Risk Assessment

Risk assessment

The proposed industrial park will be housing different industries and the required infrastructure associated with the units. Risk assessment for the proposed project is associated with construction and operation phases. Member industries that are going to be established in the industrial park have to carry out risk analysis by considering the hazards associated with handling of chemicals, based on nature of process and inventory. However, at the extent and specifics of industrial activities, a general safety and emergency preparedness plan has been prepared.

Objectives of the study

The main objectives of the study are as follows:

- Identification of hazard prone areas
- Hazard analysis and estimation of damage distance for the Maximum Credible Accident (MCA) scenarios visualized for chemical stored.
- Suggest risk mitigation measures and arrive at guidelines for Disaster Management Plan and Emergency Preparedness Plan (DMP and EPP).

Hazard identification at the proposed project site

Identification of hazards is essential for prevention of untoward incident at work place and cost effective control of accidents. Potential hazards identified in the proposed industrial park are listed below in **Table 1**.

Table 1 Type of hazards during construction and operation

Type of hazard	Line of activity	Type of associated risk
Natural	Construction & operation phase	None
Electrical	Construction & operation phase	Electrical cables, machinery/equipment, loose wiring, maintenance work etc.
Mechanical	Construction & operation phase	Associated with power-driven machines operated manually, hand held tools, failure of slip falls and traps at workplace, activities such as cutting, lifting, crushing etc.
Physical	Construction & operation phase	Noise and vibrations generated within site during construction & operations
Transportation	Construction & operation phase	Movement of heavy vehicles, transport of construction material & raw material for operations, Vehicle collision etc.
Storage and handling of hazardous materials	Operation phase	Industrial plants deal with materials, which are generally hazardous in nature by virtue of their intrinsic chemical properties or their operating conditions. Hazards in this case are associated with

Type of hazard	Line of activity	Type of associated risk
		accidental spillage and leakage of chemicals leading to fire or explosion.
Others	Construction	Civil construction works, other hot jobs done at height

Hazards due to industries

Based on the preliminary hazard analysis, the following scenarios are short-listed for consequence analysis to quantify the risks involved. The indicative list of risks and hazards that could occur at the proposed site due to presence of plants/member industries is presented in **Table 2.**

Table 2 Risks associated with industries proposed

S. no	Industries	Sub sectors	Associated risks	Mitigation measures
1	Steel based Industry	Development of secondary steel and specialty steel products	• Water entrapped by molten metal or slag may generate explosive forces that launch hot metal or material over a wide area. • Exposure to silica is a risk to workers engaged in lining, relining and repairing blast furnaces and steel furnaces and vessels with refractory materials. • Sharp engines or burrs on steel products or metal bands pose laceration and puncture hazards to workers involved in finishing, shipping and scrap-handling operations.	• Good ventilation system must be provided. • Personal protective equipment should be used • Clothing against the hazardous substances must be utilized.
2	Light Engineering	Electrical & electronic components/ instruments & equipment/ auto components	• Chemicals used for various processes, from corrosive cleaning solutions to leaking battery acid, may pose some risk during handling. • Heavy Machinery: Maneuvering a forklift or other factory machinery can result in injuries to the operators if not handled with care and utmost alertness. • Engines that run machinery, welding equipment that is used on a daily basis, and the electrical wires that keep the lights on, can each pose a significant risk for a manufacturing facility if not handled with care and alertness.	• Proper earthing must be carried out. • Personal protective equipment should be used • Regular inspection of equipment can avoid accidents and injuries.
3	Non-metallic mineral industries	Quartz/silica/precipitate calcium carbonate	• In the non-metallic mineral industries the biggest respiratory risk comes from Respirable Crystalline Silica (RCS). This can be found in stone, rocks, sands and clays, which need to be handled with proper dust control devices. • Manual handling may be the most common cause of injury at work in such industries which include work related Musculoskeletal	• Usage of nose masks to avoid inhalation of silica dust. • Personal protective equipment such as gloves, boots etc. must be used • Proper ergonomics at the work

