# Risk Assessment

## 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 multi-product SEZ/Industrial Park at Gopalpur area generally has problems related to occupational health and safety. Hence management proposes to take steps to minimize the impacts from the proposed development of industrial parkto 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 employees 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 cause the following to be completed:

a. 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.

b. 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.
c. Prepare a report of the incident with all necessary information. The reports should be prepared to reflect the seriousness of the incident.
d. Fill appropriate forms for future use.
e. If individual department procedures include all of the information required by this policy, that document can be utilized to fulfill these requirements.
f. This policy is in addition to a worker's 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 ofinstitutional 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 Parkpremises 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 industriesis due to noise hearing losses. The personal protective equipment will be given to all the workers.

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

- Industrial 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 glovesand
- 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 theproposed SEZ/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 hazardous.
- 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, equipment, 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 SEZ/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 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 plant.
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
- Electrocution

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 National Disaster Management Authority (NDMA) which are available athttp://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 proposed project site and its effects are confined to the premises, involving only the persons working in the proposed project siteand the property inside the proposed project site, it is called as on-site disaster.

**Off - siteDisaster**

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

- **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 center/room

- Key personnel

a) **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 plant showing:-
   a. Storage area of hazardous materials.
   b. Storage of safety equipment.
   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.

**b) Fire Prevention Facilities**

The unit will be provided with appropriate firefighting equipment including pumps for emergency requirement in the power plant. Any one or combination of the following system will protect all yards and plant.

- Hydrant system
- High velocity and medium velocity sprinkler system.
- Water spray (emulsifier System)
- Foam system.
- Chemical extinguishers.

The system will be designed as per the recommendations of Tariff Advisory Committee of Insurance Association of India. Applicable codes and Standards of National Fire Prevention Association (NFPA), USA, would also be followed.

- **Hydrant System**

A ring header, hydrants and hose stations will provide general plant protection.

- **Transformer Protection**

High velocity water spray system is proposed for the generator transformers and station transformers. Water supply for this system will be tapped off from dedicated high velocity sprinkler system with separate pumps.

- **Fuel Protection System**

The fuel unloading area, DM plant area, cooling tower area, STG area and boiler area will be protected from fire hazard through fire hydrant system. Two nos. of firewater pumps are envisaged, which will be installed in the pump house. One centrifugal pump driven by electrical motor is provided for high velocity sprinkler system. One jockey pump along with hydropneumatic tank will also be installed to maintain pressure in the fire hydrant lines. In addition to above, adequate number of portable fire extinguishers will be installed at strategic locations throughout the plant.

- **Fire Alarm System**

A fire alarm system would provide visual and audible alarms in power plant for fire detection at the incipient stage. The system would comprise manual call points located at strategic locations in areas which are normally manned, and automatic smoke & heat detectors located at important points such as cable vaults, control rooms, switchgear rooms etc. to detect fire at an early stage and provide visual and audible alarm.

c) **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.

### 3.1 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 plant 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 plant 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 fire fighting. 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 liaisoning 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.

**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 IA.

**Communication System**

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

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

**Siren for Emergency**

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

**Escape Route**

The escape route from each and every plant 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.

**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 SEZ/IP 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.

**Counting of Personnel**

All personnel working in the SEZ/IP 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.

**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”.

**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

**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.

### 3.2 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 Groups.
vi) Respond to queries addressed to it by the District Crisis Groups.
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.

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 parkincorporating 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.

### 3.3 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 for theProposed SEZ/IndustrialPark**

| S.No. | Name of Hazardous Materials & Location | Nature of Hazard | No. of Storage Units | Capacity of storage (kilo liters) |
|---|---|---|---|---|
| 1 | HSD (High Speed Diesel) Stored at Utilities Department | Fire & Explosion | 2 No | 50 (40 MT) |

## 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 Nf being 2.

### 5.4 Identification of Major Hazard Installations Based on manufacture, storage and import of hazardous chemical (MSIHC) Rules 1989 and the Amended Rules 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 and amendments. 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) is given in **Table 4**

**Table 4**

**Indicative Criteria for Identification of Toxic, Flammable and Explosive Chemicals (MSIHC Rules 1989 and amended in 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$^{o}$C or below; | | | |
| ii. | Highly flammable liquids: Chemicals, which have a flash point, lower than 23$^{o}$C and the boiling point of which at normal pressure is above 20$^{o}$C. | | | |
| iii. | Flammable liquids :Chemicals which have a flash point lower than 65$^{0}$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 1989and 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) /) | 560MT | 2500 MT | 20,000 MT |

*Expected Quantity to be Stored for a week

From the above table it can be inferred that HSD tanks does not (with capacity less than36MT ) 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 |
| Explosion Hazard | HSD |
| Fire / explosions due to leakage | Spillage / transfer of HSD cause explosion due to leakage |
| 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 | | Explosions | | Toxic Gas Dispersion |
|---|---|---|---|---|
| **Incident Flux $kW/m^2$** | **Damage** | **Peak overpressure (bar)** | **Damage** | |
| 37.5 | 100% lethality, Heavy damage to equipment | 0.3 | Heavy - 90% | The extent of damage depends upon the concentration of the toxic compound in the atmosphere. The relation between percent of injuries and the toxic load is normally given in the form of probity function. |
| 25.0 | 50% lethality, non piloted ignition | 0.03 | Damage of glass | |
| 12.5 | 1% lethality, piloted ignition | 0.01 | Crack of windows | |
| 4.5 | Not lethal, $1^{st}$ degree burns | | | |
| 1.6 | No discomfort even after long exposure | | | |

**Table 9**

**Radiation Exposure and Lethality**

| 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 |
| 8.0 | 60 | <1 | 3 rd |
| 12.0 | 20 | <1 | 2 nd |
| 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 FEI (Fire and Explosion Index) for HSD (High Speed Diesel) at proposed site are given in **Table 10**

The Health ($N_h$), Flammability ($N_f$), Reactivity (Nr), 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 SEZ/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&EI 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 2×50 kl. The most credible failure is the rupture of the largest pipe connecting to the storage tank. As worst case, it is assumed that if 50 kl 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/$m^2$(100% lethality occurs within the radius of the pool which is computed at 13 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/$m^2$, this vulnerable zone in which the thermal fluxes above the threshold limit for first degree is restricted to 86m in case fuel storage area catches pool fire. The risk contours are given below in **Figure 1 & 2**

### 9.2 Pool Fire of HSD Storage Tanks

A storage tank of HSD with a capacity of 50kl is considered for the proposed SEZ/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: Gopalpur, INDIA
Building air exchanges per hour: 0.50 (sheltered single storied)
Time: November 09, 2015 1705 hours ST (user specified)

CHEMICAL DATA:

Chemical Name: High Speed Diesel Molecular Weight: 114.23 g/mol
PAC-1: 300 ppm PAC-2: 385 ppm PAC-3: 5000 ppm
IDLH: 1000 ppm LEL: 9600 ppm UEL: 65000 ppm
Ambient Boiling Point: 125.7° C
Vapor Pressure at Ambient Temperature: 0.027 atm
Ambient Saturation Concentration: 27,090 ppm or 2.71%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 2.83 meters/second from S at 10 meters
Ground Roughness: open country Cloud Cover: 3 tenths
Air Temperature: 32° C
Stability Class: D (user override)
No Inversion Height Relative Humidity: 90%

