Bharat Sarkar/ Govt. of India
Shram Mantralaya/ Ministry of Labour
Khan Suraksha Mahanideshalaya
Directorate General of Mines Safety
DHANBAD

Tel. + 91 326 -222100
Fax. +91 326-2221027

No. DGMS(Tech) (S&T) Circular No. 02 of 2011 Dated, Dhanbad the 04th March, 2011

To
The Owner, Agent and Manager
of all mines

Sub: Safety Management System – Provision for auditing and review.

Sir,

The Ninth & Tenth Conference on Safety in Mines recommended adopting Risk Management as a tool for development of appropriate health & safety management systems in Indian mines. It was further suggested that the risk assessment exercise should follow an appropriate process.

The Science & Technology division of this Directorate conducted several workshops on 'Risk Management' in Indian mines with the assistance of experts from Australian International Mines Safety Training Co. Pvt. Ltd., under an Indo-Australian Aid Project. Drawing inputs from inferences drawn from the workshops and synthesizing the same with International recommended practices, a document on "Safety Management System – A guideline for implementation" was prepared and circulated as DGMS (Tech) (S&T) Circular No. 13 of 2002, a copy of which is enclosed.

You are requested to undertake the a formal risk assessment process with the help of above guidelines. It should be followed by preparation of 'Risk Management Plans' and implementation thereof, aimed at reducing the likely hood and impact of mishaps of all kinds in Indian Mines.

Yours faithfully

3/3/2011

Director General of Mines Safety

SAFETY MANAGEMENT SYSTEM
A Guideline for Implementation

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The Science & Technology division of Directorate-General of Mines Safety conducted several workshops on 'Risk Management' in Indian mines with the assistance of experts from Australian International Mines Safety Training Co. Pvt. Ltd., under an Indo-Australian Aid Project. Drawing inputs from inferences drawn from the workshops and synthesizing the same with international recommended practices, a document on 'Safety Management System—A guideline for implementation' has been prepared and enclosed as annexure—1 to Cir. Tech 13/2002. A Risk Management Plan, designed by the officials of a coal mine is given in the Annexure-II for understanding the actual process. This is given as guide only and need to be tailored for specific requirements.

The DGMS has advised mine managements to undertake a formal risk assessment process with the help of above guidelines. It should be followed by preparation of 'Risk Management Plans' and implementation thereof aimed at reducing the likelihood and impact of mishaps of all kinds in Indian mines.

Safety Management System—A Guideline for Implementation

Background

Indian Mining Industry makes a major contribution to the national economy and to the well being of the society as a whole. The country's mineral industry represents a unique mix of very small to medium to large mines. Currently there are 596 coalmines, 40 oil projects and a large number of non-coal mines with more than 6000 being in record under the Mines Act (however the figure is estimated to be much larger). Besides, there are innumerable small quarries restricted to shallow depth and employing a small number of persons and do not fall under the purview of the Mines Act. Total workforce of the mining industry in India consists of about one million. For the continuing viability and stablity of the industry, it is important that full advantage be taken of developments in mining methods & procedures, modern machinery & equipment and advances in approaches to management of all mining activities, including health & safety.

While safety in any sphere of activities is important, it has special significance when the risk is greater, Unlike the major industries, mining has high potential risk of aocidents. It has a dubious distinction of involving a very high actual hazard as the environment changes continually with the progress of work. It is, therefore, not possible for any external agency to ensure safety of any mine. The principal responsibility for the safety and good health of workers employed in mines rests with the management of that mine.

The present day environment demands to have a fresh look at *Safety Management* as a structured process composed of well defined systems that emphasise 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 and because the process of *Legislation Making* is often slow, these often trail behind the technological innovations. Trend, world over is, therefore, to make the statutory provisions 'Flexible' by switching over from the regime of *Prescriptive Regulation* to *Self Regulatory of Goal Setting Legislation*. It is now widely accepted world over that the concept of *Risk management* through *Risk assessment* contributes greatly towards achieving these objectives Considering the accident scenario in Indian Mining Industry, it has now become essential that risk assessment be undertaken of all hazardous operations, equipment and machinery, taking account of the procedures used, maintenance, supervision and management.

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 decision making authority. The system is sure to be an effective tool for improvement of health and safety scenario in our mining industry. The Risk assessment process will identify all the existing and probable hazards in the work environment and in all operations, assess the risk levels of those hazards in order to prioritise which hazard needs immediate attention for redressal, where maintenance of ongoing management will be sufficient and which are of very mild nature. Then for managing these risks, different *Mechanisms* (underlying causes) responsible for these hazards are identified and their control measures, set to timetable, 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 procedures are followed, evaluated, corrected, standardised 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 organisation. 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 responsibiity and accountability for safety among the mine employees.

