1.1 Risk Analysis

Risk is a potential that a chosen action or activity will lead to a loss of human or property.

Risk assessment is a step for Risk Management. Risk assessment is determination of qualitative and quantitative value of risk related a situation or hazard.

Hazard is a situation that poses a level of threat to life health or environment.

Disaster is a natural or man-made hazard resulting in an event of substantial extent causing significant physical damage or distraction loss of life or drastic change in environment.

Human health and Environmental risk from developmental activities is mainly due to occurrence of some accident consisting of an event or sequence of events explosion, fire and toxic hazards. Risk analysis provides a numerical measure of the risk that a particular facility poses to the public. It begins with the identification of probable hazardous events at an operational area and categorization as per the predetermined criteria. The consequences of major events or accidents are calculated for different combinations of weather conditions to stimulate worst possible scenario. These predictions of consequences are combined to provide numerical measures of the risk for the entire facility. Risk assessment should be done on the basis of past accident analysis at similar projects, previous judgments and expertise in the field of risk analysis especially in accident analysis.

Mining and allied activities are associated with potential hazards to employees as well as the public. A worker in a mine should be able to work under conditions, which are adequately safe and healthy. At the same time the environmental conditions should be such as not to impair his working efficiency. This is possible only when there is adequate safety at workplace. Hence safety is one of the most essential aspects of the industrial activities.

Objective of Risk Assessment

- Identifying hazardous activities
- Assessment of risk level and severity in different operations
- Identification of control measures
- Setting monitoring process
- Reduce the impact of mishaps of all kinds
- Reduce the inherent potential for major accidents.

The possible risks in the case of mining projects are erosion, inundation/floods, and accidents due to vehicular movement, drilling & blasting (occasional) and accidents during mineral loading and transporting etc. Mining and allied activities are associated with several potential hazards to both the employees and the public at large.

1.1.1 Risk Management

The following precautionary measures shall be taken to prevent any accident

- Elimination of the source of hazard
- Substitution of hazardous process and materials by those which are less hazardous.

- Geographical/ physical isolation of hazards from vulnerable communities
- Use of engineering controls to reduce the health risk
- Adoption of safe working practices such as regular equipment maintenance
- Use of Personal Protective Equipment should be mandatory.
- Active area of opencast workings will be kept properly fenced.
- Regular dressing of bench sides to ensure safety of workers employed within 5m of working face.
- Drafting and implementation of preventive maintenance schedule for various kinds of machinery deployed in opencast workings.
- Provision of maintenance of properly laid haul roads with parapet wall fencing or guards and road signs at strategic points.
- Precautions against danger while traversing dumpers, excavators etc. by installing audio-visual alarms and appointment of spotters.
- Transportation of Silica sand within mine workings by vehicles under the direction, supervision and control of Mine Management only.
- Proper maintenance of vehicles and weekly examination by an engineer and daily examination by a competent person.
- Entry of any unauthorized person into mine will be completely prohibited.
- Training and retraining (at specified interval) of the machinery operators.
- Adequate maintenance of electrical equipment.
- Adequate illumination after daylight.

1.1.2 Hazard Identification

It is a mining project which may have the following types of hazards associated with it.

1.1.2.1 Natural Hazards

- Earthquake
- Flooding – Heavy Rainfall/ Water Bodies

1.1.2.2 Man-Made Hazards

- Bench Slope Failure
- Vehicles and Machinery
- Loading and Excavation of Mineral
- Drilling and Blasting
- Fugitive Emissions from Mining Operations

1.1.3 Risk Assessment

Factors of risk involved due to natural calamities and human induced activities in connection with mining operations are as under:

1. Floods

Risk Involved:

The project site is in close vicinity to the Bay of Bengal and hence there is a constant risk of flood in the area during rainy season. In the recent past there was a heavy rain fall due to which the site was not approachable because of the flood in the area. However, there is no history of flood from sea.