SOURCE STRENGTH:

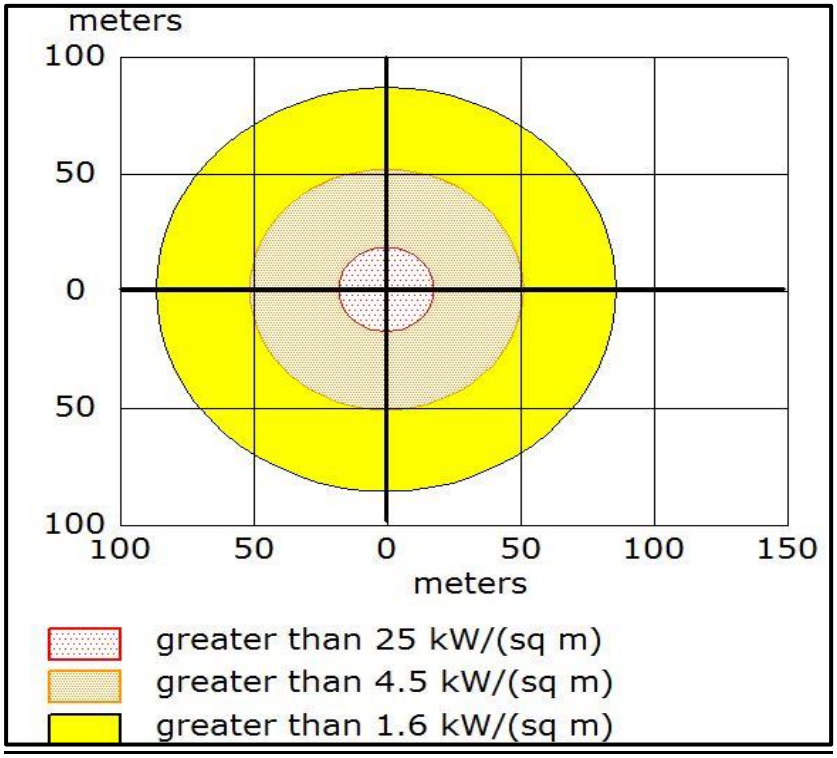
Burning Puddle / Pool Fire
Puddle Diameter: 15 meters Puddle Volume: 50000 liters
Initial Puddle Temperature: Air temperature
Flame Length: 27 meters Burn Duration: 38 minutes
Burn Rate: 917 kilograms/min
Total Amount Burned: 34,847 kilograms

THREAT ZONE:

Threat Modeled: Thermal radiation from pool fire
Red : 13 meters --- (37.5 kW/ (sqm))
Red : 18 meters --- (25 kW/ (sqm))
Orange: 29 meters --- (12.5 kW/ (sqm))
Orange: 51 meters --- (4.5 kW/ (sqm))
Yellow: 86 meters --- (1.6 kW/ (sqm))

**Figure 1**

**Thermal Radiation Threat Zone**



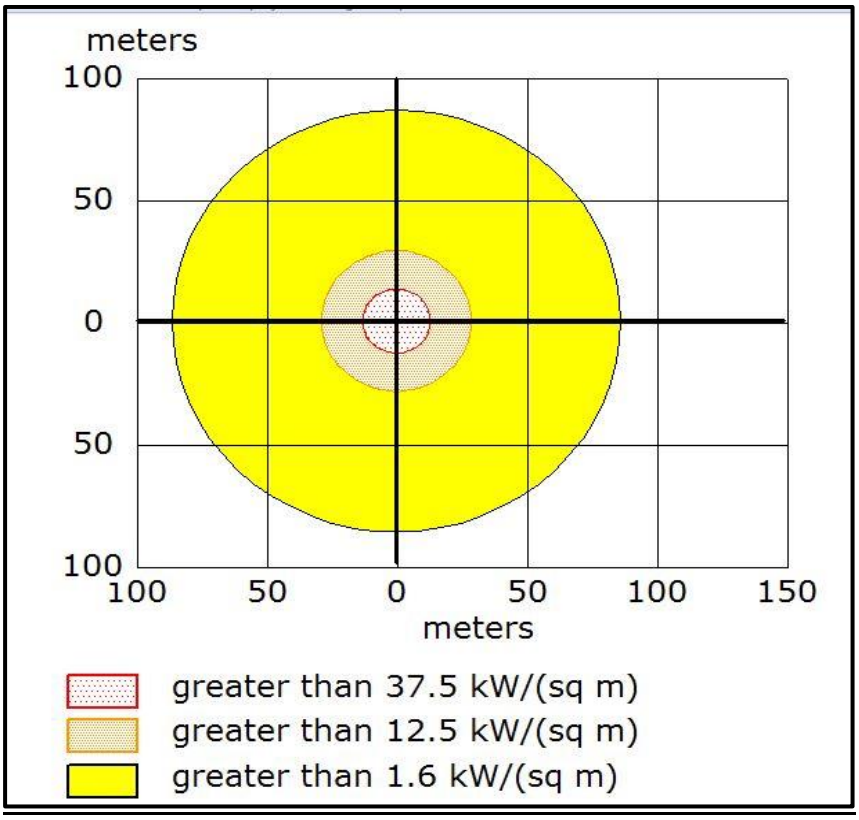
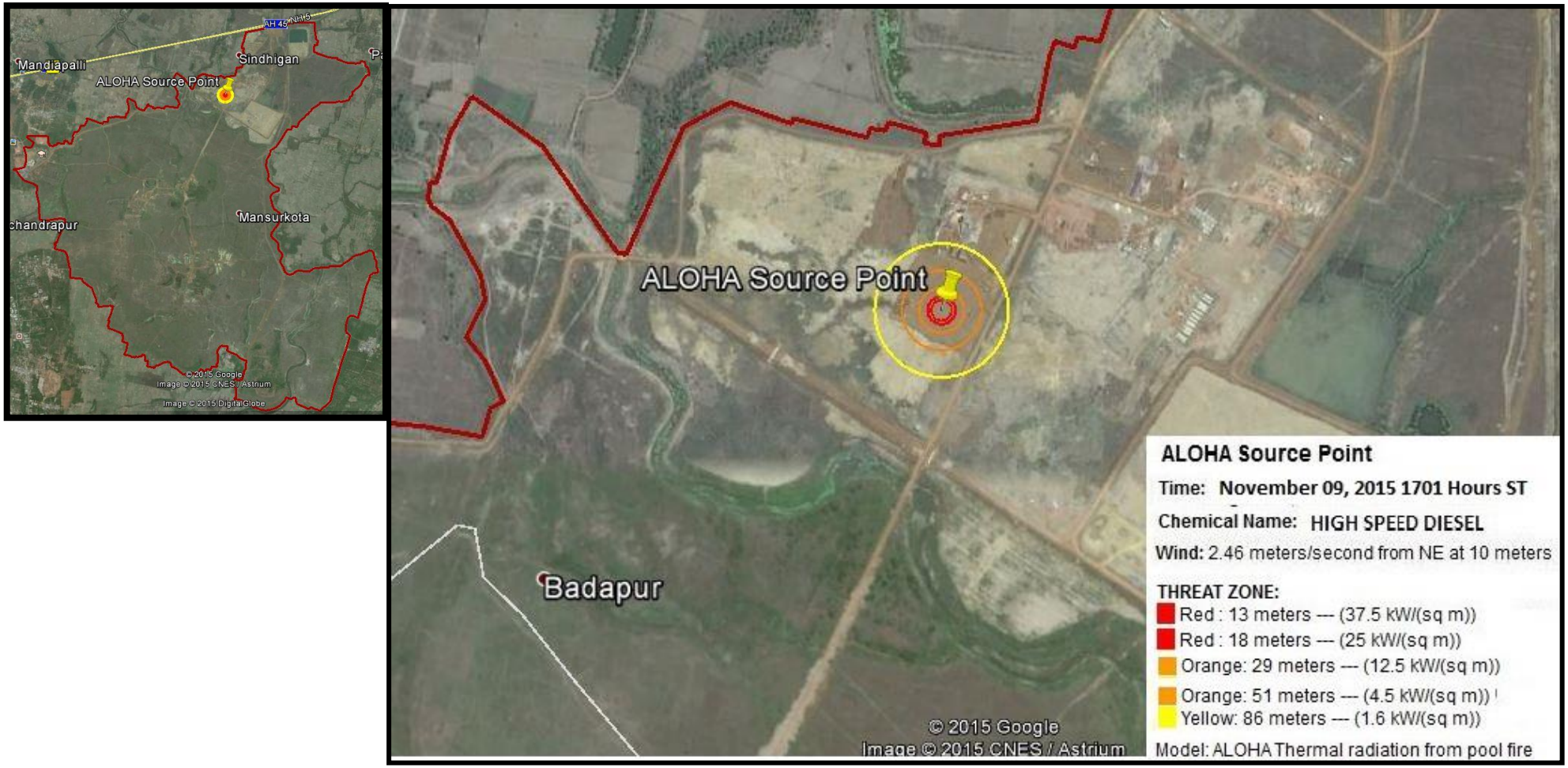



