



# PURPOSE OF THE AUDIT

- **Scope:**  
**Management of the U/G Working Environment**
- **Objective:**  
**To assist in the continuous improvement of your  
*‘Mine Safety Management Plans’***
- **Criteria:**  
**Mine Hazard Management Plans; Approved &  
Recognised Standards; Good Mining Practice;  
Legislation**



# AUDIT METHODOLOGY

- **SYSTEMS**

- » Are they in place
- » Are they suitable
- » Are they really working

- **REPORT**

- » Strengths
- » Opportunities for improvement



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# AUDIT METHODOLOGY

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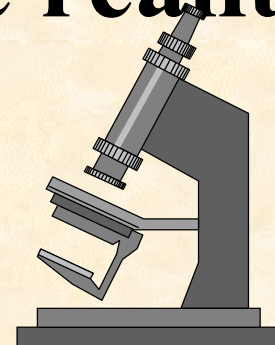


# HOW IS AN AUDIT DONE?

- **Study your documented system**



- **Compare the system with the reality on site**

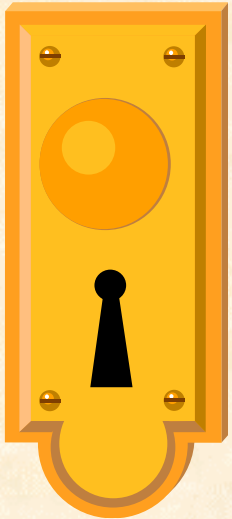




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# SYSTEMS AUDIT PROCESS

- **Management - Overview**
- **Technical / Supervisors - Detail and Effectiveness**
- **Operators - Systems in Operation**





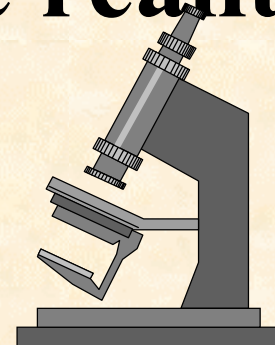
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# HOW IS AN AUDIT DONE?

- **Study your documented system**



- **Compare the system with the reality on site**







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# RISK MANAGEMENT PROGRAM



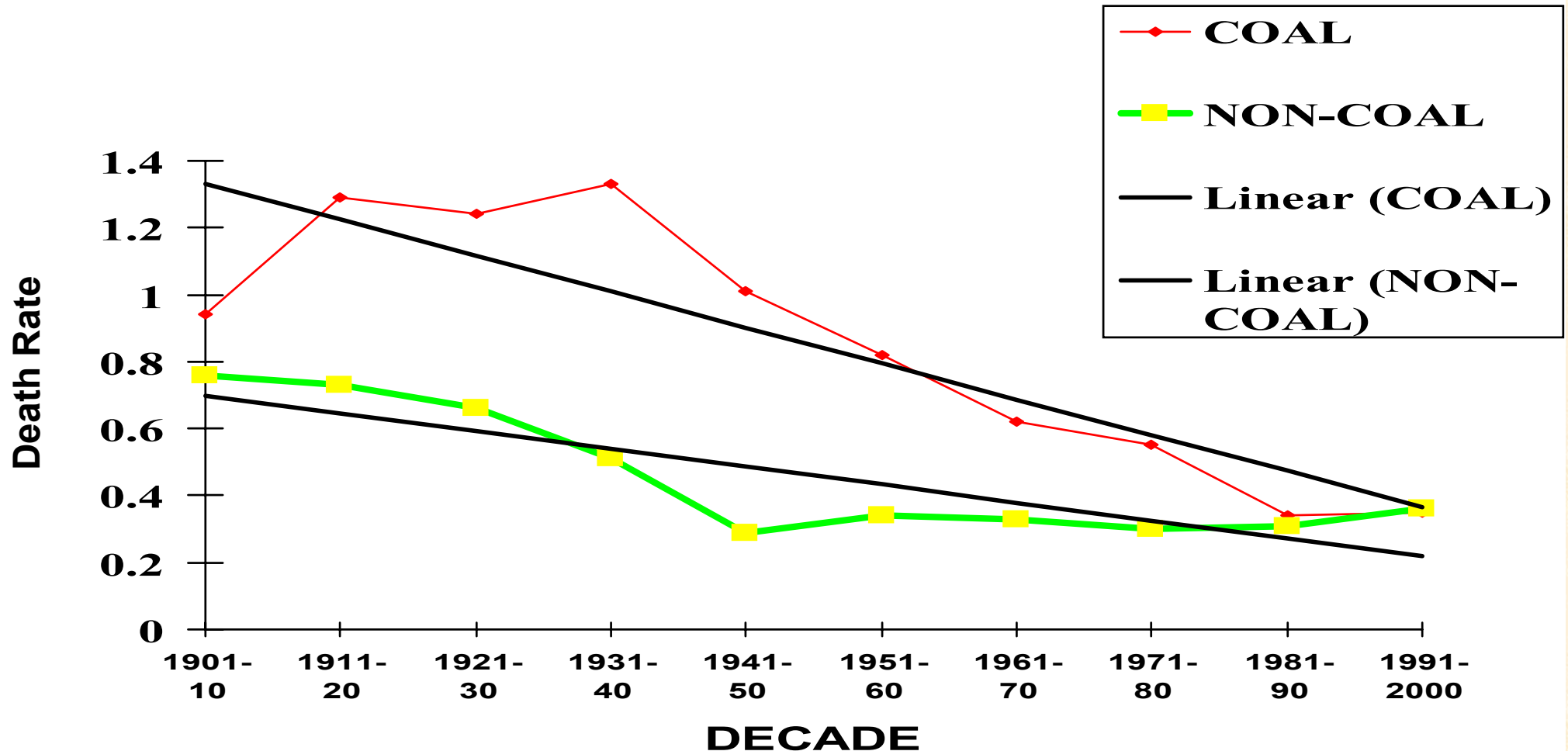
**SSS Colliery**

**11-17 July 2001**



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# TREND IN DEATH RATE PER 1000 PERSONS EMPLOYED ( 10 YEARLY AVERAGE)