2. Open cast Bench slope failure

Risk Involved:

Reasons for failure are -

- Inadequate nos. of competent persons for carrying out statutory inspections.
- Lack of supervision.
- Failure to make and keep the quarry sides secure by proper benching, sloping and keeping benches of adequate height and width.
- Undercutting so as to cause dangerous covering.

3. Vehicular Movement

Risk Involved:

- Possibilities of road accidents are possible due to rash driving/brake failure/lack of visibility.
- Possibility of overloading may injure the passer-by public.
- Vehicles moving in a steep gradient or on benches of inadequate width.
- Accidents are common during reversing of vehicles.

4. Mineral Loading, unloading and Transportation/Use of machinery:

Risk Involved:

- Use of substandard equipment.
- Accident due to generation of fly rock.
- Attempt to clean moving parts of machinery.
- Non provision or removal of guards for moving parts of machinery.

5. Drilling and blasting:

Risk Involved:

The mining will be done with semi-mechanized method without the use of drilling or blasting so there is no risk due to drilling or blasting.

1.1.4 Vulnerability Analysis

A vulnerability assessment was performed was performed for the hazards associated with the project.

S.no	HAZARD IDENTIFICATION	Severity (1-5)	Likelihood (1-5)	Severity x Likelihood (1-25) (Hazards scoring 1-9 are less serious hazards & 9-25 are very serious hazards &require risk assessment)	Proposed General Mitigation Measure/ Control
	Natural hazard				
1	Flood	5	1	5	• Limited mining will be done during rainy season. • Pre warning signs on possible heavy rains or floods or cyclones from the meteorological department will be followed. Hence during any such case the project site will be evacuated. Or if possible the excavated site will be fenced. • To prevent inadvertent entry of people near the excavated pits, long poles will be grouted as a sign of excavated site. • Warning signs in local language will be erected at the site to avoid any mishappening. Nearby villagers will be informed.
	Man-made hazards				
2	Opencast bench Slope Failure	2	2	4	• The pit will be dug only up to 3 m depth by adhering to all the safety measures. As it is well known that the overall management of the slopes created during the development of an open pit mine requires an ongoing assessment of the stability of these slopes. This assessment depends on good geological, geotechnical and groundwater models as well as an understanding of the risks and economic consequences of slope instability. A good open slope design is one that integrates all of these factors to produce a balanced compromise between safeties on the one hand, and operational and economic efficiency on the other. • As the mining will be carried out up to 3 m and the pits form will be filled due to the aeolian activity in due course of time, hence gentle slope will be maintained at the end of mining due to

					which there will be no danger to men and machineries. • There shall be adequate supervising staff and mining operation will be done under strict supervision of the Mining Engineers and Asst. Mining Engineer to avoid any mishap. • For determining factor of safety, the bench slopes shallbe monitored regularly by sensitive instruments at precise level at regular intervals to check for any possible ground movement. • Stability of benches and slope shall be ensured by full compliance of the mine plan duly approved by IBM.
3	Vehicular Movement	4	4	16	• All transportation within the mining lease working shall be carried out directly under the supervision and control of the management. • The vehicles will be maintained in good condition and checked thoroughly at least once a month by the competent person authorized for the purpose by the management. • Road signs will be provided at each and every turning point up to the main road (wherever required). • To avoid danger while reversing the equipment's/ vehicles especially at the working place/loading points, stopper shall be posted to properly guide reversing/spotting operating, otherwise no person shall be there within 10m radius of machine. Reverse horns will be fitted in all vehicles. • The maximum permissible speed limit shall be ensured. • Overloading of material will be avoided. • A statutory provision of the fences, constant education, training etc. will go a long way in reducing the incidents of such accidents. • Edge protection will be done to prevent inadvertent movement. • Visibility defects can be eliminated by the use of visibility aids such as closed circuit television and suitable mirrors.
4	Fugitive Emissions during mine operations such as excavation and loading.	2	5	10	• Regular sprinkling shall be done with operations generating dust emission. • Dumpers shall be covered with tarpaulin during transportation of material and waste. • Dust masks shall be provided for operations involving high fugitive emissions or when required.

