

To

The Owner, Agent and Manager  
of all coal mines

Sub: ACCIDENT DUE TO EXPLOSIVES - CAUSES AND PREVENTION

In every sphere of human activity there is a possibility of an accident and work is no exception. Unsafe act and unsafe conditions of work lead to an accident in mines. Two recent accidents (on 14th Nov.95 and the other on 16/17th March 1996 due to explosives caused us to take serious note of the failures involved and it was considered necessary to review the causes and circumstances leading to such accidents.

Investigations into earlier accidents due to explosives have established that accidents occur mainly due to errors and slippage on the part of supervisory staff (human elements) and due to absence of good system of blasting. It has been proved time and again that an effective enforcement of the existing procedures would make a welcome dent in the figures of the accidents due to use of explosives.

The major causes of these accidents in underground mines may be broadly presented as below-

- Blown through shots and hit by projectiles from the opposite face.
- Direct hit by projectiles on the front side of the face.
- Drilling into misfired shots
- Miscellaneous causes other than above

#### 1.0 Danger from blasting operations in coal mines having below ground workings.

##### 1.1 Causes

###### 1.1.1 Blown through shots and hit by projectiles from opposite face. Condition – A

A review of accidents was made in 1982 and attention of the management was drawn to unsafe practices in the use of explosives that took a toll of human lives in belowground coal mines.

The major cause of these accidents was found to be non-compliance with the provisions of Regulation 170(3) of the CMR 1957 viz firing shots at a face without removing persons from other face having parting within 4.5 m which resulted in flying pieces of coal inflicting injuries to the workers. Such lapses accounted for 7 fatal accidents in 1980, 2 in 1981 and 3 in 1982. In addition some more accidents resulted in serious and minor injuries and clearly established that a good number of underground workers and blasting crew were exposed to this dangerous operations. Accidents due to this type of cases were occurring even though guidelines and preventive measures were issued through circulars No. 52 of 1971, No. 1 (Tech.) of 1977. It was therefore suggested in the cir. No. 16 of 1982 that the overman incharge of the district who had to carry hand plan as per Reg.40(1)(b) shall take such step when the faces approach within 10 m of each other and consequently the shotfirer would become aware of the existence of danger on this account and would take necessary steps to withdraw persons from the vulnerable places. Thus if the surveyor, overman, mining sirdar and shotfirers are vigilant and do their routine duty this type of accidents can be prevented.

The precautions already laid down during 70s'and early 80s' in different circulars on accidents due to blown throw shots are summarised below.

- Withdrawal of persons from the face and fencing off entrance before the shots are fired at other face which is within 4.5 m of each other (Reg 170(3) read with Circular 52 of 1971)

- Putting up of notices and erecting portable fencing with caution boards in all approach galleries when the faces approached within 4.5 m (Circular 1 of 1977).
- Mining Sirdar to supervise the shortfiring operation to ensure the precautions of putting up fencings and other precautions (Circular 1 of 1977)
- Overman to give instructions in writing to the concerned shotfirer when the provisions of Regulation 170(3) are attracted and when the faces have approached within 10 m of each other. (Circular 16 of 1982).
- It was further advised that work at one of the two faces approaching each should be temporarily discontinued and connection made by advancing along one direction. The approaches to discontinued gallery shall be fenced off. (Circular No. 6 of 1983)
- When a face is temporarily discontinued it should be ensured that stopped face is always kept dry. (Circular No. 6 of 1983)

During analysis of the causes and circumstances leading to the accidents it was revealed that giving instructions to shotfirer in writing by overman and Supervision of the Mining Sirdar for Putting fences and stoppage of one of the faces and made connection from one side when the faces were within 10 m. to each other were all time consuming and needed action plan. As a result these instructions were not being complied with and accidents due to these causes continued to take place.

A review of accident due to blasting with thin parting and hit by projectiles from the opposite face for a period of last 5 years has now been made and the cause wise analysis is presented in table-1.

Table -1 Causewise incidence of fatal accidents due to blasting in coal mines.

Year	Projectiles (on same side) Direct line		Projectiles (opposite side) Blow through Thin parting		Mixture	
	No. of accident	Death	No.	Death	No.	Death
1991	2	2(6)	1	1(2)	1	1(3)
1992	-	-	-	1(6)	-	-
1993	2	2	-	1(2)	-	-
1994	3	1(1)	1	-	1	1(3) 1(4) 1(3)
1995			1	2(12)	1	1(3)
			1	1(2)		
			1	1(2)		
			1	1(7)		

\*Figures within parenthesis indicate number of persons exposed to danger due to blasting.

It is observed that except in 1994, accidents due to this cause occurred every year since 1991 and in the year 1995 there were four accidents resulting in death of 5 persons and involving 23 persons. The investigations in these cases revealed that the shotfirers were aware of the parting between the two faces but persons were not withdrawn and fenced off as per standard precautions. It is therefore re-established that there is a need for development of good blasting management practices by formulating a code of safe practices and making all the supervisory staff and officers accountable for lapses in compliance of code of safe practices.

