

# A CRITICAL APPRAISAL OF CMR/MMR TO IMPROVE SAFETY IN MINES

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## INTRODUCTION

Mining being a continuous struggle against the unpredictable forces of nature is considered one of the most hazardous operations. The history of mining in India like many other countries in the world has been marred by disasters killing a large number of workers. In spite of rapid advancement in technology and management disaster in mining, mainly due to fire, explosion and inundation have been occurring at a regular interval. Mining whether opencast or underground is not at all possible if due consideration is not paid to strata control. In open cast mining, it is the stability of open cast slopes which plays an important role while in underground mines stability of the pillars contribute to the major safety operations. Even today fall of roof and sides constitutes the single major cause of coal mines accidents. Therefore, enough room for improvement of support system, strata control management and disaster management is available. In this paper, a few important regulations of CMR/MMR has been appraised to improve safety in mines with due regard to enhancement of production and productivity. DGMS has already played a key role in this regard. Their contribution and recently adopted measures for improvement of safety in mines are also dealt with in brief.

## CONTRIBUTION OF DGMS DURING LAST CENTURY

The important steps taken towards improvement in safety during the last century are summarized in chronological order as follows:

- ❖ Enactment of Mines Act 1901.
- ❖ Institution of State Enforcement of Safety Laws with setting up of Mine Inspectorate on 7th January, 1902.
- ❖ Enforcement of Indian Electricity Act & Rules in Mines transferred to Mines Inspectorate (1922).
- ❖ Statutory appointment of qualified Surveyors at Coal Mines (1929).
- ❖ Enforcement of Coal Mines Rescue Rules (1939) - since replaced by Mines Rescue Rules 1986 and made applicable to all types of mines.
- ❖ Coal Mines Safety (stowing) Act enforced and Stowing Board set up (1946). Cess collected to assist stowing for control of fires, collapse and surface subsidence.
- ❖ Hours of work, weekly day of rest, and employment of adolescents regulated (1952).
- ❖ Central Research Station (now renamed Central Mining Research Institute) set up in 1956 to carryout long term R&D work in the field of mining and allied subject.
- ❖ Regulation and control on mining operations underground through grant of statutory permissions in respect of depillaring operations and development work beneath important surface structures and with advancing working in vicinity of water bodies, beneath fire areas etc. (1957)
- ❖ Holding of first National Conference on Safety in Mines (1958) - since then there have been nine more safety conferences.
- ❖ New code of Metaliferous Mines regulations framed on lines of Coal Mines Regulations 1957 (1961).
- ❖ Observance of Annual Mines Safety Week commenced (1963).
- ❖ Appointment of Safety Officers at Mines as Staff Officer to Manager (1965).
- ❖ Promulgation of Mines Vocational Training Rules 1966 and consequent setting up of Vocational Training Centre for workers at mines.
- ❖ Declaration of all underground coal mines as gassy (1967).
- ❖ Use of personal protective equipments made compulsory.
- ❖ Standards of ventilation, lighting, noise, accuracy of mine plans etc. lay down/recommended (1972).
- ❖ Central Mine Planning & Design Institute set up for scientific development & growth of mineral industry through R&D efforts in the areas of Hydro geological investigations, method of coal extraction, stability of old and unapproachable workings, mine subsidence & mine fires, blasting technology, etc. (1975).
- ❖ Concept of Systematic support of freshly exposed ground in development workings introduced (1976-77).
- ❖ Only approved type of machinery, equipments & appliances etc. to be used below ground (1978).
- ❖ Institution of Internal Safety Organisation (ISO) in Industry (1980).
- ❖ New comprehensive Oil Mine Regulations 1984 promulgated replacing earlier 1933 enactment.
- ❖ Statutory appointments of Workmen Inspectors & Pit Safety Committees at Mines (1986).
- ❖ Establishment of National Institute of Rock Mechanics for research in applied and basic rock mechanics in coal and non-coal mines (1988).
- ❖ Statutory formulations of Support Plans for workings in Coal Mines (1990).
- ❖ Introduction of Roof Bolting system and other types of steel supports to replace timber in Bord & Pillar workings of coal mines as per commendations of Paul

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committee (1993).

