RISK ASSESSMENT

RG OC-III Expansion

1.0 IMPORTANT SAFETY ASPECTS

The proposed RG OC-III Expansion Mine involves extraction of coal by opencast method of virgin coal seams and seams developed and depillared by underground method. As such, the safety risks involved with OC Method are studied in detail and remedial measures are suggested.

1.1 Risks associated

The major risks associated with opencast method are

- Extraction of already developed coal pillars.
- Movement of HEMM
- Drilling and Blasting Operations
- Slope Stability
- Inundation
- Working near Faults

The measures to be taken to mitigate the risks are explained in detail below.

1.1.1 Extraction of Already Developed Coal Pillars:

While working in the area where coal seams are developed, adequate safety precautions will be taken to ensure safety of men and machinery. Different safety rules in force and regulations made under Mines Act, 1952 will be strictly complied. Various precautions as laid down in DGMS circulars issued from time to time in this regard will be followed. The problems associated with extraction of standing pillars by opencast method are due to the following activities/reasons.

- Spontaneous heating & fire
- Deployment of HEMM
- Coal dust explosion
- Collapse of parting
- Drilling & Blasting

1.1.1.1 Spontaneous Heating and Fire During Extraction of Already Developed Coal Pillars:

In the old workings, due to long standing developed pillars, blasting and movement of heavy machinery creates fractures in the intervening parting and pillars. In this fractured zone, auto oxidation and heat build-up occurs resulting ultimately into open fire. The crushed coal in the developed workings might catch fire due to spontaneous heating. The main factors attributable to the bench fire due to spontaneous heating are:

- Presence of micro/macro cracks in bench walls
- Long exposure of bench walls to the open atmosphere accumulation of loose coal on the bench floor.

Precautions/Remedies to be taken for prevention of spontaneous heating and fire are furnished below.

- Orientation of benches in the quarry shall be along strike direction to maintain water level in the UG workings up to one pillar from active OC workings to prevent spontaneous heating/fire.

  - In the present proposal, the bench orientation is maintained along the strike direction keeping in view of the spontaneous heating and following strictly.

- Where seams are liable to spontaneous heating, a minimum coal bench exposure will be maintained. As far as possible, optimum quantity of blasted coal will be made available.
- In case of any indication of fire in pilot boreholes, the seams will be drowned with water. During de-watering with the advance of quarry face, slow rate of de-watering will be maintained to prevent water gas explosion.
- Exposed galleries will be blanketed with overburden.
- To lower the chemical activity of coal, the exposed coal will be treated with anti-pyrogen like Hygroscopic – Calcium Chloride, Magnesium Chloride, Sodium Chloride & Dolomite powder.
- Fire fighting plan will be prepared and will be implemented to combat anticipated and unexpected fires.
- Separate Fire Fighting crew will be trained for fighting the fire in UG developed area.
- To deal with fires, various control techniques like digging out, trenching, sealing, hydraulic sand-stowing, flushing with water/bentonite mixture through boreholes, inert gas infusion and isolation will be followed.
- Fire fighting ranges will be laid along the spoil heap side and along high wall with sufficient water pressures.

1.1.1.2 Further, the following precautions are taken to control the fire:

- Exposure of coal is restricted to a limited area.
- Fire quenching at the face is done with high-pressure, high-discharge jets.
- Fire fighting ranges are laid along the spoil heap side and along high wall with sufficient water pressures.
- After blasting, coal bench is compacted to prevent breathing of air.
- In each shift, a fire fighting crew with a supervisor is engaged for fire fighting and quenching works.

A Fire tender is provided to deal with fires. Necessary fire fighting system is also envisaged for the Coal Handling Plant (CHP), which includes fire hydrant tees at strategic locations at equal spacing of 25 to 35 meters with suitable water supply pipelines. Also portable type fire extinguishers to deal with electrical / oil /ordinary fires are provided at all strategic locations in the plant. Also automatic fire extinguishers are provided on the HEMM for continuous monitoring and operating the system.

1.1.1.3 Deployment of HEMM During Extraction of Already Developed Coal Pillars:

HEMM is bigger in size and heavier. Collapse of parting over developed pillars takes place due to heaviness of machinery. The movement of HEMM causes vibrations in the strata leading to cracks and collapse of partings. Cracks and collapses causes entry of air into developed and depillared areas leading to spontaneous heating and fire. The following precautions are taken prevent dangers due to movement of HEMM

- The galleries will be clearly demarcated over the benches with lime, flags, caution tapes with reflectors etc., for safe movement of men and machine.

- HEMM movement will be only over the pillars or over the galleries filled up and compacted with blasted material for safety of men and machinery.
- The thickness of parting in coal will be maintained not less than 6m so as to prevent the heavy machinery from falling into the underground workings.
- Holes will be drilled from the pillar sides and the parting dropped so as to fill in the void for easy working of the heavy machinery.
- Every HEMM used shall be provided with automatically operated fire detection and suppression device or system as per Reg no 139: Equipment for fire fighting of CMR 2017.
- As per CMR 2017, Reg no 135: Surface precautions against fire, will be strictly followed in case of any ground broken by movement of HEMM.

1.1.1.4 Coal Dust Explosion During Extraction of Already Developed Coal Pillars:

Danger of coal dust explosion during extraction of developed pillars by opencast method exists due to accumulation of coal dust in floor of developed galleries and heavy blasting. To preclude any such occurrence, the Directorate of Mines Safety has issued guidelines and precautions to be taken for avoiding danger of coal dust explosion as outlined hereunder:

- As the underground workings are accessible, they will be surveyed, cleaned of coal dust and thickly stone dusted before abandonment.
- Immediately prior to commencement of opencast workings in UG developed area, the area will be properly stone dusted to obviate danger of coal dust explosion due to heavy blasting in opencast mine. For the purpose, holes will be drilled from first OB bench or surface to underground gallery junctions and at least 2 tonnes of stone dust (preferably dry, water proofed limestone or dolomite dust) per hole is pushed down and then dispersed in working with the help of compressed air.

Precautions against danger of coal dust explosion while extracting pillars by opencast method—Vide DGMS (Tech.) Circular No. 3 of 1980.

