WARDENS INQUIRY

Conducted pursuant to Section 74
of "*The Coal Mining Act 1925*"

REPORT ON AN ACCIDENT
at
MOURA NO 2 UNDERGROUND MINE
on
SUNDAY, 7 AUGUST 1994

Before:

MR F W WINDRIDGE,	Warden and Coroner

Assisted by:

MR R J PARKIN,	General Manager, Capricorn Coal Management Pty Ltd
MR P J NEILSON,	Construction, Forestry, Mining & Energy Union District Secretary, United Mine Workers Division
PROF F F ROXBOROUGH,	Professor of Mining Engineering, School of Mines, The University of New South Wales
MR C W ELLICOTT,	Training and Development Officer, Department of Mineral Resources, New South Wales

APPEARANCES

COUNSEL ASSISTING THE INQUIRY

MR F J CLAIR
(instructed by Mr R Boiston of Crown Solicitor's Office, Brisbane)

COUNSEL REPRESENTING THE DEPARTMENT OF MINERALS & ENERGY

MR A J MacSPORRAN (instructed by Mr R Abraham and Mr R Hutchings of Crown Solicitor's Office, Brisbane)

Assisted by:

Inspectorate

Mr B J Lyne	Chief Inspector Of Coal Mines
Mr M P Walker	Senior Inspector Of Coal Mines Rockhampton
Mr G R Bancroft	Senior Inspector Of Coal Mines Brisbane
Mr A E Mcmaster	Electrical Inspector Rockhampton (Day 1 To Day 13)

Simtars

Dr P J Golledge	Manager Research and Technical Services
Mr D Humphreys	Principal Engineer (Mining Research)

COUNSEL REPRESENTING UNITED MINE WORKERS UNION and NEXT OF KIN

MR W A MARTIN
(instructed by Messrs R H Brittan & Associates) for the next of kin of the deceased, the Executive of the Communications and Electrical Plumbing Union and the Executive of the United Mine Workers Union

Assisted by:

Mr W Allison	District Check Inspector
Mr G Dalliston	District Check Inspector
Mr D W Mitchell	Mining Consultant (USA)

COUNSEL REPRESENTING BHP AUSTRALIA COAL

MR P H MORRISON QC,
with him MR P J RONEY
(instructed by Messrs Feez Ruthning) for BHP Mitsui Pty Ltd, BHP Australia Coal Pty Ltd, George Mason, Albert Schaus, Joseph Barraclough and Jacques Abrahamse

Assisted by:

Mr A H Schaus	Moura No 2 Superintendent (Registered Mine Manager)
Mr G A Mason	Moura No 2 Undermanager in Charge

Moura and BHP Management personnel

COUNSEL REPRESENTING AUSTRALIAN COLLIERIES STAFF ASSOCIATION

MR B A HARRISON
(instructed by Messrs John Taylor & Co) for the Australian Collieries Staff Association

Assisted by:

Mr V G Bowden	Queensland State Secretary A.C.S.A.
Mr S Brown	Central Councillor A.C.S.A.

FOREWORD

DURING the past twenty years there have been three mining disasters in the Moura district at a cost of 36 lives.

The first occurred at Kianga Mine on 20 September 1975. Thirteen miners died from an explosion which was found to have been initiated by spontaneous combustion. The mine was sealed and the bodies of the men were never recovered.

The second occurred on 16 July 1986 at Moura No 4 Mine when twelve miners died from an explosion thought to have been initiated by one of two possible sources, namely frictional ignition or a flame safety lamp. The bodies of the miners, in this case, were recovered.

The third of the disasters, which is the subject of this report, occurred on 7 August 1994 at Moura No 2 Mine. On this occasion eleven miners died as a result of an explosion. The mine was sealed and, at this time, the bodies have not been recovered.

Given this tragic history, it was inevitable that the Inquiry into this third disaster would be the focus of considerable public attention and concern. Whereas it would be incorrect to say, as a consequence, that this Inquiry has been more thorough or exhaustive than the previous two, or for that matter any other mining Inquiry, it is the case that it has been required to examine and consider a very large body of evidence and to hear and consider the testimony of a very large number of witnesses. The Inquiry acknowledges that it has not been able to be totally thorough from an investigative point of view since it has not been possible to re-enter the mine. However, it would be correct to say that the Inquiry has placed the operations, the management and the events leading to the explosion at Moura No 2 Mine under the closest possible scrutiny.

The Inquiry wishes to express and place on record its sincere condolences to the families and friends of the men who died as a result of the Moura No 2 explosion. It wishes further, to extend its sympathy to the Moura community for the many lives it has lost to coal mining over the years.

SUMMARY

AT about 2335 hours on Sunday 7 August 1994, an explosion occurred in the Moura No 2 underground coal mine.

There were twenty-one persons working underground at the time. Ten men from the Northern area of the mine escaped within thirty minutes of the explosion but eleven from the Southern area failed to return to the surface.

Those who failed to return comprised a crew of eight who were working in the 5 South section of the mine undertaking first workings for pillar development, and three others, a beltman and a sealing contractor with an assisting miner who were also deployed in the Southern side of the mine.

A second and more violent explosion occurred at 1220 hours on Tuesday 9 August 1994. Rescue and recovery attempts were thereafter abandoned and the mine sealed at the surface.

Pursuant to Section 74 of the Coal Mining Act 1925 an Inquiry was held before the Mining Warden and a panel of four other persons.

The Inquiry found that the first explosion originated in the 512 Panel of the mine and resulted from a failure to recognise, and effectively treat, a heating of coal in that panel. This, in turn, ignited methane gas which had accumulated within the panel after it was sealed. The Inquiry did not reach a finding regarding the cause of the second explosion.

While the Inquiry found that the eleven persons who failed to return to the surface died in the mine as a direct or indirect result of the first explosion no definite finding could be made regarding the precise cause of death of any of the victims.

The Inquiry made a number of firm recommendations aimed at preventing the occurrence of a similar accident. The Inquiry also identified a number of areas where there is a need for investigation and improvement to assist in securing the safety of those employed in the coal mining industry.

The Inquiry made recommendations in relation to the following:

Spontaneous Combustion Management;
Mine Safety Management Plans;
Training and Communications;
Statutory Certificates;
Ventilation Officer;
Self-Rescue Breathing Apparatus;
Emergency Escape Facilities;
Gas Monitoring System Protocols;
Sealing - Designs and Procedures;

Withdrawal of Persons;
Inertisation;
Research Into Spontaneous Combustion;
Panel Design;
Mine Surface Facilities;
Literature and Other Training Support; and
Future Inquiries.

In addition, the Inquiry has made comment on a number of other issues.

INTRODUCTION

Pursuant to Section 74 of the Coal Mining Act 1925, an Inquiry into the nature and cause of the accident was convened at Gladstone before the Mining Warden and four persons having practical knowledge and skills in the mining industry who were not connected with the coal mine where the accident occurred. Those persons, in order on the bench, were:

MR R J PARKIN	General Manager, Capricorn Coal Management Pty Ltd.
MR P J NEILSON	District Secretary, United Mine Workers Union.
PROFESSOR F F ROXBOROUGH	Professor of Mining Engineering School of Mines, The University of New South Wales.
MR C W ELLICOTT	Training and Development Officer, Department of Mineral Resources, New South Wales.

The Inquiry opened on 18 October 1994 and final submissions were heard on 6 April 1995. In conjunction with the Mining Inquiry, a Coronial Inquiry was conducted by the Mining Warden in his capacity as Coroner.

In all sixty-six (66) witnesses, who are listed in Appendix B, were examined and a total of three hundred (300) exhibits were tendered. These exhibits are described in Appendix C. The transcript of evidence heard at the Inquiry comprises some 5200 pages.

This report presents the findings of the Inquiry as to the nature and cause of events at the Moura No 2 mine together with background information on the mine, discussion of issues and events from the evidence to the Inquiry, and recommendations of the Inquiry intended to prevent the occurrence of a similar accident.

The Inquiry has elected to not group all its concluding remarks but has instead retained some within part of the report.

That part of the report, which covers events and issues, is presented as a combined narrative of more significant events at Moura No 2 and sections dealing with important issues identified by the Inquiry. Many of those sections have summary, concluding remarks toward the beginning or end of them presented in bold italics.

MINE OWNERSHIP, MANAGEMENT AND OTHERS

OWNERSHIP

All coal mining operations in the Moura area are owned by BHP Mitsui Coal Pty Ltd and operated by BHP Australia Coal Pty Ltd. Mining is conducted over a number of leases with the Moura No 2 underground mine being located on Mining Leases 5597, 5606, 5600, 5591, 5598 and 5644.

MANAGEMENT

Management and technical positions of Moura No 2 Underground Mine leading up to the accident were as follows (see also Appendix D):

R W Regan	Moura Mine Manager.
A H Schaus	Underground Superintendent and Registered Mine Manager.
G A Mason	Undermanager in Charge.
E G Long	Mechanical Engineer.
D J Evans	Mine Electrician.
J F Abrahamse	Mining Engineer.
P J Reed	Quality Superintendent
J Barraclough	Safety/Training Undermanager
M A MacCamley	Shift Undermanager
T J Atkinson	Shift Undermanager.
M A Squires	Shift Undermanager.
D Sim	Shift Undermanager
A G Morieson	Ventilation and Fire Officer.

OTHER PERSONS

Mines Inspectors

B J Lyne	Chief Inspector of Coal Mines Brisbane.
M J Walker	Senior Inspector of Coal Mines Rockhampton.
A McMaster	Electrical Inspector Rockhampton.
M Bell	Mechanical Inspector Brisbane.

District Union Inspectors

W Allison	District Check Inspector Brisbane.
G Dalliston	District Check Inspector Brisbane.
M T Best	District Check Inspector Brisbane.

Local Lodge executive members:

M R Caddell	(President)
T Dittman	(Secretary)

G R Zeibell	(Treasurer)

Mines Rescue Station

D C Kerr	Superintendent

IDENTITY OF VICTIMS

NAME	POSITION	SUSPECTED LOCATION
John Robert Dullahide	Beltman	5 South conveyors
Terry Gordon Vivian	Miner	At either 512 section seals or 4 South Level preparation seals or travelling in between
Robert Parker	Contractor	At either 512 section seals or 4 South Level preparation seals or travelling in between
Darrell William Hogarth	Miner	5 South face area
David Brian King	Miner	5 South face area
Mark Reginald Nelson	Miner	5 South face area
Christopher Robert Ritchie	Miner	5 South face area
Michael Edward Ryan	Miner	5 South face area
Michael Edward Shaw	Miner	5 South face area
Robert Allan Newton	Deputy	5 South face area
Geoffrey Mazzer	Electrician	5 South face area

BACKGROUND

MINE LOCATION AND HISTORY

Moura No 2 mine is on the eastern side of the Bowen Basin in the state of Queensland 7 km to the east of the town of Moura, a coal mining centre, located about 450 km north west of Brisbane. Figure 1 shows a map of the region.

The history of coal mining in the Moura area extends over about 35 years, involving both underground and open-cut operations. All mines are situated east of Moura and there is a fully equipped and operational mines rescue station in the town.

Moura No 2 mine started in 1970 and operated continuously thereafter up until the explosion. During the five years prior to the explosion it employed around 170 persons and annual output varied between 550,000 and 650,000 tonnes of raw coal, which came from two continuous miner production units. Over the same period the safety performance of the mine, measured on the basis of lost time injury frequency rate (LTIFR), had improved from 153 in 1989/90 to 71 in 1993/94.

It is significant to note that two other mines in the Moura area have been the subject of major explosions in relatively recent times. In 1975 an explosion at Kianga mine cost 13 lives and in 1986 Moura No 4 mine (which is immediately adjacent to Moura No 2) exploded killing 12 men.

GEOLOGY

The stratigraphic section in Figure 2 shows the sequence and typical thicknesses of the coal measures at Moura No 2 from the surface down to just below the D seam, which was the only seam being mined at Moura No 2. This particular section is above the vicinity of 512 Panel at the mine and is, thereby, indicative of the depths of the seams at that location only. The strata dips to the west at an average of about seven degrees to the horizontal and so the depths of the seams vary quite markedly across the mine. There are six main seams in the sequence comprising medium to high volatile, low ash, bituminous coking and steaming coals. These seams variously merge, split and thin out in different parts of the lease area.

As mentioned previously, Moura No 2 mined only the D seam, which is typically 4.5 metres thick, albeit extending to 5 metres in places. Its depth below the surface varies throughout the mine to something over 265 metres. Seam C , which is about 40 metres above the D seam, has been mined previously from the No 4 mine using the bord and pillar method. These workings were discontinued following the explosion at Moura No 4 in 1986. Seams A and B, which are reported to remain in place, also lie above D seam at vertical distances of approximately 125 and 100 metres respectively.

The D seam comprises fairly soft, well cleated coal. It is a gassy seam containing up to 15 cubic metres per tonne of 98 per-cent methane gas. There is no history of gas outbursts, with the seam being

sufficiently permeable to enable effective methane drainage without the application of vacuum. The coal is known to be liable to spontaneous combustion. Its proximate analysis has been reported as

Moisture	2 %
Ash	23%
Volatile Matter	22.2%
Fixed Carbon	52.7%

The seam has some minor faulting within the mine area but nothing of a major nature and is free from intrusion by dykes or sills. It is not considered to be a particularly wet seam and in some areas was deemed to be quite dusty, especially where the seam had been pre-drained of methane gas. The immediate seam roof and strata through to C seam consists mainly of competent beds of massive sandstones. The floor strata comprise sandstones and competent shales.

WORKING METHOD AT MOURA No 2

Since the Moura No 2 Mine started operations in 1970, mining of the D seam had been by a series of bord and pillar panels using continuous miners and shuttle cars. A total of 28 panels had been worked at the mine prior to 512 Panel. All panels were not of the same design. They varied in the amount of the total seam thickness extracted, in the overall panel dimensions, in the size of pillars used, in the method of strata control, in the percentage area of coal extracted and in the method of ventilation. In the latter context it became necessary, as the depth of working increased, to pre-drain methane gas from the seam by multiple in-seam boreholes prior to panel development.

In general, panels were developed by forming solid coal pillars on the advance, which was the first phase of the coal extraction process ('first workings'). Once fully developed, the second phase of the operation designs, including that of 512 Panel, were for the goaf to remain open and be supported by leaving selected pillars either totally or partially in place. It was believed that an open and ventilated goaf would mitigate the risk of spontaneous was to extract the pillars while retreating from the panel ('second workings'). On completing the extraction, the panel was abandoned and isolated from the rest of the mine by the erection of brick and cement rendered seals across all entries to the panel. These seals were erected at pre-determined locations and the foundations for them ('prep-seals') were constructed while the panel was being worked, to facilitate the speed of final sealing when necessary.

Prior to 1986 or thereabouts, panels had been designed for the goaf to collapse during the pillar extraction phase but more recent combustion.

Panel design had been evolving over several years with the objectives of improving productivity, improving coal recovery by mining to the full seam height and seeking to inhibit spontaneous combustion by ventilating an open goaf.

512 PANEL DESIGN

The design of 512 Panel was subject to several constraints. Its width was governed by the distance from 511 Panel to the 5 South development headings, and its length was determined by the extent of the methane drainage boreholes. It was the expectation of management that, with this size of panel, extraction would be completed in three to four months after development, and so well within the presumed six month minimum incubation period of the D seam coal. The panel was designed to achieve, and did achieve, the highest rate of production of any previous panel at Moura No 2 mine.

The significant geometrical features of the panel are seen in Figure 3. Its overall dimensions were approximately 440m long from the entries to the back rib and 170m wide rib to rib. It was driven, using 5 headings, parallel to and on the south side of the previously extracted 511 Panel and was separated from it by a mandatory 45m wide barrier pillar. A 37m wide pillar on the opposite side separated 512 Panel from 5 South.

The No 1 heading of 512 Panel, adjacent to 5 South, was at the highest elevation in the panel and was the main return airway. Headings 2, 3 and 4 were intake airways and No 5 heading was used as an alternate main return with No 1 heading during panel development and as an occasional bleeder return during pillar extraction. Prep-seals were erected in each of the 5 entries to the panel between the first (No 1) cross-cut and the south return of 510 Panel. The seam thickness in 512 Panel was 4.5m and its depth below the surface varied from 205m at the top entry to 265m at the diagonally opposite south-west corner. The seam, which in this area dipped to the west at 8 to 9 degrees, was separated from the C seam above by 40m thickness of predominantly massive sandstones. Seam level at the far end of the panel was approximately 45m below that of the

The area of coal to be extracted by 512 Panel had been pre-drained of methane over a period of 25 months by the pattern of boreholes shown in Figure 3. This had reduced the seam methane content from its original value of around 15m3 per tonne to about 1m3 per tonne. The area of solid coal to the south-west of the panel, which was to be mined at some time in the future, was being actively drained at the time of the explosion and approximately 5,500 cubic metres of methane per day was being extracted. The only other active methane drainage at the time of the explosion was in the 510 Panel development where an estimated entries. Correspondingly the No 5 heading (bottom return) was about 15m below the No 1 heading (top return).

An essential design feature of 512 Panel was that the goaf should remain open and be ventilated throughout the operating life of the panel. This involved keeping 13 cross-cut and the top return open for the purposes of ventilation and waste inspection. Strata control, with the need for regional stability, was therefore a dominant consideration and consultants from the Australian Coal Industry Research Laboratories Ltd. (ACIRL) were contracted to advise on a suitable panel design. The design which was finally adopted divided the panel into three compartments of roughly equal size, separated by two rows of large compartment pillars disposed across the panel. The size of the compartment pillars varied slightly, but they were, by and large, square and of typically 38-40m side length. It should be noted, however, that the compartment pillars lying immediately adjacent to the top return were split by

the line of the No 2 heading. The pillars formed within the compartments were all square with a side length of 23m. These were arranged in equally spaced rows across the panel.