- ❖ Damage of structure due to blast induced ground vibrations - permissible peak particle velocity at the foundation level of different type of structures has been standardized (1997).
- ❖ Development of Dust setting ionizer namely 'Pulver Bond' and 'Dust Bond' for suppression of dust in open cast as well as underground mines (1997).
- ❖ Use of fire-resistant hydraulic fluids in machinery use belowground in coal mines (2000).
- ❖ Recommendations of Gaslitand Court of Inquiry made.

## RECENTLY ADOPTED MEASURES TO IMPROVE SAFETY

The following major safety measures were taken recently for further enhancement of safety in the coal mines.

1. Introduction of Risk Assessment as a tool for improvement of safety
2. Conducting of Safety Audits of mines by external experts for assessment of threats and implementation of the recommendations thereof were continued.
3. Thrust was maintained on preparedness for emergencies through:
  - Reviewing Emergency Action plans for each and every working districts in underground mines.
  - Demarcating escape routes on plans as well as belowground.
  - Conducting of mock rehearsals and monitoring failure points for further improvement.
4. Introduction of Man-riding system for travel of workmen in mines having lengthy and arduous traveling.
5. Towards avoidance of accidents due to inundation:
  - Taking the required preventive measures against danger of inundation after
  - Assessment of danger from underground and surface sources of water in each mine.
  - Conducting of check surveys by company's surveyors as well as cross-checking the same in some cases by external agencies like ISM & CMPDIL.
6. Effort were taken for identification of water bodies belowground without physically proving the barrier by drilling through.
  - Electrical Resistivity survey by CMRI in ECL.
  - Seismic method for identification of water body in MCL by NIRM.
  - Ground Penetrating Radar by NIRM
  - Establishment of centralised emergency pumping arrangement for use during emergencies.
7. Thrust on measures for reduction of roof and side fall

accidents in belowground mines were continued by:

- Drawing up of Support Plans based on RMR and implementation of the same.
  - Greater use of Roof Bolting/Stitching methods of roof support by quick setting cement capsules.
  - Introduction of Resin grouted Roof Bolts in watery seams.
  - Training of Support Personnel and Supervisors
  - Involving scientific institutions for development of suitable support system for the workings.
8. Measures for reduction of accidents in opencast mines were pursued through:

- Implementation of various Codes of Practices, Traffic Rules checking of contractor's vehicles / equipment by company's engineers.
- Training of Heavy Earth Moving Machinery operators and contractor's workers.
- Enhancement of safety awareness through publicity and propaganda, safety drives, safety weeks, etc.

## SUGGESTIONS FOR IMPROVEMENT IN MMR AND CMR

- During emergency due to fire in the mine it may be desirable to reverse the airflow of main mine fan to provide an escape way or isolate the fire. As per Coal Mines Regulations, 1957 and Metalliferous Mines Regulation, 1961 in India every main mechanical ventilator in coal mines, and every mechanical (other than an auxiliary fan) in metalliferous mines, shall be so installed, designed and maintained that the air current can be reversed when necessary. Regulations are however silent about the conditions under which ventilation reversal is to be effected. According to international literature survey there should be definite guidelines to implement reversal of main surface fan. Data bank should be prepared to formulate the guidelines. This calls for R&D work in this direction.
- MMR 131 indicates standard of ventilation where it specifies the quantity of air required in every ventilation district, O<sub>2</sub>, CO<sub>2</sub> percentage and percentage of inflammable gas including temperature, velocity of air. It does not mention the techniques to be adopted to maintain the above parameter in proper level. Ventilation network analysis is one such mean. Environmental tele-monitoring system should be made applicable to every fire prone mines, may it be B & P or longwall panels. Indigenous development of environmental tele-monitoring system should be encouraged.

Central Institute of Mining and Fuel Research (Erstwhile CMRI) has started working in this respect<sup>1</sup>.

Recently, it has developed and designed a total Mine Environmental Monitoring System (MEMS) and installed at AW2 longwall panel of Jhanjra mine, ECL. Four parameters were taken viz., air velocity, air temperature, methane and carbon monoxide.

