Annex XV

Risk Assessment and Disaster Management Plan

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1.0 Scope of the RA DMP Document

This Risk Assessment and On-Site Disaster Management Plan is prepared as part of the EIA Report for obtaining Environmental Clearance for the proposed integrated TSDF, and it is to be read in continuation and context of the parent document.

Summary details of the proposed integrated TSDF a given in Sections 1.2 Nature, Size and Location of the Project in Chapter 01 Introduction, and section 2.1.1 Type of Project in Chapter 02 Project Description of the EI Report.

The RA has been carried out for risks identified from the operation of the TSDF.

An onsite DMP has been prepared based on requirements of schedule 8 (under rule 10(1)) of the Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 (amended 2000). In addition, it also adheres to the finalized Terms of Reference issued *vide*' MoEF's letter no F.No.10-16/2013-IA.III, dated 2nd December, 2013, Sr. No. (xvi) – "Submit details of a comprehensive Disaster Management Plan including emergency evacuation during natural and man made disaster".

1.1 Introduction to Risk Assessment

Risk (either health, Safety or economic), is inherent in all activities. In order to control, prevent or minimize loss of life or injury, damage to property or impact on environment, risk must be analysed and managed. Risk Assessment (RA) is a step-by-step process to identify the probability of extent of adverse consequences resulting from a specific activity, quantify risk and compare the same with known risk criteria so as to prepare and implement appropriate risk reduction measures. RA is a method that has proven its value as an all-round tool for improving the safety standards prevalent in every hazardous industry. With advancements in in-built and inherent safety systems, accidents rates have come down, but still persist at an un-acceptable levels for newer technology and new process plants. RA is a structured safety assessment tools designed for high hazard industries such as chemical, petrochemical, pesticides, pharmaceuticals, etc, supplementing other safety systems tools such as HAZOP, safety audit, and regular

incident analysis to identify the potential for incidents (near-misses, unsafe conditions) and to evaluate the necessary control measures.

1.1.1 Generic Objectives of Risk Assessment

The objectives of the Risk Assessment can be summarized as follows:

- Assessing risk levels due to the operations of the facility
- Identification of the risk mitigation measures to bring the potential risk within acceptable range
- To suggest general safety improvement measures.
- To help generate accident free hours
- To identify emergency scenarios and suggest mitigation measures.

The underlying basis of Risk Assessment is simple in concept. It offers methods to answer the following five questions:

1. What are the risks?
2. What are the causes of risks?
3. What are the consequences of risks?
4. What is the probability of the risk causing events?
5. Whether the risk is socially acceptable?

1.1.2 Philosophy behind Risk Assessment

Risk is the unwanted consequence of an event or series of events. Risk occurs when multiple risk causing factors occur at the same time causing an accident manifesting in an event like a fire or explosion. Certain risks are generally accepted as part of the industrial operations, while other low-frequency, high consequence risks attract statutory attention and are regarded unacceptable to local public.

The influence of various factors on the public perception of risk are summarised in **Table 1** as follows:

Table 1 Factors Influencing Public Perception

Sr. No.	Factors influencing public perception	Description
1.	Control	People are more willing to accept risks they impose upon themselves than to have risks imposed upon them.

2.	Dread and scale of impact	Fear is greatest where the consequences of risks are likely to be catastrophic rather than spread over time.
3.	Familiarity	People appear to be far more willing to accept risks that are familiar rather than new risks
4.	Timing	Risks are more acceptable if the risk consequences are immediate or short-term, rather than delayed consequences.
5.	Social amplification & attenuation	Concerns are increased if media coverage or graphic depiction of events is there, reduced if there is economic hardship
6.	Trust	If public trusts policy makers, public trusts regulators or industry as being honest, admit mistakes and limitations and one who take into account different views, then public is more likely to place credibility in them.

Source: British Parliamentary Office of Science and Technology – "Safety in Numbers - Risk Assessment & Environment Protection"

The need for communicating acceptable risks is very important. Though setting acceptable criterion for use in Quantitative Risk Assessments may often lead to disagreement between parties, nevertheless sound techniques and methods have led to the definition of acceptable levels of risks taking into account the need of people to feel safe in their day-to-day activities.

A Risk Assessment should therefore, be seen as an important component of any or all on-going preventive actions aimed at minimising and thus hopefully, avoiding accidents. Re-assessments should therefore follow at regular intervals, and/or after any changes that could alter the hazard, so contributing to the overall prevention programme and disaster management plan of the project.

1.1.3 Methodology of Risk Assessment

The risk is measured usually by various screening techniques that vary from one technique to another. No single risk measure is sufficient for conveying all the possibilities and combinations in process risks. The basic methodology adopted for risk assessment is generally based upon the nature of the hazard, the basic need for conduct of risk assessment and the information and resources available for such risk assessment.

Probability of Occurrence	Severity of Incident			
	Major	Significant	Minor	Incidental
Frequent (Incident may occur on annual basis or more)				
Occasional (Incident may occur several times during facility life)				
Seldom (Incident may occur once during facility life)				
Unlikely (Given current practices and procedures, incident is not likely to occur at this facility)				

Legend

SEVERE	HIGH	MODERATE	LOW

The following illustrates the detailed philosophy of the classification of incidence severity.

MAJOR INCIDENTS	• **Personnel**: Fatality or permanently disabling injury • **Community**: One or more severe injuries • **Environmental**: Event having serious on-site or off-site impact, results in off-site agency involvement and a major fine, serious negative public health or financial impacts, major local negative media coverage, international negative media coverage. • **Facility**: Major or total destruction to process area(s)
SIGNIFICANT INCIDENTS	• **Personnel:** One or more severe injury • **Community:** One or more minor injuries • **Environmental:** Event having significant on-site or off-site impact and requiring prompt agency and corporate notification, serious negative public impact or perception, significant local negative media coverage, a fine is likely. • **Facility:** Major damage to process area(s)
MINOR INCIDENTS	• **Personnel**: Single injury, not severe, possible lost time. • **Community**: Odour or noise complaint from public • **Environmental**: Event results in agency reporting or consent violation, minor negative public impact or perception, little or no local media coverage, a fine is not likely • **Facility**: Some equipment damage
INCIDENTAL INCIDENTS	• **Personnel**: Minor or no injury, no lost time • **Community**: No hazard to public, no public complaint • **Environmental**: Environmental event with no agency involvement or consent violation, no negative public impact or perception. • **Facility**: Minimal equipment damage

Another RA method generally used for the classification of incidence and used for Risk Analysis is the NIOSH method. The NIOSH method gives in brief the methodology and the Hazard Risk Matrix to assess the risks posed by use of hazardous substances and operations.