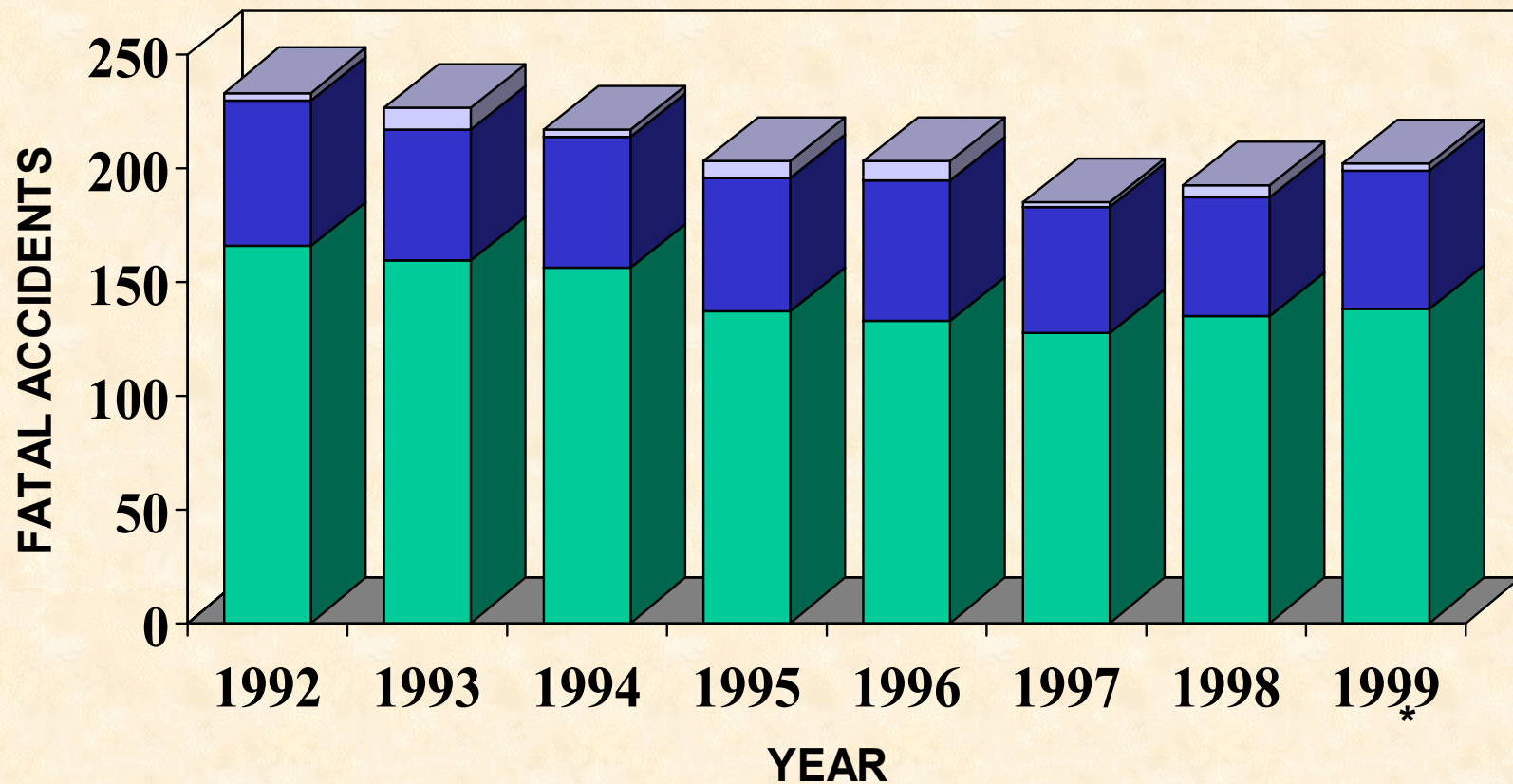






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# TREND IN INCIDENCE OF FATAL ACCIDENTS IN MINES



\* 1997 : UPTO OCT.

COAL METAL OIL



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# Facts of Life

- It is impossible for the Dept to ensure safety
- Mine management and workers have the fundamental role
- They have to accept responsibility
- The Dept must encourage, facilitate, control and monitor the acceptance and resulting levels
- It is not possible to check safety at the hand of major accidents and their frequency
- There must be an input driven mechanism
- Risk assessment and safety management plans is an input method from both the mines and Department's It is pro-active



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# **RECOMMENDATIONS OF THE 9<sup>th</sup> CONFERENCE ON SAFETY IN MINES**

**Held on 2-3 February, 2000 at New Delhi**

## **Recommendation: 4.0**

### **Risk Management as a Tool for Development of Appropriate Health and Safety Management Systems**

- 4.1 Every mining company should identify one or more mines and should undertake a formal risk assessment process aimed at reducing the likelihood and impact of mishaps of all kinds in mines. Subsequently risk assessment process should be extended to other mines.**
- 4.2 Risk assessment process should aim at effective management of risks, by identifying:
  - (i) which risks are most in need of reduction, and the options for achieving that risk reduction**
  - (ii) which risks need careful on-going management, and the nature of the on-going attention****
- 4.3 The risk assessment exercise should follow an appropriate process**
- 4.4 Risk management plans shall be prepared on the basis of risk assessment and implemented in the identified mines.**





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# **Risk Assessment: Where?**

- **Potential for mishap - with serious consequences**
- **Presence of large number of risks with varying degree of consequence and likelihood**
- **Mines having limited resources**
- **Availability of early warning in way of “near miss” situations**
- **Changed circumstances**
- **New equipment, methods, etc**
- **Modification of method, machines, etc**



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# MERITS OF RISK ASSESSMENT

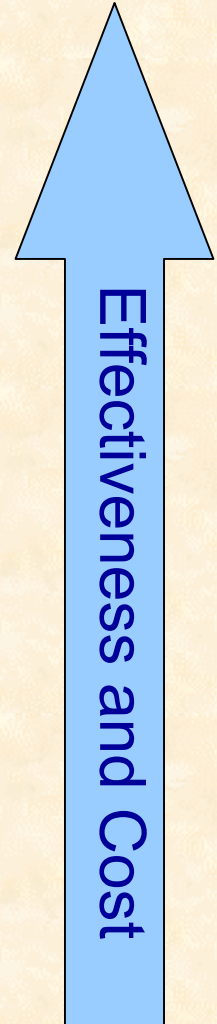
- **Gainful utilisation of resources**
- **Casts specific responsibility on operators**
- **Eliminates confusion**
- **More acceptable for involvement of grass root levels**
- **Designed by operators**
- **Flexible**
- **Selection of best possible means to achieve goal - left to operators**
- **Introduction of new technology expedited**
- **No scope for gray areas**



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# Risk Control Hierarchy

- ⇒ **Elimination** - Modification to the process method or material to eliminate the hazard completely. ( 100% )
- ⇒ **Substitution** - replace the material, substance or process with a less hazardous one. ( 75% )
- ⇒ **Separation** - Isolating the hazard from persons by safeguarding, or by space or time separation. ( 50% )
- ⇒ **Administration** - Adjusting the time or conditions of risk exposures ( 30% )
- ⇒ **Training** - Improving skills therefore making tasks less hazardous to persons involved. ( 20% )
- ⇒ **Personal protective equipment** - using as the last resort, appropriately designed and properly fitted equipment where other controls are not practicable. (5% )
- ⇒ **Remember the risk hierarchy is only a guide to the type of actions required.**







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# Risk Rating Criteria

Consequence		Exposure		Probability	
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 = Consequence x Exposure x Probability**

**Maximum Risk Rating = 500**

**Risks  $\geq 20$  to be referred to Management for Action**



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# Initial Hazard Identification - SSS Colliery

## 29 Hazards Initially Identified

No.	Description of Hazard	Conseq.	Probab.	Exposure	Total
1	Existing Mine Fire	5	10	10	500
2	Roof fall (Strata control)	5	10	10	500
3	Mine Gases	5	10	10	500
4	Waterlogged workings	5	7	10	350
5	Survey- incorrect mine plan	5	7	10	350
6	Improper survey instruments	5	7	10	350
7	Lack of skilled persons/using unskilled persons	5	7	10	350
8	Inundation from surface source	5	7	10	350
9	Surface blasting and vibrations	5	7	5	175
10	Winding (Shaft)	5	3	10	150
11	Boilers	5	3	10	150
12	Blasting	5	3	10	150
13	Spontaneous Combustion	5	3	10	150
14	Unauthorised entry to mine workings	5	7	3	105
15	Coal dust - explosion	5	2	10	100
16	Lack of illumination	1	10	10	100
17	Haulage & transport failure	5	3	5	75
18	Side fall	1	7	10	70
19	Moving machinery (illegal man-riding sdl)	1	7	10	70
20	Electricity	1	10	5	50
21	Drivages not to plan	5	3	2	30
22	Fire damp CH <sub>4</sub>	5	2	2	20
23	Material handling	0.3	7	5	10.5
24	Respirable dust	0.1	10	10	10
25	Noise	0.1	10	10	10
26	Inadequate Ventilation	0.1	7	10	7
27	Slippery roadway	0.1	7	10	7
28	External Threat - terrorist/sabotage/indiscipline/security	1	2	2.5	5
29	Improper travelling roadway	0.1	7	3	2.1



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## Hazard Identification - SSS Colliery

**HAZARDS IDENTIFIED AS HIGH RISK**

**(Risk > 200)**

**Requiring immediate attention**

No.	Description of Hazard	Conseq.	Probab.	Exposure	Total
1	Existing Mine Fire	5	10	10	500
2	Roof fall (Strata control)	5	10	10	500
3	Mine Gases	5	10	10	500
4	Waterlogged workings	5	7	10	350
5	Survey- incorrect mine plan	5	7	10	350
6	Improper survey instruments	5	7	10	350
7	Lack of skilled persons/using unskilled persons	5	7	10	350
8	Inundation from surface source	5	7	10	350