1. Ahead of the bottom bench in overburden holes should be drilled 18 m apart in grid pattern from top bench in overburden or surface to the underground galleries. The distance between the 1st row of holes and quarry face should be 6 m or less.
2. After holing through of the galleries in coal the drill rod should be withdrawn and at least 2 tonnes of stone dust fed through the borehole.
3. The drill rod should then be lowered through the borehole again so that it is well in the heap of stone dust dropped on the floor of the underground galleries.
4. Compressed air should then be blown at the rate of not less than 20 cu. m per minute under pressure of at least 3.5 kg cm^2 for a minimum 45 minutes. This time can be proportionately reduced if compressed air at higher pressure is available.
5. The steps (2), (3) and (4) shall be repeated with 2 tonnes or more of stone dust dropped in each hole.

1.1.1.5 Collapse of Parting During Extraction of Already Developed Coal Pillars:

The strata between a quarry bench floor and roof of an old underground working may be weak and may collapse as a result of movement of HEMM and equipment may fall in the excavated space of old workings. In case of any fire in underground workings it may lead to accident.
Precautions/ Remedies to be taken to prevent collapse of parting are furnished below.

- A parting of 4m/6m of OB/coal over the developed pillars will be maintained. To ensure the parting advance pilot boreholes will be drilled.
- A plan showing the parting thickness, position of underground galleries and junctions will be marked and maintained.
- Pilot holes will be drilled to know the roof levels of U/G workings. The position of underground standing pillars will be earmarked by drilling additional pilot bore holes randomly in advance of 100 to 200m from coal bench to adopt suitable precautionary measures.
- The above said steps will be strictly followed in RG OC III Expansion Mine and will also implement all the necessary steps to avoid these types of dangers.

1.1.1.6 Drilling and Blasting During Extraction of Already Developed Coal Pillars:

The works of drilling and blasting, including issue and transport of explosives, in the proposed quarry shall be placed under the charge of a person designated as Blasting Officer possessing at least First Class Manager's Certificate of competency.
Drilling and blasting over the underground developed galleries poses a major hazard compared to that of over the virgin patches. Apart from the standard precautions that will be taken during drilling and blasting operations in the opencast mine, special precautions as mentioned below will be taken during extraction of developed pillars.

Precautions/Remedies to be taken to prevent dangers associated with drilling and blasting are furnished below.

1.1.1.6.1 Demarcation of UG workings:

- The thickness of parting over developed seam will be maintained not less than 6m to prevent chances of the heavy machinery from falling into the underground workings.
- The actual working plans of the opencast mine and the plans of the developed underground mine workings will be maintained and checked regularly.
- The galleries and junctions of the developed underground workings will be plotted accurately and clearly on the plan of the opencast workings, and also demarcated on the OB and coal benches.

1.1.1.6.2 Drilling:

- Holes will be drilled in the pillar and the parting allowed to be dropped so as to fill in the void for easy working of the heavy machinery.
- The spacing of the holes in the last overburden bench (immediately above the coal seam) will be adjusted that the holes will not lie immediately above the galleries, as far as possible, to ensure that the blast holes do not directly fire into the underground workings.

1.1.1.6.3 Blasting:

- No blast hole will be connected to galleries. If strata is cracked, bottom 2m of blast hole will be filled with sand.
- For blasting in hot coal strata, special explosives will be used after bringing down the blast hole temperature to below a certain permissible limit (80°C) with the help of water. Blasting operations will be carried out within 2 hours after charging of explosive.
- Slurry/Heat resistance emulsion explosives will only be used in case of blasting in hot strata.
- The manner of extraction of pillars is by drilling and blasting holes in the coal pillars only from top downwards. During blasting bottom initiation system will be adopted.

- No delay detonators will be used for blasting in coal.
- All blast holes in last OB bench and in coal will be charged with water ampoules or with moist sand for at least 0.6m in length, at the bottom of the hole.
- The blasted coal will be evacuated as early as possible.
- Reg no 202: Blasting in fire areas in opencast mines in CMR 2017 will be strictly followed.

1.1.2 Movement of HEMM:

In the proposed RG OC III Expansion Mine coal extraction and OB removal is proposed to be done by HEMM. As such movement of HEMM poses a major risk for safety of persons employed. Measure to prevent accidents due to Trucks and Dumpers are as under:

- All transportation within the mine working will 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 week by the competent person authorized for the purpose by the Management.
- Sufficient lighting and road signs will be provided at each and every turning point especially for the guidance of the drivers at the night.
- To avoid danger to human life while reversing at the embankment and tipping points, these areas will be maintained human free. Human movement in the haul roads will be avoided.
- All statutory provision of the fences, constant education, training etc. will be arranged to reduce accidents.
- Drains will be provided on either side to keep the road dry. Sharp curves will be avoided.
- The haul road width of 30 m has been designed considering space for dozer track, pipes, electric lines, cables.
- Haul roads will be designed in such a way to have one way traffic where ever possible. Where one way is not possible there the haul road will be sufficiently widened.
- Separate haul roads provided for coal and OB transportation.
- Separate way for light vehicles will be maintained.
- Traffic rules will be framed and strictly implemented in true spirit.
- Only properly trained workmen will be employed in the mine.
- Safety gadgets like radium jackets, whistles will be provided to all workmen.
- The safety procedures to be followed by contractor will be incorporated during tendering process itself.
- Reg no 216: “Design, operation and maintenance of HEMM including trucks, tippers and dumpers” will also be strictly followed.

1.1.3 Drilling and Blasting Operations:

In the proposed RG OC III Expansion Mine breaking of Overburden and coal will be done by drilling and blasting system, which involves use of explosives in large quantity. In the top most benches at areas falling within 500 m from village boundaries controlled blasting technique will be adopted for both overburden and coal in order to avoid danger of fly rock.

1.1.3.1 Drilling Operation:

Accidents occur while transporting, positioning of drill machines and during drilling operations. The following precautions will be taken.

While transporting drill machine, its mast will be lowered, even within the drilling area on inclined plane (High gradients) to avoid toppling of drill machine.

- While positioning drill machine on inclined planes, wedges will be used under jack pads for leveling of the drill machine.
- While changing drill rods, proper Holding of drill rods on drill mast is ensured.
- The drilling crew will be provided with radium jackets.
- Holes will be drilled in the pillar and the parting allowed to be dropped so as to fill in the void for easy working of the heavy machinery.
- Blasting Operation

Precautions to be observed during blasting operations

- No blast hole will be connected to galleries. If the strata is cracked, bottom 2m of blast hole will be filled with sand.
- For blasting in hot coal strata, special explosives will be used after bringing down the blast hole temperature to below a certain permissible limit (80°C) with the help of water. Blasting operations will be carried out within 2 hours after charging of explosive.
- Slurry/Heat resistance emulsion explosives will only be used in case of blasting in hot strata.
- The manner of extraction of pillars is by drilling and blasting holes in the coal pillars only from top downwards. During blasting bottom initiation system will be adopted.
- No delay detonators will be used for blasting in coal.
- All blast holes in last OB bench and in coal will be charged with water ampoules or with moist sand for at least 0.6m in length, at the bottom of the hole.
- The blasted coal will be evacuated as early as possible.