#### 1.1.2 Direct hit by projectiles on the same side. Condition - B

The unsafe practice commonly adopted by some shotfirers was the main cause of accident under the condition. Here the shotfirer used to fire shots without ensuring that all persons were removed from the danger zone or that they had taken adequate shelter from flying pieces of

coal/stone. DGMS Circular No.16 of 1970 however, outlined the desirability of taking proper shelter.

It was also revealed that unsafe practice of firing shots in a face in two rounds instead of one created confusion amongst the workers who inadvertently entered the danger zone when the second round of shots was fired and this resulted in hitting by projected pieces of coal resulting in accidents. This practice of blasting in two rounds of charged shots for convenience of the shotfirer or for some other reasons (viz. inadequate exploder capacity, more than 10 shots are to be fired in a face) is not permitted under Regulation 168(10) and (16) and this was pointed out vide Circular No. 16 of 1982.

Moreover adequate precautions exist in the Regulation to prevent inadvertent entry into such dangerous areas but there used to be failure somewhere else in the observance of these stipulated precautions.

Thus there is a need to educate the workers on the system of blasting and not to rush into the workings unless asked to enter the face by the shotfirer or his helper. There is also a need to explain to them the implication of danger zone and to be outside the zone or to be at the resting place. All the operations to be carried out by the shotfirer may be in quick succession and may lead to lapses somewhere and therefore the whole system of blasting is to be evolved involving also mining sirdar, senior supervisor and officers in the operation.

#### 1.1.3 Drilling into misfire shots.

##### Condition - C

The accident due to this cause in coal mine has been occurring even though the statute provides detailed precautions. One of the major reason is lack of proper system of inspection after firing and hurry on the part of shotfirer to leave the mine as soon as the shots are fired.

Another reason as supported by second school of thought that when a round of holes is connected in series either all the holes will fail to blast or all of them will blast and there is no chance of a single misfired hole. However enquiries into misfired shots with different types of detonators has proved that due to varying characteristics of electric detonators possibility of one or more holes in a round of shots failing to detonate can not be ruled out.

#### 1.2 Prevention

For compliance of adequate precautions and thereby to prevent accidents due to above major causes, a system approach for introduction of code of safe practices has been suggested.

##### Card System

Under the existing system, the errors and omissions arising out of 'human elements' in the conduct of blasting operation are generally not recognised by the officers and supervisors. The card system is therefore designed to reduce the errors due to human elements to the minimum and ensure effective compliance with the laid down procedures and precautions which ultimately would result in preventing accidents due to explosives.

The simple logic behind the card system is that whenever a card of any supervisor/competent person is under the possession of his boss or other competent person it is accepted as a proof that dangers arising out of any operation (here blasting) have been explained to him and he has handed over his card as a proof of his acquaintance with the dangers of the operations or compliance with the procedures. This system will take care of all the ills of verbal instruction/confirmation which in majority of the cases create confusion in the confined environment of underground workings.

In this system the blasting operations would be carried out by a team of officers and supervisors with well defined areas of jurisdiction and responsibility of each. If each one does his job sincerely the whole operation would be safe.

## Definitions

Shotfirer (SF) means the Mining Sirdar-cum-shotfirer who is to blast the face.  
 Explosive Carrier (EC) means who carries explosives and also assists the shotfirer in blasting and as well as guarding the entries/approaches to the site of blasting.

Shotfiring Mazdoor (SM) - The worker whose services are temporarily requisitioned at the time of blasting is temporarily SM for the designated period. SM is selected from sincere face workers and he is given the charge of guarding whenever more number of shortfiring personnel is required. He would assist the S.F. in guarding the entries during blasting.

The Mining Sirdar, Shotfirer and Explosives carriers are issued cards. The S.M. is issued cards by the overman before start of blasting operation. The cards bear the name of the person, his personal number and designation. The cards are signed by the Manager or Safety officer of the colliery, the records of which are maintained.

## Duties

Assist Manager/Under Manager - To ensure that the Mining Sirdar, Shotfirer and Explosive carriers have been provided with cards duly signed by the Manager or Safety officer. He is also to ensure that some spare cards are issued to the overman of the district for use in case more than regular number of assistants are required for guarding the entries. A list of persons from the category of face workers (who are being groomed for the supervisory examination) spread over three shifts is to be prepared by him in advance who could be requisitioned for the job of shortfiring Assistant temporarily as and when required.. He shall ensure that in every shift adequate number of assistants are on duty under the control of the overman and the Mining Sirdar.

Overman - To ensure that no person is engaged in blasting without a card with him duly signed by the Manager or Safety officer and that sufficient number of shotfiring assistants has been provided to the shotfirer. He is to carry the spare cards and issue to the face workers from the prepared list as and when required.

He is to inform the Mining sirdar and shotfirer whenever the working faces approach with 10 m of each or two sets of workings approach within 10 m of each other.

He shall ensure that guards have been placed at the vulnerable entries which are not within the blasting zone.