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## Hazard Identification - SSS Colliery

### OTHER HAZARDS IDENTIFIED AS RISKS REQUIRING MANAGEMENT ACTION

(Risk  $<200$  and  $>20$ )

No.	Description of Hazard	Conseq.	Probab.	Exposure	Total
9	Surface blasting and vibrations	5	7	5	175
10	Winding (Shaft)	5	3	10	150
11	Boilers	5	3	10	150
12	Blasting	5	3	10	150
13	Spontaneous Combustion	5	3	10	150
14	Unauthorised entry to mine workings	5	7	3	105
15	Coal dust - explosion	5	2	10	100
16	Lack of illumination	1	10	10	100
17	Haulage & transport failure	5	3	5	75
18	Side fall	1	7	10	70
19	Moving machinery (illegal man-riding sdl)	1	7	10	70
20	Electricity	1	10	5	50
21	Drivages not to plan	5	3	2	30
22	Fire damp CH <sub>4</sub>	5	2	2	20



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## Hazard Identification - SSS Colliery

**OTHER HAZARDS IDENTIFIED AS **LOW RISK**  
BUT TO BE REVIEWED**

**(Risk <20)**

No.	Description of Hazard	Conseq.	Probab.	Exposure	Total
23	Material handling	0.3	7	5	10.5
24	Respirable dust	0.1	10	10	10
25	Noise	0.1	10	10	10
26	Inadequate Ventilation	0.1	7	10	7
27	Slippery roadway	0.1	7	10	7
28	External Threat - terrorist/sabotage/indiscipline/security	1	2	2.5	5
29	Improper travelling roadway	0.1	7	3	2.1



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# SUMMARISED HAZARD IDENTIFICATION

## SSS Colliery

### 11 Major Hazard Categories Identified

- (1) Mine Fires
- (2) Inundation
- (3) Machinery
- (4) Strata Control
- (5) Mine Gases
- (6) Electricity
- (7) Blasting & Use of Explosives
- (8) Haulage & Transportation
- (9) Spontaneous Combustion
- (10) Occupational Health
- (11) Emergency Response





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# Categorisation of Identified Risks

No.	Major Hazard	Sub Category of Hazard
1	Mine Fires	<ul style="list-style-type: none"><li>Existing Mine Fire</li><li>Lack of skilled persons/using unskilled persons</li><li>Surface blasting and vibrations</li><li>Unauthorised entry to mine workings</li><li>Coal dust – explosion</li><li>Inadequate Ventilation</li></ul>
2	Inundation	<ul style="list-style-type: none"><li>Waterlogged workings</li><li>Survey- incorrect mine plan</li><li>Improper survey instruments</li><li>Lack of skilled persons/using unskilled persons</li><li>Inundation from surface source</li><li>Surface blasting and vibrations</li><li>Drivages not to plan</li></ul>
3	Machinery	<ul style="list-style-type: none"><li>Lack of skilled persons/using unskilled persons</li><li>Winding (Shaft)</li><li>Boilers</li><li>Lack of illumination</li><li>Moving machinery (illegal man-riding sdl)</li></ul>



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## Categorisation of Identified Risks (continued)

No.	Major Hazard	Sub Category of Hazard
4	Strata Control	<ul style="list-style-type: none"><li>❑ Roof fall (Strata control)</li><li>❑ Side fall</li><li>❑ Lack of skilled persons/using unskilled persons</li><li>❑ Survey- incorrect mine plan</li><li>❑ Improper survey instruments</li><li>❑ Surface blasting and vibrations</li><li>❑ Lack of illumination</li></ul>
5	Mine Gases	<ul style="list-style-type: none"><li>❑ Mine Gases</li><li>❑ Fire damp CH<sub>4</sub></li><li>❑ Coal dust – explosion</li><li>❑ Inadequate Ventilation</li></ul>
6	Electricity	<ul style="list-style-type: none"><li>❑ Electricity</li><li>❑ Lack of skilled persons/using unskilled persons</li></ul>



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## Categorisation of Identified Risks (continued)

No.	Major Hazard	Sub Category of Hazard
7	Blasting & Use of Explosives	<ul style="list-style-type: none"><li>❑ Blasting</li><li>❑ Lack of skilled persons/using unskilled persons</li><li>❑ Coal dust – explosion</li><li>❑ Drivages not to plan</li></ul>
8	Haulage & Transportation	<ul style="list-style-type: none"><li>❑ Lack of illumination</li><li>❑ Haulage &amp; transport failure</li><li>❑ Moving machinery (illegal man-riding sdl)</li><li>❑ Material handling</li></ul>
9	Spontaneous Combustion	<ul style="list-style-type: none"><li>❑ Spontaneous Combustion</li></ul>
10	Occupational Health	<ul style="list-style-type: none"><li>❑ Respirable dust</li><li>❑ Noise</li><li>❑ Lack of illumination</li></ul>
11	Emergency Response	<ul style="list-style-type: none"><li>❑ Improper travelling roadway</li></ul>





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# Initial Hazard Identification

## SSS Open Cast Mine

12 Hazards Initially Identified

	Description	Conseq.	Probab.	Expos.	Total
1	Ground control	5	2	10	100
2	Haulroads	1	7	10	70
3	Moving machinery	1	7	10	70
4	Working over developed pillars	1	7	10	70
5	Blasting & use of explosives	1	7	5	35
6	Inadequate illumination	1	3	10	30
7	Electricity	1	7	3	21
8	Fall from height	1	3	5	15
9	Dust & noise	0.1	10	10	10
10	Electrical storms	5	1	2	10
11	Manual handling	0.3	3	5	4.5
12	Emergency response				



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# HAZARDS INITIALLY CHOSEN FOR DEVELOPMENT OF SAFETY MANAGEMENT PLAN

- (1) MINE FIRES**
- (2) INUNDATION**



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# Development of Safety Management Plan for:

## MINE FIRES

### Assessment Team

Mr U Pandit  
Mr Navin Kumar  
Mr HKP Lala  
Mr AK Choudhary  
Mr K Singh  
Mr Salim  
Mr V Mali  
Mr PL Vyas  
Mr Sujay Gangopadhyay  
Mr Satish Kumar

### Title/Position

Assistant Manager  
Ventilation Officer  
Surveyor  
Overman  
Foreman Electrical  
Area Safety Officer  
General Worker  
Project Officer  
DDMS  
DDMS





