

Risk Assessment Studies

1 Safety Management Plan

During construction, erection, testing, commissioning, operation and maintenance, the manpower, materials and machines are the basic inputs. The proposed development of industrial park at Gollapuram village generally has issues related to occupational health and safety. Hence management proposes to take steps to minimize the impacts from the proposed development of industrial park to ensure appropriate occupational health, safety including fire plans by adapting occupational health & safety measures as per standard procedures & local guidelines. All these activities again may be classified based on activities which needs attention during construction, erection, operation and maintenance phases.

Over-exertion, ergonomic injuries and illnesses caused due to repetitive motion and manual handling are among the most common during construction. The proper steps for their prevention and control include:

- Training to be given to the workers regarding the lifting of materials & handling, placement of weight limits, planning of work, selection of tools and implementation of administrative controls in the site for the development.
- Implementation of good house-keeping practices, such as the sorting and placing loose construction materials or demolition debris in identified areas away from foot paths.
- A fall protection plan will be implemented for the persons who will work in heights and also depending on the nature and aspects of the fall hazard.
- Appropriate techniques and measures will be taken for the prevention and control of hazards caused by the objects and moving machinery in proposed site during constructional phase.
- Suitable dust suppression techniques will be implemented like water spraying to minimize dust from vehicle movements and also proper Personal Protective Equipment (PPE) used at excessive levels.

a) Policy

The employee's safety policy includes the following:

- Contact their immediate supervisors according to individual department policies. What happened will be sorted out through the accident reporting and investigation process.
- The supervisor or employee should responsible for the following to be completed:
 - Obtain the names, addresses and phone numbers (work and home) of any witnesses. Interview the witnesses and prepare a report including statements

- from the witnesses. The report should include any suggestions to prevent a similar accident or incident from occurring in the future.
- Take photographs of the property damage or defect. A sufficient number of photos should be taken to fully describe the damage to a person who has not been at the scene.
 - Prepare a report of the incident with all necessary information. The reports should be prepared to reflect the seriousness of the incident.
 - Fill appropriate forms for future use.
 - If individual department procedures include all of the information required by this policy, that document can be utilized to fulfill these requirements.
 - This policy is in addition to a workers compensation reporting requirements.

Appropriate risk management strategies will be implemented to protect the community from physical, chemical or other hazards associated with sites through a combination of Institutional and administrative controls by adopting the community health and safety measures as per Standard procedures & local guidelines provided for community health and safety.

To control communicable and vector-borne diseases attributable in the proposed site are not potentially serious health threat to project personnel and residents of local communities. The investigation facilities are available to monitor all the employees for the occupational health diseases expected due the production activities in the industrial park premises and also maintaining periodical check-up of our all workers from certified industrial & occupational health physician. The industrial park will maintain the first aid box with sufficient medicines to face any emergency in the industrial premises.

The problem of occupational health in the operation and maintenance phase of member industries is due to noise hearing losses. The personal protective equipments are given to all the workers.

The working personnel are given the following personnel protective equipments as appropriate to their working environment.

- Safety Helmet
- Face shield with replacement acrylic vision
- Zero power plain goggles with cut type filters on both ends
- Welders equipment for eye and face protection
- Ear muffs
- Canister gas mask
- Self-contained breathing apparatus
- Leather apron
- Full body Safety harness

- Leather hand gloves
- Acid/Alkali proof rubberized hand gloves
- Electrically tested electrical resistance hand gloves and
- Industrial safety shoes.

Emergency medical facilities are available round the clock for attending emergency arising out of accidents, if any. All working personnel are medically examined at least once in every year and at the end of his term of employment.

b) Safety Plan

Safety of both men and materials during construction and operational phases is of concern. The preparedness in the proposed site for the occurrence of possible disasters is known as emergency plan. The disaster in the proposed site may be possible due to leakage of hazardous fuels like HSD, collapse of structures and fire/explosion etc.

Keeping in view the safety requirement during construction, operation and maintenance phases, developer/common facilitator propose to formulate the safety policy and the same will be further strengthening after establishment of the proposed industrial park

The safety policy is based on the following regulations:

- To allocate sufficient resources to maintain safe and healthy conditions of work
- To take steps to ensure that all known safety factors are taken into account in the design, construction, operation and maintenance of member industries, machinery and equipment
- To ensure that adequate safety instructions are given to all employees
- To provide wherever necessary protective equipment, safety appliances and clothing and to ensure their proper use
- To inform employees about materials, equipment or processes used in their work which are known to be potentially hazardous to health or safety
- To keep all operations and methods of work under regular review for making necessary changes from the point of view of safety in the light of experience and upto date knowledge
- To provide appropriate facilities for first aid and prompt treatment of injuries and illness at work
- To provide appropriate instruction, training, retraining and supervision to employees in health and safety, first aid and to ensure that adequate publicity is given to these matters
- To ensure proper implementation of fire prevention methods and an appropriate firefighting service together with training facilities for personnel involved in this service
- To organize collection, analysis and presentation of data on accident, sickness and

- incident involving people injury or injury to health with a view to taking corrective, remedial and preventive action
- To promote through the established machinery, joint consultation in health and safety matters to ensure effective participation by all employees
 - To publish/notify regulations, instructions and notices in the common language of employees
 - To prepare separate safety rules for each type of occupation/processes involved in a proposed industrial park and to ensure regular safety inspection by a competent person at suitable intervals of all buildings, equipments, work places and operations in all member industries.

2 Safety Organization

▪ Construction and Erection Phase

A qualified and experienced safety officer shall be appointed by the member industries and for the entire industrial park. The responsibilities of the safety officers include identification of the hazardous conditions and unsafe acts of workers and advice on corrective actions, conduct safety audit, organize training programs and provide professional expert advice on various issues related to occupational safety and health. He is also responsible to ensure compliance of safety rules/ statutory provisions. In addition to employment of safety officer by industry every contractor, who employs more than 250 workers, in the proposed site for the industrial park/member industry shall also employ one safety officer to ensure safety of the worker, in accordance with the conditions of contract.

▪ Operation and Maintenance Phase

When the construction is completed the posting of safety officers shall be in accordance with the requirement of Factories Act and their duties and responsibilities shall be as defined thereof.

A training center shall be set up at the proposed industrial park. Safety training shall be provided by the safety officer with the assistance of external faculty members called from professional safety institutions and universities. In addition to regular employees, contract labors shall also be provided safety training. To create safety awareness safety films shall be shown to workers and leaflets etc.

