reactive substances
- Group 4 – Explosive substance
- Group – 5 Flammable substances

Table 4 shows the list of major chemicals which have been identified as hazardous, as per the MSIHC amendment rules 2000 and which are to be considered as MAH installations.

Table 4 Hazardous chemicals at project site

Chemical	Use	Nature of Chemical	Type of Storage & No's	Storage Quantity
HSD	Fuel for D.G sets & incinerator start-up	Flammable	Vertical & 1No.	10 kl
Isopropyl Alcohol	Solvents recovered will be stored and sold to the end user	Very highly flammable		1 kl
Butanol		Highly flammable		
Toluene		Very highly flammable		
Dimethylformamide		Flammable		
Orthodichlorobenzene		Flammable		

The summary of physical properties of chemicals at site is given in **Table 5**. HSD is mainly used for DG sets and for incinerator start-up activity. Around 1.2 kl of HSD is expected to be consumed during this operation and on an average, 10 days of incinerator is operative. The inventory of HSD of 10 kl tank is stored at project site. The solvents are recovered through

solvent recovery unit of 5 kl capacity and 1 kl of each solvent is considered for storage. For risk assessment, complete tank is considered for any accidental release of fuel due to leakage.

Table 5 Physical properties of chemicals at site

Chemical	Codes/ Label	TLV (mg/m^3)	BP	FP	LEL	UEL
			(°C)		%	
HSD	Flammable	800 ppm	215 - 376	32	0.6	6.0
Isopropyl Alcohol		400	82.6	11	2	12.7
Butanol		100	118	35	1.45	11.25
Toluene		100	111	6	1.1	7.1
Dimethylformamide		10 – 30	153	67	-	-
Orthodichlorobenzene		50	180.5	66	2.2	9.2

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

Fire Explosive Toxicity Index (FETI) for HSD

The computations of FETI (Fire and Explosion, Toxicity Index) for HSD at proposed TSDF is shown in **Table 6** and the subsequent F&EI categories are given in **Table 7**. The capacity of HSD Storage tank (2 KL) was considered for these studies. The Health (Nh), Flammability (Nf), Reactivity (Nr), and MF (Material Factor) under consideration was derived from NFPA (National Fire Protection Association) codes. The GPH (General Process Hazard Factor) and SPH (Specific Process Hazard Factor) was calculated accordingly. Based on F&EI (Fire and Explosion Index), HSD comes under “Low” category and nil toxicity.

Table 6 F&EI of fuels used for the proposed project

Chemical/Fuel	NFPA Classification				GPH	SPH	*F&EI	Toxicity Category	F&E Category
	N_h	N_f	N_r	MF					
HSD	1	2	0	10	1.8	2.8	50.4	Nil	Low

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

The F&EI values are ranked into following categories

Table 7 F&EI category

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

1.2.4 Nature of hazard from oil storage

Diesel is a flammable liquid having a flash point of 32°C. However, its auto ignition temperature is 225°C. Its boiling point ranges between 215-376°C. Major hazards from oil storage can be fire and maximum credible accidents from oil storage tank can be

a) Tank Fire and

b) Pool / Dyke fire.

Similarly, for the solvents it can be seen as fire hazard to be a major cause and none of them are toxic to cause other accidental scenario.

a. Tank fire

A series of incidents could lead to tank fire. Oil is stored in a floating roof tank. Any leak in rim seal that leads to accumulation of vapour could be a source of fire. Further, this lighting can be a source of ignition and can cause tank fire. At times, overflow from tank leading to spillage may also cause vapour cloud formation which in turn catches fire. This can again 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. When 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.

1.2.5 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 for both the effect on building and plant equipment and also for the effect on personnel. However the variation of likely exposure time is more marked with personnel, due to possibility of finding shelter coupled with protection of the skin (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. The effect of heat radiation on percentage fatality with variation in exposure time is given in **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 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 when people do not run away immediately or when no protection is available. The effects on humans due to variations in heat flux and duration of exposure have been developed in the form of a Probit model which gives following values for human fatality levels as shown 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