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# RISK ASSESSMENT

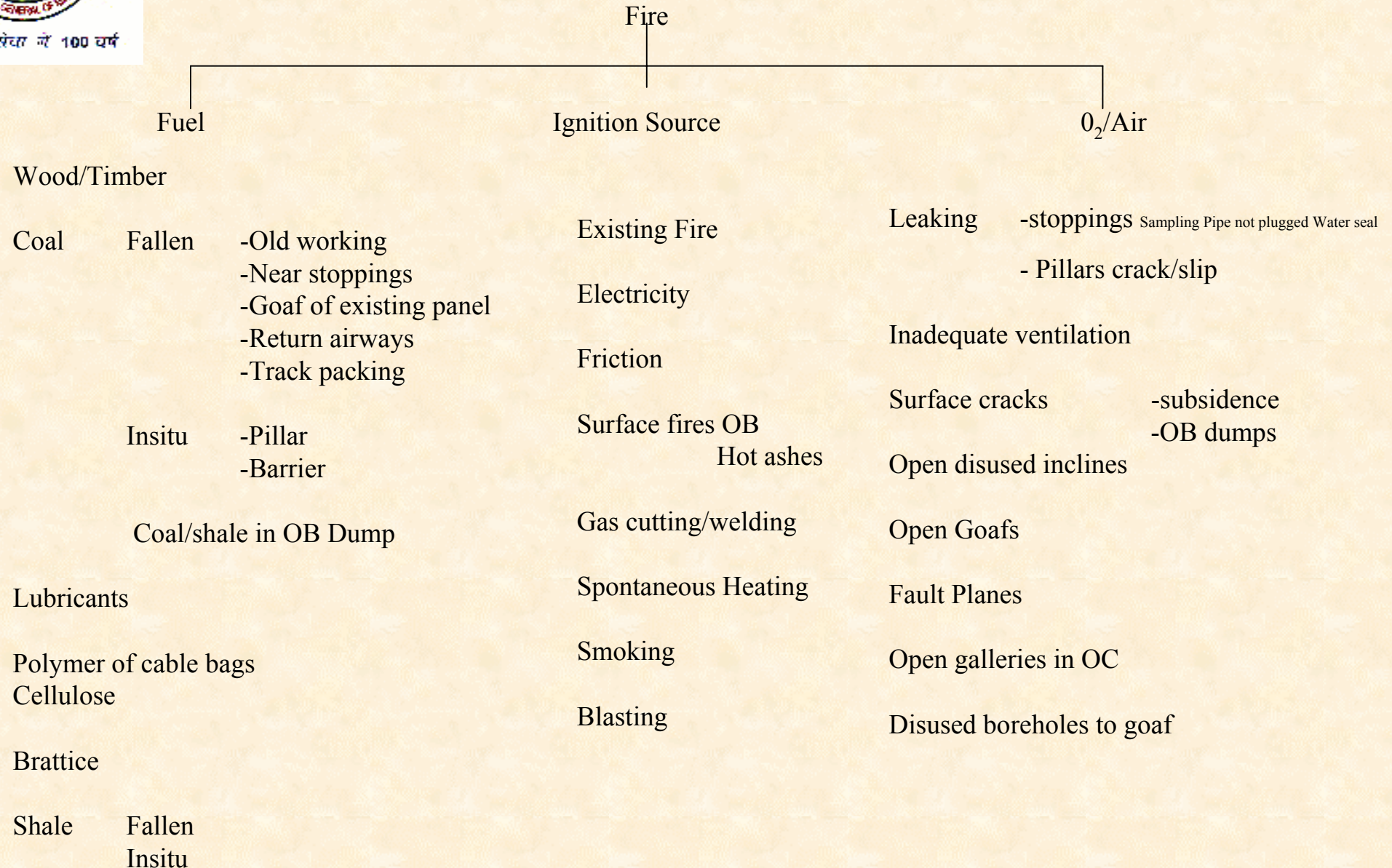
## Step 1:

Identify MECHANISMS by which fire can occur using Fault Tree Analysis



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# Fault Tree for Mine Fires SMP





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## DEVELOP ACTION PLAN

### Step 2:

Identify CONTROLS (Existing and Possible New) for reducing RISK

### Step 3:

Identify PROCEDURES for implementing and maintaining controls

### Step 3:

Identify RESPONSIBILITIES





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# Examples of controls and Procedures for Mine Fire SMP

Mechanism	Control	Relevant Legislation CMR (1957)	Procedure	Existing Procedure Y/N	Responsible Person
<b>Fuel Source</b>					
Timber left in goaf	Complete recovery	110	Timber recovery by Silvester chains and stacked at specific place or reused	NO	Timber man, sirdar, OM, AM
Insitu Coal Pillar	Extract all pillars		Plan to extract panel	NO	Manager & AM
	Decoaling the area and stowing with sand		Method of work as specified	NO	Manager
<b>Ignition Source</b>					
Existing Fire	Quench with water		Fire fighting plan detailing damming of water and ensuring the safety of the UG	NO	Project Officer, Manager & AM
	Dig out the fire (Small)		Handling hot coal, fire fighting monitoring for CO	NO	Manager, AM & OM
<b>Spontaneous Combustion</b>	<b>Spontaneous combustion S</b>	<b>118 A</b>	<b>Spontaneous combustion SMP</b>	<b>NO</b>	<b>Manager &amp; project officer</b>
<b>Air Source</b>					
Open goafs	Isolate goafs with stoppings	118A (1) (a)	Stopping procedure	YES	Manager, SO
	Removal of OB Blanketing on surface for those exposed to the surface		Detailed Plan	NO	Project officer, SO
Disused Boreholes	Seal them with concrete		Borehole plugging	NO	Surveyor & SO
<b>FIRE</b>	Monitor for Carbon Monoxide		Monitoring procedure detailing the equipment to be used calibration of equipment and frequency of	YES	VO OM
	Self rescuers		Emergency response	YES	Everyone



- **Note**
- Many procedures are not prepared
- Existing procedures do not cover the hazards
- **Lack of Knowledge of procedures is a major Problem**
- **All procedures need to be detailed, giving personal responsibilities and equipment requirements and written down**

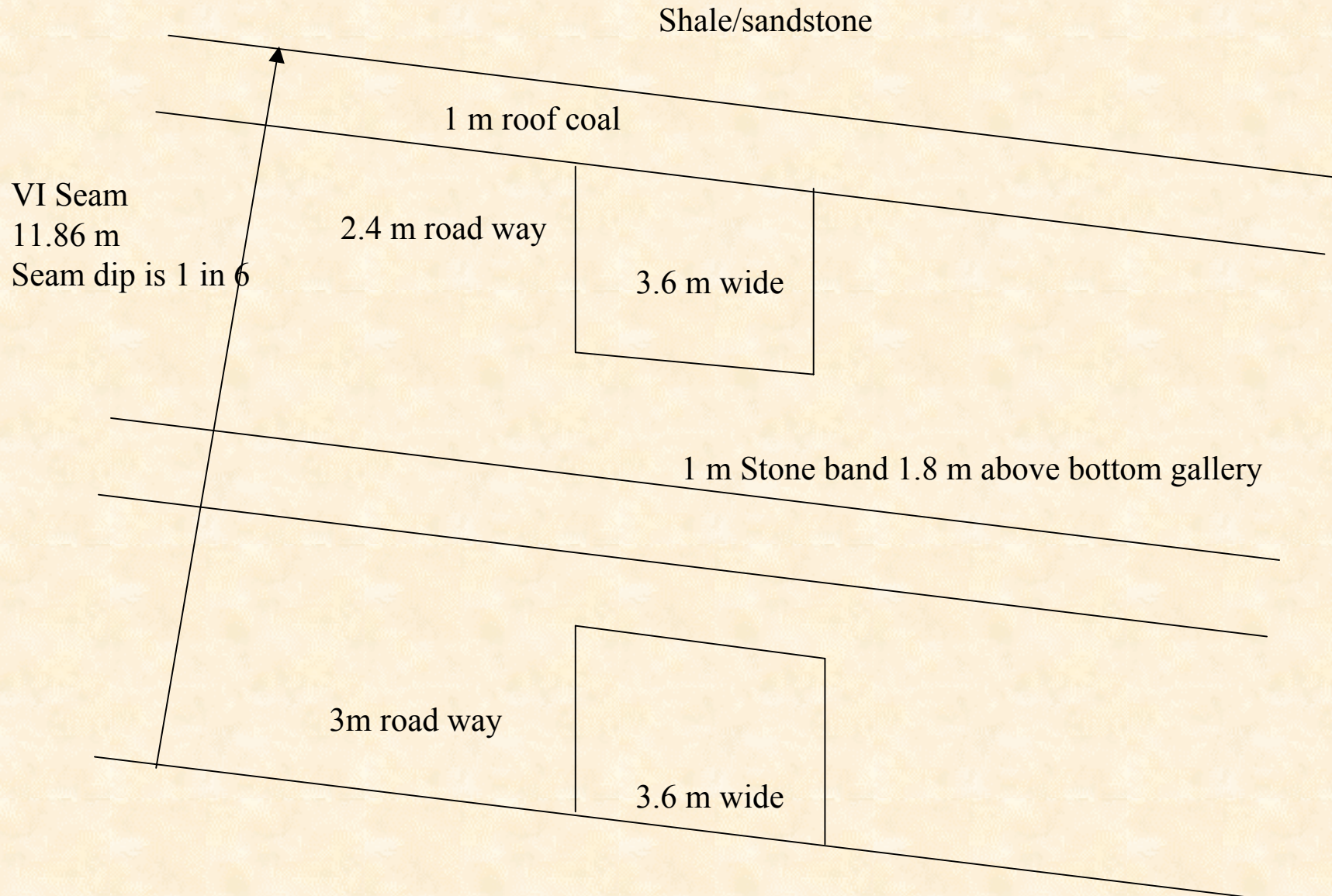
Safety Management Plans assist in **Preventing** Problems as well as dealing with problems