1.1.3.1.1 Blasting in fire areas:

Strike orientation of benches is envisaged for holding of water in UG workings thereby preventing fire problem in UG galleries while extraction of pillars by OC. As stated in CMR 2017, Reg No. (202) will be strictly complied with in area where blasting is done in fire areas.

Precautions that are to be followed for blasting in fire areas are given below:

1. (a) No explosive other than slurry and emulsion explosive shall be used.

   (b) Blasting shall be done with detonating fuse down the hole.

2) Temperature inside the blast holes shall be measured (before filling with water) and if the temperature exceeds 80°C, in any hole, such hole shall not be charged. Records of measurement of temperature in each hole shall be maintained in a bound paged book.

(3) All blast holes shall be kept filled with water. When any hole is traversed by cracks or fissures, such hole shall not be charged unless it is lined with an asbestos pipe and the hole

filled with water. In addition, bentonite should be used for sealing any cracks at the bottom of the holes.

(4) Detonating fuse shall not be laid on hot ground without taking suitable precautions which will prevent it from coming in contact with hot strata.

(5) The charging and firing of the holes in any one round shall be completed expeditiously and in any case within 2 hours.

(6) Blasting operations shall be carried out under the direct supervision of an assistant manager**.**

Opencast operations involve heavy blasting in overburden and coal. Most of the accidents in blasting occur due to the projectiles, as they may sometimes go even beyond the danger zone, mainly due to overcharging of shot holes or as a result of certain special features of the local ground. Fly rocks, Vibrations, dust and noise problems are common problems associated with blasting operations.

Proper precautions will be taken by way of posting guards, siren etc. at the time of blasting. Men and machinery will be withdrawn to safer place before blasting. Blasting will be done between shift timings. Proper care in storage, transport and handling of explosives will be taken to ensure safety in blasting operations.

By doing controlled blasting techniques ground vibrations resulting from blasting will be minimized. The peak particle velocity of vibration is now accepted as the more reliable criterion for assessing the damage potential of vibrations. This factor takes into account both frequency and amplitude giving an indication of the level of hazards and fairly accurate indication of the "nuisance" value of the movements.

USBM have statistically established a relationship between peak particle velocity (V) with the maximum charge per delay (W) and the distance of the shot from the measuring point (D).

$$V= H (D/W^{1/2}) B$$

Where H and B are constant and $(D/W^{1/2})$ is called the Scaled 'distance'.

Chargé/hole will be restricted as per distance from villages. Safety zone as required by mining statutes will be ensured.

There are a large number of factors that influence fly rocks. Most important of these factors are long explosive columns with little stemming at the mouth of the hole, irregular shape of face, long water column in holes, loose stones on face of the surface blasting area, and strong wind.

1.1.3.1.2 Measures to Control Ground Vibrations & Fly Rocks:

- Shots will be muffled so that the flying fragments do not project beyond a distance of 10 meters from the place of blasting.
- Optimum delay sequence and stemming to column ratio will be maintained to minimize the fly rock distance and ground vibration intensity.
- Basing on the distance of the nearest sensitive areas from the epicenter of the blast, charge weight shall be altered to meet the stipulated standards.
- Blast hole geometry will be designed considering bench height, diameter of hole, type of explosive, nature of rock, level of fragmentation required etc.
- Total charge per blast will be divided in to several parts so as to keep minimum explosive per delay i.e. use of milli-second delay detonators & relays.
- Concentration of explosive is avoided by using deck charging technique.

- Distance between blasting point and the structure to be protected will be earmarked.
- A free face will be always maintained.
- In multi row blasting, greater relief will be provided between rows using suitable delay intervals.
- All loose debris will be cleared off the blasting site before blasting.
- As per Reg no 196: “Taking shelter before firing shots” will be strictly followed.

1.1.4 Slope Stability

1.1.4.1 Stability of Quarry Benches:

Collapse of sides/slopes is likely to pose problems in the opencast mine. Proper benching and sloping will be ensured to guard against collapse of sides. For stability of benches at low wall side (in crop side) the benches up to 840m RL are designed to have 5m height, 10m berm width and 70° angle with horizontal. High wall benches are designed to have 10m height, 10m berm width and 70^{0} angle with horizontal. The slope of final high wall is at $37^{0}46$’ for better stability. Corridors of 30m width at 100m vertical interval are envisaged to ensure slope stability at high wall side and to serve as access for back filling. Moving front benches are designed with 10m bench height and 40m berm width and for coal transportation and backfilling activities with the haul gradient maintaining at 1 in 16 as per the statute.

- Slope stability radars will be provided for continuous monitoring of high wall benches.
- Drains will be provided to protect the slope surfaces against rain-cuts and seepage during rains. These make a safe way to discharge top and surface water to the bottom of the quarry.
- Constant vigilance will be maintained on the conditions of benches with special reference to accumulation of water and development of cracks.

1.1.4.2 Stability of Over Burden Dumps:

The high overburden dumps may cause landslides. High overburden dumps created at the quarry edge may cause sliding of the overburden dump or may cause failure of the pit slope due to excessive loading, thereby causing loss of life and property.

The following precautionary measures will be taken to ensure slope stability.

External dump:

- Top soil is removed from the external dump area before Start of dumping.
- The floor of internal dump is roughened before start of dumping.
- Hard OB will be dumped with height of decks restricted to 30m.
- Maximum height of external dump is restricted to 120m. The maximum height of internal dump will be 120m above ground level.
- Width of berm is kept at least 30m for stability & also for allowing safe machinery movement.
- Dump slope for each deck to be at natural angle of repose of 37.5º and overall slope will be 25º64”.
- Track Dozers will be deployed for shaping the dumps.
- Planting of trees will be done to improve the stability of dumps to prevent erosion.

- A sturdy stone toe wall is built around the toe of each deck of dumps.
- At the edges of finished decks the slope angle will be flattened by about 5° lower than the angle of repose which varies from site to site but it is generally expected to be around 37.5°.
- Planting vegetation as early as possible over the overburden dump slopes.
- The drainage channels along the overburden dump toe will be maintained to provide additional protection.
- The floor of internal dump will be roughened before start of dumping.