Rupture of HSD tank with a damaged hole is considered as one of the major accidental scenarios in which large quantity of HSD will be leaked into the surrounding areas of the storage tank. If any ignition source is available near the accidental site, the leaked fuel will easily catch fire. It is assumed that the complete liquid leaks due to tank failure or ruptures and develops into a pool and gets ignited. Hazard distances have been arrived due to effect of pool fires. For computing the damage distance from the tank failure area, Areal Locations of Hazardous Atmospheres (ALOHA) software is used. Full tank storage capacity has been considered for the calculations. The effect of heat radiation and subsequent damage distances for HSD and 5 solvents are given in **Table 10 and 11.**

Table 10 Effect of heat radiation due to HSD storage tank (Pool fire)

Input Data		**Results of computation**	
Spilled quantity	10 kl	Flame length	21 m
Circular opening diameter	10 cm	Max burn rate	341 kg/min
Wind speed	2.2 m/s	Total amount burned	6961 kg
Heat Radiation at ground level kW/m^2		**Damage distances (m)**	
25.0		<10	
12.5		17	
4.5		31	

A review of the above table clearly indicates that for heat radiation of 25 kW/m^2, the damage distance is found to be around 10 m from the accidental site whereas for heat radiation of 12.5 kW/m^2, the impact distance is 17 m. For a heat radiation of 4.5 kW/m^2, the damage distance is 31 m. The risk contour for HSD is given in **Figure 1** and thermal radiation threat zone in **Figure 2.**

Table 11 Effect of heat radiation due to solvent leakage (Pool fire)

	N-butyl alcohol	**Isopropanol**	**N,N-dimethyl formamide**	**O-dichloro benzene**	**Toluene**
Spilled quantity (kl)	1				
Opening diameter (cm)	10				
Wind speed (m/s)	2.2				
Max flame length (m)	15	14	13	16	21
Max burn rate (kg/min)	277	258	244	312	355
Total amount burned (kg)	797	771	934	1288	857
Thermal radiation damage distances					
Red (25 kW/ m^2)	<10 m	<10 m	<10 m	<10 m	<10 m
Orange (12.5 kW/ m^2)	14 m	13 m	12 m	<10 m	16 m
Yellow (4.5 kW/ m^2)	25 m	23 m	22 m	19 m	30 m

Table 11 shows the effect of heat radiation due to solvent leakage. It is observed that, for heat radiation of 25 kW/m^2 the damage distance is found to be less than 10 m from the accidental site, whereas for heat radiation of 12.5 kW/m^2, the impact distance is in the range of 10-16 m. For a heat radiation intensity of 4.5 kW/m^2, the damage distance is in the range of 19-30 m. The threat zone for the proposed solvents is given in **Figure 2.**

