OUTBURST EXPERIENCES AT METROPOLITAN COLLIERY

by
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ABSTRACT

Instantaneous outbursts have occurred at Metropolitan Colliery from the pick and shovel work of early days to the modern mining techniques of today. Developments have been the introduction of an emission index to measure the proneness of the coal to outbursts, drainage and destressing by large diameter holes, attempts at higher productivity by the introduction of pulsed infusion shotfiring and improvements in ventilation.

The future plans and aims for the Colliery include prediction of outbursts, seam gas pre-drainage and longwall mining.

HISTORICAL

Metropolitan Colliery is the most northerly exploitation of the Illawarra Coal Measures. Work commenced in 1888 with the sinking of two vertical shafts to the Bulli Seam and the development of an area at depths to 450 m to the north and east of the shafts. All work was by hand, with some single shotfiring. The coal was the highest rank found in the Sydney Basin - 18% V.M. (a.f.d.), except where subject to contact metamorphism. The seam gas was largely $CH_4$ with perhaps 20% $CO_2$ (Hargraves, 1963) and numerous outbursts were experienced on small faults and dykes up to 1913, with some fatalities (Fig.1). Because of its high rank and relative dullness the coal was highly prized for locomotives and ships bunkers as a relatively smokeless fuel.

The lower rank 22%+ V.M. (a.f.d.) Western Area, also at a depth of 450 m, was opened up from 1925. During this year an outburst fatality with $CO_2$ occurred during hand mining work with single shotfiring on a fault. Thereafter, pilot hole boring (43 mm diameter) up to 70 m ahead of the development face was practised. The Colliery was one of the earliest mechanised mines in Australia and in 1954 another outburst fatality occurred - with $CO_2$ - during undercutting. This event, together with the fatal outburst at Collinsville, Queensland within several weeks, highlighted the possibility of instantaneous outbursting in two Australian coal basins and sparked off research into the problem in Australia (Hargraves, 1958).

EARLY OUTBURST WORK

Because undercutting was suspect as the initiator of the 1954 outburst at Metropolitan Colliery (and possibly at Collinsville too) and also was related to overseas occurrences, it was discontinued virtually at once. Single shotfiring was also discontinued. Centre shearing was substituted, with two six shot rounds to complete coal preparation. Later, with the availability of better shotfiring apparatus, twelve shot rounds to a centre shear

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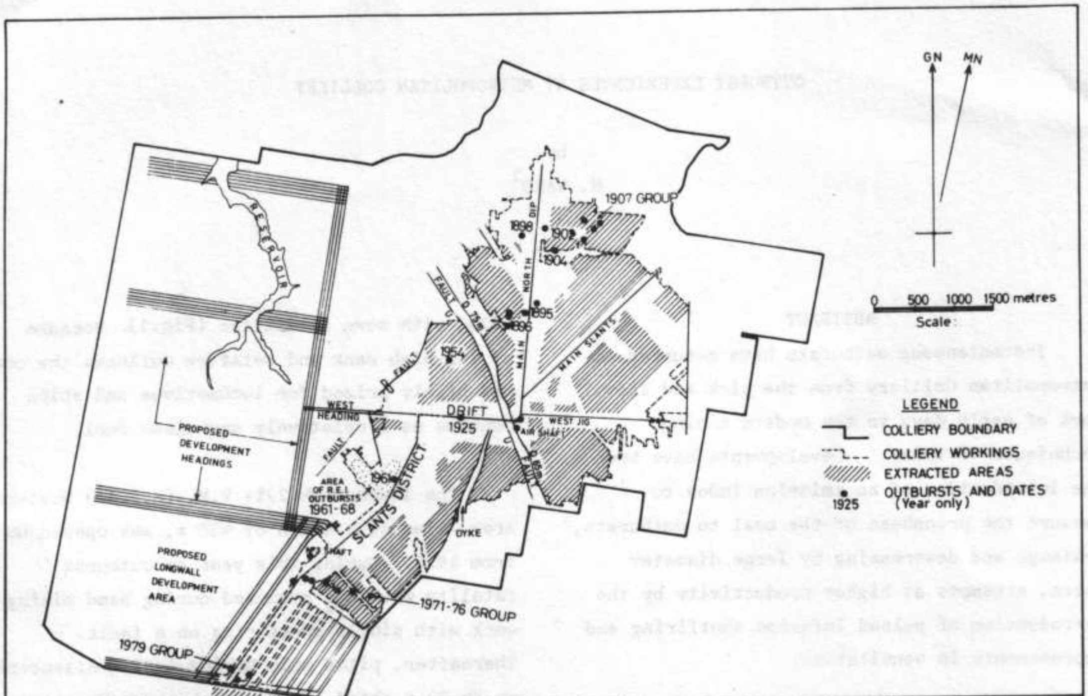