Methodology :

- List of all possible hazards that exist in the study area.
- Assessment of all the possible hazards that exist in the study area.
- Selection of the identified hazards for consequence analysis.
- Consequence analysis of the identified areas.

The Hazard Risk Matrix is a useful tool to accord a risk rating for each hazard identified in terms high, medium or low. The Hazard Risk Matrix is illustrated below.

The terms *Hazard* refers to a situation that has damage potential, *Probability* is the likelihood that the particular hazard will lead to damage, *Severity* is an estimation of how serious will be the manifestation of the damage.

The Risk Assessment methodology also involves analysis of hazardous materials used.

In the case of the Project, many substances (raw materials, fuels, intermediates) and processes pose one or more of the following hazards:

- Flammability – Solvents, flammable chemicals, petroleum fuels, flammable wastes
- Explosion – Hydrogen, Natural Gas, Pressure Reactors, Boiler, Incinerator
- Toxic – Catalysts, toxic chemicals such as Formaldehyde
- Reactive – Sulphuric Acid

Hazard Risk Matrix

1. Hazard : _____
2. Potential Location : _____

_____

_____

_____

Probability	**Severity**		
	Low	**Medium**	**High**
Low			
Medium			
High			

3. Area in which potential location(s) exists:

4. Date:

Notes (if any)

2.1 Risk Identification

The proposed integrated TSDF poses hazards from the following operations as given in **Table 2.** Hazards have been identified inside the battery limit of the project boundary and cover operation phase of the project. All risks due to transportation of hazardous material, both incinerable and landfill-able will be dealt with per provision of the Hazardous Waste (Management, Handling and Transboundary Movement), Rules, 2008 (amended)[1]. A summary/draft spill response plan if given as **Appendix I** of this report for consideration of the Project for conversion into a SOP/WI in operation phase. Proper storage practice of hazardous waste is suggested in **Appendix II** for elaboration and adoption in the operation phase of the Project.

Table 2 Hazards Identified in the Project

Sr.	Location/Operation	Type of Risk	Summary Mitigation Measures
1.	Handling of hazardous waste during sampling	Occupational exposure	• Use of PPEs • Drums to be opened for sampling under suction hood
2.	Accidental thermal exposure in Incinerator	Occupational exposure	• High temperature parts of the Incinerator will be guarded with railing and insulation plates/wire meshes to prevent any accidental thermal exposure to the operators/repairers of the Facility. • Unskilled workers will not be given access or instructed to carry out any operation in the high temperature and otherwise hazardous areas of the Plant. • A small first aid centre with facility to give first aid to small burns, cuts and minor exposures to toxic fumes, etc. will be part of the Facility.

[1]*Inter alia* under:
1. Chapter –VI Packaging, Labelling, and Transport of Hazardous and Other Waste
2. 24. Liability of Occupier, Transporter, Operator of a Facility and Importer
3. Form 9 [Rule 19 (2)] Transport Emergency (TREM) Card
4. Form 12 (Rule 23) Format of Accident Report[1]

3.	Accidental spillage of wastes during feeding in the Incinerator	Occupational exposure	• Drum crushing and repacking will be carried out in an inert environment with Negative air/filtration. • Liquid waste will be pumping directly from the drums into the Incinerator using long suction pipe and/or Organic liquid wastes will also be fed from liquid wastes storage tanks. • Liquid feeder will have check valve or nitrogen pressurization between cycles to prevent back flow Incinerator • HVAC in waste staging area will be provided with adequate ventilation to prevent the accumulation of heavier than air gases; exhaust from HVAC system in waste staging area will be sent to the boiler combustion air intake zone in order to minimize fugitive emissions.
		Pool fire on the floor of the Incinerator feeding area	• Consequence analysis, **Table 3.**
4.	Loss of containment of auxiliary fuel (NG) in the PRS/metering skid area	Jet fire, UVCE	• Consequence analysis, **Table 3.**
5.	Exposure to hot gases and spray of alkali scrubbing media in the Gas Cleaning System of the Incinerator	Occupational exposure	• The out comer gas duct of the gas from the Incinerator to the WHR Boiler will be insulated with refractory insulation up to the inlet of the GC system. Gas at the inlet of the scrubber will be around 180 to 220 ^{0}C, beyond the alkali scrubber, the temperature will be in the range of 50-60 ^{0}C. • The flue gas ducts being at height will be inaccessible to any person except to trained operators who might require maintenance access. • Operators working in the caustic lye tank at the bottom of the scrubbers, near the feed pump will don appropriate PPE.
6.	Accidental thermal exposure in MEE	Occupational exposure	• Surfaces working above 65 0C will be insulated with PUF and clad with aluminium sheet.
7.	Accidental human exposure to high voltage electric system in the alternator, PCC/MCC Panel, Substation, synchronizing panel,	Occupational exposure	• Conventional insulations and electrical safety precautions will be followed. • Necessary precautions will be taken in the design and operation of the high voltage electrical equipment. • Due care about integrity of insulation will be taken especially during the

	emergency DG Set.		monsoon months.

2.1.1 Consequence Analysis

Of the hazards likely to arise from operation of the project in the **Table 2**, two hazards have been identified for CA, as given in **Table 3**. The CA has been carried out based on the following identified release scenarios from the respective sources. The CA has been carried out for Pasquill and Gifford atmospheric stability class 'D – neutral' and 'F – stable'[2].

Table 3. Identification of Release Scenarios for Consequence Analysis

Sr.	Failure Case	Failure Mode Type	Consequence
1.	Loss of containment of one 200 l solvent drum	Total loss of containment of one 200 l drum containing 180 l incinerable residue suspended in a flammable solvent, drained onto concrete floor of the warehouse/loading area in the incinerator, evaporative dissemination, vapour cloud meeting with a source of ignition	Pool fire Radii of flame and heat flux zones for representative solvents for atmospheric stability class D and F are given in **Table 4.**
2.	0.5'' leak in 50 NB NG pipeline at 5 bar	(a) full bore rupture on 2" pipeline at 5 bar pressure	Jet fire Radii of flame and heat flux zones are given in **Table 4.**
		(b) 0.5" leak on the 2" pipeline at 5 bar pressure	Jet fire Radii of flame and heat flux zones are given in **Table 4.**

Rationale for selection of candidate solvents for fire scenarios is given in technical notes in **Inset 1.** Properties of relevance of the solvents for fire (Solvent Properties under Normal Atmospheric Conditions) is given in **Appendix III.** Candidate solvents fall under the category of Highly Flammable Liquids and Flammable Liquids per Schedule I [Rules 2(e) (i), 4(l) (a), 4(2), 17 and 18], indicative Criteria and List of Chemicals, Part I, Manufacture, Storage and Import of Hazardous Chemical Rules, 1989 (amended 2000). Description of facility for use of natural gas as auxiliary fuel is given in in technical notes in **Inset 2.** Heat radiation and corresponding thermal damage criteria for fires are given in **Table 5**.