3 Risk Assessment Plan

Risk involves the occurrence or potential occurrence of some accident consisting of an event or sequence of events. Risk (R) can be mathematically expressed as $R = fD$ where R is the risk (individual or societal), f is the frequency of occurrence of an undesired event and D is the expected damage distance due to likely occurrence of that unfortunate event. The main objectives of the study are as follows:

- i. Identification of hazard prone area and estimation of damage distance for the

- Maximum Credible Accident (MCA) scenarios visualized for storages.
- ii. Computation of frequency of occurrence of hazards and evaluation of risk.
- iii. Based on the studies, suggest risk mitigation measures and arrive at guidelines for Disaster Management and Emergency Preparedness Plan (DMP and EPP).

4 Inventory at Site

The inventory at the project site is given in the **Table 1**

Table 1
Storage Capacity in project site

S.No	Name of Hazardous Materials & Location	Nature of Hazard	No. of Storage Units	Capacity of storage (Liters)
1	HSD (High Speed Diesel) Stored at Utilities Department	Fire & Explosion	1 no	2500

5 Hazard Identification and Preliminary Hazard Analysis

5.1 Introduction to Hazard Identification

Identification of hazards in proposed site is of primary significance in the analysis, quantification and cost effective control of accidents involving chemicals and process. A classical definition of hazard states that hazard is in fact the characteristic of system/plant/process that presents potential for an accident. Hence, all the components of a system/plant/process need to be thoroughly examined to assess their potential for initiating or propagating an unplanned event/sequence of events, which can be termed as an accident.

5.2 Identification of Major Hazardous Units

Hazardous substances may be combustible/ flammable in nature. The HSD characteristics proposed to be stored at the project site are given in **Table 2**

Table 2
Summary Table on the Inventories

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

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

5.3 Classification based on Inventory Rating

In order to ensure a steady supply of raw materials, process chemicals and fuels, adequate inventory of all these materials is maintained at the project site. The quantities stored and the degrees of hazard in terms of NFPA ratings are given below. The National Fire Protection Agency, USA (NFPA), on scale 0 to 4 (least to worst), hazard rating is used as a tool to assess the preliminary hazard potential of a material shown in the **Table 3**

Table 3
Properties of Fuel employed

S.No	Raw Material	N _h	N _f	N _r
1	HSD (High Speed Diesel)	1	2	0

From the above table it can be inferred that HSD falls under the category of “moderate” category of flammability index with N_f being 2.

5.4 Identification of Major Hazard Installations Based on Manufacture, Storage and Import of Hazardous Chemical (MSIHC) Rules 1989 and Amended in 2000

Following accidents in industry in India over the past few decades a specific legislation covering a major hazard activity has been enforced by Govt. of India in 1989 in conjunction with Environment Protection Act, 1986. This is referred here as MSIHC Rules 1989. For the purpose of identifying major hazard installations the rules employ certain criteria based on toxic, flammable and explosive properties of chemicals.

- Besides a list of hazardous substances with their threshold quantities are provided in Part II of Schedule I of the rules
- Schedule II of the rules sets out the threshold quantities for isolated storage units
- Schedule III gives a list of hazardous chemicals with their threshold quantities. In this schedule different chemicals are classified into distinct groups viz. Group 1 - Toxic substances, Group 2 -Toxic substances, Group 3 -Highly reactive substances, Group 4 -Explosive substances and Group 5-Flammable substances.
- Schedule IV of the rules indicate various operations which are hazardous during production, processing or treatment of organic and inorganic chemicals.

Indicative criteria for identification of toxic, flammable and explosive chemicals (MSIHC Rules 1989, Amended in 2000) is given in **Table 4**

Table 4
Indicative Criteria for Identification of Toxic, Flammable and Explosive Chemicals (MSIHC Rules 1989, Amended 2000)

a. Toxic Chemicals				
Chemicals having the following values of acute toxicity and which, owing to their physical and chemical properties, are capable of producing major accident hazards				
S. No.	Degree of Toxicity	Medium lethal dose by the oral route (oral toxicity) LD 50 (mg/Kg body weight of test animals)	Medium lethal dose by the dermal route (dermal toxicity) LD 50(mg/Kg body weight of test animals)	Medium lethal concentration by inhalation route (four hours) LC50 (mg/L inhalation in test animals)
1.	Extremely toxic	1-50	1-200	0.1-0.5
2.	Highly toxic	51-500	201-2000	0.5-2.0
b. Flammable Chemicals				
i. Flammable gases: Chemicals which in the gaseous state at normal pressure and when mixed with air become flammable and the boiling point of which at normal pressure is 20°C or below;				
ii. Highly flammable liquids: Chemicals, which have a flash point, lower than 23°C and the boiling point of which at normal pressure is above 20°C.				
iii. Flammable liquids : Chemicals which have a flash point lower than 65°C and which remain liquids under pressure, where particular processing conditions, such as high pressure and high temperature, may create major accident hazards				
c. Explosives				
Chemicals which may explode under the effect of flame, heat or photo-chemical conditions or which are more sensitive to shocks or friction than dinitrobenzene.				

Based on the indicative criteria inventory (liquids/fuels) stored in proposed site has been analyzed for applicability of MSIHC Rules 1989, amended 2000 and the results are summarized in **Table 5**

Table 5
Applicability of MSIHC Rules to Storages

S. No.	Chemical/ Fuel	Listed in Schedule	*Actual Expected Quantity	Threshold Quantity	
				for Application of Rules 5,7 – 9 and 13 - 15	for Application of Rules 10 - 12
1	HSD	3 (2(e)(iii),5 and 6(1)(a) /)	2.1 T	2500 T	20,000 T

*Expected quantity to be stored for a week

From the above table it can be inferred that HSD tanks does not (with capacity 2.1 T) attract rules 2(e)(iii), 5 and 6(1)(a) and 7-15, as the stored quantities are less than that of the stipulated threshold quantities

6 Short Listed Hazards

Based on the preliminary hazard analysis, the following scenarios are short-listed for consequence analysis to quantify the risks involved. The nature of hazards that could occur in proposed site is presented in the **Table 6** along with the sources.

Table 6
Short Listed Hazards

Nature of Hazards	Sources & Location
Fire hazards	HSD storage area, storage & handling of HSD in DG power house
Accidents due to material handling equipment	Connected with all material handling activities and equipment
Dust hazard	Storage and handling of product concentrate at production block as well in storage yard
High voltage electrical hazard	DG power house, switch yard, HT motors/ lines
Fall from height	Civil construction works, welding and other hot jobs done at height.

