Risk assessment report

1.1 Risk assessment

Risk assessment is essentially a process for identifying assessing and controlling risks in the work place. Mining and related activities are associated with several potential hazards to both employees and the public at large. A worker in a mine should be able to work under conditions which are pleasingly safe and healthy. At the same time the environmental conditions should not spoil his working efficiency. This is possible only when there are sufficient safety measurements taken in mine. Hence mine safety is one of the most crucial aspects of working mine. Gare Palma Sector II Coal Mine is proposing Open cast and Underground mining operations, indeed safety of the mine and employees are taken care by the Metalliferous Mines Regulation 1961 and its subsequent amendments.

1.2 Objectives

Hazard Identification and Risk Assessment is aimed at identifying hazardous chemicals quantifying the consequences of mine operations. The specific objectives of the study are:

- Identification and assessment of major accident hazard potential in the mine operations.
- Identification of major failure scenarios
- Consequence Analysis of the scenarios with respect to dispersion of released gases, areas affected by fire or explosion etc.
- The report includes a description of the hazards arising out of the activity together with an account of the controls that are in operation.

1.3 Inventory at Site

The inventory at the project site is given in the **Table 1.1.**

Table 1.1
Storage Capacity in project site for the proposed Mine Area

Name of Hazardous Materials & Location	Nature of Hazard	No. of Storage Units	Capacity of storage per unit (KL)	Total Storage Capacity per unit (KL)
HSD (High Speed Diesel) Stored at Utilities	Fire & Explosion	3 No	100	100

1.4 Hazard Identification and Preliminary Hazard Analysis

1.4.1 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.

1.4.2 Identification of Major Hazardous Units

Hazardous substances may be Flammable substances, which are given in **Table 1.2.**

Table 1.2
Summary Table on the Inventories

Chemical	Codes/ Label	TLV	FBP	MP	FP	UEL	LEL
						%	
HSD (High Speed Diesel)	Combustable	800 ppm	215 - 376 °C	NA	55 °C	6.0	0.6

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

1.4.3 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. 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 1.3.**

Table 1.3
Properties of Fuel employed

Raw Material	Health Hazard N_h	Fire Hazard N_f	Reactivity Hazard N_r
HSD (High Speed Diesel)	1	2	0

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

1.4.4 Identification of Major Hazard Installations Based on Manufacture, Storage, and Import of Hazardous Chemicals (MSIHC) Rules 1989 and the Amended Rules in October 1994 and January 2000

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

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

A systematic analysis of fuels and their quantities of storage has been carried out, to determine threshold quantities as notified by MSIHC Rules 1989 and amended rules in 1994

and 2000 and the applicable rules are identified. Indicative Criteria for Identification of Toxic, Flammable and Explosive Chemicals (MSIHC Rules 1989) is given in **Table 1.4.**

Table 1.4
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) LC_{50} (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 ^{o}C and which remain liquids under pressure, where particular processing conditions, such as high pressure and high temperature, may create major accident hazards			
c. Explosives				
Chemicals which may explode under the effect of flame, heat or photo-chemical conditions or which are more sensitive to shocks or friction than dinitrobenzene.				

Based on the indicative criteria inventory (liquids/fuels) stored in proposed site has been analyzed for applicability of MSIHC Rules 1989 and the results are summarized in **Table 1.5**.

Table 1.5
Applicability of MSIHC Rules to Storages

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**
HSD	3 (2(e)(iii),5 and 6(1)(a) /)	255 T	2500 T	20,000 T
*Expected Quantity to be Stored for a week				

From the above table it can be inferred that HSD tanks does not (with capacity 255 T) attract rules 2(e)(iii), 5 and 6(1)(a) and 7-15, as the stored quantities are less than that of the stipulated threshold quantities

1.5 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 1.6** along with the sources.

Table 1.6
Short listed Hazards

Nature Of Hazards	Sources & Location
Fire Hazards	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.

1.6 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.

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.