[2] Pasquill, F. (1961). The estimation of the dispersion of windborne material, The Meteorological Magazine, vol 90, No. 1063, pp 33-49.

Table 4. Consequence Footprints

Sr.	Chemical	Failure Mode	Consequence	Footprint							
				Flame length (m)		Heat flux (10 kW/sq.m) (m)		Heat flux (5 kW/sq.m) (m)		Heat flux (2 kW/sq.m) (m)	
				Atmospheric Stability Class							
				D	F	D	F	D	F	D	F
1.	Toluene	Total loss of containment of a tightly stoppered 200 l MS solvent drum	Pool fire	9	12	15	10	19	16	25	26
2.	Methanol			3	4	<10	<10	<10	<10	<10	<10
3.	Is propanol			5	7	<10	<10	11	<10	14	15
4.	Ethanol			3	6	<10	<10	<10	<10	<10	13
5.	n-Butyl Acetate			7	9	11	<10	14	11	18	18
6.	m-Xylene			9	12	15	<10	18	15	24	25
7.	n-Bitanol			6	8	10	<10	12	10	16	17
8.	Natural gas	full bore rupture on 2” pipeline at 5 bar pressure	Jet fire	1	1	<10	<10	<10	<10	<10	<10
9.	Natural gas	0.5” leak on the 2” pipeline at 5 bar pressure	Jet fire	4	1	10	<10	10	<10	12	<10

Note: n-Butanol vapour cloud is not within flammable limits in the assumed modelling conditions. However, a force burn has been modelled.
Note: <10 m consequence footprint explained in technical note in **Inset I**

Table 5. Heat Radiation and Thermal Damage Criteria

Sr.	Heat flux (kW/sq.m)	Likely Damage
1.	10	potentially lethal within 60 sec
2.	5	2nd degree burns within 60 sec
3.	2	pain within 60 sec

Inset I

Technical Notes

Rationale for selection of Candidate Solvents:
Common medium boiling range industrial solvents have been chosen as candidate solvents for carrying out the consequence analysis. Common low boiling solvents such as Pentane, n-Hexane, Acetone, Methyl Ethyl Ketone, Ethyl Acetate, n-Heptane, etc. with flash points lower than 0^0 C are recovered in the industries and do not come with incinerable industrial residue for incineration.

Reasons for no formation of CVCE:
Due to low level of congestion and open, naturally aspiring shed (air changes up to 30), none of the solvents formed vapours within their respective LELs and UELs to support Confined Vapour Cloud Explosion.

Consequence Analysis Model used
ALOHA 5.4.4, developed by US EPA (Office of Emergency Management) and NOAA (Emergency Response Division), August, 2013.

Near field patchiness in ALOHA 5.4.4
ALOHA does not consider the near-field region, including the effects of momentum jets. Considerable information on eddy size and turbulent intensity is required to model this region properly. As a result, ALOHA refuses to provide plume information for distances less than approximately 10 m.

Inset II

Technical Notes

Natural Gas Meter Regulating Skid:
Natural gas is supplied in Vapi by M/s Gujarat Gas Ltd.

NG comes to the industrial premises (inside battery limit of the client) in underground PE pipeline (25, 50, 80 and 100 NB, 1.5 to 5 bar working pressure) to a MR Skid. Client usually tap NG at 100 – 300 m.bar pressure through a pressure reducing valve.
Source: Gujarat Gas Ltd. (+91

Reasons for no formation of UVCE:
The high pressure parts of the NG pipeline are in an open-to-air MRS. The Model does not allow UVCE consequence in the rapid-dissipation-of-vapour scenario.

Reasons for no formation of jet fire near the incinerator:
Jet fire scenario can be supported only in case of flammable gas pressures over one atmosphere, therefore there is no possibility of jet fire in the client-side, low pressure NG circuit.

2.1.2 Inference

As seen from the **Table 4** Consequence footprint, heat flux values of 10 kW/sq.m (potentially lethal within 60 seconds) are within 15 m from the source. Distance from where fire-fighting can be carried out for the fire consequences (2 kW/sq.m) are within 25 m from the source.

The project is not a Major Accident Hazard (MAH) unit as it does not store or handle any chemical listed in Schedule 3 Part-I (Named Chemicals) and Part-II (Classes of chemicals not specifically named in Part-I), [Rule 2(e) (iii), 5 and 6(1) (a)] List of Hazardous Chemicals for Application of Rules 5 and 7 to 15.

There are no significant off-site consequences likely from the operation of the proposed integrated TSDF as projected by the consequence analysis model. All the consequences footprints for fatality/grave injury to personnel are within the site boundary.

The Incinerator and the warehouse will be under sprinklers installed per NFPA 13, 2016. The TSDF will also be provided an annular fire hydrant system (with double headed monitors, fire hose reel, hose boxes, and a fire panel with MCP system in accordance with TAC Fire Protection Manual, 9th edition, 1982, and relevant OISD codes (OISD Guideline 115, 206 and OISD Standard 108, 114, 116, 117, 118, 124, 129, 135, 142, 145) as applicable.

Conditions of storage of proper storage of material per "Performance Evaluation and Monitoring of the Common Hazardous Waste Treatment Storage and Disposal Facilities including Common Hazardous Waste Incinerators (HAZWAMS/… /2010-2011), CPCB, May, 2010" is given in **Appendix I**.

The Project will assess applicability of provisions of the Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 and make arrangements for its compliance.

3.1 Disaster Management Plan

3.1.1 Need for a DMP

Hazardous Waste Treatment and Disposal Sites are a critical and terminal element in the hazardous waste value chain. Heterogeneous and unidentifiable nature of hazardous chemicals and inter-non-compatibility of the chemical constituents make the hazardous waste collection, co-storage, handling and final disposal a challenging task for hazardous waste professionals. Irrespective of the type of waste coming to the Facility, all wastes, to varying extents are hazardous.

Incinerator operating at high temperature, the Combined Cycle Power Plant, the MEE, etc. pose significant thermal exposure hazard to the work force working in the Project.

Disaster prevention through good design, operation, maintenance and inspection are essential to reduce the probability of occurrence and consequential effect of the above mentioned eventualities. However, it is not possible to totally eliminate such eventualities as random failures of equipment or human errors, omissions and unsafe acts cannot be ruled out. An essential part of major hazard control has therefore, to be concerned with mitigating the effects of such disasters and restoration of normalcy at the earliest.