Figure 1 ALOHA source point on the layout

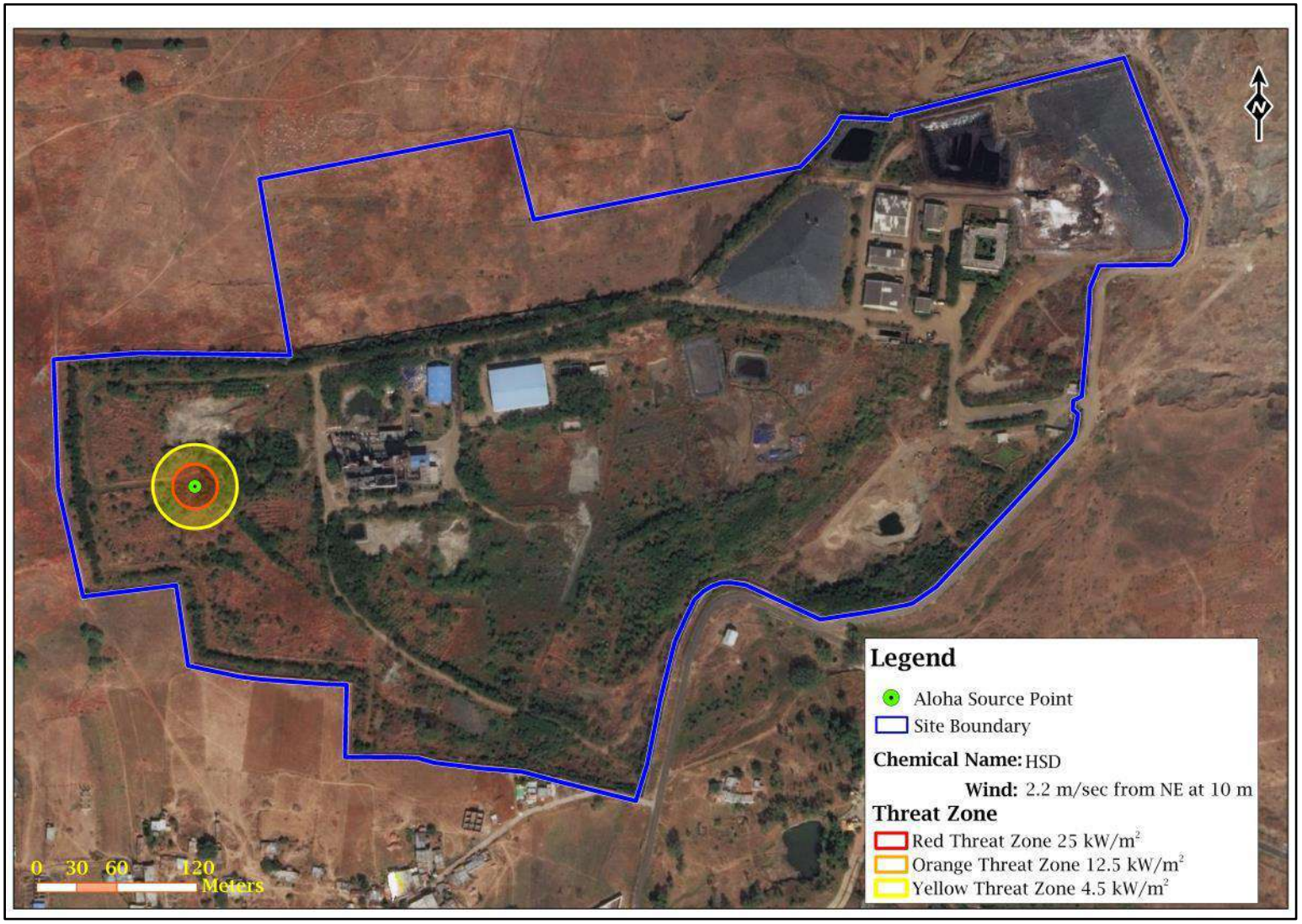
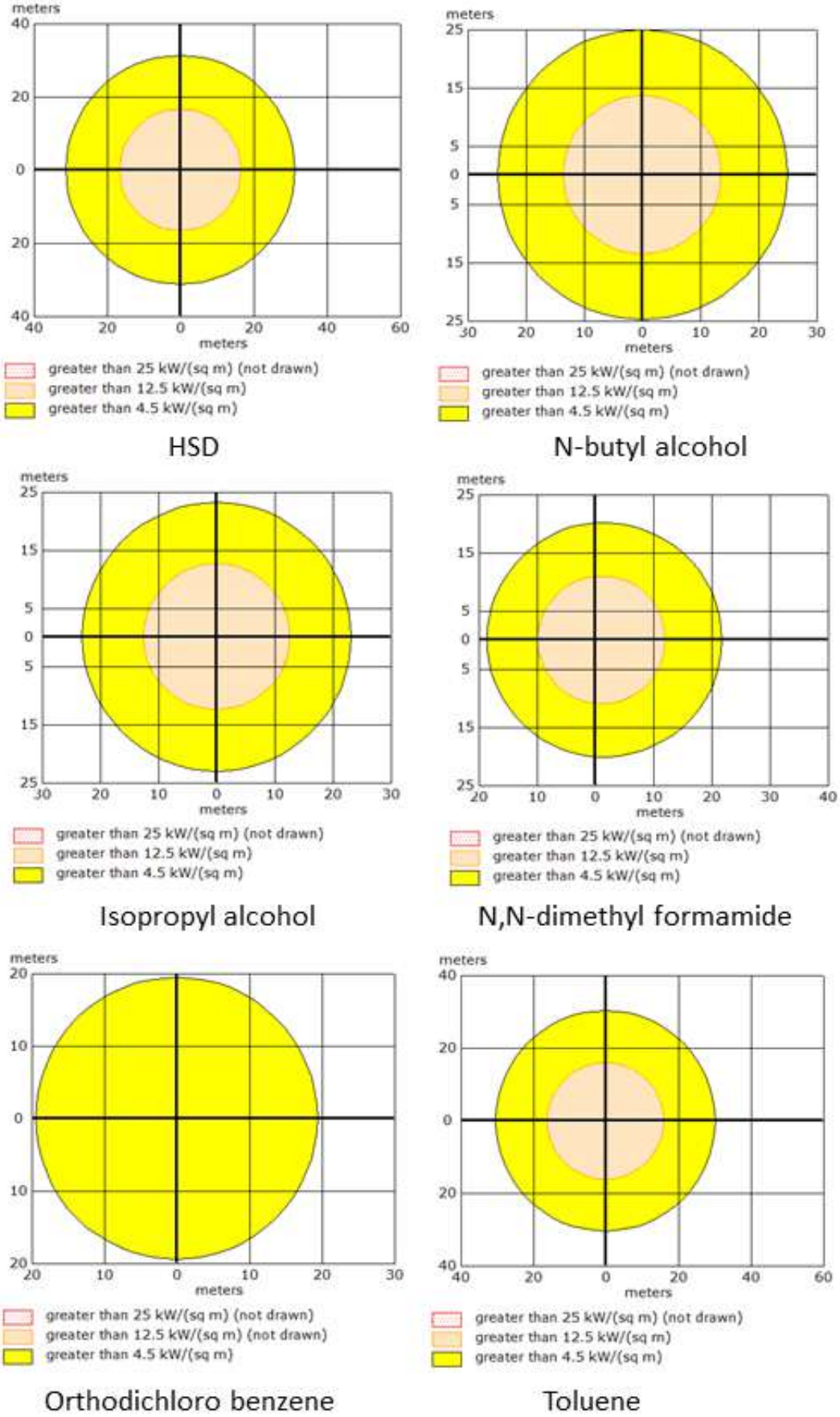