**Figure 2**

**ALOHA Source point on thelayout**



# 10 Disaster Management & Emergency Preparedness for Natural disasters

## 10.1 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.

Odisha is vulnerable to multiple disasters. Due to its sub-tropical littoral location, the state is prone to tropical cyclones, storm surges and tsunamis. Its densely populated coastal plains arethe alluvial deposits of its river systems. The rivers in these areas with heavy load of silt have very little carrying capacity, resulting in frequent floods, only to be compounded by breached embankments.

Though a large part of the state comes under Earthquake Risk Zone-II (low damage risk zone), the Brahmani Mahanadi graben and their deltaic areas come under Earthquake Risk Zone-III (moderate damage risk zone) covering 43 out of the 103 urban local bodies of the state. Besides these natural hazards, human-induced disasters such as accidents, stampede, fire, etc., vector borne disasters such as epidemics, animal diseases and pest attacks and industrial/chemical disasters add to human suffering.

The Odisha State has a history of recurring natural disasters. While the coastal districts of Odisha are exposed to floods and cyclones, western Odisha is prone to acute droughts; a large section of the state is also prone to earthquakes. In addition, the State is also affected by disasters like heat waves, epidemics, forest fire, road accidents etc. The history of disasters substantiates the fact that about 80% of the state is prone to one or more forms of natural disasters. Odisha has a history of recurring natural disasters.

## 10.2 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. However, the contiguous patch consisting of the subdivisions of Padampur, Bolangir, Titlagarh, Patnagarh, Nuapada, Khariar, Bhwanipatna and Phulbani comprising of 47 blocks have been identified as drought prone zone.

The seismic zoning of Odisha falls between zones I to II i.e. low damage risk zone and moderate damage risk zones. The parts of districts coming under moderate risk zones are: Sundergarh, Jharsuguda, Bargarh, Sambalpur, Deogarh, Angul, Dhenkanal, Jajpur, Cuttack. Khurda, Puri, Jagatsinghpur, Kendrapara, Bhadrak, Mayurbhanj&Balasore. While districts coming under low damage risk zones are Malkangiri, Koraput, Rayagada, Gajapati, Ganjam, Kandhamal, Nawarangpur, Kalahandi, Nuapada, Bolangir, Sonepur, Boudh, Nayagarh and Keonjhar.

There has been an alarming increase in the number of road accidents in the state in recent years. Poor road conditions, weak enforcement of laws, disregard for safety values, mechanical failures and lack of road awareness are the main causes of road accidents.

### 10.3 Cyclone

Due to Odisha's sub-tropical littoral location, the state is prone to tropical cyclones, storm surges and tsunamis. Most of the cyclones in Bay of Bengal occurring frequently during the northeast monsoon (october to december) cross the Odisha coast that too specifically near Goapalpur compared to their landfall in Andhra Pradesh and Tamil Nadu. The strong wind, associated with storm surge and flooding in coastal areas due to heavy rainfall causes massive destruction. Cyclones over the Bay of Bengal mostly move westward, northwestward or northward and cross the east coast of India or Bangladesh. This section describes the possibility of occurrence of Cyclone and the related high wind speed, the expected storm surge along the coastal region due to the passage of Cyclone and also the impact in case of occurrence of tsunami. The possible periodicity of the occurrence, intensity of occurrence, impact on the coastal form and people, the risk assessment and the disaster management plan are enumerated.

#### Storm Surge

Occurrence of storm is a common phenomenon in Bay of Bengal during northeast monsoonparticularly in September, October and December. The region near Gopalpur is prone tofrequent passage of cyclone and the associated storm surge. Based on the data published byIMD in, 'The tracks of storms and depressions in the Bay of Bengal and the Arabian Sea-1877to 2014', fifty five storms had occurred in the vicinity of Krishnapatnam in 138 years, i.e.from 1877 to 2014. Referring to below **Table 12**, it can be seen that the occurrence of cyclones ismore frequent in the month of September andOctober (11), followed by august (10). If acyclone with a wind speed exceeding 180 kmph develops, it brings heavy rain with a stormsurge > 3 m.

**Table 12**

**Track of Storms and Depressions (From 1877 – 2014)**

| Month | Crossed in the Vicinity |
|---|---|
| January | - |
| February | - |
| March | - |
| April | - |
| May | 1 |
| June | 7 |
| July | 5 |
| August | 10 |
| September | 11 |
| October | 11 |
| November | 7 |
| December | 3 |
| Total | **55** |

**Storm surge and the associated effect during the storm**

If a cyclone approaches the project region, it will be followed by heavy wind, incessant rain, coinciding with the high tide time, flooding from catchments and the storm surge causing the rise in water level on low lying areas and draining basins. In addition during the event of storm, high waves approach the coast and break. The heavy rainfall causing huge flood in the river as well as the opening of inland dams/reservoirs will cause stagnation of flow and inundation leading to killing people and damaging the coastal properties. For exampleduring the disastrous cyclones like Andhra Pradesh cyclone (November, 1977), Odisha cyclone (November, 1999) and Rameswaram cyclone (December, 1964), thousands of people were killed and there was a huge damage to the coastal properties

**PHAILIN cyclone in 2013**

The Very Severe Cyclonic Storm (VSCS) "PHAILIN" hit Odisha coast on 12.10.2013 and the landfall point was exactly near Gopalpur port in Ganjam district. The wind velocity wasrecorded to be 205-220 kmph. After hitting the Gopalpur coast, the cyclonic storm with astorm surge of around 3.0 m height ravaged the coastal districts of Ganjam, Puri, Khordha,Jagatsinghpur and Kendrapara. Apart from the coastal districts, the adjoining districtsnamely, Gajapati, Nayagarh, Keonjhar, Kandhamal, Koraput, Mayurbhanj, Bhadrak, Balasore,Jajpur, Cuttack, Bolangir and Angul have also been seriously devastated by the resultant flood. The cyclone was accompanied with torrential rains for 3 days, leading to floods in anumber of major rivers.