5	Mineral Loading and Excavation/ Machinery Operation/Slip and Trip of Workers in Working Areas	4	4	16	• Regular safety audit shall be carried out. • Only authorized personnel will be allowed in the operation area. • Vocational training shall be given to all operators and workers of the mine. Mining operations shall be carried out under proper supervision. • All the trucks loading and operating machines will have horns. • The mineral will be loaded in trucks mechanically *i.e.* by JCB during mining. There is least possibility of injury to the person during loading operation at mine. • Complete mining operation will be carried out under the Management and control of experienced and qualified Mines Manager. • During heavy rainfall the mining activities will be closed. • All persons in supervisory capacity will be provided with proper communication facilities. • Competent persons will be provided first aid kits which they will always carry. • Mobile Fencing shall be installed during operation at the bench. • Signage shall be installed for all movement areas of machines and everyone on site will be made to wear PPE in these areas. • All machines and vehicles shall be maintained by the maintenance incharge.

1.2 Disaster Management Plan

Safety of mine and the employees is taken care of by the mining rules & regulations as per Metalliferous mines regulations 1961, which are well defined with laid down procedure for safety, which when scrupulously followed safety is ensured not only to manpower but also to machines & working environment. Disaster Management Plans are prepared as proactive measures which help reduce effect of the accident/disaster and enable quicker recovery.

Plans for Disaster Management:

1.2.1 Onsite emergency planning:

An onsite emergency is caused by an accident or hazard that takes place within the plan area and the effects are confined to the plant area.

The onsite emergency plan consists of following key elements:

- Planning as per hazard analysis
- Preventive measures

- Emergency response procedure
- Recovery procedure

On Site plan shall be in place which includes the following:

a. Regular safety audit/inspection

b. Incident Response team and role and responsibility of each member

c. Procedures for taking care of incidents/emergencies

d. Mock drills

e. Assembly point

f. Communication system/arrangement with administrative and regulatory agencies, media and public etc.

g. Siren for declaring/closing emergency.

h. Regular training on first aid and evacuation etc.

Flood

- A training plan will be prepared for mine workers to cope up with the disaster. A mock drill will be carried out before the start of the rainy season so that at the time of disaster workers do not panic and can do pre-assigned jobs regarding safeguard of themselves and others.
- Only limited mining will be done during rainy season.
- The meteorological department gives pre warning on possible heavy rains or floods or cyclones. Hence during any such case the project site will be evacuated or if possible the excavated site will be fenced.
- To prevent inadvertent entry of people near the excavated pits, long poles will be grouted as a sign of excavated site.
- There will be warning signs in local language will be erected at the site to avoid any mishappening. Nearby villagers will be informed.

Waste Dump Management

There is 2% of waste generation which will be utilized at M/s MMPL washery plant after washing so no waste dump will be created at mine site.

Fire Management

There shall be provision of mobile fire extinguishers at the mine office. There will also be buckets for sprinkling sand if there is a fire outbreak as water is not readily available at the site.

Explosive Handling

There is no blasting required. Mining will be done by using excavators only.

Training

Following training shall be provided to the workers from time to time:

- Safety Education & Awareness
- Holding annual safety weeks
- Imparting basic and refresher training to new and old employees respectively.

Communication

Supervisor will be provided with the wireless/mobile phones to communicate in case of any abnormality.

1.2.2 Offsite emergencyplanning:

Offsite emergency plan defines the various steps to tackle any offsite emergencies which may affect surrounding areas of the project has to be prepared after due final discussion with local panchayat and revenue officials

Offsite emergency planning mainly consists of –

a. Contact details of fire brigade, local police, hospitals, local district administration, factory inspector, state pollution control board, state electricity board etc.

b. Demographic details and topography map of the surrounding area.

c. Communication system/arrangement with above mentioned agencies, media and public.

Communication

The telephone numbers and addresses of adjoining mines, rescue station, police station, fire service station, local hospital, electricity supply agency and standing consultative committee members are also maintained for any emergency requirement.

