

FINDINGS AND RECOMMENDATIONS

RE: INQUEST INTO THE DEATHS OF R. BODKIN:
M. HOUSE: S. OSMAN AND C. LLOYD-JONES:
ON THE 24TH NOVEMBER, 1999 AT THE E26 LIFT 1 MINE
NORTH PARKES MINES, PARKES, NEW SOUTH WALES

INTRODUCTION

North Parkes Mines is the holder of Mining Lease 1247; the company extracts copper and gold from ore bodies within the lease area. One ore body, referred to as E26, commenced by way of open cut and then operated as an underground block cave mine. This method had not been used in any other mine in Australia at the time, but had been used in various other countries around the world, in particular South Africa.

To set up the block cave mine, the company employed the services of consultants with experience and expertise in the block cave method and also employed personnel, for senior positions, who had experience in working in block cave mines in other parts of the world.

Once the mine was in production stage, the consultants had reduced involvement and the experienced miners found other employment away from the company, thus leaving many in the company whose only experience in block cave mining was that gained at North Parkes.

There were difficulties with caving almost from the very start. However, the ore body was collapsing in sufficient quantities for production to proceed. With the cave back becoming stable, it was thought desirable to conduct a drill and blast program and then an hydraulic fracturing program in an attempt to bring down the ore body. To this end, the mining company employed a drilling contractor.

The drill and blast program was not as successful as originally hoped. For production to continue, the extraction rate of the ore was in volumes greater than those which were falling from the cave back. This in turn created a void between the cave back and the top of the muck pile on the extraction level - this void increased with time and eventually the air void was some 180 metres in height.

On 24th November, 1999, the North Parkes E26 Mine was in a maintenance shutdown; there were approximately 65 persons working underground at about 2.50pm. A catastrophic event occurred over a period of about four minutes, where the ore body above the cave back collapsed into the void, creating an air blast which travelled through underground workings of the mine, in particular through a drive which is referred to as One Level.

The force of the air blast was such that roof bolts and metal mesh were bent, motor vehicles destroyed and four workers within the vicinity were killed. Two of those persons, Ross Bodkin and Michael House, were employed by North Parkes Mine, the other two, Stuart Osman and Colin Lloyd-Jones were employed by the contracting company Pontil. The latter two were employed on that day to conduct drill and hydraulic fracturing procedures on the cave back, the former two, it appears, went down the mine to investigate the caving activities which had been taking place.

Workers on other levels felt the effect of the blast but were not injured.

The circumstances surrounding the event were investigated by the Investigation Unit attached to the NSW Department of Mineral Resources. A seven volume report prepared by that Unit was tendered to the Inquest.

The Inquest occupied twenty four days of hearing evidence from personnel who were down in the mine at the time of collapse, from mine personnel who were not down the mine at the time, from persons who were involved in setting up the mine and from independent persons who have extensive experience within the mining industry.

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FINDINGS AND RECOMMENDATIONS

FINDINGS

I make the following findings:-

1. That Colin Lloyd Jones, Stuart Osman, Ross Bodkin and Michael House at approximately 3pm on the 24th November, 1999 died from the effects of multiple injuries sustained as a result of an air blast through the one level exploration drive, which was a result of a massive collapse of the caveback above the air gap within E26 block cave mine at the North Parkes Mine.
2. I find that the risk of air blast as a result of the sudden collapse of cavebacks was well known within the block cave mining industry and to North Parkes Mines.
3. I find that the greater the air gap the more severe will be the consequences from air blast caused by sudden massive failure of the caveback.
4. I find that the only reason that the air gap void was allowed to become as large as it was on the 24th November, 1999 was that North Parkes Mines maintained a production rate far greater than the rate at which the ore was falling from the caveback. It is quite clear that the production rate took precedence over factors which concerned the safety of those within the mine.
5. I find that a minimum muckpile of sixty metres above an extraction level is not per-se a guarantee of safety from the effects of air blast for personnel working on an extraction level.

6. I find that no reason has been given to this inquest as to why the deceased contract drillers, Colin Lloyd-Jones and Stuart Osman, were continuing to perform tasks on One Level at the direction of North Parkes Mine up to and at the time of the air blast on the 24th November, 1999.
7. I find:-
 - (a) That the bulkhead designed to safeguard against air blast on One Level played no part in the air blast that occurred on One Level on the 24th November, 1999.
 - (b) That the usefulness of the bulkhead as a safeguard against air blast on One Level was negated by:-
 - (i) Allowing the bulkhead to come into the zone of influence of subsidence of the cave; and
 - (ii) Allowing the dog-leg cuddy to also come into the zone of influence of subsidence of the cave.
 - (c) That North Parkes Mine should have been aware that the position of the bulkhead as a safeguard against air blast on One Level had been compromised and no longer served that purpose before the 24th November, 1999.

Before outlining my recommendations, I should comment about those recommendations relating to the size of the air gap. In considering evidence of witnesses at the Inquest concerning the North Parkes Mine experience, it appears the best practice would be to maintain a maximum air gap height of approximately 15 metres during the "Initial Zone" of a block cave. That of course would be subject to mine design, as some situations may demonstrate that such a air gap would be unsuitable. I have specifically refrained from specifying a maximum gap size in the recommendations having regard to the practical operational constraints in each separate instance.

I should also add that the following recommendations came about after considerable discussion between the experts of all parties who appeared before this Inquest.

RECOMMENDATIONS

1. The circumstances and causes of this event and the findings and recommendations of the Inquest shall be made known to the Mining Industry through appropriate technical publications and technical forums. North Parkes Mines is to, with respect to the circumstances and causes of this event:-
 - (a) Submit a technical paper to the Australasian Institute of Mining and Metallurgy ("AusIMM");
 - (b) Submit a technical paper and present to the International Caving Study ("ICS");

- (c) Present papers to the NSW Minerals Council, the AusIMM (NSW) branch meetings and the Eastern Australia Ground Control Group ("EAGCG")

on such dates and occasions as are agreed between North Parkes and the Department of Mineral Resources of NSW.

The Department of Mineral Resources is to monitor and verify that this dissemination of information is undertaken.

2. In addition to Recommendation 1 above it is recommended that the Department of Mineral Resources of New South Wales bring the findings and recommendations of this Inquest to the attention of the Mining Industry and the education establishments servicing the Mining Industry.
3. Any Mine Operator intending to employ the process of block cave mining to identify and analyse the elements of all the risks associated with its block cave operations and develop and maintain hazard management procedures for the management of:-
 - (a) The void above the muckpile;
 - (b) The height of the muckpile above the extraction level; and
 - (c) The air blast hazard and shall include all the appropriate controls for the air blast at all openings or potential openings into the caving zone.

Management of the major hazards in a block cave mine must include recognition of the fact that these three issues are interrelated and cannot be managed as discrete elements.

4. In order to establish the hazard management procedures referred to in recommendation 3, the two controls, height of muckpile and air gap above the muckpile in a block cave mine, require more specific definition.

It should be recognised that there are three principal zones within the caving operational life, each of which may have different control strategies. The three zones are:-

- (i) Initial zone, from the commencement of the caving/undercut operation, up to the point where the minimum muckpile height is established (defined below);
- (ii) Intermediate zone, above the initial zone, where “steady-state” caving conditions are expected to prevail, through to the point where free surface proximity must be considered, which may alter the rock failure or caving mechanism (see (iii) below);
- (iii) Surface proximity zone, (including proximity to any underground ‘free’ surface or overlying void), where surface interaction can affect the caving mechanisms and behaviour, due to changes in the mining-induced stress regime.

Control limits for muckpile heights and air gaps cannot be arbitrary, fixed numbers to be applied universally, but must incorporate the following elements in their determination, on a site by site basis:-

(a) **Muckpile Heights**

Minimum muckpile heights (above the extraction level) must be determined and, once established, maintained throughout a caving operation. Such determination must be undertaken as part of the mine design process (and should be subjected to external audit by a suitably qualified consultant or consultants and reviewed by the 'Department of Mineral Resources', and should take account of all relevant issues including:-

- (i) Shape and size (fragmentation characteristics) of typical muckpile material and any anticipated variation throughout the caving zones;
- (ii) Presence of clay minerals, water or other material that may affect the degree of compaction and permeability of the muckpile;
- (iii) Number, location and distribution of underlying voids; competence of underlying mine infrastructure;
- (iv) Presence, location, number and relative resistance of any additional voids, through which any potential air blast could escape.