Guidelines for Implementation

The guideline is structured in the following way :

1. Objective
2. Structure (Strategic, Management, Operations)
3. Processes for Hazard Identification & Risk Assessment
4. Appendices.

1. Objective of the Guideline

This Guideline is to assist mines put a renewed focus on managing health and safety in their workplace.

The risk of various hazards arising in any mine ranges from almost zero to very high depending upon the deposit being worked, the complexity & size of mining operation as well as the conditions under which this is done and culture of the mines. Whilst many of these are mitigated by following the Standards, the aim of this Guideline is to introduce new methods to assess and manage hazards in mines.

The Safety Management System established by a mine must ensure all risks are identified and critical risks are controlled to ensure long-term health and safety.

A Safety Management System should set the culture, framework and actions necessary to ensure that mining operations are carried out safely.

In order to turn these commonly agreed principles into an effective safety management system for the mine, the system may include the following elements—

- Health & Safety Policy of the company and the mine
- Roles and Responsibilities of all levels in the organisation
- Specified competencies of staff
- Safety Committee, formation and role
- Method to identify and control high risk
- Forward Programme to ensure actions to control hazards are carried out
- Emergency Preparedness to cope with a hazard if it should ocur.
- Monitoring processes for all identified hazards with or without residual risks.
- Identification of trigger points and resultant actions if these are reached.

- Safety clearance for new equipment, work methods and materials used.
- Accident Statistics collection, analysis & actions.
- Reporting and record keeping requirements
- Auditing and review processes

2. Structure of The Safety Management System

The basis for ensuring safe and healthy production depends primarily on—

2.0 Attitude of workforce at all levels

- Competent people
- Fit-for-purpose equipment
- Suitable work methods (or processes and procedures)
- Planned and controlled work environments

Good management will set standards to achieve these objectives and a suggested structure for the Safety Management System is summarised below and detailed in Sections 3 to 5.

2.1 Strategic Level

The following management strategies are required :

- Development of organisation mission statement and policy, giving high regard to safety and production, strongly backed by management and owners.
- Have policies made by the organisation that ensures health and safety a critical element in all mining activities.
- Delegate organisational responsibility to appropriate levels.
- Institute formal structures and committees to discuss and implement safety improvements.
- Establishing and maintaining the Safety Management System.

2.2 Management Level

Management is responsible to follow the strategic lead of the organisation by :

- Implementing and managing site-specific Safety Management Plans.
- Identification of major hazards and assessment of risks.
- Managing hazard reduction plans.
- Defining appropriate roles and responsibilities.
- Having personnel with approproate competencies for the work.
- Having site-specific and tested emergency processes in place.
- Providing appropriate guidelines, directives and training.
- Operaton of formal structures and committees.

2.3 Operational Level

At operational level managers/safety officers, workmen inspectors and workers should—

- Assess risks associated with each step of all work.
- Develop and maintain a Manual outining worksafe standards and guidelines.
- Ensure personnel are trained to a competent level for each work task.
- Follow safe operational processes and procedures.
- Actively participate in safety committees and continuous improvement.

3. Strategic Level

3.1 Health & Safety Policy

The Mine Health and Safety Policy is a statement by the organisation of its occupational health and safety philosophy and intentions. It provides a framework for action to achieve safety objectives and targets. The Policy should—

- Provide a mission and vision of a healthy and safe work place
- Be inclusive and understood by everybody in the mine
- Provide management commitment for—
  - A healthy and safe work place
  - Regular review of risks
  - Support for a Safety Management System (Safety Committee, Risk Assessment, Continuous Improvement etc.)
- Carry the expectation that mine management, supervisory staff and work persons willingly comply with it.