Internal dump:

- Maximum height of internal dump in the will be restricted to 120m above ground level.
- Width of berm is kept at least 30m for stability & also for allowing safe machinery movement.
- Track dozers will be deployed for shaping the dumps.
- Planting of trees will be done to improve the stability of dumps to prevent erosion.
- The floor of internal dump will be roughened before start of dumping.

1.1.4.3 Further, the following precautions will be observed for dump stability

- Run-off from slopes of internal dumps, in-pit slopes and access roads of the project shall be channelled to flow through a common drain into the surface drains.
- Changing the gradient of the topography to be away from the quarry area and OB dumps as barrier.
- Drains will be provided to protect the slope surfaces against rain-cuts and seepage during rains. These make a safe way to discharge top and surface water to the bottom of the quarry.
- Constant vigilance will be maintained on the conditions of benches with special reference to accumulation of water and development of cracks.
- The drainage channels along the overburden dump toe will be maintained to provide additional protection.
- For 37.5° overall dump angle, the factor safety is 1.
- Top Soil/ BC Soil Characteristic studies will be done based on Soil Penetration Tests (SPT) and others as may be prescribed by taking the soil core samples for the calculation of dump parameters in that particular area of dump.
- Planting vegetation as early as possible over the overburden dump slopes.
- The drainage channels along the overburden dump toe will be maintained to provide additional protection.
- Piezometric wells will be established to assess and monitor the ground water levels around the dump.
- Further, bore holes of 30 m depth in 400x 400 m grid pattern are being proposed in the external dump areas and at an interval of 100 m around the periphery of dump for finding out Soil characteristics by conducting Soil Penetration Test (SPT) by collecting

and analyzing the core samples. The soil characterization studies along piezometric data are being used in finalising the dump parameters.

- Besides, recommendations on Pit/ Dump Slope stability studies conducted by CSIRO, Australia in SCCL mines vide CRP/RND/A-98/Workshop/259 dt 31.03.2017 shall also be complied where ever it is applicable.

1.1.4.4 Scientific Studies: Scientific studies were undertaken for RGOC III Extension Project in respect of internal and external slope stability by CIMFR, Dhanbad. The following additional recommendations were made.

- The slope stability condition of internal dump should be reviewed after achieving 120m.
- Preferably no coal ribs should be left: if unavoidable it should be punctured at 50m interval to prevent accumulation water.
- Better water management is required by providing horizontal holes with perforated pipes at 10m interval, puncturing the coal rib at the lower level of the dump.
- The water accumulation in the de-coaled floor of the quarry should be checked /minimized by ensuring natural gravitational drainage of water towards the main sumps. It will prevent the dumping in water to increase the dump slope stability condition.
- The interface layer i.e., debris of coal dust, fragmented rock, soil mixed with water should be cleared as far as possible from the de-coaled floor before dumping by dragline.
- The dumping by dumpers should be at least three dragline heaps away.

1.1.5 Inundation from the surface water:

There is a remote chance of inundation for proposed RG OC-III Expansion Mine workings due to inrush of surface water in the rainy season and also stagnant water in underground mines since provision is made in FR for adequate pumping arrangements. The main precautions that will be taken to prevent inundation in RG OC III Expansion Mine are as follows:

- The actual working plans of the opencast mine and the old plans of the developed underground mine workings will be maintained and checked regularly. The HFL of the nallah, river or tank is marked on the plan.
- Sufficient water garlands will be provided to prevent inrush of surface water into the quarry from dump yards and catchments water from surface areas.
- Construction/strengthening of berms/bunds on surface along quarry boundary will be done during every rainy season. Suitable monitoring system will be established to take care of any contingencies.
- When the workings are drenched with water due to fire the water level is maintained according to progress of face advancement in such a way that men and machinery can work safely.
- Proper drains will be cut around the quarry to divert away the water during rainy season, from entering the quarry. The drains will be connected to natural drainage system of the area. If any faults intersect the drain around the quarry/ drain connecting to natural drainage system and/or loose strata found at the bed of drain around quarry, RCC slabs suitably designed as per the site conditions will be laid in the disturbed areas of drains. Further, geo membrane will also be provided under RCC slab portion to prevent seepage at portions where faults exist.

- Sumps and pumps of adequate capacity will be provided within the quarry.
- The actual working plans of the opencast mine and the old plans of the developed underground mine workings will be maintained and checked regularly. The HFL of the nallah, river or tank is marked on the plan.
- Proper arrangements for embankment or diversion if any will be made.

1.1.6 Working near Faults

General Precautions while working at Fault:

- As far as practicable benches shall not be parallel to fault plane and it shall be in oblique to the fault plane.
- Adequate precautions shall be observed to prevent entry of water into the fault plane.
- Blasting near the fault planes shall be done in such a way that the small strips of material should not be left hanging against the fault.
- Additional lighting arrangements shall be made in the vicinity of fault.
- Fault planes shall be surveyed in advance and anticipated location of fault shall be marked in the field as well as in plans and concerned statutory supervisors shall be informed in writing.
- If a fault forms the boundary of the quarry floor,
    - The high wall benches should be formed cutting across the fault plane i.e., excavating the entire heave zone in the process.
    - As far as possible, benches should not be formed parallel to and abutting against a fault plane since they are likely to fail/slide.
    - Thus, the safer method could be to align the benches perpendicular/oblique to the fault plane while approaching a fault.
- Wherever, benches are aligned parallel to fault plane,
    - The excavation of benches should be from top downward.
    - The fault plane(s) exposed on the floor of the quarry needs to be benched though it amounts to stripping additional quantities of OB.
    - Additional care also needs to be observed by fixing prefabricated concrete channels along the drains when the fault crosses the drains around the quarry to prevent inadvertent entry of water into the quarry.
- Jallaram Nallah is flowing from west to east from the project area. The diversion of the nallah was addressed in I Revision of the RG OC III Expansion Project and diverted the nallah along the project boundary. A bund of +3m was constructed against the jallaram nallah to avoid inadvertently entry of water into the quarry area. The RL of the constructed bund at mine entrance at Venkatrao palle is 850.20
- Further, it is proposed to divert the nallah along the quarry boundary and drain into the existing Nallah.
- Further garland drain is also proposed all along the quarry to prevent any surface water flowing into quarry and will be connected to natural drainage system.
- the entire drains passing along the boundary is to be taken up at fault(s) portions along the east and In RG OC-III Expansion Mine F-60 and F-62 faults may likely cross Jallaram Nallah.
- Wherever the F-60 and F-62 faults intersect with the Nallahs and drains around the quarry/ drain connecting to natural drainage system and/ or loose strata found at the bed

of drain around quarry, RCC slab suitably designed as per the site conditions will be laid. Further geo membrane will also be provided under RCC slab portion to prevent seepage at portions where faults exist.