In Ganjam district alone 2812 villages have been affected. Apart from loss of life, powersupply, water supply system and communication system were totally disrupted

and lakhs ofpeople were rendered homeless. Public and private properties, agricultural crops and

horticultural plantations have suffered severe damage. All surface communication systems,telecommunication, power supply and water supply were totally disrupted.This post cyclone survey along the coast indicated heavy erosion along the beaches.Maximum erosion was noticed in the project shore front. The high sand dune which exists inthis area got eroded to a great extent. Approximately about 66 m3 per meter length of thebeach sand appeared to be eroded compared to the pre cyclonic condition. The shorelinereceded for about 2.5 km long coastline due to the passage of cyclone.

**Rainfall:** During Phailin cyclone occurred in october 2013, it caused very heavy to extremelyheavy rainfall over Odisha coast leading to floods, and strong gale wind leading to largescale structural damage and storm surge leading to coastal inundation over Odisha.Maximum rainfall occurred over northeast sector of the system centre at the time oflandfall. Maximum 24 hour cumulative rainfall of 38 cm was reported over Banki in Cuttackdistrict of Odisha.

The Gopalpur port breakwaters were totally shattered and partially submerged. Somedamage to the infrastructure close to the beach at the tourist location of Gopalpur on seawas also noticed. The Pudumpetta fishing village at north of Rushikulya mouth was moreaffected due to its close proximity to the beach. Houses with thatched roofs and tin sheetroofs suffered heavy damages especially those located near Gopalpur port. The damage wasminimal beyond Puri beach.It was noted that the impact of the cyclone and inundation to interior regions were reduceddue to the existence of the high level sand dunes. The inundation line due to the Phailincyclone is shown in Fig. 36. The water line entered about 60 m into the shore.However the inundation was low due to the presence of high sand dunes in this region.Therefore it is imperative to stabilize the dunes as it forms a natural protection to minimizedamages along the coast during any cyclone.

### 10.4 Tsunami

Tsunami is a series of wave train generated in the ocean by a hydraulic impulsive force that vertically displaces the water column. Earthquakes, landslides, volcanic eruptions, explosions and even the impact of cosmic bodies taking place in the ocean can generate Tsunami waves with long periods (≈ 30 min), long wave length (≈ 100 km) with a high velocity of propagation (≈ 700 km/hr).

Tsunamis are shallow water waves which propagate with phase velocity equal to the square root of the product of the acceleration due to gravity and the water depth. For example, in the Pacific Ocean, where the typical water depth is about 4000 m, the tsunami wave travels at about 700 km/hr. Because the rate at which the wave loses its energy is inversely related to its wave length, tsunami not only propagates at high speed, but it can also travel great transoceanic distances with limited energy losses and reach

different continents in shorter time i.e., the energy propagating with a tsunami waves remain nearly constant. Among the various factors causing the occurrence of tsunami,

the large vertical movements of the earth's crust is more predominant and it can occur at tectonic plate boundaries. The plates that interact along these boundaries are called faults. Around the margins of the faults, the denser oceanic plates slip under the continental plates in a process known as subduction. Such subduction earthquakes are particularly very effective in generating the devastating tsunamis.

The energy flux due to tsunami is proportional to its velocity of propagation and height and it remains nearly constant till reaching the coast. Consequently, the velocity of propagation gets retarded when it enters shallower water and its height gets amplified. Because of this shoaling effect, the tsunami that is imperceptible at Deep Ocean close to centimeter height may rise up to several meters near the coast called run up.

When Tsunami finally reaches the coast, the crest of the wave appears as rapidly risen water mass gushing into the coastline as a bore with a crashing velocity of 700 km/hr for more than 10 - 30 min. The trough of the wave will appear as the withdrawal of water mass with same speed back into the ocean swallowing everything on the land and dragging back into the ocean.

Possible intensity of tsunami In worst case, if a tsunami occurs due to the movement of Andaman and Indonesian plate then there will be surging of tsunami waves with a speed of > 60 kmph into the shore and the run-up will be > 4 m. The gushing of water will sweep and flood the areas having elevation < 3 m MSL.

### 10.5 Disaster Management Plan for Tsunami and Storm Surge

Cyclone, tsunami and storm surge are the most destructive force among the naturaldevastations. It causes instant disaster and burial of lives and destruction to entire coastalproperties. The damage and loss can be minimized if appropriate preparedness plan isformulated. The following statutory guidelines are recommended by National DisasterManagement Authority (NDMA) to minimize the impact due to cyclone, tsunami and storm.

Development of sand dunes along the coast with shrubs or Casuarina trees forstabilization of the sand dunes (Tsunami Mound).Raising the ground level (above the design water level) with natural beach sand so asto rehabilitate the coastal region.Development of coastal forest (green belt) by planting casuarinas and coconut treesalong the coastline to cover minimum of about 500 m width of the beach.Adopting natural beach nourishment to create steep beach face.Creation of sandy ramps at close intervals along the coast.

In addition to the guidelines by NDMA, it is also necessary to adopt various preventiveactions in the coastal region of the project site.

**Preparedness Plan**

The preparedness plan shall contain details about:

- Warning that should be given
- Protective measures to contain the effect of surging water level and
- Other

Precautionary measures to be taken. The following measures are the key aspects in thepreparedness plan.

- Coordination with international and national agencies
- Vigilant online monitoring
- Emergency evacuation

**Coordination with International and National Agencies**

International: Following a series of tsunamis that hit Japan and North America, aninternational tsunami warning network was put in place in 1960s in regions around them Pacific Ocean. This network is administered by National Oceanic and AtmosphericAdministration (NOAA), USA. NOAA comprises of hundreds of seismic stations worldwide,which can detect earthquakes that are precursors to tsunami. This network also includescoastal tide gauges that detect local changes in sea level and sophisticated DART Buoys(Deep Sea Assessment and Reporting of Tsunamis Buoys) in the Pacific basin, capable ofdetecting even a centimeter change in water depths in ocean. DART was introduced in 2003.This system consists of a pressure sensor anchored to the sea floor and a surfacetransmitter. When potentially dangerous seismic activity is detected, the network of DARTbuoys will detect the small change in the sea level.

Tsunami waves do not induce high surface elevation in deep ocean and hence theirpresence is not felt in deep ocean until they reach the shallow water close to coast. If anysmall yet potentially significant sea level change is noted following a seismic activity, thedata are transmitted acoustically to the surface buoys and relayed by satellites to thewarning stations. Computer modelling converts the data into a prediction of potentialdamages for the use of the members of the network.