Figure 2 Thermal radiation threat zones for HSD and solvents



1.3 Emergency preparedness at MPWMP

An emergency will be declared if an untoward event, i.e., fire, major fuel/inflammable material spillage or a major injury / accident occurs and requires the mobilization of all possible resources to handle the same. In view of the hazardous nature of products/process handled at the project site, MPWMP has prepared an EPP. The plan is based on various probable scenarios like fire, explosion, natural calamities etc. The consequences arising out of such incidents are accurately predicted with the help of latest techniques available and mentioned in preceding sections.

The EPP is outlined in two sections. The first section explains the organizational set up, operational systems, actions on site, link with off-site emergency plan. The second section discusses the disaster management plan and mitigation measures after commissioning of work at site.

1.4 Organizational set up and infrastructure for emergency operations

The organizational set up for emergency operations is given in **Table 12** and the required infrastructure is summarized below.

Table 12 Organizational set up for emergency operations

Emergency Site	Incident Controller	Emergency Administration Coordinator
Land Fill, SEPs, Incinerable Waste Stores, HSD storage tank/Waste Storage Sheds and Stabilization Unit	HOD (Operations)	HOD (P&A)
Laboratory	Lab Manager	HOD (P&A)
Material Stores, Workshop, DG Set, Diesel Stores, Open Stores, Transformer area	HOD (Services)	HOD (P&A)
Administrative, Weighbridge, Security, Sampling Bay, Canteen, Overhead Water Tank area and greenbelt area	HOD (P&A)	HOD (Services)

Emergency Control Room- Emergency control room is to be set up and marked on the site plan. The control room will be the main focal point in case of an emergency, from where the operations to handle the emergency are directed and coordinated. It will control all the 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.

1.4.1 Roles and responsibilities of emergency personnel

The general roles and responsibilities of the emergency personnel involved are tabulated in **Table 13**.

Table 13 Roles and responsibilities of the emergency personnel

Emergency Control Team Members		Roles and Responsibilities
Emergency Controller	Project Head	• Assess and evaluate the scale of emergency and activate the emergency plan accordingly • Ensure that the emergency services have been called in and where required that nearby firms have been informed. Relevant authorities for public facilities must also be contacted as appropriate • Exercise direct operational control of those parts of site outside the affected area • Liaise with meteorological offices where weather conditions could have a strong influence on the development of the incident. • Maintain continuous review of possible developments and direct shut down of operations and evacuation of plant in consultation with the incident controller • Liaise with chief officers of fire and Police services, health and safety authorities. • Provide advice of possible effects on areas outside the works • Arrange for chronological record of the emergency to be maintained and ensure that evidence is preserved for enquires conducted by statutory authorities • Where the emergency is prolonged, arrange for relief of personnel and the provision of catering facility • Control rehabilitation of affected area on cessation of emergency
Incident Controller	Respective HOD	• Assess the scale of emergency and send information to the emergency controller • Direct to shut down of operations and try to minimize further aggravation of the incident • Ensure that all key personnel and help from fire brigade is called for • Communicate continually with emergency controller and inform all developments as appropriate • Conduct search for causalities