			Disorders (MSDs) such as upper and lower limb pain/disorders, joint and repetitive strain injuries of various. • In the non-metallic mineral industries the substances that can cause skin health problems are: ○ Wet cement ○ Resins and hardeners ○ Solvents used in paints, glues or other surface coatings ○ Oils and greases	station must be implemented.
4	Aerospace & defense hardware	MSME industries	• Risks related to chemical or fuel storage leading to fire or other types of accidents are not envisaged in these types of industries. However, risks are associated with the postural errors during lifting, handling etc. operations of the processes.	• Ensuring proper and safe storage of fuels on-site. • Proper ergonomics at the work station must be implemented.
5	E-waste	Metal & scrap recycler – steel industry E-waste recycler – engineering sector	• Slips, trips, and falls during collecting and transporting e-wastes. • Crushing hazards like traffic accidents when transporting e-waste, using machines that have moving parts, such as conveyors and rolling machines. • Hazardous energy released during the installation, maintenance, or repair of machines, equipment, processes, or systems • Working overtime near loud noises from drilling, hammering, and other tools that can make a great noise lead to hearing loss.	• Personal protective equipment (PPE) such as gloves, eye goggles etc. must be used • Ear muffs, cotton buds provided to personnel to reduce ill-effects of noise generating equipment.
6	Gems & jewelers	Gold processing/gems cutting	• Use and disposal of chemicals used in gemstone manufacturing (cutting & polishing, jewelry manufacturing) process. • Use of chemicals or gases such as acetylene for welding purposes etc.	• As needed for welding, hand, head, and body protection to help prevent injury from radiation and sparks
7	Logistic hub	Office spaces for trading/ ware houses/	• Crushing hazards like traffic accidents when transporting e-waste, using machines that have moving parts, such as conveyors and	• Training on safe usage of equipment given to personnel

		packaging & assembling units/ truck terminal/ yard activities/ courier services/ banking restaurants/ ATM	rolling machines. • Manual handling, may be the most common cause of injury at work which include work related Musculoskeletal Disorders (MSDs) such as upper and lower limb pain/disorders, joint and repetitive strain injuries of various. • Construction risk**:** Risk of property damage or liability stemming from errors during the building of new projects	• Proper ergonomics at the work station must be implemented.
8	Renewable energy	Solar power	• Manufacturing process includes a number of hazardous materials, most of which are used to clean and purify the semiconductor surface. • These chemicals include hydrochloric acid, sulfuric acid, nitric acid, hydrogen fluoride, 1,1,1-trichloroethane, and acetone. • Workers also face risks associated with inhaling silicon dust. • There are emissions associated with stages of the solar life-cycle, including manufacturing, materials transportation, installation, maintenance, and decommissioning and dismantlement.	• Personal Protective equipment such as gloves, goggles etc. must be used. • To avoid inhalation of dust or other emissions, nose masks must be worn by personnel.
9	Textile & apparel	Weaving + apparel/ fabrication workshop/apparel design & training center/ ginning	• Exposure to cotton dust: Workers engaged in the processing and spinning of cotton are exposed to significant amounts of cotton dust, particles of pesticides and soil. Exposure to cotton dust and other particles leads to respiratory disorders among the textile workers. • Workers in the textile industry are also exposed to chemicals, especially those engaged in the activities of dyeing, printing and finishing. Exposure to noise • Ergonomic issues are observed in a majority of the units engaged in textile-related activities.	• Good ventilation system must be provided. • Proper ergonomics at the work station must be implemented. • Personal protective equipment should be used.

MSIHC Rules 1989, 2000

Identification of hazardous chemicals is done in accordance with MSIHC (Manufacture, Storage and Import of Hazardous Chemicals) 1989 and its subsequent amendment, 2000. The detail of threshold storage of the fuel as per MSIHC amendment rules, 2000 and quantity of the chemical to be stored at the industrial park are given in the following **Table 3.**

Table 3 Details of chemicals and applicability of MSIHC rules

Chemicals	Storage type	Listed in scheduled	Threshold quantity (Tons) as per rules	
			4,5,7-9,13-15	10-12
HSD (High Speed Diesel)	Tank	1 (part I)	5000	50000
Acetylene	Cylinder	1 (part II)	1000	5000
Chlorine	Cylinder	3 (part I)	10	25

Inventory of materials

A total of 8 x 250 kVA, 23 x 500 kVA, 18 x 750 kVA D.G. sets are proposed for the industrial park, based on the land areas of the individual plots. Since 750 kVA is the highest load capacity proposed, and considering it as the worst-case scenario for leakage of fuel, ALOHA risk analysis has been carried out. An individual industry would store HSD of capacity of 1000 lts per tank/drum, at any given time. An inventory of chemicals and materials used at the site are given in **Table 4** and their physical properties are given in **Table 5**.