1.7 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 shown in **Table 1.7.**Damage criteria in **Table 1.8.**

Table 1.7
Mathematical models and analytical models for Hazard Analysis

S. No	**Explosions**	
1	Pool fire	Fire ball

Table 1.8
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, 1st degree burns			
1.6	No discomfort even after long exposure			

1.8 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 1.9** and the capacity of HSD storage tank is given in **Table 1.10.**

The Health (N_h), Flammability (N_f), Reactivity (Nr), and MF (Material Factor) for HSD considered 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 1.9
F&EI of fuels used for the proposed Mine Area

Chemical/Fuel	NFPA Classification				GPH	SPH	*F&EI	F&EI Category
	N_h	N_f	N_r	MF				
HSD	1	2	0	10	1.1	1.4	50.4	Light
FEI = MF *(1+GPH) * (1+SPH)								

The F&EI values are ranked into following categories

Table 7.10
F&EI Category

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

1.8.1 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.

1.8.2 Pool Fire of HSD Storage Tanks

Three storage tanks of HSD with a capacity of 100 KL is considered for the 4 DG sets of 2500 kVA and HEMM (Heavy Earth Moving Machines) for proposed Gare Palma Sector II Coal mine. 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 due to leakage gets ignited.

Scenario: HSD tank is on fire

Site data:

Location: RAIGARH CHHATTISGARH, INDIA
Building Air Exchanges per Hour: 0.46 (unsheltered single storied)
Time: January 8, 2017 20:37 hours ST (using computer's clock)

Chemical data:

Chemical Name: TRIDECANE Molecular Weight: 184.36 g/mol
PAC-1: 0.0026 ppm PAC-2: 0.029 ppm PAC-3: 2.3 ppm
LEL: 5500 ppm UEL: 47000 ppm
Ambient Boiling Point: 233.5° C
Vapor Pressure at Ambient Temperature: 1.13e-004 atm
Ambient Saturation Concentration: 117 ppm or 0.012%

Atmospheric data: (manual input of data)

Wind: 1.34 meters/second from E at 3 meters
Ground Roughness: open country Cloud Cover: 5 tenths
Air Temperature: 33° C
Stability Class: D (user override)
No Inversion Height Relative Humidity: 50%

Source strength:

Leak from hole in horizontal cylindrical tank
Flammable chemical is burning as it escapes from tank

Tank Diameter: 2.0 meters Tank Length: 3.5 meters
Tank Volume: 11.0 cubic meters
Tank contains liquid Internal Temperature: 33 °C
Chemical Mass in Tank: 7,496 kilograms
Tank is 91% full
Circular Opening Diameter: 2.5 inches
Opening is 0 meters from tank bottom
Max Flame Length: 14 meters Burn Duration: 53 minutes
Max Burn Rate: 142 kilograms/min
Total Amount Burned: 7,496 kilograms
Note: The chemical escaped as a liquid and formed a burning puddle.
The puddle spread to a diameter of 6.9 meters.

Threat zone:
Threat Modeled: Thermal radiation from pool fire
Red : 11 meters --- (12.5 kW/ (sq m))
Orange: 21 meters --- (4.5 kW/ (sq m))
Yellow: 36 meters --- (1.6 kW/ (sq m))