Disaster Management Team

A standing consultative committee will be formed under the head of mines manager. The members consist of safety officer/medical officer/Asst. manager/ public relation officer/ Foreman/ and environmental engineer.

Roles and responsibilities of the team shall be-

- Any abnormality shall be reported to the Top management.
- The management shall make cordial relations with the local authorities, hospitals etc. to help them during crisis.
- There will be communication facilities provided by the management at the mining site for better response time.
- A doctor and supporting staff will be there to provide first aid facilities to the workers in case of any mishap.
- Provision of Ambulance at the site with first aid facilities.

1.3 Occupational Health and Safety

Occupational health and safety deals with the safety and health of the persons employed in the working zone. Working in mines has harmful effects on the health of those employed and there are numerous diseases arising from employment in opencast mines such as silicosis, manganese poisoning, hearing impairment, asthma etc. Some of the hazards are dust, vibration, noise, ergonomics etc.

The personnel employed in the mine are also exposed to a number of hazards at work which may cause them to be involved in an accident due to material handling, machinery etc. as mentioned in Risk Assessment.Accidents cause injuries and can be life-threatening to personnel. Thus occupational health and

safety is a crucial aspect to be considered in mines for the well-being of the personnel involved. Proper measures taken for injury prevention decrease probability and severity of accidents.

1.3.1 Safety Audits and Accident Prevention

Regular safety audits shall be carried out at site to decrease possibilities of hazards causing accidents or injury. All mining activities shall be carried out under proper supervision of mining engineers and safety officers. All personnel involved in mining shall undergo training for mine safety.

1.3.2 Occupational Disease

The reported figures and surveys conducted by Directorate General of Mines Safety (DGMS) and other organizations like National Institute of Occupational Health (NIOH) etc. revealed that there have been some new trends in the occupational health scenario other than the conventional diseases like Respiratory disorders.

Following areas of occupational diseases are emerging with the changes in the mining industry:

- Musculoskeletal Disorder
- Noise induced hearing losses
- Health impact due to diesel particulates from emission of diesel operated vehicles and equipment
- Hand-arm vibration, whole body vibration due to use of drills, HEMM etc
- Presence of snakes and other reptiles in the mining area
- Polluted drinking water
- Excess working load and overtime
- Presence of mosquitos in the lease area
- Sudden accident in the mining area causing personal injury

1.3.2.1 Health measures to be considered

- Sanitary facilities shall be well equipped with suppliers and employees shall be encouraged to wash frequently, particularly those exposed to dust.
- In the event of temporary closer, approaches will be fenced off and cautionary notice displayed in English and regional language.
- Rotation of workers exposed to dusty and noisy areas.
- First aid facilities in the mining areas.
- Provision of personal protection devices to the workers. The personal protection equipment being provided are –

S.No.	Item	Equipment
1.	Face protection	Face Shield
2	Eye protection	Different types of goggles used for different purposes.
3.	Ear protection	Ear plugs, ear muffs
4.	Leg Protection	Safely shoes, gum shoes
5.	Working at height	Safety belts
6.	Head Protection	Safety helmets
7.	Protection from Dust	Dust Mask

- Periodic medical examinations shall be conducted for all personnel, and specific surveillance programs instituted for personnel potentially exposed to health hazard. The medical examination required to carry out at the time of appointment of every employee. Provided that in case any dust related disease, test shall be conducted more frequently as the examination authority deems necessary.
- Medical camp will be organized for the worker every year.
- At the end of mining operation, test will be conducted to assess health of workers.
- Workers will be informed and trained about occupational health hazards, if identified.
- Any worker's health related problems will be properly addressed.
- The personnel working in dust prone areas will be examined every year as per the DGMS circular No.01 of 21.01.2010.
- Quick-Fix designed by OSHA's ergonomics standards will be followed to reduce work-related musculoskeletal disorders (MSDs).
- Rotation of workers exposed to high noise areas will be carried out.
- Lyophilized Polyvalent Anti snake venom serum will be available at the mine site for snake bites.