Table 4 Inventory of chemicals at the proposed project site

Chemical	Use	Nature of chemical	Type of storage & No's	Storage quantity
HSD	Fuel for D.G. sets	Flammable	Vertical – 1 No.	1,000 lts.
Acetylene	Welding purpose	Flammable	Vertical – 1 No.	50 lts.
Chlorine	Disinfectant	Toxic	Tonner – 1 No.	970 kg
Note: 750 KVA DG set – 0.21 ltr/hr – requirement 8 hrs 1260 lts – maximum storage in the industry will be 20 KL of HSD (for two weeks)				

Table 5 Characteristics of chemicals used

Chemical	TLV (mg/m^3)	BP	MP	FP	UEL	LEL
		(^{0}C)			%	
HSD	800	215 – 376	NA	55-65	6.0	0.6
Acetylene	-	- 84	- 80	- 17	100	2.5
Chlorine	500	- 34	- 101	-	-	-
TLV : Threshold Limit Value			BP : Boiling Point			
MP : Melting Point			FP : Flash Point			
UEL : Upper Explosive Limit			LEL : Lower Explosive Limit			

Maximum credible accident (MCA) analysis

MCA analysis is carried out to arrive at hazard distance for worst case scenario. The consequence of all the scenarios is computed and hazard distances are worked out and

listed for flammable and possible explosion effects. High Speed Diesel (HSD) will be used as fuel for running D.G sets, acetylene will be used for welding purpose and chlorine will be used as a disinfectant.

Fire and explosive index (FEI)

The FEI calculation is a tool to help determine the areas of greatest loss potential in a particular process and also enables one to predict the physical damage that would occur in the event of an incident. The computations of FEI are derived from National Fire Protection Association (NFPA) code using Appendix A or NFPA (49, 704, 325M) or MSDS of chemicals to determine Health (N_h), Flammability (N_f), Reactivity (N_r), and Material Factor (MF) under consideration. The general process hazard (GPH) and specific process hazard (SPH) factors were calculated accordingly.

FEI = MF *(GPH) * (SPH)

The FEI and TI values are ranked into following categories as per **Table 6** and calculated values are given in **Table 7.**

Table 6 FETI category

S.No	FEI	Category
1	< 65	Low
2	65 ≤ F&EI < 95	Moderate
3	≥ 95	Severe

Table 7 FEI of fuel used for the proposed project

Chemical/Fuel	NFPA classification				GPH	SPH	FEI	FEI category
	Nh	Nf	Nr	MF				
HSD	1	2	0	10	1.8	2.8	50.4	Low
Acetylene	0	4	3	29	-	-	-	-
Chlorine	3	0	0	1	1	2.7	2.7	Low

From the above table, it can be inferred that, HSD comes under low category and nil toxicity.

Hazard from HSD, Acetylene and Chlorine storage

HSD: Diesel is a flammable liquid having a flash point of 55-65°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

a. Tank fire

Oil is stored in a floating roof tank; any leak in rim seal or spillage leads to accumulation of vapour which can be a source of ignition and can 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, it will be restricted within that dyke. After sometime, the vapour from the pool can catch fire and can cause pool or dyke fire.

Acetylene: Acetylene when leaked into the atmosphere forms a mixture of air-acetylene because of its high reactivity resulting in a violent explosion. Two scenarios have been considered, one being flammable area vapor cloud and other being BLEVE (boiling liquid expanding vapor explosion).

Chlorine: Chlorine is a greenish-yellow, highly reactive halogen gas that has a pungent, suffocating odor. The vapor is heavier than air and will form a cloud in the vicinity of a spill. Like other halogens, chlorine exists in diatomic state in nature. Chlorine is extremely reactive and rapidly combines with both inorganic and organic substances. Chlorine is an eye and respiratory tract irritant and, at high doses, has direct toxic effect on lungs. The critical values of chlorine concentrations in air are given in **Table 8.**

Table 8 Critical concentrations of chlorine

Criteria	Concentration (ppm)
LC_{50}	293 ppm/1Hour (rats)
Immediate Damage to Life and Health (IDLH)	10
Short Term Exposure Limit (STEL)	1
Timed Weighted Average (TWA)	0.5

Heat radiation and thermal damage criteria

The level of damage caused by heat radiation due to fire is a function of the duration of exposure as well as heat flux (i.e. radiation energy onto the object of concern). The damage and fatality due to the exposure time are very important in determining the degree of fatality and corresponding effect distance. However, the variation of likely exposure time is more marked with personnel, due to the possibility of finding shelter coupled with protection of the skin (clothed or naked body). The effect of heat radiation on percentage fatality with variation in exposure time is given in **Table 9**.