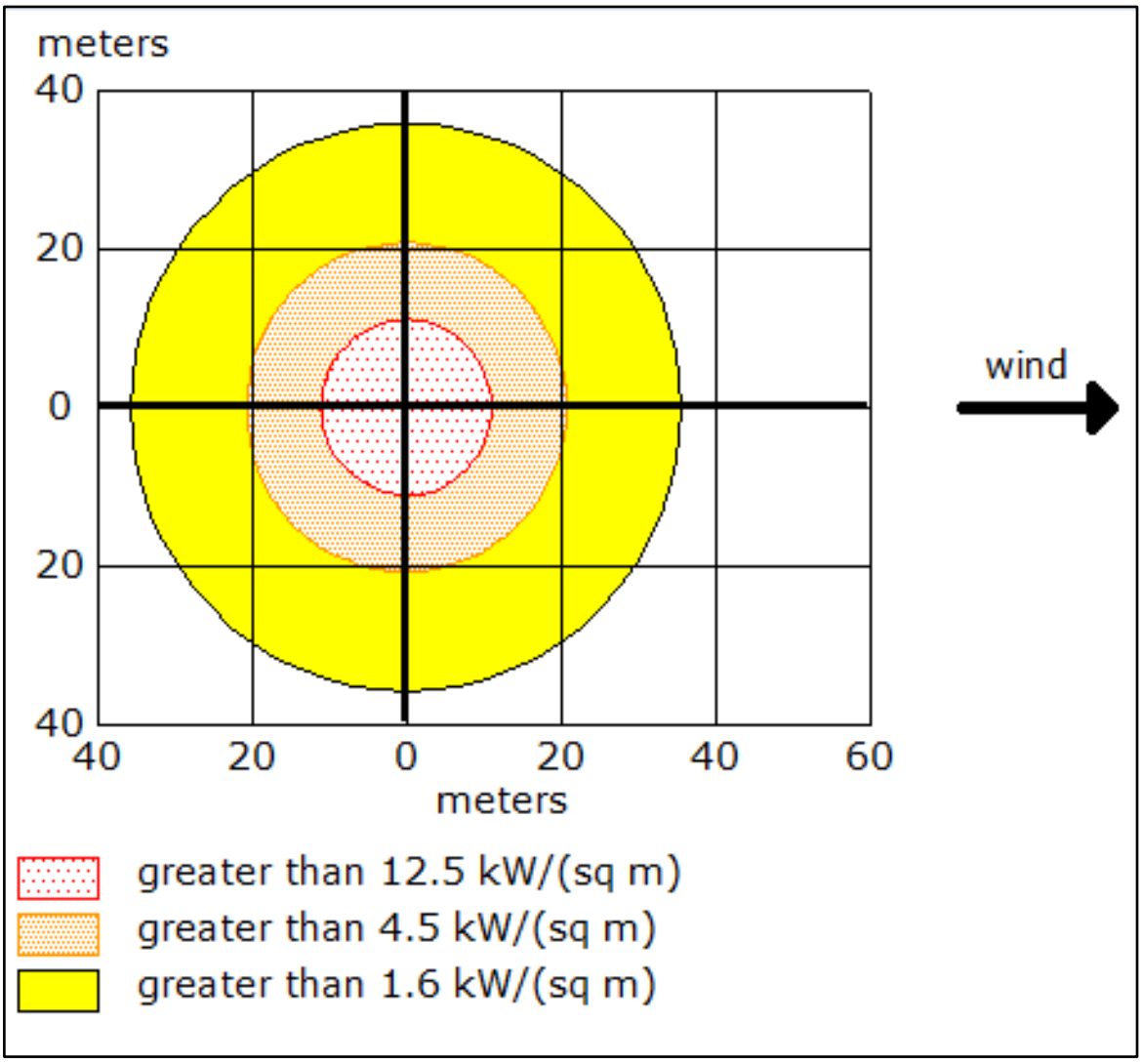
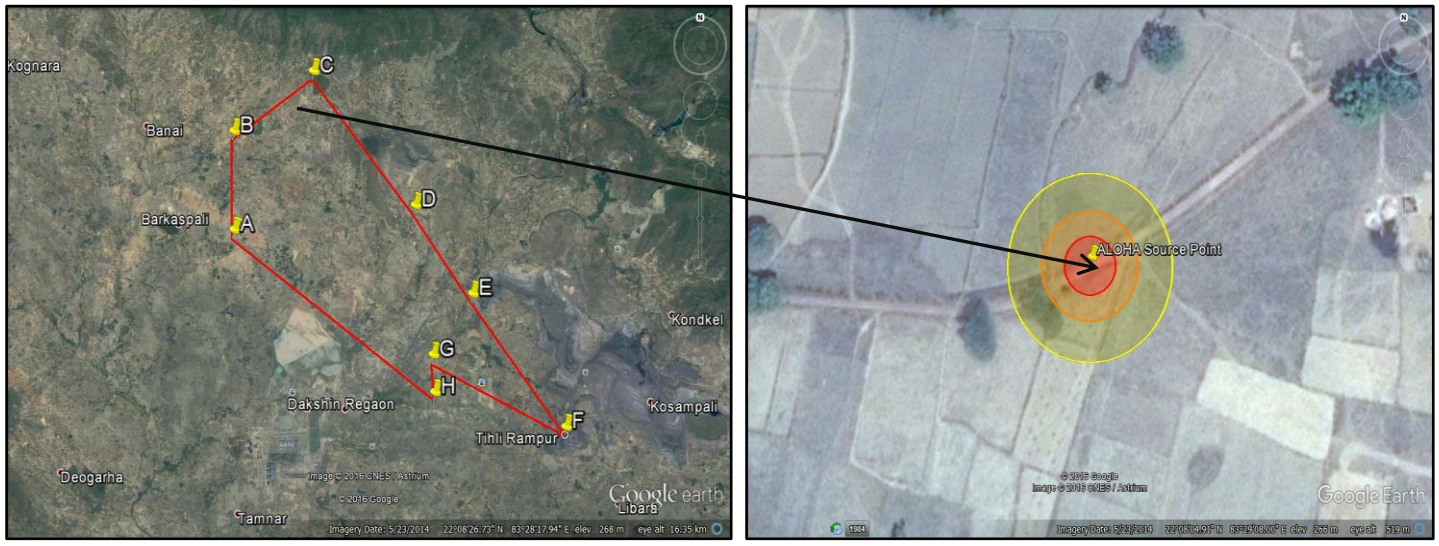