This arrangement of pillars meant that No 4 heading had to be divided into two parallel sub-headings, so that there were in effect six headings within the compartments. All other headings, Nos 1, 2, 3 and 5 were straight. When fully developed the panel had a total of 13 cross-cuts which were numbered sequentially from the panel entry.45,000 cubic metres per day was being extracted. The in-seam boreholes used to drain the 512 Panel coal were sealed off after completion of the drainage process.

The development phase of 512 Panel started in November 1993 and comprised 7.5m wide headings and cross-cuts to form the layout of pillars described. These first workings were limited in height to the top 3m of the seam with the intention to mine to the full seam height during pillar extraction. The coal was mined using a Joy 12CM continuous miner with shuttle cars wheeling to a belt conveyor in No 3 heading.

Roof support during development comprised a 1.5m square pattern of 1.83m long chemically anchored roof bolts with butterfly plates. Coal ribs were supported by 1.8m long bolts spaced 3m apart along the pillar side just above mid-height and angled up into the roof strata. Additional rib support was provided at intersections.

The extraction phase of the operation, which started on 29 April 1994, involved rib-stripping alternate rows of those pillars within the compartment areas to leave narrow L-shaped stooks between adjacent rows of intact pillars. This was, in effect, a 'take a row leave a row' method of panel extraction.

The extraction phase also involved the systematic mining of the approximately 1.5m thickness of bottom coal by ramping down in the exposed coal floor to the base of the seam with the continuous miner. When cutting bottom coal the continuous miner was operated remotely to avoid persons being exposed to the hazard of the resulting high ribs.

Although bottom coal had been taken in 511 Panel and in 401/402 Panel by ramping down with the continuous miner, the method used in 512 Panel was different. Rather than ramping down to floor level and then extending longitudinally, in 512 Panel bottom coal was taken by a succession of repetitive ramps such that the operator was always outside the ramp area and thus not exposed to high ribs. This led to a coal canch at the start of the ramp area followed by a sequence of large serrations of solid coal across the width of the final floor. It was planned to take bottom coal throughout the panel except along cross-cut 13 and along the top return. The extent of bottom coal extraction is indicated by the cross-hatching in Figure 3.

No additional supports were required to be set during the extraction phase. There was a requirement to spread up to 300 kg of stone dust into the extracted area each shift while mining. After extraction, there were exposed roof spans of up to 25m, or thereabouts, with the potential
for localised falls of ground in the goaf exacerbated by some geological faults and areas of flaky roof.

The final sealing of 512 Panel, which was done on 6 into 7 August, used Tecrete seals, a type not previously used for that purpose at Moura No 2. The Tecrete seal is characterised by the erection of a wall of wire mesh baskets into which a proprietary type of plaster is poured. The plaster hardens and strengthens with time to eventually provide a final seal which is said to meet statutory requirements.

The final sealing is performed at a prepared site where an outer framework for the seal has been previously constructed ('prep-seal'). This outer framework, to which the final seal is built, is constructed of similar wire baskets and plaster and is recessed into the roof, floor and sides. It is also reinforced and anchored to the roof and sides using strata bolts.

In concluding this description, it is important to note that the design of 512 Panel incorporated several features not previously used at Moura No 2. These were:

- the division of the panel into compartments, separated by large compartment pillars,
- the use of short successive ramps with a remotely operated continuous miner to extract bottom coal, and
- the use of Tecrete seals for the final sealing of a panel.

VENTILATION OF THE MINE

Air entered the mine through the four portals driven into the seam at the highwall access which became the Main Dips headings. One of these intakes directed air to wipe seals in the abandoned southern district which thereafter returned directly to the upcast shaft.
Ventilation for the mine was provided by two parallel centrifugal exhaust fans located at the top of a 158m deep vertical upcast shaft. The shaft was located to the northside of the main North West dips roadways about 1300m inbye from the main portals. The fans, which were electrically driven, were connected to the shaft by steel ducting which was fitted with two explosion pressure relief panels. A backup diesel powered alternator was installed to provide sufficient power for one of the two fans to continue operating in the event of a power supply failure. This alternator was designed to start automatically and did so after the first explosion. Operational alarms and ventilation pressure monitoring at the main fans were relayed back to the mine office monitoring station.

Correspondingly a ventilation split approximately 400m inbye of the portals directed some air to wipe seals of abandoned north panels and this air also returned directly to the upcast shaft. From the Main Dips, there were main ventilation splits to direct and return air separately to the 4 South and 5 South districts, with this air being further subdivided to ventilate each working area independently. There was a two entry connection between the main intakes of 4 South and 5 South outbye of the working areas which had been driven to facilitate materials transport. The remaining air, inbye of the 5 South main intake, continued along the Main Dips to the furthest inbye working of 1 North West and returned to the upcast shaft by a single return on the north side.

In 1992, at management's request, a detailed analysis of the ventilation system at Moura No 2 was undertaken by International Mining Consultants Pty Ltd. This was instigated because of high

ventilation resistances in the mine leading to problems in achieving the required quantities of air. The main fan installation was delivering approximately 225 m3/s of air at a pressure of about 1.5 kPa which was at a point on the fan performance curve significantly lower than considered normal. The problem was to be resolved by erecting an additional overcast near the bottom of the upcast shaft and in parallel to an existing overcast that was seen to be the main cause of the high resistance. The second overcast was commissioned in February 1994.

VENTILATION OF 512 PANEL

The ventilation to both 510 and 512 Panels came via the 510 Panel entries off the main 5 South intakes. Panel 512 was ventilated as a split from 510 Panel and from which point both panels were ventilated in parallel. The planned minimum quantity of air to ventilate 512 Panel was specified, in the mine managers Part 60 submission, as 30m3/s. This corresponded to an estimated methane concentration of 0.3 percent in the main body of the panels return airways.

The air entered the panel via headings 2, 3 and 4 and exited through headings 1 and 5, which were otherwise described as the 'top return' and 'bottom return' respectively. The quantity of air flowing through the panel was controlled by two regulators, one of which was in the south return of 510 Panel and located just outbye of 512 Panel. The other was located in the bottom return of 512 Panel just inbye of the south return of 510 Panel.

During the development phase of 512 Panel, the top and bottom returns were used alternately as the main return for the panel, according to the location of the working place at the time. When pillars were being developed on the lower or northern side to the panel, the bottom return was deployed as the main return. Conversely when developing the upper or southern side of the panel, the top return was made the main return.

During the extraction phase, the top return became the main return for the panel, with the bottom return being used for only part of the time. The intention was that as much as possible of the air entering the panel should be made to pass through the goaf before leaving the panel. When, however, the bottom return was being rib-stripped and on those occasions when bottom coal was being mined up-dip from the bottom return, it was deemed necessary to open the regulator in the bottom return to cause adequate ventilation to pass over the continuous miner. At all other times the intention was that the bottom return regulator should be shut.

The quantity of air flowing in 512 Panel during pillar extraction was nominally 45m3/s, but the actual amount varied between 35 and 55m3/s according to changing circumstances both in 512 Panel and elsewhere in the mine. After entering the panel along the intake headings, the air was directed to the working face, across the continuous miner and thence into the goaf using brattice ventilation. The amount of air allowed to leak through the brattice line and directly into the goaf was controlled by the 'tightness' of the brattice.

The distribution of air in the goaf was controlled by regulators erected across headings 2, 3, 4 and 5 between 12 and 13 cross-cuts. In addition, stoppings were erected in each of the cross-cuts 1 to 12 between headings 1 and 2. Those in cross-cuts 11 and 12 had 1m2 and 2m2 apertures respectively and the one in cross-cut 9 had a 3m x 1m flap that could be opened or closed, all of which was to control air flow through the goaf as panel extraction proceeded.

When extracting pillars in seams liable to spontaneous combustion there is a statutory requirement for the quantity and quality of air flowing through the panel to be measured and recorded every week. This requirement was consistently met at Moura No 2. In respect of quantity, it was done by measuring the velocity of the air leaving the panel using a vane anemometer at two designated ventilation stations where the cross sectional area of the airway had been accurately surveyed. One of the ventilation stations (VS 46) was for the top return and the other (VS 59) was for the bottom return, both located between No 1 cross-cut and the south return of 510 Panel. Correspondingly, in respect of air quality, the concentration of carbon monoxide in the return air from 512 Panel was measured weekly at both stations using hand held gas detector tubes. Moreover, the concentration of carbon monoxide, oxygen, methane and carbon dioxide was continuously monitored by the Maihak Unor gas analysis system from two tube bundle sampling points, one located in the bottom return (Measuring Point No 5) and one in the top return (Measuring Point No 16). It should be noted that at the time of sealing 512 Panel, the location of these measuring points was changed. Measuring Point No 16 was moved into the south return of 510 Panel outbye of 512 Panel and Measuring Point No 5 was placed behind the 512 Panel seal in No 3 heading to monitor the composition of the atmosphere in the panel after sealing.

GAS MONITORING AT THE MINE

The Maihak Unor system at Moura No 2 was a tube bundle type gas sampling and analysing system which took samples of air from 12 pre-determined locations in the mine, including Measuring Points 5 and 16 at 512 Panel.

The air samples were drawn continuously through small bore plastic tubes, one from each sampling point, to the surface monitoring station. The set of tubes extending into the mine is described as the 'tube bundle'. At the surface station the gas samples were dewatered and filtered of particulate matter before being passed through one paramagnetic and three infra-red gas analysers. The infra-red analysers for methane and carbon monoxide were capable of operating on two different ranges as follows:

	Low Range	**High Range**
Methane (CH_4)	0 - 5 %	0 - 100 %
Carbon Monoxide (CO) (* parts per million)	0 - 100 ppm *	0 - 1000 ppm*

However, both the infra-red analyser for carbon dioxide, and the paramagnetic analyser for oxygen, operated on a single range, thus:

	Single Range
Carbon Dioxide (CO_2)	0 - 5 %
Oxygen (O_2)	0 - 21 %

The measured gas concentrations along with Graham's ratio were routinely displayed on the computer screen, automatically checked against alarm settings and then stored on the computers hard disk. The on-screen display and disk record of data also included the corresponding date, time of day and barometric pressure. Gas trends with time, or on the basis of either the Ellicott diagram or the Coward diagram could be called up for display as required. Data for gases at normal concentrations were displayed in green colour, but this changed to red when the concentration exceeded a pre-set alarm level. When an alarm situation was acknowledged the colour changed to blue.

Although the samples were drawn continuously from the mine through the 12 tubes, they were analysed in turn on a cyclic basis. This comprised analysing the air from one of the tubes for approximately one minute and then repeating the process sequentially for all of the tubes. Hence the atmosphere at each measuring point in the mine was being analysed and the result recorded every 12 minutes or so.

The gas concentration data were checked automatically by the system against manually pre-set values. When a pre-set value was exceeded, a loud siren sounded outside the control station. This audible alarm was in addition to the colour of the relevant data display on the computer screen changing from green to red. The audible warning system was not, however, dedicated to the gas monitoring system but served as an alarm for other systems at the mine.

Alarms from the gas monitoring system had to be acknowledged by entering two digits into the system keyboard. It was supposed that the person acknowledging the alarm would use the final two digits of his cap lamp number for purposes of identification. This was not the practice however, and any two digits would serve, as was commonly done, to acknowledge an alarm. The system automatically maintained a record of all incidents of alarms, including gas concentration, time of event, time of acknowledgment, and time and value of any subsequent resetting of the alarm level. This information constituted the 'alarm log'. The two digits causing the alarm to be acknowledged were also recorded but were of no value since they did not identify the person involved.

The length of the individual sampling tubes comprising the tube bundle varied according to the distance from the surface monitoring station to the sampling point underground. Accordingly there was a time lag between taking the sample and analysing it, corresponding to the time taken for the sample to travel to the surface. The time lag varied between tubes from approximately 10 minutes to 73 minutes according to distance.

The system was checked on a regular basis by introducing calibration gases of known concentration sequentially into each of the tubes at the underground monitoring points. The measured gas

concentrations at the surface and the time taken for the gas to reach the analyser provided the means for identifying leaks or restrictions to flow in the tube bundle system. This procedure, which is known as a 'span gas test', was carried out on 7 August 1994. Because 512 Panel was being closely monitored at that time, following its sealing, the normal testing procedure was modified to allow data from Measuring Points Nos 5 and 16 to be continuously displayed on the computer screen.

The analysers at Moura No 2 were routinely serviced and maintained by Maihak Australia at six month intervals. This included calibration of the analysers and correcting any drift. The most recent service before the explosion was carried out on 23 June 1994. The system had, moreover, been upgraded with a new data recording and control computer on 27 July 1994.

In addition to the Maihak Unor system, Moura No 2 also had a Computer Assisted Mine Gas Analysis System (CAMGAS). This system is based on the use of gas chromatographs (GC) and is capable of detecting and measuring several more gases than the Maihak Unor system, most notably those gases that can be indicative of the presence and progression of a mine fire.

CAMGAS was located at the mine surface at the same station as Maihak Unor. It was a stand alone system and was designed to receive samples of mine air collected by hand in special plastic bags. A computer modem link was in place to transmit test results to SIMTARS laboratories for expert analysis and interpretation.

The analytical capability of the CAMGAS - GC is summarised:

Gas Component	**Analytical Range %**	**Analytical Range %**
(chemical symbol)	*low span method*	*high span method*
Helium (He)	0.01 - 0.1	0.01 - 5
Hydrogen (H_2)	0.01 - 0.1	0.01 - 5
Oxygen (O_2)	0.10 - 25	0.10 - 25
Nitrogen(N_2)	0.10 - 100	0.10 - 100
Methane (CH_4)	0.001 - 5	0.10 - 100
Carbon Monoxide (CO)	0.001 - 1 (10 - 10,000ppm)	0.10 - 100 (>100ppm)
Carbon Dioxide (CO_2)	0.001 - 2	0.01 - 100
Ethylene(C_2H_4)	0.001 - 0.1 (10 - 1,000ppm)	0.10 - 10 (>100ppm)
Ethane (C_2H_6)	0.001 - 0.1 (10 - 1,000ppm)	0.10 - 10 (>100ppm)

It is significant to note that the CAMGAS - GC is incapable of reliably discriminating carbon monoxide levels below 10 parts per million (ppm). So it is not a useful instrument for detecting low carbon monoxide levels. Its main value lies in its ability to analyse for the full range of gases in a single sample and, thereby, provide compatible data for the calculation of critical gas ratios and other indicators of danger.

The second means to the Maihak Unor system for routine monitoring of carbon monoxide levels at Moura No 2 was the use of on-site hand operated gas detector tubes. Correspondingly, the second

means for methane detection was the use of on-site hand held MSA Minder Portable Gas Detectors which were carried routinely by mine officials.

NATURE AND CAUSE

DISCUSSION

An underground explosion at the Moura No 2 mine ultimately resulted in the death of eleven persons. The explosion occurred at approximately 2335 hours on Sunday 7 August 1994. This was followed by a second and much more violent explosion at 1220 hours on Tuesday 9 August which apparently devastated the mine and led to the decision to seal it.

At the time of the first explosion there were 21 persons in the mine, 9 of whom were working in the North West section, 11 were deployed to the southern area of the mine and one was working in the Main Dips belt area. Those in the southern area of the mine comprised 8 in the 5 South crew, a beltman, and a sealing contractor with an assisting miner.

Approximately 20 minutes after the first explosion 10 of the men underground escaped to the surface safely without external aid. Those who escaped comprised the 9 persons in the North West panel and the one person in the Main Dips. All those who escaped from the mine did so with the aid of carbon monoxide filter self rescuers. The evidence was that these became hot during use indicating that the wearers were in a carbon monoxide contaminated atmosphere.

The North West panel crew utilised transport available in the section at the time of the explosion. Their passage out of the mine was impeded by poor visibility and there was evidence that some of the survivors were physically distressed when they reached the surface.

Communication with the crew in the 5 South panel was lost at the moment of the first explosion. No persons returned to the surface from the southern area of the mine.

Expert opinion, in evidence to the Inquiry, was unanimous in concluding that the first explosion most probably occurred in the 512 Panel, located on the Southern side of the mine. The explosion was generally considered to have been a relatively weak methane explosion. There was some evidence that propagation by coal dust may have occurred into the 5 South Panel.

Seven possible fuel and ignition source combinations for the first explosion were identified in evidence. These are:

512 Panel - with a post sealing gas accumulation in 512 Panel as a fuel source and with spontaneous combustion as a source of ignition**.**

512 Panel - with a post sealing gas accumulation in 512 Panel as a fuel source but with an ignition source other than spontaneous combustion. In particular the possibility of an ignition source in the vicinity of, but external to, the seals was raised in the evidence of expert witnesses from MSHA.

5 South Panel - it was believed that coal cutting may have been in progress at the time of the explosion close to a disused methane drainage hole from which gas could have been issuing. An explosive atmosphere could have accumulated to be ignited by frictional sparking from cutter picks, a cable flash or some other source.

520 Panel - in the vicinity of 520 Panel headings where methane drainage was in progress to possibly cause an accumulation of methane to be ignited by some unknown source.

510 Panel - where methane drainage was in progress. A leakage of gas leading to an explosive atmosphere to be ignited by some unknown source.

Wal's Workshop - a stub entry off the 5 South bottom return where methane might have accumulated to be ignited by some unknown source. A methane blower had been encountered in this entry and the entry was ventilated by a brattice wing.