Disaster Management Planning is therefore an essential and critical component of such disaster minmizing measures. It is through such planning that one recognizes that accidents are possible and arrive at their impacts. The plan also helps in deciding On-site emergency procedures that need to be implemented in the event of an emergency.

Various statutory requirements, rules & Government orders have been in power to enforce safety and environmental measures in such hazardous industries. It is mandatory to prepare an On-site Emergency Plan. Section 41-B (4) of the Factories Act-1948 (as amended) requires that every occupier shall draw up an on-site emergency plan and detailed disaster control measures for his factory. It is also mandatory to prepare an on-site emergency plan under the MSIHC Rules, 1989 (amended, 2000), notified under EP Act, 1986.

It is not possible to envisage and detail every action that should be taken in an emergency to harness the basic elements of emergency preparedness such as gravity of emergency, communications of information, onsite action for process and emergency controls, mobilization of internal and external resources for fire and toxic release control, warning people at right time, evacuation, medical preparedness, pollution control, etc. Emergency organization is set up specifying duties and responsibilities of all to make best use of all resources to avoid confusion while tackling the emergency.

3.1.2 Objectives of DMP

The main objectives of an On-Site Emergency Plan are:

- To define, and assess emergencies, including risk and environment impact.
- To safeguard employees & people in vicinity and restore normalcy soon.
- To minimize damage to property or/and the Environment
- To inform authorities and the mutual aid centres for help if need arises.
- For planning effective rescue and treatment of injured and affected.

- To ensure safety of the workers before personnel re-enter and resume work.
- To work out plan with all provisions to handle emergencies and to provide for emergency preparedness and the periodical rehearsals of the plan.

The On-Site Emergency Plan has therefore to be related to the identification of sources from which hazards can arise and the maximum credible loss scenario that can take place in the concerned area. The Plan takes into account the maximum credible loss scenario - actions that can successfully mitigate the effects of losses/disasters need to be well planned so as they would require less effort and resources to control and terminate emergencies, should the same occur.

Formulation of On-Site Emergency plan cannot possibly be an end by itself. It needs to be tested by holding of mock emergency simulation and drill every six months. Any shortcomings revealed during such exercise should thereafter be corrected by amending the Plan. The Plan should be for times to come; hence it must be reviewed at periodic intervals. The Plan should be also reviewed and updated when:

1) Major alteration or extension of the facility is carried out.
2) Major change in habitation or land use of the neighbourhood takes place.
3) Important telephone numbers used are altered; facilities (for e.g., medical, emergency control centre of local crisis group, etc.) are changed.

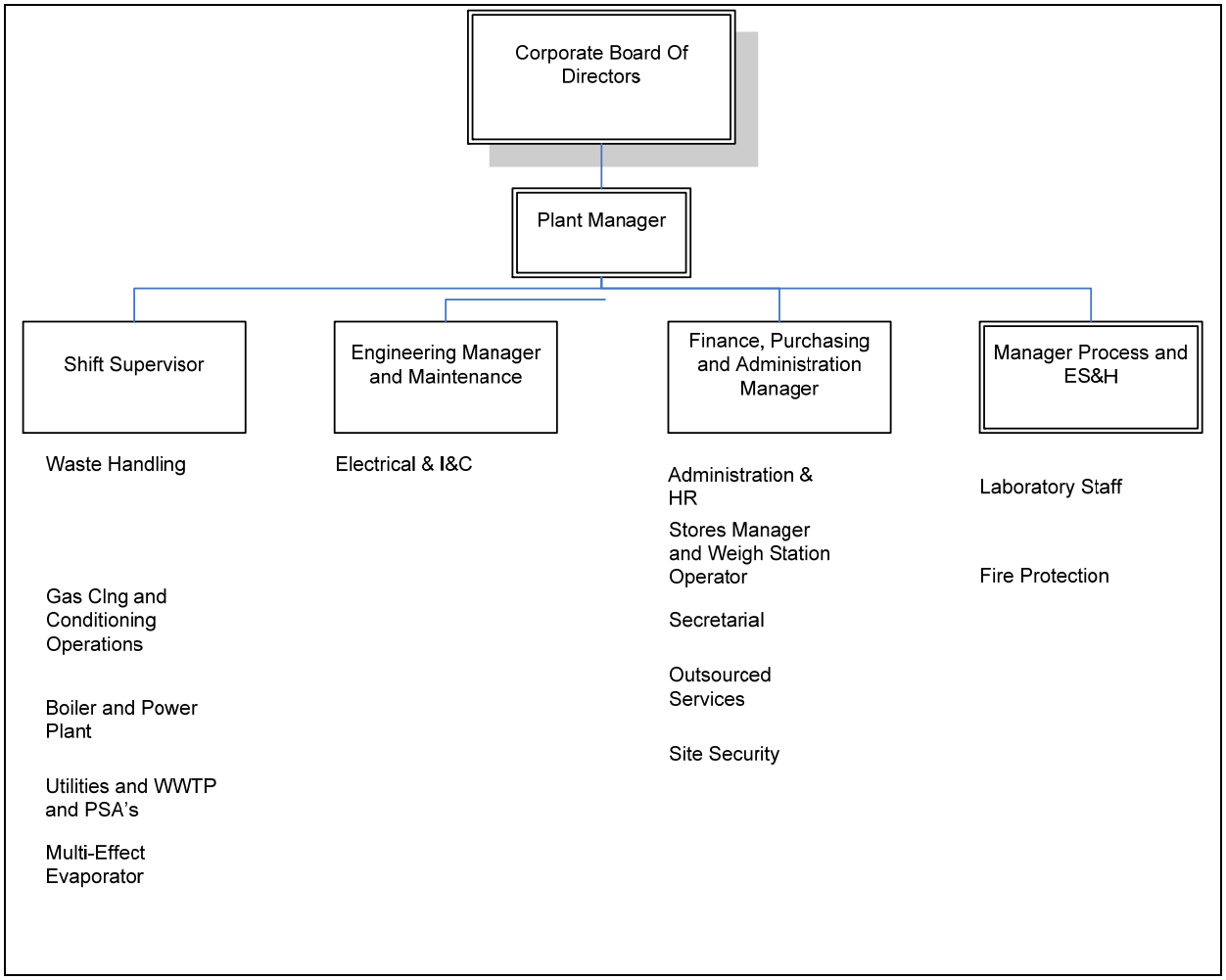
3.1.3 The Emergency Management Team

Any emergency may start as a small incident that may become a major accident if not controlled in time. At the initial stages, the emergency organization (to be formulated at the time of the commissioning stage of the Project) shall be put into action. If the incident goes beyond control, the Site Main Controller will actuate the On-site Plan at the appropriate stage as considered necessary. When emergency becomes catastrophic and the Site Main Controller considers evacuation beyond the Plant premises necessary, the situation will be handed over to Local/District Crisis Group authorities for implementing the Off-site Emergency Plan. The management of emergency henceforth has to be controlled by the District Crisis Management Group from control room under the supervision of the District Collector.