Figure 1.1
Risk & Hazard Scenario may possibly occur due to HSD tank on fire



THREAT ZONE:
Red: 11 meters --- (12.5 kW/ (sq m)
Orange: 21 meters --- (4.5 kW/ (sq m)
Yellow: 36 meters --- (1.6 kW/ (sq m)

1.9 Hazards in Mines

The mining industry has witnessed innumerable number of accidents which are categorized simple & fatal. Even though high priority was given to safety in true spirit, all kinds of accidents occurs. Accident of hazardous situation may arise due to occurrence of any one of the following cases.

- Outbreak of fire
- Inundation
- Air blast
- Sudden rush of back fill material
- Machineries, Heavy materials, Electrical installation etc

1.9.1 Outbreak of fire

Outbreak of fires is generally caused due to electrical fault, mechanical friction, blasting, welding, explosions etc. Outbreak of such a fires in an open gallery of a mine generates huge quantity of toxic gases & smokes.

1.9.2 Machineries, Heavy materials, Electrical installation etc.

Machine failures are common in all industries. The reasons for certain accidents were recognized for mechanical failures. A machine which has not been conducted periodical maintenance and service may leads to an accident. Accidents were also due reckless handling of machineries, heavy materials. Electricity was the heartbeat of mines. If any power failure occurs in underground mining that would result in the death of thousands of workers.

1.10 Risk management in the proposed mine

1.10.1 Measures against the outbreak of fire

- Surface workshops, diesel filling station, and compressor house, electrical sub-stations are provided with firefighting equipment's and are maintained regularly.
- Dry vegetation is not allowed within 15m from any of the entrance to the mine, diesel storage and magazine house.
- Regular inspection will be done to remove accumulation of greasy material, cotton waste; old conveyor pieces, waste hosepipes, wooden scrap etc. are checked regularly.

Adequate number of persons will be trained in firefighting activities. Mock drills will be conducted on regular basis.

On the appearance of signs indicating that a fire has broken out, all persons other than those whose presence in the mine is deemed necessary for dealing with the fire shall be immediately withdrawn from the mine.

Firefighting operations will be carried out under the supervision of competent person along with trained firefighting personnel.

A sufficient supply of sand or incombustible dust or sufficient portable fire extinguishers shall be provided at every entrance of the mine, canvas grease, oil or other inflammable material is stored. Provision for water under pressure will be provided at suitable locations. Suitable types of fire extinguishers are provided at different locations to deal with any kind of fire.

1.10.2 Precautions against seepage of water

A water draining plan showing the following features will be maintained as required by the regulations.

- The position of workings.
- The position of every dyke, faults and other geological disturbances, with the amount and direction of throw.
- Every source of water such as river, stream, water course and reservoir-water logged opencast workings on surface and also the outline of all water logged workings measured in any direction.
- Every reservoir, dam or other structure, either above or below ground, constructed to withstand a pressure of water or to control an inrush of water, along with reference to its design and other details of constructions.
- Surface contour lines drawn at vertical intervals not exceeding five meters.

1.10.3 Precautions against Machineries, Heavy Materials, Electrical Installations

Suitable overhead crane for lifting and transportation shall be provided where materials are handled. Proper tools and tackles are used with well-trained man power. Precautionary instruction shall be displayed on boards, near the potent moving machinery, hazards etc. Proper guards are provided on moving parts of machinery and equipment. Required electrical hazards prevention arrangement is followed and maintained on continuous basis that is zero open connections, suitable joint insulations and easy access to control panels etc., suitably precautionary instructions are displayed on board near the potent electrical hazard etc. suitable electrical protections shall be provided as required by statue.