511 Panel - as a result of methane leaking through the seals to be ignited by some unknown source.

Expert testimony ranked the probability of an ignition of methane occurring in 512 Panel goaf and at five other sites and this suggested the following probabilities:

512 Panel goaf	-	close to 99.5%
5 South Panel	-	close to 0.50%
520 Panel	-	close to zero
510 Panel	-	close to zero
Wal's Workshop	-	close to zero
511 Panel	-	close to zero

On the basis of all the evidence available to the Inquiry the overwhelming likelihood is that 512 Panel was the seat of the first explosion. For some other part of the mine to have been the seat of that explosion would, on the basis of that evidence, be no less than a bewildering coincidence.

There is no evidence on which to reach a conclusion on the circumstances leading to the second explosion. It is likely, however, that the first explosion may have resulted in several open fires spread throughout its zone of influence which could have continued to burn for many hours.

There could also be several potential sources of methane to create a further and much larger explosive atmosphere, one such possibility being the result of damage from the first explosion to the methane drainage system in that part of the mine. Another is the breaching of previously sealed areas by the first explosion.

Sealing of the mine removed any opportunity for underground entry for purposes of inspection and investigation to assist in determining causal factors. The only post sealing underground evidence has come from borehole camera work in the vicinity of 511 and 512 Panel seal sites and the results of gas analyses from borehole samples.

However, the Inquiry in reaching its conclusions had available a considerable body of evidence in the form of: the sworn testimony of mine management and employees; evidence presented by both local and overseas expert witnesses; mine reports and other documentation; and gas and ventilation monitoring results from a variety of sources.

On the basis of the available evidence the Inquiry has concluded that sealing of the 512 Panel after completion of production, resulted in the build up of methane to explosive concentrations within the panel. Evidence before the Inquiry also strongly indicated that a heating arising from spontaneous combustion of coal was present in the panel for some time prior to sealing.

The heating was of sufficient intensity to act as a source of ignition for gas in the panel, and this combination was the immediate cause of the first explosion.

Contributing causes to the first explosion were identified as a number of failures in responses, approaches or systems at the mine. These were:

- ***failure to prevent the development of a heating within the 512 Panel;***
- ***failure to acknowledge the presence of that heating;***
- ***failure to effectively communicate and capture and evaluate numerous tell-tale signs over an extended period; and***
- ***failure to treat the heating or to identify the potential impact of sealing with the panel consequently passing into an explosive range due to the methane gas accumulating in the panel.***

Ultimately, there was failure to withdraw persons from the mine while the potential existed for an explosion.

FORMAL FINDINGS

In relation to the nature of events at Moura No 2 underground mine beginning on 7 August 1994, the Inquiry finds that:

- an explosion originated in the 512 Panel of the mine at approximately 2335 hours on 7 August 1994;
- a second explosion occurred at approximately 1220 hours on 9 August 1994;
- the eleven persons who failed to return to the surface from the Southern side of the mine died in the mine as a direct, or indirect, result of the first explosion.

In relation to the cause of events at Moura No 2 underground mine beginning on 7 August 1994 the Inquiry finds that:

· the first explosion resulted from a failure to acknowledge, and effectively treat, a heating of coal in the 512 Panel which, in turn, ignited methane gas which accumulated in the panel after sealing of the panel;

· due to insufficient evidence, no finding can be made regarding the cause of the second explosion;

· due to insufficient evidence, no definite finding can be made regarding the actual cause of death of any of the victims.

ISSUES AND EVENTS

FAILURE TO PREVENT THE HEATING

The failure to prevent the development of a heating in the 512 Panel is attributed to a number of aspects of the design and operation of the panel together with certain beliefs concerning panel life in relation to an assumed incubation period.

While no one feature of the design and operation of 512 Panel is identified as directly causing the development of a heating, a number are considered less than desirable in that respect.

The first of these is the amount of loose coal left from the mining process and of fractured coal from rib and stook instability. Both of these are considered undesirable from a point of view of spontaneous combustion management.

No supports were set during the extraction phase of 512 Panel and with roof spans of up to 25 metres localised falls of roof could be expected and did occur. Fallen rock may well have covered some loose coal and so screened it from goaf ventilation.

While loose coal is inevitably left with any method of extraction, the particular way bottom coal was extracted in 512 Panel by ramping down probably left greater quantities than had been the case with other methods of extraction.

This was worsened by limiting the length of ramps since a certain quantity of cut, but unrecovered, coal was left in each ramp. These significant quantities of loose coal in the ramp areas would likely not all be effectively ventilated. This may have been exacerbated by local roof falls burying the unrecovered coal.

In addition high ribs adjacent to ramp areas were prone to collapse giving rise to accumulations of loose coal at the sides of stooks and pillars. The stresses induced on remnant pillars would have been sufficient to cause some fracturing of the coal giving rise to the potential for the ingress of air and so the development of a deep seated heating.

While a relatively high ventilation quantity was available in the 512 Panel it is very likely that because of large open areas that ventilation was somewhat sluggish in the goaf. Although sluggish, ventilation may well have been adequate to effectively ventilate the goaf, if the intent of the panel ventilation design had been adhered to and had other factors not intruded. Those other factors, however, caused undesirable (from the point of view of the prevention of a heating) loss of, or variation in, ventilation to parts of the goaf.

The intent of the ventilation design was that holes in the stoppings between the back row of pillars act, in effect, as regulators to balance ventilation across all parts of the goaf. In practice, however, there

was evidence that these appliances were affected by roof falls or local strata instability and that their function was, at times, compromised.

There would inevitably be areas in the goaf which were likely to have been less than effectively ventilated, notably in cross cuts between headings and in the corners of the L shaped remnant pillars. These would have been fertile areas for the development of a heating.

In addition, there was evidence of ventilation problems with gas backing up the number two heading. This was generally associated with the erection of a line of brattice to channel air to the continuous miner when working near the bottom side of the panel. If this brattice line was made too tight then insufficient leakage ventilation was available to effectively remove gas from the top rear corner of the panel.

There can be little doubt that remedial measures taken to clear these gas accumulations caused variation in the distribution of goaf ventilation. A number of instances where the goaf was deliberately 'flushed' were identified in evidence.

On other occasions when mining up dip near the bottom of the panel, while stripping the bottom return rib, the bottom return regulator was opened to facilitate ventilation across the miner. This appliance was meant to be shut at the completion of the up dip sequence, but on some occasions it was not. This was recognised by the registered mine manager, Schaus to be compromising positive goaf ventilation and the practice stopped. The likely compound effect of all these ventilation alterations was considered undesirable by the Inquiry from the point of view of the prevention of spontaneous combustion in the 512 Panel.

Overall, it seems that day to day ventilation problem solving, and operational, or accidental alterations to panel ventilation may have defeated the overall design intent regarding positive, controlled goaf ventilation and so increased the likelihood for spontaneous combustion in the panel. It seems likely that parts of the goaf may have been alternately starved of, and then supplied with, ventilating air; a most undesirable situation.

This situation was probably not helped by the absence at the mine of a dedicated and regularly updated plan showing the state of mine ventilation together with the status of regulators and other appliances. The alteration of regulators at the mine appears to have been, to some extent, uncontrolled and unrecorded with no single point of reference, or for that matter responsibility, for the status of ventilation. There was evidence that some attempt had been made by safety/training undermanager, Barraclough, to implement recording of the status of regulators on a white board in the undermanager's office but this initiative appears to have fallen into abeyance.

Coal in the panel had been drained of gas for about 25 months prior to mining. As well as removal of gas this also resulted in the removal of water from the coal. Expert opinion, in general, agreed with the proposition that this may well have increased proneness to spontaneous combustion through two mechanisms. The first was through the removal of barriers to the ingress of oxygen to the coal and the

second was the possibility of the generation of heat through hydration of the coal if subsequently wetted.

There appears to have been heavy reliance at the mine on the concept of an incubation period for the seam being mined. This was revealed in evidence to have some roots in the report of the Inquiry into the Kianga explosion which occurred in 1975. In general it was considered that the rapid extraction of panels within the presumed incubation period provided an effective defence to spontaneous combustion since panels would be extracted and sealed before a heating was likely to develop.

The following, from the evidence of Schaus, illustrates this and also illustrates how such perceptions may be perpetuated:

> "Now, when you were having discussions about taking up the position at Moura, did you have some discussions with a couple of representatives of BHP, Mr Sleeman and Mr O'Reagan? - *Yes, that's correct.*
>
> "Did one of those gentlemen tell you something about control mechanisms employed at Moura for spon com? - *I remember having a discussion with John Sleeman before I took my position underground. It was in relation to the work model for Moura No 2 Underground and over dinner, so very informally. We were discussing the features, if I may say, of Moura No 2 Underground after being - after accepting the position basically. I hadn't started at Moura yet but I had accepted the position, and it was a briefing about the work model before I actually went to the mine. Over that meal I inquired of how the spontaneous combustion issue was controlled at Moura No 2 Underground. I realised, although I had suspected it but I wasn't sure, that the seam was liable to spontaneous combustion. I learned that at the interview. Mr Sleeman told me that the main method of control was that by design the panels were laid out in such a manner that the time it took for them to go to their limit and come out was within the incubation period.*
>
> "Did you understand something from what you had said about what that incubation period was? -*At that time I don't think any period of incubation as such was mentioned. I understood that by design Moura No 2 Underground - the panels were such that they were progressing to a limit and coming out well within the incubation period.*
>
> "And was the concept of an incubation period something that you knew about before that time? -*The concept of incubation period has been known to me since my studies as a mining engineer."* **(Transcript p3903)**

The 512 Panel provided just such a case. There appeared a belief at the mine that spontaneous combustion was under control and that those measures in place could be relied upon firstly to prevent a heating and then to provide adequate warning should that prevention fail.

Incubation period is a commonly used term in coal mining and is generally acknowledged as the time between initial exposure of coal to the atmosphere and the subsequent onset of self heating. Although in common use its actual value in any particular case is difficult to determine and then may be influenced by many factors. Since 512 Panel was to be extracted well within the presumed incubation period of six months, spontaneous combustion, although routinely monitored for, appeared not to have been seen as a significant risk. In a risk assessment conducted after extraction in the panel had commenced spontaneous combustion appears to have had no particular prominence. The preoccupation appeared to be with machine operation and roof and rib stability. Of the risks assessed in that exercise forty-two concerned machine operation. There were sixteen roof and sixteen rib related risks, seven concerned ventilation and gas, six concerned persons injuring themselves, and there was one for spontaneous combustion. The current controls identified for spontaneous combustion were a short panel life and continuous gas monitoring. A possible extra control was identified as pumping water into old workings. In the event this was not done.

There appeared to be no spontaneous combustion precautions taken in the 512 Panel above and beyond those for other, recent panels although in reality the 512 Panel was probably always at greater risk from spontaneous combustion.

Reliance on incubation period as a primary, if not sole, determinant of the likelihood of spontaneous combustion led to some false sense of security and likely to a failure to take precautions and be sufficiently alert to other indicators of spontaneous combustion. This may, in turn, have made a contribution to failure to detect the developing heating through some complacency based on incubation period expectations.

It must now be obvious that reliance on the concept of an incubation period is not an adequate defence in the face of the many other factors likely to influence the likelihood of a heating.

Incubation period may have some utility if all those other factors are both fully understood and essentially constant. At Moura because of the continual change in panel design and working methods virtually nothing was constant.

FAILURE TO RECOGNISE THE HEATING

Failure to recognise the onset of the heating arose from a number of factors including:

- ***less than adequate knowledge about spontaneous combustion among those at the mine;***
- ***less than desirable application of what knowledge there was;***
- ***failure to make effective use of some available equipment;***
- ***failure to make any use of other available equipment;***
- ***failure of, or failure to maintain, communication and reporting systems; and***
- ***lost opportunities through less than adequate responses to information available.***

Whereas there appears to have been a considerable overall knowledge base at the mine on the subject of spontaneous combustion, no individual was completely, or even sufficiently, well versed in the many factors leading to development of, and surrounding the detection of, a heating. There also appears to have been an absence of the application of knowledge in practice. When questioned at the Inquiry, most said they could associate the importance of sensory indicators, such as smell, with the likelihood of a spontaneous combustion. However, it appears that the gravity of this relationship was not recognised in practice and the knowledge not effectively applied at the mine by all those with awareness of those 'smells' that had been noticed.

Of particular concern to the Inquiry was the apparent attitude and state of knowledge of mine officials in relation to spontaneous combustion.

Many, in the course of evidence, revealed that they had either not seen, or had not read, standard industry literature on the subject. All must have touched on the subject as part of mining education, as part of preparation for attaining statutory mining qualifications or as part of mines rescue training, but, with the exception of the undermanager McCamley, do not appear to have revisited it, at any time, of their own accord.

There appeared to be a singular lack of concern from those in positions of authority at the time of the explosion, that is from undermanager up, to maintain and update knowledge. This apparent lack of concern on the part of mine management with maintaining up to date knowledge was of alarm to the Inquiry.

Training related to spontaneous combustion and provided by the mine itself, in response to statute, could best be described as minimal and, in fact, was recognised as requiring updating by the mine's training undermanager, Barraclough. The training was based on a training manual, prepared in 1988, and commissioned and distributed by the then Queensland Coal Association. In this material spontaneous combustion is covered within the broader subject of "Fires, Fire Fighting and Explosions in Coal Mines". Smell or odour is cited, albeit not prominently, as a possible means of detecting goaf fires.

Barraclough intended to prepare a training package specifically on spontaneous combustion but, in part due to the unavailability of some publications, had not done so. He elected, instead, to conduct self rescuer training.

The publications sought by Barraclough are commonly referred to as the Red Book and the Blue Book and were prepared in response to the Inquiry into the 1975 Kianga explosion. They arose from a recognition that the training of the coal mining workforce in relation to spontaneous combustion needed to be improved. The publications have not been updated since that time nor has their content been republished in another form.

The mine also seemed to rely on mines rescue as a de facto provider of a knowledge base over a range of safety areas for mine management and the workforce. This certainly appeared the case with spontaneous combustion knowledge.

In 1989 a seminar was conducted at SIMTARS covering issues related to coal mine fires and explosions. The seminar, which was aimed at the training of mining officials, arose from a recommendation of the 1986 Moura Inquiry. It was attended by mine managers, inspectors, mines' rescue superintendents, and check inspectors.

The material distributed at that seminar comprised three volumes and contains some of the most comprehensive notes available at that time, and for that matter since, on the subject of spontaneous combustion. The fate of that information at Moura mine is a matter for regret.

The seminar was attended by Reed, the then registered mine manager, who subsequently implemented a system for the determination of "CO make" as a spontaneous combustion indicator. In this implementation Reed appears to have dealt primarily with the ventilation officer, Morieson and passed the seminar material to him. Rightly or wrongly "CO make" and associate knowledge were seen as a 'management tool'.

It should be noted that material related to "CO make" and its use is only a very minor part of the information provided by the Seminar.

There appeared to be no structured dissemination of the SIMTARS material at Moura mine, but rather, a reliance on 'learning by association' of others, surrounding him, on the part of Reed. As a result the knowledge apparently did not effectively go beyond Reed and Morieson. This arrangement may well have been adequate while Reed remained in close control of the Moura underground operations but the utility of it appears to have suffered considerably with his departure.

Other means through which knowledge from the SIMTARS Seminar may have reached the rest of Moura management and, perhaps, the workforce do not appear to have been effective either. Although Mines' Rescue personnel were participants at the Seminar some important information from that source does not appear to have been effectively conveyed in subsequent training at Moura. Proposals, around the time of the Seminar, to repeat it in some modified form for other industry personnel never came to fruition due to a lack of interest and/or funding.

This lack of dissemination of the most concise and up to date knowledge failed to counter, or at least left in place, a number of beliefs. It was widely believed that a slow, steady rise in CO production could not constitute a problem and that an exponential rise was required to indicate a heating.

A large number of witnesses indicated that an exponential rise in either CO concentration, or the equivalent in "CO make", was a tell-tale and unambiguous sign of a heating. This was expressed as the situation 'taking off' or showing some dramatic rise. However, none could recount the source of such an impression.

This was put into context in evidence from Reed:

> "There is evidence here from various people that you would wait until you saw an exponential rise before you acted and determined there was a heating? - *My answer to that is we had an exponential rise in '86, and, as we know, that's too late."* **(Transcript p3375)**

Whereas it was widely believed that frequently occurring or persistent benzene or tarry smells were significant indicators, it was not recognised that occasional wafting or fleeting smells may be important tell-tale signs of an incipient heating. When such signs did occur they were discounted as erroneous, or as the smell of roof bolt resin or the smell of discarded oil cans in the goaf, and were not investigated with appropriate thoroughness.

In this respect much material from the SIMTARS seminar was prophetic, and in particular the following passage:

> "Even when sophisticated gas analysis equipment is available for detection of carbon monoxide or other gases, it can be extremely difficult to pinpoint the source of gases in order to locate a heating and to enable remedial action to be initiated. Most heatings develop deep in broken coal where air flows are low, and where barometric and thermal effects may be significant.
>
> "Often a heating is first detected by an examining official detecting a faint smell for a fleeting instant. Further detailed examination of the area reveals no detectable CO or any further smell or other indication.
>
> "This process may be repeated on several occasions until detectable concentrations of CO begin to appear on a continuous basis, and these can be traced to the source and action taken to control the heating."

In total there were a significant number of reports of 'smells' from the 512 Panel during its life and, indeed, these proved to be fleeting. In this respect they did not reward subsequent observation and left the scope for those making, or hearing of, those examinations to reason away not only the occurrence but, unfortunately, the potential importance of those signs.

As early as 17 June the then undermanager McCamley had cause to examine the 512 goaf in response to a ventilation layering and recirculation problem and at that time noticed what he, in evidence, described as 'a slight tar smell'. Regrettably, no mention of a smell made its way to McCamley's undermanager's shift report and McCamley's claims of verbal reporting of the occurrence of that smell, to the undermanager in charge, Mason and Schaus, remained uncorroborated. McCamley inspected the 512 goaf a number of further times up until the last shift he worked at Moura on 28 June. At no time was the observation of a smell repeated.