1.3.3 Activities posing risks during mining

1.3.3.1 Loading and Excavation of Mineral

Affected Personnel: All operators of machinery for loading and excavation are at high risk. All helpers and other personnel in the mine are at moderate to low risk.

S.no.	Hazard Identified	Severity (1-5)	Likelihood (1-5)	Severity x Likelihood (1 x 25)	Proposed Mitigation
1	Injury due to Falling of rock from the boom of excavators	4	2	8	• Cabin shall be provided on all excavators/ other machinery so that no rocks hit the operator • All operators and other workers in close proximity shall be trained in their jobs and wear all PPE
2	Accidents due to bench Collapse due to undercutting of Benches	1	2	2	• Undercutting shall be avoided by mine supervisor
3	Accidents due to movement and operation of Heavy Machinery	4	4	16	• Signage in all movement areas of machines • Areas of movement of vehicles shall be marked and everyone in the site will be made to wear PPE at all times when present in

					these areas. • Only authorised/ designated personnel shall be allowed in the operation area • Reverse horn shall be installed on all machines prior to their deployment for operation • Vocational training to all operators and workers of the mine.Awareness programme for health effects on exposure to mineral dust will be organized for employed person as well as for nearby villagers.
4	Dust Exposure	2	5	10	• Personal Protective Equipment (Dust masks) shall be provided to workers and water sprinkling shall be carried out in working areas.
5	Exposure to Noise	2	5	10	• Mining operation do not include any major source of generation of noise in the working area, thus noise levels are not of significant levels. However, ear plugs will be provided to all workers in the area. • Audiometry test of the workers shall be done regularly & medical health provided wherever required.

1.3.3.2 Transportation of Material

Affected Personnel: Drivers and operators of machinery are at high risk from this activity. All other personnel working in the mine are at moderate risk by this activity.

S.No.	Hazard Identified	Severity (1-5)	Likelihood (1-5)	Severity x Likelihood (1 x 25)	Proposed Mitigation
1.	Injury due to falling of minerals from truck	4	2	8	• It shall be ensured by senior personnel that trucks are not overloaded. • Material outside the mine shall go in a covered truck; covering shall be done by

					tarpaulin.
2.	Accidents due to movement of vehicles	3	3	9	• Signage of vehicular movement areas. • PPE shall be worn by operators and workers in these designated areas.
3.	Injury due to falling of machines/ vehicles from bench and in the working area	4	3	12	• Use of helpers during reverse operation of the machine • Working bench width shall be kept adequate to the width and turn of the vehicles/machines • Overcrowding of vehicles shall be avoided near loading areas.
4.	Brake Failure	3	1	3	• All vehicles/machines shall be maintained by the maintenance incharge.
5.	Speed control	3	2	6	• Speed of vehicles will be restricted below 25 km/hr to mitigate dust generation while transporting of mineral.

1.3.4 Plan for Accidents

Mining site shall arrange for /provide at least the following to mitigate any accident that occurs due to operation:

1. First Aid facilities at site
2. Ambulance
3. Tie up with primary health center for immediate treatment
4. Strict implementation and training of a detailed on-site emergency plan. The Plan shall be prepared by a competent agency.

1.3.5 Monitoring Mechanism

Following Activities shall be done by the proponent as a proactive measure for mitigation of Occupational Risks:

1. Six monthly monitoring of Exposure levels (Total Suspended Particulate, Fraction of Fine Dust {$PM_{2.5}$}, Ultra-fine dust {PM_1}) of high risk workers of all activities. In case necessary a onetime chemical speciation of the dust shall be done to measure levels of Sulphates, Lead, Nickel, Arsenic, Silicates in the dust collected etc.
2. Six Monthly Health check-ups for all workers which includes Chest X-Ray, Lung Function Test, ENT Check-ups, Vision Check-ups, Audiometric Tests, Liver and Kidney Function Tests, ECG, Blood Sugar etc.
3. Six Monthly Check-up of Drinking water for the site workers to ensure compliance to IS 10500:2012 standards