7 Maximum Credible Accident Analysis

Hazardous substances may be released as a result of failures or catastrophes, causing possible damage to the surrounding area. This chapter deals with the question of how the consequences of the release of such substances and the damage to the surrounding area can be determined by means of models.

A disastrous situation is generally due to outcome of fire, explosion or toxic hazards in addition to other natural causes, which eventually lead to loss of life, property and ecological imbalance.

Major hazards posed by hazardous chemical storages can be identified taking recourse to MCA Analysis. MCA analysis encompasses certain techniques to identify the hazards and calculate the consequent effects in terms of damage distances of heat radiation, toxic releases, vapor cloud explosion, etc. A host of probable or potential accidents of the major units in the complex arising due to use, storage and handling of the hazardous materials are examined to establish their credibility. Depending upon the effective hazardous attributes and their impact on the event, the maximum effect on the surrounding environment and the respective damage caused can be assessed.

Various models for calculating the physical effects of the incidental release of hazardous substances are detailed subsequently. First, attention is paid to the factors, which are decisive for the selection of the models to be used in a particular situation, after which the various effect models are discussed.

8 Injuries Resulting from Flammable Liquids

In the case of flammable liquids such as HSD for immediate ignition of a pool fire will occur. The injuries in this case are mainly caused by heat radiation. Serious injuries as the result of the shock wave generally do not occur outside the fire ball zone. Fragmentation of the storage system can cause damage up to distance of over 50m depending on the capacity of the affected storage tank. If the gas is not ignited immediately, it will disperse into the atmosphere. If the gas cloud ignites it is assumed that everyone present within the gas cloud will die as a result of burns or asphyxiation. Outside the gas cloud the duration of the thermal load will be too brief to cause any injuries. In the event of very rapid combustion of the gas cloud the shock wave may cause damage outside the limits of the cloud. Explosive combustion will only occur if the cloud is enclosed to some extent between buildings and obstacles. The mathematical models and analytical models for hazard analysis of the flammable liquids in the proposed site are as given in **Table 7**, damage criteria in **Table 8**, radiation exposure and lethality in **Table 9**

Table 7

Mathematical Models and Analytical Models for Hazard Analysis

S. No	Explosions	
1	Pool fire	Fire ball and physical over pressure models

Table 8

Damage Criteria

Heat Radiation	
Incident Flux KW/m ²	Damage
37.5	100% lethality, Heavy damage to equipment
25.0	50% lethality, non piloted ignition
12.5	1% lethality, piloted ignition
4.5	Not lethal, 1 st degree burns
1.6	No discomfort even after long exposure

Table 9

Radiation Exposure and Lethality

Radiation (KW/m ²)	Intensity	Exposure (seconds)	Time	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
8.0		60		<1	3 rd
12.0		20		<1	2 nd

Radiation (KW/m ²)	Intensity	Exposure (seconds)	Time	Lethality (%)	Degree of Burns
12.0		50		8	3 rd
12.5		--		1	--
25.0		--		50	--
37.5		--		100	--

9 Pool Fire Analysis of HSD Tanks

The detailed computations of F&EI (Fire and Explosion Index) for HSD (High Speed Diesel) at proposed site are given in **Table 10** and F&E categories are given in **Table 11**.

The Health (N_h), Flammability (N_f), Reactivity (N_r), and MF (Material Factor) for HSD fuel under consideration was derived from NFPA (National Fire Protection Association) codes. The GPH (General Process Hazard Factor) and SPH (Specific Process Hazard Factor) was calculated accordingly. Based on F & EI (Fire and Explosion Index), the HSD fall under light degree of hazard category and nil toxicity. Thus risk assessment and hazard analysis has been carried out due to fire hazard for HSD storage tanks by carrying out MCA (Maximum Credible Accident) analysis.

Table 10
F&EI of Fuels Used for the Proposed Industrial Park

Chemical/Fuel	NFPA Classification				GPH	SPH	*F&EI	F&E Category
	N _h	N _f	N _r	MF				
HSD	1	2	0	10	1.8	2.83	50.89	Light

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

The F&EI values are ranked into following categories

Table 11
F&E Category

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

9.1 Damage distance computations for MCA (Maximum Credible Accident) analysis

The major hazard scenarios identified for the possibility of occurrence are mainly concerned with HSD Storage tanks.

The maximum capacity of the storage of HSD will be 1×2500 L. The most credible failure is the rupture of the largest pipe connecting to the storage tank. As worst case, it is assumed that if 2.5 KL of HSD is leaked and the entire contents leak out into the dyke forming a pool, which may catch fire on finding a source of ignition.

A perusal of the above table clearly indicates that 37.5 KW/m² (100%) lethality occurs within the radius of the pool which is computed at 14 m tank on pool fire. This vulnerable zone will damage all fuel storage equipment falling within the pool radius.

Similarly the threshold limit for first degree burns is 1.6 KW/m², this vulnerable zone in which the thermal fluxes above the threshold limit for first degree is restricted to 88m in case fuel storage area catches pool fire.

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

9.2 Pool Fire of HSD Storage Tanks

A storage tank of HSD with a capacity of 2500 liters is considered for the proposed industrial park. Tank fire would occur if the radiation intensity is high on the peripheral surface of tanks leading to increase in internal tank pressure. Pool fire would occur when fuel oil collected in the dyke due to leakage gets ignited. As the tanks are provided within the dyke the fire will be confined within the dyke wall.