National: After the 2004 tsunami affected the Indian sub-continent, the followingorganizations are involved on watch and cautioning the government and public in the eventof possibility of occurrence of tsunami. As a part of tsunami hazard mitigation, warningsystems have been established in India by the coordination of the following organizations.

- Indian National Centre for Ocean Information Services (INCOIS), Hyderabad.
- National Disaster Management Authority (NDMA), New Delhi.
- Indian Meteorological Department (IMD), New Delhi.
- National Institute of Ocean Technology (NIOT), Chennai.

The contact details of international and national agencies are given in **Table 13**

**Table 13**
**Contact Details of International and National agencies**

| Organization | Address | Email ID | Contact Number |
|---|---|---|---|
| INCOIS | Ocean Valley,<br>Pragathi Nagar (BO),<br>Nizampet (SO),<br>Hyderabad – 500090 | www.incois.gov.in | +91 - 40 - 23895002 |
| NDMA | NDMA Bhavan,<br>A-1 Safdarjang Enclave,<br>New Delhi,<br>DL 110029. | www.ndma.gov.in | +91 - 11 - 26701700 |
| IMD | Mausam Bhavan,<br>Lodi road,<br>New Delhi,<br>DL 110033. | www.imd.gov.in | +91- 11 - 24699216 |
| NIOT | Velachery - Thambaram main Road,<br>Narayanapuram,<br>Pallikaranai,<br>Chennai 600100. | www.niot.res.in | +91 - 44 - 66783300 |
| NOAA | 1401, Constitution Avenue,<br>NW. Room 5128,<br>Washington, USA.<br>DC 20230 | www.noaa.gov | - |
| Andaman Nicobar Administration | Andaman & Nicobar Administration o/o secretary (GA),<br>Secretariat,<br>Port Blair. | webmaster.and@nic.in | +91- 3192 - 236572 |
| Indian Navy Detachment, Port Blair. | Port Blair | hqancpro@rediffmail.com | +91 - 3192 - 232012<br>+91 - 3192 - 232023 |
| Andaman Harbour works, Port Blair. | Chief Engineer & Administrator office,<br>Post Box No:161,<br>Port Blair 744101. | alhw@and.nic.in | +91 - 3192 - 232864 |
| District Collectorate, Ganjam District Odisha State. | District Collector | dm-ganjam@nic.in | 06811-263700 |

INCOIS in collaboration with NIOT has deployed DART buoys at 3 locations in the deep oceanalong the fault plane of Andaman plate and Indonesian plate. The data transmission systemhas been effectively linked through satellite with 24 hours online monitoring at NIOT,Chennai.

The online monitoring is capable of raising alarm in case of instantaneous change in surfaceelevation exceeding centimeter which can be caused by the generation of tsunami.IMD interacts with the above institutions and takes the responsibility of broadcasting thedisaster through various media. In case of a tsunami, the warning is usually broadcastbased on the earthquake occurred in the nearby ocean. Irrespective of definite occurrenceof tsunami, the possibility to occur is also considered as equally vulnerable and accordinglythe warning news is instantly flashed through radios and TVs. The notification is followed byorders from the local government authorities on reinforcing evacuation, prohibition toenter the demarcated risky zone and mobilizing facilities for easier evacuation andaugmenting medical facilities.

There are a variety of evacuation notification systems in case of cyclone, tsunami and stormsurge. They include sirens, weather radio, emergency alert system, telephones, emergencyweather information network etc. In each system, it should be noted that the applicationand message is consistent as well as continuous with repetition of messages with periodicityat short time interval. It should be ensured that the warning reaches immediately to allpeople prone to the devastation.

**Vigilant Online Monitoring**

The time at which the cyclone, storm surge or tsunami may reach the coast can bepredicted with sufficient lead time. The destruction can be minimized if the coastalpopulations are warned and evacuated to elevated place and inland in time. Thereforekeeping vigil on the warning is the very important aspect in protecting the lives. TSL shouldhave an agreement with NIOT/INCOIS/IMD by enrolling themselves as the potential users.Live contact should be kept with the organizations indicated above transmitting the instantwarning on occurrence of cyclone, tsunami and storm surge. A vigilant team must becreated and they should be deputed to the above organizations to attend the trainingprograms and to understand the method of monitoring and the kind of emergencypreparedness. The vigilant team must monitor the warning systems around the clock.

The vigilant team should have proper knowledge about the warning systems and shouldhave attended the training programs conducted by the tsunami warning centres. Thetraining should be given periodically to update the system and methods of warning. Theteam should take the responsibility of giving immediate warning to the people in andaround the power plant in case of Tsunami and they have to undertake the EmergencyPreparedness Action. Safety drills should be conducted periodically.

Operational and emergency preparedness procedures should be planned meticulously inorder to act on the warning and to disseminate it rapidly and effectively to the public.

**Emergency Evacuation**

Evacuation of people from risk areas is the first priority when early warning is received orthe natural warning sign indicates the immediate arrival of cyclone, tsunami wave or rise ofstorm surge.

Evacuation plan describes the time span available before and during the tsunami or stormsurge event. When facing local threat, evacuation procedures most possibly will have thecharacter of a 'runaway effort' and people should not expect to receive much institutionalsupport. The primary objective should be bringing as many people as possible out of thereach of the wave's impact to safe or 'relatively safe' areas. Therefore necessary steps haveto be taken in advance to enable and support the community at risk to protect themselvesat any time.

**10.6 Mitigation measures against Tsunami**

Although the impact of tsunami and storm is disastrous, the impact can be minimized byadopting the key components of mitigation measures. It was noticed during December 2004tsunami that the places located behind the highly elevated dunes, forest departmentplanted Casuarina tress, dense plantations, mangrove forests, offshore coral reefs, long saltpan heaps etc., were considerably protected. These areas experienced very low damagewithout causing death of the people. The kinematic energy of the tsunami waves riding intothe land gets dissipated due to these natural barriers. Thus the nature gives the scientificunderstanding of preparing the energy dissipating obstruction on the shore that can greatlyprotect the people and property against tsunami.

The mitigation measures to be taken normally vary according to the local site conditions.Accordingly, in general case, the following mitigation measures are seen to be effective forthe proposed project:

- Bio shield
- Construction of tsunami mound
- Construction of tsunami/cyclone shelter

**Bio Shield:**It is a general belief that natural formations such as coralreefs, grass beds, coastal vegetation such as mangroves,estuaries and deltas of river mouths and flood plains play animportant role in dissipating the forces of tsunami waves.

A bio-shield formed by planting a vegetation belt along coastlines would protect the regionagainst coastal storms, cyclones and tsunamis. The plantations could absorb the force ofsevere storms and tsunamis, and it could act as a 'carbon sink' by absorbing emissions ofthe greenhouse gas. The coastal vegetation also has a very important role in stabilizing andtrapping marine sediments and forming a protective buffer between the land and the sea.