The On-site Emergency Plan is to be drawn by appointing key personnel and defining their specific duties that will be handy in emergency. To control the emergency in the most effective manner it is important that roles and responsibilities are well defined and the command structure is absolutely clear.

The key roles exercised during the emergency are those of "Incident Controller" (whose main function is to take charge of the incident) and of the "Site Main Controller" (whose main function would be to take overall charge of rescue, facilitation, media briefs, etc.). In addition, other individuals would be assigned specific responsibilities. These people would report to "Incident Controller" or "Site Main Controller" during the time of emergency and would work under his instructions. The functions and their key responsibilities are discussed later. Proposed organization chart for Emergency Management Team of the Plant is given as **Figure 1**.

Figure 1. Proposed Emergency Management Team



3.1.3.1 Responsibility of the Emergency Organization

(A) Responsibilities and Duties - Incident Controller

In case of emergency during any shift hours, the Manager Incinerator, MEE and TG Operations will act as the Incident Controller with assistance from the respective Area In-charge. The stand by position for Incident Controller is Manager EHS. As soon as the Incident Controller is aware of the emergency and its location, he will

i. Assess the scale of the emergency and decides accordingly. On his decision, he will activate the subsequent emergency procedure.

ii. Direct all operations within the affected area with the following priorities
   - authorize initiation of Emergency Shut Down Procedure of the Plant (Incinerator, WHRB, Power plant and MEE)
   - secure the safety of personnel
   - minimize the damage to the plants, property and the environment
   - minimize spill/loss of hazardous waste
   - ensure that outside emergency services are called in.
   - ensure that the key personnel have been called in.

iii. Direct the rescue and fire fighting operations until the fire brigade reaches the Plant.

iv. Ensure that the affected area is searched for any casualties.

v. Ensure that all non-essential workers in the affected area evacuate to the appropriate assembly point.

vi. Set up a communication point and establish telephone contact with the Emergency Control Centre of the Local Crisis Group.

vii. Report all the significant developments to the Site Main Controller.

viii. Provide advice and information to the senior officer of the fire brigade.

ix. Will provide evidence that would facilitate any subsequent inquiry into the cause and circumstances of the emergency.

(B) Responsibilities and Duties - Site Main Controller

The Project Site Operation Head will assume this role in case of incident during general shift. In case of incident outside general shift hours, the Landfill/Civil Construction Manager will be called to Site immediately to take up the responsibility. For the interim period till he arrives, the Incident Controller would play the role of the Site Main Controller. The Plant Manager will join the Incidence Controller at the Site Emergency Control Centre upon arrival.

On arrival, Site Main Controller will:

i. Relieve the Incident Controller of responsibilities for overall control.

ii. On declaration of major emergency, ensure that the outside emergency services are called in. Nearby companies are informed, if required.

iii. Ensure that the key personnel are called in.

iv. Exercise direct operational control of those parts of the works outside the affected area.

v. Maintain a speculative continuous review of possible developments and assess these to determine

most probable course of events.

vi. Direct the shutting down and evacuation of the Plants in consultation with the Incident Controller and key personnel.

vii. Ensure that the casualties are receiving adequate attention. Arrange for additional help, if required. Ensure that the relatives of affected persons are informed.

viii. Liaise with chief officers of the fire and police services and with the experts on fire, safety, health, etc.

ix. Ensure the head counting of personnel.

x. Control the vehicle movement inside the Plant for fire fighting and rescue operations.

xi. Arrange for a chronological record of the emergency to be maintained.

xii. Issue authorized statements to the news media. If necessary, keep Head Office informed about developments.

xiii. Ensure that proper consideration is given for preservation of evidence

xiv. Control the rehabilitation measures in the affected area.

(C) Responsibilities and Duties – Key Personnel

(C 1) Site Safety Supervisor

i. He will be in charge of overall activities and work under the guidance of the Manager EHS.

ii. Coordinate all plant operations, judicious shutdown of running units where necessary and restrict product movement to and from the Plant and gate.

iii. Advise other blocks, such that the hazard is localized and does not spread to other units such as the power plant, MEE and waste storage area.

(C 2) Maintenance Team

i. Lead the fire fighting team drawn from other fire stewards and non stewards in the event of fire.

ii. Maintain and provide safety appliances for emergency and guide them for proper use.

iii. Ensure that correct fire extinguishers are used and there is no wastage

iv. Ensure that fire does not spread and escalate in such a way so as to endanger other toxic waste storages.

v. Ensure that proper evacuation methods for various chemical releases are followed and that other materials likely to be affected are stored in safe form away from the affected area.

vi. Ensure availability of fire extinguishers, spares and stock items such as foam, etc. and mobilize from other areas as and when necessary.

vii. Ensure that sufficient water is available for fire fighting. In case of the water supply falling short,

arrange for the additional water tankers.

viii. Lead the fire fighting effort with the main hydrant crew.

(C 3) Auxiliary and Maintenance Role: Nominee: (Pollution Control Hardware Executive) in general shift and Plant Safety Supervisors outside general shift hours)

i. Ensure switching off of power as the case may be, as directed by the Incident Controller

ii. Arrange for emergency lighting should the need arise through the shift electrician.

iii. Organize for evacuation of material inventory should there arise the possibility of fire escalation involving hazardous waste.

iv. Ensure the availability of utilities to combat the emergency.

v. Ensure that power supply to gas handling equipment such as ID Fans, scrubber circulation pumps, main hydrant pump, etc. is available.

vi. Ensure that machines such as lifting tools, tackles, pump, torch lights, ropes, etc. are available for emergency purposes in good conditions at all times.

vii. Ensure that all necessary mechanical drives are available and in working condition for emergency and that the DG set is available for emergency power.

(C 4) Communications Role: Nominee: HR-PR-Liaison Manager assisted by Telephone Operator in General Shift and Security in charge during off general shift hours

i. Under the guidance of the Site Main Controller, the Communications Nominee would handle the responsibility of releasing information to the public or news media.

ii. Handle communication and transport of victims, communication with external authorities, neighbouring industries etc. and inform members of the company's top management team regarding the incident in co-ordination with the Site Main Controller.

iii. Inform the Factories Inspector, Police, fire stations, hospitals, neighbouring companies and other relevant agencies for necessary help as per pre- set plan and under the guidance of the Site Main Controller.

iv. Inform the families of possible victims.