(b) **Air Gaps**

The determination of the maximum allowable air gap (vertical distance between the top of the muckpile and the cave back) for each of the three caving zones must be undertaken as part of the mine design process (and should be subjected to external audit by a suitably qualified consultant or consultants and reviewed by the Department of Mineral Resources) and should take account of all relevant issues including:-

- (i) Rock mass characteristics and cavability assessment within the caving zone, plus variations expected both laterally and vertically, due to geological variation and/or stress or other geotechnical factors;
- (ii) Estimate of volumetric swell or bulking factor for caved material, on the basis of above and other appropriate assessments and subsequent operational monitoring determination;
- (iii) Depth and three-dimensional stress environment (pre-mining, and mining-induced);
- (iv) Three-dimensional geometry (shape, size/volume) of the caving zone or potential void;
- (v) Presence of any actual or potential voids connecting the caving void to other mine workings or the surface;
- (vi) Anticipated rate of cave propagation.

The above design process for determination of maximum allowable air gaps applicable for each of the three zones should be subject to ongoing review during the caving operation.

Initial Zone

In the case of the "Initial Zone", the smallest possible maximum air gap height must be used, within practical operational constraints, up until such time as the minimum muckpile height is established.

Intermediate Zone

In the “Intermediate Zone”, or “steady-state” caving region, a maximum air gap height should be determined, taking into account all of the above design parameters.

Surface Proximity Zone

The extent of the surface proximity zone will vary depending on factors such as mining geometry and ground conditions. Typically this extent (the distance between the top of the cave back and the overlying “free surface”) may be within the range of 1 to 1.5 times the minimum transverse span of the fully developed cave void. Once the cave back reaches the surface proximity zone, the maximum air gap limits should be reviewed and appropriate management strategies employed taking into account the design parameters above. In particular, the changed stress environment and potentially different failure mechanisms must be built into the design methodology. Strategies may include isolating the potentially affected areas to allow the cave to propagate.

Control of Cave Propagation

Throughout the caving operation, the mine operator must be aware of the size of air gap that would allow uncontrolled cave propagation through to the “free surface”. This is determined by multiplying the swell factor by the remaining uncaved ore column height. For example, if the appropriate swell factor is 20%, and the remaining height of uncaved ore column is 160m, then the size of air gap that would allow cave propagation to the “free surface” would be:-

$$0.2 \times 160 = 32\text{m (or greater)}$$

A factor of safety, which reflects both the uncertainties in the determination of the swell factor and any influence irregular geometry may have, should be applied to prevent propagation to the free surface. This factor is likely to be in the order of 0.75, dependant on the quality of information on the predicted swell factor and the knowledge of the geometry of the air gap. Applying this factor to the above example, the air gap that would inhibit uncontrolled cave propagation would be:-

$$0.75 \times 0.2 \times 160 = 24\text{m (or less)}$$

In instances where caving mechanisms and geotechnical parameters are well understood, the factor may be closer to unity. This would need to be supported by engineering and geotechnical analysis, within the initial mine design process for cave management (and subject to audit and review, as previously outlined) and should also be subject to ongoing review during the caving operation.

Under normal operating conditions, this air gap should not be exceeded unless alternative measures have been put in place to mitigate against any hazards resulting from an uncontrolled cave propagation event.

The maximum air gap heights applicable throughout all three zones of the caving operation must therefore be determined through a design process that recognises all of the issues set out in 4(b) and results in selecting the minimum values determined from all of the different considerations.

Any departure from recommendation 4 is to be evaluated and reviewed by the Department of Mineral Resources.

5. North Parkes Mines install and maintain a monitoring system capable of measuring at appropriate intervals the caveback location and muckpile location and a seismic monitoring system capable of assessing the frequency, magnitude and the location of caving activity for the duration of the progression of the cave.
6. **Mine design and operation.** The Mining Industry should incorporate the following specific recommendations into all relevant codes of practice or industry guidelines for safe mine design and operation:-
 - (a) Identification of the core risks that are inherent in the proposed mining operation/methods under consideration, at the time of the initial feasibility study stages of a project;
 - (b) The above core risk identification should generate both a means of comparison of alternative mining method options, at the feasibility stage, as well as a subsequent package of priority management strategies for elimination or control of these core risks to an acceptable level, throughout the future life of the project;
 - (c) At the feasibility and design stages of any mining project, the project should be subjected to a rigorous process of independent audit, by a team that is at least external to the dedicated project team. Such an audit process should address both the economic and technical aspects of the project, and must include an assessment of the core risks identified and the proposed means of addressing such risks;

- (d) The above audit process should be repeated at regular “milestone” stages of a mining project (not necessarily by an external team), from conceptual planning through to and during operations. Such ongoing audits should include review and scrutiny of initial planning and design issues in the light of changing conditions or circumstances, to ensure that the critical safety-related design issues and management strategies continue to be both appropriate and adequate;
 - (e) The responsibility for initiating and conducting such audits, and for the key actions arising from them, must be clearly defined and assigned within the management organisational structure.
7. Mine operators use their best endeavours to ensure that all underground mines have adequately assessed all risks and develop and maintain a hazard management procedure to cover all hazards associated with the mining method used or proposed to be used at the mine. The hazard management procedure shall include:-
- (a) A process of ongoing risk assessment; and
 - (b) A risk assessment taking into account any change in the size and shape of the void and any potential air blast, inrush of water from surface or insitu sources; and
 - (c) Appropriate response procedures when such a change occurs, including the use of trigger levels that require specific management responses.

This hazard management procedure shall be consistent with the requirements of Clause 20 of the Mines Inspection General Rule 2000.

8. Mine operators use their best endeavours to ensure that the risk management processes used at a mine satisfy the standards in the DMR's guidelines for risk management - MDG1010 Risk Management Handbook for the Mining Industry and MDG1014 Guide to Reviewing a Risk Assessment of Mine Equipment and Operations, subject to the review detailed in Recommendations 11 and 12 below.
9. Mine operators use their best endeavours to ensure that all risk assessments and their outcomes be incorporated in the overall safety management plan for the operation.
10. The mining industry and relevant stakeholders use their best endeavours to ensure that mines:-
 - (a) Have processes in place that take into consideration key technical knowledge and specialist advice on the safe operation of the proposed mining method, for evaluating and integrating into the mine's safety management plans; and
 - (b) Ensure whether their in-house expertise includes appropriately experienced staff in critical fields who are capable of assessing the core safety risks throughout the mine life; and
 - (c) Have processes in place to review their mine safety management plan, whenever there is a change in staff filling critical positions responsible for the safe operation of the mine, in order that 'corporate memory' is retained; and

- (d) Have processes in place for establishing clear terms of reference for the engagement of any consultant which set out the scope of their involvement including the technical outputs, reporting requirements and detail the relevant authorities and responsibilities of both parties; and
 - (e) Have protocols in place for requiring consultants to adequately communicate issues to all relevant parties during their period of engagement.
11. The Department of Mineral Resources, in consultation with the mining industry and relevant stakeholders, review its guidelines for risk management - MDG1010 Risk Management Handbook for the Mining Industry and MDG1014 Guide to Reviewing a Risk Assessment of Mine Equipment and Operations in the light of the North Parkes experience. The review should include information on:-
- (a) Identifying, analysing and ranking core risks during the mine design stage;
 - (b) Selecting independent persons or suitable mine personnel with appropriate qualifications, skills, training and experience in the conduct of risk assessment;
 - (c) Establishing and maintaining adequate records of the processes used, information considered, persons consulted and decisions made during the risk assessment;
 - (d) Ensuring appropriate risk ranking tables or matrices are understood and applied consistently; and

- (e) Identifying a mine position that is responsible for the overseeing, the implementing of appropriate controls and reporting on the management of the identified core risks.
12. The Department of Mineral Resources review its publication Minerals Industry Safety Handbook, documenting the lessons and outcomes from this Inquiry and include:-
- (a) The hazard of voids in underground mines;
 - (b) The hazard of air blast in underground mines; and
 - (c) In the case of major hazard identification by reference to Clause 20 of the Mines Inspection General Rule 2000 any hazard that has a fatality as a consequence must be categorised as a Major Hazard, regardless of matrix scoring systems adopted. All major hazards must have a higher level of risk management response, and such responses must be incorporated and maintained within the management systems of the mine (including assigned responsibility and accountability for each response), for the duration of the mine operation, unless the hazard can be eliminated.
13. Universities, recognised training authorities and other educational organisations, in consultation with relevant regulatory authorities, mine operators and professional associations, review their courses in mining engineering, geotechnical and related fields to ensure that adequate content is given in all courses associated with mining operations, as to engineering principles, design, uncertainty and risk management. Specifically such review shall seek to ensure that, the disciplines of core risk identification and fundamental principles of rock engineering behaviour, relative to different mining methods and ground conditions is incorporated as necessary.