On 24 June during the afternoon shift the deputy, Robertson noticed a smell at 7 cross cut 1-2 heading.

This observation found its way to his deputy's shift report thus:

> '... informed the U/Manager that at this point there was a strong "benzene" type smell and to keep an eye on it.'

Descriptions of the smell varied in the evidence of others and, in particular, the ventilation officer Morieson described it as a 'chemical' smell. Notwithstanding this, throughout the Inquiry no satisfactory explanation of the fate of that report was forthcoming. This was despite the fact that, if taken on its face value, the report must have been alarming to anybody reading it. The undermanager on shift, Squires, did not deny that he may have read it, but did not recall doing so. Similarly, he did not deny being informed, but could not recall being so. The report was not counter-signed by Squires, nor for that matter any other under manager.

The end result was that the content of the report simply 'slipped through the cracks'. There appears to have been no follow-up action and every official of the mine examined by the Inquiry, bar Robertson, denied knowledge of the report or its content. It should also be noted that Robertson himself appears to have made no follow-up, even by way of casual enquiry, of the fate of his observation of 24 June.

There were no further 'smell' reports from 512 until after extraction was completed and production ceased early on the morning of Friday 5 August.

EVENTS SURROUNDING 22 JULY 1994

The normal ventilation officer for the mine, Morieson went on leave from Friday 15 July and returned on 5 August when he worked afternoon shift as a production deputy. During Morieson's absence the deputy and miner's officer at the mine, Bryon acted as the ventilation and fire officer.

On Friday 22 July Bryon, in the company of another deputy Rose, got a higher than expected gas detector tube reading in the 512 top return when taking readings associated with the normal weekly "CO make" monitoring. The result of 8 ppm was higher than the approximately 6 ppm being indicated at the time by the mine's tube bundle system for the Top Return of 512 Panel. When combined with the bottom return make, a figure of 18.98 l/min was obtained for the "CO make" of the panel.

In response to concerns raised by this reading a party comprising the mining engineer, Abrahamse, the Mines' Rescue Superintendent, Kerr and the shift undermanager, Atkinson conducted an inspection of 512. Kerr, who happened to be at the mine on that day on other business, became involved at the request of Mason. The group obtained several readings of the order of 5 ppm CO in the top return and noticed nothing else that gave rise to concern. The 'high' CO reading was, on the basis of these further examinations, discounted as an anomaly. Apparently none of those making this assessment knew of the ventilation difficulties and 'smell' observations in June.

The acting registered manager Barraclough did, however, cause some ongoing observation of 512 to be undertaken. This appears to have resulted from discussion and some form of agreement with Bryon. Barraclough's record book entry for 22 July noted:

> "512 Panel Continuing rib stripping in the 3-4 cut through area. Roof and rib conditions appear stable. Maihak CO readings remain stable at 6 ppm (14.9 l/min) with Drager reading rising to 8ppm. Drager readings will be taken and recorded daily."

Although Barraclough indicated that the purpose of further monitoring was simply to maintain a comparison between Drager readings and those of the tube bundle system, that purpose became confused in the observance. The sequence of events appears to have been as follows:

· Barraclough requested Abrahamse to initiate a system for the daily taking and recording of Drager readings by deputies;

· in response, Abrahamse produced a blank of the normal worksheet for "CO make" monitoring. He appears to have written the formula for "CO make" calculation on the sheet (already the exercise appears to have gone beyond Barraclough's intent). He also produced a "CO make" graph up to that time;

· this worksheet was used during the ensuing weekend by Atkinson and deputies to not only record Drager and Maihak readings but also to record "CO make" calculations;

· on Monday 25 July Mason posted a written instruction requiring deputies to take readings. His recollection was that the instruction required daily readings and the taking of not only CO and air velocity readings, but now methane, oxygen and wet and dry bulb temperature readings as well. He could not explain how all these readings related to the original intent of the exercise, with which he appeared to be familiar, but had to concede their relevance to "CO make" monitoring;

· in practice, deputies began to take the required readings not just on a daily basis but every shift and the readings from then on appear on deputies reports right through until Saturday 6 August. There were some deputies, however, who did not appear to know why the readings were being taken;

· entries were made to the worksheet and "CO make" figures calculated up until day shift on 26 July, apparently by a number of people, but not thereafter.

Abrahamse examined the worksheet on 25 July and placed it in a folder in the undermanager's office. At this stage, the end of any use of the deputy's readings to update the worksheet, or for that matter for any other purpose, appears to have coincided with Abrahamse going on sick leave from 26 July.

Barraclough, through noting deputies' reports and verbal communication concluded that there was no significant change in CO readings and that the issue of the 'high' reading of 22 July appeared to be resolved. He did not refer to the worksheet initially prepared by Abrahamse.

This passage of events appears to have been based on good intent arising as it did out of some genuine concern. However, any initial direction the exercise had, appeared to have been very quickly lost and no one, with the exception of Barraclough, seems to have followed anything up. Mason having issued the directive to take the readings did not do so. Abrahamse' interest does not appear to have survived his four day sick leave and even Barraclough appears to have been satisfied that gas detector tube readings were not changing and so took no further interest.

Undermanagers who were not immediately involved, if they had read the deputies' reports, must have noticed the sudden appearance of extra readings on those reports and yet, it seems, no one questioned what was going on. Similarly, some deputies seem to have simply taken the readings because they were told to and thought nothing more of it.

The implementation and demise of any 'system' for more closely monitoring conditions in 512 Panel are seen to be of relevance for two reasons.

Firstly, the data generated by the deputies' readings may have, if somebody had been monitoring them, provided an opportunity for concern to be raised earlier with regard to the 512 Panel.

From a base of near 14.0 l/min around 22 July, deputies' readings taken during the following two weeks would have produced "CO make" results of 19.36, 17.03, 18.94, 16.57 and finally on the night and day shift of 6 August, 18.94 and 21.04 l/min respectively. These calculations were not made until after the event. However, while they were the subject of post-event rationalisation based on the vagaries of gas detector tube or ventilation readings, or ventilation alteration in other parts of the mine, or their being spot readings not necessarily reflecting trends; their non-calculation prior to the explosion must remain a source of lost opportunity to raise concern surrounding the 512 Panel.

Secondly, the events related to 22 July must be seen as an indicator of the abysmal state of communications at Moura No 2. Any original focus the exercise had was quickly lost and people appeared to have been simply going through the motions of doing something without much regard to purpose. Even the registered mine manager, Schaus indicated that he did not become aware of the events of 22 July until he looked at the mine record book on Sunday 7 August some five days after his return from leave. This was also despite Schaus, upon his return from leave on 2 August, having discussed the state of the mine with Barraclough. He was also unaware of any concern about, or closer monitoring of, 512 Panel which was, or had been, in effect at the mine.

AFTERNOON SHIFT - FRIDAY 5 AUGUST

During the afternoon shift of 5 August the deputy, Caddell in the company of miner O'Brien noticed a smell at 10 cross cut while inspecting the top return in 512 Panel. This observation was recorded in his deputy's report:

> "An inspection ... was made of the top return to 13 cross-cut. A strong tar smell was evident at 10 cross-cut ..."

The circumstances of the verbal reporting of the facts of this inspection to the undermanager Squires remain in some doubt, along with the actual description used for the smell. However, Squires did ask Caddell to keep an eye on the 512 Panel during the double shift he was about to work. Caddell suggested to Squires that the sealing of the section should be brought forward. Squires visited the 512 Panel at approximately 1800 hours. He did not however proceed further inbye than the vicinity of the goaf edge at 1 cross cut.

For the ensuing night shift, Caddell handed over the 512 Panel to the deputy Newton. It was a weekend practice at the mine for deputies to arrange their own duties and Newton was one of the normal 512 deputies. It remains uncertain whether Newton inspected down the number one heading to 13 cross-cut during the course of that night shift and so revisit the point where Caddell noticed the smell. There is no mention of having done so in Newton's deputy's report. Newton's intention, expressed in the evidence of Caddell was to "go straight down and go to the Unor point and take readings and his own observations." **(Transcript p29).** At the end of the shift Newton informed Caddell that the [CO and methane] readings were unchanged.

Squires returned to the mine for day shift Saturday 6 August. He missed Caddell and did not specifically enquire of Newton about 512 since he was, at that time, unaware that Newton was the 512 deputy for the previous shift. This caused a discontinuity in the observation of 512 and, perhaps, a further lost opportunity for consistent information to be gathered and passed on.

During day shift on 6 August the deputy, Klease noticed what was variously described as a haze or heat 'shimmy' around a fall area in the vicinity of 2 cross-cut, 2-3 heading. He also noticed a 'benzeney' smell subsequently in 1 heading of 512 together with a 'haze'. Since equipment was being recovered from the section there were diesel machines operating which confounded efforts to reach a firm opinion about the nature of the haze and a small increase noted in CO concentrations.

At the last observation made by Klease at around 1145 hours a reduced haze was noted in 1 heading and in 2 heading a shimmy could be noted at 2 or 3 cross-cut together with a 'very, very weak' smell. There was no mention of smell recorded in Klease's deputy's report, although a haze was recorded. There is no evidence that Klease traversed the top return.

The recollections of Klease and Squires varied as to whether Klease had reported any smells or haze to Squires. Squires though, during a visit to 512 Panel some time around 1100 hours, had noticed a normal, but strong, goaf smell in 2 heading together with a faint 'haze' and air migrating slowly back

out of 2 heading. His conclusion was that there had been some change in the panel since the previous day. The reversal of air in 2 heading was seen as undesirable, at least from the point of view of the potential for recirculation, and in Squire's evidence provided, in itself, a justification for sealing the panel. This was claimed by Squires in evidence to be a more pragmatic solution than trying to solve a ventilation problem in a panel which was, by now, extracted and unproductive.

Squires contacted Mason by telephone at his home some time after 1100 hours. As a result of that conversation the sealing of the panel was brought into effect as a 'precautionary' measure.

Work on sealing the 512 Panel commenced, in effect, during that day shift with Squires redirecting the Tecrete seal contractor, Stampa to take sealing equipment from the 4 South panel to 512. Extra mine labour, on overtime, was organised for the afternoon shift by Squires, through union personnel. Mason made arrangements for the other in-charge Tecrete seal contractor, Parker, to attend the mine on afternoon shift although he had not been rostered to do so.

Mason and Squires conferred at shift change and Squires briefed the oncoming crews. The content of that briefing remains somewhat uncertain as a result of the varied recall of Squires and Mason. Squires indicated that he told those assembled that the panel was being sealed because of the detection of a slight haze and goaf smell. He thought he might have mentioned CO readings but could not recall mentioning Caddell's observation of the Friday. Mason recalled that Squires had mentioned the tarry smell and haze to the men. Squires appears not to have mentioned recirculation as a factor in the decision to seal the panel.

Sealing proceeded during the afternoon shift, with Mason in charge, and with the deputy McCrohon, initially, assigned to the 512 Panel. The other deputies on shift were Graham and Tuffs. Graham visited the 512 Panel at around 1630 hours. He examined the vicinity of 2 and 3 heading, at 2-3 cross-cut.

Early in the afternoon shift McCrohon had travelled four pillars inbye in the top return and took gas readings. These showed nothing which caused him alarm. Mason visited the panel later in the shift. It was intended that he and McCrohon perform a further inspection of the top return but access proved too difficult due, in part, to the progress of the top return seal.

The visit by McCrohon is the last known time that someone was in the top return of the panel. Remarkably, since Caddell's discovery of a smell at 10 cross-cut during the Friday afternoon shift, it appears that no one had returned to that particular location to follow matters up.

Tuffs went to the 512 Panel at around 1830 to 1900 hours to relieve McCrohon for a time. His evidence was that during his time in the panel he noticed a tarry smell near the seal in the top return and the same type of smell, but of less strength, at the goaf edge in 2 and 3 headings, and that he informed Mason of this observation. Mason denied being told by Tuffs of anything about a stink in the panel that evening. Since Tuffs was only relieving in the panel for a time he did not complete a report with respect to the panel. His 'smell' observations went unrecorded and subsequently uncorroborated.

Tuffs was relieved at the 512 Panel by Graham. It was Graham who completed the deputy's report for the shift which contained observations made by McCrohon and then Graham himself. No record was made of any concern by either of them.

At approximately 2100 hours Mason contacted Schaus by telephone, to inform him of events.

In Schaus' recollection the conversation commenced: "I thought I'd just ring you to tell you what's happening to your mine." **(Transcript p3884)** and Mason related the observations of Caddell, Klease and Squires together with his inability to inspect the top return due to lack of access. Schaus' recollected impression was that Mason considered the sealing of 512 to be something of an "overkill". Interestingly, Schaus also was of the impression that the weekend sealing was always intended.

The sealing of the panel continued into the night shift with Klease returning as the 512 deputy and Mason remaining on duty at the mine. The sealing was completed at around 0115 hours on Sunday 7 August apparently without any further indication of smell or haze or abnormal conditions of any sort. Mason left the mine at 0145.

While access was still available, there was no comprehensive inspection of the 512 Panel triggered by any of the observations, or verbal or written reports starting with Caddell's of 5 August. This was despite the fact that both the top return and 13 cross-cut were most likely trafficable; it being a specific design intent of the 512 Panel to allow such an inspection of the waste. Instead, sealing of the panel was, apparently, seen as a panacea to confused and, probably, ill founded notions as to what was occurring.

At the Inquiry a number of persons gave evidence as to smells noticed in the vicinity of 512 during the sealing process. In particular the Tecrete contractor, Stampa recounted a smell 'that I have never smelt underground before'. However, the evidence of those involved in and supervising the sealing was variable and largely uncorroborated with respect to noticing and reporting smells and hazes.

The Inquiry concluded that these reports may well have been coloured by differing individual perceptions, the passage of time and the merging of pre and post event knowledge. Certainly more weight must be given to reports of smells, and for that matter other observations, of which there was some record made prior to the explosion. The Inquiry considered there to have been enough of such evidence to firmly indicate a problem in the 512 Panel, had that evidence been effectively gathered and evaluated prior to the explosion.

Despite some subjective difficulty with sensory indicators such as smell and haze in the underground environment they are, nonetheless, widely recognised and often vital indicators of spontaneous combustion. Information commonly covered in attaining statutory qualifications, and mines rescue training materials both, clearly, make this association.

The vast majority of management, and many of the workforce at the mine were highly likely, at some time, to have been exposed to this association. Such an association not being made in practice was a stark failure in the application of knowledge which must have been widely available at the mine. This, in turn, must bring into serious question the efficacy of training arrangements at the mine in relation to spontaneous combustion recognition.

CIRCUMSTANCES OF THE 512 SEALING

The sealing of the 512 Panel was originally proposed for early in the week beginning 8 August. Only preparatory work for sealing had been scheduled by Mason at the regular weekend-work planning meeting of Thursday 4 August. The first mention of sealing appears to have been around the day to afternoon shift change of 5 August when Squires asked Mason if the panel could be sealed over the weekend. Mason initially did not assent to a change to the work schedule but subsequently relented to the point of supporting sealing on the following Sunday (7 August) subject to resource availability. The final decision to seal was taken at about noon on Saturday 6 August as a result of another approach to Mason by Squires. This decision was put into effect immediately.

The sealing of the panel was no doubt brought forward from the time originally planned. To that end extra weekend labour was organised which necessitated consultation with a site union official since overtime limits were to be exceeded. In addition, the duties of the sealing contractor, Stampa were altered and he was sent to the 512 Panel, with the other contractor, Parker being called to the mine at short notice.

The spectre of a heating in the 512 Panel is reinforced by the evidence available from the Tecrete contractors. In the case of Stampa there is the following description, in evidence, of Squires approach to him to relocate from the 4 South panel to 512:

> "With Michael and you, the conversation? You can't sit there now and tell us what was said? -*Yeah, well, I was - there was heating.*
>
> You say there was a heating? - *Yeah.*
>
> What did he say? Just tell me what he said? - *Well, 'Get your gear over there, it is heating up'.*
>
> 'Get over there, it is heating up'? - *Yeah, 'Start sealing'.*" **(Transcript p244)**

In Parker's case it is mute, posthumous evidence in the form of a diary entry, discovered after the event:

> "George Mason requested 1pm that I go in because of concerns over heating."

This entry was evidently made some time between 1300 hours Saturday 6 August and the time of the first explosion. Mason, in evidence, indicated that he had taken trouble to explain to Parker the reasons for sealing panels, in justification of his requiring Parker to attend the mine, and that this background information must be the source of Parker's record. That may be so, but it still indicates the nature of an underlying concern at the time regarding 512 Panel.

This theme is also evident in the following passage from Mason's evidence:

> "Why would you need to bring the sealing forward from the Sunday as planned to the Saturday?- *Mr Squires requested that he seal the panel as a precautionary measure.*
>
> A precautionary measure against what? - *I would presume the development of a spontaneous combustion event."* **(Transcript p3673)**

Notwithstanding this, both Squires and Mason disputed in evidence any suggestion that they believed on Saturday 6 August the panel should be sealed because of the presence of a heating. Mason stated a number of times in evidence that the 512 Panel was to be sealed as a "precautionary measure".

The Inquiry was satisfied, on the balance of the evidence surrounding events of 5 and 6 August, that it was suspected that there was a heating in progress within the 512 Panel and that the panel was sealed with some urgency and with the expectation that doing so would control the heating and so prevent the development of a source of ignition.