(C 5) Security Role: Nominee: Security In Charge

ii. Ensure the deployment of security to restrict the movement of personnel and vehicles and safe guard the Plant, personnel and property.

iii. Keep a count of (head count) of persons in the Plant premises, visitors, etc.

iv. Organize to ensure that emergency vehicles are available for emergency use and are deployed effectively.

v. Prevent unauthorized entry and exit from the Plant gate during the emergency period.

vi. Sound the siren at the gate on the instruction of the Incident Controller.

(C 6) Role of the Incidence Spotter/Reporter

i. On noticing a fire or toxic release, he will immediately shout FIRE, FIRE, FIRE and also try to alert the personnel in the vicinity.

ii. He will try to extinguish/control the fire/accident by using proper first aid fire fighting equipment (like fire extinguishers, sand buckets) and safety equipment.

iii. He will arrange to inform the area in charge about the incident.

iv. If possible, he shall try to salvage the equipment and materials not involved in the fire/ accident.

(C 7) Role of Non Essential Staff

They shall act as per the instructions of their respective Shift Supervisors. They shall proceed to the designated Assembly Point ad stay put till further instructions are passed. They shall not panic, and shall cooperate to get the head count. They shall point absence/entrapment of a fellow worker in the Plant. They shall also be on a stand-by to be called for aiding the emergency management.

3.1.3.2 Emergency Infrastructure

3.1.3.1a Emergency Control Centre (ECC)

The designated Emergency Control Centre are:

(i) Control Room of the Project

(ii) Reception Centre in the gate Complex Building - alternate

Both these emergency control centres must have the following facilities:

(i) Equipped with adequate means of communication to several locations inside and outside the Plant as:

- Internal telephone facility
- External telephone facility
- Paging (PA system)
- Siren facility

(ii) Availability of relevant data which are required to manage the emergency, such as:

- Total inventory of the hazardous waste in the storage places in bulk, drums and as liquid waste.
- Location of safety equipment
- Fire hydrant system and alternate supply sources

- Stock of other fire fighting materials.
- Work entrance and road system.
- Assembly point, casualty treatment centres.
- Location of the work in relation to surrounding community.

(iii) Availability of additional work plans, which may be illustrated during an emergency such as:

- Areas affected / endangered
- Deployment of emergency vehicles and personnel
- Areas where particular problems arise e.g. fractured duct/pipelines.
- Areas evacuated and other relevant information.

(iv) Availability of several copies of the On-site emergency plans.

(v) Availability of note pads, pens, pencils, markers to record/marking the message received and any instructions for delivery of runners.

(vi) Availability of nominal rolls of employees.

(vii) Availability of addresses and telephone numbers of the employees.

(viii) Availability of the list of key personnel, their addresses and telephone numbers.

(ix) Availability of roll call boards at assembly point.

(x) Availability of adequate and essential safety and personnel safety equipment such as: Torches, explosimeters, personnel protective equipment, respiratory equipment, etc.

3.1.3.1b Assembly Point

In vulnerable plants and potential affected areas, all non-essential workers (who are not assigned any emergency duty) shall evacuate the area and report at the designated Assembly Point. The need to evacuate non-essential workers will be determined by the gravity of the emergency and assessment of the emergency by the Incident Controller. Only one Assembly Point is proposed as given below:

- Near Security Main Gate

3.1.3.1c Evacuation and General Procedures

The emergency evacuation procedures will be as:

- On receipt of evacuation instructions, the personnel in the affected area shall proceed to their designated Assembly Point.
- When the emergency is announced, one security guard at the Plant gate will be posted by security station and he will secure the halting of all the routine traffic and material movement in to the Plant. This guard shall clear the road coming into the Plant from the main gate, so that if outside emergency vehicles are needed the road will be clear.
- All personnel of the Plant should remain at their announced Assembly Point until the

clear signal is announced.

- When the emergency announcement has been made, outside contractors in the Plant are to be instructed to report for the gate. Their supervisors should make a count of all the personnel and report this data to the security at the gate.
- Evacuation of the people will be especially in the opposite direction of exposure / wind direction.

3.1.3.1d Counting of Personnel

During evacuation all personnel of the Plant should remain at their announced Assembly Point. Counting will be done here and it will be cross-checked with time office record.

When the emergency announcement has been made, outside contractors in the Plant are instructed to report to the gate for counting purpose. Their supervisors should make a count of all personnel and report this data to the time office and security at the gate.

3.1.3.1e Access to Records

All the necessary and important documents, drawings, data and other records should be kept in a separate documentation room at Administrative Building and it should also be covered by smoke detectors.

3.1.3.1f Termination of Emergency

Site main controller will issue the instructions for "All clear" signal in consultation with Incident controller.

In absence of Site Main Controller, Incident Controller will issue the instructions for "All Clear" signal in consultation with the other Emergency Management Team members.

Continuous siren will be sounded for indicating the clearing of emergency.

3.1.3.1f Public Relations

The emergency news will be issued only by the Site Main Controller (through the HR-PR-Liaison Manager) to public or news media.

Proper and right news will be communicated to the surrounding public and their inquiries will be answered to their satisfaction, by personnel and administration department.

Nobody should attempt to communicate independently with the media as this could result in serious communication gaps and panic.

3.1.3.1g Re Entry Procedures

- Before re entry in the area, all necessary tests will be done to confirm the presence of acid fumes, hazardous chemical sprays, hydrocarbons, explosive materials, poisonous gases, smoke, etc.
- Proper house keeping will be restored.
- All the affected equipment, areas etc. will be checked for their normal operation.
- Thorough check up of the whole Plant will be done by safety personnel and then re entry of required personnel will be allowed.

With a view to accommodate the evacuated personnel from the affected plants / departments and also to make the evacuation safe, Assembly Points will be clearly marked, displayed conspicuously by boards at various locations in the premises. The Assembly Point will be approachable from all the Plants departments.

At the time of emergency, the Assembly Point will be operated depending upon the direction and location of emergency site, security supervisor / guard will be available round the clock and shall monitor the assembled personnel.

Before reaching the Assembly Point, it might be required to pass through an affected area. Suitable personnel protective appliances including masks, respiration, etc. will be used which will be available from the Plants to the workers. For a short duration, even a wet handkerchief will be effective to filter out toxic fumes for few seconds before reaching the shelter of the Assembly Point.

3.1.3.3 Emergency Containment Procedure

In case of fire/toxic release in the Incierator and Waste Storage Area, the person detecting the incidence should immediately inform the Plant Manager and Shift Supervisor. Two trained persons from the Hazard Containment Team (Maintenance team, Pollution Control Hardware team and Plant Safety team) should immediately don the protective gear and attempt to contain the incidence preferably under the guidance of MEE Incinerator and TG Operations Manager. The personnel from the rescue team must also be kept on standby donning the requisite protective gear in case information about any person in need of a rescue is received. The signal for evacuation of the area should be given simultaneously and a general alert sounded.