1.10.4 Precautions against dust, waste, oil etc.

Dust is suppressed at the place of formation for that purpose wet drilling will be done; water is sprayed on conveyors and at crushing and screening site. Proper dust extraction system is installed in the crushing and screening plant. Machineries are installed on impervious flooring waste oil is collected in impervious pits with sand, spillage is kept bare minimum. The pits are cleaned periodically while charging oil for machines as per the schedule; waste oil is collected in cans and sent to the waste oil-refining unit separately.

1.10.5 Personnel safety & General

Necessary safety equipments like mask, helmet and boots are provided to all the employees working in the mining site as well as other locations. Persons are authorized for various skilled works. Suitable guards to prevent danger adequately fence every exposed part of any machinery used as or forming part of the equipment of a mine. Only authorized and trained persons are permitted to operate and maintain equipments. Danger signs are displayed at appropriate locations.

1.10.6 Safety Management

Safety management for mining operations is governed by a very well defined set of rules and regulations etc. framed by Government of India and modified time to time. All the operations in any metalliferous mines are carried out under the mines act 1952, rules and regulations framed under it. Metalliferous mines regulations is a comprehensive legislation framed under the mines act and it takes care of the technical and safety aspects of the mining operations.

1.11 Safety aspects and disaster management

All types of industries face certain types of hazards which can disrupt normal activities abruptly and lead to disaster like fires, inundation, failure of machinery, explosion to name a few. Similarly coal mines also have impending dangers or risk which need be investigated addressed, disaster management plan formulated with an aim of taking precautionary steps to avert disaster and also to take such action after the disaster which limits the damage to the minimum.

1.11.1 Inundation

There is one prominent water course passing through the eastern part of the block i.e. Kelo river. An action plan is needed to be drawn as a contingency measure. A stand by diesel generator will be provided for un-interrupted supply of power to the pumps in the event of failure of power.

The mine working will be protected from the river inundation by providing embankments on either side of the river. The embankments will have 3m height and 10m width. Adequate measures to protect the mine workings from surface water flow during the rains will be taken by way of providing garland drains around the mine excavations and also by providing suitable drainage gradients for mine benches. Sumps of adequate capacity will be provided on the quarry floor. The coal excavation and transport machinery are organized to be sited over the coal bench top and will not be affected by water accumulation from rains or strata seepage.

No water accumulation in OC mine workings will be allowed to remain when the UG mining operations are in progress. Hence there is no danger of inundation from these rivers.

1.11.2 Disaster due to failure of pit slope

The proposed OC mine is planned for future 29 years period operation. The ultimate depth at the end of mining operation will be upto about 205m; the general surface level varies between 190 and 200m RL.

Slopes of pits (opencast mine) with such depth can cause pit slope failures thus endangering the safety of the mine. This problem has been overcome by changing over to inside dumping (backfilling) at the early stage from 6th year of mine operation. All of the OB waste has been planned to be backfilled combined with rehandling which will act as support to the pit slope.

Strict vigil will be kept by reconnaissance surveys especially in rainy season to detect any impending danger so that the men and equipment can be accordingly moved out of danger area in time.

1.11.3 Disaster due to failure of waste dump

There are two types of waste dumps which are discussed below:

1. Surface dump

Sliding of surface waste dump is an equally severe risk compared with quarry slope failure. Hence, it is imperative that the degree of hazard against potential failure of waste dump slope should be identified and that precautionary measures are to be adopted, if required.

The surface waste dump will be located within the ML area over the dip part of the block. The temporary dumping is proposed to be carried out upto 100m height. The waste dump will be rehandled between 7th and 20th year however a part of it will be stabilized by tree plantations and other arrangements as detailed below:-

- Drains will be made on the top of waste dump to arrest uncontrolled descent of water to drain away during rainy season through specially made chutes. Besides gullies (chutes) will be cut for flow of water from the waste dump slowly to channelize it to garland drain. This precaution is necessary to prevent erosion of waste dump here and there due to erratic flow of rainwater.
- On the slope of the dump, small pits of 0.3 x 0.3 x 0.3 m will be cut and seedlings will be planted and also over the 1.5m width of top from edge of the bench similar plantation shall be done so that the top of the waste dump slope will get stabilized.
  A stone toe wall will be made all around the waste dump to prevent waste dump material being carried out of the dump area and mixing with the general drainage system of the area.
- A garland drain will be constructed all around the waste dump area for smooth flow of water.
- The overall slope of dump sides will be kept below 28°, each their being at 37°.
- Though the height of the surface dumps will be 100m, with the help of additional precautions being taken as mentioned above, there is no dangers of the slope failure of the surface dumps.