3.2 Safety Management - Roles and Responsibilities

Ensuring the safety of a mining operation is a complex task requiring the continued commitment of all personnel associated with the mine, as well as compliance with all safety legislation, guidelines and circulars. The effective management of safety within a mine includes the following—

- A sound Health & Safety Policy which is supported by all sectors of the mine.
- Clear roles and responsibilities of all personnel for safety
- A safety management programme and forward plan
- A safe work place design for jobs, equipment and materials
- Induction, training & continuous improvement of staff

- Hazard identification and control management
- Appropriate accident and emergency plans
- Effective accident/incident investigation and reporting
- Auditing of processes and outcomes against Policy
- Review of safety management plans

In the effective management of safety, all mine personnel have different roles to play but still have the same objective. They also share a duty of care to—

- Provide a safe place of work
- Provide proper equipment and facilities
- Have and follow a safe system of work
- Have competent staff and employees
- Look after fellow workers
- Take appropriate precautions (eg. use of Personal Protective Equipment)
- Raise safety issues and continuously improve
- Have appropriate emergency procedures

The roles of the following Key Staff in the Safety system should be clearly spelt out in the safety management system as well as in all the lower levels of the plan :

Owner, Agent, Manager, Supervisor, Safety Officer, Workman Inspector, Trade Union Representative, Mechanic, Operator, Worker, Contractor and Contractor Management etc.

3.3 Safety Committee

The Safety Committee can have a significant role in effective Mine Safety Management. It contains representatives from all aspects of the mine, with a focus on ensuring and improving health and safety in the workplace. Whilst the committee's function is well defined in the Mines Rules, the Safety Plan needs to outline the operation of the Safety Committee to ensure committee members and the mines workforce are quite clear on its role, its responsibilities and objectives.

The types of areas to clarify are—

- The members of the Committee & their roles
- Key Responsibilities of the Committee to—
  - Improving health and safety in the workplace
  - Reviewing accident / incident reports & statistics
  - Identify hazards & the review of action plans
- Meeting arrangements for sub-committees, if formed

- Implementing & managing the Plan (schedule of activities)
- Reporting responsibilities and notice boards.

3.4 Overall Safety Management System and Plans

Activity	Frequency	Role-Action
Management	Annually	Set and review Mine Health & Safety (H&S) policy
	Annually	Lay basis for Safety and Hazard Management Plans
	Annually	Arrange for internal/external audits.
Regular Health and Safety meeting involving representation across the mine.	Annually	Review H & S policy set by management
	Annually	Implement/manage Safety/Hazard Management Plans
	Annually	Create and manage the Safety Manual
	Annually	Establish high risk areas/issues in mine for review
	Annually	Set programme & responsibility for the forthcoming year for hazard review and other issues (eg. training, job analysis, equipment assessment etc.)
	Quarterly	Review/Participate in new Hazard examinations
	Monthly	Review accident statistics and accident investigation, adverse incident analysis and make appropriate decisions.
	Monthly	Conduct site inspections
	Monthly	Raise matters of H & S concern
	Monthly	Report against Safety and Hazard Management Plan
	Special	Arrange special meetings as required.

4. Management Level

4.1 Hazard Identification & Risk Management

The management of the mine should conduct a risk assessment process to identify any hazard that could influence the safety and health of workers of the mine.

For all hazards that pose a potential chance of multiple fatalities at one time and are not fully controlled, a *Hazard Management Plan* must be drawn up.

To operate mines safely all hazards must be quickly identified and controlled. Using a risk ranking process can assist mine staff to identify the highest risk hazards for attention. This process is summarised below and detailed in Section 7.

- Identify hazards
- Assess the risks posed by these hazards (risk ranking)
- Control or treat hazards to reduce unsafe or unhealthy situations

This technique should be used to assist effective management of safety in the workplace within the Safety Management Plan.

It should be noted that Hazard Identification and Risk Assessment should not be considered to be a once off occurrence but should be done at regular intervals to ensure that the plans to cope with the identified hazards are pertinent and up to date.

4.2 Safety Management Plans

The Safety Management Plan is a working document, which outlines all of the actions to be carried out to ensure safety and health at the work place. This document is fundamental to management of safety by the Health and Safety Committee and Management. The sort of issues which should be addressed in Safety Management Plan include—

- Important committee or safety related meeting dates
- Dates to review policies, manual or work procedures
- Dates required for major hazard analyses to be completed
- Outcomes or actions following review of hazards, accidents or statistics
- Actions, dates and responsibilities to complete agreed actions
- Achievement of actions

4.3 Safety Manual

Accompanying the Safety Management Plan should be a Safety Manual. This manual would outline the operational procedures to comply with the overall and specific hazard management plans.

It is the document that would be available to all workers on site and should enable them to be aware of not only this framwork within which they have to do their work but also what is expected from them to ensure a safe and healthy work environment. It could contain—

- Relevant Acts, Regulations and Circulars
- Emergency Procedures
- Standing Orders

officer, supervisor, worker) as well as workers from different aspects of the operation to provide different perspectives or views, likelihood, consequence and controls that are both practical, feasible and cost effective. The members of the team should be varied from session to session to gain a broad perspective of the hazards across a site.