SITE DATA:

Location: Gollapuram, INDIA

Building Air Exchanges Per Hour: 0.50 (sheltered single storied)

Time: March 08, 2016 1501 hours ST (user specified)

Chemical Data:

Chemical Name: High Speed Diesel

Molecular Weight: 114.23 g/mol

Ambient Boiling Point: 215 - 376° C

Atmospheric Data: (Manual Input of Data)

Wind: 2.4 meters/second from E at 10 meters

Ground Roughness: open country Cloud Cover: 3 tenths

Air Temperature: 30° C

Stability Class: D (user override)

No Inversion Height

Relative Humidity: 70%

Source Strength:

Burning Puddle / Pool Fire

Puddle Diameter: 15 meters

Puddle Volume: 2500 liters

Initial Puddle Temperature: Air temperature

Flame Length: 27 meters

Burn Duration: 2 minutes

Burn Rate: 910 kilograms/min

Total Amount Burned: 1746 kilograms

Threat zone:

Threat Modeled: Thermal radiation from pool fire

Red : 14 meters --- (37.5 kW/(sq m))

Red : 19 meters --- (25 kW/(sq m))

Orange: 30 meters --- (12.5 kW/(sq m))

Orange: 53 meters --- (4.5 kW/(sq m))

Yellow: 88 meters --- (1.6 kW/(sq m))

10 Disaster Management Plan (DMP)

A Disaster is called when following one or the other or more incidents occur:

- i) Risk of loss of human lives-ten or more in one single situation
- ii) A situation which goes beyond the control of available resource of the industrial park
- iii) Loss of property as a consequence of the incident is over Rs. 1 Crore and/or bears a potential to the above
- iv) A situation apparently may not have much loss but its long-term severity can affect loss of life, production and property.

Disasters occur due to:

i). Emergencies on account of:

- Fire
- Explosion
- Spillage of toxic chemicals
- Electrocutation

ii) Natural calamity on account of:

- Flood
- Earth quake / Cyclone / Storm / Cloud burst / Lightning

iii). External factor on account of

- Food poisoning
- Sabotage

The objective of the study is to assess the likely hazards and risk associated with process and preparation of preliminary Disaster Management Plan (DMP). These guidelines would be in addition to the guidelines issued by the NDMA which are available at <http://ndma.gov.in/ndma/guidelines.html>. The main objectives of DMP are:-

- To control and contain the incident/accident and if possible, eliminate it
- To minimize the effects of the incident on persons, property and environment

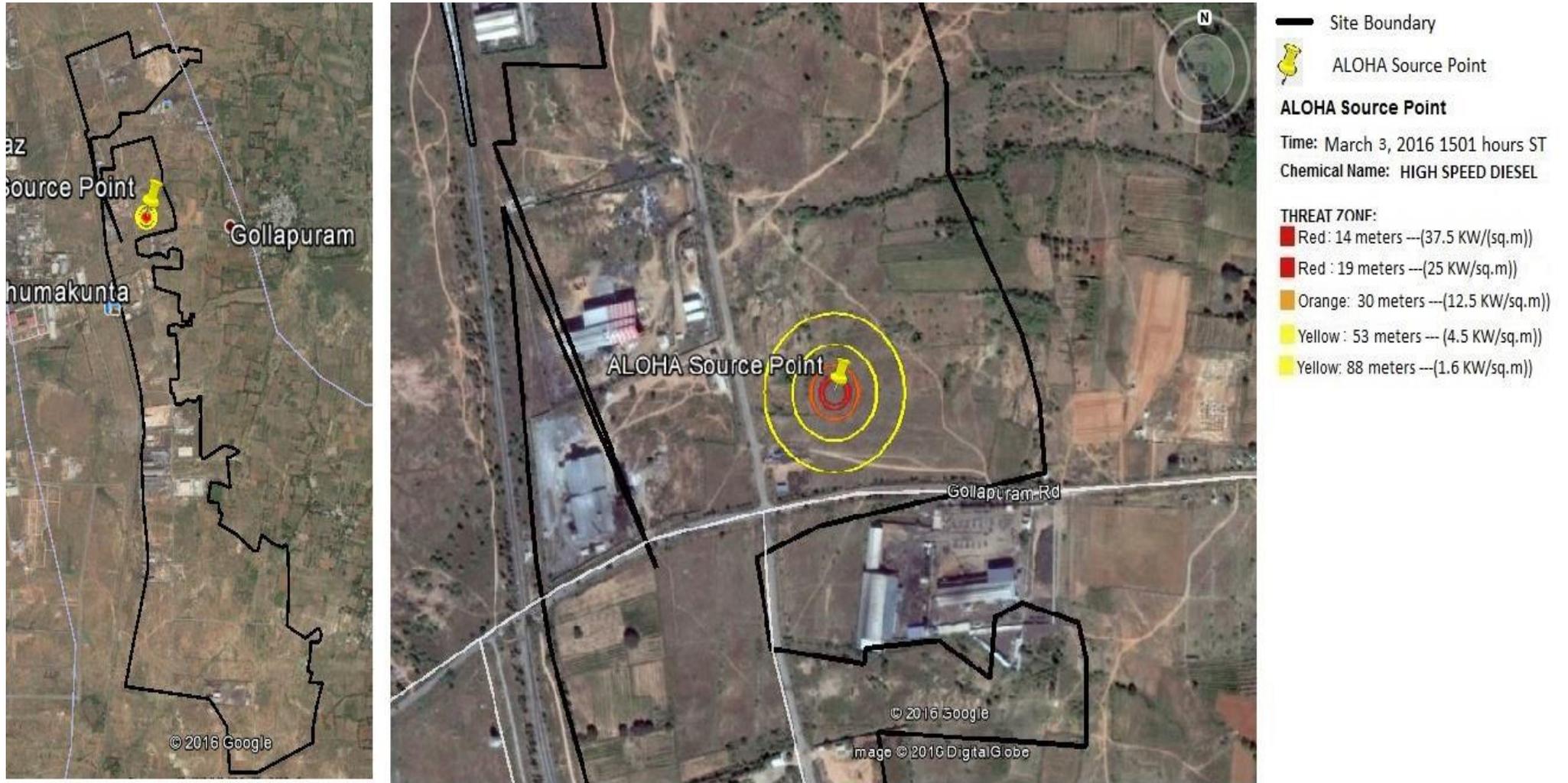
On-site Disaster

If an accident/incident takes place within the industrial park and its effects are confined to the premises, involving only the persons working in the industrial park and the property inside the industrial park, it is called as on-site disaster.

Off-site Disaster

If the accident is such that its affects inside the industrial park are uncontrollable and it may spread outside the premises, it is called as off-site disaster.

Figure 1
ALOHA Source Point on the Layout



10.1 On-Site Disaster Management Plan

Main elements of On-site Emergency plans

- Leadership and administration.
- Role and responsibilities of key personnel.
- Emergency action.
- Light and power.
- Source of energy control.
- Protective and rescue equipment.
- Communication.
- Medical care.
- Public relation.
- Protection of vital records.
- Training.
- Periodical revision of plan.