14. Where a new mining method is introduced by a mine owner into any mine within NSW, the Regulator should familiarise itself and relevant Officers in the core risk of such method, so that they have a good working knowledge of current best practice in that mining method, to enable them to evaluate any proposal by the mine and to fulfil its responsibilities.
15. DMR Inspectorate personnel should have a protocol for seeking, and a means of accessing specialist resources or advice, as required, in order to satisfy themselves that certain action proposed by a mine operator is suitable for the task. This means of access may be in the form of in-house resources; ability to engage independent experts directly; or ability/authority to ask the mine to engage in agreed independent expert or second opinion.
16. Finally I recommend that further research be encouraged within and on behalf of the Mining Industry into the issues of the fundamental understanding of air blasts - air blast mechanisms, prediction and control strategies (**including bulkhead design**), inter-relationship with caving behaviour and rock failure mechanisms and subsequent design procedures. The outcomes from such further research should then be directed into ongoing review and refinement of the various guidelines and design processes and parameters referred to above.

Before setting out any findings of fact on which my formal findings and recommendations are based it is my intention, because of the various parties' submissions, to set forth the applicable law pertaining to my coronial duty.

THE LAW

CORONIAL DUTY

Section 22 of the Coroners Act 1980 (NSW) relevantly provides:-

"22 Finding of coroner or verdict of jury to be recorded -

- (1) The coroner holding an Inquest concerning the death or suspected death of a person shall, at its conclusion or termination, record in writing his or her findings or, if there is a jury, the jury's verdict, as to whether the person died and, if so:-
 - (a) The person's identity;
 - (b) The date and place of the person's death; and
 - (c) Except in the case of an inquest continued or terminated under Section 19, the manner and cause of the person's death.
- (2)
- (3) Any record made under the provisions of Sub-section (1) or (2) shall not indicate or in any way suggest that an offence has been committed by any person."

In the present Inquest the identity of the four deceased, the place and date of death of each deceased are known. Thus Sub-sections (1)(a) and (b) of Section 22 are satisfied.

Sub-section 1(c) of Section 22 requires me to record in writing the "manner and cause" of death.

The phrase "manner and cause of death" has received judicial consideration and the attention of learned authors over the years. Regarding the meaning of this phrase I need go no further than to set out extracts from **McClemens J's** judgment in Ex parte Minister of Justice: Re Malcolm; Re Inglis (1965) NSW 1598 and Coroners Act 1960-1963. I pause to note that in the 1960 Act Inquest was defined to mean "inquest by a coroner into the manner and cause of death of any person".

In Ex parte Minister of Justice it was common ground that the deceased had died from pneumonia. What was in issue was whether the pneumonia was the consequence of the poisoning by the inhalation of phosphine during fumigation work at a wheat silo. The coroner at Inquest found merely that the deceased died of pneumonia.

At p.1604 His Honour said:-

"I think where the Coroners Act speaks of the cause of death it means the real cause of death; namely, the disease, injury or complication, not the mode of dying as eg heart failure, asphyxia, asthenia etc. In this case, obviously, the pneumonia was not the real cause of death; this was merely a final result operating on a man who was suffering from a bed sore, bladder infection, secondary infection from the bed sore, who was inert, vegetative,

and incontinent of urine and faeces. But were these things in him caused by the inhalation of poison gas? They might have been, they might not. If what really brought him to this pass "poisoning" and hence caused the death then the poisoning can be fairly said to be the real cause of death."

At the same page His Honour went on to adopt the following passage from Jervis on Coroners 9th Ed p.83:-

"All deaths can in a sense be regarded as natural. This is true in a philosophic sense in that it is part of man's lot to die. It is also true in a medical sense in that in all cases death is brought about by the failure of one or other of man's organs. In order, therefore, to distinguish between one sort of death and another it is necessary to consider not the terminal cause of death but the cause which was the real cause of death. Difficult legal and medical questions may be raised in deciding how far back in the chain of causation a coroner should go in considering what was the real cause of death. Thus osteomyelitis, which is a septic disease of bone, may occur naturally or may, for instance be caused by injury from a fall: tetanus, which is an infection, proceeds from a wound: an old lady may die in hospital from hypostatic pneumonia months after a fall which injured her hip. It is suggested that in so far as the terminal cause of death directly and consequently follows from a definable event the death should be regarded as being caused by the definable event."

I have also taken into account my statutory obligations pursuant to Sections 19 and 22A.

Section 19

After due consideration I have come to the conclusion that Section 19 does not apply to this inquest.

Section 22A

This section provides:-

- (1) A Coroner (whether or not there is a jury) or a jury may make such recommendations as the Coroner or jury considers necessary or desirable to make in relation to any matter connected with the death, suspected death, fire or explosion with which an inquest or inquiry is concerned;
- (2) Public health and safety are examples of matters that can be the subject of a recommendation. A recommendation that a matter be investigated or reviewed by a specified person or body is an example of a recommendation that can be made;
- (3) The record made under Section 22 is to include any recommendations made by the Coroner or jury. The record must not indicate or in any way suggest that an offence has been committed by any person."

I have made recommendations in light of the evidence that I have heard and read during this inquest. In accordance with sub-Section 22A(3) those recommendations are part of my written record I have made pursuant to Section 22.

STANDARD OF PROOF

The standard of proof which I apply is that of the civil standard which has been expressed in various ways including proof to the reasonable satisfaction of the particular tribunal. In applying this standard and weighing the evidence before me I note the words of His Honour Dixon J, as he then was, in Briginshaw v Briginshaw (1938) 60 CLR 366 at 362, where His Honour said:-

“... reasonable satisfaction is not a state of mind that is attained or established independently of the nature and consequence of the facts to be proved. The seriousness of an allegation made, the inherent unlikelihood of an occurrence of a given description, or the gravity of the consequences flowing from a particular finding are considerations which must affect the answer of the question whether the issue has been proved to the reasonable satisfaction of the tribunal. In such matters “reasonable satisfaction” should not be produced by inexact proofs, indefinite testimony, or indirect inferences. Every one must feel that, when, for instance, the issue is on which of the two dates an admitted occurrence took place, a satisfactory conclusion may be reached on materials of a kind that would not satisfy any sound and prudent judgment if the question was whether some act had been done involving grave moral delinquency. Thus, Mellish LJ says, “No doubt the Court is bound to see that a case of fraud is clearly proved, but on the question at what time the persons who have been guilty of that fraud commenced it, the Court is to draw reasonable inferences from their conduct”.”

I also note **Blackburn DJ** in Barten v Williams 20 ACTR 10 at 12, who, when dealing with an application to cancel a builder's licence, said:-

"It was submitted for the Respondent that the standard of proof required was proof on a balance of probabilities. I do not dissent from this except to this extent: I am reluctant to apply what Dixon J called 'a mere mechanical comparison of probabilities' (Briginshaw v Briginshaw (1938) 60 CLR 336 at 361) to an issue as serious as the one before me, which may result in the cancellation of a builder's licence and thus the termination of his capacity to earn his livelihood in that occupation. I accept the "balance of probabilities" rule, if it is qualified in the way in which Dixon J qualified it in the case cited, ie, by saying that I can regard a fact as established only if I can entertain a reasonable satisfaction of its truth."

With the above in mind I set forth below my reasons and findings as to the manner and cause of the deceased's death.

BLOCK CAVING MINING METHODS

A synopsis of the block caving method is as follows:-

1. Ore is removed from the base of the ore body at what is termed the extraction level.
2. The removal of this ore creates a void or air gap between the cave back (roof) and the caved ore.

3. Once ore is removed from the base of the ore body to the extent of the predetermined area of the hydraulic radius then the area left by the removed ore, the air gap, will fill with caved material from the cave back (roof) which is above the air gap.
4. The caved material is then taken from the extraction level which causes the caved material to move downward and away from the cave back. When sufficient material is removed the air gap will develop again, which allows the cave back to again cave (or propagate) and fill the air gap. This method of propagation and extraction is then used from the extraction level to the surface.
5. The cave is controlled by having minimum air gaps between the propagated material and the cave back. Consequently control of caving can be achieved by not removing material at the extraction level and thus choking off any further opportunity for the cave back to propagate by limiting the volume of air gap to zero.

RISKS INVOLVED IN BLOCK CAVE MINING METHOD

6. One of the risks inherent in the block caving method is the risk of air blast from a sudden collapse of the cave back into the air gap.