2. Backfill dump

The height of the backfill dump will be maximum upto about 180m which will, though, be supported at the sides by quarry batters but the main advancing front of the backfill dump towards dip side will be amenable to slope failure. No danger is anticipated for the equipment or manpower because the backfilling will start only after total coal evacuation from the Quarry. The dump will be planted as soon as ultimate height (surface level) is achieved. It is planned not to have overall gradient of the dump more than 28°.

A systematic study will be commissioned to study the various slope stability parameters to reach at the optimum slope angle during the mine operation period. Appropriate factor of safety will be adopted supported by sensitivity analysis of critical parameters. It is also proposed to monitor the backfill dump with latest geo-technical/surface/equipment e.g. Bore hole extensometer, tape extensometer, EDM, Piezometers, Theodolites etc. The monitoring will commence as a part of safety measures.

1.11.4 Disaster due to surface fire/coal stack fires

Sufficient fire extinguishers will be installed at selected locations on surface like Electrical Sub-stations, work-shop, Garage, Diesel Depot, Stores etc. Besides, sufficient number of water hydrants with sufficient hose pipes will be made available in the surface for fire protection.

In order to prevent fire hazards in coal stock piles, following types of precaution shall be taken.

1. Prevent the happening or presence of any external source of fire in the vicinity of coal stockpiles i.e.
   - naked fire
   - electric fire
   - fuel oil fire

In case of electric equipment operating in the vicinity of fuel oil being used or stored in the vicinity of the coal stock piles, appropriate types of fire extinguishers will be provided on or near such equipment in order to extinguish the fire at the very start.

2. Restrict the stacking height of the coal to below two meters. Higher height may only be attempted for shorter interval of stacking.
   The time and height shall be established with respect to spontaneous combustion which will help in restricting to safe parameters.
3. Appropriate arrangement will be made by inserting pipes in the stack to monitor the internal temperature of coal. In case, temperature is found to shoot above safe limits, the coal from the part of stack shall be immediately dug out and disposed safely.
4. In certain mines, the insitu coal exposed in coal bench catches fire due to spontaneous heating which has to be kept under vigil. Under such circumstances the affected area of coal shall be separately dug up and disposed off safely.

1.11.5 Possible dangers due to storage of explosives in the magazine

Since site mixed slurry will be used, there will be no requirement of large storage facilities. However a 2 X 20 T capacity magazine is to be provided for the storage of primers detonators, fuse etc.

The explosive magazine is designed in such a manner that normal chances of fire inside the magazine ruled out. Still following precaution are taken:

- Clearance of dried vegetation within 15m of Magazine House.
- Installation of lightening arresters on the Magazine to prevent damages in the event of an explosion.
- Provision of fire extinguishers, water and sand filled buckets.
- Arrangement of mounds around the magazine to mitigate damage in the event of an explosion.
- Keeping a safety zone margin around the Magazine as per the guidelines given in Schedule VIII of The Explosives Rules, 1983. The safety distance of 605m will be maintained from the public establishments.

1.11.6 Storage and use of explosives

Do's

1. Store explosives only in licensed magazine.
2. Always maintain magazine in good condition.
3. Always keep gangway of 60cm between stack of explosives boxes and wall.
4. Mark license no. And validity prominently on licensed premises.
5. Mark 12mm thick red line 2.5m above floor level inside the magazine and do not stack explosives boxes above it.
6. Always keep stock of explosives within licensed capacity.
7. Always issue old explosives first.
8. Provide security guards round the clock.
9. Keep security guard's shelter at a distance of 30m from magazine.
10. Always sell explosives to person/firm having valid license.
11. Always report loss, theft or short receipt of explosives to controller of explosives and police.
12. Always take precautions to prevent mechanical impact of any hard object with explosives.
13. Always employ certified blaster for blasting operations.
14. Mark '**danger – explosive'** and '**turn off radio transmitter'** at the site.
15. Sufficient warning like display of red flag, whistle sound shall be given to public before blasting. Also display blasting time.
16. Suspend blasting operations during thunderstorms.
17. Blasting schedules should be arranged in such manners that all holes charged with explosives are immediately blasted on the same day. In case, for any reason, such charged holes cannot be blasted on the same day, these sleeping holes charged with explosives should be properly guarded from a suitable safe distance, till the same are blasted.
18. Always return unused explosives after day's work to the magazine before sunset.