- Similarly, re-in forcement of west boundaries of the quarry depending upon the site specific conditions.

1.2 Safety Management Plan

Mining, by its very nature, is a hazardous industry. All over the world many countries have proven that the risks of mining can be controlled to acceptable levels through effective safety and health management systems – supported by formal risk management processes that identify hazards, assess and rank risk, determine control measures and monitor effectiveness of the controls.

The ninth and tenth Conference of Safety in mines recommended adopting Risk Assessment as a tool for development of appropriate health & safety management systems in Indian mines. The eleventh Conference further recommended that the managements of every mining company should adopt the process of safety management system and commit itself for proper formulation and implementation of the same in totality.

Drawing inputs from inferences draw from several workshops on “Risk Assessment” in Indian mine conducted by DGMS, a document on “Safety Management System – A guideline for implementation” was prepared and circulated as DGMS (Tech) (S&T) Circular No. 13 of 2002. Another guideline in this regard titled “Safety Management System – Provision for auditing and review” was issued by DGMS (Tech) (S&T) Circular No. 02 of 2011. As a sequel to above circulars for further effectiveness of Safety Management System DGMS (Tech.) (S&T) Cir no 5 of 2016 was also circulated. Reg-104 under CMR 2017 requires owner, agent & manager of every mine to prepare and implement an auditable document, **Safety Management Plan**.

1.2.1 Steps involved in Safety Management Plan

STEP – 1 Management Role & System Risk Review:

STEP – 2 Hazard identification & Risk Assessment

STEP – 3 Development of Risk Management action plan

STEP – 4 Safety system Audit

STEP – 5 Safety System review by monitoring committee

STEP – 6 Repetition of all the steps

Brief description about each step:

Step 1 Management Role & System Risk Review:

1. Review of management safety policy.

2. Review of management responsibility & commitment.

3. Review of the works by different committees

Step 2 Hazard identification & Risk Assessment:

The analysis of risk involves understanding the nature of the hazard; the nature of existing controls and recovery measures; assessing the likelihood of the hazard occurring; and the severity of its consequences should it occur.

Consequences and likelihood are identified and combined to produce a level of risk. Consequences and likelihood may be estimated using statistical analysis and calculations.

Risk Score = Consequence x Exposure x Probability

Consequence is the size of loss or damage. In terms of health and safety, it is the degree of harm that could be caused to workers exposed to the hazard, the potential severity of injuries or ill health and / or the number of persons who could be potentially affected.

Exposure is percentage of time personnel are present.

Probability is chance that they will be harmed.

Step - 3 Development of Risk Management Action Plan:

The preparation of a Risk Management Plan (RMP) requires risk assessment in the mine. Risk assessment is a process of logically assessing the risks involved in an activity to determine the actions necessary to reduce control and or manage the risks. Risk management aims to reduce the likelihood and impact of mishaps of all kinds. In the mining industry, with its inherent potential for major accidents which could injure or kill many people, damage the environment, cause serious loss of production and hence profit, there is a particular need for a sound approach to the process of risk management.

Step – 4 Safety system Audit:

1. In this step we have to audit the safety status of the mine.
2. Regular safety auditing to be established in the mine.
3. Basing on the above audit, preparation & formulation of COPs & SOPs whenever necessary.
4. Decide control operations
5. Document procedure for each control
6. Fixing up of responsibilities

Step – 5 Safety System Review by Monitoring Committee:

All steps in the risk management process should be monitored and subject to review. For each stage adequate records should be kept to demonstrate how decisions were made and what the outcome of the process. Review the audit reports in statutory forums & non statutory forums in mine & area level from time to time and frequently to motivate the workmen about safety.

1.2.2 10.2.3.1. Risk Assessment and Management

The present-day environment demands to have a fresh look at Safety Management as a structured process composed of well defined systems that emphasizes continuous improvement in work quality, health, welfare and productivity of workforce engaged in mineral industry through setting up of improved safety standards and their effective implementation and administration. Because the statutory provisions can never be fully comprehensive, appropriate and site specific. Trend, World over is, therefore, to make the statutory provisions ‘Flexible’ by switching over from the regime of ‘Prescriptive Regulation’ to ‘Self Regulatory or Goal Setting Legislation’.

It is now widely accepted world over that the concept of “Risk Management” through “Risk Assessment” contributes greatly towards achieving the objectives.

Introduction of risk management as a tool for development of good health and safety management system is a breakthrough in the traditional strategy as it differs from the existing one by involving the entire staff in the realization of safety improvement programme with responsibility and accountability sharing proportionate to the decisions making authority. The system is sure to be an effective tool for improvement of health and safety scenario in our mining industry.

1.2.3 10.2.3.1.1 Risk Assessment

Risk Assessment process identifies all the existing and probable hazards in the work environment and in all operations, assess the risk levels of those hazards in order to prioritize which needs immediate attention for redressal, where maintenance of ongoing management is sufficient and which are of very mild in nature. Then for managing these risks, different mechanisms (underlying causes) responsible for these hazards are identified and their control measures, set to time table, are recorded pinpointing the responsibilities.

Further, the monitoring and auditing at regular interval recommended as a part of the system would ensure that safe operating procedure are followed, evaluated, corrected, standardized and documented training procedures for workers and executives are in place and are carried out regularly, and commitment to health and safety is demonstrated at all levels of organization. On implementation of the system, an appropriate safety level in each stage of operation may be obtained by a systematic and documented management system with well-defined responsibility and accountability for safety among the mine employees.

1.2.4 The process of calculation of Risk:

The Risk Score for a Hazard is dependent upon the chance of occurrence and the impact of such an occurrence (Consequence). Hence-

Risk Score = Consequence x Likelihood

Consequence is the size of loss or damage. In terms of health and safety, it is the degree of harm that could be caused to workers exposed to the hazard, the potential severity of injuries or ill health and / or the number of persons who could be potentially affected. It has been kept in mind that the consequence of hazard may be in terms of loss of assets or cost to the company in terms of money or production.

Likelihood is the chance that the hazard might occur. In some cases the personnel are exposed to the hazard for a part of the time. A more detailed analysis is carried out of the risk by taking this factor in to consideration.