O.P.C.O.C.M. SYMPOSIUM 1980 | FIG. 1. HISTORY OF OUTBURST EXPERIENCE AT A.I.S. METROPOLITAN COLLIERY - N.S.W. | B.H.P. AUSTRALIA R.M.S.C.

and then full face firing using milli second delay detonators were introduced. Many outbursts were induced with the latter practice (Hargraves, Hindmarsh, & McCoy, 1964). Studies of the gassiness of the coal related to the occurrences allowed the development of a gassiness index to outburst proneness (Fig. 2). Additionally, more fundamental research work examined seam gas pressures, composition, flows, incremental flows, coal strengths, rank, gas property etc., variables, ventilation effects, mining layout and mining method considerations etc. (Hargraves, 1963).

The possibility of employing preventive large diameter holes, as used overseas, was examined with improvised boring equipment, including destressing effects and gas drainage effects with time, leading to a designed pattern of large diameter preventive holes. A safeguard with this design was the concurrent use of emission indices to monitor proneness (Hargraves, 1969).

## PRACTICE AND EXPERIENCE WITH LARGE DIAMETER HOLES

Partly on the basis of the above work, partly nominally, a hole diameter of 300 mm was chosen. The first large diameter borer was a modified Edeco Hydrac methane drainage drill mounted on a shortwall cutter flitting trolley. Then a drill was designed to fit into a shuttle car so that the gummings would be handled more readily by the car. Later, drills for large diameter holes were designed and fabricated in Australia (by Fox and Mole).

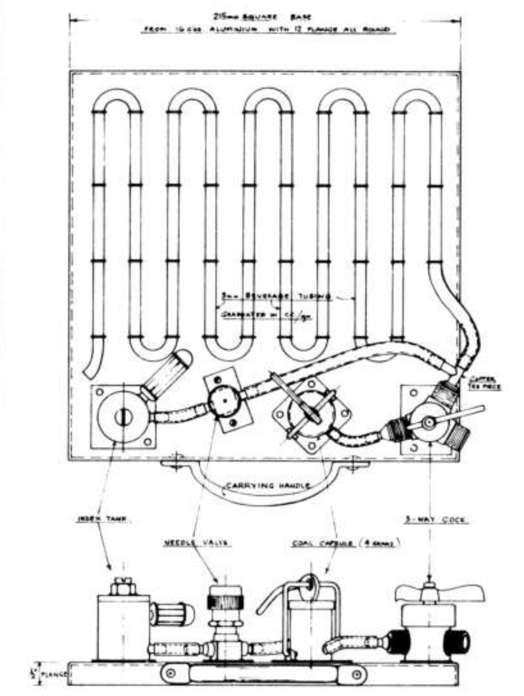



FIG. 2 EMISSION VALUE METER.

The pattern comprised two holes - one on each rib line, with the constraint that continuous mining was not to take place outside the pattern of holes or within 3 m of the butts of the holes. A 60 day initial drainage period was used, making necessary a large number of faces in a development panel to cope with this waiting period. Later, with experience of emission value index monitoring, the drainage period was reduced to 40 days and then the specific delay period was removed allowing emission value monitoring only to determine whether to mine at any one time. Places slow to drain were treated with extra (centre) holes or were fired with full face rounds (inducer shotfiring). During this phase of work no outbursts were experienced in the places prepared with large diameter holes, except for two minor instances - one where the hole pattern was suspect and the other in the vicinity of a fault. The notion was growing that, in the presence of faults, it might be justified to discount the accepted gas emission value.

## ATTEMPTS AT HIGHER PRODUCTIVITY

### GENERAL

Some success was achieved in the development headings of the mine using the continuous miner and large diameter preventive holes as described above but it was apparent that if higher productivity was to be achieved then the deficiencies with preventive holes must be looked at.

### DEFICIENCIES OF LARGE PREVENTIVE HOLES

The boring of the pattern of holes in the face of the heading was time consuming. Further, the holes had a tendency to wander off line, which, with the conditions of use for continuous miners in first workings, restricted the advance of the mining operations if the holes converged or diverged too much, thus making the place too narrow or too wide. Ideally, the holes should be one pillar length long, but striking of the floor or roof or excessive wander by one or both holes reduced the effective length of the pattern. By having to follow the line of the holes, difficulties were experienced in driving straight roadways which created problems especially in the conveyor roadways.

The number of entries driven in development panels was greater than that required under normal mining conditions, this mainly being due to additional pit room for the continuous miner whilst places were occupied by the boring machine or whilst awaiting a drainage time period. Even with this additional pit room, numerous mining shifts were lost due to high gas emission values. This was more pronounced before the abolishing of the minimum drainage period as mining with the continuous miner could not take place within the specified drainage period. Also, mining time was lost because of unexpectedly having to flit the miner and shuttle cars from place to place as a result of high gas emission values developing.