Concerning this particular risk the following has been said:-

(a) **Text Book Authors**

In the **Mining Engineering Handbook** (eds. Cummins & Given, 1973),
Julin and Tobie state, at p.12-163, the following:-

"There is a limit to the rate that this caving action progresses, which is relative to the structure of the material being caved. If rock is drawn faster than the ore caves a void will be created that could result in a dangerous situation. The uncaved portion, or large part of the uncaved portion, might drop as a block, causing a destructive air blast through the extraction opening. It also is possible to form a stable arch, if the rock mass is strong enough, so that it is difficult to promote further caving."

In the **Underground Mining Methods Handbook** (Hustrulid, 1982), Julin and Tobie state, at p.969, the following:-

"If the ore is drawn faster than the caving progresses, a void over the caved material will be created that could result in a very dangerous situation. The uncaved portion, or large part of the uncaved portion, might drop as a block, causing a destructive air blast through the extraction opening. It is also possible to form a stable arch, if the rock mass has sufficient strength, so that it is difficult to promote further caving. In this case, the block should be enlarged until caving starts or some means of inducing a cave must be employed."

In **Rock Mechanics for Underground Mining**, Brady and Brown (1993) at p.428 state:-

"If arching is able to develop to such an extent that a stable, self-supporting arch forms above a drawn-out area, several serious consequences can follow. Production will cease in the area concerned, the possibility of damage to installations and injury to personnel exists from the impact loads and air blast that can be produced when the arch eventually fails, and the expense of the measures that may be necessary to induce caving can render the operation uneconomic."

In the **SME Mining Engineering Handbook**, 2nd Edition (Hartman, 1992), Orr at p.1841 states:-

"For example, utilisation of block caving in an ore body with poor natural cave characteristics will create bridging problems. Attempts to dislodge hangups expose personnel and equipment to unstable ground, and eventual failure can result in an air blast."

- (b) In February 1998 North LTD produced a document entitled "**Block Caving, Guidelines for Project Assessment**" (this is Appendix 7.47 of the DMR report).

The North LTD document referred to above, at pp.2 and 26, states:-

"Any waste capping material should also be cavable to prevent the generation of air gaps which may result in catastrophic failures. Draw of caved material must be matched to the propagation rate of the cave back. Overdraw will result in the creation of an air gap between the cave back and rill. This air gap can allow the entry of waste dilution and may cause damaging air blasts if large sections of the back collapse."

- (c) Mr. E. Tota, the North Parkes Manager mining between 1993 and 1997 gave an interview with North LTD's auditors, KPMG. This was approximately at the time of or just after Mr. Tota departed. In this document, which I will refer to in more detail below, Mr. Tota described the safe working practices that should be adopted regarding the size of air gaps and the risk of air blasts.

NORTH PARKES MINE'S REACTION TO THE RISK OF AIR BLAST

- 7. North Parkes reacted to the risk of air blasts in various ways two of which were:-
 - (a) The adoption of the minimum of sixty metres of caved material above the extraction level; and
 - (b) The construction, at the behest of the DMR Inspector, of a bulkhead in One Level.

I will deal more fully with each of these air blast risk alleviations below.

It is therefore clear from the above that the risk of air blast from the sudden collapse of cave backs was well known.

I therefore find that the risk of air blast as a result of the collapse of cave backs was well known to the block cave mining industry and to North Parkes Mines.

HISTORY OF THE E26 BLOCK CAVE MINE. NORTH PARKES MINE

I have set out below the history of the E26 Cave Mine using the report produced by Mr. Peter Doyle of the Investigation Unit of the Department of Mineral Resources (Exhibit 6), the oral evidence of the witnesses who appeared at the Inquest and the documentary evidence that has been tendered.

1. The development of the E26 Mine commenced in 1993.
2. In January 1994 the North Parkes board accepted a proposal for the mining of the E26 ore body using the block caving method.
3. Although the block caving method for the mining of ore bodies had been employed in countries outside Australia such a method had not been used in this country. The E26 Block Caving Mine was therefore the first of its kind within Australia.
4. Apart from the uniqueness of the block caving method to Australia, the E26 mine had two further differences from other block cave mines, they were:-
 - (a) The fact that the height of the ore body to be caved (480 metres) in the first lift, exceeded any previous block cave mine; and
 - (b) The ore bodies restricted hydraulic radius relative to the mining rock mass rating (MRMR). The hydraulic radius being the area of ore removal required from the ore body which will induce the ore above to cave naturally into the air gap created.

I pause here to note that within the E26 ore body there were a number of differing MRMR's. The gypsum leached zone, being near the surface and above One Level Drive was the least competent zone within the ore body. As such the hydraulic radius required to induce caving in the gypsum leached zone was less than the hydraulic radius for ore zones beneath it. This fact was known to North Parkes Mines.

5. Prior to any ore being extracted from the extraction level of E26 an exploration drive off the main decline was driven into the ore body of E26. This exploration drive was between the extraction level and the surface being approximately 230 metres above the extraction level. This exploration drive was named One Level and was the place that the deceased Pontil Drillers, Stuart Osman and Colin Lloyd-Jones were working on the 24th November, 1999. The deceased Ross Bodkin and Michael House were making their way to One Level by vehicle at the time of the air blast.
6. During the period leading up to production on the extraction level, which began in 1997, North Parkes Mines had employed up to five geotechnical staff all of whom had block caving experience from various overseas countries. After production began in 1997 the number of experienced block caving staff reduced to one. From that time all other staff at the E26 mine had block caving experience only at North Parkes E26 Mine. This experience did not extend the full cycle of a block cave mine; ie it did not extend to having experienced a broken column of ore from the extraction level to the surface.
7. Mr. Ed Tota was Manager Mining at North Parkes Mine from 1993 to 1997. He was very experienced in block cave mining. It was he that had put together the experienced block caving team that were present at the E26 mine from 1994 to 1997.

8. Mr. Tota left North Parkes in 1997. His position as Manager mining was taken by Mr. Ross Bodkin, one of the deceased. At approximately the time of leaving North Parkes Mr. Tota had a meeting with North LTD's auditors KPMG. The purpose of this meeting was the preparation of a document, primarily for taxation purposes of research and development of block caving. Contained within this document were Mr. Tota's views regarding the continued safe operation of the E26 mine using the block caving method.

9. Of the views expressed by Mr. Tota the following are of consequence.

(a) Of the production of the cave he said:-

"It can be limited by the rate of cave of the rock actually breaking upwards (ie the rock will actually break upwards at a certain rate). If extraction is carried out at a faster rate than the rock is breaking, once it is in cave mode, then a large gap will form and that is very dangerous."

(b) Later in the document, Mr. Tota discusses the necessity of control of the caving gap (air gap), he states:-

"The caving gap and the control, in terms of other block cave mines compared to NPM is that in other mines traditionally the gap has not been well controlled, in that there have been some spectacular failures in terms of allowing the gap to become too large and then a failure (ie sudden caving) occurring which has fairly catastrophic consequences for the cave."

"In block caving it is necessary to keep the gap to a minimum because if an air gap does develop, the cave tends not (to) occur by the ore falling away in little pieces. The ore tends to come down in big slabs because the caving process is structurally controlled, like the situation at NPM. The monitoring at NPM, especially the seismic monitoring will be seismic activity in terms of stressing and so but there would have been no actual advance of the cave roof, but then the cave roof will advance by 20m in one go and that is a danger. This is because if there is an air gap of (say) 20m, solid rock coming down off the roof could push out millions of cubic metres of air which has a restricted passageway consequently all in its path is literally blasted out of the way. This is a very dangerous situation and people have been killed on numerous occasions in block cave mines due to that reason. This is why control of gap is very important."

10. The cave back in the E26 Block Cave Mine developed a stable arch. The result of this was that gravity induced caving of the ore body ceased. The cave did not propagate as expected.
11. Though the cave back did not cave as expected ore was still removed from the extraction level. As a consequence of this ore removal from the extraction level and the lack of caving the air gap between the top of the muckpile (caved material) and the cave back increased after 1997 from approximately thirty metres in height to approximately 180 metres in height on the 24th November, 1999.

12. To counter any adverse effects from air blast to the extraction level North Parkes adopted a rule to have as a minimum amount at least of sixty metres of broken ore above the extraction level (the sixty metre muckpile). It should be noted that at any given time this sixty metre muckpile may have been more than sixty metres. I have heard evidence that on occasion it was considerably more.
13. Because of the cave backs failure to propagate under the influence of gravity alone, North Parkes implemented the following methods to induce caving:-
 - (a) Hydraulic fracturing which involved the drilling of holes around the cave and then introducing water under pressure into these drill holes which would induce propagation; and
 - (b) The drilling and blasting of the cave which increased the cave's 'footprint' and would, hopefully induce gravitational propagation of the cave.

Pontil Pty Ltd (now called Major Pontil Pty Ltd) was retained to carry out the above activities.