Table 9 Effect of heat radiation

Radiation intensity (kW/m^2)	Exposure time (seconds)	Lethality (%)	Degree of burns
1.6	--	0	No discomfort even after long exposure
4.5	20	0	1^{st}
4.5	50	0	1^{st}
8.0	20	0	1^{st}
8.0	50	<1	3^{rd}
12.0	20	<1	2^{nd}
12.0	50	8	3^{rd}

Radiation intensity (kW/m^2)	Exposure time (seconds)	Lethality (%)	Degree of burns
25.0	--	50	--
37.5	--	100	--

It is observed that the exposed persons normally find shelter or protection from the heat radiation (e.g. against a wall) within 20 seconds. However, exposure time 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 model which gives the following values for human fatality levels as shown in **Table 10**.

Table 10 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

Tank rupture is considered as one of the major accidental scenarios in which a large quantity of HSD will be leaked into the surrounding areas of the storage. If an ignition source is available near the accident site, the leaked fuel will easily catch fire. It is assumed that the complete liquid leaks due to tank rupture and develops into a pool and gets ignited. Hazard distances have been arrived due to the effect of pool fires. For computing the damage distances, 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 is given in **Table 11.**

Table 11 Effect of heat radiation due to HSD storage tank (pool fire)

Input data		**Results of computation**	
Spilled quantity	1 kl	Flame length	7 m
Circular opening diameter	2.5 cm	Max burn rate	21.4 kg/min
Wind speed	2 m/s	Total amount burned	629 kg
Heat radiation at ground level kW/m^2		**Damage distances (m)**	
12.5		<10	
4.5		11	
1.6		16	

Acetylene:

Cylinder with a damaged hole is considered as accidental scenario. Cylinder of 50 liter volume is considered. Aperture of 2 cm is considered and following results are obtained using ALOHA.

Flammable area vapor cloud

Threat Zone:

Red: 16 meters --- (25000 ppm = LEL)

Orange: 22 meters --- (15000 ppm = 60% LEL = Flame Pockets)

Yellow: 70 meters --- (2500 ppm = 10% LEL)

BLEVE

Percentage of Tank Mass in Fireball: 100%

Fireball Diameter: 16 meters Burn Duration: 2 second

Threat Zone:

Red: 14 meters --- (37.5 kW/m^2)

Orange: 18 meters --- (25 kW/m^2)

Yellow: 26 meters --- (12.5 kW/m^2)

Chlorine:

One tank of approximately 1 Ton capacity is proposed to be located in the plant. Any leakage in the system will cause toxic release which will spread in down wind direction.

Threat Zone:

Model Run: Heavy Gas

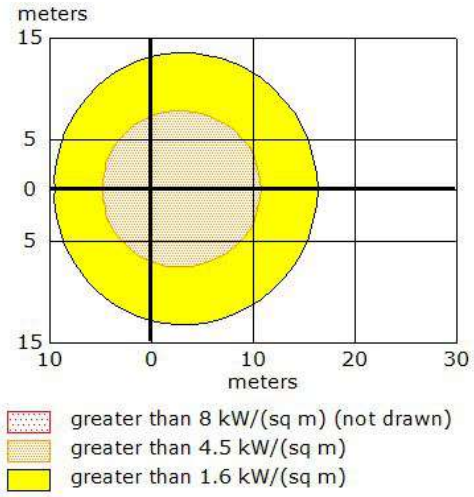
Red : 48 meters --- (20 ppm)

Orange: 163 meters --- (2 ppm)