**Planting of Casuarinas:**
Casuarina equisetifolia is the most popular farm forestry tree in thecoastal lands of mainland India. The Casuarinas planted along the east-coast protected theregion from cyclone in November, 1999. Planting Casuarinas along the coastal front wouldprovide substantial protection to the project region from the impacts of storm surges andtsunami. Hence the water level rise during a tsunami or storm will not have any majorimpact in this region.

**Construction of Tsunami Mounds:** One of the natural methods of protecting the shore from the natural disasters like tsunamiand storm surge is to construct tsunami mounds which will effectively help to dissipate theenergy of tsunami surge and protect the leeward side. The shorefront of the project regionhas rows of elevated sand dunes > 8 m and it can serve in the place of the construction oftsunami mounds.

**Tsunami/Cyclone Shelter:** The warning and disaster evacuation system is the most important element in ensuring thepublic's safety. Suitable shelter must be constructed in order to evacuate the people in caseof emergency.

The time of arrival provides only a limited time for people to move safely to the shelter. Twocyclone shelters per cluster must be provided along the region of TSL. After thewarning/siren is given, the government authorities will start the evacuation and the peopleliving in the interior area will have to be moved to the cyclone shelter built along the coastalstretch.

The location of the shelter must be chosen such that it is easily accessible for workers inindustries and for the public living in the vicinity. Maintenance of these shelters and theaccess roads and keeping them in good condition throughout the year to its functionalrequirements is very important.The shelter should be equipped with water supply, toilets, first aid centre, generators,ration storing rooms and minimum cooking facility. The shelters should be designed to bearthe workers in the industry and the people living in the vicinity. The stairway should be wideenough (>3 m) for the rushing people to climb the top without confusion and struggle. Itshould have an elevated handrail with proper light and ventilation. There should not be anywindows on the seaward side to avoid the entry of water due to rising tsunami wave. Butenough windows and other ventilation measures must be provided on the leeward side ofshelters.

**Escape Routes:** The availability of safety zones that can be used as evacuation sites withinwalking distance must be inspected. People can be evacuated to hills over ten metres in elevation or the deep inland (>1 km) out of coastal inundation. Good elevated roads shouldbe laid along the escape route to safe places which can be waded even during flooding.

### 10.6 Emergency Alarm from Government Institutions

M/s Tata Steel SEZ Limitedshould jointly make understanding with NIOT/INCOIS/NDMA and a communication linkshould be established through satellite or GPRS. In case of emergency if warning is given atthe above mentioned institutions, they can instantly activate the alarm at the industriesthrough satellite/GPRS and give caution to the vigilant team so that they can immediatelystart the rescue operation.

## 11 Occupational Health and safety

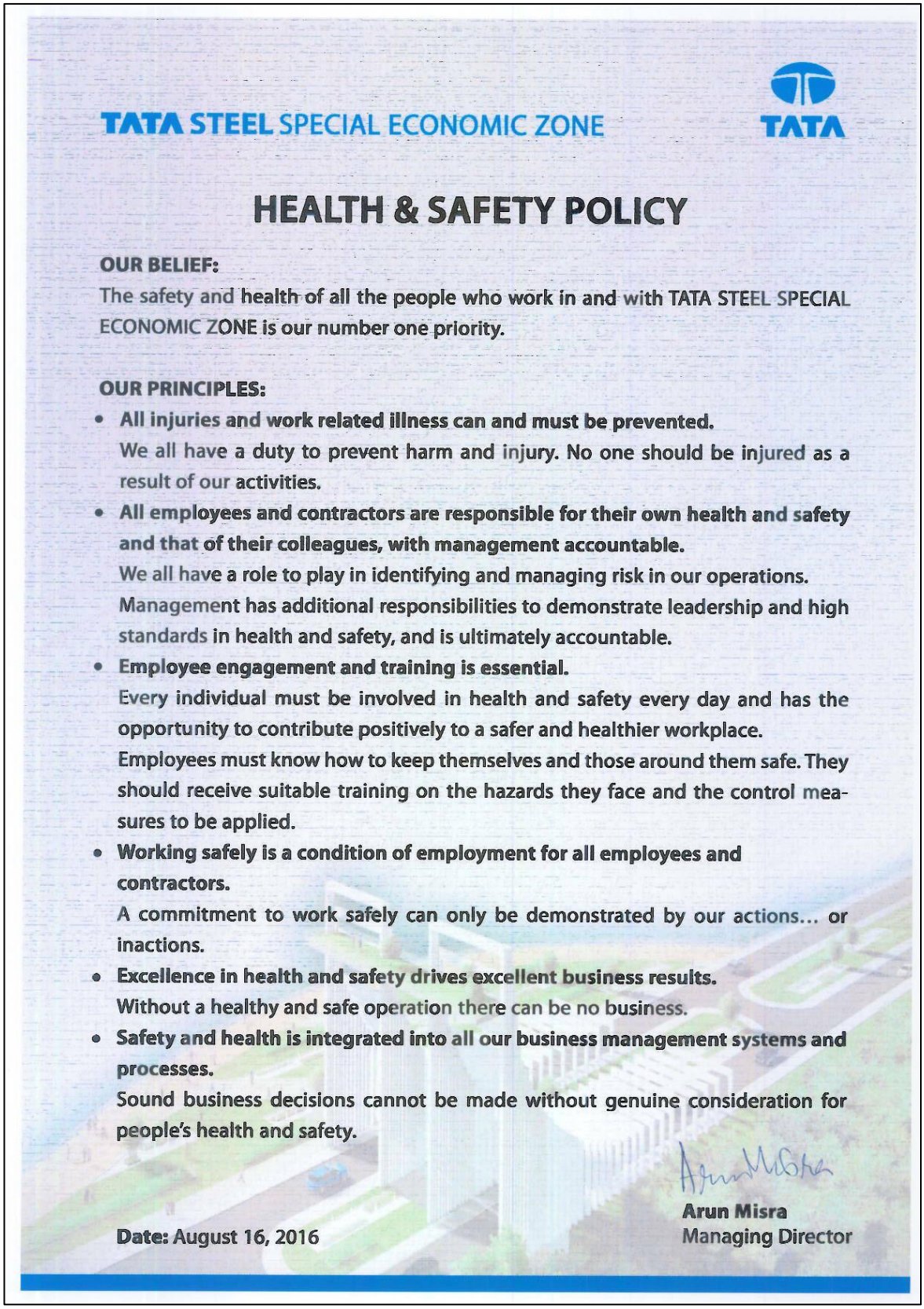
### 11.1 Introduction

Maintaining a high degree of physical, mental and social wellbeing of employees ensures high productivity and overall sustainability of the proposed project. TSSEZ has a strong occupational health and safety policy (OHS). Thehealth and safety policy of TSL is shown in **Figure 3**

### 11.2 Occupational Health

Corporate policy of TSSEZ includes the occupational health care of the work force for all theoperational units. TSL is accredited with ISO-14001, ISO-18001 and SA-8000 for all the operating units. The proposed units would also come under the same corporate umbrella to adopt occupational health standards similar to other operating units. To start with, there would be first aid stations and an industrial health laboratory within the plant to take care of the comprehensive health management system of the plant personnel. 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 stylemanagement, wellness management, stress management, ergonomics, early diagnosis &treatment, burn safety & eye care, gas & heat hazards, occupational lung diseases, physicalfitness, nutrition etc. The occupational health hazards with permissible limits and mitigation is presented in **Table 14**

**Figure 3**
**Health & Safety Policy of M/s Tata Steel SEZ Limited**



TATA STEEL SPECIAL ECONOMIC ZONE

TATA

# HEALTH & SAFETY POLICY

**OUR BELIEF:**

The safety and health of all the people who work in and with TATA STEEL SPECIAL ECONOMIC ZONE is our number one priority.