1. In case of fire involving hazardous material, the person noticing the fire would shout “fire” and inform the Shift Supervisor and Manager EHS immediately. The designated personnel would rush to the incident site for emergency actions while others would go to the designated Assembly

Point. The Incident Controller would assess the incident and coordinate all the efforts in bringing it under control. If need be he would issue instructions for external communication and help.

2. In case the fire involves hazardous waste that emanates toxic vapours the Incident Controller would issue additional directions on priority with respect to protective gear, protective measures, first aid and evacuation of the area in a proper manner and direction.

3.1.3.4 Recovery Procedure

It has to be appreciated that no two emergency situations are going to be alike since the escalation process depends upon a large number of variables including the response actions. It is therefore, not only impossible but also dangerous to lay down clear-cut and simplistic responses applicable to all situations. For each emergency situation, spot decisions will need to be taken often under high stress conditions. Proper understanding and adequate training of personnel in regard to the underlying escalation mechanisms and the appropriate mitigating factors alone can provide correct responses.

3.1.4 Emergency Management Guidelines for Possible Risk Scenarios

3.1.4.1 Fire in Waste Storage Area/Loading Area of the Incinerator

- Fire in a fuel/flammable liquid will burn quietly until it is extinguished or until the material is consumed completely. Water applied on the surface of the burning material will not do any harm.
- Call for help immediately from all available employees and also local fire brigade in accordance with the existing instructions should also be given.
- Wet the other flammable material with water to cool it and to prevent fire from spreading.
- Wet down with water the sides and roofs of the warehouses, pump houses and other structures which are close-by.
- Work to keep the fire from spreading.
- The heat from a nearby fire beating on other drums may vaporize certain volatile materials so as to cause a positive stream of vapour to flow from the drums vents and this stream of vapour may catch fire. As long as the heat of the outside fire continues to beat on the other drums, this stream of vapour will continue to come out through the vent and in almost all cases will burn harmlessly. It is usually best to let it burn until the outside fire is extinguished because if this vapour fire is extinguished sooner, the vapour may spread along the ground and cause a serious flash when it catches fire there.
- In most cases, ground or spill fires are responsible for the spread of most field fires. Fight ground or spill fires with water fog or dry chemical extinguisher. Keep adjacent containments cool through the use of water but only when the paint blisters.

3.1.4.2 Fire in Pumps and Other Rotating Equipment

- Call for help immediately from all available employees and also outside help in accordance with the existing instructions, call for medical help if necessary.
- Work to prevent the fire from spreading.
- Shut down the pumps / other equipment by cutting off the power supply.
- Remove any person who might have been near the process area at the start of the fire and get medical help immediately.
- Close valves and manifold valves on lines to prevent the material from running up and spreading.
- Put sand on small spills to absorb and smother the fire.
- Use dry chemical extinguishers or sand on fires inside the motors.
- Wet down with water all structures close to the fires.
- When burning material is running from the pump house or out of a broken connection in the manifold check the flow or direct to points where it will not endanger installation and surrounding property.

3.1.4.3 Fire at Small leak in Pipeline

- A fire at a small leak in pipeline must be attacked promptly with nearest available fire extinguisher before it has a chance to spread and get out of control. Call for help from all the available employees at the same time.
- Work to keep the fire from spreading.
- Shut off flow of material in line by closing valves and by stopping pumping.
- Cover the material pool by sand and build up the pile of sand so as to cover the leak.
- Put foam on the burning material pool. Apply the foam gently so as not to scatter the burning material.
- Build earth dykes around the material pool to prevent spreading of burning material.
- Do not leave material trapped in short lengths of pipe exposed to fire between the closed valves, since, material so trapped and heated often bursts the pipe and spills out spreading the fire.
- Wet down adjacent structures to keep them cool.

3.1.4.4 Fire in Drums

- Call for help from all available employees
- Work to keep fire from spreading. Cooperate as far as possible with the fire fighters to prevent the spread of fire.
- Clear away surrounding drums and packages from the points endangered by the fire.
- If tank truck drum filling/emptying is in progress, suspend all filling operations and drive tank truck away to a safe point.

- Do not move the nearby drums in a manner that the stacking of the drums is disturbed, resulting of drums toppling and bursting, leading to spear of fire.
- If burning pieces are falling inside the Waste Storage Shed, beat out flames with wet sacks or throw sand or dirt on them.
- If there are pipelines close to the fire, cover them up with sand or dirt or empty the contents if possible.
- Wet down with water, structures inside and which are close to the fire.
- Do not use the foam equipment but hold them in reserve for material fires which might be started by adjacent fire.

3.1.4.5 Electric Fires

- Disconnect the affected area's electric supply.
- Attempt to extinguish fire with the help of CO2 and DCP type fire extinguishers.
- If fire is not extinguished, extinguish by spraying water with fog nozzle after ensuring complete isolation of electric circuit.
- NOTE THAT FOAM OR WATER CAN ONLY BE USED AFTER THE ELECTRIC SUPPLY IS TOTALLY DISCONNECTED.

3.1.4 Emergency Procedure during Natural Disasters

Vapi being near sea coast and being in high rainfall area may experience high rainfall induced short inundations. In addition, the Project Site lies in earthquake zone III per IS 1893 (Part 1) 2002. Proposed emergency responses to the two most probable/likely natural events are discussed as follows.

3.1.4.1 Earthquake

Earthquakes present unique problems as they upset the complete infrastructure necessary for rescue and restoration of normalcy. For example, it could prevent emergency personnel from reaching victims, it increases the risk of landfill wall/liner catastrophic breach, fire and electrical shock, could result in complete failure of the telephone and other communication systems, disruption of water for fire fighting/ other reasons, and increases the possibility of burst pipelines carrying hazardous material. It could, in addition, prevent ambulances evacuating victims, fire personnel from reaching the fire incident areas, result in major structural debris causing secondary damage and most importantly, could affect the entire emergency organization that is geared up for chemical emergencies. Damage from falling structural debris could signal an end to conventional plans.

The main actions for earthquake incidents include preventive (pre incident), during incident and post incident actions. Each earthquake, depending upon its intensity (as measured on the modified Mercalli

Scale) would have different extent of damage. Some mild earthquakes could result in minor tremors felt within and the landfill and Plant area.