- Open cast mines has witnessed many changes from manual mining in the 50's to highly mechanised one with Heavy Earth Moving Machines (HEMM) in early 90's. this calls for a separate legislation detailing every aspect of open cast mining. It is learnt that DGMS is about to come up with open cast mine legislation.
- Beneficiation plants/washeries deal with appreciable size of motor horsepower and these plants are managed by personnel other than persons holding Mine Manager's Certificate of Competency. It is to be seen whether these plant activities to be covered under Mines Act. Safety aspects of processing plants should be introduced in the regulation.
- In order to carry loading of explosives in large number of holes in highly mechanized mines to meet high rate of excavation and avoid shifting of large excavating equipment / drills provisions are required for permitting sleeping of holes for a reasonable period. This is with respect of Regulation 162(16) of MMR for firing of shot holes. Das, 1993 remarked that maximum days must be stipulated for the "sleep holes" depending upon the shelf life of the explosive and the impact of the explosives on the blasting accessories<sup>2</sup>. The site should be properly attended round the clock. Red flags are to be fixed over each of the sleep hole to give visual warning to any unauthorized persons. Movement of Heavy Earth Moving Machineries shall not be done within a distance of 100m from the outskirt of the blasthole zone.
- Loose stones, debris are bound to be there after blasting operation in any opencast excavation process. In this connection Regulation 106(4) and 106(5) or MMR need modification. Stability of slope in large opencast mines in another problem which demands special attention. Regulations detailing out all those aspects are needed.
- As per DGMS Circular 46/1963, in most mines, air measurement readings, as recorded, are not correct due to the fact that<sup>3</sup> -
  - ❖ Anemometers used have not been calibrated for a long time and are, therefore, giving very misleading figures; and
  - ❖ Air measurement stations are badly sited and are not maintained in a stream lined condition.

Regulations do not spell out the time interval/frequency of calibration of air measuring instrument. It is done mainly when DGMS officials object or set pressure on to the mine authority for such calibration.

- In the era of globalization new technology has come

- up. But the legislative procedure to match with the new technology is yet to be formulated. This results in unsafe operations. Further, the work persons are not well educated, trained or skilled to adopt such new technology enhancing chances of more human error.
- Private entrepreneurs are now playing a considerable role in the mining industry. Outsourcing of certain operations and equipment is also becoming quite common. This adds to some new dimension to the safety aspects of mining industry. Contractors play a major role in outsourcing activities. Neither contractors nor employees working under him are conversant with mining law and safety practices<sup>4</sup>.
- It is our practical observation that the quality of Brattice cloth we receive for testing as per IS 4355:1977 differs from the one which we see in mines. The whole purpose of Brattice cloth testing is to make available of good quality sample to the mine authority. There should be proper verification/checking before the Brattice cloth reaches to the mine concerned. Accordingly some regulations may be framed.
- Open cast coal mines deals with considerable amount of topsoil. A good mining practice speaks for scrapping of the top soil with small excavators before excavating the overburden and stores it in a scientific manner so that biotic properties are not lost. This top soil may be utilised for reclamation of overburden to use the land for agriculture or forestry purpose. Unfortunately, in coal mines, there is no such regulation for topsoil management.
- Bord & pillar mining method is the prevalent method of underground mining which contributes as much as 94% of the present underground production of coal. Considering the present and past experience of the Indian mining industry, this method of mining is going to dominate the near future. Improving the efficiency through complete mechanization for greater depths is the need of the hour.
- Introduction of LHDs, SDLs with chain conveyor, Road header and continuous miner can bring revolutionary changes. In fact semi-mechanisation is the prerequisite to reduce the concentration of workforce in potentially dangerous coal face. But many a times, it is difficult to utilise them, to their full capacity, with the existing 4.8m width of gallery as restricted by CMR 99. Free movement of the machinery is mainly restricted by the supports in the gallery and junctions. There should be some specific guidelines for gallery width with respect to method of mining and level of mechanization being adopted.
- With the advancement of technology and resources, Indian mining industry is now in a position to decide the optimum pillar size under given depth and/or geomining conditions. But formation of wider pillars

beyond the size suggested by CMR 99 is not possible even if outcome of studies suggests a wider size. Thus, CMR 99 and its practicability with the changing mine scenario are required to be appraised.