**OUR PRINCIPLES:**

- **All injuries and work related illness can and must be prevented.**
  We all have a duty to prevent harm and injury. No one should be injured as a result of our activities.
- **All employees and contractors are responsible for their own health and safety and that of their colleagues, with management accountable.**
  We all have a role to play in identifying and managing risk in our operations. Management has additional responsibilities to demonstrate leadership and high standards in health and safety, and is ultimately accountable.
- **Employee engagement and training is essential.**
  Every individual must be involved in health and safety every day and has the opportunity to contribute positively to a safer and healthier workplace. Employees must know how to keep themselves and those around them safe. They should receive suitable training on the hazards they face and the control measures to be applied.
- **Working safely is a condition of employment for all employees and contractors.**
  A commitment to work safely can only be demonstrated by our actions... or inactions.
- **Excellence in health and safety drives excellent business results.**
  Without a healthy and safe operation there can be no business.
- **Safety and health is integrated into all our business management systems and processes.**
  Sound business decisions cannot be made without genuine consideration for people's health and safety.

**Arun Misra**
Managing Director

**Date:** August 16, 2016

**Table 14**

**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 Exp.Limit (REL) : 100 mg/$m^3$ TWA | Ansel Nitrile chemical resistant gloves, chemical resistance gloves, 3m Disposable respirators |
| 5 | Diesel | Threshold Limit Value (TLV) :800 ppm | Ansel Nitrile chemical resistant gloves, chemical resistance gloves, 3m Disposable respirators |
| 6 | LPG | Threshold Limit Value (TLV) :1000 ppm TWA | 3m Disposable Respirators |
| 7 | Acetylene | 14 mg/ cum of air | 3M Disposable Respirators |
| 8 | Working at height | 2 m above ground level | Double lanyard full body safety harmless. Life line support. Proper IITS (information, instructions, training, supervision) provided. |
| 9 | Excavation | 1.5 m depth | Gum Boot, ramp, shoring, benching etc. Proper IITS implemented. SOP & Standards implemented. |
| 10 | Scaffolding | 2 m above ground level | Railings in access, work platform, hand rail, mid rail, toe guard. System scaffold standard implemented |
| 11 | Welding/ Gas- Cutting | - | Apron, leather hand gloves, face-shield, black goggles, SOP implemented |
| 12 | 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 |

M/s.Tata SteelSEZ Limitedwould conduct practice of health care surveillance of its employees by ways ofroutine health check-ups, audiometric examination & hearing conservation for the employeesexposed to high noise levels, statutory eye examination and colour vision test, X-rayinvestigation, blood examination, lung function test, cardio profiler test for diabetic and bloodpressure patients etc. Routine reviewing of the health status and hygiene would berecommended. Under the health check-up program a routine surveillance of the contractor'semployee's health status would be carried out during the construction stage and also duringoperational stage. The action plan for implementation of OHS standard is presented in **Table 15**

**Table 15**

**Action Plan for Implementation of OHS Standard**

| S.no. | Type of Health Possible Health Hazards | Preventive Action Plan |
|---|---|---|
| 1 | Fall from height | • All workers working at height To Be examined specially for vertigo & certified.<br>• Workers to be supplied with pipe 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 | • Positive isolation.<br>• Barricading installation.<br>• Use of pipe, gloves, shoes, helmet, goggles |
| 6 | Eye injury | • Use of goggles.<br>• Supply of water tap at strategic locations.<br>• Providing first aid available within 10 minutes Ambulance service for major injury |
| 7 | Risk of road traffic accident | • Entry of only authorized vehicle.<br>• Speed limit regulation and display of speed limit area.<br>• Mandatory use of seat belt.<br>• Regular maintenance of road. |
| 8 | Noise pollution | Use of noise mask/ ear plugs at high decibel sound area |
| 9 | Exposure to work zone Dust | • Water sprinkling on services roads.<br>• Use of mask.<br>• Vacuum cleaning of shop floors.<br>• 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 | • Storage of chemicals in confined area as per regulations.<br>• To be handled by authorized persons only.<br>• Use of PPE |
| 12 | Periodic health checkups | • Pre-employment health checkup.<br>• Health checkup every 2 years |
| 13 | First aid back up | • One first-aid centre to run inthe factory premises.<br>• Ambulance service to be available round the clock |

## 12 Corporate Environment Policy (CEP)

Tata Steel SEZ's Environmental Policy guides approach of TSSEZ towards environmentmanagement. Improvements in environmental performance are driven through its totalquality management process. Management tools are used for deployment of actions acrossthe units for improvement and sustenance of environmental performance. The overallenvironmental performance, including mitigating and controlling environmental impacts, issubject to continuous and detailed scrutiny by the board of directors, with the board'ssafety, health and environment subcommittee providing direction on environmentalperformance.TSSEZ's environment policy is a formal expression of the company's overall intensions anddirections related to its environmental performance. It also establishes basic commitmentsand provides a framework for developing strategies and action plans. TSSEZ Environmental Policy is as given in **Figure 4.**

More focus is given on Quality of work and infrastructure development by adopting international standards & customer satisfaction & providing safe & secure friendly atmosphere to all. TSSEZ Quality Policy is as given in **Figure 5** andthe organization structure of the project team who has administrative control is as shown on **Figure 6**