Action Plan for On-Site Disaster Management Plan

- Designated control centre/room
- Key personnel

10.1.1 Control Centre

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 centre are:-

- i. Internal and external communication.
- ii. Computer and other essential records.
- iii. Daily attendance of workers employed.
- iv. Storage of hazardous material records and manufacturing records.
- v. Pollution records.
- vi. Walky-talky.
- vii. Plan of the industrial park showing:-
 - a. Storage area of hazardous materials.
 - b. Storage of safety equipments.
 - c. Firefighting system and additional source of water.
 - d. Site entrance, roadway and emergency exist.
 - e. Assembly points.
 - f. Truck parking area.
 - g. Surrounding location.
- viii. Note Book, pad and pencil.
- ix. List of key personnel with addresses, telephone number etc.

10.1.2 Fire Prevention Facilities

The unit will be provided with appropriate firefighting equipment including pumps for emergency requirement. Any one or combination of the following system is proposed.

- Hydrant system
- High velocity and medium velocity sprinkler system.
- Water spray
- Foam system.
- Chemical extinguishers.

Applicable codes and standards of National Fire Prevention Association (NFPA), USA, would also be followed.

10.1.3 Assembly Points

A safe place should be pre-determined as assembly point where in case of emergency personnel evacuated from the affected areas are to be assembled. The workers, contract workers and visitors should assemble in assembly point in case of emergency and the time office clerk should take their attendance so as to assess the missing persons during emergency.

10.1.4 The Key Personnel for onsite emergency

1. Works main controller.
2. Works incident controller.
3. Other key officers
 - a. Communication officer
 - b. Security and fire officer
 - c. Telephone operators
 - d. Medical officer
 - e. Personnel/administrative officer
 - f. Essential work team leaders

1. Works Main Controller

The general manager of the site should act as main controller. His duties are to:-

- i. Assess the magnitude of the situation and decide whether the evacuation of staff from the industrial park is needed.
- ii. Exercise and direct operational control over areas other than those affected.
- iii. Maintain a continuous review of possible development and assess in consultation with work incident controller and other key personnel.
- iv. Liaison with police, fire service, medical services, factory inspectorate and other Govt. agencies.
- v. Direct and control rehabilitation of affected area after emergency.
- vi. Intimate off-site emergency controller if the emergency spreads beyond the factory premises and likely to affect the surrounding area.
- vii. Ensure that evidence is preserved for enquiries to be conducted by statutory authorities.

The works main controller will declare the emergency and he will instruct gate office to operate the emergency siren after assessing the gravity of the situation.

2. Work Incident Controller (WIC)

He is the next responsible officer after the works main controller. Generally the supervisor is designated as work incident controller. In case of emergency he will rush to the place of occurrence and take overall charge and report to the works main controller by personnel communication system like cell phones or walky-talky and inform about the magnitude of emergency. He will assess the situation and considering the magnitude of emergency he will take decision and inform communication officer to communicate the news of emergency to different agencies. He will give direction to stop all operations within the affected area. He will take the charge of main controller till the main controller arrives. He will order for shutdown and evacuation of workers and staffs from affected area. He will inform all key personnel and all outside agency for help. He will inform security and fire officers and state fire services. He will ensure that all non-essential workers/staff are evacuated to assembly point and areas searched for casualties. He will report all significant development to communication officer. Moreover he will advise to preserve evidence of emergency into the cause of emergency.

3. Other Key Personnel and their duties

a. Communication Officer. On hearing the emergency siren/alarm he will proceed to the control center and communicate to work incident controller. He will collect information from the emergency affected area and send correct message to work main controller for declaration of emergency. He will maintain a log book of incident. He will contact all essential departments. He will take stock of the meteorological condition from local meteorological department. He will communicate all information as directed by works main controller.

b. Security and Fire Officer. The security or fire officer will be responsible for the firefighting. On hearing the emergency alarm/siren, he will reach the incident area with fire and security staff. Immediately after arrival to the emergency area, he will inform through telephone or walky-talky to the communication officer. He will inform to the work incident controller about the situation and requirement of outside help like state fire service and other members. At the site, the entire fire squad member will respond to the advice and information given by the works incident controller. The security will control the visitors and the vehicle entry.

c. Telephone Operator. In case of fire is discovered but no emergency siren is operated, he shall ensure the information about the location of the fire/emergency incident from the persons discovered/notices the above and communicate to different key personnel immediately with clear message.

d. Medical Officer. Medical Officer with his team will report to the works incident controller on hearing the fire/emergency siren immediately. The ambulance will be parked nearest to the site of incident. Name of injured and other casualties carried to the

hospital will be recorded and handed over to works incident controller. The ambulance will carry the injured to the nearest hospital for treatment.

e. Personnel/Administrative Officer. He should work as a liaison officer liaising with works main controller and other essential departments such as police, press and statutory authorities. His responsibilities shall include:-

- To ensure that casualties receive adequate attention to arrange additional help if required and inform relatives.
- To control traffic movement into the factory and ensure that alternative transport is available when needed.
- When emergency is prolonged, arrange for the relief of personnel and organize refreshment and catering facilities.
- Arrange for finance for the expenditure to handle the emergency.

10.1.4.1 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 IP.

10.1.4.2 Communication System

Communication is a key component to control an emergency. The following communication system may be provided in the IP

- Walky-Talky.
- Telephone (internal & external).
- Cell phone.
- Intercom/paging.
- Runners (verbal or written messages).

10.1.4.3 Siren for Emergency

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

10.1.4.4 Escape Route

The escape route from each and every plant of the industrial park 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.

10.1.4.5 Evacuation

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 industrial park 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.

10.1.4.6 Counting of Personnel

All personnel working in the industrial park should be counted. Time office persons should collect the details of personnel arriving at the assembly point. These should be checked with the attendances of regular workers, contract workers present in the site on the day of emergency. The accident control should be informed and arrangement should be made for searching missing persons in the emergency affected area. The employees' address, contact number of next to kin should be maintained in the time office so that during emergency relatives of those affected due to emergency may be informed accordingly. Information in respect of emergency should be given to the media and other agency.

10.1.4.7 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".

10.1.4.8 Emergency facilities

The following facilities should be provided to tackle any emergency at any time.