PULSED INFUSION SHOTFIRING

Pulsed infusion shotfiring was introduced as another means of destressing and degassing the zone immediately in front of the working face (Hargraves, 1974). An exemption was applied for and granted to fire more than one shot at a time and for the use of water as the stemming material to replace clay. The exemption also required the use of Hydrobel explosive and Hydrostar detonators. Three holes were bored by hand held machines to a depth of six metres, positioned at mid seam height, with one centre hole and two flanking holes. The infusion holes were bored on a non-production shift. Infusion at 17 kg/cm$^2$ was used for a two hour period, then the shot holes were charged and infusion restored before firing. The infusion guns were made at the Colliery and consisted of two concentric pipes with compressed rubber washers which expanded when the exterior 25 mm pipe was screwed over the interior 12 mm pipe to seal the hole. The mains pressure of 17 kg/cm$^2$ was used as the infusion pressure and the holes were fired under this pressure.

With the introduction of pulsed infusion shotfiring, the need for multi entry development panels was reduced due to the quicker degassing and destressing effect on the coal. Working conditions were improved also as roadways could be driven better on line and productivity increased due to lesser man hours used than in boring large holes and less time was lost in flitting machines.

IMPROVEMENT IN VENTILATION

With the multi heading development used with the large diameter boreholes, it became very difficult to ventilate all the places. A

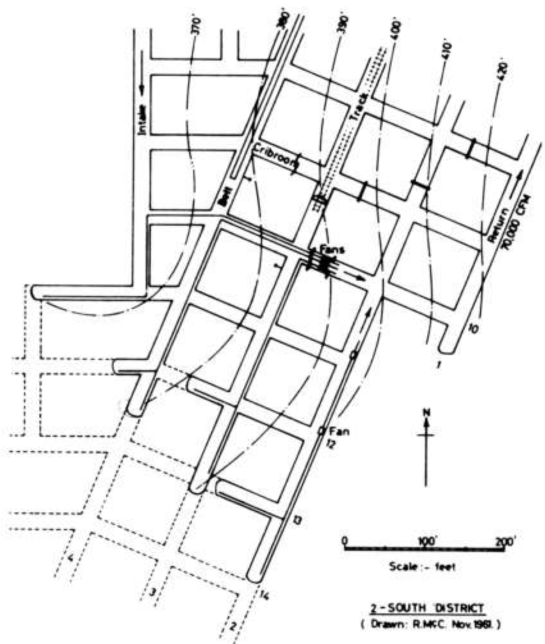



Fig. 3 Complex ventilation arrangement with multiple exhaust fans.

system of ventilating all the working and preparation places was devised (Fig. 3) using 480 mm axial flow fans on 460 mm ducting. These fans have a capacity of approx. 3.8 m$^3$/sec on open circuit. In some working places, it was necessary to have two of these fans in series. The main fan at this stage was almost at its limit because of its capacity, because of high mine resistance and because of the remoteness of the upcast shaft from the working panels. It was decided to sink a better located upcast shaft and to install a new surface fan.

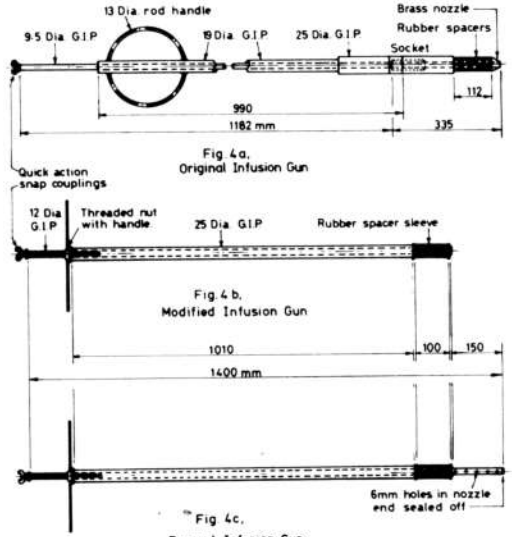
With the commissioning of this fan, the air leakages throughout the mine were greatly reduced due to the eliminating of many adjacent intakes and returns and this allowed more available air for the working faces. The 480 mm fans were replaced with Richardson centrifugal fans of approx. capacity 9.4 m$^3$/sec which greatly increased the air flow over the continuous miner.