**Figure 4**
**Environmental Policy**

**Figure 5**
**Quality Policy**

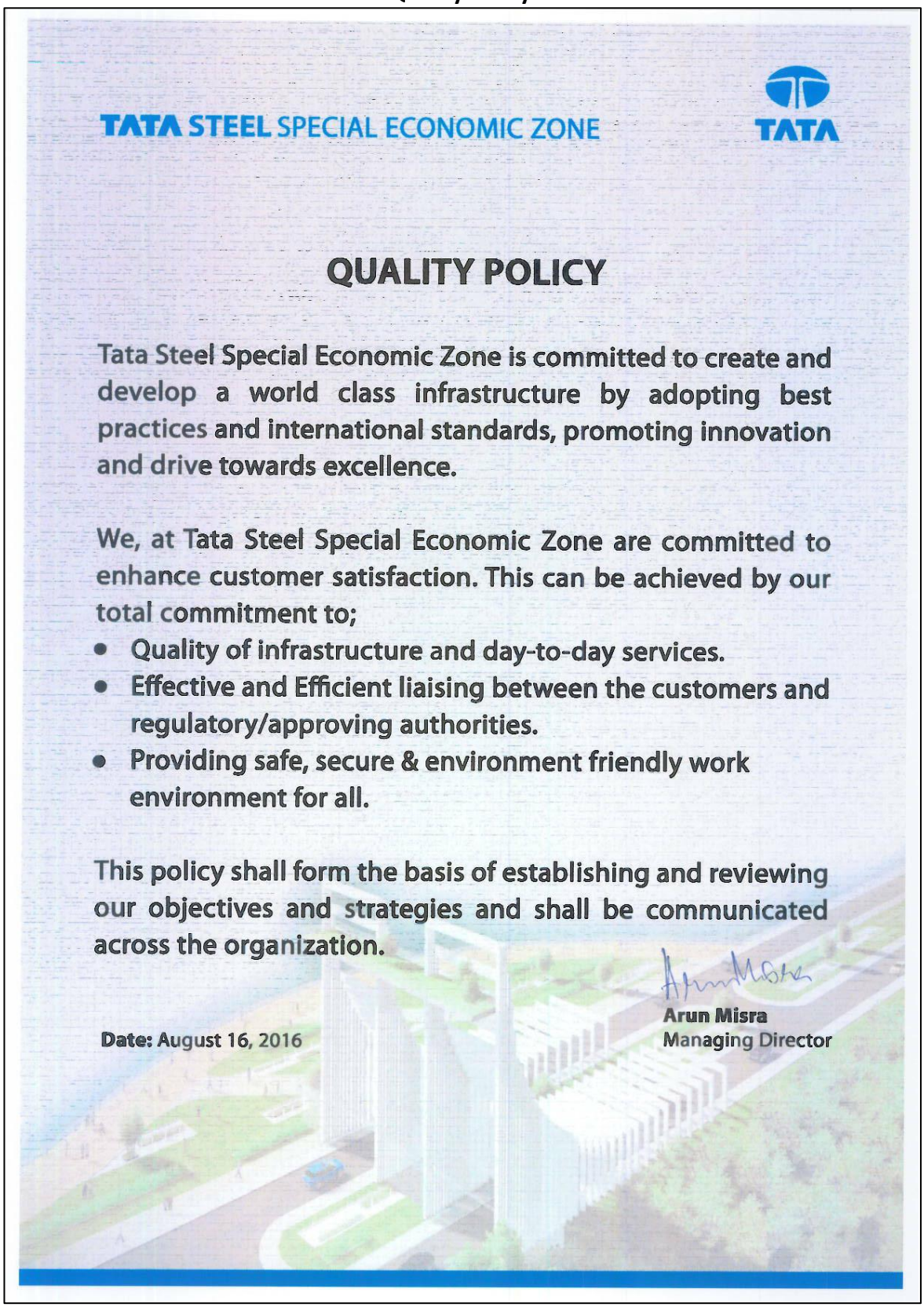
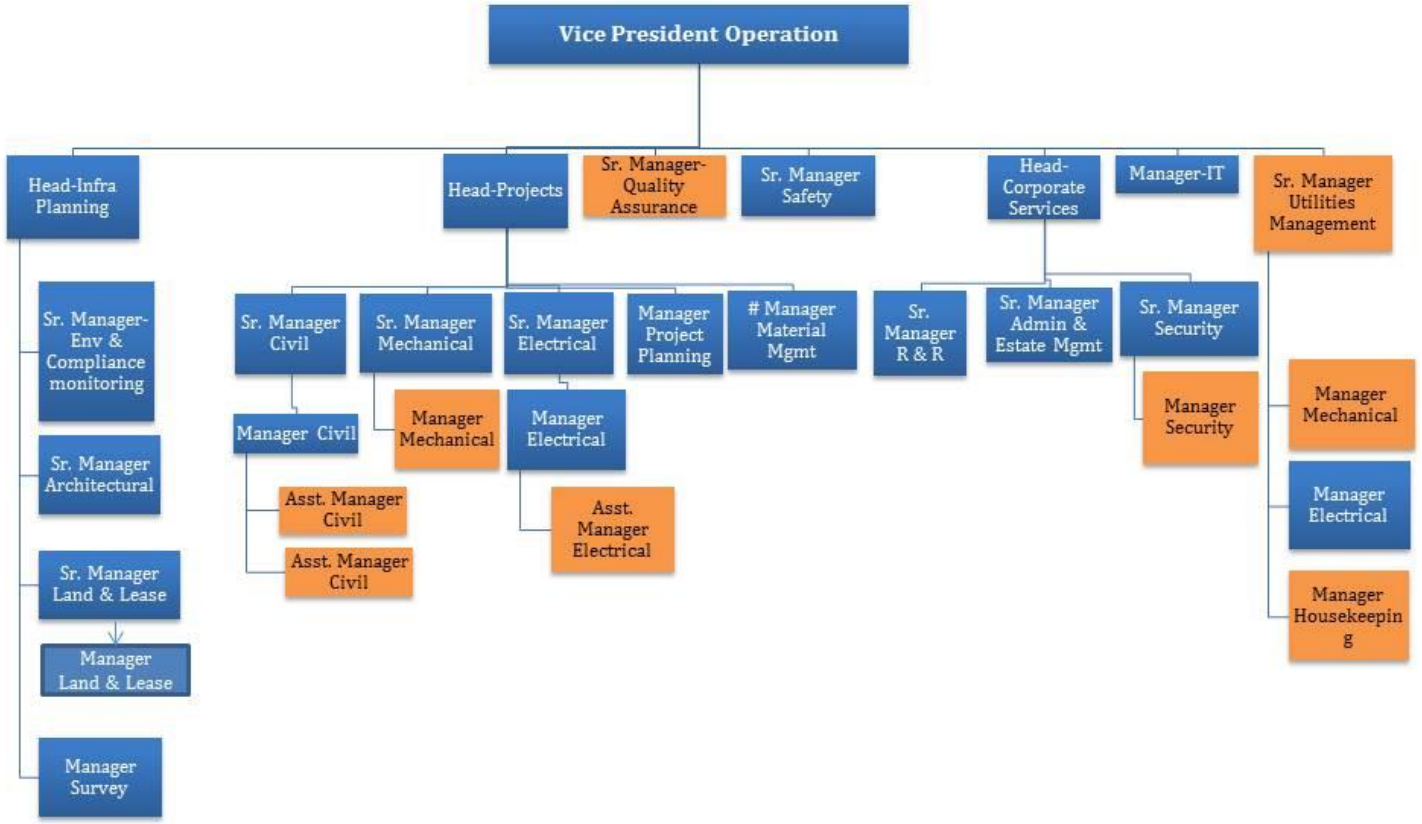


**Figure 6**

**Organization Structure**



**Roles and Responsibility**

**Chief of the Project**

- Overall driving force of the team
- Coordinate with top management and project team for implementation of theprojects
- Ensure implementation of statutory requirements
- Monitor and control schedule and cost of the project

**HOD Environment /Sr. Manager Environment**

- Identify and review the various statutory requirements that are applicable to theproject
- Obtain necessary permits, consents, clearances, licenses that are required for theproject for environment related matters
- Facilitate, monitor and review the implementation of various requirements related toenvironment protection in the project
- Plan, organize and review the monitoring of environmental parameters
- Timely submission of reports, retunes, statements, status of the MoEFCC/OPCB/CPCB
- Provide inputs to the top management for review of environmental compliances
- Plan, organize and review the afforestation measures in the project

**Head-R&R**

- Ensure implementation of R&R in the project as planned
- Plan, organize, implement the social and peripheral development activities in thenearby vicinity