- Fire protection and firefighting facilities
- Emergency lighting and standby power
- Emergency equipment and rescue equipment
- Breathing apparatus with compressed air cylinder
- Fire proximity suit
- Resuscitator
- Water gel Blanket
- Low temperature suit
- First aid kit
- Stretchers
- Torches
- Ladders
- Safety Equipment
 - a. Respirators
 - b. Gum boots
 - c. Safety helmets
 - d. Asbestos rubber hand gloves
 - e. Goggles and face shield

- f. Toxic gas measuring instruments
- g. Explosive meter
- h. Oxygen measuring instruments
- i. Toxic gas measuring instrument
- j. Wind direction indicator

10.1.4.9 On-site Emergency Plan should contain

1. Site plan and topographic plan
2. Plan showing the firefighting facilities
3. Plan showing hazardous material storage area
4. Material safety data sheets for hazardous chemicals
5. Facilities available in main control center
6. List of emergency equipment
7. List of Safety Equipment
8. List of important telephone numbers and addresses
 - i. Nearest hospitals and ambulance service center
 - ii. Nearest fire station
 - iii. Govt. Officials
 - iv. Transport provider
9. Names and address & contact telephone number of key personnel

The on-site emergency plan so prepared shall be documented in a printed form in sufficient copies to give all concerned for knowledge, study and easy follow up. The emergency plan shall be rehearsed and practiced at regular intervals to test efficiency of personnel, equipment coordinated efforts and to increase confidence and experience to operate such plan. The plan so prepared should be updated annually and uploaded in the factory website for easy reference.

10.2 Off-site Disaster Management Plan

The main objectives of the off-site emergency plan are:-

- i. To save lives and injuries
- ii. To prevent or reduce property losses and
- iii. To provide for quick resumption of normal situation or operation.

Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996 prescribes for the constitution of the state crisis group as apex body at the State Level to deal with major chemical accidents and to provide expert guidance for handling major chemical accidents. Schedule 7 and Schedule 8 of the chemical accidents (Emergency Planning, Preparedness and Response) Rules, 1996 prescribes for the constitution of district and local crisis groups.

The composition of the district crisis group has been prescribed under the chairpersonship of district collector and local crisis group under the chairpersonship of sub-divisional magistrate. The district crisis group shall meet every forty five days and send a report to the state crisis group. The local crisis group shall meet every month and forward a copy of the proceedings to the district crisis group.

A. Functions of the State Crisis Group

- i) Review all district off-site emergency plans in the State with a view to examine its adequacy in accordance with the manufacture, storage and import of hazardous chemical, rules and forward a report to the central crisis group once in three months
- ii) Assist the state government in managing chemical accidents at a site
- iii) Assist the state government in the planning, preparedness and mitigation of major chemical accidents at a site in the State
- iv) Continuously monitor the post-accident situation arising out of a major chemical accident in the State and forward a report to the central crisis group
- v) Review the progress report submitted by the district crisis group
- vi) Respond to queries addressed to it by the district crisis group
- vii) Publish a list of experts and officials in the State who are concerned with the management of chemical accidents.

B. Functions of the District Crisis Group

- i. Assist the preparation of the district off-site emergency plan
- ii. Review all the on-site emergency plans prepared by the occupier of major accident hazards installation for the preparation of the district off-site emergency plan
- iii. Assist the district administration in the management of chemical accidents at a site lying within the district
- iv. Continuously monitor every chemical accident
- v. Ensure continuous information flow from the district to the centre and state crisis group regarding accident situation and mitigation efforts
- vi. Forward a report of the chemical accident within fifteen days to the state crisis group
- vii. Conduct at least one full scale mock-drill of a chemical accident at a site each year and forward a report of the strength and the weakness of the plan to the state crisis group.

C) Functions of the Local Crisis Group

- a) Prepare local emergency plan for the industrial pocket
- b) Ensure dovetailing of local emergency plan with the district off-site emergency plan
- c) Train personnel involved in chemical accident management
- d) Educate the population likely to be affected in a chemical accident about the remedies and existing preparedness in the area
- e) Conduct at least one full scale mock-drill of a chemical accident at a site every six months and forward a report to the district crisis group and
- f) Respond to all public inquiries on the subject.

Central Control Committee

As the offsite plan is to be prepared by the government, a central control committee shall be formed under the chairmanship of the district collector. Other officers from police, fire service, factory inspectorate, medical department shall be incorporated as members of the central control committee. Under the central control committee the following committees shall be constituted under the control of the district collector.

- i. Incident and environment control committee
- ii. Fire control committee
- iii. Traffic control, law and order, evacuation and rehabilitation committee
- iv. Medical help, Ambulance and Hospital Committee
- v. Welfare, restoration and resumption committee
- vi. Utility and engineering services committee
- vii. Press, publicity and public relations committee

The off-site emergency plan shall be prepared by the district magistrate in consultation with the factory management and Govt. agencies. The plan contains up-to-date details of outside emergency services and resources such as fire services, hospitals, police etc. with telephone number. The district authorities are to be included in the plan area.

- a. Police department
- b. Revenue department
- c. Fire brigade
- d. Medical department
- e. Municipality
- f. Gram panchayat
- g. Railway department
- h. Telephone department
- i. Factory department
- j. Electricity department
- k. Pollution control department
- l. Explosive department
- m. Press and media

Mock exercises on off-site plan should be carried out at least once in a year to train the employees, up to date the plan, observe and rectify deficiencies.

Each industrial unit or group of units should prepare separate emergency preparedness and DMP which will be in sync with the main DMP of industrial park incorporating details of action to be taken in case of any major accident/disaster occurring within the unit. The plan should cover all types of major accident/occurrences and identify the risk involved in the industry. Mock drills on the plan should be carried out periodically to make the plan foolproof and persons are made fully prepared to fight against any incident in the industry. The plan will vary according to the type of industry and emergency.

11 Disaster Management & Emergency Preparedness for Natural disasters

11.1 Introduction

The natural disasters include cyclones, floods, earthquakes, volcanic eruptions, famines, drought, landslides etc. Amongst all the ones mentioned floods and earthquakes are the most common in India. India is no exception as it has been traditionally vulnerable to natural disasters on account of its unique geo-climatic conditions.

Natural disasters can neither be predicted nor prevented. The problem before us is how to cope with them, minimizing their impact. Increase in urban population coupled with the construction of man-made structures often poorly built and maintained subject cities to greater levels of risk to life and property in the event of earthquakes and other natural hazards. One of the main objectives is to reduce the risk of loss of human life and property and to reduce costs to the society. We have to recognize that in such cases of natural disasters, we deal with phenomena of enormous magnitude that cannot be controlled by any direct means of human intervention. But what we try to do is to reduce the impact on human beings and property.

