



## Best Practice Guidance for Effective Methane Drainage and Use in Coal Mines

# Best practice gas control and explosion prevention

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# Contents

1. Principles of gas control and explosion prevention
2. A practical risk assessment tool for gas control and explosion prevention
3. Conclusions

# Explosive mixtures are unavoidable

In situ coal seam gas usually comprises high purity methane.

Flammable gases are only produced once a coal seam is disturbed by mining and the released gas mixes with air.

Mixing of air and methane occurs in the open goaf behind the coalface. Before the gas is diluted to safe concentrations it will inevitably pass through the explosive range.

Coal seam  
>95% CH<sub>4</sub>



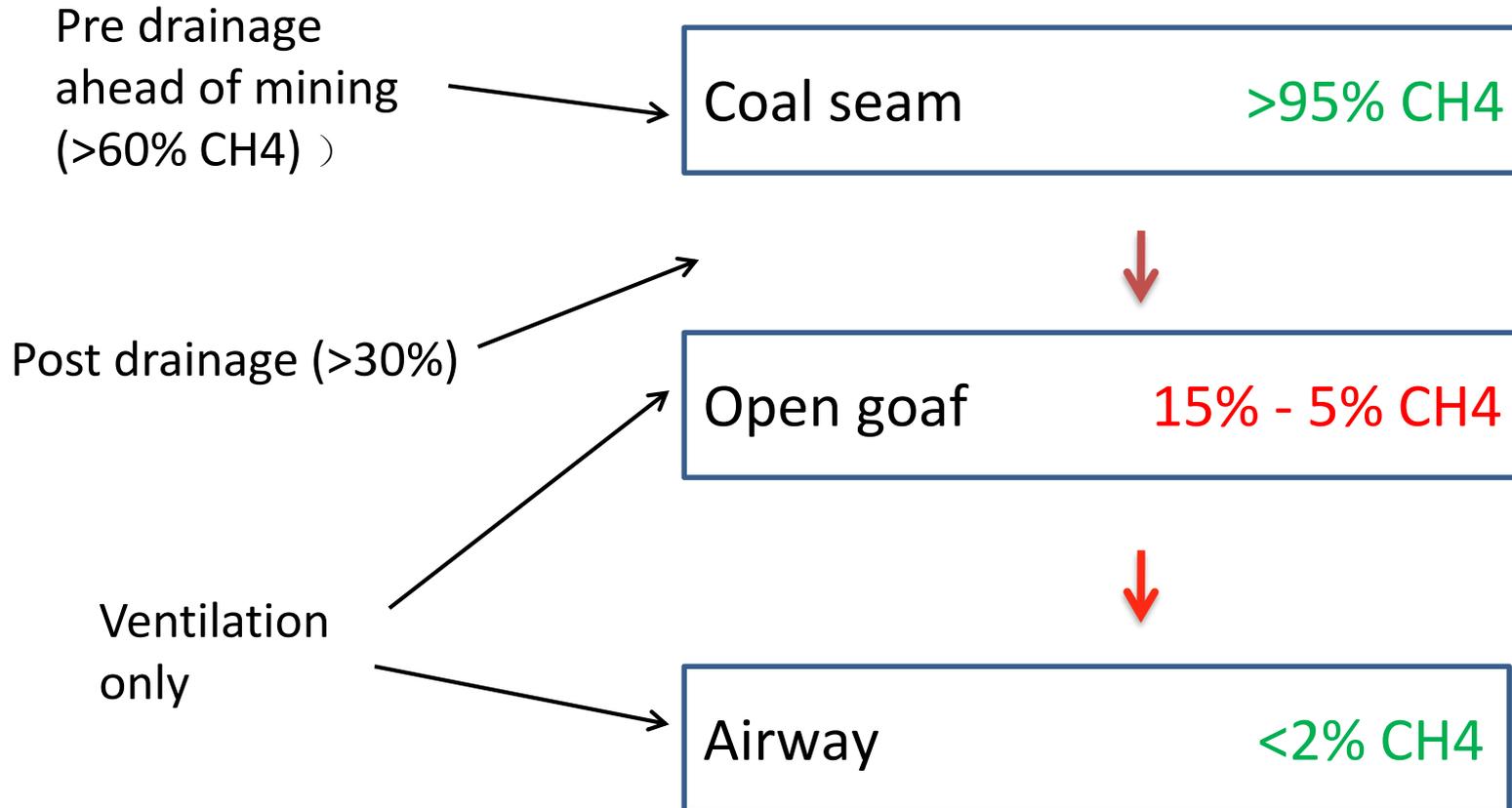
Open goaf  
15% - 5% CH<sub>4</sub>



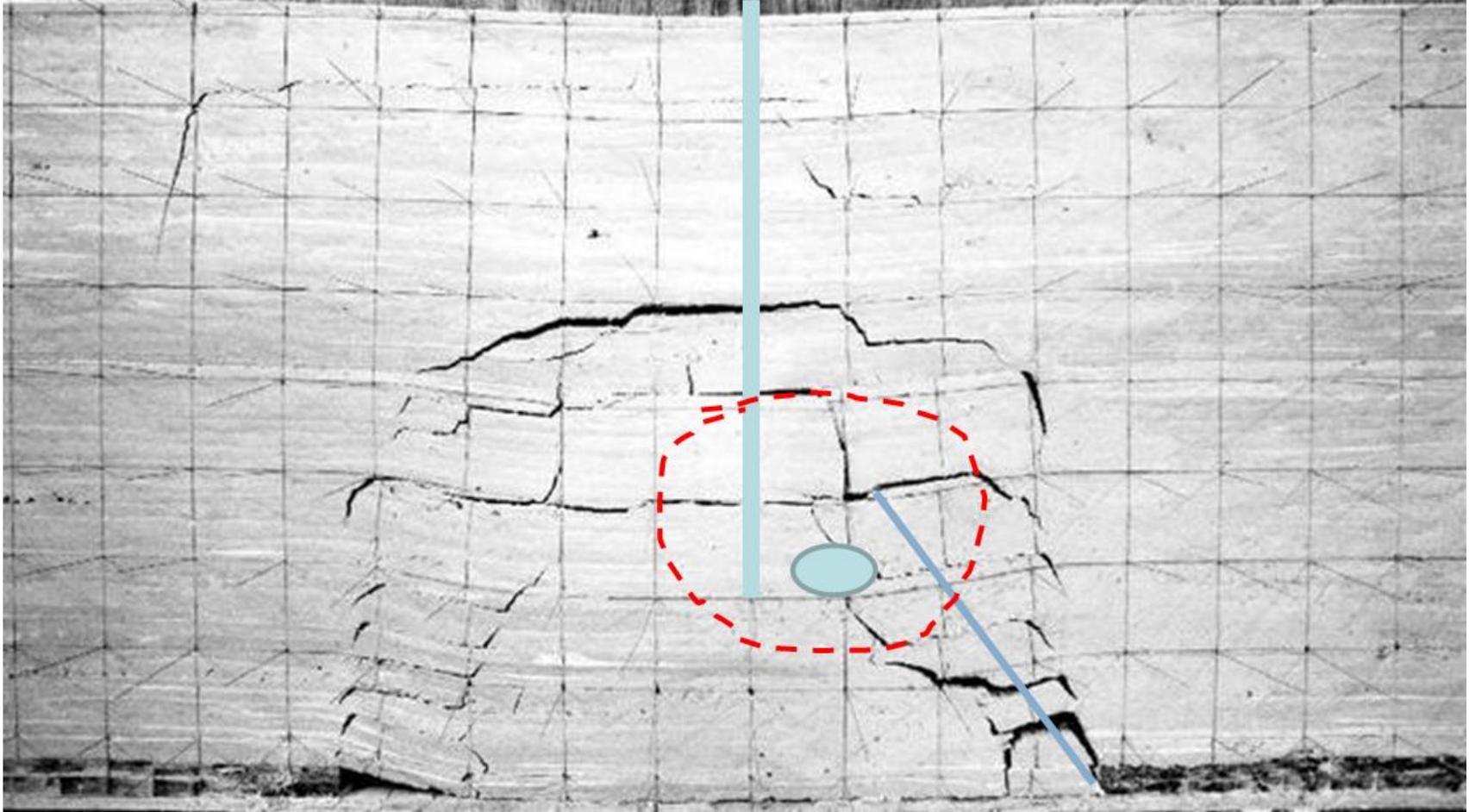
Airway  
<2% CH<sub>4</sub>

**But, explosions can be prevented by application of the following control principles:**

# a) Minimising flammable gas accumulations

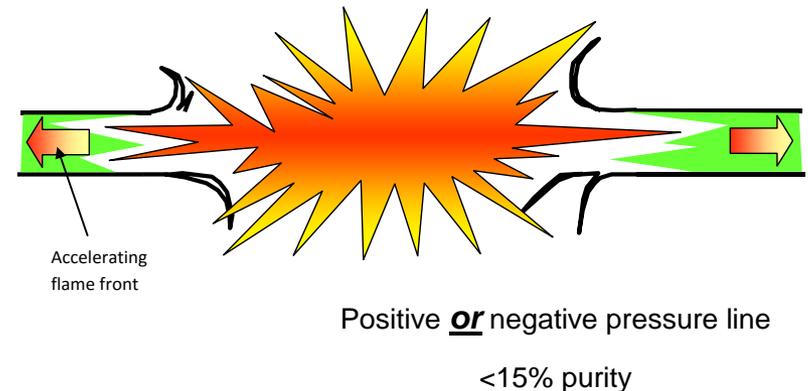