Emergency Control Team Members		Roles and Responsibilities
		• Liase with emergency Control Team during the incident and guide the Emergency Officer as required • Ensure that any evidence which may be required for further investigations is preserved
Engineering Co-ordinator	HOD (Incinerator)	• Co-ordinate closes down of operations as requested by the incident controller • Arrange for Fire Brigade help • Ensure Electrical Team has assumed position at the Electrical control room with his emergency team • Ensure workshop Team has assumed position at the pump house with his emergency team • Arrange for additional extinguishers, fire hoses, nozzles etc. from time to time • Take charge as Incident Controller in his absence
Emergency Officer	OHC In-charge	• Co-ordinate closes down of operations as requested by the Incident Controller • Advise fire and security staff in the factory of the incident zone and cancel the alarm • Announce on Public Address System (PAS) or convey through telephones or messengers • Arrange for additional extinguishers, fire water, pumps etc. from time to time
Emergency Administration Co-ordinator	HOD (P&A)	• Obtain the number of people at site • Arrange head count of personnel at assembly point, main gate, as well as the personnel at Emergency site • Assist Emergency Controller in communicating about nature of assistance required from civic Authorities (District Magistrate's Office) • Assist emergency Controller in declaring Major Emergency to the Civic authorities like Dist. Emergency Authority • Keep necessary transport at the Main gate • Direct relief team (selected by him at spot) to proceed to the Emergency site along with first Aid Kits, Stretches, Oxygen etc. under advise of the emergency controller • Receive instruction form the Emergency Controller for any assistance from the following authorities
Security Co-ordinator	Security In-charge	• Stop entry / exit of all vehicles other than fire brigade • Arrange to park all loaded / partly loaded trucks in a safe place • Keep control over the employees assembled near the gate and not allow them to go near the scene of incident

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 such as - fire or gas, normal fire siren, emergency/evacuation and high-pitched wailing Siren. Apart from these alarms, an adequate number of external and internal telephone connections should be installed for passing the information effectively.

1.5.2 Warning system and control

Control Centres - The control centres should be located at an area of 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.

Emergency Services - Under this, each site 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.

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 are to be worked out in the plan to facilitate additional help, such as fire-fighting or medical attention which might be beyond the capacity of an individual unit.

1.6 On-site emergency plan of MPWMP

An on-site emergency is caused by an accident that takes place in plant itself and the effects are confined to the premises involving only the people working in the project site. Therefore the onsite Emergency Plans deal with handling of emergency within the plant boundaries mainly with the help of proponent's own resources. MPWMP has a well-established onsite and offsite emergency plans in place to control the emergency situations arising out of any elements of major concern. The following steps will be followed in case of an emergency at the site:

- There is one long siren for the declaration of emergency and three intermittent sirens for the termination of emergency. On hearing the emergency siren, all the people will immediately stop their works and come to the assembly point. HOD (P&A) or his nominee will locate the emergency site and inform the same to the EHS In charge and Project Head. In case of failure of alarm system, information shall be conveyed to the telephone operator who will make announcement through PAS installed. If everything fails, a messenger could be used for sending the information.
- The project head, EHS in-charge and emergency control team will move to the incident site. The HOD P&A will select people gathered at the assembly point and direct them to the incident side depending on the necessity. Emergency Administrator will go to ECC and activates the emergency plan.