Andhra Pradesh is most vulnerable to cyclones, heavy rains, and floods including drought due to its widespread and peculiar geographic location. The state's vast coastline is 1030 km and second largest in the country. Andhra Pradesh has the longest coast line on the eastern coast of India. The rainfall in the state is influenced by both south west, and north-east monsoons. The annual normal rainfall of Andhra Pradesh is 940 mm. Andhra Pradesh is exposed to cyclones, storm surges, floods and droughts. Every two to three years, Andhra Pradesh experiences a moderate to severe intensity cyclone or landfall.

11.2 Major Disaster profile

The pattern of drought in the state is of a varied one, sometimes affecting the entire state, sometimes a few regions, and sometimes a few districts.

❖ Drought

Drought is one of the most crippling hazards that impact the state. AP is the third most drought prone State. AP has 8 chronically drought prone districts. Anantapur, YSR Kadapa, Chittoor, Nalgonda, Kurnool, Prakasam.

❖ Vulnerability to Floods & Cyclones

- The entire coast of AP is vulnerable to cyclones, nine coastal districts are most vulnerable.
- More than 103 cyclones have affected Andhra Pradesh this century.
- Severe cyclones occur every two to three years.
- In 2015, 44% of AP's total area- vulnerable to tropical storms and coastal belt is most vulnerable.

❖ **Earthquakes**

According to seismic zoning of India, the country is divided into five seismic zones based on severity. ANDHRA PRADESH lies in three zones –Zone II, Zone III. Anantapur district is in zone II (moderate risk zone).

11.3 Disaster Management & Emergency Preparedness for Natural disasters

As per Disaster Management Act, 2005, “disaster management” means a continuous and integrated process of planning, organizing, coordinating and implementing measures which are necessary or expedient for:

- (i) Prevention of danger or threat of any disaster
- (ii) Mitigation or reduction of risk of any disaster or its severity or consequences
- (iii) Capacity-building
- (iv) Preparedness to deal with any disaster
- (v) Prompt response to any threatening disaster situation or disaster
- (vi) Assessing the severity or magnitude of effects of any disaster, evacuation, rescue and relief
- (vii) Rehabilitation and reconstruction

Disaster Management can be defined as the organization and management of resources and responsibilities for dealing with all humanitarian aspects of emergencies, in particular preparedness, response and recovery in order to lessen the impact of disasters.

Disaster management involves all levels of government. Nongovernmental and community based organizations play a vital role in the process. Modern disaster management goes beyond post-disaster assistance. It now includes pre-disaster planning and preparedness activities, organizational planning, training, information management, public relations and many other fields. Crisis management is important, but is only a part of the responsibility of a disaster manager. The newer paradigm is the Total Risk Management (TRM) which takes a holistic approach to risk reduction

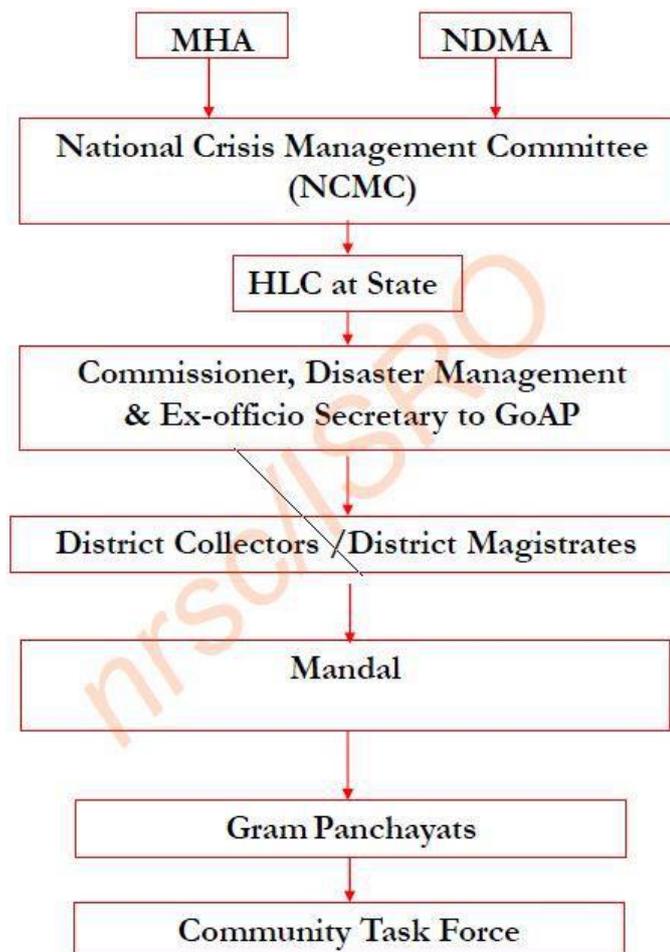
The traditional approach to disaster management has been to regard it as a number of phased sequences of action or a continuum. These can be represented as a disaster management cycle. The basic disaster management cycle context of six main activities.

Disaster management cycle is given as **Figure 2** and disaster management mechanism in Andhra Pradesh is given as **Figure 3**

Figure 2
Disaster Management Cycle



Figure 3
Disaster Management Mechanism in Andhra Pradesh



Phases of Disaster Management

There are three key phases of activity within disaster management:

1. **Pre – Disaster:** Before a disaster to reduce the potential for human, material or environmental losses caused by hazards and to ensure that these losses are minimized when the disaster actually strikes.
2. **During Disaster:** It is to ensure that the needs and provisions of victims are met to alleviate and minimize suffering.
3. **Post Disaster:** After a disaster to achieve rapid and durable recovery which does not reproduce the original vulnerable conditions traditionally people think of disaster management only in term of the emergency relief period and post disaster rehabilitation. Instead of allocated funds before an event to ensure prevention and preparedness. A successful disaster management planning must encompass the situation that occurs before, during and after disasters.

Pre – Disaster Phase Prevention and Mitigation reducing the risk of disasters involves activities, which either reduce or modify the scale and intensity of the threat faced or by improving the conditions of elements at risk. Although the term “prevention” is often used to embrace the wide diversity of measures to protect persons and property its use is not recommended since it is misleading in its implicit suggestion that natural disasters are preventable. The use of the term reduction to describe protective or preventive actions that lessen the scale of impact is therefore preferred. Mitigation embraces all measures taken to reduce both the effects of the hazard itself and the vulnerable conditions to it in order to reduce the scale of a future disaster. In addition to these physical measures, mitigation should also be aimed at reducing the physical, economic and social vulnerability to threats and the underlying causes for this vulnerability. Therefore, mitigation may incorporate addressing issues such as land ownership, tenancy rights, wealth distribution, implementation of earthquake resistant building codes, etc.