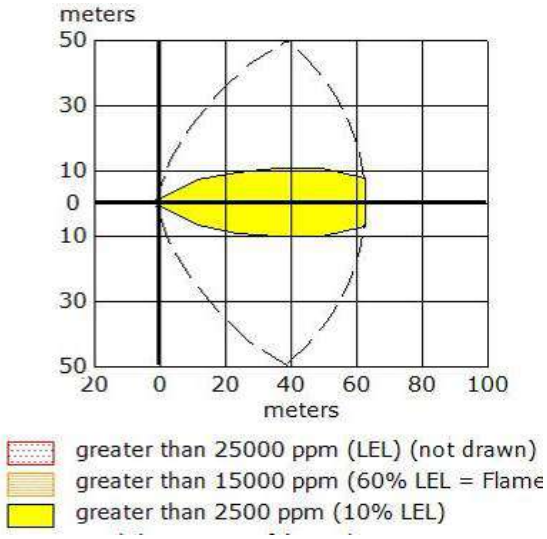
Yellow: 340 meters --- (0.5 ppm)

The risk contours for the chemicals are given in the following **Figure 1.**

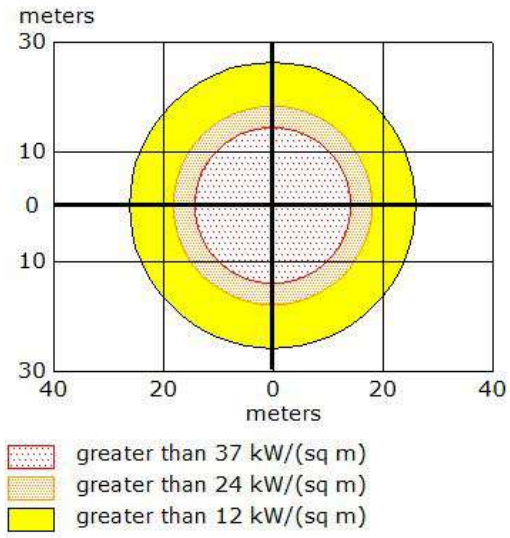
Figure 1 Risk contours of HSD, Acetylene and Chlorine



HSD – 1 kl

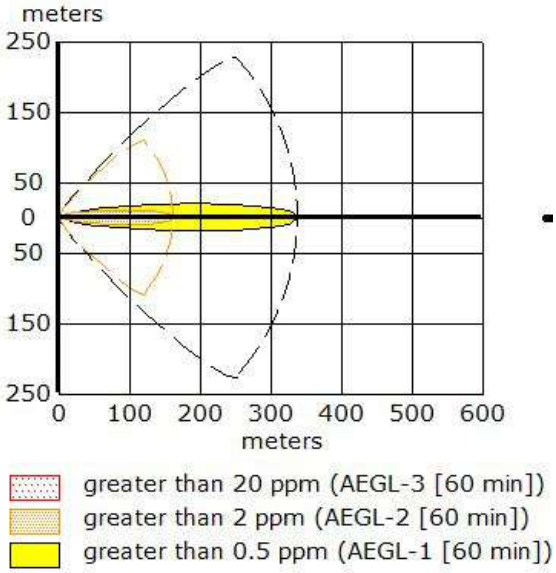


Flammable area vapour cloud



BLEVE

Acetylene – 50 ltr



Chlorine – 970 kg

Fire hazards

The major factors responsible for fire emergency may be due to an accidental ignition of the inflammable materials in the storage or any electrical short-circuit etc. On a large scale this may lead to an explosion under certain circumstances or even an explosion can cause massive fire.

Precautionary measures

To increase the level of safety, 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.

- Sufficient units of oxygen cylinders, medical kits and masks to be kept and maintained properly at site in order to prevent smoke inhalation during any fire accident, especially for those with respiratory disorders which can be very dangerous
- Firefighting equipment such as DCP, CO_2, foam type fire extinguishers, fire tenders etc.in adequate numbers to be kept with proper maintenance
- Fire hydrant and monitoring system to be installed and properly maintained to take care of any fire hazard
- Fire detection/alarm system to be provided for control rooms, cable galleries, transformer area etc.
- Emergency evacuation plan in coordination with local authorities to be prepared and displayed at common assembly points and important sites of the project facility
- Caution boards shall be displayed in all appropriate places within the project site and list of important telephone numbers to be displayed at prominent locations
- Regular mock drills to be conducted to create awareness on procedures to be followed in times of emergency situation/evacuation.

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 12**.

Table 12 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 the person to lie down ii. Cover burned areas with a sterile dressing or clean cloth and lightly bandage iii. If clothing is adhering, do not disturb; leave the clothing iv. Keep the person warm. If a person is not nauseated, he may have sips of water v. Arrange for immediate medical care

Electrical hazards

Electrical hazards can cause burns, shocks, and electrocution which can lead to serious injury and even death when dealing with potentially serious electrical works.