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## Section of VI Seam







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## Method of Work

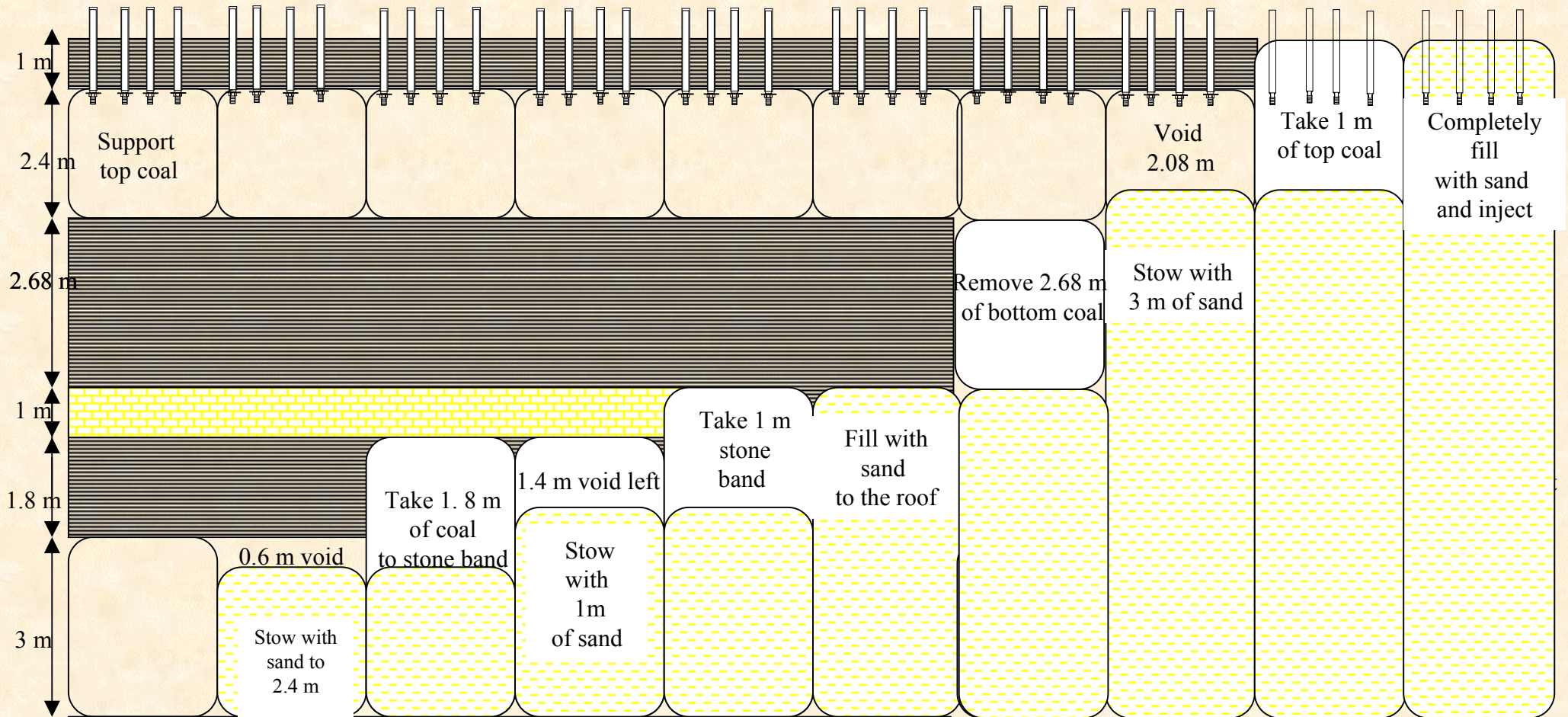
- Roof bolt top section
- Stow Bottom section to developed height (2.4m)
- Take 1.8 m roadway above stowed sand
- Stow with sand (1m)
- Take 1m of stone
- Stow to roof
- Go to the top section and take the floor (2.68m)
- Stow (3 m)
- Take 1 m of roof coal
- Stow to the roof

**\* No coal or carbonaceous material to be left in the decoaled area. While shovelling on sand, Iron sheets shall be used .**



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### Roof bolt pattern to be determined by the Mine Manager



Stage 1: Support coal in top gallery

Stage 2: Sand Stow bottom gallery to 2.4 m

Stage 3: take 1.8 m of roof coal from bottom gallery

Stage 4: Stow an additional 1 m of sand

Stage 5: Take 1 m of stone

Stage 6: Completely fill bottom gallery by sand stowing

Stage 7: Remove 2.68 m of bottom coal

Stage 8: Stow with 3 m of sand

Stage 9: Take 1 m of top coal

Stage 10: Stow completely and inject



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# RISK ASSESSMENT

## Step 1:

Identify the hazards associated with the method of work

## Step 2:

Ranking of Likely RISK

Consequence Criteria		Exposure Criteria		Probability Criteria	
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		





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## Hazard Identification for driving isolation trench in VI seam

	Consequence	Exposure	Probability	Total
<b>Lack of Knowledge on procedures</b>	<b>5</b>	<b>10</b>	<b>10</b>	<b>500</b>
<b>Fire jumps existing barrier</b>	<b>5</b>	<b>10</b>	<b>7</b>	<b>350</b>
<b>Bed separation of roof on top gallery</b>	<b>5</b>	<b>10</b>	<b>7</b>	<b>350</b>
<b>Fire can jump the sand barrier</b>	<b>5</b>	<b>10</b>	<b>7</b>	<b>350</b>
<b>Improper Stowing procedure</b>	<b>5</b>	<b>5</b>	<b>7</b>	<b>175</b>
<b>Blasting vibration Breaks existing stoppin</b>	<b>5</b>	<b>10</b>	<b>3</b>	<b>150</b>
<b>Inadequate ventilation</b>	<b>5</b>	<b>10</b>	<b>3</b>	<b>150</b>
<b>Improper emergency response system</b>	<b>5</b>	<b>2</b>	<b>10</b>	<b>100</b>
<b>Bed separation of sandstone channel</b>	<b>5</b>	<b>10</b>	<b>1</b>	<b>50</b>
<b>Haulage</b>	<b>1</b>	<b>10</b>	<b>3</b>	<b>30</b>
<b>Poor stowing rate and compaction</b>	<b>0.3</b>	<b>10</b>	<b>7</b>	<b>21</b>
Drilling and Blasting operation	0.3	10	3	9
Drift stability	0.3	10	3	9
Improper Loading Procedure	0.1	10	2	2
Inadequate survey information	0.1	10	2	2