6.2.2 Identifying the Hazards

The process of identifying hazards is possibly the most important part of the whole risk assessment process. This can be done in many ways but the objective is to ensure that all of the possible hazards are identified.

Hazards are only discounted when they have been assessed not to pose a risk. Until that is done all possible hazards should be identified and noted down.

Normally the best process is to proceed step by step through a task. A number of other processes can also be utilised—

- Previous experience of accidents or occurrences in the mine.
- Work process evaluation
- Consultation with employees who may have experience in the job
- Off-site specialists with experience at other mine sites (consultants).
- Fault tree analysis to determine underlying issues and hazards that might not be evident at first glance.
- Safety statistics for this or other mines.
- Significant incident, near-miss or accident reports
- Inspections in the mine

Another method is to consider the hazards that could occur from an unwanted release of energy (eg. mechanical, electrical, gravity, fluids or air, chemical, nuclear, heat, light, noise)

Decide how to divide up the workplace, e.g.—

- By activities (or processes) e.g. drilling & blasting, load and haul, crushing;
- By equipment, machinery e.g. mobile plant, trucks, conveyors, crushers;
- By geographical areas e.g. pit, compound, workshop;
- By specific job activity.

Look at specific issues and jobs. Break processes up into nodes. Examine each node independently and look at failure modes or things that can go wrong for each node. Examine accident-prone jobs or situations. Carry out a brainstorming exercise and visit the site, identify all hazards. Hazards will be identified that are likely or less likely, have major and minor impact and importance. At this stage collect, do not exclude ideas, be defensive or squash potential hazards that are raised. Record findings.

Notwithstanding whichever method is used for identification of the hazards, they should all be noted down so that a record of their existence is kept. This can be used to save time and effort when further rounds of risk assessment are being done. Simple forms are provided in the Appendix for use.

There should also be a mechanism for reporting of hazards by staff as they are found which is separate from the format risk assessment process. Hazards are to be recorded before staff forgets about potential hazards, or are not selected for the risk assessment team.

6.2.3 Assessment of the Risk & Ranking

Objectives of risk ranking are to—

- Identify which risks are most in need of attention, and the options for achieveing that risk reduction.
- Identify which risks need careful ongoing management, the nature of the ongoing management as well as the indicators that show that the risk is being managed.
- Identify triggers which might be used to monitor that hazard and initiate remedial action if elimination is not feasible.

The process of Risk Ranking is carried out by considering both the Likelihood of the occurrence of each Hazard and the potential Consequence should the Hazard occur. Each can be estimated or calculated by engineering principles. This will enable the risk ranking to be carried out. Risks are ranked according to the level of risk i.e. the highest risk to the lowest risk. It is important that the risks are ranked to identify those requiring immediate attention and maximise benefits from the efforts.

The risk of any hazard is dependent upon the chance that it will occur (liklihood) and the impact of an occurrence (consequence) :

Risk Score = Likelihood x Consequence

Consequence is the size of the loss or damage. In terms of health and safety, it is the degree of harm that could be caused to people exposed to the hazard, the potential severity of injuries or ill health and / or the number of people who could be potentially affected. It should be remembered that consequence of a hazard need not only be in terms of safety criteria but could also be in terms of a money loss, incurred costs, loss of production, environmental impacts as well as public outrage.

Likelihood is the chance that the hazard might occur.

In some cases personnel are only exposed to the hazard for part of the time. A more detailed analysis can be carried out of the Risk Ranking by taking

this into consideration. Replacing Likelihood by Exposure (% time personnel are present) and Probability (chance that they will be harmed),

Risk score = Probability x Exposure x Consequence

The values used for Likelihood, Consequence. Exposure or Probability need to be agreed to by the risk assessment team.

Risk ranking can be determined by qualitative and quantitative means. It should however be remembered that none of these methods are best. The best choice of method will depend on the circumstances and preferences at the mine at the time the exercise is done. However regardless of the method, establishing Risk Ranking will set priorities for Hazard control. The most important purpose in Hazard Identification, Risk Assessment and Ranking is to draw up and implement plans to control these hazards. However, keeping the acceptance of the participants during workshops conducted at different mines, a criteria table for Quantitative Risk ranking is given in Section 7.

These plans are then included in the Safety Management Plan.