Prevention of electrical accidents

- Proper grounding to avoid static electricity build up and avoid electric shocks/fire accidents during thunder bolt strikes
- Flexible cords connected to appliance should be wired to confirm to the international colour code
- Use of intrinsically safe electrical installations and non-sparking tools
- The appliances used should be of tested and certified makes 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.
- CO_2 or dry chemical fire extinguishers shall be kept in sufficient numbers at individual industrial units

Spillage contingency

Identification of probable materials for spillage and adopting prevention/ control measures for safe and healthy working area for personnel and machinery.

Prevention measures

- Routine checks of the system or storage units
- Any leakage should be arrested in shortest possible time
- Storage of absorbents to clean any oil spill and properly disposed to APPCB/CPCB authorized recyclers

Occupational health and safety

Maintaining a high degree of physical, mental and social wellbeing of employees ensures high productivity and overall sustainability of the proposed project. There would be an emergency medical center within the industrial park to take care of the comprehensive health management system of the each individual plant personnel which are to be developed in the proposed industrial park. Regular health education programs and other health care initiatives would be taken up to uphold workers general health conditions.

The occupational health hazards with permissible limits and mitigation is presented in **Table 13.** The action plan for implementation of OHS standard is presented in **Table 14.**

Table 13 Occupational health hazards with permissible limits and mitigation

S.No	Hazards	Permissible exposure level (PEL)	Measures to be adopted at site
1	Dust level	2 mg/m^3 in closed work zone 500 µg/m^3 in open work zone Cr^{+6} ≤ 5µg/m^3 & Total Cr ≤2 mg/Nm^3 as per OSHAS 2006 guidelines	Dry fogging, preventing leakages, conducting environmental audits and strict adherence to pollution control measures
2	Noise	85 db(A)/ 8 hours duration	Ear plugs and Ear muffs
3	Vibrations	Exposure action value (EAV) - 2.5 m/s^2 A(8)	Reducing the time spent holding vibrating equipment or work pieces, hand gloves, fiber handles
4	HSD	800 mg/m^3, TLV (vapors/ aerosol)	Proper ventilation, use of PVC gloves, safety glasses, air purifying respirators for uncontrolled release
5	Working at height	2 m above ground level	Double lanyard full body safety harness. Life line support. Proper IITS (information, instructions, training, and supervision) provided.
6	Excavation	1.5 m depth	Gum Boot, Ramp, Shoring, benching etc. Proper IITS implemented. SOP & Standards implemented.
7	Scaffolding	2 m above ground level	Railings in access, work platform, hand rail, mid rail, toa guard. System scaffold standard implemented
8	Welding/ glass-cutting	-	Apron, leather hand gloves, face-shield, black goggles, SOP implemented
9	Material handling	Max. 50 kg/ adult male, 30 kg/ adult female	Cotton gloves, safety shoe (steel toe), safety helmet. Head & shoulder load carrying is strictly prohibited

Table 14 Action plan for implementation of OHS standard

S.No	Type of possible health hazards	Preventive action plan
1	Exposure to construction material	Use of nose mask, gloves and shoes by all workers
2	Fall from height	• All workers working at height to be examined specially for vertigo & certified. • Workers to be supplied with PPE like belt, harness, helmet, gloves etc. and their use to be made mandatory
3	Slip, trip or fall on the level	All workers to use non slip safety shoes
4	Injury caused by	Use of helmet by all workers

S.No	Type of possible health hazards	Preventive action plan
	falling objects	
5	Exposure to extreme temp.	In summer, working hours to be rescheduled as per government guideline
6	Electrical injury	• Positive isolation. • Barricading installation. • Use of PPE (like gloves, shoes, helmet etc.)
7	Eye injury	• Use of goggles. • Supply of water tab at strategic locations. • Providing first aid available within 10 minutes ambulance service for major injury
8	Risk of road traffic accident	• Entry of only authorized vehicle • Speed limit regulation and display of speed limit area • Mandatory use of seat belt • Regular maintenance of road
9	Noise pollution	Use of noise mask/ ear plugs at high decibel sound area
10	Exposure to work zone dust	• Water sprinkling on services roads • Use of mask • Vacuum cleaning of floors • Prevention of leakage from furnaces, conveying systems and routine preventive maintenance
11	Exposure to hazardous chemicals	• Storage of chemicals in confined area as per regulations. • To be handled by authorized persons only • Use of PPE
12	Periodic health check-ups	• Pre-employment health check-up • Health check-up every 6 months
13	First aid back up	• One first-aid center to run in the factory premises • Ambulance service to be available round the clock

Disaster management plan

The DMP is aimed to ensure safety of life, protection of environment, protection of installation, restoration of production and salvage operations in the same order of priorities. For effective implementation of DMP, it should be widely circulated and personnel training are to be provided for rehearsals/drills.