14. Another purpose of the use of the above methods was to break the stable arch that had formed within the cave back and allow gravity based propagation to take place.
15. Prior to the air blast on the 24th November, 1999 the hydraulic fracturing and the drill and blast program did not initiate gravitational propagation of the cave back. These methods did however lead to significant propagation of the cave back particularly on several days prior to the 24th November, 1999.

16. The hydro fracturing and drill and blast programs were carried out at various times from the North and South Drives of One Level. The North and South Drives of One Level were parallel with the side of the cave. As part of these programs a dogleg cuddy was developed off the South Drive towards the cave void.
17. On the 31st August, 1998 the cave back intersected One Level and continued on to the surface. As a consequence One Level now ended as an opening into the air gap between the muckpile and the cave back.
18. On the 29th September, 1998, Mr. L.M. Stevens, a Mines Inspector from the Department of Mineral Resources contacted North Parkes Mines pointing out the potential for an air blast into One Level from its opening into the air gap below the cave back.
19. As a consequence of the concerns raised by Mr. Stevens a bulkhead was built on One Level some little distance forward of the junction of the North and South Drives and towards the air gap below the cave back. This bulkhead was installed on the 20th November, 1998, it reached full strength on the 18th December, 1998. A viewing door approximately one metre in diameter was built into the bulkhead. The bulkhead's position was approximately ten metres back from the caves anticipated footprint.
20. Between the installation of the bulkhead on One Level on the 20th November, 1998 and the air blast on the 24th November, 1999 the cave void was observed, through the bulkhead door, to be advancing towards the bulkhead.

21. The advancement of the cave void towards the bulkhead and the North and South Drives of One Level, was confirmed by measurements taken and interpreted by North Parkes staff. These interpretations between the 28th August, 1999 and the 22nd November, 1999, two days before the air blast, showed that the side of the cave may have undercut the dogleg cuddy which was off the South Drive and may have undercut or left the bulkhead on the edge of the cave void. During this period the dogleg cuddy was taped off and access to it prohibited.
22. However the hydro fracturing program continued from One Level's North and South Drives during the period 25th August, 1999 to the 24th November, 1999. This required the Pontil drillers to be present on One Level to carry out this activity.
23. On the Saturday prior to the incident large falls from the cave back occurred, this was estimated at up to half a million tonnes. Propagation of the cave back continued to occur between this time and Wednesday the 24th November, 1999. The hydro fracturing program continued during this period, notwithstanding these large falls.
24. On Monday the 22nd November, 1999 the cave back had penetrated the gypsum leached zone (Annexure of Joanne Dudley).
25. Pontil drillers, Ernest Boyd and Richard Dodds, commenced their shift on One Level at 7pm on Tuesday the 23rd November, 1999. The large falls from the cave back during their shift concerned them and they spoke with their North Parkes Supervisor, Con Murphy. Because of concerns for their own safety Boyd and Dodds left One Level.

26. Boyd and Dodds contacted North Parkes Management Personnel, Messrs. Van As and Secis. Boyd and Dodds were told that the mine was caving as expected. But to remain out of One Level until they felt it safe to return.
27. At the 7am shift changeover on the morning of the 24th November, 1999, Con Murphy informed Robert Cunningham, the day-shift Underground Production Supervisor, of his and the Pontil drillers' concerns, regarding the caving of the previous night.
28. The Pontil drillers, Colin Lloyd-Jones and Stuart Osman (the deceased), came on shift at 7am on the 24th November, 1999. They went to One Level to continue their drilling tasks for the hydro fracturing program which was still continuing.
29. At approximately 1pm on the 24th November, 1999 Mr. Spratt, a North Parkes employee, went to One Level and videotaped the bulkhead area. Various management personnel are to be seen and heard on this video.
30. At the time of the air blast which was approximately 2.50pm-3pm on the 24th November, 1999 the height of the air gap was approximately 180 metres from the muckpile to the cave back. The air gap void contained approximately 4.1 million cubic metres of air.
31. To use the words of the investigation report of the New South Wales Department of Mineral Resources:-

"On 24th November, 1999 at approximately 2.50pm there was considerable caving followed by a sudden massive caving event, in the block cave top of the E26N ore body. This occurred when the vast majority of about 5.5 million cubic metres of rock (approximately 14,500,000 tons) from the roof of the cave to the surface, collapsed into the void over a period of approximately four minutes."

32. As a result of the collapse the air was expelled from the air gap void, venting through the base of the open cut above the void, through the muckpile onto the extraction level through the draw points and through One Level.
33. After the air blast the mine personnel who were located underground at the time made their way to SCADA control and eventually were evacuated to the surface.
34. Dr. Fuller, as part of the DMR investigation examined One Level, the North Drive and the South Drive. A fair summation of his evidence was that:-
 - (a) The air blast that came into One Level from the air gap void probably came through the dogleg cuddy, along the South Drive and into the North and Centre Drives.
 - (b) There was no sign of the bulkhead or Centre Drive where it had been, only rubble, in all probability the bulkhead having collapsed into or having been taken into the air gap void by the falling cave back.
 - (c) It was not possible to view the dogleg cuddy in the South Drive but it had probably collapsed into or been taken into the air gap void by the falling cave back.

I note that Dr. Fuller produced a video of his inspection which shows the path of the air blast with bent bolts etc appearing to mark its path.

Having set out the relevant history of the E26 Mine from its inception to the occurrence on the 24th November, 1999 I deal with specific matters which I consider played a part in the manner and cause of the death of each deceased.

SIZE OF THE AIR GAP

When the block cave mining was initiated at the E26 mine, the opinion of those people at the mine who were experienced in this mining method, was that the air gap between the muckpile and the cave back should never exceed a height of ten to fifteen metres.

Witnesses have expressed their reasons for such a maximum height. These reasons being:-

- (a) That the ore that has caved into the air gap will fill this void and choke off any further caving from the cave back. No further caving of the ore body could take place until the caved ore was extracted and a further air gap created. This would then control the caving of the ore body, not only vertically but horizontally;
- (b) The second reason for maintaining an air gap maximum height of ten to fifteen metres was that if there was a sudden collapse of a large volume of ore from the cave back into the air gap void, then the air blast created by that collapse would be limited and less injurious to either personnel or property.

As I have stated in the history of the E26 Mine Mr. Ed Tota, a Mining Engineer, commenced employment at North Parkes Mine in August 1993 in the position of Manager Mining. He left North Parkes Mine in May 1997. Prior to leaving North Parkes, Mr. Tota made an extensive statement for North LTD's Accountants KPMG. That statement was apparently prepared for the purposes of a taxation benefit regarding research and development of block cave mining. It was a detailed statement which contained a reference to the height of the air gap void and outlined the risks and difficulties which could occur if the air gap void was allowed to become too large. It appears from the evidence given at the Inquest that Mr. Tota's document was not only retained by KPMG but was also available to personnel who were working at the E26 Mine after Mr. Tota had resigned.

Following the departure of Mr. Tota it is quite clear from the evidence that North Parkes Mines experienced a great deal of difficulty in inducing the propagation of the cave back. This was due to the formation of the 'stable arch' within the cave. This of course led to concerns about production.

Notwithstanding the effects of North Parkes Mines to 'destabilise' the cave back using hydro fracturing and drill and blast programs, the rate at which the E26 ore body was caving was at a slower rate than the extraction rate desired by North Parkes Mines. Put simply more was extracted from the cave than was caving.

As a consequence over a period of time the amount of ore extracted from the extraction level far exceeded that which was falling from the cave back. Consequently the size of the air void increased dramatically.

For a reason that is not readily apparent the height of the air gap was no longer a concern to those responsible for the working of the E26 Mine. Attention having been diverted from the height of the air gap and focussed onto the size of the muckpile of ore which was above the extraction level.

Communication between the mining company and its consultant in South Africa, Dr. Dennis Laubscher, turned upon the size of the muckpile above the extraction level. Written communication with South Africa, Dr. Laubscher, the consultant, appeared to make no reference whatsoever to the size of the air void. The concern seemed to be as to whether or not sixty or seventy metres of muckpile would be adequate to prevent any air blast problems on the extraction level.

Upon perusal of the evidence, one gains the impression that North Parkes was relying solely upon the advice of Dr. Laubscher concerning the size of the muckpile, to obviate any difficulties which may occur from air blast. It is difficult to know what was in Dr. Laubscher's mind when he was replying to emails and faxes which were forwarded to him from the North Parkes Mine; Dr. Laubscher was unable to attend the Inquest due to illness. However one gains the impression in reading the requests from North Parkes Mines and the reply thereto by Dr. Laubscher that Dr. Laubscher was simply replying to a single simple request without having in front of him the full picture that was existing at the North Parkes Mine at that particular time. It is unknown as to what assumptions Dr. Laubscher was considering before answering the request put to him by the North Parkes mining personnel.