Replacing Likelihood by Exposure (percentage of time personnel are present) and Probability (chance that they will be harmed).

Risk Score = Consequence x Exposure x Probability (CEP)

Experience and CEP:

The absolute CEP is not in itself a meaningful number. It is only meaningful when compared to other CEP numbers to allow assessment of the risk and actions to be taken to reduce the risk. The individual areas of concern are assessed (preferably by a team or group of people to allow discussion and to prevent personal bias) and CEPs assigned to the various factors. The CEPs can then be prioritized (highest first) to have corrective action to reduce the CEP. Where there is experience of accidents and events, then the actual historical records can be used to build the CEP factors and to justify the values used or set CEP threshold for action.

Assessment of the relative factors can be based on:

(a) Previous events at our mine.

(b) Similar events in other mines in India.

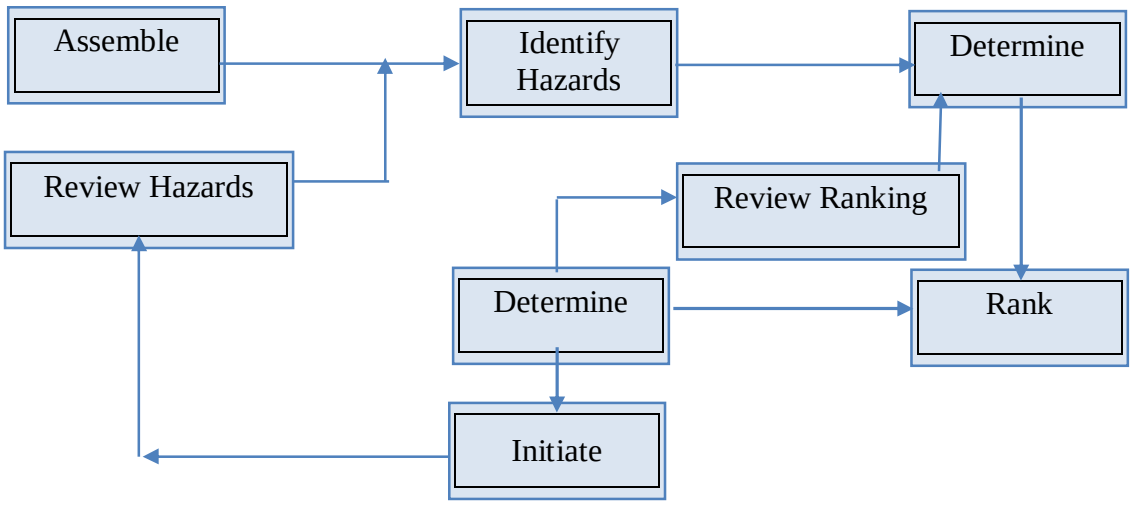
(c) Analogous events all over the world in mining or in any industry for similar activities.

The amount of previous information available has been used to provide for a well-reasoned judgment for the allocation of values to the individual factors. The use of historical data and experience at the mine has been the main pillars of support for the preparation of this document.

A risk assessment is not a static document that is prepared and then displayed. We believe that this document is a 'Living Document'. The initial focus will be on reducing the highest CEP factors in the document. But this will simply mean that other and lower CEP factors will come to the top of the list. These 'top of the list' factors are then subjected to analysis and improvements made to lower the overall risk profile. This is part of the reason for avoiding an absolute CEP threshold. The tasks to work on are always those at the top of the list and reducing these will reduce the risk profile of the mine as whole.

Consequence	Scale	Exposure	Scale	Probability	Scale
Several Dead	5	Continuous	10	Expected/ almost certain	10
One Dead	1	Frequent (Daily)	5	Quite possible/likely	7
Significant chance of Fatality	0.3	Seldom (Weekly)	3	Unusual but possible	3
One Permanent Disability	0.1	Unusual (Monthly)	2.5	Only remotely possible	2
Small chance of fatality	0.1	Occasionally (Yearly)	2	Conceived but unlikely	1
Many lost time Injuries	0.01	Once in 5 years	1.5	Practically impossible	0.5
One lost time injury	0.001	Once in 10 years	0.5	Virtually impossible	0.1
small injury	0.0001	Once in 100 years	0.02		

Risk Assessment process: (Flow diagram)



The Hierarchy of Controls

- Elimination: Remove material, substance or process to eliminate the hazard completely (100%)
- Substitution: Replace with less hazardous material, substance or process (75%)
- Separation: Isolate hazard from person by guarding, space or time separation (50%)
- Administration: Adjusting the time or conditions of risk exposures (30%)
- Training: Improving skills making tasks less hazardous to persons involved (20%)

- Personal Protective Equipment: Used as the last resort, appropriately designed and properly fitted equipment where other controls are not practicable (5%).

Based on Risk Assessment process, following are the various activities that will be identified, which can cause risks/accidents/incidents.

1. Drilling & Blasting
2. Overburden dump yards.
3. Operation of Heavy Machinery.
4. The Side Collapses.
5. Plying of HEMM on haul roads
6. Loose Dumps of Coal
7. Working near Faults
8. Inundation
9. Fire Hazards in Coal Benches.

1.3 Risk Management

It is the overall description of the steps taken to manage risk, by identifying hazards and implementing controls in the work place. Risk Management process involves the following steps*:*

a. Accident / Incident Reporting & Investigation:

