Case Study: Reducing explosion risk in room-and-pillar mines – South Africa

Initial conditions: An increase in severity of explosions in very thick (4-6 m high), low-gas content (0.5 to 2 m^3/t) coal seams being worked using mechanised room-and-pillar methods, in this particular mining region, required a regulatory and practical response to reduce risk. About 75% of explosions were initiated in or close to working face entries with the dominant source of ignition being frictional (Landman, 1992). The still significant number of explosions in non-face areas emphasised the difficulties of controlling methane in room-and-pillar mines using ventilation methods. Airflow in room-and-pillar workings differs from that in longwall workings due to the repeated abrupt expansions and contractions where longitudinal roadways intersect transverse cross-cuts.

The build-up of gases in high production sections with inadequate ventilation and transmission of flame in undetected roof layers of methane (Table 1) were considered significant risks which should be controllable (Creedy & Phillips, 1997).

Table 1. Assessment of ignition risk from methane layering in room-and-pillar mines

Potential Failure	Possible Causes of Failure	Preventative Measures
Failure to prevent an ignition	• Inadequate or unreliable auxiliary ventilation in headings. • Deficiencies in machine ventilation systems. • Worn picks, blocked sprays, low water pressure.	• Use of suitably designed and protected equipment. • High standards of maintenance. • Effective monitoring.
Failure to exclude ignition sources	• Electrical power and frictional ignition sources associated with continuous miners. • Smoking and other illegal activities.	• Strict training and supervision of staff. • Contraband searches on entry to the mine.
Failure to disperse methane layering	• Insufficient ventilation capacity. • Inadequate local ventilation arrangements.	• Methane control procedures. • Availability of air movers and other suitable equipment.
Failure to detect methane layers	• Incorrect monitoring locations. • Lack of suitable monitoring equipment. • Inadequately trained staff.	• Site specific monitoring programme. • Suitable monitoring probes, especially for high roadway sections. • Training.
Failure to prevent methane layering	• Ventilation quantities too low. • Unreliable ventilation.	• Ventilation planning. • Locally enhanced roof ventilation.
Failure to prevent emission of methane	• Methane emissions are a natural consequence of underground coal working.	• Methane drainage.

Gas control problems: Ventilation of working faces requires auxiliary ventilation drawing air from the last-through-road. The mined sections comprise an extensive chequer-board of roadways and pillars, all of which cannot be effectively ventilated due to the massive amounts of air required and the difficulty of distributing it evenly. To ensure main ventilation flows reach the working faces, these worked-out areas are closed off with temporary screens; gas can therefore accumulate in the enclosed areas behind the face.

In mines where accumulations of water and methane pressures were identified as a possible cause of roof falls, roof-bolted boreholes were interspersed with open, free-draining boreholes. Some emitted gas at low flow rates, which could form extensive methane layers, and would remain undetected unless probed close to roof level–difficult in the high roadways.

Solutions: Gas control where partial extraction mining methods are practised can be assisted by in-seam, predrainage; postdrainage is rarely required as roof and floor coal-bearing strata are not significantly disturbed. In low gas-content seams, predrainage is of little benefit. Gas drainage was therefore not a viable option for this region. A practical solution necessitated improving ventilation practice.

It is not practicable to ventilate worked-out sections to the same standard as working sections due to the finite supply of air available. Emphasis in these changed circumstances was therefore directed at the introduction of effective monitoring schedules involving gas detection in the roof and air velocity monitoring in the general body of room-and-pillar workings in which ventilation quantities have been reduced pending sealing-off the area.

The highest risk area was considered to be the working faces and a code of practice for ventilating mechanised sections was developed by the government regulator (Department of Mineral and Energy Affairs, 1994). A fundamental criterion was that flammable gas concentrations should be less than 1.4%, and in order to secure this the following measures were recommended:

- A minimum air velocity in the last-through-road of at least 1.0 m/s (many mines chose to install a continuous, remote velocity monitor).
- Use of effective auxiliary ventilation in headings (secondary ventilation).
- Regular measurement and recording of critical ventilation data.
- Inspections of gassy sections at intervals not exceeding one hour.
- Automatic electrical isolation of mechanical cutting if the secondary ventilation system ceases to operate.
- Special precautions when approaching emission risk zones associated with igneous intrusions and geological anomalies.
- Continuous gas monitoring in the heading being mined.
- On-board scrubbers on continuous mines are now mandatory.