Mining Sirdar - To supervise blasting operations when the faces are within 10 m of each other. He shall discuss with the overman before positioning the guard at the entries to the opposite face. He shall be with the shotfirer when the guards are posted at different entries.

Shotfirer - In addition to his duties of firing shots he is to discuss with the overman and mining sirdar for posting guards.

Explosive carrier/S.M. - Shall carry out the duties assigned to him by the shotfirer. He shall handover the card to the shotfirer before blasting and shall not leave the place unless asked by the shotfirer. He shall collect the card from the shotfirer after shotfiring.

Magazine clerk - He shall check the card of the S.F. and E.C.. before issue of explosives to them.

## Blasting with card system -

### Condition A -

When two faces are within 10 m of each other. (Refer Sketch - 1, 2, & 3)

The Manager shall issue instructions in writing to work only one side of the face at a time in one shift which is considered to be safe practice. The following procedures in different stages shall be followed in chronological order to ensure safe blasting.(Annexure - I).

Stage – I : The overman shall study the plan and explain mining sirdar (MS) and shotfirer(SF) when the two faces have approached within 10 m. The overman in presence of Mining Sirdar shall inform the workers about stoppage of opposite face. The opposite face shall be adequately fenced off under guidance of overman and in presence of mining Sirdar.

Stage - II : Overman will discuss with Mining sirdar and shotfirer for identification of vulnerable entries for posting of guards. If more number of guards is required, the overman will issue cards to face workers who would be designated as SM. Care shall be taken to post guards at places with at least 2 right angle bends.

Stage - III : The overman will collect the card of shotfirer as a proof that information about 2 faces approaching within 10 m has been communicated to shotfirer, and adequate numbers of assistants has been provided. The Mining Sirdar shall hand over his card to the shotfirer as a proof that the opposite face has been stopped and fenced off adequately.

Stage - IV :The Shotfiring Mazdoor(SM) shall be posted at the required places & the cards of Shotfiring Mazdoor (S.M.) shall be collected by SF. The S.M. shall not leave the place till he is asked by SF to do so.

Stage - V : Before blasting shotfirer will go round the area and post the guards (EC) at the identified places to be guarded. The EC shall ensure that workers are withdrawn from the designated face to be guarded and are taken to shelter beyond the blasting zone. EC shall handover the card to SF and shall remain at the place specified by the SF and shall not leave the place before getting his card back from the SF.

Stage - VI : After completion of firing and inspection of the face the shotfirer shall intimate the mining sirdar. The mining sirdar after checking the face and securing roof and sites shall inform the shotfirer to allow the workers to enter the face.

Stage - VII : The shotfirer shall go round the place and handover the cards to the EC/SM. He then allows the workers to enter the face(s).

Stage - VIII : The shotfirer shall handover the card to mining sirdar.

Stage - IX : After completion of blasting in the shift the shotfirer shall collect the card from the overman.

### Condition –B

Under normal condition of blasting - Direct hit by projectiles in front of the face as shown in sketch No. 4.

In this case adequate parting between opposite faces exists. So the entries to opposite faces need not be fenced off. The following procedures in different stages shall be followed in chronological order to ensure safe blasting (Annexure-II).

Stage – I : The overman shall study the plan and explain the Mining Sirdar (M.S.) and Shotfirer (SF) about the vulnerable entries for posting of guards. The overman will arrange for

adequate number of assistants (SM) for posting as guards in addition to explosive carriers(EC) wherever required. The shotfirer (SF) shall handover the card to overman as a proof that he has been informed about the condition of different faces, no faces are approaching within 10m. to each other and adequate number of assistants has been provided.

Stage - II : The shotfirer shall prepare charges in the face and after completion of charging post shotfiring mazdoors (SM) whenever required at the appropriate places and collect cards from them. The shotfiring mazdoor shall ensure that no workers allowed to enter within the danger zone. He shall not leave the place till the card is collected by the shotfirer and he is asked by the shotfirer to move from the place.

Stage - III : The rest of the blasting preparation prior to firing shall be completed. The shotfirer shall then post explosive carriers and collect cards from them. He will take adequate shelter and after giving adequate warning shall fire the shots.

Stage - IV : After waiting for sometime the face environment shall be checked by the shotfirer. He shall intimate the condition to the mining sirdar.

Stage - V : The Mining sirdar shall checkup the face and after securing roof and sides allow the workers to enter the face.

Stage - VI : The shotfirer shall go round the workings and hand over the cards to E.C. & S.M.

Stage - VII : After completion of blasting of the district the shotfirer shall collect the card from the overman.

Condition - C

Drilling into Misfired shots.

Stage - I : The overman who kept the card of the S.F. under possession shall not return the card unless a joint inspection is made in 2/3 faces blasted at the end of shotfiring operations.

Stage- II : The whole system of blasting can be improved by continuous monitoring of blasting efficacy and therefore reducing the possibilities of misfired shots.

1.3 Supervision - The blasting operations shall be under the charge of Assistant Manager/ under manager of the mine.