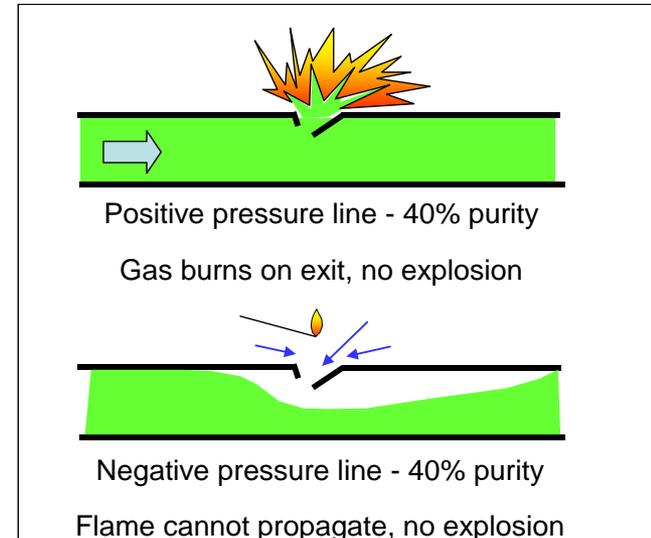


# Methane goaf drainage principles



# Avoiding explosive mixtures in methane drainage systems

- Underground pipe systems are vulnerable to damage from mine vehicles, transport systems and their loads, blasting activities, strata movement and roof collapse
- There is a finite risk of integrity failure
- Gas mixtures in or near the explosive range should not be transported



## b) Applying factors of safety in determining allowable methane concentrations

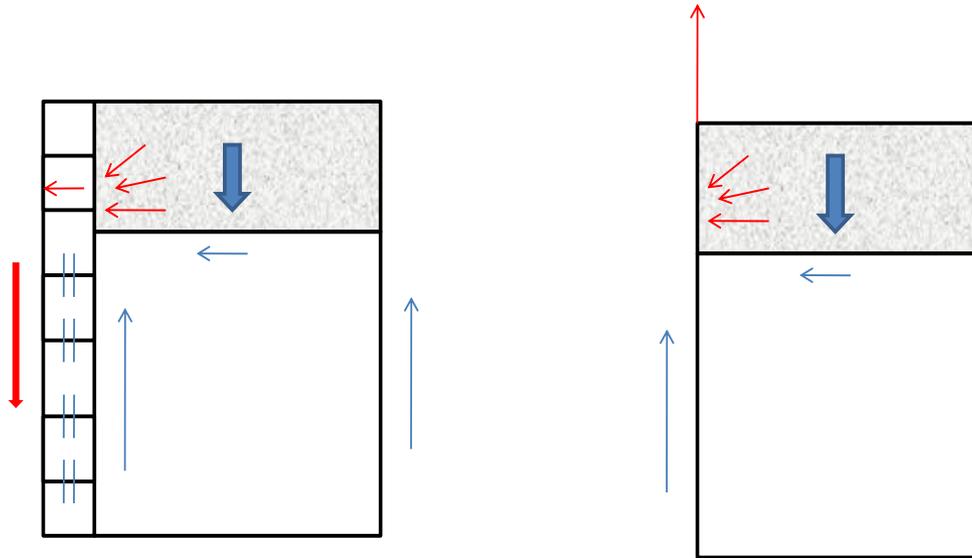
	Activity/location	Range CH4 %	Factor of safety
<b>Above upper explosive limit of 15% CH4</b>	Transport of drained gas in pipeline	Min 22- 40	1.5-2.7
	Utilisation	Min 25-40	1.7-2.7
<b>Below lower explosive limit of 5% CH4</b>	General airway	Max 1.0-1.4	3.6-5.0
	Return airway	Max 0.75-2.0	2.5-6.7

## **c) Minimising potential sources of ignition**

- Regularly inspect and maintain electrical equipment, flame proof enclosures, protection systems, connectors and cabling. Isolate faulty equipment immediately.
- Zero tolerance to contraband especially smoking materials
- Water sprays behind cutting picks and proprietary machine ventilation devices to prevent frictional ignitions
- Careful management of blasting materials and their application

## d) Maintaining separation between gas accumulations and ignition risks

Divert gas away from working areas and potential ignition sources using ventilation pressure



3-road ventilation system

Y-type ventilation system

# **A practical risk assessment tool for gas control and explosion prevention**

# What is risk?

- Risk is the likelihood that a hazard will cause harm together with a measure of the severity of the harm
- There are risks associated with everything we do
- Risk-free is an idealised concept and not a realistic objective
- Risk can be quantified in terms of probability but there is rarely sufficient statistical data to achieve this in the workplace
- Risks should be controlled to be “as low as reasonably practical”