The objective of DMP is to make use of combined resources of the Industrial Park facilities and outside services to achieve the following:

- Safeguard people and minimize damage to property and environment
- Formulate emergency teams with defined roles & responsibilities for effective communication and links with various government and non-government agencies
- Providing effective rescue, safe rehabilitation of affected people and immediate medical treatment of casualties

- Identification of any dead persons and handing over to the relatives and reimbursing proper applicable compensations
- Preservation of relevant records for the subsequent inquiry into the cause and circumstances of emergency
- Press/ media handling and issuing notification at large level

Any emergency situation has to be categorized as an on-site or an off-site emergency. On-site emergency comes into effect when hazards are confined within the premises while off-site emergency is when any hazard occurs beyond Industrial Park or project site premises.

On-site disaster management plan

The DMP must be related to the final assessment and it is the responsibility of APIIC management and industries within Industrial Park to formulate it. The plan will include the following elements.

- Assessment of the magnitude and nature of the events for seen and their probability of occurrence
- Organizational structure with appointment of key personnel defining their roles and responsibilities and establishment of emergency control center (ECC)
- Procedures for raising alarm and communication both within and outside the Industrial Park

Individual industries will be having their own on-site disaster management plan and they will be having their own team for management of disaster of the respective unit. However at the industrial park level the EHS team will coordinate with individual units disaster management teams for controlling the disaster at industrial park level if any.

Organizational structure

The organizational setup for emergency operations for on-site hazard control is essential near the incident site which helps in dealing with emergencies.

Roles and responsibilities of emergency team

The general roles and responsibilities of the emergency personnel involved are

- Assess the magnitude of the situation and decide if staff needs to be evacuated from their assembly points to identify safer places
- Exercise direct operational control over areas other than those affected
- Undertake a continuous review of possible developments and assess in consultation with key personnel
- Liaise with senior officials of police, fire brigade, medical and factories inspectorate and provide advice on possible effects on areas outside the factory premises
- Arrange for additional help from the neighbouring industries and local authorities
- Look after rehabilitation of affected persons on discontinuation of emergency

- Direct to shut down of operations and try to minimize further aggravation of the incident
- Ensure that all key personnel and help from the fire brigade is called for
- Conduct search for causalities
- Assign jobs to emergency squad
- Communicate to various safety and rescue departments with the incident controller for external help
- Fire extinguishers, hoses, nozzles, foam compound located in various points shall be drawn and arrange for fire fighting
- Coordinate with fire brigade and help them
- Ensure availability of necessary antidotes/ medicines in case of toxic release
- Stay on alert for first aid and medical treatment for chemical poisoning and other injured persons carried at the security room
- Examine and quickly assess the condition and treat
- Report to the hospitals and make arrangements for likely more cases of injuries
- Arrange for shut down of non-essential utilities and power supply to the affected area
- Execute leakage control operations in consultation with incident controller
- Arrange for changeover of pumps and system with standby in case of any difficulty
- Carry safety equipment, Self-Contained Breathing Apparatus (S.C.B.A), stretcher and artificial resuscitators from the departments and report to the shift in charge and the incident controller working as per their directions
- Evacuation of all visitors and contract people to assembly point

Emergency control center

This is the main center from where the operations to handle the emergency are directed and coordinated. Facilities to be made available in the control center are:

- Internal and external communication with adequate number of telephones and walky-talkies with list of key personnel with addresses, telephone number etc.
- Computer and other essential records
- Daily attendance of workers employed
- Storage of hazardous material records and manufacturing records
- Location of fire-fighting system, assembly points and additional source of water.

Alarm system

Alarm system varies and will depend on the size of the works area - simple fire bell, hand operated siren – break open type, fire alarm etc. Automatic alarm may be needed for highly hazardous nature of industries in the site.