- The in-charge of general store/work shop will search for the emergency at store/workshop surroundings, starting from fuel storage, open stores, temporary stores etc.
- The landfill supervisor will look for emergency around landfill.
- The main gate security will sound the "EMERGENCY SIREN" under instructions of the Incident Controller, to declare emergency.
- The emergency administrator is informed about the incident with details of place, magnitude of mishap and follow instructions.
- The emergency administrator moves to emergency control centre, activates the emergency plan based on the feedback obtained from the Incident Controller or other reasonable sources

1.6.1 Existing facilities

The existing facility is well equipped with necessary safety equipment and details are given in **Table 14 & Table 15**. All fire prone areas are equipped with various type extinguishers to control the spread of it. Diesel storage drums are surrounded with deck wall compartment to avoid unwanted spillage.

Table 14 Existing fire extinguisher details

S. No.	Location	Type of fire extinguisher	Capacity
1	Admin block	BC type	4.5 kg
2	Admin block	BC type	4.5 kg
3	Admin block	BC type	4.5 kg
4	Admin block	BC type	4.5 kg
5	Canteen	AB type	9 ltrs
6	Gen. stores	AB type	50 ltrs
7	Gen. stores	AB type	50 ltrs
8	Gen. stores	BC type	4.5 kg
9	Stabilization unit	AB type	9 ltrs
10	Stabilization unit	BC type	5 kg
11	Temp. waste store shed	BC type	50 kg
12	Temp. waste store shed	AB type	50 ltrs
13	Temp. waste store shed	BC type	50 kg
14	Temp. waste store shed	AB type	50 ltrs
15	Fire hyd.- pump house	BC type	4.5 kg
16	Inc. waste store shed	AB type	50 kg
17	Inc. waste store shed	AB type	50 kg
18	Inc. waste store shed	AB type	50 kg
19	Inc. blending shed in front	AB type	50 kg
20	Inc. blending shed in front	AB type	50 kg
21	Inc. blending shed in front	AB type	50 kg
22	Inc. blending shed behind	BC type	9 kg
23	Incinerator -Elect Room in f/o	BC type	5 kg
24	Incinerator -Elect Room in f/o	BC type	5 kg

25	Incinerator -Elect Room -Inside electrical room	BC type	5 kg
26	Incinerator -Elect Room in f/o	BC type	4.5 kg
27	Incinerator - Inside Elect Room in f/o	BC type	4.5 kg
28	Incinerator -PLC room	BC type	5 kg
29	Incinerator –PLC room	BC type	4.5 kg
30	Incinerator -PLC room	BC type	5 kg
31	Incinerator –PLC room	BC type	4.5 kg
32	Incinerator -tank area near elect. Room	BC type	50 kg
33	Incinerator -tank area near elect. Room	AB type	50 kg
34	Incinerator -near RK	BC type	5 kg
35	Incinerator -near RK	BC type	5 kg
36	Incinerator -near RK	BC type	9 ltrs
37	Incinerator -near RK	BC type	5 kg
38	Intractable store (B/H Gen. Stores)	AB type	9 ltrs
39	Intractable store (B/H Gen. Stores)	AB type	50 ltrs
40	Vehicle Maintenance Shed	BC type	50 ltrs
41	Weigh bride	ABC type	5 kg
42	Security Office	ABC type	5 kg

Table 15 Other safety equipments

S. No.	Description	Location	Quantity
1	Siren	Main Gate & Inc. Plant	2
2	Sand Buckets	Temp. Store Shed, Inc. Waste Store Shed, Inc. Tank Area	21
3	Smoke Detector	Waste Store Shed	4
4	Lighting arrestor	Inc. Plant & Intractable Waste Store Shed	2
5	Spark arrestor	Main Gate, All Hzw Vehicle, Stores	10
6	Breathing Apparatus	Inc. Plant	3
7	Medical Oxygen Cylinder	OHC	1
8	Eye Wash Body Wash shower	Lab, Stabilization Shed, Inc. Waste Store Shed, Tank Area, Inc. i/f PLC Room, Inc. Blending Shed	6
9	High Pressure DCP Line (At HOT Zone in INC)	Inc Plant	1
10	Ambulance	Available At Facility	1
11	First Aid Box	Main Gate, Weigh Bridge, OHC Room, Stores, Lab, Inc. Plant & All the HzW & Staff Vehicles	10
12	Spill Control Kit	Weigh Bridge, Temp. Store Shed, Stabilization Shed, Inc. Plant & All HzW Waste Carrying Vehicle	10

1.7 Off-site emergency plan of MPWMP

When the damage extends to the neighboring areas, affecting local population beyond plant boundaries, off-site emergency plan is put into action in which quick response and

services of many agencies are involved. The off-site emergency plan of MPWMP is presented in **Table 16**.