DAY AND AFTERNOON SHIFT - SUNDAY 7 AUGUST

Squires returned to the mine to take charge of the Sunday day shift. During that shift the increase of gas concentrations in the, now sealed, 512 Panel was noted. This increase was expected as the panel filled with methane gas after sealing and the "CO make" of the panel immediately prior to sealing continued increasing after sealing. Through observation of the Maihak system Squires estimated that the CO concentration in 512 Panel was increasing at a rate of approximately 6 ppm per hour. This observation was purely descriptive with Squires not being able to say what he was looking for in estimating the increase.

Squires also obtained a printout from the Maihak system of gas concentration trends over the course of the shift. This showed an apparent linear increase in methane and carbon dioxide concentrations and an associated linear decrease in oxygen.

Deputies for the Sunday day shift were Newton, Caddell and Henderson. Newton had responsibility for the 510 Panel and brattice work to ventilate the 512 seals; Caddell undertook regular testing of the Maihak system through the introduction of span gas underground to each active sampling line; and Henderson acted as a spare deputy inspecting all parts of the mine other than 510/512. During the shift he observed the brattice ventilating Wal's workshop to be intact.

After 'smoko' Squires contacted Mason at home by telephone to enquire about conditions during sealing.

Mason related his inspection of 512 in company with McCrohon on the Saturday afternoon and that nothing that caused concern had been noted. Squires informed Mason that the CO increase behind the seals appeared to be linear with no signs of an exponential increase and in further conversation they concluded that no problem was evident.

Squires and Newton proceeded underground at about 0950 on an inspection during which they noted that the 512 seals were under positive pressure with very slight leakage at seals 1,2 and 3. While at 512 they discussed changing the temporary seal ventilation arrangement to a permanent one on night shift. They also visited 1 North West, 5 South and the 510 gas drainage installations.

At around 1430 hours Squires had a conversation with Schaus, who had come to the mine, during which Squires related the trends observed in gas concentrations within 512. It was during this visit that Schaus made a mine record book entry for an inspection which he had conducted on Friday 5 August. He recorded on this occasion:

> "512 Panel: Panel completed on N/Shift. Machines being recovered. CO readings climbing steadily (8ppm @ 19 l/min) Section will be sealed as soon as possible (This week end) 0.5% CH4 detected at goaf edge. Goaf appears stable."

and incorrectly dated the entry 5/4/94.

It was at this time that Schaus first became aware of events on and following 22 July, apparently not having been briefed on them earlier when resuming duties as registered manager from Barraclough.

Squires departed the mine at around 1520 hours. Deputies for the afternoon shift were Blyton and Helander and scheduled work included work on shuttle car anchorages in 1 North West and moving equipment from 512 to 4 South Level to allow resumption of work on seals there. The shuttle car anchorages were known to have been completed but the evidence is unclear on the equipment move.

During the course of the shift Blyton became aware of the general trend in the atmosphere of the 512 Panel and in particular that the area was indicated to enter the explosive range sometime between 2330 and 2400 hours. He observed the Maihak system a number of times during the shift and noted the progression toward the explosive range on the Ellicott diagram which the system displayed.

In a telephone call to Mason on the Sunday afternoon/evening at around 1830 hours Squires relayed the gas trend information and canvassed how the night shift crew should be approached. It was estimated that by the start of the night shift the CO concentration would be of the order of 130 to 140 ppm and that indications were that sometime during the night shift the atmosphere in the 512 Panel would enter the explosive range (greater than 5 percent methane). Opinion was that the 512 Panel was behaving much as expected.

Squires returned to the mine at around 2130 and met Blyton in the showers at around 2150. There was some discussion on the state of the mine but any reservations which Blyton may have held were not vigorously conveyed to Squires. Shortly after, Blyton departed the mine without seeing any of the oncoming night shift deputies.

Although it was the usual practice at the mine for successive deputies to not have contact during weekends, the absence of that contact in this instance was a lost opportunity for communication regarding the state of the mine. This practice is undesirable in circumstances such as when there has been recent sealing of a panel.

NIGHT SHIFT - SUNDAY 7 AUGUST

After assembly, the 5 South crew with Newton as deputy and, then, the 1 North West crew with Graham departed the surface at approximately 2220. There was no evidence of concerns being raised by the crews prior to proceeding underground. A transport driver, Bennedick proceeded with the 5 South crew in order to return their transport to the surface.

The miners Dullahide, and Vivian together with Parker remained on the surface. In response to a manning shortage Squires again contacted Mason at home by telephone to ascertain his wishes regarding labour deployment. It was decided to deploy Dullahide to belt patrol and Vivian was assigned to assist Parker with 4 South Level prep seal construction.

In response to a report of a burst water hose on the continuous miner two fitters were deployed to the 1 North West section early in the shift and took transport to that section. The deputy McCrohon commenced work at 2300 on outbye belt patrol duties.

The last known position of Dullahide was in the vicinity of the 5 South No 1 conveyor to Dip 2 conveyor transfer point.

Parker's intentions appear to have been to get some roof bolts from the stores compound, to go to 512 to pick up some gear and then proceed to the 4 South Level prep seals.

THE FIRST EXPLOSION

At approximately 2330 Squires noted that production from the 5 South section was well below expectation and, in response, telephoned the section. He spoke to the electrician, Mazzer, who informed him that there had been some concern over a noise in the vicinity of the hydraulic pump motor of the continuous miner. Mazzer indicated that mining was proceeding but that a fitter may like to look at the motor later. As Squires was responding that he would organise it, the phone cut out. This was the time of the first explosion.

All of the nine men who were working in the 1 North West panel survived the explosion. Some of them felt their ears "popping" and others were knocked over by a pressure wave. The ingress of dust and acrid smoke into the intake airways caused the men to use their self rescuers and leave the mine. The evidence given by the survivors about the heat experienced from the self rescuers suggests they were exposed to carbon monoxide gas.

Statements from the survivors indicated that visibility was severely restricted on their way out of the mine. The men also reported difficulty in finding their way out of the face area of the panel where no consistent guide was available.

There was no evidence of significant damage to the transport and conveyor roads from the surface and into the mine as far as 1 North West panel. Several timber props were reported as having been dislodged and across the transport road near the entrance to the mine.

The belt deputy, McCrohon who at the time was at 15 cut-through on the Main Dips belt, experienced "popping" of the ears and about 20 seconds later was knocked over by a strong blast of air contaminated with dust. He left the mine by his own means and met the 1 North West crew at the mine portal entry, then travelled in one of the underground diesel vehicles to the mine office.

Squires contacted Mason immediately after noticing dust all around the portals. Mason instructed Squires to not let anyone else go underground, to get the mines rescue suits ready and to contact the rescue station. Mason contacted Schaus by phone and then proceeded to the mine. Schaus proceeded separately to the mine. The mine's emergency procedure was implemented and the inspectorate notified of the situation. The incident was further controlled by an incident control team comprising mine, inspectorate and union personnel.

EFFECTS AT THE MINE

At the same time as the explosion occurred power to the mine was interrupted. Power to the mine's twin ventilation fans was interrupted due to an apparent fault in the underground electrical circuit assumed to have been caused by the explosion. The stand-by diesel alternator automatically started to provide emergency ventilation. This was sufficient to power only one of the two fans and it is estimated that about 60 to 70% of the normal ventilating quantity was restored. Power was restored to both fans approximately 3 hours after the explosion and the fans appeared to operate normally.

No damage was done to either fan although an explosion relief door was blown about four metres away from the fan housing. This was replaced at approx 0040 hours Monday 8 August. The total mine ventilation pressure was reduced by an estimated 15 mm water gauge from that existing before the explosion.

The explosive forces apparently caused the detachment of each of the Victaulic pipe range systems connected to the surface boreholes at 520 and 5 South which became subsequent sample points after the explosion. Approximately 50,000 cubic metres of methane which was being drained from the mine

each day was thereafter a contaminant of the underground mine atmosphere. Evident damage to the mine's tube bundle system prompted steps to drill four boreholes into the 512 goaf area; the vicinity of the 5 South face; a 5 South/510 roadway junction; and, a Main Dips intake airway, in order to ensure gas samples were available from known locations underground. The 512 goaf hole was reported to be blowing outwards and having a bitumen smell while the other holes exhibited negative pressure consistent with the main fan operating.

Gas samples apparently taken by Mines Rescue members were put through a gas chromatograph soon after the SIMTARS staff arrived on site at 0530 hours on Monday 8 August. Samples were taken from the methane drainage boreholes, each of which appear to have become detached from the underground pipe range. Another sample point was the mine fan on the surface. Although contamination of the samples was evident they appeared to indicate three things:

- hydrogen, ethane and ethylene were present in the mine;
- explosive mixtures of gases remained over a large area of the underground workings; and
- greater than 5000 ppm of carbon monoxide existed.

The high methane levels throughout the mine very soon after the explosion indicated that some seals around previous goaf areas were probably destroyed and the contents of the sealed area contaminated the mine atmosphere after the explosion.

Inspection of the boreholes at around 1700 hours revealed that difficulty was being experienced in preventing contamination of samples due to leakage of fresh air into the boreholes. This appeared to have been caused by the mine fan applying a negative pressure to the mine.

Samples taken from the boreholes and the damaged tube bundle system revealed the presence of explosive mixtures of gases and very high carbon monoxide concentrations in several places in the mine continually up until the second explosion. This was one of the factors which prevented the sending of rescue teams underground and necessitated keeping personnel away from the mine entries.

FAILURE TO WITHDRAW PERSONS

There were three key questions facing the Moura mine management on the night of Sunday 7 August 1994:

- should the men go underground;
- what do we tell them; and
- what if they raise concerns?

There appeared to be no decision on the part of mine management whether to have the workface remain out of the mine or not. Squires alone appears to have raised some concern that people be informed but this did not lead to any coherent efforts to do so. Management seemed most concerned that the men may seek to keep themselves out of the mine and that appeared to be the tenor of what

discussion there was on the matter. Of the three questions which faced them, Moura management seems only to have addressed, in any way, the final two.

On the afternoon of Sunday 7 August Squires raised with Schaus the question of an appropriate course of action should the men have any concerns about the 512 Panel passing into the explosive range. It was anticipated, at that time, to do so during the coming night shift. In response Schaus suggested that no one should be forced down the mine and that Mason should be contacted in the event of concern being raised.

In addition, when Squires contacted Mason at around 1830, he sought an opinion as to how issues surrounding the 512 Panel, and in particular its entering the explosive range, should be approached with the night shift. Mason's reply, in essence, was that if no one else raised a concern then neither should Squires and that if anyone elected to not go down the mine then they should not be forced to do so. Mason interpreted Squires approach to have arisen out of some ill ease with having to deal with a new shift; this being the first time that Squires was to be in charge of the permanent night shift.

The background of sealing panels at Moura No 2 was that, apart from a couple of times, the rule rather than the exception was to continue to work underground as sealed panels passed through the explosive range. This appears to have been accepted by management as the norm. This norm was not tested as a result of concern, or confusion, or precaution which had prompted the early sealing of the 512 Panel.

There were assumptions on the part of management that the workforce knew of the signs that had prompted the bringing forward of the sealing of 512. The basis for this was given in evidence as the fact that many of those who were to go down the mine on the evening of Sunday 7 August 1994 had worked on the sealing of the panel and that from there the 'grapevine' would be sufficient to ensure that all were informed.

The following passage is from the evidence of Mason in relation to his conversation with Squires on the Sunday evening:

> "Can we move on with the conversation? Did he ask you something about how he should deal with the matter at the start of shift that night? - *Yes, he did.*
>
> What did he say about it and what did you say about it? - *Well, I was rather confused. Michael asked me then at that point, after I had explained to him my - how - I'd explained to Michael how I would deal with the situation, then he asked me how I wanted him to deal with it, how I wanted him to broach the subject at start of shift. I was somewhat confused, because I had just spent time going through that with him.*
>
> Again, if you could try to give the conversation that took place as best you can remember on this aspect of the telephone call? - *Michael asked me how I wanted him to approach the subject at the start of shift; did I want him to summon all the men together and give them a run-down of the events that had transpired. I told Michael there was no need to do that. I did*

not believe there was a need to do that, as quite a number of the people who worked permanent night shift had been involved with those events on the weekend. They had been there through the sealing, there were deputies that had been at work through the sealing and the shifts preceding and the shifts subsequent. I told him that I thought that the men would be well aware of the situation as it was.

But when you say "the situation as it was", what are you referring to there? - *Well, that course of events that had transpired over the weekend.*

But I'm just interested in what you mean when you say the men would have been well aware of what the situation was. Can you explain that reference - "the situation as it was"? - *Well, all those things that we have spoken about up to...*

Just run through them? - *That the panel had been sealed as a precautionary measure as a result of a number of observations that had been made - I guess basically that's it.*

The men that were to go down on the night shift that night, do you say that they would have been aware of this report from Mick Caddell about a slight tarry smell on the Friday afternoon? - *I believe they would have been, yes.*

How would they have become aware of that? - *The people who were involved on the sealing process had that - had those circumstances explained to them.*

But not all of these men that were to go down on the Sunday night had been involved in the sealing process, had they? - *That's correct.*

So, on what basis did you expect that those people would have become aware of this report of Mick Caddell on the Friday afternoon of a slight tarry smell? - *News around the mine - there is quite a good grapevine at work. People always seem to have knowledge of events that transpire in the mine.*

So, you were relying on the grapevine, in effect; is that what you are saying? - *Yes."* **(Transcript p3566)**

In addition to this assumption, there was no discernible action on the part of management to, in any way, test the knowledge of the workforce nor to ensure that they were fully informed for what was to become the life and death decision they were tacitly expected to make. There was in fact no clear signal to the workforce that would tell them that it was left in their hands to make such a decision. They, quite reasonably, appear to have expected management with, generally, better access to information and knowledge to make such decisions with regard to the safety of the mine.

The Inquiry does not accept that the workforce must have known all, or even sufficient, relevant facts to do with the state of the mine. Even if they had known them it is considered unlikely that they would have been sufficiently well understood.

This is supported by the following, from the evidence of Schaus:

> "Right. In your experience, when a panel is sealed is there a topic of conversation that assumes more prominence amongst the miners, namely the seals? - *The fact that the seals are erected and that the gases are going up, I believe that a significant part of the workforce is aware of that. I'm not saying they all do take that into account but.*
>
> Is it a topic of conversation amongst miners after seals? - *Yes, but I - I honestly think that not all of them understand it either."* **(Transcript p3931)**

It is the opinion of the Inquiry that events at Moura surrounding assumptions as to the state of knowledge of the night shift on 7 August, and the safety of those at the mine, represent a passage of management neglect and non-decision which must never be repeated in the coal mining industry. Mineworkers place their trust in management and have the right to expect management to take responsible decisions in respect to their safety. They also have the right to expect management to keep them informed on any matter likely to affect their safety and welfare.

It is regrettable that the air of caution, arising out of uncertainty, which was exhibited at the mine in order to bring forward the sealing of 512 Panel did not extend to the general safety and welfare of the workforce and, in particular, to informing and keeping persons out of the mine for a time subsequent to that sealing.

HEATING SCENARIOS

It was expected at the mine that the atmosphere in the 512 Panel would enter the explosive range. The mine's tube bundle monitoring system gave those present a reasonable estimate of when it would do so. It was, therefore, known approximately when there would be sufficient fuel and oxygen to support an explosion. In effect the Maihak system through the displayed Ellicott diagram was telling them that the 512 Panel could explode; and it did.

What was apparently unexpected was a source of ignition in or near the panel sufficient to ignite the accumulated methane gas. It appears almost certain that the source of ignition was a heating that had developed in the panel.

There remains a number of possibilities for the nature of that heating:

> · it developed in broken coal left in a ramp when bottoms were taken during mining. This might have been shielded from cooling ventilation as a result of location, being under a roof fall, covered with stone dust, or some combination of these;

· it developed in broken coal which resulted from rib spall. Similarly this may have been shielded by location, stonedust, or a subsequent roof fall; or

· it developed in fractures formed in a crushed remnant pillar or stook.

These possibilities are not mutually exclusive and there is the possibility for some combination of all to have occurred.

The balance of opinion expressed at the Inquiry, however, indicated that the heating was most likely deep seated, relatively small and intense. The principal bases for this opinion were the transient nature of any tell tale signs and the far greater potential for a small, deep-seated heating to be masked.

If indeed the heating was small and deep seated it may well have been present in the panel for some time. Suggestions that this may have started around early to mid June probably should not be discounted. If that was the case then the panel contained its own 'seed of destruction' long before sealing and the first explosion.

GAS MONITORING AND INDICATORS

The principal means that the mine employed for detecting the onset of spontaneous combustion was by means of measuring CO concentrations in return airways and from these measurements deriving the related measure, 'CO make'.

An advantage of monitoring 'CO make' as opposed to CO concentration is that it takes into account any changes in ventilation quantities (assuming constant efficiency of that ventilation in collecting CO) and so may be a more reliable measure. Awareness, in Australia, of the potential use of "CO make" as an indicator of the degree of oxidation of coal effectively dates back to 1985 and the publication of the first edition of "A Manual on Mines Rescue, Safety and Gas Detection" by Strang and MacKenzie-Wood. Here, the carbon monoxide make is presented as an adjunct to Graham's ratio in providing a guide to fire intensity, thus:

> "If the carbon monoxide concentration and air quantity is known then 10 litres of carbon monoxide production per minute requires investigation and 20 litres of carbon monoxide production per minute indicates that considerable danger exists."

Despite the apparently strict relationship given in this context, the evidence of MacKenzie-Wood at the Inquiry, was that the figures of 10 and 20 l/min, were only ever meant as a guide and should only be interpreted that way. This was despite a common perception to the contrary that had arisen from the Strang and MacKenzie-Wood publication. MacKenzie-Wood's evidence also indicated that this "CO make" guidance had been taken up by at least one mine in Queensland to establish action limits different from the 10 and 20 litre per minute figures. These concepts were reinforced in a 1992 review

of the subject of spontaneous combustion detection at which MacKenzie-Wood and officers of SIMTARS were participants.