6.2.4 Treatment, Controls and Action Plans

Examine the high priority risks. Consider the potential to reduce or eliminate the risk by using the hierarchy of controls. This assists establishing methods to reduce the risk. From experience, the effectiveness of each method is given as a percentage after each of the control descriptions.

Elimination : Remove step 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%).

Control measures can reduce either the Likelihood or Consequence of the event or both. Depending on the level or reduction of the hazard there could still be residual risk that needs to be monitored so that a secondary prevention process can be initiated when trigger points are reached.

The team should develop an action plan recommending actions, responsibilities and when it should be completed. Put forward to decision-making authority and review if necessary. Make a decision to proceed.

Allocate tasks, monitor progress. Review implementation effectiveness and determine if other hazards have been created. Pursue continuous improvement.

A number of forms are included for carrying out this activity. Alternatively, the use of software tools will enable the recording of controls and allocation of responsibility for controls. Whichever method is used, it should be formalised and controlled periodically.

6.3 Induction, Training & Continuous Improvement

Each mine will have training programmes for employees, which need to be reviewed against safety criteria. The updating of training requirements should include retraining of existing personnel to the new skill level. This can be performed on-the-job. When the new skill, procedure, etc. has been taught to an individual and he has been assessed to have achieved that Competency, this should be recorded. This allows the mine to track staff that are qualified to perform particular tasks. In some instances, staff should be prevented performing tasks until they have been correctly trained in new procedures and are considered competent to perform a task safely.

6.4 Accident/Incident Reporting & Investigaton

This would be a Standing Order to ensure compliance with Regulations and to inform mine personnel on 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

6.5 Auditing & Review/Revision

Reviewing the effectiveness of programmes 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 would audits be done, what systems or areas would be audited and reporting arrangements.

7. Process

Using the equations in Section 6.2.3 the following values can be used to calculate Risk Score for a Hazard.

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Risk score = Probability x Exposure x Consequence

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7. Process

Using the equations in Section 6.2.3 the following values can be used to calculate Risk Score for a Hazard.

Risk score = Consequence × Likelihood
Risk score = Consequence × Probability × Exposure

Scale for consequence

• Several dead	5
• One dead	1
• Significant chance of fatality	0.3
• One permanent disability/less chance of fatality	0.1
• Many lost time injuries	0.01
• One lost time injury	0.001
• Small injury	0.0001

Scale for exposure

• Continuous	10
• Frequent (daily)	5
• Seldom (Weekly)	3
• Unusual (Monthly)	2.5
• Occasional (Yearly)	2
• Once in 5 years	1.5
• Once in 10 years	0.5
• Once in 100 years	0.02

Scale for probability

• May well be expected	10
• Quite possible	7
• Unusual but possible	3
• Only remotely possible	2
• Conceivable but unlikely	1
• Practically impossible	0.5
• Virtually impossible	0.1

8. Conclusion

Management of safety issues based on assessment of risks not only integrates safety with productivity but also can be used as a very good tool for reduction of costs. The systems stand on the premise that all risks need not be eliminated and different control measures can be adopted for different levels or risks. The key here is to aim for ALARA (as low as reasonably achievable), which eventually depends on cost considerations. The system allows prioritisation of allocation of scarce resources thereby cutting costs and

reducing wastages. This assumes great importance in the current Indian scenario.

The other merits of the system are that it is created by the mine operators themselves through considerable brainstorming. This approach lets the mine operators/users feel ownership of the system, something that is not cast upon them by experts, Government agencies or outsiders, and hence chances of successful implementation is much more. In this system, grey areas are minimized, responsibilities for action are pinpointed and scopes for auditing and improvements are always present.

For convenience of mine operators, the following Annexures are given :

Annexure I : Forms for risk assessment, its control and audit.

Annexure II : Risk Management Plan, designed by the officials of a coal mine.

These guidelines are given for guidance only and they need to be tailored for specific requirements.

Annexure - 1

Typical Risk Management Forms

1. Hazard Identification and Risk Ranking

Leader..... Team..... Date.....

Ref. No.	Identified Hazard	Existing Controls	Estimate the Risk				Risk Rank
			Likelihood		Conseq-uence	Risk Score	
			Exposure	Probability			

2. Control / Treatment of Risks

Leader..... Team..... Date.....

Ref. No.	Treatment options	Cost or difficulty to implement	Effectiveness of treatment			Selected method
			Likelihood	Consequence	Risk	

3. Action Plan

Leader..... Team..... Date.....