What is clear from the evidence is that North Parkes Mines completely ignored the initial guidelines for the maximum height of the air gap which was set down by experts in the block caving field when the mining initially commenced.

The Inquest was told by a number of witnesses that no matter what style of mining takes place there is always a danger of an air blast within a mine. That of course is true, however the size of the void is directly related to the size of the air blast. The air gap void in this instance was far bigger than any other void which may exist in other mines within Australia. It was up to 180 metres in height above the muckpile and contained approximately 4.1 million cubic metres of air.

The simple fact is that if the void had remained ten to fifteen metres or even slightly larger and had not increased to 180 metres, the air blast, if there was a sudden failure, would not have had such a catastrophic effect as it did on this occasion. That conclusion is inescapable.

I therefore find that the greater the air gap the more severe will be the consequences from air blast caused by sudden massive failure of the cave back.

I also find that the only reason that the air gap void was allowed to become as large as it was on the 24th November, 1999 was that North Parkes Mines maintained a production rate far greater than the rate at which the ore was falling from the cave back. It is quite clear that the production rate took precedence over factors which concerned the safety of those within the mine.

SIXTY METRE MUCKPILE

ADOPTION OF SIXTY METRE MUCKPILE ABOVE EXTRACTION LEVEL

On the 25th September, 1997 a meeting took place at North Parkes of the management of the mine. The minutes of that meeting contain, in part, the following:-

"DC presented table on interpreted air gap over next three months assuming no further caving.

	<u>Av.ore column</u>	<u>Av.air gap (m)</u>
	<u>Height (m)</u>	
End of October	84	23
End of November	78	29
End of December	72	35

DHL - original guideline during undercutting was height of air gap should not exceed 20% of caved height. However with completion of u/cut guideline is height of ore above draw-point rather than height of air gap." (See Exhibit 11)

From the above the following is of interest:-

1. 'DC' is the initials for Diamin Chen.
2. The forecast shows that as the average ore column decreases the average air gap increases.
3. 'DHL' is the initials for Dr. Laubscher.
4. That the original air gap was not to exceed 20% of the caved height.
5. That the guideline is, after the completion of the undercut, "the height of ore above the draw-point rather than height of air gap."

There is no clearer evidence of the abandonment of the maximum air gap safety factor than the above.

Four days after the meeting on the 25th September, 1997, Michael House, (one of the deceased), wrote to Dr. Laubscher in which, apart from other matters, the following appears:-

"I have also been asked to seek some technical backup for the height of broken ground guidelines you sent in a fax to Andre dated 4/9/97. We are putting in a 60m buffer - ie no draw-point to be drawn once the height of broken ground above it reduces to

60m. The average height at the moment is 88m, however by the end of December the average height will be only 72m and some draw-points would have reached the 60m and would therefore be closed (assuming the worst case of no more caving). The maximum height of the air gap would only be 35m. Is this a concern? We have closed off access to the 9830 level and have placed stockpiles along the west, Central and Eastern Drives."

In answer, Dr. Laubscher wrote:-

"HEIGHT OF CAVED ROCK OVER AD/P - My figure is based on an assessment that 30m is known to be too little and that we have never had problems with 70m. Also the relief will be on 9830 level." (See Exhibit 12)

From the above it can be assumed that the minimum of a sixty metre muckpile above the extraction level was adopted by the mine at the end of September beginning of October 1997.

Mr. Vink, who was Acting Manager Mining from August 1999, said in evidence that the concept of a maximum air gap applying to the cave was abandoned in September, October 1997 (Vink. T, 10th September, 2002, p.507.44).

I also note that at the time of the abandonment of the maximum air gap policy and the adoption of the "60 metre muckpile rule" the cave back had not intersected with One Level. One Level was not intersected by the cave back until approximately August 1998 almost twelve months later.

MINIMUM HEIGHT OF MUCKPILE

This minimum muckpile height was set as a result of air blasts which had occurred in other mines throughout the world. As pointed out by Dr. Laubscher:-

“30m is known to be too little and that we have never had problems with 70m.”

However, no details of air gaps as to height or volume which may have caused the air blasts that lead to the conclusion that 30 metres was too little and 70 metres was enough. Without such detail I can only rely upon the sworn evidence of the witnesses that have given evidence to this inquest.

When the event occurred on the 24th November, 1999 at North Parkes, evidence from all the witnesses, which were on or below the extraction level, clearly shows that there was a severe effect on those levels as a result of the air blast. People were thrown against cars, people were unable to stand up, dust filled the whole area, vibrations were of a frightening nature, pressure on the ear drums of people were so severe that they felt pain and it was fortunate that no person was injured.

It is not known if the sixty metre muckpile above the extraction level would have prevented injury on that level if the barrier in One Level had not been penetrated by the air blast.

As I mentioned earlier one doesn't know what was going through the mind of Dr. Laubscher when correspondence was going back and forth concerning a minimum height for the muckpile above the extraction level.

I have not come across any copies of correspondence between North Parkes Mines and Dr. Laubscher asking him whether the sixty metre muckpile above the extraction level was adequate in a situation where there was a 180 metre air gap between such muckpile and the cave back.

It is obvious that North Parkes was prepared to reduce production to ensure that the muckpile did not become less than sixty metres in height. One wonders as to why the size of the air void was not being taken into account in determining this muckpile height, and furthermore as to why follow-ups were not being done as to the adequacy of the bulkhead on One Level after it had been put in place.

I have heard evidence that the ability of the muckpile to resist an air blast will depend upon:

- (a) The volume of the air blast;
- (b) The nature of the muckpile itself.

Having heard the evidence I am far from satisfied that a figure of sixty metres of muckpile above an extraction level is all that is required to ensure the safety of personnel working on that extraction level from the effects of air blasts. Particularly air blasts of the type experienced at North Parkes Mine on the 24th November, 1999.

I therefore find that a minimum muckpile height of sixty metres above an extraction level is not per-se a guarantee of safety from the effects of air blast for personnel working on an extraction level.

CONTINUING OF DRILLING AND HYDRAULIC FRACTURING

Drilling, blasting and hydraulic fracturing was being performed in an attempt to destabilise the cave back. From the evidence presented in the Inquest it is quite clear that although success had been achieved by using these methods, it was indeed slow, labourious, and the rate of caving was no doubt a concern to the mine management and to the mine workers in general.

More than one of the witnesses who gave evidence at the Inquest indicated the excitement that was throughout the mine when caving had commenced, some days prior to the major event occurring on the 24th November, 1999. Witnesses indicated that as far as they were concerned this ensured some security for their employment in the near future.

It is clear that the excitement induced by the caving clearly overrode any concerns about dangers from such large collapses which caused the horrific air blast in this instance. This fact is self evident from the video tape taken by Mr. Spratt shortly before the collapse occurred. This was so even though the cave back had entered the gypsum leached zone of which it was known that:-

- (a) It was a weaker rock structure than the rock structures below it; and
- (b) The hydraulic radius required for it to cave naturally under gravitational influence was less than the hydraulic radius required for the caving of less weaker rock zones below it.

The fact that having a greater hydraulic radius below the gypsum leached zone than the hydraulic radius required for its gravitational induced caving to occur would, one would think, have alerted the mine to the possible danger of a collapse to the surface. However, from the evidence, it is clear that the possibility of a collapse of the cave back into the air gap void over such a short period of time, (approximately four minutes) was not seriously entertained by the mine personnel nor by the mine's consultants.

One need go no further than the evidence of Mr. Vink, Acting Manager Mining at the time, Mr. Van As, North Parkes Geotechnical Engineer and Mr. Jakubec, a representative of SRK which had undertaken a cavability and mining review for North Parkes Mine.

Mr. Vink said to the DMR investigators when asked:-

"Q59. Was there any discussion about the stability of the cave back immediately prior to the accident?

A. Yes, I guess in the sense that there was a lot of eager anticipation about reaching the gypsum leach(ed) zone. My understanding would be that everyone believed that there would be some sort of a continuous caving initiated and there was intense interest in the cave back wire frames over that last say week or two before the accident because I think that the muckpile, the cave back I produced in early November showed the highest stream was about 10,070 so everyone knew that was only about ten metres and there was a lot of anticipation about what would happen but."

Whilst Mr. Van As said:-

"We never believed that it would have the impact of a massive failure, not the gypsum leached zone and everything below the gypsum leached zone."

Mr. Jukubec was asked the following questions to which he gave the following answers:-

"Q. So with an air gap of 180 metres and widening the radius when you only required smaller radiuses above that, would that not simply cave all into the air gap right to the surface?