The system in place at the Moura No 2 mine for monitoring the 'CO make' of working panels was introduced by the former manager Reed sometime after attending the SIMTARS seminar of 1989. That system, in its final working form, comprised the ventilation officer, Morieson, taking weekly ventilation readings at designated ventilation stations in panel returns. In addition, a gas detector tube reading for CO was taken in order to provide some comparison with readings being produced by the Maihak system.

The ventilation readings were combined with a weekly average CO figure from the Maihak monitoring system for the corresponding monitoring point at, or near, the ventilation station to produce a "CO make" figure. Although this meant that the concentration and ventilation quantity readings were not concurrent and so, the resultant 'CO make' was strictly speaking invalid, the system did provide a great degree of smoothing in the data produced and so may have been of some benefit in the monitoring of longer term trends. The downside was that any shorter term changes in 'CO make' would be masked although the CO concentration recording, readout and alarm facilities of the Maihak system may be expected to adequately cater for such shorter term variation.

Another shortcoming in the arrangement at Moura was the relatively high air quantity passing the monitoring point in the top return of the 512 Panel. This was typically of the order of 40 cubic metres per second, resulting in a 'CO make' change of some 2.40 l/min for each 1 ppm change in CO concentration. What may have appeared to some as relatively insignificant changes; of the order of 2 ppm as a CO concentration may well have appeared differently if considered as an increase of near 5 l/min as a 'CO make'.

In all, there was a great reliance at the mine on the monitoring system's ability to detect any significant increase in CO produced from a panel and so provide some alert. This coupled with the perception that a sharp rise in CO production was a necessary accompaniment to the start of a heating set the tenor for how that whole issue was approached.

Given the conventional wisdom that CO was the primary indicator of spontaneous combustion activity this was probably not unreasonable, but may well have reduced awareness of the importance of other indicators such as smell, haze, or condensation; and the importance of effectively capturing and evaluating occurrences related to those indicators.

As an aid to monitoring trends, Abrahamse had developed a spreadsheet model into which Morieson could enter measurements, calculate 'CO make' and produce trend graphs with time. It was the normal practice at the mine that these graphs were produced weekly for active extraction panels. This normally occurred on a Friday and copies of data and graphs produced given to the manager, posted on a notice board in the deputies surface crib room near the start point, and a copy filed.

The state of knowledge regarding 'CO make' levels, and their potential significance, at the mine prior to 7 August 1994 appears to have been as follows:

· there was some knowledge, primarily attained through mines rescue training of the 10 and 20 l/min guidelines contained in the published work of Strang and MacKenzie-Wood.

· despite the system of 'CO make' monitoring having been in place at the mine for some considerable time there were two distinct schools at the mine: the concentration watchers; and the make watchers. The concentration watchers were either unfamiliar with, or uncomfortable with, 'CO make' and so preferred to monitor and make judgements based on concentration.

· again, despite the existence of the 'CO make' system along with the regular supply and display of graphs of 'CO make' with time, most at the mine (including the mine manager who was supplied with the graphs) were concentration watchers;

· those in senior management positions and, in particular Schaus, Mason and Squires did not admit to being familiar with the 10 and 20 l/min guidelines, or for that matter 'CO make' concepts, prior to the event. They rather preferred to rely on monitoring CO concentrations and to look for any rapid increase;

· Schaus and Squires had been mines rescue trainees, Mason, apparently, had not;

· Morieson recognised the guidelines but reasoned that they had been derived for different coals and so weren't strictly applicable;

· Morieson, as a personal initiative, had made an experience based assessment that from a base of 2 l/min (resulting from panel development) the 'CO make' of 512 Panel might be expected to increase at a rate of approximately 1 l/min per week.

· this led to a final estimated 'CO make' from the panel of around 14 l/min. Morieson appears to have discussed these matters with Abrahamse, but no one else;

· the potential for the apparent 'CO make' to be influenced by such factors as panel working layout was recognised. In particular, it was recognised that a measured 'CO make' may be influenced by where the continuous miner was in relation to the width of the panel (This was used as part justification for taking weekly average CO concentrations to remove 'bumps' from trend graphs produced);

· on taking over as registered manager in December 1992, Schaus spent two days being briefed by the outgoing manager, Reed. Part of that briefing included discussion of the monitoring of 'CO make'. The evidence is that Reed related to Schaus that the 5 North panel of the mine had been sealed, as a precautionary measure, when the 'CO make' for the panel reached 12 litres per minute.

· Schaus did not appear to use the 12 l/min figure as a trigger for any evaluation or other action. Nor did he develop, or cause to be developed, any other alarm or action level based on CO concentration or make;

· the 'CO make' from the 512 Panel was recognised to be higher in relative terms to that from other recent, comparable panels. This was attributed to the nature of mining in 512; the extensive taking of bottoms and the leaving of relatively larger quantities of loose coal.

In the course of the Inquiry the following additional evidence emerged regarding 'CO make':

· its accurate measure is dependent on the efficiency of ventilation in sweeping a panel and collecting CO. It follows from this that ventilation alterations which change the course of, and so the efficiency of, goaf ventilation may influence the apparent 'CO make'. It also follows that as a goaf becomes more extensive a similar effect may occur which masks the true 'CO make';

· factors which may affect the production of CO include: the size of a panel, the mining method as it impacts the amount of coal surface left exposed, the reactivity of the coal, and the rate of coal production; and

· a difficulty with 'CO make' as an indicator is that it is not an absolute measure of the type and extent of oxidation. A certain 'CO make' may result from a benign, but extensive ambient temperature oxidation of coal. A similar level of 'CO make' may result from a dangerous, intensive oxidation which is sufficiently hot to act as a source of ignition for methane. To make matters worse, these possibilities are not mutually exclusive and that same level of 'CO make' may, clearly, be the result of some combination of both extensive and intensive oxidation occurring simultaneously.

The 'CO make' for the 512 Panel did exhibit an increase with time of extraction not entirely inconsistent with Morieson's prediction, although at a somewhat greater rate than predicted. The 'CO make' appears to have tracked production reasonably closely until around mid June where the relationship appears to break down. It is probably not coincidence that it is around this time that the ventilation difficulties and remedial measures taken occurred and this, in all likelihood, influenced the efficiency with which ventilation swept the goaf at that time.

By mid July the 'CO make' had reached a level around the maximum predicted by Morieson, but the panel still had some 3 to 4 weeks to complete extraction. This did not appear to cause any re-evaluation of the 'CO make' situation, although this may well have been because Morieson was on leave at the time.

The events of 22 July did apparently cause some evaluation of the 'CO make' in 512 but it was concluded, as revealed in evidence by mine manager, Regan and Mines Rescue Superintendent Kerr

that the mining characteristics of 512 could be, and in fact were, used to explain the level of 'CO make' being observed.

With the exception of some mention which Kerr made of the 'CO make' from 512 and the likelihood of it resulting from a somewhat different method of mining, in the course of a phone conversation with MacKenzie-Wood some days later, there appears to have been no other attempt by anyone at, or associated with the mine, to seek any other opinion on the matter. It should be noted that Reed remained associated with the mine as Quality Assurance Manager but no one appears to have sought the benefit of his experience.

Nor does there appear to have been any attempt to test the assumption that the 'CO make' could be attributed in large part to the method of mining 512. The assumption remained untested: albeit an assumption based on some reasoning on the part of Morieson and others, but, nonetheless an untested assumption.

At that time levels of around 6 ppm CO were being indicated by the Maihak system in the 512 top return. This apparently low concentration may well have given some comfort to those whose practice it was to watch the concentration rather than the make of CO.

On Schaus' return from leave on 2 August he recalled, in evidence, noting the 512 top return CO concentration to be of the order of 7 ppm. This compared with his recollection of 6 ppm prior to his departure some three weeks earlier and was not cause for alarm. His mine record book entry for Friday 5 August noted 8 ppm.

Examination of data from the mine's Maihak system reveals that during the week starting 1 August the CO concentration in the 512 top return increased steadily from around 6 ppm at the beginning of Monday 1 August to exceeding 9 ppm on a number of occasions during the evening of 5 August. It might also be noted that the last week of the panel's life was the week of greatest coal production.

A number of alarms were raised by the Maihak system during this week commencing with a breaching of a 7 ppm CO level on the morning of Tuesday 2 August and followed by a reading of 8.8 ppm breaching an alarm level of 8 on Wednesday, 8.03 ppm breaching 8 on Friday 5 August and 8.33 breaching 8 on the morning of Saturday 6 August. These alarms were generally not acknowledged for periods of hours. The identity of those doing so remains unknown, and early in the week there had been a re-setting of the CO alarm level, again by a person unknown.

The mine had no protocol or authorities in effect for the acknowledgment of alarms, or for that matter, the re-setting of alarm levels. While the alarms did not signal any dramatic rise in CO levels they nonetheless should have had the potential to trigger some closer consideration and investigation of the 512 Panel. This potential was never realised and yet again represents a lost opportunity for some form of action to have been taken.

At around the time when sealing was put into effect Klease, the 512 Panel deputy for day shift Saturday 6 August, recorded 8-9 ppm by means of gas detector tube in the top return. Data from the Maihak system indicates readings in the mid 8s for around this period.

Before proceeding underground on Saturday afternoon shift Mason made an estimate of the 'CO make' from the top return, from the preceding deputy's measurements. His calculations produced a result of some 19 l/min. Mason could give no reason for making the calculation other than that he was "looking for something to do to try and give me some comfort". We note the inconsistency of these actions with Mason's earlier evidence to the effect that he did not understand 'CO make'. Nevertheless his estimate of the 'CO make' is consistent with that of Schaus for Friday 5 August and recorded in the record book on 7 August.

After sealing, gas concentrations indicated by the Maihak system behaved in a manner consistent with what could reasonably be expected. There appeared to be an essentially linear increase in concentrations of CO and methane accompanied by an associated reduction in oxygen. Expert evidence was that Squire's estimate of an increase of around 6 ppm per hour for the 'CO make' is not inconsistent with the 19 l/min variously estimated shortly prior to sealing (although Squires did not have the means of knowing this at the time).

The steep, or exponential, rise in CO production from the 512 Panel, which would definitely have aroused concern, just simply, did not occur. In this respect the monitoring of CO on which the mine relied so heavily as an indicator of a worsening situation failed in practice. This must surely bring into question the wisdom of a total reliance on CO as an indicator to the exclusion of the potential importance of other tell-tale signs related to spontaneous combustion.

Another commonly used indicator of spontaneous combustion, Graham's ratio, achieved prominence during the Inquiry. Graham's ratio may be variously thought of as a ratio of carbon monoxide to oxygen deficiency or, in other words, the ratio of carbon monoxide produced to the oxygen consumed by an area of a mine. Its prominence was, in no small part, due to some quite extraordinary efforts at post-event normalisation and rationalisation of the large mass of data from the mines tube bundle system. In fact, this treatment wasn't confined to Graham's ratio and was also reflected in what the Inquiry heard about 'CO make' and related matters This, in turn, was accompanied by some rather selective attitudes to the data and it was interesting to note that approaches to Graham's ratio, to questions surrounding the validity of the ratio after sealing, and to 'CO make' and other gas indicators proceeded largely along 'party lines'.

Notwithstanding the 'partisan' nature of the evidence the following appears to have been the situation at Moura regarding Graham's ratio, and information reasonably available from it:

· Graham's ratio was routinely derived from gas concentration measurements within the tube bundle system and displayed along with those results;

· despite this facility no real cognisance was taken of the ratio and it was, with the exception of Barraclough, simply not used by anyone at the mine;

· Barraclough recognised Graham's ratio as the primary means of detecting spontaneous combustion, this dating back to his original training in the 1950s;

· the former manager, Reed did not consider Graham's ratio to be useful at Moura it having not indicated a heating in 1986 when other measures did;

· Schaus was aware of Graham's ratio from his original training but upon arriving at Moura noted that it did not seem to be used. Probably as a consequence he does not appear to have used it either, instead relying on what systems seemed to be in place;

· Mason testified that he had some interest in it when he transferred from the Moura No 4 mine to Moura No 2 to around 1986 but was now by no means familiar with it or its use;

· Squires knew what is was, but did not have a feel for any critical values of the ratio. He further seems to have assumed that if it was important then the Maihak system would produce some form of alarm indication for it;

· overall attitudes to the Graham's ratio were no doubt shaped by the mine's use of CO production as a chosen primary indicator of spontaneous combustion;

· at the time of sealing 512 the ratio exhibited a value of approximately 0.2 having risen gradually throughout the life of the panel;

· some short term fluctuations, of the order of 0.03, did occur around mid-June and at other times but these were not noted at the mine (in the absence of anyone paying very close attention to the ratio this is not surprising);

· after sealing the displayed value of the ratio for the sampling point behind the 512 seals increased over a period of some 22 hours to a value of approximately 0.8;when graphed for the Inquiry this increase appeared substantially linear but slightly convex upward, but nobody at the mine graphed it;

· there was evidence that Graham's ratio values available at the mine would have been influenced by variation in sensitivity of the oxygen analyser through barometric pressure effects, and an approximately 0.4% low reading offset introduced at a time unknown;

· these influences may have confounded the use of the ratio prior to sealing, if anyone had been paying very close attention to it, but no one was;

· there was considerable debate as to the utility, or otherwise, of Graham's ratio after sealing as a valid ongoing indicator of combustion activity;

· the former manager, Reed had some time ago discarded it for this role because of the rapidity with which Moura goafs gassed out;

· apart from an indication from Barraclough that he was aware of the value of the ratio from 512 Panel, when acting as registered manager, there was no evidence of the ratio being used in conjunction with the 512 Panel;

· there was expert opinion to the effect that the ratio does have some validity for some time after sealing. This was, however, tempered with caveats related to the need for considerable experience and expertise in using such information;

· there was expert opinion to the effect that while the values of Graham's ratio available to those at Moura may well not have triggered alarm in themselves, that had they been taken in context with all the potentially available information they should have done so.

The end position of the Inquiry with regard to Graham's ratio and its potential utility as means to provide some alert, is that it was like many other things at the Moura No 2 mine. Had it been used routinely, had it been used in context with other information, and had it been seriously considered after the sealing of 512 then it may have tipped caution in the right direction. In the event, it wasn't used and it did not - another lost opportunity!

FAILURE OF REPORTING AND COMMUNICATION

It has not escaped the Inquiry's attention that a number of important events in the short, but turbulent, life of the 512 Panel seemed to happen on a Friday: the undermanager McCamley's investigation of a ventilation difficulty on 17 June; Robertson's 'smell' report of 24 June; the events of 22 July; and, ultimately Caddell's observations of 5 August. In all these instances the need for some ongoing action and continuity was challenged by the change in shift arrangements occurring at weekends. In particular, the loss of face to face contact between deputies at change of shifts and deputies being accorded the leeway of selecting their own duties.

In addition, during the life of the panel there were significant comings and goings of what were key personnel. McCamley, who had certain concerns with the 512 Panel left the mine for alternate employment. The registered manager Schaus was absent for a significant period, from 11 July through 2 August, returning as he did five days before the first explosion. The ventilation officer Morieson was also absent in what now appears to have been a critical period toward the end of the life of the 512 Panel. The demise of any 'system' resulting from the events of 22 July appears to have coincided with Abrahamse departure on sick leave.

Other key personnel at the mine came, and went, apparently without ensuring that all relevant information was either captured, or passed on, or in fact acted upon. Undermanagers' shift reports were totally preoccupied with logistic arrangements with the result that vital safety related information was left in the province of deputies' reports or word of mouth. For their part, deputies' reports were

typically perfunctory and in the case of Robertson a critical report appears to have either not been read, or if read, not acted upon. Any illusion that verbal reporting, at what was after all a relatively small mine, was working sufficiently to ensure adequate information flow was ill founded and any such system just plainly did not work.

Communication at the mine was within the ambit of the Quality Assurance (QA) system for which the mine had received accreditation from Standards Australia in 1994. The suggestion from evidence was that the QA system was developed to reflect what was happening at the mine and, at least in the initial stages, was seen as a means of documenting the way the mine did certain things. Given the actual state of communications at Moura it must be concluded that the QA system, rather than reflecting what was actually happening, was somebody's view of what should be happening.

The remoteness of the QA system from actual practice at the mine was further indicated by the evidence of the undermanager in charge, Mason, who, despite having a significant proportion of his duties fall within the coverage of the QA system, testified that he had never reviewed those components of the system covering those duties.

In addition, the two most senior operational managers, the registered manager and under manager in charge, had widely different perceptions about when the 512 Panel was originally intended to be sealed. The players in the events surrounding 22 July had no knowledge of earlier, and potentially relevant, observations and actions. The registered manager on return from leave remained unaware of any of the 22 July issues until 7 August when he first examined the mine record book, five days after his return. Schaus was not aware that the sealing of 512 panel was under way until after the sealing had actually started. He had not been informed of the sealing until that point, nor that the sealing had been brought forward from the original time intended by Mason.

The working relationship between Schaus and Mason appears to have been less than co-operative and to not have supported effective communication to an extent necessary between a manger and an undermanager in charge of a mine.

In all, it must be said that there appeared a total absence of any coherent, disciplined system at the mine to deal with the spontaneous combustion hazard which they faced. A direct consequence of this absence of a system was that no one person, or group of persons, at any time had all the facts available to them on which to base decisions.

There appeared to be no one who was a single and responsible recipient of a series of apparently disconnected but vital pieces of information. No one was put in, or for that matter assumed, a position where they had the whole picture. Perhaps, during his time as registered manager, Reed may have been in such a position, but he left no durable arrangements in place to ensure that any system he was using was maintained. Schaus, for his part, appears to have assumed that such arrangements existed whereas the evidence to the Inquiry has shown clearly that they did not.