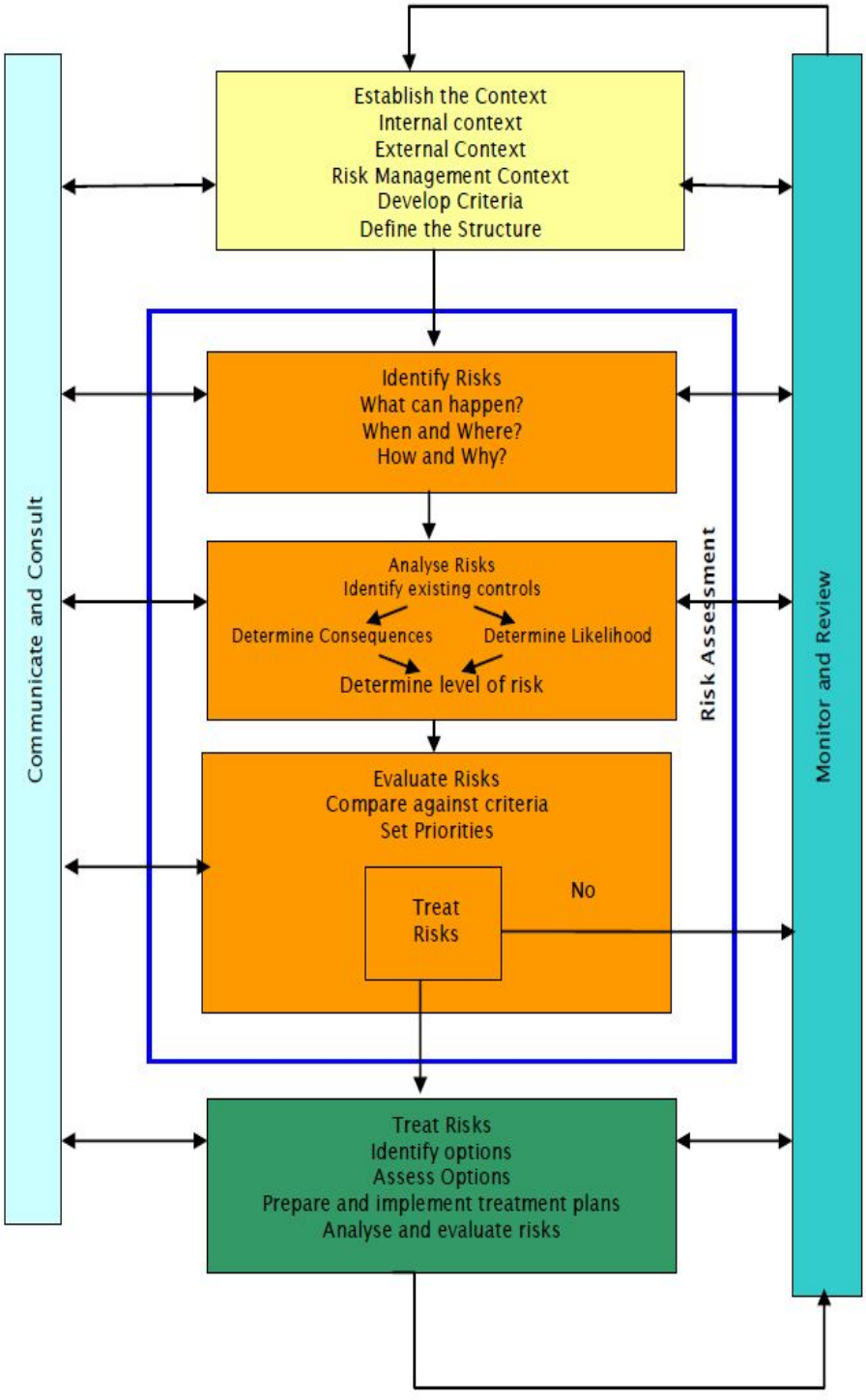
This would be a Standing Order to ensure compliance with Regulations and to inform mine personnel of responsibilities and reporting requirements. It should cover-

- Responsibility of those on the site
- Immediate response and Emergency backup
- Notifying key staff of accident
- Securing the site
- Treatment of any injuries
- Investigation and Reporting
- Review of any recommendations and determining actions.

b. Auditing & Review / Revise:

Reviewing the effectiveness of programs within the Safety Management Plan. This should be an on-going process. This should show whether policies, Regulations and expectations are being met or where systems can be made more effective. Both internal and external audits should be considered. Auditors need training to be objective and independent. Management Team or the Health and Safety Committee would have to decide how often audits would be done, what systems or areas would be audited and reporting arrangements.

Detailed Flow Chart of Risk Management Process in Detail



1.4 Disaster management

In spite of rapid advancement in management and technology, disasters in mining mainly due to fire, explosion, inundation, failure of working benches and failure of internal dump yard occur sporadically all over the world.

Consequences of disaster are enormous in terms of loss of lives and property. The loss of morale and public image further create an awkward situation for the mine concerned as well as the entire Company.

A sound Disaster Management Plan (DMP) to minimize the consequences of the disaster and to restore the normal operation at the earliest must be formulated by each mine depending on site-specific conditions.

Explanation

A disaster is any unexpected event that can kill 10 or more persons thereby disrupting all operations in a mine. Any disaster threatens the reputation of a company. If any such disaster occurs, the DMP should be initiated. The decision for implementation of the plan in case of a disaster is to be initiated by senior most officer of the mine i.e. Agent/Colliery Manager.

A situation where a small fire or an accident involving two or three persons that can be dealt by mine level organization, shall not be deemed as a disaster but is an emergency for the mine. Mine Manager should deal this emergency as per the Emergency Plan, which is prepared as per CMR, 199 A and any local emergency plan prepared. The senior most officer of the mine can change the Emergency Plan into a Disaster Management Plan if the situation warrants.

In any rescue organization, its state of readiness is of vital importance. In fact it should be military-like discipline setup. Fortunately, disasters do not happen frequently, but whenever a disaster strikes the industry, it severely tests the management's state of preparedness and the Action Plan. It is, therefore, important that no sense of complacence should be allowed to develop and every effort made to provide a best Disaster Management Plan for mines that is capable of being implemented promptly and without any confusion, and which serve its main purpose of saving precious lives of workers with least possible delay.

Further, the facilities to be provided for dealing with fires, spontaneous heating, accumulation of gases etc., have been specified in the CMR, 1957 and those for rescue and recovery work have been detailed in the Mines Rescue Rules, 1985.

1.4.1 Preparedness for Disasters:

When a disaster occurs in a mine, the situation has to be dealt quickly. The first few hours after occurrence of disaster is very crucial. If the key persons at the frontline react quickly and act in a organized manner as per the advance planning in the initial moments after the occurrence of disaster, many lives can be saved. Decisions taken on the spur of the moment will not bring in as good results as properly planned procedures will. Advance planning is the most logical way of minimizing the time losses in emergency. Advance planning and preparation has two aspects, namely,

- Creating a Disaster Management Committee (DMC) that should go into operation immediately on the occurrence of a disaster, and
- Building up of physical facilities that may be needed to cope up with any disaster.

After any disaster, the nature and importance is such that the situation demands that presence of senior officers of the Company, Director of Mines Safety, senior leaders of the trade union and State authorities. The basic role of Disaster Management committee will be handling of the situation that is, planning the strategy to deal with the situation, giving necessary guidance to conduct the rescue and recovery operation. The DMC will also be dealing VIPs and public relations in addition to other support activities to deal with the situation.