Some of the precautions that are important to face an earthquake situation include:

- Basic earthquake related training to staff (behaviour during earthquake, how to recognize, dos and don'ts etc.)
- As blackout is possible, a kit containing flashlights, portable radio, basic tools, etc. should be available for emergency.
- Basic precautions such as sitting away from wall hanging items, bolting of almirahs to the wall rather than loosely lying cupboards, pasting tape to the glasses to avoid excessive shattering.
- Actions during an earthquake would depend upon the severity of the quake and the extent of damage- however, the basic steps for safeguarding life safety (top most criterion) include:
- Activation of the fire orders, for fires is likely in case of major earthquakes. Pipelines would be expected to rupture as too would storage tanks- this would result in a large scale spillage and possible fire of flammable material. The fire fighting system is likely to be incapacitated. In addition, power supply may be (most likely) cut off. Most likely, therefore, the Off Site Plan would need to be activated, as fatalities beyond the installation boundary wall are likely to be affected.

The main action would involve :

- Stopping any operations in process or Offsite areas.
- Cutting off the power supply (if not cut off on its own already) to avoid electrical shocks, fires, etc.
- Sending away hazardous waste trucks and effluent tankers to safe zones for further instructions.
- Halting or minimizing this flow of material may be attempted where practical and if possible without endangering human life.

For personnel, important instructions include:

- Drop, cover, and hold.
- Get under a heavy table or desk and hold on, or sit or stand against an inside wall if inside the admin block and unable to come out. If possible to come out without difficulty, assemble outside the admin block to avoid fatality due to structural collapse
- Keep away from windows as these may shatter/ crack resulting in possible injury.
- If indoors in admin block, stay there.

- If outdoors, stay outdoors away from fall objects (lighting poles, pipe racks, structural roofs, etc.), falling debris, trees, and power lines.
- Vehicle drivers should drive to a clear spot and stay in the vehicle. They must avoid stopping on or under pipe racks.

Post earthquake actions are extremely important and these include:

- Expect aftershocks. They are just as serious as the main earthquake. Many earthquakes in the past were multiple tremor ones, not a single quake.
- Put on shoes to protect from broken glass and chapels, etc. are to be avoided at any cost.
- Check for injuries and fires (secondary fires could be raging).
- Use a flashlight to inspect for damage
- Do not go into damaged areas unless specifically trained to do so.
- Do not use telephones except in emergencies.
- Do not use vehicles except in emergencies.
- Use a portable radio for information.
- Assist in rescue of co workers and other persons who could be present at the installation as per the Fire Orders.

3.1.4.1 Floods

Floods are natural calamities that have the potential to cause widespread damage to human beings and property. Flood planning is perhaps the best protection against flood damage. Floods however occur after pre-warning, enabling advance action. Flood could damage landfill structure, completely submerge process equipment, buildings, and pipelines and wash away the hazardous waste inventory present at the Site. Most importantly, floods could result in chemical poisoning, drowning deaths and injury. Main actions during flood revolve around the following:

- Cut-off electrical supply to prevent electrocution
- Switch off / discontinue all operations at the installation.
- Establish contact with the flood control room (Government) for up to date status.
- Flood damage control methods include:
- Keep insurance papers, important documents, and other valuables in a safe-deposit box at a safe location.
- Have a flood kit containing portable radio, flashlight, and emergency supplies.
- Move furniture and other items to higher levels in advance.
- Listen to portable radio for up-to-the-minute information.
- Use telephones only for life-threatening emergencies.

- Evacuate, if necessary, and follow instructions.
- Do not walk or drive through flood waters.
- Stay off bridges where water is covering them.
- Heed barricades blocking roads.
- Keep out of storm drains and irrigation ditches.
- Use a flashlight to check for damage
- Stay out of the disaster area.
- Do not use vehicles except in emergencies.

Possibility of pollution after flood may be ascertained along with officials of the Pollution Control Board and necessary samples drawn from agreed points. Remedial actions as necessary may then be planned.

Appendix I

Summary/draft Spill Response Plan during transportation of Hazardous Waste

- Wastes from generators of different industries will not be carried together.
- Transporter will immediately cordon off the area of spillage. Spill control technique such as absorption in saw dust, sand, absorbent media, or on site inertization will be carried out by Transporter in assistance with the TSDF mobile team.
- The driver will be trained in safe handling of hazardous wastes. The truck will carry DCP type fire extinguisher(s).
- Trucks carrying hazardous waste will be painted in high visibility colours and will be fitted with 'HAZARDOUS WASTE' banners on all sides.
- The cargo hold of the truck carrying hazardous waste will not have any source of spark from the exhaust of the vehicle or any electrical connection.

Appendix II

Suggested Proper Storage Practice for Hazardous Waste[3]

a. Flammable, ignitable, reactive and non-compatible wastes should be stored separately and never should be stored in the same storage shed.

b. Storage area may consist of different sheds for storing different kinds of incinerable hazardous wastes and sheds should be provided with suitable openings.

c. Adequate storage capacity (i.e. up to 50 % of the annual capacity of the hazardous waste incinerator) should be provided in the premises.

d. Storage area should be designed to withstand the load of material stocked and any damage from the material spillage.

e. Storage area should be provided with the flameproof electrical fittings and it should be strictly adhered to.

f. Automatic smoke, heat detection system should be provided in the sheds. Adequate fire fighting ystems should be provided for the storage area, along with the areas in the facility.

g. There should be at least 15 meter distance between the storage sheds.

h. Loading and unloading of wastes in storage sheds should only be done under the supervision of the well trained and experienced staff.

i. Fire break of at least 04 meter between two blocks of stacked drums should be provided in the storage shed. One block of drum should not exceed 300 MT of waste.

j. Minimum of 1 meter clear space should be left between two adjacent rows of pallets in pair for inspection.

k. The storage and handling should have at least two routes to escape in the event of any fire in the area.

[3] Performance Evaluation and Monitoring of the Common Hazardous Waste Treatment Storage and Disposal Facilities including Common Hazardous Waste Incinerators (HAZWAMS/… /2010-2011), CPCB, May, 2010

Appendix III

Solvent Properties under Normal Atmospheric Conditions[4]

Solvent	Closed Cup Flash Point (^{0}C)	Lower Explosive Limit (% v/v)	Lower Explosive Limit (% v/v)	Autoignition temperature (^{0}C)
Toluene	4	1.3	7	535
Methanol	10	7.3	36	455
Isopropanol	12	2	12	425
Ethanol	13	3.3	19	365
n-Butyl Acetate	24	1.7	15	370
m-Xylene	25	1.1	7	525
n-Butanol	35	1.4	11.2	340

[4] Working with modern Hydrocarbon and Oxygenated Solvents: A Guide to Flammability, American Chemistry Council, Solvents Industry Group, January 2008