There was also no system to trigger the bringing together of people to consider the overall picture. From the Friday afternoon shift onwards any discussion between the three key players in assessing the safety or otherwise of the mine, Schaus, Mason and Squires only proceeded one-on-one, and often by telephone.

There was no collective effort but, rather, an apparent willingness to chance one's arm on the largely subjective opinion of another, and then with that opinion backed up by only limited, if any, personal observation or objective data.

While management may have a reasonable expectation to be informed of certain matters it also has an obligation to put in place and, most importantly, to maintain systems for the capture and proper evaluation of all necessary information. At Moura No 2, while the expectation may not always have been fulfilled, then neither was the obligation honoured.

EQUIPMENT THAT WAS NOT USED

The on-site gas chromatograph was not used to gain information about the 512 Panel prior to the first explosion. There appeared, from the evidence, a perception at the mine that the instrument was intended only for emergency response, its installation having resulted from a recommendation of the 1986 Moura Inquiry related to the availability of chromatographs at or near mine sites. This was to overcome one of the 'tyrannies of distance' in Queensland and enable gaining of information about atmospheres from mines more quickly than would be the case from having to wait for the arrival of equipment and expertise from Brisbane or another centre.

While the detection limit for CO of the chromatograph may be seen as a reason for its not being used for that gas it does not justify it not being used to monitor for other gases and, in particular, the higher hydrocarbons which are a tell-tale sign that a heating may be present at a relatively advanced stage. It does not seem to have occurred to anyone that the chromatograph may have been useful in the examination of 512 Panel, or that it may have been a means of gaining a further insight into what was happening in the panel after sealing.

Although the detection limits of the chromatograph may have compromised its usefulness in analysis of samples with high associated air quantities, such as in the 512 top return, it may well have been of utility in a close examination of other parts of the panel prior to sealing, or in the analysis of the atmosphere behind the seals as a precautionary measure. While it can't reasonably be said that the use of the chromatograph would have prevented the outcome at Moura , its non-use must certainly represent yet another lost opportunity to gain knowledge of the actual situation in 512.

In the event no samples were introduced to the chromatograph until after the arrival of SIMTARS personnel at the mine. This was despite the apparent collection of gas samples prior to that time by Mines' Rescue personnel who do not appear to have had the capability to use the chromatograph to analyse them. Clearly, if the intent of the on-site chromatograph was to provide rapid results before the arrival of SIMTARS then that intent was not met.

The mine also possessed a Probeye infra-red imager. This item of equipment was utilised in searching for a suspected heating in the 5 North section in 1986. In the interim it appears to have languished in a cupboard. It was not used by McCamley in his examination of the 512 goaf on 17 June nor by anyone else who may have suspected something amiss with 512 Panel. The evidence suggests that, in any case, it could not be used at short notice due to the absence, at the mine, of a high pressure argon cylinder required to charge the Probeye unit prior to use.

EVIDENCE FROM AFTER THE EVENT

Evaluation of the results of analysis of gas samples taken from boreholes after the first explosion were a means of indicating the fuel involved. The boreholes were in three locations with respect to the underground workings:

· in the 512 Panel at around 3 heading, 4 cross cut;

· in the 510 Panel at around 1 heading, 17 cross cut; and

· in the right hand entry of 520 Panel (off 5 South Bottom Return).

Samples from both the 512 and 510, through the 'H/C Index', indicated methane to have been the predominant fuel of the first explosion.

The sample from 520 Panel indicated a predominantly methane ignition with possible involvement of coal dust. The possible involvement of coal dust could not, however, be clearly separated from the possibility that some post explosion combustion such as a fire or smouldering may have occurred.

Other boreholes were sunk in order to attempt the collection of photographic evidence in the form of video recording. These were located outside seals in 1 Heading of 511 Panel (a brick seal) and 2 Heading of 512 Panel (a Tecrete seal). A borehole attempted in the vicinity of a seal in the 5 South panel proved unsuccessful. Evidence obtained from the boreholes indicated the following:

· both the 511 and 512 seals originally in the vicinity of the boreholes were absent;

· there appeared to be seal debris outbye the 512 seal at a short distance from the original seal location;

· there appeared to be bricks from the 511 seal inbye the original seal location; and

· a number of roof bolts that had provided reinforcing for the 512 seal appeared to be bent outbye;

· there was no evidence of the presence a crib table and Tecrete batcher (mixer) which had been observed in the vicinity of the 512 seal by Blyton during the afternoon shift of Sunday 7 August; and

· a number of props were still standing in the vicinity of both seals.

These observations indicate an explosion occurred within the 512 Panel. The proximity of seal debris to the 511 and 512 seals may indicate those seals to have been destroyed by a relatively weak explosion, and, by inference, the first explosion. These indications are, however, by no means certain and do not preclude the possibility of explosion initiation external to the 512 Panel.

THE SECOND EXPLOSION

The second explosion occurred at approximately 1220 hours on Tuesday 9 August 1994 and was observed by many of the people on site. The observed effects indicated that it was more violent than the first explosion. The ducting linking the mine fan to the shaft was destroyed, some sections being reportedly launched into the air. Large volumes of dust, smoke and gases, including carbon monoxide, were forcefully emitted from each of the entry tunnels into the mine. The surface facilities including the emergency control room, the gas monitoring room and the bathroom, although being over 250 metres away and to the side of the mine openings were covered with dust. The prevailing wind brought products of combustion from the mine to the surface facilities. Carbon monoxide levels around the surface facilities rose to over 400 ppm and required the use of self rescuers and immediate evacuation of the area.

Contamination of the atmosphere around the surface buildings continued after the main blast with smoke continuing to issue from the underground tunnels. This made the Emergency Control Room unfit to use and, as a result, gas analysis equipment was relocated to a safe position several kilometres away in the open cut mine office complex.

Smoke and dust were emitted continuously from the entry tunnels after the explosion. Mine ventilation was reversed with the upcast shaft becoming the fresh air intake for the mine. These observations led to an assumption that active fires remained underground.

SEALING OF THE MINE

In order to control the suspected underground fires, a decision was taken to seal the entrances to the mine including the shaft. This decision was made on-site by the incident control team. The following is the incident log book entry apparently made by senior inspector Bancroft:

"Consideration of all factors incident team unanimous that if it were possible to recover victims it should be done. However all evidence particular 2nd explosion there was no hope of recovering victims or finding any evidence of cause. Incident team unanimous that shaft and tunnel should be permanently sealed."

There was no safe access for persons to enter the open cut excavation tunnel entry area and the only readily available safe method was to push mine spoil over the edge of the highwall, the spoil covering the entries. Consideration was given to locating an airlock in the transport tunnel, however neither a pre-fabricated airlock nor a safe access to install one was readily available.

Two options were considered for sealing the mine fan shaft:

- fill the shaft with spoil up to the base of the C Seam; or
- place a concrete or steel lid on the shaft collar which could later be removed and also isolate No 4 mine workings from the shaft thereby allowing an easier re-entry into the mine.

In the resulting course of sealing, the upcast shaft was filled to the surface with spoil and the highwall entries closed off by pushing spoil material over the edge of the highwall.

MATTERS THAT REMAIN UNCLEAR

The time and cause of death of those who perished remains unknown. It is not known whether they survived the immediate effects of the first explosion; or whether they were able to don self rescuers. It is not known whether the 5 South crew assembled, or whether they had started to travel in an attempt to get out of the mine. While some expert opinion indicated that the availability of self-contained self rescuers may have enhanced survival chances, this can be by no means certain in the absence of definite knowledge of the fate of the victims.

The balance of expert opinion was that the 5 South crew may well have survived the first explosion and so may have been able to don self rescuers. This appeared to be based on the 512 Panel being the source of the explosion, the effects observed by those in the 1 North West section and Main Dips and resulting estimates of explosion pressures. Had the victims survived the immediate effects of the first explosion, they would have subsequently been exposed to high concentrations of carbon monoxide. In such an atmosphere, heat generated within the type of filter self rescuer in use could have rapidly become intolerable to a wearer and so cause its removal and exposure of the wearer to the poisonous carbon monoxide.

The location of the belt patrolman, Dullahide, remains unknown as does the location of Parker and Vivian and their vehicle. In particular, it is not known whether Parker and Vivian were in the vicinity of the 512 seals at the time of the first explosion or whether they had proceeded to 4 South Level. The apparent absence of the Tecrete batcher from near the belt road seal of 512 may be an indication that they had been to 512 to collect it but had then departed.

The cause of the second explosion also remains unknown although a remnant fire or smouldering material from the first explosion appear likely initiators. The source of fuel for the second explosion is also uncertain, the primary possibilities being gas from previously sealed areas breached by the first explosion, or gas from a damaged gas drainage installation.

RECOMMENDATIONS

PREAMBLE - THE FUTURE

The previous three Inquiries into major explosions in Queensland coal mines have consistently made recommendations aimed at addressing perceived deficiencies in the coal industry's arrangements for training, or the state of knowledge of industry personnel. There has also consistently been the conduct of seminars and symposia as a response to those disasters, accompanied by the production of publications about the hazards of underground coal mining revisited in the course of those Inquiries. These measures have, however, clearly not been effective in the longer term with the industry displaying, as it does, a capacity to lose sight of the lessons of the past and to not maintain an adequate knowledge base among key personnel.

In response to the Moura No 2 incident, the subject of this Inquiry, there will no doubt be an early spate of training, the conduct of seminars and symposia and, probably, the production of more publications. The immediate past track record is that these measures will be effective for somewhere around a decade with fundamental problems beginning to re-emerge somewhat earlier.

There seems a clear need to put measures in place to ensure that vital lessons are effectively revisited and that the past is not repeated. To not do so is to invite further disasters.

It is with this grave concern that the following recommendations have been drafted - a concern that there must be fundamental and permanent change in the current approaches and attitudes in the coal industry.

The recommendation relating to statutory qualifications is intended to ensure that those holding such qualifications revisit the lessons and update their knowledge. Similarly, the recommendation for spontaneous combustion management plans is intended to ensure that spontaneous combustion never again becomes the subject of assumption as a means of management, and that capable, reliable and durable arrangements are put in place to effectively manage that hazard. There must surely be a sense of deja vu with the recommendation relating to industry training as it applies to spontaneous combustion - how many times does it have to be said?

Within a number of recommendations and comments which follow, there are lists of matters that might be considered. Where these lists appear they are in no way to be considered exhaustive but rather indicative of the types of matters that should be taken on board. Deliberation should not be limited to the actual content of any of the lists.

Many of the recommendations and comments contain a suggestion that industry working parties be convened by the Chief Inspector of Coal Mines for certain purposes. This approach has been taken because, although the Inquiry considers itself to be in an excellent position to identify issues which should be addressed, it recognises that it may well not be in the best possible position to work through those issues to an optimal conclusion.

It is the express intent of the Inquiry that where such groups are convened that all reasonable steps are taken on the part of Government to ensure that they are adequately resourced and supported for the tasks with which they are charged. It is also expected that employers and unions provide adequate support for these processes. The work of the groups cannot be considered complete until the results of their work are in place, and effectively operating, in the coal industry.

In framing its recommendations the Inquiry took careful note of and received encouragement from various reported undertakings of the Minister for Minerals and Energy to fully implement, as soon as practicable, the recommendations of the Inquiry.

The recommendations which follow are in no express or implied order of importance or urgency of implementation, they being considered equally important. Where a recommendation was not considered warranted by the Inquiry but it still wished to direct attention to a matter then a comment has been made to that effect. These comments follow the recommendations.

SPONTANEOUS COMBUSTION MANAGEMENT

The absence of a specific and durable system for the management of the spontaneous combustion risk was identified as germane to the ultimate outcome at Moura No 2.

Taking into account contemporary approaches to safety management, and considering events at Moura No 2, it appears reasonable that such a system for spontaneous combustion management should be built on certain principles to achieve required objectives.

The management system should be based on an assessment of the spontaneous combustion risk present at a mine and there should be reassessment of that risk from time to time and modification of the system, if required. The system should also contain provision for review of adequacy both on a regular basis and as a result of defined events or significant change in operating conditions.

Responsibilities and authorities of all persons with a role in the operation of the system should be defined and the system should be in a form which allows up to date information to be effectively communicated to those concerned. The system should contain means to ensure that appropriate training is delivered to persons operating within the system.

There must be means of attaining assurance that the system is being followed at the mine and this should involve a schedule of timely internal and external audits of system integrity and operation.

There must be measures defined by the system to, as far as practicable, prevent the occurrence of spontaneous combustion. Such measures may include, but may not be limited to, mine and panel design together with ventilation and working methods.

There must be effective means for the gathering of information related to spontaneous combustion with an emphasis on early detection and evaluation. These should include, but may not be limited to, appropriate gas monitoring, personal observation and reporting processes.

Means for the evaluation of spontaneous combustion related information must be defined, together with decision processes covering both the evaluation of that information and resulting actions.

Responsibilities and authorities within those decision processes must be made clear.

Such a system should take the form of a spontaneous combustion management plan which should, in turn, form part of a broader mine safety management plan. Clearly, where a mine develops and implements a broader mine safety management plan, then, the requirements of a spontaneous combustion management plan may be incorporated in the broader plan but must still be subject to any conditions applied to stand-alone spontaneous combustion management plans.

It is **recommended** that all mines be required to develop and implement a spontaneous combustion management plan along the lines outlined to provide effective long term control of that risk and which satisfies any requirements of the Chief Inspector of Coal Mines as a condition for continued operation of the mine.

MINE SAFETY MANAGEMENT PLANS

While identifying the specific need for a management plan to deal with spontaneous combustion it is clear that it is not the only risk area requiring such structured management. Several areas in addition to spontaneous combustion were identified in evidence where Moura No 2 was deficient including ventilation, gas monitoring and evaluation, and communications.

These and other matters should be the subject of management plans formulated and implemented as the primary means of controlling risks at a mine and which complement statutory requirements to aid in ensuring the safety of mine personnel.

It is **recommended** that mines be required to put in place Mine Safety Management Plans to cater for key risk areas. It is further **recommended** that Mine Safety Management Plans be based on detailed risk/hazard analyses.

Mine Safety Management Plans should be regularly audited both internally and externally and meet any requirements of the Chief Inspector of Coal Mines.

Key risk areas which should be addressed by Mine Safety Management Plans include, but may not be limited to:

- Ventilation
- Spontaneous Combustion

· Gas Management
· Methane Drainage
· Emergency Evacuation
· Strata Control

The plans should include:

· standards to be adopted at the mine for the prevention, management, and control of risks which have been identified by the risk analysis;
· action plans in the event of an identified risk occurring;
· appropriate training programmes for the identification and prevention of risks; and
· procedures which are consistent with the intent of Quality Assurance Standards.

TRAINING AND COMMUNICATIONS

There is a basic need for all members of the coal mining industry in Queensland to improve their knowledge with regard to the fundamentals of spontaneous combustion and the underground mining problems associated therewith. A lack of appreciation of these fundamentals obviously contributed to the disaster at Moura No 2.

It is clear from the evidence that many personnel at the Moura No 2 mine from the superintendent down were inadequately trained in important aspects of their duties. Some training initiatives had commenced at the mine in recent times, but overall the extent of training seems to have been inadequate to keep people up to date. It would seem that as far as the miners and deputies were concerned there was reliance on the training offered by the Mines Rescue Service, particularly with regard to spontaneous combustion, but this training avenue was available only to those involved in mines rescue.

At Moura No 2 there were many examples of failure to effectively communicate, for example:

· deputies not having contact with oncoming deputies over weekends;
· information from external seminars not being effectively disseminated to appropriate personnel;
· information not being effectively captured from deputy's reports; and
· senior management not being aware of the occurrence of vital tell-tale signs in the mine.

There were numerous reports of smells and hazes from 17 June through 6 August 1994 as well as increasing levels of CO (both in concentration and make). The lack of an effective communication system at the mine culminated in miners going underground on the evening of 7 August some of whom had no knowledge of the full circumstances that existed in the mine at the time.

Had there been an effective communication system in place at the mine then all personnel may well have been able to assess all of the vital pieces of information available and so changed the course of events.

It is **recommended** that all employees be effectively trained to:

· recognise indicators of specific mine hazards, such as spontaneous combustion, and their control; and

· become sufficiently familiar with mine gases, and associated risks.

The identification and prevention of these risks must be a part of a compulsory approved training scheme, as well as part of the mine induction process.

It is further **recommended** that all persons holding statutory appointments, including inspectors must undertake:

· training in communications by completing an approved training course that deals will all aspects of communications; and

· completion of a retraining course each year, progressively covering and periodically revisiting mine gases, spontaneous combustion, mine fires, emergency procedures and communications, as they impact on the mine where they are employed, or over which they have jurisdiction.

Emergency procedures should be exercised at each mine on a systematic basis, the minimum requirement being on an annual basis for each mine.

These training provisions are intended to be mine-site specific and are, therefore, additional to the following recommendation relating to the maintenance of statutory certificates.

STATUTORY CERTIFICATES

As demonstrated repeatedly in evidence, it should not be taken for granted that a statutory certificate of competency to practise as a mine manager, undermanager or deputy carries an assurance that the person possessing it is maintaining, and where necessary developing, the original knowledge base required for the appointment.

It is **recommended**, therefore, that the procedures for granting statutory certificates for underground coal mining and the conditions under which they are awarded, be reviewed. In particular, it is **recommended** that certificates not be granted for life and that a system needs to be developed and put into effect as soon as practicable that requires certificate holders to demonstrate their fitness to retain

the certificate of competency on a regular basis, at intervals of not less than three and not more than five years.

The process should aim to ensure that certificate holders maintain a sound knowledge base on, and keep abreast of, technical developments in coal mining and most particularly those relevant to coal mine safety.