Ref. No.	What is to be done	Target date	Responsibility	Signed off on completion

Annexure - 2

Some Case Studies

Mine A

***Step* 1. Initial Hazard Identification, Risk Assessment and Prioritisation**

No.	Description of Hazard	Conse-quence	Probabi-lity	Exposure	Total Risk
1.	Inundation	5	10	10	500
2.	Poor Quality of Supplied Material	5	10	10	500
3.	Geological Disturbance	5	10	10	500
4.	Improper Strata Control	5	7	10	350
5.	Training Facilities Inadequate	5	7	10	350
6.	Shortage of Skilled Persons/development of unskilled persons	5	7	10	350
7.	Inadequate Communication system	5	7	10	350
8.	Poor Supervision	5	7	5	175
9.	Spontaneous Combustion	5	3	10	150
10.	Improper Surveying	5	3	10	150
11.	Explosives / Blasting	5	3	5	75
12.	Haulage	1	7	10	70
13.	Machinery	1	7	10	70
14.	Lack of Awareness	1	7	10	70
15.	Sealed Off Panels	5	3	2.5	37.5
16.	Inadequate Supply of Spare Parts	0.3	7	10	21
17.	Use of Uncalibrated Instrument	1	7	3	21
18.	Ventilation not to Plan	0.1	10	10	10
19.	Other : Fires	0.1	7	10	7

Step 2. **Identifying Mechanism contributing principal Hazards and Ranking**

No.	Major Hazard	Mechanism	Cons.	Prob.	Expo.	Risk
1.	**Inundation**	– River overflow above HFL	5	7	10	350
		– Waterlogged Working U/g	5	2	10	100
		– Inrush through subsidence cracks/ Bore Hole	5	7	2	70
2.	**Poor Quality of Supplied Material**	– Improper procurement procedure	5	7	10	350
		– Inspection procedure not followed	5	7	10	350
		– Improper storage	5	3	10	150
3.	**Geological Disturbance**	– Presence of fault & slip planes	5	10	10	500
		– Fractured roof	5	10	10	500
4.	**Improper Strata Control**	– Failure to identify bad roof	5	10	10	500
		– Improper dressing	5	7	10	350
		– Improper supervision	5	7	10	350
		– Poor workmanship	5	7	10	350
		– Non-superimposition of some pillars in contiguous working	5	7	10	350
		– Inadequate support design	5	3	10	150
		– Poor quality of support material	5	3	10	150
5.	**Training Facilities Inadequate**	– Non-existence of training schedule for skill development	5	7	10	350
		– Untrained trainers	5	3	10	150
		– Infrastructure not to the requirement	5	10	10	500
		– Non-existence of Feedback / Test	1	10	10	100
6.	**Shortage of Skilled or Authorised Person/Deployment of Unskilled person**	– Absenteeism	1	7	5	35
		– Training not done as per requirement	1	7	10	70
		– Manpower sanction not as per requirement	5	7	10	350
		– Examination for workmanship not done regularly	1	10	10	100
7.	**Inadequate Communication**	– Non-availability of spare parts	5	7	5	175
		– Inadequate capacity of exchange	5	10	10	500
8.	**Poor Supervision**	– Negligence/Lack of commitment	5	7	3	105
		– Not having proper knowledge/ experience	5	3	3	45
		– Inadequate training	0.3	3	3	27
		– Shortage of supervisors	5	7	5	175
9.	**Spontaneous Combustion**	– Panel extraction beyond incubation period	0.1	3	10	03
		– More coal left in goaf	0.1	10	10	10
		– Improper management of subsidence area	5	2	2.5	25
		– Poor construction / maintenance of seals	5	3	10	150