पञ्चमः वर्षः संस्कृतः १०० वर्ष

Hazard	Control	Relevant Legislation CMR (1957)	Procedure	Existing Procedure Y/N	Responsible Person
<b>Lack of Knowledge on Procedures</b>	Procedures must be written to cover all of the hazards		Safety Management Plans	NO	Project Officer & Manager
	Train the people in the procedures		Exhibiting, coaching, practical training Test	NO	Assistant Manager SO OM
	Only use trained personnel for the task		Adherence to standing order instruction	NO	Everyone
	Consistent Supervision		Adherence to standing order instruction	NO	Manager & Assistant Manager
	Regular Monitoring		Safety Management Plans	NO	Assistant Manager SO OM
<b>Fire jumps existing barrier</b>	Existing stoppings sealed and the sides have been injected		Stopping procedure	YES/NO	VO & SO& AM
	Pressure balancing		Stopping procedure	NO	VO & SO& AM
	Stowing outbye of the stoppings		Stowing procedure, Barriers, drainage support, personal positioning	NO	Manager & SO and AM
	Monitoring & inspection and Regular Sampling		Inspection and monitoring, Temperature Toximeter calibration of instruments, birds Gas chromatogrpah	NO	SO, VO AM
	Speed of extraction		Panel plan	NO	AM, OM
			Staffing	NO	AM, OM
			Equipment requirements	NO	Project officer manager
	Emergency withdrawal	199 A	Emergency response including the training in the use of self rescuers and communication and evacuation routes	NO	Manager and SO OM





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Hazard	Control	Relevant Legislation CMR (1957)	Procedure	Existing Procedure Y/N	Responsible Person
<b>Bed separation of coal roof on top gallery</b>	Securing the roof	108	Supporting including specification of support density – props/ roof bolts	YES	Manager AM, OM Sirdar
	Inspection		Sirdar's inspection	YES	MS OM
	Dressing	102	As standard procedure to be explained to dressers on the job	NO	Sirdar and Overman AM to monitor
<b>Fire can jump the sand barrier</b>	Total removal of coal	118 A	Method of work	NO	Manager
	Compaction of sand stowing		Stowing procedure, to detail compaction methods	NO	Manager & SO and AM
	Injection with binding material		Injection procedure detailing pressure of injection, mixtures and depth of holes	NO	AM, OM, SO
	Extend the barrier to prevent the fire jumping around the edge		Special Procedure for this work	NO	Surveyor, Safety Officer and AM
	Construction of isolation stoppings outbye of the sand barrier		Stopping procedure	YES	Manager & SO and AM
	Monitoring and inspection and taking of samples		Inspection and monitoring, Temperature Toximeter calibration of instruments, birds Gas chromatograph	NO	SO, VO AM
	Emergency withdrawal	199 A	Emergency response including the training in the use of self rescuers and communication and evacuation routes	YES	Manager and SO OM





श्रम की सेवा में 100 वर्ष

Hazard	Control	Relevant Legislation CMR (1957)	Procedure	Existing Procedure Y/N	Responsible Person
<b>Improper Stowing</b>	Written procedure		Stowing procedure detailing laying of Pipes, personal positioning – no one at the barricade when stowing, Hydraulic profile, construction of barricade, water drainage, location of bunkers, supervision	NO	Manager & SO Surveyor & AM
	Training in the procedure		Coaching, practical training, test, observation	NO	Assistant Manager, SO, OM
	Sand & Water is available		Design process to identify sand requirements	NO	Surveyor & Project Officer
<b>Blasting vibration Breaks existing stoppings</b>	Delay sequence of blasting		Blasting procedure- including details of delay detonators to be used/supplied	YES	Project officer, Manager, Overman, Sirdar & Shotfirer
	Quantity of explosives		Blasting procedure	YES	Manager, Overman, Sirdar & Shotfirer
	Design of drilling pattern		Blasting procedure	YES	Manager & SO
	Controlled blasting		Blasting procedure	YES	Overman, Sirdar & Shotfirer
	Stemming		Blasting procedure	YES	Shotfirer
	Training		Coaching, practical training, test, observation	YES	Assistant Manager, SO, OM



उत्कृष्ट विद्या नै 100 वर्ष

Hazard	Control	Relevant Legislation	Procedure	Existing Procedure	Responsible Person
<b>Inadequate ventilation</b>	Ventilation survey & measurement	130	Ventilation measurement, Anemometers and tapes stop watch	YES	VO
	Ventilation planning		Mine Ventilation siting of fans, length of ducting size of ducting	NO	Manager, VO
	Fans auxiliary fans with ducts	137	Mine ventilation -Specification and usages	YES	Manager, VO
	Brattice		Brattice usage	YES	VO, OM
	Stoppings, Air doors, air crossings	136	Mine Ventilation, stopping procedure	YES	Manager, AM, VO
	Inspections	136	Ventilation inspections	YES	OM, MS
	Training & Awareness		Induction and refresher training	NO	Workman's inspector and SO
	Monitoring CO, CH <sub>4</sub> temperature and humidity	130	Sampling procedure detailing where and when to sample what instruments used how records are kept	YES	VO,
<b>Improper emergency response system</b>	Documented system	199 A	Detailing escape routes and use of self-rescuer. And roles and responsibilities for officers	YES	Manager & SO
	Audit & review of the system		Review the system as the project is developed ie changing ventilation circuits and effects on escape routes	NO	SO
	Training / exercise		Emergency procedure	NO	SO, AM OM
	Communication - telephones		Emergency procedure	YES	Engineer Foreman, everyone





उद्योग की सेवा में 100 वर्ष

Hazard	Control	Relevant Legislation	Procedure	Existing Procedure	Responsible Person
<b>Bed Separation of sandstone channel</b>	Support rules	108	Temporary support, Managers support rules	YES	Manager, Timber man, General Mazdoor, Sirdar
			Dressing	NO	Dressor, MS
			Inspection	YES	MS
	Speed of extraction		Panel plan	NO	AM, OM
			Staffing	NO	AM, OM
			Equipment requirements	NO	Project officer manager
<b>Haulage</b>	Haulage rules	87 & 89	Adherence to the rules to detail no of tubs, location of haulages, track laying, signals etc	YES	Manager, haulage operators and signal man, MS, foreman, OM Engineer
<b>Poor stowing rate and compaction</b>	Written procedure		Stowing procedure detailing laying of Pipes, Hydraulic profile, construction of barricade, water drainage, location of bunkers, supervision	NO	Manager & SO Surveyor & AM
	Training in the procedure		Coaching, practical training Test and Observation	NO	Assistant Manager, SO, OM
<b>Drilling and blasting operations</b>	Preparation of Safe Operating Procedure for drilling and blasting		Dressing, hole pattern, stemming, guards, monitoring and inspection	YES	Shotfirer, MS, Drillers, dresser
<b>Drift Stability</b>	Support the drift		Procedure for crossing the drift, direction, gradient	NO	Manager, Surveyor
<b>Improper Loading Procedure</b>	Training		Training procedure detailing the correct system, lead, loading of tubs etc	NO	AM, OM MS, loader Underground Munshi
<b>Inadequate survey information</b>	Detail surveying and offset plan	58	Surveying to include details of equipment used and the system of surveying and accuracies	NO	Survey Officer





एश्ट की सेवा में 100 वर्ष

# Development of Safety Management Plan for:

## INUNDATION

### Assessment Team

- (1) Mr N.P. Singh -Colliery Manager
- (2) Mr B. N. Prasad - Safety Officer
- (3) Mr N. Kumar - Ventilation Officer
- (4) Mr B. K. Pandey - Asst Manager
- (5) Mr U.P. Roy - Senior Survey Officer
- (6) Mr R. N. Singh - Foreman in-charge

- (7) Mr M. M. Singh - Senior Overman
- (8) Mr S. Halder - Dep. Dir. DGMS
- (9) Mr S. Bagchi - Dep. Dir. DGMS
- (10) Mr Ashim Sinha - Dep. Dir, DGMS
- (11) Mr Mike Walker - Senior Mines Inspector, Qld
- (12) Mr Robert Guy - Project Manager



एशोक की स्तंभों ने 100 वर्ष

# RISK ASSESSMENT

## Step 1:

Identify MECHANISMS by which inundation can occur

## Step 2:

Ranking of Likely RISK

Consequence Criteria		Exposure Criteria		Probability Criteria	
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		