Siren for emergency

Siren for emergency should be different from the normal siren. The emergency siren should be audible to a distance of 3-5 km radius. The emergency siren should be used only in case

of emergency. All employees and workers need to be made aware of siren and their immediate action on hearing to emergency siren

Escape route

The escape route from each and every plant of the industrial area should be clearly marked. The escape route is the shortest route to reach out of the plant area to open area, which leads to assembly point. This route should be indicated on the layout plan attached to the on-site management plan and also be displayed in appropriate and significant common places for evacuation in emergency.

Emergency evacuation plan

An emergency action plan covers designated actions employers and employees must take to ensure employee safety from fire and other emergencies. All non-essential staff should be evacuated from the emergency site. As soon as the emergency siren rings the workers have to shut down the industry and move to the assembly point. The shutdown procedure in case of emergency should be prepared and kept ready and responsible persons should be nominated for the purpose. Emergency evacuation plan may include the following:

- A preferred method for reporting fires and other emergencies
- An evacuation policy and procedure
- Emergency escape procedures and route assignments, such as floor plans, workplace maps, and safe or refuge areas
- Names, titles, departments, and telephone numbers of individuals both within and outside your company to contact for additional information or explanation of duties and responsibilities under the emergency plan
- Procedures for employees who remain to perform or shut down critical plant operations, operate fire extinguishers, or perform other essential services that cannot be shut down for every emergency alarm before evacuating
- Rescue and medical duties for any workers designated to perform them

On-site mock drills

Preparation is the key to effective response to workplace disasters. Mock drills help prepare employees to respond quickly, calmly and safely. The broad objectives of mock drills are:

- To review the disaster management plan
- To evaluate the emergency response plan and standard operating procedures of the industry/district/s selected for mock exercise
- To highlight the roles and responsibilities of various stakeholders and enhance coordination among emergency support functions of various stakeholders at district level

- To generate public awareness by involvement of local government, NGOs and public and to identify the gaps in resources, manpower, communications and in any other field.

All clear signal

After control of emergency, the work incident controller will communicate to the works main controller about the cessation of emergency. The main controller can declare all clear by instructing the time office to sound "All Clear Sirens".

Mutual aid system

Mutual aid scheme should be introduced among industries so that in case of emergency necessary help from mutual aid partner may be extended. Essential elements of this scheme are:-

- Mutual aid must be a written document signed by the chief executive of the Industries concerned
- Specify key personnel who are authorized to give requisition of materials from other industries
- Specify the available quantity of material/equipment that can be spared
- Mode of requisition during emergency and mode of payment/replacement of material given during an emergency
- May be updated from time to time based on experience gained

Mock drills on emergency planning should be conducted once in 6 months and sequence of events should be recorded for improvement of the exercise. Exercises on on-site emergency planning should be monitored by the high officials of the organization and the plan should be reviewed every year.

Off-site disaster management plan

When the damage extends to the neighbouring areas, affecting local population beyond plant boundaries, the off-site emergency plan is put into action in which quick response and services of many agencies are involved. The types of emergency that can occur are:

- Spillage of material during transport
- Collision with other vehicle, pedestrians, trees or objects at the side of the road and injury to persons/damage to the vehicle due to the accident
- Toppling of truck
- Fire on material during transport

Based on the level of emergency, necessary action will be taken by the concerned authorities at local level/ district level/ state level. However, certain control measures will be taken to prevent it from being catastrophic.

Preventive and control measures

- Train the driver and cleaner to seal the container doors properly before lifting the container on the truck and on spill clean-up procedure
- Check and repair containers before sending and carry the MSDS of the chemicals
- Ensure that spill kit, first-aid box and PPE are available in the truck for use in case of emergency
- Report the matter to the nearby police station and project authorities
- Immediately inform the site in-charge or the deputy site in-charge, in absence of site in-charge
- Based on the seriousness, a unit personnel to be sent to the accident site without delay

Preparedness for natural disasters

According to seismic zoning the site lies in Zone II (very low risk zone) and no incidents of such have been reported till date. The area is undulating and is away from populated area. Hence, there would be no human or property loss in any disaster condition.

The rainfall during rainy season is not adequate and also the site area being situated at elevated level the drains flow out from the site leading to no stagnation of water, there are no major rivers / sea near to the proposed project. Hence, the site is very far from being affected from any kind of natural disaster (floods, tsunami, etc.,), so no possible preparedness plan has been considered.