Table 16 Off-site emergency plan

S.No	Type of Emergency	Preventive and Control Measures
1	Spillage of waste during transport.	• Check and repair containers before sending to the generator's site. • Train the driver and cleaner to seal the container doors properly before lifting the container on the truck and on spill clean-up procedure. • Fill container up to about 80% and cover with tarpaulin to prevent flying dust. • Ensure the spill kit and PPE is available in the truck for use in case of emergency.
2	Collision with other vehicle, pedestrians, trees or objects at the side of the road and injury to persons / damage to vehicle due to accident.	• Hire drivers who have valid license and well trained in hazardous waste transport. • Ensure vehicle is well maintained and certified before it is sent out of the gate. • Ensure valid insurance is available for the vehicle. • Maintain first aid box with content in the vehicle. • Maintain Phone No's of authorized hospitals, specialist doctors, police station, and the fire station in the vehicle also paint the paint the phone No of the unit on the vehicle. • Inform authorized hospital over phone. • Ensure first aid is given to the injured quickly and is taken to the nearby hospital for necessary treatment. • Report the matter to nearby police station and project authorities. • Immediately inform the site in-charge or his deputy in the absence of site in-charge. • Based on the seriousness the site in-charge will send the unit Personnel manager and the site transport in-charge to the accident site without delay. • Take care of the injured without any delay and the unit personnel manager will follow up the requirement of further treatment.

S.No	Type of Emergency	Preventive and Control Measures
		• The transport in-charge and the personnel manager will deal with the police department for the release of driver and the vehicle.
3	Toppling of truck and spillage of waste.	• Hire only qualified drivers. • Keep the vehicle insurance updated. • Carry the MSDS issued by the waste generator • Barricade the area till the resumption of normalcy. • Contain and lean the spillage using the spill kit. • Report to project official and inform pollution control board officials. • Complete rescue work of the truck.
4	Fire on waste material during transport.	• Ensure fire extinguishers are available in the truck • Ensure that the driver and cleaner are trained in the use of fire extinguishers. • Inform the driver and cleaner, MSDS detail of the waste from the comprehensive analysis and the easy identification method before sending them for collection. • Park the vehicle at the side away from busy area. • Avoid inhaling the smoke or gases emanated due to the fire. • Stand on up wind direction. • Use the fire appliance and fight fire. • Barricade the area and stop other vehicle movement if fire is uncontrolled. • Inform the nearest fire station and police the exact location where the vehicle is parked and the details of MSDS of the material on fire. • Maintain the phone numbers including mobile numbers of fire station, police station, waste generator and company emergency team members in the vehicle. • Give cool water bath as first aid to persons if at all there are burns and send for further treatment to the nearest hospital. • Inform project officials and the waste generator. • One who receives the information has to inform the site in-charge immediately.

S.No	Type of Emergency	Preventive and Control Measures
		• Site in-charge has to send the lab in-charge, site safety officer and lab technician immediately to collect waste samples for further analysis and as well as to gather and record on hand information from the site. Photographs of the scene will also help to analyse and to educate others and increase awareness thus reducing accidents • Collect relevant information from the accident spot for analysis of accident and the safety officer will complete the investigation report and the root cause of the accident. • Inform pollution control board if required. • Inform insurers if there is damage. • Preserve the manifest copy issued by the waste generator for further investigation purposes. • Share the details of accident with the site in-charge and the team of drivers. • Implement preventive measures as per the recommendations given by the enquiry team to prevent such accident in future.

1.8 Disaster management plan

A disastrous event strikes suddenly, violently and with/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. Most disasters such as earthquakes, floods, hurricanes, sandstorms, landslides, tsunamis and volcanoes are natural and cannot be prevented. But we can learn to deal with the difficult situations that arise due to them. To minimize the extent of damage consequent to any disaster, restoration of normalcy is the main purpose of DMP. Disaster 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

Though the first response to a disaster is the job of the local government's emergency services, it is always advisable to develop teams within the organization for taking

immediate rescue action if possible. The project authorities have to prepare 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. The following disasters are anticipated for the current TSDF and the mitigation measures are proposed accordingly:

- 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 public health in the vicinity.