Preparedness: This brings us to the all-important issue of disaster preparedness. The process embraces measures that enable governments, communities and individuals to respond rapidly to disaster situations to cope with them effectively. Preparedness includes for example, the formulation of viable emergency plans, the development of warning systems, the maintenance of inventories, public awareness and education and the training of personnel. It may also embrace search and rescue measures as well as evacuation plans for areas that may be “at risk” from a recurring disaster. All preparedness planning needs to be supported by appropriate rules and regulations with clear allocation of responsibilities and budgetary provision. Early warning, this is the process of monitoring the situation in communities or areas known to be vulnerable to slow onset hazards, and passing the knowledge of the pending hazard to people in harm’s way. To be effective, warnings must be related to mass education and training of the population who know what actions they must take when warned.

The Disaster impact: This refers to the “real-time event of a hazard occurring and affecting elements at risk. The duration of the event will depend on the type of threat; ground shaking may only occur in a matter of seconds during an earthquake while flooding may take place over a longer sustained period. During disaster phase response This refers to the first stage response to any calamity, which include for examples such as setting up control rooms, putting the contingency plan in action, issue warning, action for evacuation, taking people to safer areas, rendering medical aid to the needy etc., simultaneously rendering relief to the homeless, food, drinking water, clothing etc. to the needy, restoration of communication, disbursement of assistance in cash or kind. The emergency relief activities undertaken during and immediately following a disaster, which includes immediate relief, rescue, and the damage needs assessment and debris clearance.

The Post- disaster Phase Recovery: Recovery is used to describe the activities that encompass the three overlapping phases of emergency relief, rehabilitation and reconstruction.

Rehabilitation: Rehabilitation includes the provision of temporary public utilities and housing as interim measures to assist long-term recovery.

Reconstruction: Reconstruction attempts to return communities to improved pre-disaster functioning. It includes such as the replacement of buildings; infrastructure and lifeline facilities so that long-term development prospects are enhanced rather than reproducing the same conditions, which made an area or population vulnerable in the first place.

Development: In an evolving economy, the development process is an ongoing activity. Long term prevention/disaster reduction measures for examples like construction of embankments against flooding, irrigation facilities as drought proofing measures, increasing plant cover to reduce the occurrences of landslides, land use planning, construction of houses capable of withstanding the onslaught of heavy rain/wind speed and shocks of earthquakes are some of the activities that can be taken up as part of the development plan.

12 Occupational Health and safety

12.1 Introduction

Maintaining a high degree of physical, mental and social wellbeing of employees ensures high productivity and overall sustainability of the proposed project.

12.2 Occupational Health

There would be first aid stations and an industrial health laboratory 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 health education program includes the topics like occupational health, noise hazards, exposure to toxic chemicals and heavy metals, cardiac risks reduction, life style management, wellness management, stress management, ergonomics, early diagnosis & treatment, burn safety & eye care, gas & heat hazards, occupational lung diseases, physical fitness, nutrition etc. The occupational health hazards with permissible limits and mitigation is presented in **Table 12**. The action plan for implementation of OHS standard is presented in **Table 13**

Table 12

Occupational Health Hazards with Permissible Limits and Mitigation

S. No	Occupational & Safety Hazards	Permissible Exposure Level (PEL)	Measures 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 & 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, fibre handles
4	Kerosene	Recommended Exposure Limit (REL) : 100 mg/m ³ TWA PEL : None	Ansel nitrile chemical resistant gloves, chemical resistance gloves, 3M Disposable respirators
5	LDO/HSD	Threshold Limit Value (TLV) : 800 ppm, TWA (vapors/ aerosol)	Proper ventilation, use of PVC gloves, safety glasses, air purifying respirators for uncontrolled release
6	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.
7	Excavation	1.5 m depth	Gum boot, ramp, shoring, benching etc. Proper IITS implemented. SOP & standards implemented.
8	Scaffolding	2 m above ground level	Railings in access, work platform, hand rail, mid rail, toa guard. System scaffold standard implemented
9	Welding/ Gas- Cutting	-	Apron, leather hand gloves, face-shield, black goggles, SOP implemented
10	Manual 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 13

Action Plan for Implementation of OHS Standard

S. No	Type of Possible Health Hazards	Preventive Action Plan
1	Fall from Height	<ul style="list-style-type: none"> All workers working at height to be examined specially for vertigo & certified. Workers to be supplied with personal protective equipment (PPE) like belt, harness, helmet, gloves use has been ensured
2	Slip, Trip or Fall on the Level	All workers to use non slip safety shoes
3	Injury Caused by Falling Objects	Use of helmet by all workers
4	Exposure to Extreme Temp.	In summer working hours to be rescheduled as per government guideline
5	Electrical Injury	<ul style="list-style-type: none"> Positive isolation. Barricading installation. Use of PPE, like gloves, shoes, helmet, goggles
6	Eye Injury	<ul style="list-style-type: none"> Use of goggles. Supply of water tab at strategic locations. Providing first aid available within 10 minutes ambulance service for major injury
7	Risk of Road Traffic Accident	<ul style="list-style-type: none"> Entry of only authorized vehicle. Speed limit regulation and display of speed limit area. Mandatory use of seat belt. Regular maintenance of road.
8	Noise Pollution	Use of noise mask/ ear plugs at high decibel sound area
9	Exposure to Work Zone Dust	<ul style="list-style-type: none"> Water sprinkling on services roads. Use of mask. Vacuum cleaning of shop floors. Prevention of leakage from furnaces, conveying systems, DE/ FE systems and routine preventive maintenance
10	Exposure to Cement (During Construction)	Use of nose mask, gloves and shoes by all workers
11	Exposure to Hazardous Chemicals	<ul style="list-style-type: none"> Storage of chemicals in confined area as per regulations. To be handled by authorized persons only. Use of PPE
12	Periodic Health Check Up	<ul style="list-style-type: none"> Pre-employment health check-up. Health check up every 2 years
13	First Aid Back Up	<ul style="list-style-type: none"> One first-aid centre to run in the factory premises. Ambulance service to be available round the clock