100 वर्षों का सफर

# Risk Assessment: INUNDATION - Underground Mine

**Hazard: Drowning of underground persons**

Mechanism	Conseq.	Exposure	Probab.	Risk
Pillar failure due to fire allows connection with surface water body	5	10	7	350
Failure of river bank during heavy rain	5	10	7	350
Failure of drift dam 10 to 11 Seam	5	10	7	350
Surface flooding or water body enters through goaf or mine entries	5	5	7	175
Barriers against flooded old workings failing under hydrostatic pressure	5	10	3	150
Accidental holing into old flooded workings	5	5	2	50
Failure of river bank due to damage from mine subsidence	5	10	1	50
Pillar failure or creep allows goaf formation to connect with water body/aquifer	5	10	0.5	25
Roof fall in development workings taps overlying aquifer or water accumulation	5	1.5	2	15
Workings intersect geological structure providing water flow channel	1	2	1	2
Workings intersect open boreholes	0.1	2	7	1.4
Goaf development/cracking to surface due to mining	0.1	2	2	0.4
Workings intersect aquifer	0.1	1.5	0.5	0.075





उद्योग की सुरक्षा में 100 चर्च

# Risk Assessment: INUNDATION - Open Cast Mine

**Hazard: Drowning of surface persons**

Mechanism	Conseq.	Exposure	Probab.	Risk
Failure of barrier between adjacent opencast mine containing water	5	10	1	50
Opencast excavation intersects flooded underground workings of SBC	5	10	1	50
Opencast excavation intersects flooded unknown or incorrectly mapped u/g workings	1	10	2	20
Opencast excavation intersects flooded underground workings of adjacent mine	1	5	1	5
Geological structure provides water flow path from water accumulation	0.3	10	1	3
Opencast excavation intersects natural in situ water accumulation	0.1	10	1	1



# DEVELOP ACTION PLAN

## Step 3:

Identify CONTROLS (Existing and Possible New) for reducing RISK

The Controls for the 3 highest Risk Mechanisms are shown here:

- (1) Pillar failure due to fire allows connection with Ekra Jore**
- (2) Failure of river bank during heavy rain**
- (3) Failure of drift dam 10 to 11 Seam**



उद्योगों में सुरक्षा के 100 चरण

# Identify Controls

**Mechanism:**

**Pillar failure due to fire allows connection with Ekra Jore**

**Risk Ranking = 350**

Current Controls	Possible New Controls
Borehole filling with concrete of roadways around pillar beneath river	Install subsidence monitoring stations around area
No more mining under river	Define extent of fire and effect of remedial work by monitoring temps
Daily inspection of surface area for subsidence effects	Construct culvert drain over river bed
Filling cracks in river bed with grout	River diversion to new course unaffected by underlying workings
Monitoring and recording of u/g water levels in No.5 Pit	Re-line original river bed with concrete and re-divert river to original course
Pumping to maintain required water levels	Formal development of Emergency Evacuation Plan
Water Danger Plan with warning level specified as standing order	Provision of emergency dewatering pump system
Standing order for emergency mine evacuation (with water level trigger)	Training of workforce in inundation management plan
Simulated evacuation exercises	





राष्ट्र की सेवा में 100 वर्ष

# Identify Controls (continued)

**Mechanism:**

**Failure of river bank during heavy rain**

**Risk Ranking = 350**

Current Controls	Possible New Controls
Inspection by Manager	Increase bank to comply with statutory specs (3m above HFL)
Top of bank constructed 1.5m above HFL (198.64m)	Engineering appraisal to test strength and identify critical sections of bank
Some sections reinforced with concrete wall	Increase concrete reinforcement
Maintenance of bank to maintain dimensions	Widen the bank and reinforce key areas
24 hour watch during monsoon period	Desilting of river bed at upstream side
Additional lighting for observation at key sites	Training of workforce in inundation management plan
Overflow provision with old river course during heavy rain	
Flow Alarms	



एक कोयला खनन क्षेत्र में 100 वर्ष

# Identify Controls (continued)

**Mechanism:**

**Failure of drift dam 10 to 11 Seam**

**Risk Ranking = 350**

Current Controls	Possible New Controls
Water Danger Plan 10 Seam with warning level specified	Evaluate possible sites to construct back-up or alternative dams
Monitoring and recording of water levels in 11 Seam at 5 Pit	Barrier pillars to protect dam marked on plans for mining in lower seams
Routine observation of water levels in 10 Seam	Review Water Danger Plans
Standing order for emergency mine evacuation (with water level trigger)	Formal development of Emergency Evacuation Plan
Simulated evacuation exercises	Provision of emergency dewatering pump system



## DEVELOP ACTION PLAN (continued)

### Step 4:

Identify PROCEDURES for implementing and maintaining CONTROLS

### Step 5:

Identify RESPONSIBILITIES

Again, the Procedures and Responsibilities for the 3 highest Risk Mechanisms are shown here:

- (1) **Pillar failure due to fire allows connection with Ekra Jore**
- (2) **Failure of river bank during heavy rain**
- (3) **Failure of drift dam 10 to 11 Seam**





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- **Note**
- Many procedures are not prepared
- Existing procedures do not cover the hazards
- **Lack of Knowledge of procedures is a major Problem**
  - All procedures need to be detailed, giving personal responsibilities and equipment requirements and written down

Safety Management Plans assist in **Preventing** Problems as well as dealing with problems



उद्योग की सेवा में 100 वर्ष

# Action Plan: Mechanism #1

## Pillar failure due to fire allows connection with Ekra Jore

**Hazard:** Drowning of underground persons

**Mechanism #1:** Pillar failure due to fire allows connection with surface water body

**Risk Ranking:** 350

Current and Possible Controls	Procedure	To be developed by Dec 1, 2001	Responsible Person
Borehole filling with concrete of roadways around pillar beneath river	Design grouting plan	Yes	Area Civil Engineer
	Maintain plan showing position and number of boreholes and estimated grout quantities	Yes	Colliery Surveyor
Install subsidence monitoring stations around area	Establish subsidence grid	Yes	Project Officer
	Subsidence monitoring procedure		Colliery Surveyor
No more mining under river	"No more mining under river" – incorporate into Inundation and Strata Control HMP		Project Officer
Define extent of fire and effect of remedial work by monitoring temperatures	Develop temperature monitoring plan	Yes	Area General Manager
	Install monitoring bore holes and thermocouples		Safety Officer
Daily inspection of surface area for subsidence effects (during monsoon period)	Procedure for inspection and recording results	Already exists	Colliery Manager
	Daily Inspections	Exists	Colliery Survey Officer





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## Action Plan: (continued)

### Mechanism #1: Pillar failure due to fire allows connection with Ekra Jore

**Mechanism #1: Pillar failure due to fire allows connection with surface water body (continued)**

Current and Possible Controls	Procedure	To be developed by Dec 1, 2001	Responsible Person
Construct culvert drain over river bed	<b>Engage suitable civil engineers to assess feasibility and design culvert.</b>	Yes	Area General Manager
	Construction Procedure		Area General Manager
	Engage contracting construction firm to construct culvert		Area General Manager
	Supervise Construction		Colliery Civil Engineer
Filling cracks in river bed with grout	<b>Develop inspection and grout filling procedure</b>	Yes	Colliery Civil Engineer
	<b>Grouting of cracks</b>	Yes	Colliery Civil Engineer
River diversion to new course unaffected by underlying workings	<b>Engage suitable civil engineers to assess feasibility and design of river diversion.</b>	Yes	Area General Manager
	Construction Procedure		Area Civil Engineer
	Engage contracting civil firm to construct river diversion		Area Civil Engineer
	Supervise diversion project		Colliery Civil Engineer
Monitoring and recording of u/g water levels in No.5 Pit	<b>Incorporate 5 pit monitoring into documented procedure for water level monitoring under Inundation HMP.</b>	Yes	Colliery Manager
	<b>Underground monitoring of water levels</b>	Yes	Assistant Colliery Manager
	<b>Maintain plans and records of water level monitoring</b>	Yes	Colliery Surveyor
Re-line original river bed with concrete and re-divert river to original course	<b>Engage suitable civil engineers to assess feasibility and design of old river bed re-lining and re-diversion.</b>	Yes	Area General Manager
	Construction Procedure		Area Civil Engineer
	Engage contracting civil firm to construct old river bed lining and re-diversion		Area Civil Engineer
	Supervise re-diversion project		Colliery Civil Engineer