No.	Major Hazard	Mechanism	Cons.	Prob.	Expo.	Risk
10.	**Improper Surveying**	– Calibration of instrument not being done regularly	5	2	10	100
		– Non-superimposition of some pillars formed earlier	5	10	10	500
		– Surveying not done in time	5	3	3	45
11.	**Explosives/ Blasting**	– Not taking proper shelter specially with respect to contiguous working	5	3	5	75
		– Possibility of blown through shots	5	3	5	75
12.	**Haulage**	– Poor quality of existing ropes & rollers	1	3	10	30
		– Safety devices not adequate	1	3	10	30
13.	**Machinery**	– Maintenance schedule not followed	1	7	10	70
		– Temporary trailing cable joints	1	7	10	70
		– Bye-passing protective devices	5	3	5	75
		– Unskilled operators	1	3	5	15
		– Moving parts of machines	1	10	10	100
14.	**Lack of Awareness**	– Non-existence of documented procedures	1	10	10	100
		– Improper / inadequate training	1	3	5	15
		– Improper conmmunication	5	3	3	45
		– Inadequate Publicity / Objective not explained	1	3	3	09
15.	**Sealed Off Panels**	– Improper management of subsidence area	5	2	2.5	25
		– Poor construction / maintenance of seals	5	3	10	150
		– Improper supervision	5	3	5	75
		– Improper sampling & analysis procedure	5	2	10	100
16.	**Inadequate supply of spare parts**	– Improper procurement planning	1	7	5	35
		– Delay in procurement action	1	7	3	21
		– Importance not given to the indents	1	10	10	100
17.	**Use of uncalibrated Instrument**	– Non-existence of calibration procedures	5	7	5	175
		– Non-existence of calbibration Infrastructure	5	10	5	250
		– Non availability of spare Instruments	5	7	3	105
18.	**Ventilation not to Plan**	– Delay in construction of stoppings	0.1	7	10	7
		– Tampering of ventilation devices	0.1	7	10	7
		– Poor construction of stoppings	0.1	3	10	3
19.	**Others : Fires**	– Conveyor Fire	0.3	2	3	1.8
		– Electrical Fires	5	7	5	175
		– Fire during gas cutting	1	3	2.5	7.5
		– Spilled off Lubricants	0.3	1	2	0.6

Step 3. Control Measures & Procedures for Respective Mechanisms contributing Hazards

Mechanism	Control	Relevant Statute	Procedure	Existing Procedure Y/N	Responsible person
Inundation					
– River overflow above HFL	– Embankment – Float Alarm, Guard & Wireless		– Water danger Procedure		
– Waterlogged Working U/G	– Pumping, Dams & Inspection		– Pumping procedure		
– Inrush through subsidence crucks/ Boreholes	– Garland drain, Crack filling & Inspection		– Subsidence management procedure		
Poor Quality of Supplied Material					
– Improper procurement procedure	– Agent to apprise competent authority for necessary steps		– To be prepared centrally		
– Inspection procedure not followed	– Agent to ensure		– do -		
– Improper Storage	– Agent to ensure appriise GM		– Storage procedure		
Geological Disturbance					
– Presence of Fault & Slip-Plane	– Effective Supervision & Additional Support		– Inspection, Supervision & Monitoring procedure		
– Fractured roof	– —do—		– Support procedure		
Improper Strata Control					
– Failure to identify bad roof	– Effective Supervision		– Inspection, Supervision & Monitoring procedure		
– Improper Dressing	– Proper dressing & Proper Supervision		– Dressing procedure		
– Improper Supervision	– Effective Supervision		– Inspection, supervision & monitoring procedure		
– Poor Workmanship	– Training, Test & Monitoring – Marking such pillars U/G & alert concerned people during extraction		– Training procedure & Inspection, Supervision & monitoring procedure		
– Non-superimposition of some pillars in contiguous working	– Review Support Design		– Survey procedure		
– Inadequate Support Design	– Corrective Steps		– Procurement procedure		

Mechanism	Control	Relevant Statute	Procedure	Existing Procedure Y/N	Resp sib per
– Poor quality of support material					
Training Facilities Indaequate					
– Non-existence of skill training schedule	– Preparation of skilled		– Training procedure		
– Untrained trainers	– Training for trainers – Group VTC to be equipped		- do- –do-		
– Infrastructure not to the requirement			-do-		
– Non-existence of Feed-back/Test	– To be started		-do-		
Shortage of skilled persons/ Deployment of unskilled persons					
– Absenteeism	– Disciplinary action, Work programme		– Colliery Standing Order		
– Trg not done as per requirement	– Comply				
– Manpower sanction not as per requirement	Agent to apprise competent authority				
– Examination for work-manship not done regularly	-do-				
Inadequate Communication system					
– Non-availability of spare parts	– Agent to arrange		– Procurement procedure		
– Inadequate Capacity of Exchange	– Agent to apprise competent authority				
Poor Supervision					
– Negligence/Lack of Commitment	– Monitoring, Motivation & Enforcement of discipline		– Inspection, Supervision & Monitoring procedure		
– Not having proper knowledge/Experience	– Training & Feedback		– Training procedure		
– Inadequate training	–do–		–do–		
– Shortage of Supervisors	– Transfer & Train to become competent		–do–		
Spontaneous Combustion					
– Panel extraction beyond incubation period	– Plan to extract panel within incubation period		– Extraction procedure		