- Reg.100(5) implies "where possible, suitable means shall be adopted to bring down the goaf at regular intervals" in case the method of mining is by caving. In this context, induced caving by underground blasting is the most commonly practiced technique in Indian mines as no additional set up and laboratory tests are required for its application. But guidelines are not available for its practice.
- Though there is no guideline as to amount of explosives to be used for induced caving of roof rock by blasting in an underground mine, DGMS stipulations on maximum permissible charges in a shot hole for coal winning vide Table 1 was used in some of the mines and it was found that height of roof that can be dislodged is limited to 6-8m with the permitted amount of explosives depending upon the gassiness of seam for any particular mine.
- In Chucha West Mine of SECL Seam V having thickness of 3 to 3.45m has been depillared safely with strata monitoring and induced caving by blasting using the stipulations specified in Table 1. Though, severity of falls has been reduced and no overriding has been recorded since its inception, spalling of 0.5 to 1 m is commonly seen in pillars, one pillar ahead from pillar under extraction. Based on the instrumentation observations CMRI suggested blast to a height of 15m for maintaining safe stress level in workings, but it is really difficult to blast to a height of 15m long hole with permitted amount of explosive. In addition to this number of induced caving techniques are available and each is having its own limitations. Thus, more R&D is required to formulate specific guidelines or code of practice for selection of a particular induced caving technique with range of suitable technical parameters for its effective application along with permissible charges of explosives in case of induced caving by blasting from underground.

**Table 1: DGMS Stipulations on Maximum Permissible Charges in a Shot Hole**

Type of Explosive	Gassiness of Seam	Winning Method	Max. permissible charge/shot hole (gm)
P1	Degree I	Out face	800
P3	Degree I, II & III	Out face	1000
P5	Degree I	Blasting off the solid	1000
P5	Degree II & III	Blasting off the solid	565

- Since working are becoming deeper day by day spalling of pillar sides has become a common issue and to resolve this side bolting have also been adopted by miners in some cases. Thus, there is a need to formulate specific guidelines regarding length and

diameter of such bolts. Depth up to which they should be inserted and the distance between two such adjacent bolts, so that they should not pose any inconvenience during depillaring operation.

- Many accidents due to fall of roof have taken place where the immediate roof is massive sandstone and still workings under such roof are in peril. Spalling of coal, air blast in B&P workings, collapse of faces and overriding of pillars are some common phenomena associated with such roof. In this regard, CMR 100(2) implies "The extraction or reduction of pillars shall be conducted in such a way as to prevent as far as possible, the extension of a collapse or subsidence of the goaf (stoped out areas) over pillars or mineral blocks which have not been extracted". It needs to be more elaborative regarding depillaring sequence of adjacent panels which otherwise may lead to seam corner formation when excavated area is nearby.
- Inundation is a potential danger to coal mines. In this regard, CMR 127/MMR 128 should be strictly adhered to. Incorrect mine plan had been a major contributory cause in many of the cases when the source of water has been below ground. Efforts were made time to time to improve the accuracy of mine plan. The status of mine plan however, is still far from satisfactory. In the past six years it has become a recurring problem to coal mining industry particularly to BCCL causing loss of precious lives. Many coalmines of Jharia and Raniganj Coalfield before nationalization were operated in a small way by petty owners. After nationalization many of these mines were amalgamated to form larger mines resulting in destroying our reducing the inter-mine and inter-unit barriers. This established the connections between different mines in different seams resulting in transfer or danger from one mine to another.
- Unsystematic or unorganized mine closure leads to illegal mining which causes loss of property, destabilizes the railway track line and invites fire trouble too. A number of accidents have taken place in the past is continuing to pose dangers to the life of personnel involved in such activities. The only effective way to deal with this problem is to completely fill up the excavation to the level of the adjacent ground or restore the land to its original condition or in other words adoption of systematic closure of mine. In this regard, Government of India vide circular no. 14/2003 has issued mine closure plan guidelines for non-coal sector and accordingly MCDR 1988 and MCR 1960 has been amended incorporating these guidelines. Similar guidelines for coal sector is required to be framed to stop illegal mining and accidents associated with it.

## CONCLUSIONS

Strata Control, Fire & Explosion and Inundation are the major problems affecting safety and productivity in underground mining. However, fall of roof and sides are the predominant cause of fatalities in belowground coal mines. Of the different types of strata that are involved in falls causing accidents sandstone constitutes almost 30% of accidents. Thus, measures suggested in this respect must be taken care of. Further, to ensure safety with more and more automation in the years to come which involves complex interaction of several processes, greater vigil and upgradation of skills, adequate ventilation, certain regulations highlighted in this paper should be reviewed and reframed for greater mechanization and safety at work places. Time & again, it has been found that unsafe practices on part of human are the major cause of fatalities which need to be focused along with law and order situation of any region to reduce avoidable accidents. In addition to this, framing of mine closure guidelines for coal sector on the lines of Government of India circular no. 14/2003 may reduce illegal mining to a large extent.

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