(a) Yes of course. That's what you're trying to do with the block caving operation.

Q. Then why is it that you say that you didn't think it would all cave quickly?

Mr. Rushton: I object.

The Witness: Because I didn't believe it.

Mr. Rushton: I withdraw the objection.

Counsel Assisting: Q. Because you didn't believe it?

A. That it would cave within four minutes as I mentioned.

Q. Well, it wasn't a monolithic event, was it?

A. No, I believe it wasn't.

Q. It was simply a reaction of the cave propagating very very quickly?

A. Yes, it did indeed propagate quickly. I was saying I wasn't expecting that speed of propagation." (T, 19th September, 805.30)

That the above was clearly the view of the majority of the North Parkes Mine personnel is borne out by an examination of the video taken by Mr. Spratt on One Level not long before the air blast. It is clear from that video that the concept of being in a dangerous position is not apparent.

However none of the above explains why the Pontil drillers were still continuing with the hydro fracturing program on One Level. The Spratt video shows caving taking place as it had been for some four to five days previously.

No reason has been given to the Inquest as to why the Pontil drillers were still required on One Level. The Pontil employees who were drilling on One Level on the shift before the incident took place; Boyd and Dodds, had left the area because they were concerned about their safety. Communication at the time had been made with the senior personnel of the North Parkes Mine, Messrs. Secis and Van As. Those drillers were informed that they should remain in a safe area until they felt confident that they could return to the site. The urgency of this information in one way or another seemed to have been lost in between the change of shifts. As I have said from the amount of ore which was falling in the previous four to five days one wonders as to why it was necessary to continue on with the drilling program on One Level.

It is clear from the evidence and the records that before the 7am shift commenced on the 24th November, 1999 the North Parkes Mine was aware that the cave back had just moved into the gypsum leached zone. North Parkes knew that once the cave back reached into that area that caving would be more rapid. Clearly there was no need to send the drillers in to continue the drilling and hydraulic fracturing on the shift in which the event occurred. It appears that no-one gave any thought to that matter.

Not only should it have been clear that it was not necessary at that point of time to continue with the drilling and fracturing but with the knowledge that the dogleg cuddy off the South Drive of One Level was undercut, which was a contributing factor, one would have thought, you would not want personnel to be in that area during that shift.

I find that no reason has been given to this Inquest as to why the deceased Pontil Drillers, Colin Lloyd-Jones and Stuart Osmond, were continuing to perform tasks on One Level up to and at the time of the air blast on the 24th November, 1999.

THE BULKHEAD ON ONE LEVEL

The purpose of the bulkhead on One Level was to prevent air blast and water entry into One Level. See the statement and evidence of L.M. Stevens, Mr. Vink (T, 11th September, 540.36) and correspondence from North Parkes Mine to the DMR.

According to Dr. Laubscher in his interview (p.59) he said of the strength and placement of such a bulkhead:-

"If you're putting a bulkhead in then obviously it has got to be strong enough in the first instance and certainly it's got to be out of the zone of influence of any subsidence, so that is actually a requirement."

Mr. Vink agreed with this statement (T, 10th September, 534.27 and T, 11th September, 551.32). Dr. Bartlett also agreed with this statement (T, 18th September, 743.37)

As I have said earlier, off the South Drive of One Level a dog-leg cuddy had been excavated towards the void. The following evidence regarding the dog-leg cuddy and the bulkhead is in my view important.

David John Scadding gave evidence of going into the dog-leg cuddy when it was taped off. He said he knew he should not have been there, but he shone a torch down the drill holes that were there. He said he estimated the cave was about two metres away from the floor he was standing on. He said that the area had been taped off about ten days before the collapse.

James Davidson said that he and Ron Secis took it upon themselves to tape off the dog-leg cuddy. He said he could see the end of the holes which were drilled into the floor, beyond that was the cave.

According to Jo-Anne Dudley, Mining Engineer, the dog-leg cuddy may or may not have been undercut, but was roped off just in case. However, from wire frame diagrams tendered to the inquest and from other evidence it is clear that the dog-leg cuddy had been undercut well before the collapse occurred.

Ms. Dudley indicated that she thought the bulkhead was for protection from air blast and water inflow from the pit above. She gave evidence of the bulkhead being 24.5 metres from the cave, two days before the collapse. The witness Natalie Sydenham was on One Level the day before the event and she looked through the bulkhead and estimated the cave to be fifteen metres away. I accept the figure put before the inquest by Jo-Anne Dudley; one must have some reservations about an estimate by Natalie Sydenham. However, if Ms. Sydenham is correct, the cave was retreating dangerously close to the bulkhead in a very short period of time. There appears to be no follow up as to the closeness of the cave to the bulkhead after Jo-Anne Dudley's reading two days prior to the event.

Ernest Boyd was a Pontil Driller who worked on One Level during the shift before the collapse. He said that 4.5 m of drive on the cave side of the bulkhead had been lost since his last shift.

The evidence before the inquest shows that the cave was very close to the bulkhead. If the bulkhead was not undercut, it is clear that it was within the zone of influence of any subsidence of the cave. No evidence of the bulkhead could be found by the investigators after the event, clearly it fell into the void as the collapse occurred.

As the adequacy of the strength of the bulkhead will never ultimately be known, it is clear the location of the bulkhead was within the zone of influence of any subsidence of the cave.

It has been said that the bulkhead played no part in the air blast that entered One Level. I accept that, however, the point is it should have. That is what its purpose was, to eliminate the risk of air blast to One Level. The reason that it played no part was that:-

- (a) The advancing cave had placed the bulkhead within the zone of influence of subsidence; and
- (b) The bulkheads usefulness as a guard against air blast to One Level had been negated by the undercutting and closeness of the cave to the dog-leg cuddy.

As such I find:-

- (a) That the bulkhead designed to safeguard against air blast on One Level played no part in the air blast that occurred on One Level on the 24th November, 1999;
- (b) That the usefulness of the bulkhead as a safeguard against air blast on One Level was negated by:-
 - (i) Allowing the bulkhead to come into the zone of influence of subsidence of the cave; and
 - (ii) Allowing the dog-leg cuddy to also come into the zone of influence of subsidence of the cave.
- (c) That North Parkes Mine should have been aware that the position of the bulkhead as a safeguard against air blast on One Level had been compromised and no longer served that purpose before the 24th November, 1999.

GENERAL COMMENTS

Before concluding my reasons for my findings, I should say that during the inquest certain matters have arisen which I feel I should comment upon lest my silence be construed as a tacit approval.

Those matters are as follows.

LACK OF COMMUNICATION ON ONE LEVEL

It is also of concern that the communication to any personnel who were on One Level, was difficult and in some parts, notably the South Drive, non-existent. It appears that in some instances communication could have been made to a vehicle which was on One Level, but this was not always possible. Even if it were possible it is certainly an inadequate form of communication, having regard to the fact that the noise from the machinery would generally drown out any indication that someone was trying to communicate with the workers via their motor vehicle, nor was I impressed with the evidence of a visual signal from the vehicle to alert the personnel that someone was trying to communicate with them. They may not have been looking.

There was evidence that attempts were made to rectify the communication difficulties with that particular area. The efforts to rectify the problems were to no avail.

It is mere speculation to say that good communication with the South Drive on One Level on this particular occasion may have prevented the tragedy, which occurred to these four people. However one would expect in this modern age that it is completely unacceptable to have personnel working in an isolated area, which is inherently dangerous, without adequate communication with them being available.

ADEQUACY OF MONITORING OF CAVE

During the Inquest there was a lot of debate as to whether or not the monitoring of the cave and alarm systems on One Level were appropriate or adequate in all the circumstances.

The alarm systems that were in place on One Level, in particular the South Drive, was a system which was a crude manual system. The system was such that if rock fell away from the area in which the alarm was located, the alarm would go off, and those on One Level would be aware of this. However, from the evidence, those in SCADA control would not be aware that alarms were going off on One Level, they would have to be told.

It would appear that these simple alarms would be effective in relation to minor incidents of rock falling away from the side. However, one does not know as to the extent of the warning, if any, that was given to the Pontil drillers on One Level when this catastrophic collapse occurred.

Insofar as the electronic monitoring systems that were initially installed in the E26 Mine, it appears that there is a variety of opinions as to whether or not, if they were in place on this day, they would have been of any assistance to those in the area.

Although the more sophisticated seismic monitoring system was installed initially in the E26 Mine, it appears that it was taken away due to two factors:-

- (a) The belief by some people as to the system being non effective; and
- (b) The cost in maintaining such monitoring system within the cave area.