The authorized persons involved in disaster management plan are immediately required to take up the allotted positions and start playing assigned roles. For this purpose Mock

rehearsals will be conducted regularly. Further the safety gadgets/materials required in case of emergency are listed and stock of such materials in adequate quantities is kept at central locations near to the mines.

1.4.2 Disaster Management Plan (Mitigative Measures):

There are three phases in dealing with a disaster, namely:

- The first is information stage-when information is sent to various agencies;
- The second is assessment stage – when the effects of the disaster, the resources required to mitigate the consequence, and the manner of conducting rescue, recovery and rehabilitation is assessed; and
- The third is action stage – when action is started.

The three stages are not distinctly separate but have certain amount of overlap.

1.4.2.1 Information Stage:

Duty persons employed in the mine:

If any person discovers or learns of any dangerous incident, he should immediately inform the surface telephone operator / Manway Clerk or the nearest available official who must at once report it to the telephone operator/ Manway Clerk.

Duty of Telephone Operator / Manway Clerk:

Upon receiving information of an incident, the telephone operator / manway clerk shall immediately inform the Manager or the Official present at the time. In the event of an incident requiring rescue services, he must inform the Rescue Station without delay.

The Manway Clerk while receiving the information by phone should gather the information regarding the place of accident, number of persons involved, nature of help required and record the same with name of the person who informed and pass on the same to the Manager and wait for further information from the underground. He should not leave the place for any purpose whatsoever.

In case the phones are not working, he should sent the information through a special messenger who is available on the surface preferable in writing without leaving the Manway. In the absence of the Manager, he should pass on the information at the mine to the senior most officer available at the mine.

For this purpose, all man way clerks should be properly trained to react immediately after the incident with minimum time loss. Guidelines for reaction at the time of disaster should be framed and it shall be inculcated to him. He should have a prioritized list of persons to be called with their telephone numbers.

Immediate Response of the Manager:

On receiving the information, he should inform the Agent and rush to the mine and personally assess the situation by contacting the Supervisor over telephone. He should then communicate the GM and Nodal Officers to initiate DMP.

Appointment of Nodal Officers:

GM of the Area should nominate two senior officers by name as Nodal Officers to communicate the disaster message to various authorities. The two senior officers, preferably one is Area Safety Officer and the other is SO to GM. Two more senior officers shall also be nominated as alternative officers.

Role of Nodal Officers

Nodal Officer 1, i.e., Area Safety Officer will inform to the following authorities:

- CGM (SAFETY)
- All the Directors
- SO to C&MD
- DGMS Authorities
- District Magistrate
- District Collector
- Superintendent of Police of District level
- Mine level and Area level Union delegates, belonging to Recognized and Representative Unions
- Company level Union members, belonging to Recognized and Representative Unions.
- Press.

Nodal Officer 2, i.e., SO to GM will inform the following:

- Rescue Station
- Local Hospital In-charge
- CMS
- Transport
- Stores Officer
- Area E&M engineer
- Area Survey Officer
- Area Personnel Dept. In-charge
- Area Finance Dept In-charge
- Regional Level Mining Technical expert
- Local Police Inspector

The two Nodal Officers will have separate individual tasks. Soon after receiving the information, they should proceed to the mine. The Nodal Officers should continuously go on giving half hourly updated information to CGM (Safety), the members of Disaster Management Committee, all the Directors of the Company, DGMS Authorities, SO to C&MD, District Magistrate, District Collector, Superintendent of Police, until they arrive at the site.

Mock drills are the best tool for assessing preparedness of the key functionaries in case of disaster & also it will help them correct their mistakes & increase their preparedness. Mock drills have to be conducted regularly involving all key functionaries.

1.4.2.2 Assessment and Dealing:

Role of Supervisor:

In the First Stage, the supervisor or underground official should immediately take necessary steps in case of danger to evacuate the persons who are likely to be affected in the district and from other districts via escape routes to surface.

Mining Sirdar and Overman should take immediate steps to send information to all the persons and advise them to assemble at the district station. He can take full count of all the work persons to determine the number of missing persons, if any. From here, the persons not required to deal with emergency can be advised to take a safe escape route to the surface.

In case specific help is required in alteration of ventilation circuit or restriction of air quantity by barricading, he should communicate the same and obtain the consent of the senior most officers. If time does not permit and the situation warrants, he is free to proceed with the work if the safety of the workmen is at stake.

Role of the Manager:

After reporting to Area General Manager based on first-hand information gathered at the mine, he should ensure the arrival of rescue personnel. The services of rescue trained persons available at the mines should be utilized till the rescue brigade members arrive. He should inspect the affected site either alone or along with the Area General Manager and Rescue Superintendent.

Role of the Area General Manager:

Soon after receiving the information, The Area General Manager should make a quick underground visit to assess the situation and give necessary guidance to Agent/Manager and Regional Technical Expert. He should come to surface to ensure functions of the Core Committee.

The Area GM will assess the gravity of the situation. The Manager will assess the requirement of men and material. The Superintendent of Rescue Station will assess the rescue requirement.

After assessment, the Area General Manager and Superintendent of Rescue Station should go to surface and take active participation with a Disaster Management Committee DMC members to draw the line of action.

In a Disaster Management Committee meeting, the Area GM should ensure the formation of Control Rooms and Supporting Committees by verifying the check list.

The dealing of disaster should be carried out as per the written guidelines given by DMC. A senior most officer of SCCL will be authorized by DMC to oversee the rescue and recovery operation and check whether complied as per the written guidelines received.

As far as possible, the Manager and Agent of the affected mine should not be encouraged to undertake rescue and recovery works directly, as they will be subjected to high stress and strain. They also should be provided good security arrangements. Their services can be utilized in the form of technical support with regard to the mine.

1.5 Crisis Management Plan

In case of Disasters involving 50 persons or more – Crisis Management Plan prepared by Ministry of Coal and Mines for Flooding/Fires In Coal mines has been received by SCCL, for implementation.

As per the above Plan, any mishap arising out of flooding and fire in the coal mines will be treated as a Disaster when lives of 50 persons or more deployed below ground in the affected mine are lost or threatened.

The first information report should be sent in the format prescribed (contained in the Crisis Management Plan) by the Colliery Manager to the CMD/Chief Executive and to District Magistrate/District Collector. The CMD/Chief Executive of the company will in turn inform to the Secretary, Department of Coal. District magistrate/District Collector will inform the Chief Secretary of the State where the mine is located, immediately through Fax/E-mail or any other quickest means of communication within one hour of occurrence of disaster.

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