1.8.1 Major explosion of chemicals / fire and toxic gas release in landfill or stores

a. Control measures during planning:

- Ensure that the material collected is 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 that good covered storage space is available for incinerable waste material and the storage area 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 and 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 equipments 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.

b. Control measures during operation:

- Ensure public liability insurance cover is in force for the site. Plan for the disposal of low flash point materials immediately on arrival and minimize inventory of these materials and flammable materials. Reactive materials shall be 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, fire-fighting 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 fire-fighting 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 fire-fighting 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. Inform company authorities through phone. 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.

- 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.
- 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.
- 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.
- 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.

1.8.2 Contamination of soil and water sources due to leakage of contaminants

a. Control measures:

- Before commencing the operations, collection of soil and water samples from the site have to be carried out to establish the base line data. Ensure public liability insurance cover is taken for the site.
- Make sure that the preparation of landfill pits is done as per the laid out standard. Special care should be 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.

b. 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.

1.8.3 Release of toxic gases from incinerator

a. 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 starting to feed the waste material in to the incinerator.
- Install windsocks 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. Re-analyze 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.

b. After the incident:

Evacuate everyone from the site and the vicinity to safe place. Additional care has 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.

1.8.4 Hazards due to combustibles

Hazards during storage and handling of combustible materials like plastics, paper and wood are very common. In the current expansion project, facilities for recycling of waste paper and plastic are proposed. Hence there are chances of hazards due to these combustible materials.

When inflammable material is crushed, conveyed and stored, the risk of fire increases as these materials are usually dry and need only low ignition energy to ignite. The extent of damage due to fire in a waste recycling facility can occur due to several reasons like oxygen

content of the material, particle size and shape, moisture content, turbulence etc. A fire in these units can spread very quickly. Therefore, a fast acting fire protection system or safety measures to mitigate the conditions is required.

Control measures

- A well-defined process for managing plastics and paper shall be in place not to let the waste build up and the waste shall be compacted to reduce its volume.
- The combustible materials shall be stored in containers made of non-combustible material. Generally, metal bins shall be used as they don't burn and won't add to the fire. A rubber lid shall be provided on the top of the containers to prevent fire.
- Where possible, access is restricted to the areas where waste is stored.
- Rubbish containers shall never be overfilled and always kept securely shut.
- Paper bales shall be arranged in an interlacing pattern rather than arranging directly on top of each other. This will reduce air-flow and fire intensity.
- Separating ignition sources from areas where explosive atmospheres may form will reduce the risk of explosion considerably. Regular inspection, testing, and maintenance of equipment are vital to their proper operation and the prevention of fires.
- Oxidant reduction can be accomplished by adding inert gas to enclosed processes in order to reduce the oxygen concentration to a level below that required for ignition to occur.
- Portable fire extinguishers capable of extinguishing combustible dust fires should be provided throughout the process area.
- Automatic sprinkler protection should be provided in all buildings or rooms in which the storage, handling, or processing of combustible dusts is conducted.
- Spray or fog nozzles should be provided for hose stations and extinguishers to reduce the potential of dust being thrown in suspension.
- Employees should be informed of the hazards in their work area and trained to protect themselves from the hazards. The training should include instruction on what they are to do in an emergency.

1.9 General prevention measures for other hazards

1.9.1 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

- Regular mock drills 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 who smoke inhalation can be very dangerous.
- Plant manager will be advised to ensure that the firefighting equipments are in good working conditions in sufficient numbers

1.9.2 Electrical accidents

Electrical hazards can cause burns, shocks, and electrocution which can lead to serious injury and even death.

Prevention of electrical accidents

- Flexible cords connected to appliance should be wired to confirm to the international colour code.
- The appliance should preferably be tested and certified by a national or reputed standards testing authority
- 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.
- 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. In case of dangerous electrical leakage to earth, it should automatically cur off the supply of electricity.

1.10 First aid and emergency procedures

Burns can cause due to acid spillage and leakage of electricity. Curative measures for any issues of burns and first aid procedures are given in **Table 17**.

Table 17 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.

1.10.1 Mock drill monitoring

Mock drills have 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. 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 rescue teams and treatment of casualties.
Fourth Step	:	Test Emergency isolation, and shut down
Fifth Step	:	Conduct a full rehearsal of the actions to be taken during an emergency.