RATIONALISING PULSED INFUSION SHOTFIRING TECHNIQUES WITH PRODUCTION TARGETS

With the ever increasing need for coal, both for steel making and export, the technique of pulsed infusion shotfiring was examined in an effort to increase the output. Initially it was thought that if the area immediately in front of the working face could be destressed and degassed more rapidly then the preparation of a distance in excess of 6 m ahead of the face could be examined. The abolishing of one of the preparation shifts might then be considered. Perhaps higher water pressures could give greater penetration of the fissures, providing shorter duration of destressing and degassing.

An intensifier pump was obtained and pressures up to 62 $kg/cm^2$ were tried over a period. It was found that no extra relief was obtained by this method. The suggestion was that the higher water pressure was damaging the roof. The possibility of a further infusion period after the shots had been fired was considered but this proved to be unsuitable as in most instances the guns were blown out of the holes on firing. Moreover, in 80% of holes on firing, the guns were damaged, sometimes beyond repair. In the instances when the guns did stay in the holes and further infusion was applied to them, it made little or no effect on the emission value reading.

The original infusion gun (Fig. 4a) was found to be unsuitable as it damaged the detonator leads due to the outside tube turning to tighten the seal. The gun was modified (Fig. 4b) to eliminate the outside tube from turning thus reducing the occurrences of broken detonator leads. The gun was further modified (Fig. 4c) after an incident which nearly caused a serious




Figs 4 Types of Water Infusion Guns

accident. From investigations at the time of the incident, it was assumed that the centre hole in the gun was blocked by the shot being fired. The gun remained in the shothole and on trying to remove it by slackening the seal nut, it flew out of the hole, ricocheted across the heading and completely pierced a 150 mm diam. wooden prop some 10 m down the heading from the face. In an effort to prevent a recurrence, a 150 mm length of 12 mm pipe was added to the inside end of the gun. Radial holes were drilled into the pipe and the end was blocked up (Fig. 4c).

IMPROVEMENTS IN PRODUCTION

Infusion during the 2 hour pre-fusion period was examined. It was found that after a period of approx. 10 min, very little extra water was infused. It was then decided to eliminate this 2 hour infusion period and charge the holes as soon as they were bored. By the time that the shotfirer had made his final checks at the face, proceeded to his firing station (not less than 100 m outbye the face in intake air) and made further tests at this point, a 10 min infusion period had elapsed. This period was regarded as adequate, Now the shots are fired after this short period of infusion.

By adopting this system, consecutive production shifts can now be worked in a development panel, in fact four production shifts per day have been worked in one panel for two weeks with great success. The possibility of outbursts has by no means been eliminated at Metropolitan Colliery. Four occurred in 1979. On investigation of the most recent outbursts, it has been found that some deficiencies in the system have occurred. The emission value meter itself tends to fail to danger if not used with rigid discipline. If the operator is not trained in the correct use of the meter, an artificially low reading may be obtained, giving a false sense of security. The emission holes if bored in the wrong location, can give false emission values of the zone immediately in front of the working face. Mining beyond the butt of the emission holes has been suspected on at least two outburst occasions.

## FUTURE PLANS AND AIMS

Based on the concept of the coal being less likely to outburst on open end lifts than in the splitting of pillars, it has been decided to develop the mine for longwall retreating extraction. The mine is divided into three main areas for longwall extraction, each area containing an estimated 12 longwall faces, each face being 150 m wide by up to 2,000 m long giving in the region of 800,000 tonnes of coal from each longwall. It is planned to increase the Colliery output from the present 1,800 tonnes per day to 4,500 tonnes per day by 1984. To achieve and maintain this level of output it is anticipated that six continuous miners will be required to keep longwall development ahead of extraction. The need for this number of continuous miner panels is due to the precautions needed in predicting outburst prone conditions every 3 m of advance in solid drivages. Up to 1 hour per production shift can be lost in these tests not solely in the tests themselves, but in having to secure the place right to the face for the testing.

The possible options under outbursting conditions are prediction, control and prevention. Regarding prediction, as stated above the gas emission value whilst useful as an outburst proneness index, has shortcomings in regard to operation. Of the other methods of prediction, the microseismic method appears most promising, although much unsuccessful, if not abortive, work has been done over several decades. The problem is to filter out extraneous frequencies to allow identification of significant dynamic events associated with outbursts, and not confused by the normal vibrations of regular coal production. Further the problem is to identify the preliminary patterns to such dynamic events of sufficient duration to allow prediction and withdrawal of men. Already some such research has been undertaken at Metropolitan Colliery. The methods of control, whilst reasonably effective still have shortcomings in addition to introducing other dangers. Present trends in prevention research are more regional in concept, involving longer drainage holes, perhaps with hydraulic fracturing, and certainly with longer duration of drainage. Both drainage from surface and from underground locations are under consideration, the former impeded, perhaps by significant depth of cover. In any event, for drainage success, the low permeability of the coal needs to be overcome.