# What is risk assessment (RA) and how is it applied effectively?

- RA is a fundamental, operational Occupational Safety & Health (OSH) management tool used in countries that have goal-based OSH legislation
- RA is a tool for preventing accidents; it also prevents loss of production
- RA is only effective if management is involved
- Third party RA is ineffective
- Effective RA tools are simple to apply

## An introduction to the “3T” Risk Assessment method

- Workplace risk assessment is ineffectively implemented in most countries often because of complexity and lack of resources
- The focus of the simple 3T method is not on preparing paper reports but removing and controlling the hazards in practice
- The method comprises a modular hazard and check tool
- The difficulty of quantitative evaluation of probability is avoided by using a risk matrix which evaluates the effectiveness of current controls

# The 3T risk assessment matrix

Current level of prevention and control	Potential severity of injuries & diseases		
	Slight	Serious	Major
Control is sufficient, no problems apparent	1: Risk is Insignificant.	1: A slight risk. Keep observing the situation.	2: Low risk. Check that the problem remains under control.
Some controls need improvement, problems have arisen	2: A low risk. Keep observing the situation and carry out easy to implement measures.	3: Medium risk. Plan and carry out suitable measures.	4: High risk. Plan and carry out corrective measures quickly.
Considerable need for improvement, frequent problems	3: Medium risk. Plan and carry out suitable measures.	4: High risk. Plan and carry out corrective measures quickly.	5: A major risk. Plan and carry out corrective measures immediately.
Control is sufficient, when: <ul style="list-style-type: none"> <li>a) machines, tools and structures comply with law and standards</li> <li>b) work is designed and organised to be safe and healthy</li> <li>c) employees are trained, and they actually use correct (safe) working practices</li> </ul>			

# Methodology for major gas hazard risk assessment

- **Identify all gas hazards**
- **List controls for each gas hazard**
- **Assess the effectiveness of each control**
  - Is the control performing as designed?
  - Do monitoring results confirm its effectiveness ?
  - Is the equipment fit for purpose?
  - Is equipment being maintained?
  - What is the potential impact if the control fails
- **Apply the risk matrix and record the risk factor for each control**  
**Recommend measures to improve controls with risk factors >3**
- **Identify the manager responsible for action and the date for improvements to be completed**

# Example major gas hazard risk assessment (part only)

Item	Hazard	Details of hazard	Control method	Remarks	3T risk score
G1	Total gas emission	Gas is released into the mine airways from all coal seams disturbed by mining activity and from worked out areas	Dilution to permissible concentration by main ventilation. Monitored methane concentrations should not have exceeded maximum permissible limits	No high methane concentrations recorded	2
G2	Gas not captured by methane drainage	Gas not captured by pre or post drainage is emitted into the mine airways during production	Gas drainage capture sufficient to allow planned production. Monitored methane concentrations should not have exceeded maximum permissible limits in the longwall return airway	Quality of captured gas variable, control could be improved. No stoppages for gas	3
G3	Explosive gas mixture in gas drainage pipes	Explosive mixtures arise when too much air is drawn into the methane drainage system	Design and regulate the gas capture and drainage system to ensure methane concentration >30%	Gas in drainage system within explosive range	5
G4	Methane layering in blind headings	Methane emitted into the roof of mine roadways forms a low density layer if not mixed and dispersed using ventilation air. A methane layer can transmit a flame long distances	Sufficient quantity and velocity of auxiliary ventilation to dilute gas to permissible concentrations and disperse any methane layers	No layering detected. Good auxiliary ventilation standards	2

There are 14 categories in the full gas hazard risk assessment table and more can be added

# Conclusions

# Effective explosion prevention involves:

- A strong regulatory, inspection and enforcement system – experienced inspectors with the authority to halt the mine if operations are unsafe but also willing to offer guidance to mine managers
- Safety focused management – zero tolerance of unsafe practices
- Application of risk management tools
- Worker participation – the main stakeholder in underground safety; risk assessment trained, able to report dangers and refuse unsafe work without fear of reprisals
- Education and training – to understand, assess and control risks

# Importance of risk management

- Safe working conditions in gassy mines cannot be achieved solely through legislation or even the most advanced technology
- A risk assessment approach to minimising explosion risks should be combined with strong enforcement of safety regulations **to prevent** accidents
- Management, organisational structure, worker participation, training, and regulatory and enforcement systems are all essential components of an effective risk management process

## Improved management of gas risks will lead to:

- Fewer accidents
- Increased productivity
- Lower costs
- Enhanced gas utilisation, and
- Lower greenhouse gas emissions

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