Don'ts

1. Don't sell explosives to blaster on the strength of the shot firer's permit.
2. Don't sell explosives to unauthorized person.

3. Don't undertake construction of building for manufacture or storage of explosives unless you obtain construction approval from licensing authority and NOC from district magistrate.
4. Don't abandon any explosive material after use at site.
5. Don't store explosives outside magazine.
6. Don't use sparking tools.
7. Don't throw, drop boxes of explosives.
8. Never use bale hook during loading/unloading of explosives boxes.
9. Don't cut explosives cartridges or change description of explosives.
10. Don't deface markings on cartridge or box of explosives.
11. Don't store high explosives and detonators together.
12. Don't use misfired explosives.
13. Don't use deteriorated or exuded explosives.
14. Don't attach detonator to detonating cord until everything is ready for blast.
15. Don't use mobile phones/pagers near place of storage and use of explosives.
16. Don't use iron implements during preparation of charges.
17. Don't deliver explosives unless photograph and signature of authorized person are verified.

1.11.7 Transport of explosives

Do's

1. Always maintain transport vehicle in good mechanical & road worthy condition.
2. Always carry two fire extinguishers in explosives van.
3. In case of breakdown of explosives van, inform controller of explosives and local police.
4. Always carry following documents during transport of explosives:
   a) Indent in form RE-11
   b) Pass in form RE-12
   c) Copy of explosives van's license.
   d) Bill/invoice.
5. Two armed guard should always accompany explosives van during transport of explosives. In sensitive area notified by MHA, the police armed guard shall be provided.
6. Employ only trained driver and cleaner, whose antecedents are verified by police.
7. Always maintain 300m distance between two vans carrying explosives.
8. Always load/unload explosives only when explosives van's
   a) Engine of the vehicle is stopped.
   b) Wheels chocked.
   c) Hand brakes applied.
9. Always avoid routes passing through centre of dense habitation and municipal limits.
10. Always give notice of accident to controller of explosives, District Magistrate and police.

Dont's

1. Don't stop explosives van un-necessarily or for longer duration during transportation on road
2. Don't transport flammable substance with explosives.
3. Don't transport detonators with other type of explosives.

4. Don't carry passengers while transporting explosives in van.
5. Don't employ any person:
   a) Who is below 18 years of age
   b) Who is in state of intoxication
   c) Who is mentally or physically challenged
6. Do not transport explosives in the night (from Sunset to Sunrise) in the sensitive areas notified by Ministry of Home Affairs (MHA).

1.12 Catastrophic Events

1.12.1 Fires in Forest

Forest fires are a common feature in forested mountain areas. In the project area of there is no evidence indicating extensive fire causing damages to habitats in the recent historical period. The people in the surrounding villages & who will be deputed for mining activity will be provided with adequate knowledge about the pre caution and preventive measures.

1.12.2 Floods

No catastrophic events due to floods have occurred in the project area. The project area does not fall under very heavy rainfall area. The Kelo river catchment comprises mostly forest areas with steep slopes which do not allow the flood waters to inundate the areas causing damages. Hither to no record of evidences available as to the damages due to flood in the area.

1.12.3 Earth Quakes

The project area falls within seismic zones III as per seismic zoning map of India. Historically and instrumentally recorded data on earth quake show that the project site area and its neighborhood falls within the Narmada- one lineament zone which passes through the central India from west to east and is seismically active. The region experienced earthquakes up to a magnitude of 6.5. The list of prominent amongst these is given in **Table 1.11.**

Table 1.11
List of Prominent Earthquakes

S .No	Location	Magnitude	Damages
1	Damoh in May 1846	6.5	Not felt in the region
2	Stone valley Earthquake of 2nd June 1927	6.5	Not felt in the region
3	Satpura Earthquake of 14th March 1938	6.3	Not felt in the region
4	Balaghat Earthquake of 25th August 1957	5.5	Not felt in the region
5	Jabalpur Earthquake of 22nd May 1997	6.0	Not felt in the region
6	Earthquake on 6th April 2000 around Bilaspur	4.0	Not felt in the region