Notwithstanding the varying opinions as to the value of the seismic system and any other monitoring systems of the monitoring of the cave that was in place at the time of this disaster and its usefulness to North Parkes Mine personnel, Dr. Fuller has said in his report:-

“Overall coverage of cave monitoring was initially adequate, particularly with the limited access available with such a high cave block. However, with a reduction in geotechnical staff and a perceived general loss of confidence by management in some of the monitoring systems meant that the operation was forced to rely on what I regard as base level monitoring of the cave. With only a partially formed cave and no control over caving location that would usually occur with a filled void and an appropriate draw strategy, this level of cave back monitoring can only be regarded as providing barely adequate feedback to mine management about cave back location and cave back shape.”

Nothing that I have seen or heard in this Inquest would make me do other than accept the above statement without qualifications.

I therefore find that the level of cave monitoring performed by North Parkes Mines of its E26 Mine provided barely adequate feedback to mine management about cave back location or cave back shape.

ROLL OF MINES INSPECTOR AND THE DEPARTMENT OF MINERAL RESOURCES

It was on the 31st August, 1998 that the cave back had intersected One Level. On the 29th September, 1998 Mr. L.M. Stevens, a Mine Inspector from the Department of Mineral Resources, contacted the North Parkes Mine management regarding the potential of an air blast on One Level.

It would appear that Mr. Stevens was undertaking a major risk hazard survey in relation to North Parkes Mine and was concerned about the risk of an air blast from the void between the muckpile and the cave back and into One Level which at that time was simply open to that void. What occurred following Mr. Stevens' inquiry was the design and construction of a bulkhead on One Level by North Parkes Mine.

Mr. Stevens indicated that he left the specifications in the hands of the North Parkes Mine. He indicated in Court that North Parkes Mine had a very good safety record and consequently he relied upon the company's expertise and the trust that he placed in them to construct a bulkhead of a satisfactory standard that would withstand an air blast. Furthermore he indicated that he did not have access to experts who may be able to check the standard proposed by North Parkes Mine nor did he have that expertise himself.

Mr. Stevens indicated that his only follow-up after that was an indication by North Parkes as to when the bulkhead would be put in place. He told the Inquest that with the large number of mines that were within his jurisdiction coupled with the limited resources both in personnel and time, he found it necessary to rely upon the mining company to "do the right thing". Mr. Stevens also relied upon North Parkes to place the bulkhead in the appropriate position on One Level.

When Dr. Laubscher was interviewed he indicated that a bulkhead must be adequate and must be placed out of the zone of influence of any subsidence.

He said, at p.59 of his statement:-

"If you're putting a bulkhead in then obviously it has got to be strong enough in the first instance and certainly it's got to be out of the zone of influence of any subsidence, so that is actually a requirement."

There is no doubt the purpose of the bulkhead at One Level was to alleviate the risk of air blast and water flow (Vink T, 11th September, 540.36).

From the evidence before the Inquest the door which was attached to the bulkhead was generally open; this would certainly reduce the effectiveness of the barrier against any air blast which may occur. Furthermore it is quite clear from the evidence before the Inquest that portion of the drive on One Level upon which the bulkhead was constructed, collapsed into the void during the catastrophic event.

It is evident that neither personnel from North Parkes Mine, nor the Mines Inspector from the Department of Mineral Resources, had any regard to the position of the bulkhead as time went by. One Level was being eroded back towards the bulkhead during the time between the bulkhead's installation and the 24th November, 1999. Some time before the event, the dogleg cuddy on the South Drive had been undercut and there is evidence to suggest that One Level had been undercut back towards the bulkhead's position. Examination of the "wire frame" drawings compiled by the North Parkes personnel prior to the 24th November, 1999 clearly showed that the position of the bulkhead was no longer "out of the zone of influence of any subsidence".

Some time before the catastrophic event the dogleg cuddy had been roped off, prohibiting people from entering and furthermore the area immediately in front of the bulkhead had been roped off. The roping off of these areas could only have been done because of the potentiality of danger to any personnel entering that area. There is no suggestion that North Parkes Mine was in the throes of making arrangements for constructing another bulkhead on One Level which was located away from the influence of the subsidence. This makes it apparent that no one was giving a great deal of thought as to the possibility of the problems which and in fact did occur with the large collapse of the ore body.

COMMUNICATIONS BETWEEN WORKFORCE AND MANAGEMENT

It was clear early in the Inquest that very few of those working within North Parkes Mine were aware of what an air blast was. Very few working within the mine were aware of what could happen if an air blast occurred. It would appear that there had been scant or indeed no information given to the workforce concerning the dangers from air blast.

During the shift prior to the catastrophic event occurring, the workers employed by Pontil, who were engaged in the drill and hydro fracturing in the South Drive of One Level, had left their work post due to their concerns that they may have been in some type of danger. Those concerns were relayed to senior personnel of North Parkes. The drillers were informed that they should not return to the workplace until they felt it was safe to do so.

One wonders as to the communication between the management and the workforce when the next change of shift took place. Some of the following shift gave evidence of hearing "something about the Pontil drillers leaving their post the night before", others indicating to the Inquest that they heard nothing about what had occurred on the previous shift.

Mr. Con Murphy, the North Parkes Production Team Leader, was on duty the shift before the event took place. The concerns of the Pontil drillers on One Level were expressed to Mr. Murphy and he in turn passed those concerns on to the leaders at the shift change. It would appear however that the concerns of Mr. Murphy were not regarded by those who received them as being of a serious nature.

Robert Wayne Cunningham, at the time was Production Superintendent at the mine. At the shift changeover, Mr. Cunningham was aware of the passing over of information that the Pontil Drillers had come off One Level on the previous shift because of cave propagation noises. The following exchange took place in Court:-

“Q. Well what inquiries did you make about the drillers leaving One Level?

A. Not a great deal - that was that the noises were there, that the cave was propagating, and basically that the cave was behaving and caving as it should.

Q. Well didn't this unusual event inspire you to take the matter further, to find out what it was?

A. I did report it further, yes.

Q. What did you do?

A. As part of the flow-on from the shift change I gather information which I report to the Managers' meeting and production meeting, which is the 8 o'clock meeting, by a telephone hook-up to the surface."

And a few questions later:-

"Q. You didn't tell them about the drillers leaving One Level?

A. No I didn't pass that on.

Q. Why not?

A. Probably was more concerned about letting them know that the caving event was a higher priority, the duration of the caving event."

And later:-

"Q. You didn't tell them that the drillers had come off One Level?

A. I didn't tell them the drillers had come off and reported the noises, no.

Q. Why didn't you report that?

A. As I said I - the duration of the caving from 8.30 through till 1 o'clock was the important factor."

The importance of the drillers coming off the job was lost between Mr. Murphy and Mr. Cunningham, Mr. Cunningham said that he did not ask Murphy why the drillers had come off the job and it appears Cunningham assumed they simply were reporting caving noises. There is no doubt that the Production Superintendent had in mind the fact that the cave back was falling and production would increase. He appeared to be oblivious to the fact that there may be danger.

LOCATION OF WATER ABOVE MINE SITE

Adjacent to the ore body on the surface was constructed a dam which had contained a large amount of water. In addition, there was apparently some water in the open cut pit above the ore body, this being catchment of run-off water from the rain.

The concern of workers about the water in the open cut was expressed by Mr. Murphy in his evidence of 12th June, 2002. At page 464 of the transcript, in answering questions he states:-

“... we had a few discussions, one of the questions raised is “how much dirt is going to fall, could it cave through to the surface”, there was concerns raised about the amount of water that was in the open pit at that time and I know Ernie was quite concerned about the whole situation, if it did fall.”

Evidence of various witnesses during the inquest was that there was a large amount of water flowing down the drive. Indeed one witness made a statement that he was driving in his vehicle and came across a wall of water some two feet high.

My conclusions on hearing all the evidence was that the water which was flowing down the mine came principally from a broken water pipe which was subsequently turned off. If some had come from the open cut pit, it was certainly of a quantity which was insufficient to put lives at risk.

Although the dam which was constructed on the surface adjacent to the ore body was in fact breached at some point of time, it occurred some days after the event. The obvious concern was that due to its close proximity to the ore body, there was a possibility that the dam could have been breached at the time when the cave back broke through to the surface. If that had occurred, the only place for the water to run would have been the extraction level. This almost certainly would have resulted in more fatalities.

It is fortunate that the dam was not breached during the catastrophic event, nor was the water in the open cut sufficient to cause any difficulties.

The reason I refer to this is that the mining industry ought to be alert to the potential of danger in the placement of dams containing water or other liquids and to the location of water catchment areas.

JOHN BAILEY

Coroner

18th March, 2003