Mechanism	Control	Relevant Statute	Procedure	Existing Procedure Y/N	Responsible person
More coal left in goaf - Improper management of subsidence area - Poor construction/ maintenance of seals	- Extract judiciously - Crack filling/Afforestation & Proper Monitoring - Construct & Maintain seals as detailed in sealing Procedure		- Extraction procedure - Subsidence management procedure - Sealing procedure		
Improper Surveying					
- Calibration of Instrument not being done regularly	- Regular calibration		-		
- Non-superimposition of some pillars formed earlier	- Mark such pillars at site & work accordingly		- Extraction procedure		
- Surveying not done in time	- Regular Survey		- Survey procedure		
Explosives / Blasting					
- Not taking proper shelter specially with respect to contiguous working	- Monitor the efficacy of taking shelter		- Drilling & Blasting procedure		
- Possibility of Blown through shots	- Stop one of the approaching faces when within 9m.		- Survey procedure		
Haulage					
- Poor quality of existing ropes & rollers	- Procure ropes & rollers in advance & change old ones timely.		- Machinery Installation & Maintenance procedure		
- Safety devices not adequate	- Install monkey catches in Endless track & maintain all safety devices.		- Conveying & Hauling procedure		
Machinery					
- Maintenance schedule not followed	- Implement, Monitor & / or take conective action for non-compliance		- Maintenance Schedule		
- Temporary trailing cable joints	- Step doing temporary joints		- Inspection, Supervison & Monitoring Procedure		
- Bye-passing protective devices	- Stop machines if protective device is not functioning				
- Unskilled operators	- Stop machine if trained operator is not present-train more operators				

Mechanism	Control	Relevant Statute	Procedure	Existing Procedure Y/N	Responsible person
– Moving parts of machines	– Fence moving parts of machines & Don't allow people wearing loose dresses		– Unsafe Practices/ Unsafe Act & Colliery Standing Order		
Lack of Awareness					
– Non-existence of documented procedures	– Document all Procedures & issue to concerned persons				
– Improper / inadequate training	– Training & Feedback		– Training procedure		
– Improper communication	– Detailed written Communication either by letter or on Notice Board				
– Inadequate Publicity/ Objective not explained	– Explain the objective				
Sealed Off Panels					
– Improper management of subsidence area	– Blanketing / Crack filling & proper monitoring		– Subsidence management process		
– Poor construction / maintenance of seals	– Construct & maintain seals as detailed in sealing procedure		– Sealing procedure		
– Improper supervision	– Regular supervision		– Inspection, supervision & monitoring procedure		
– Improper sampling & analysis procedure	– Sampling & analysis as per Sampling Protocol		– Sampling protocol		
Inadequate Supply of Spare Parts					
– Improper procurement planning	– Advance planning considering past requirement & growth		– Material procurement & storage procedure		
– Delay in procurement action	– Avoid delay				
– Importance not given to indents	– Agent to send reminders				
Use of Uncallibrated Instruments					
– Non-existence of calibration procedures	– Develop a system for periodic calibration, document, implement & monitor				

Mechanism	Control	Relevant Statute	Procedure	Existing Procedure Y/N	Responsible person
– Non-existence of calibration infrastructure – Non availability of spare instruments	– Competent authority may be apprised & reminded for need & status.				
Ventilation not to plan – Delay in construction of stoppings	– Competent authority may be apprised about the rettratic of contractor for doing jobs at lower rates and may be requested to solve the problem at the earlier.				
– Tampering of ventilation devices – Poor construction of stoppings	– Effective Inspection & Supervision		– Sealing procedure		
Other : Fires – Conveyor Fire	– Clean spilled coal/ dust regularly & maintain drums & rollers properly		– Conveying & Hauling Procedure		
– Electrical Fires	– Maintain as per Schedule a Fire extinguisher of Dry Chemical powder/ CO_2/ABC type near electrical appliances. Machines shall not be operated bye-passing protective devices or with temporary cable joints, Joint boxes shall be compounded. Use only approved type electrical appliances. – Site of gas cutting must be stone dusted well if combustible material is there &		– Maintenance Schedule – Fire prevention procedure		

Mechanism	Control	Relevant Statute	Procedure	Existing Procedure Y/N	Responsible person
– Fire during gas cutting	arrangement for water & fire extinguisher must be kept ready. – Clean all spilled off oil/lubricants well to make the site inherently safe.				

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