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## Action Plan: (continued)

### Mechanism #1: Pillar failure due to fire allows connection with Ekra Jore

**Mechanism #1:** Pillar failure due to fire allows connection with surface water body (continued)

Current and Possible Controls	Procedure	To be developed by Dec 1, 2001	Responsible Person
Pumping to maintain required water levels	Review current pumping requirement and capacities.	Yes	Colliery Engineer
	Document pumping procedure and incorporate in Inundation HMP.	Yes	Colliery Manager
	Incorporate standing order into documented procedure for water level monitoring under Inundation HMP and in Emergency Evacuation HMP.	Yes	Colliery Manager
Formal development of Emergency Evacuation Plan	Development Emergency Evacuation HMP	Yes	Colliery Manager
	Review water level trigger against known mine evacuation times.	Yes	Project Officer
	Determine realistic mine evacuation times by practical exercises.	Yes	Project Officer
Water Danger Plan with warning level specified as standing order	Incorporate Water Danger Plan into documented procedure for water level monitoring under Inundation HMP	Yes	Colliery Manager
Provision of emergency de-watering pump system	Review of emergency pumping capacity requirements.	Yes	Colliery Engineer
	Procedure for installation, maintenance and testing of emergency pumps.	Yes	Colliery Engineer
	Install pumps.	Yes	Colliery Engineer
Standing order for emergency mine evacuation (with water level trigger)	Incorporate standing order into documented procedure for water level monitoring under Inundation HMP and in Emergency Evacuation HMP.	Yes	Colliery Manager
	Review water level trigger against known mine evacuation times.	Yes	Project Officer
	Determine realistic mine evacuation times by practical exercises.	Yes	Project Officer
Training of workforce in inundation management plan	Assess need for training of all or part of workforce in basic Risk Assessment principles prior to training in specific HMP's	Yes	Safety Officer
	Develop suitable training and assessment package in Inundation HMP		Safety Officer
	Develop training strategy & schedule		Safety Officer
	Deliver training		Safety Officer
Simulated evacuation exercises	Procedure for scheduled emergency exercises under Emergency Evacuation HMP	Yes	Project Officer
	Undertake emergency exercises	Yes	Assistant Colliery Manager/Safety Officer



एक कोयला से 100 वर्ष

## Action Plan: Mechanism #2

### Failure of river bank during heavy rain

**Hazard:** Drowning of underground persons

**Mechanism #2:** Failure of river bank during heavy rain

**Risk Ranking:** 350

Current and Possible Controls	Action/Procedure	To be developed by Dec 1, 2001	Responsible Person
Inspection by Manager	Procedure for inspection and recording results.	Yes	Colliery Manager
Top of bank constructed 1.5m above HFL (198.64m)	Make decision whether to engage consultants to do testing of river bank and design increased size	Yes	General Manager
Increase bank to comply with statutory specs (3m above HFL)	Engage suitable civil engineers to do testing and make recommendations before increasing bank height.		General Manager
	Procedure for increasing bank height.		General Manager
Engineering appraisal to test strength and identify critical sections of bank	Engage suitable civil engineers to do testing and make recommendations.		General Manager
Some sections reinforced with concrete wall	Assess need for further concrete reinforcement in conjunction with civil engineering appraisal above		General Manager
Increase concrete reinforcement			
Maintenance of bank to maintain dimensions	Formalise procedures for maintaining the bank	Yes	Colliery Manager
	Maintain bank as per procedures	Yes	Colliery Manger
Widen the bank and reinforce key areas	Develop design based on civil engineering appraisal and recommendations		General Manager
24 hour watch during monsoon period	Develop written procedures for 24 hour watch of river	Yes	Colliery Manager
De-silting of river bed at upstream side	Risk assess de-silting to ensure other hazards are not created.	Yes	Project Officer
	Develop safe de-silting procedure	Yes	Colliery Manager
Additional lighting for observation at key sites	Review adequacy of lighting at key sites.	Yes	Colliery Engineer
Training of workforce in inundation management plan	Assess need for training of all or part of workforce in basic Risk Assessment principles prior to training in specific HMP's	Yes	Safety Officer
	Develop suitable training and assessment package in Inundation HMP		Safety/Training Officer
	Develop training strategy & schedule		Safety/Training Officer
	Deliver training		Safety/Training Officer





उद्योग की सेवा में 100 वर्ष

## Action Plan: (continued)

### Mechanism #2: Failure of river bank during heavy rain

#### Mechanism #2: Failure of river bank during heavy rain (continued)

Current and Possible Controls	Action/Procedure	To be developed by Dec 1, 2001	Responsible Person
Overflow provision with old river course during heavy rain	Review risk of water entering workings through old river course during flooding – ensure adequately sealed. <b>URGENT</b>	<b>Yes – URGENT</b>	Colliery Manager
	Procedure for maintenance of sealing of old river course. <b>URGENT</b>	<b>Yes – URGENT</b>	Colliery Manager
Flow Alarms	Review adequacy	Yes	Safety Officer
	Ensure adequate communication system to relay alarm to mine site <b>URGENT</b>	<b>Yes – URGENT</b>	Area Telecommunications Eng
	Procedure for inspection, maintenance, testing of alarm system <b>URGENT</b>	<b>Yes – URGENT</b>	Colliery Engineer





एक वीर लेखक ने 100 वर्ष

# Action Plan: Mechanism #3

## Failure of drift dam 10 to 11 Seam

**Hazard:** Drowning of underground persons

**Mechanism #3:** Failure of drift dam 10 to 11 Seam

**Risk Ranking:** 350

Current and Possible Controls	Action/Procedure	To be developed by Dec 1, 2001	Responsible Person
Water Danger Plan 10 Seam with warning level specified	Incorporate Water Danger Plan into documented procedure for water level monitoring under Inundation HMP	Yes	Asst. Colliery Manager
Evaluate possible sites to construct back-up or alternative dams	Detailed review to determine where further dams can be constructed <b>URGENT</b>	Yes – URGENT	Area Manager Planning/Safety
	Detailed review to determine whether 10/11 seam dam can be reinforced.	Yes	Area Manager Planning/Safety
	Employ consultant to design dam(s)		Area General Manager & Director Technical
	Construct dams to engineering specifications		Area Civil Engineer
Monitoring and recording of water levels in 11 Seam at 5 Pit	Incorporate 5 pit monitoring into documented procedure for water level monitoring under Inundation HMP.	Yes	Colliery Manager
Barrier pillars to protect dam marked on plans from mining in lower seams	Protection of all critical structures, including dams, to be addressed in the Strata Control HMP		Project Officer
Routine observation of water levels in 10 Seam	Monitoring procedure as above.	Yes	Colliery Manager
Review Water Danger Plans	Undertake review of Water Danger Plans	Yes	Colliery Manager
Standing order for emergency mine evacuation (with water level trigger)	Incorporate standing order into documented procedure for water level monitoring under Inundation HMP and in Emergency Evacuation HMP.	Yes	Colliery Manager
Formal development of Emergency Evacuation Plan	Development Emergency Evacuation HMP	Yes	Colliery Manager
	Review water level trigger against known mine evacuation times.	Yes	Project Officer
	Determine realistic mine evacuation times by practical exercises.	Yes	Project Officer
Simulated evacuation exercises	Procedure for scheduled emergency exercises under Emergency Evacuation HMP	Yes	Colliery Manager
Provision of emergency de-watering pump system	Review of emergency pumping capacity requirements.	Yes	Area Engineer (E & M)
	Procedure for installation, maintenance and testing of emergency pumps.	Yes	Colliery Engineer
	Install pumps	Yes	Colliery Engineer