VENTILATION OFFICER

Although a person with the title "Ventilation and Fire Officer" was appointed at Moura No 2, he did not have overriding responsibility, under the manager, for the mine ventilation system. Rather, the role of ventilation officer appears to have been one of taking statutory measurements, keeping records and little else.

The provision and maintenance of good ventilation is vital to the safety of underground coal mines and there must be a system in place to secure it. We believe that an essential requirement to that objective is to have a person who is in charge of ventilation at a mine and is directly responsible to the manager for the provision, maintenance, monitoring and control of ventilation.

It is **recommended** that a position of ventilation officer be established as a statutory position at all underground coal mines. The ventilation officer appointed must have demonstrated competencies appropriate to the duties and responsibilities of the position and would be directly responsible to the mine manager for the planning, design and implementation of the mine ventilation system and for the establishment of effective standards of ventilation for the mine, methods for its control and protection, monitoring of performance, reporting procedures, maintenance of ventilation records and plans, and emergency action plans.

The mine manager may be the appointed ventilation officer. Otherwise, if the ventilation officer has other duties at the mine, they would be subordinate to those of ventilation officer.

SELF-RESCUE BREATHING APPARATUS

While some managed to effect an escape from the Moura No 2 mine, others did not. Those who escaped did so with the aid of filter self rescuers and available transport. Those who did not escape also had filter self rescuers but were in a different part of the mine and so in an area of probable different effects from the first explosion and its products. The 5 South crew and the belt patrolman did not have transport available. The sealing contractor and assistant probably did.

There is a lack of firm evidence as to the actual fate of the victims. It is not known whether they were able to put on their filter self rescuers, nor whether, and to what extent, they were able to assemble or to attempt to leave the mine.

Their ability to put on self rescuers must have been influenced by any effects of the first explosion to which they were exposed. The effects of the explosion may have had the potential to cause death directly, or to result in serious injury, unconsciousness, concussion, severe burns, or even confusion which may have prevented them putting on their self rescuers in time. There is, however, no conclusive evidence on this.

There is a possibility that had they been able to put on their filter self rescuers these devices may still have been ineffective in supporting life due to conditions of low oxygen or high carbon monoxide, or a combination of both, arising from the first explosion. There was opinion in evidence which supported this possibility, and if in fact this was the case at Moura, this gives rise to issues of the overall adequacy of filter type self rescuers and whether they should be replaced by oxygen self rescuers.

In the absence of supporting evidence and with the perceived complexity of the overall issue of life support for escape, the Inquiry feels it inappropriate to make the simple recommendation that filter self rescuers be replaced with oxygen self rescuers. The Inquiry recognises that it is not in the best possible position to fully evaluate the many issues surrounding self rescuer technology and in particular such important matters as the effective duration and in-service reliability of different types of self rescuers.

The Inquiry is, however, certain that the current-day adequacy, or otherwise, of filter self rescuers is an important issue that the coal industry must address. It is, therefore, recommended that a representative industry working party, containing appropriate expertise, be convened by the Chief Inspector of Coal Mines and that group be charged with the development of guidelines for the industry covering life support for escape.

These guidelines must:

- effectively address the use of alternatives, or supplements, to the use of filter self rescuers such as oxygen self rescuer technology;
- adopt best available technology and practice as assessed world-wide;
- not consider the issue of self rescuers in isolation, but rather as part of an overall escape strategy, including related issues such as segregated airways, designated escapeways and refuge chambers; and
- lead to the development and introduction of oxygen based escape systems from underground coal mines, as a means to maximise the likelihood of survival, in the event of fires or explosions.

When developed, the guidelines must be expediently and effectively implemented by legislative or other means. The Inquiry considers that suitable guidelines should be prepared as soon as practicable and that effective implementation should take no longer than two years from the date of this report.

EMERGENCY ESCAPE FACILITIES

In respect of facilitating the emergency escape of persons from a mine, there are lessons to be learned from the experiences of the men who escaped from Moura No 2 following the first explosion.

They had immediate problems of disorientation and subsequently of knowing their whereabouts during the journey outbye. Moreover, (and in addition to self-rescue breathing apparatus) the use of motorised transport was a significant factor in making good their escape.

Accordingly, it is **recommended** that the Chief Inspector of Coal Mines set up a working party, comprising persons with appropriate knowledge and experience, to examine and report on a range of issues relating to emergency escape facilities.

The group should investigate means whereby persons in any part of a mine, who are subject to disorientation or severely impaired visibility, are able to find their way out of the mine. Consideration should also be given by the group to the potential role for motorised transport in emergency escape arrangements.

Several counsel made submissions to the Inquiry urging that consideration be given to the introduction of refuge chambers in underground mines. The intention is that strategically placed self contained life support chambers could provide vital refuge for mineworkers who are trapped below ground. Although there is no evidence that refuge chambers would have assisted those who perished at Moura No 2, the proposal is worthy of careful evaluation. The working party should, therefore, fully investigate the potential for refuge chambers in underground coal mines as part of an overall escape strategy.

Two further specific issues, proposed in submissions to the Inquiry should also be considered by the group. One is the introduction of a requirement for all underground mines to have one intake airway that is completely segregated from other parallel intake airways so as to provide two separate means of egress from the mine via an intake airway.

The other is the development and provision of portable equipment capable of rapid deployment to mine sites to bore a large diameter hole from the surface to reach miners trapped below ground. This would be a means of quickly establishing communication, providing life support and a possible route for emergency recovery of personnel.

The working party should be established immediately and work expeditiously to produce a report to the Chief Inspector of Coal Mines. The report should make specific recommendations regarding emergency escape facilities for the Chief Inspector of Coal Mines to consider and forward to the Minister for implementation.

GAS MONITORING SYSTEM PROTOCOLS

The Inquiry heard considerable evidence surrounding the approach at Moura No 2 to the setting and acceptance of alarms within the mine's tube-bundle gas monitoring system. The mine did not have a set protocol for the management of those alarms and many of the practices in use were identified as less than desirable.

In addition, span gas testing of the tube bundle system was undertaken on the morning after sealing. While there was no evidence that this practice compromised the quality of information gained from the 512 sealed area it is, nonetheless, identified as having the potential to do so.

It is **recommended** that mines be required to develop and implement protocols for the setting, re-setting, and the noting and acceptance of alarm conditions raised by any gas monitoring system in use at the mine. In particular, such protocols should define:

- who is authorised to set or change alarm levels and the recording of those settings or changes;
- who is responsible for the acknowledgment of alarms and recording of acknowledgments;
- who is responsible for communicating the occurrence of alarms and initiating action as a result of those alarms; and
- how the actions of responsible persons, and the identity of those persons, are to be recorded.

There also appears a need for mines to schedule gas monitoring system testing to occur before critical times when the system may be required, such as after sealing an area, and for consideration to be given to making gas alarms readily distinguishable from other alarms.

SEALING - DESIGNS AND PROCEDURES

The evidence from Moura No 2 makes it crystal clear that the sealing of an area in a gassy mine should never be considered a routine or trivial event. The Inquiry established that seals were destroyed as a result of one or other of the explosions at Moura No 2 which gives rise to important questions on the adequacy of current designs of seals and sealing practices.

Existing legislation requires that permanent seals be able to withstand a pressure of 345 kPa and, in the case of mines with seams liable to spontaneous combustion, be capable of being erected in three hours. These requirements were not satisfied at Moura No 2 and it is almost certain that two of the 512 Panel seals were still soft at the time of the first explosion.

The evidence is not that the statutory requirements are inadequate, but begs the question are they sensible and achievable in the context of reasonable mining practice? We believe that these aspects of the current legislation concerning seals need to be comprehensively reviewed. This review should take into account best available technology and practice as assessed world-wide. The Inquiry believes further that it is necessary to set minimum standards and requirements for the design, installation and maintenance of seals and for the maintenance, control and management of sealed areas.

In respect of the design, installation and maintenance of seals, the Inquiry **recommends** that:

· the location of final seals be subject to approval by the District Inspector of Mines;
· it be a requirement that seals be constructed using only materials that have been approved for the purpose by the Chief Inspector of Coal Mines; and
· the Chief Inspector of Coal Mines should determine and then apply requirements appropriate for the design and installation of seals and for their long term stability.

In respect of the control and management of sealed areas, the Inquiry **recommends** that minimum requirements provide for:

· the continuous and effective sampling and monitoring of the atmosphere in a sealed area including a minimum number of sampling points and suitable location(s);
· means whereby the pressure difference between the inside and outside surfaces of seals can be measured;
· the effective ventilation of the outside surfaces of seals; and
· regular inspection and periodic auditing on the long term performance of seals and sealed areas.

Any sealed area has the potential to explode. It requires only two concurrent conditions - an explosive atmosphere and an ignition source. The atmosphere in many sealed areas, sooner or later, enters and passes through the explosive range of methane in air and then moves safely beyond it. If there is nothing to ignite the mixture at this stage, it will not explode. If, however, there is the potential for an ignition source, such as a heating or frictional spark, then the possibility of an explosion must be acknowledged and it will exist for as long as the atmosphere remains explosive. The importance of the adequate monitoring of sealed areas to detect potential sources of ignition cannot be overemphasised.

It is for these reasons that the Inquiry further **recommends** that it be a requirement that no part of a mine be sealed without the prior written approval of the District Inspector of Mines (other than in an emergency, whereupon the inspector must be informed as soon as practicable thereafter).

The mine manager should be required to submit to the inspector a formal proposal to seal an area of the mine and this should include:

· a complete specification for the seals proposed including the location, method of construction, and the materials to be used;
· a risk assessment (involving mine management, the district inspector and the district union inspector) of the potential hazards introduced by sealing (or by not sealing) the area;
· the gas monitoring system, location of the gas monitoring points proposed and arrangements for post-sealing ventilation of the seals; and
· a management plan for the sealing operation including the long term security of the seals and the arrangements for evacuation of the mine during and after sealing.

Persons should not be allowed to remain in or enter a mine following a sealing without the manager first having obtained the written consent of the District Inspector of Mines.

WITHDRAWAL OF PERSONS

There was no protocol at Moura No 2 for the withdrawal of persons from the mine in response to potential dangers. This left consideration of questions of withdrawal to those officials who happened to be on duty at any particular time. In the actual event the question of withdrawal was immersed in uncertainties with regard to the state of the mine and, in any case, appeared to have been left largely to the opinion of the middle ranking official who happened to be on duty. Any attempts that official made to obtain guidance from more senior management were not fruitful and, ultimately, any question of staying out of the mine was left to the workforce. This situation is totally unacceptable.

It is **recommended** that mines be required to develop and implement protocols, as a statutory requirement, for the withdrawal of persons when conditions warrant such action. It is further **recommended** that the Chief Inspector of Coal Mines convene an appropriate industry working party to develop guidelines for the use, in turn, of mines in the development of protocols for the withdrawal of persons. Developed and implemented protocols should be required to conform with the guidelines.

Protocols developed for the withdrawal of person should also be subject to agreement amongst all parties with a valid interest at any particular mine and should be subject to review by the inspectorate.

INERTISATION

Given the situation of Moura No 2 on 5 August, it seems that the only realistic course of action that could have been taken to avoid total loss of the mine would have been to inertise the atmosphere inside 512 Panel. Had that course of action been proposed, it is significant to note that suitable inertising equipment was not available anywhere in Queensland.

It is **recommended** that the research which has been previously undertaken by the committee which was instigated as a result of the Moura 1986 Inquiry be evaluated as soon as possible by representatives from the Inspectorate, Miner's Union, and Coal Operators, in order to determine the most appropriate method of inertisation for Queensland coal mines.

It is further **recommended** that funds to be made available through the Queensland Government in order to obtain such a system, such that equipment for the inertisation of a coal mine or parts of a mine, with appropriately trained people and operating systems, be readily available for use in Queensland Coal Mines. This equipment should be maintained and operated by the Queensland Mines Rescue Service in a central location such that it can service all the mines in Queensland on a fee for service basis.

RESEARCH INTO SPONTANEOUS COMBUSTION

Evidence before the Inquiry indicated that there is a great deal of basic scientific and technical knowledge already available on the subject of spontaneous combustion of coal; on its causes, its detection and methods of dealing with it.

The regrettable fact is that much of this information is not widely known, and not readily available to mine operators. The reason may lie in the diffuse nature of some of the information, resting as it probably does in various parts of the world and in different languages in a plethora of technical and scientific journals, books, research reports, theses and the like.

It is **recommended** that funds be made immediately available to undertake an exhaustive international literature and data search, to critically review the literature and data and to prepare a comprehensive state-of-the-art report on the subject of spontaneous combustion in coal mines.

The investigation should include the collection and analysis of the available international information on field experiences with notable spontaneous combustion events in mines, on the circumstances of the occurrences and of the actions taken. This would establish a portfolio of case studies (against which the likely efficacy of different strategies could be assessed) for education and training purposes.

The investigation should also seek to indicate what research programmes are in progress or planned on the subject of spontaneous combustion at recognised world centres, with a view to helping identify priority research areas for the Australian coal industry to pursue and towards establishing collaborative research links with those centres. The report should be published and made widely available, particularly to the Australian coal mining community.

The Inquiry is not in a position to recommend who should be commissioned to undertake the project. SIMTARS might have the range of technical expertise required for the task but it may be profitable to have more than one organisation working on it conjointly. The project should have high priority and urgency as a necessary pre-requisite to the formulation of an Australian research strategy on spontaneous combustion.

PANEL DESIGN

Part 60 of the General Rules for Underground Coal Mines (Second Working Extraction) requires the mine manager to submit to the inspector, for approval, full details of the proposed scheme of work for the extraction of pillars or of secondary workings of bottom coal.

The legislation stipulates the submission to include information on a list of factors all of which clearly relate to the safety of the proposed scheme of work. None of these factors, however, refer specifically to or can be construed as being directly related to spontaneous combustion as an issue for consideration in the proposed scheme of work.

The requirements, as set out, were complied with at Moura No 2 in respect of 512 Panel. In addition, the manager, albeit prompted by others, arranged for a risk assessment of the proposed extraction design. The assessment made scant reference to spontaneous combustion and then only with a low level probability that it could arise from the extraction of bottom coal. Moreover, the consequence of an occurrence was rated at the lowest safety level, mentioning short panel life and use of continuous gas monitoring as existing safeguards. Flooding the panel with water was mentioned as a further safeguard if required.

As we now know, the factors considered and taken account of in the design of 512 Panel and its extraction were lamentably inadequate. It is **recommended**, therefore, that it be made a requirement of Part 60 (Second Working Extraction) submissions that spontaneous combustion be specifically included as a factor to be considered and evaluated.

MINE SURFACE FACILITIES

The Inquiry recognises that layout of mine entries relative to surface installations could impede or prevent emergency procedures in the aftermath of a disaster. Layouts for new mines should take this potential into account and be subject to the approval of the Chief Inspector of Coal Mines.

The Inquiry **recommends** that underground mines develop a surface area plan showing the location of mine entries, ventilation fan(s), access roads, surface installations, administration buildings and other infrastructure. Copies of the plan should be provided to the Chief Inspector of Coal Mines and lodged with the mines rescue brigade and local police station.

It is further **recommended** that both new and existing mines make provision for the rapid sealing of the mine from the surface through the installation of an air lock facility in at least one of the mine intakes for ready access to re-enter the mine. The plan should also indicate the location of any surface boreholes that may facilitate the monitoring of the underground atmosphere.

LITERATURE AND OTHER TRAINING SUPPORT

The Inquiry has formed the view that the present status of the literature and other learning aids on spontaneous combustion and access to them by mining officials, mineworkers, trainees and mining students needs to be addressed. In particular it **recommends** that:

- the handbooks on spontaneous combustion, commonly referred to as the red and blue books, be revised, updated and republished for education and training use, particularly at colliery level;
- a supply of the handbooks be maintained with provision of periodical review of content for updating;
- appropriate audio-visual aids be produced for education and training purposes, particularly at colliery level; and

· as part of their safety training facilities, coal mines establish a reserved area accommodating a basic library of safety literature and other learning materials available for mine officials and mineworkers to consult at any time.

Correspondingly, the Inquiry believes that a thorough academic grounding on the subject of spontaneous combustion is an essential educational pre-requisite for statutory qualifications as manager, undermanager and deputy in coal mining.

We **recommend**, therefore, that to be accredited as satisfying the academic pre-requisites for the granting of manager's, undermanager's, and deputy's certificates of competency in coal mining, all courses of instruction be required to include adequate instruction on spontaneous combustion (its nature, cause, detection and management) using appropriate supporting literature, case study material and other learning aids.

Given Australia's status as an advanced nation in the world of coal mining, we believe that the industry should support and be supported by a well established and developing body of technical literature and technology transfer capability. It is in this context that we urge the Australian coal industry to consider reintroducing the financial support needed for the production and national distribution of a high quality journal devoted to the regular publication of technical and scientific papers and notes on coal mining matters including safety. (We note that there is no longer an Australian, coal mining specific, publication of this type available to the industry). It should, furthermore, look favourably on supporting the wider distribution of important learning materials generated from selected safety workshops or specialised safety courses.

FUTURE INQUIRIES

The Act provides for the Mining Warden and a panel of four persons having practical knowledge and skill in the mining industry to preside over an Inquiry. However the Act does not provide for continuity of an Inquiry should any one or more of the panel be unavailable to continue their role.

The Inquiry has grave concern that given the duration and nature of the Moura No 2 Inquiry, should any panel member have become unavailable due to any circumstances, the Inquiry would have had to start again. This may have resulted in considerable cost and social impact.

Consequently, the Inquiry **recommends** that the Act be amended to enable either proxy or alternative members to fill temporary or permanent positions on the panel or for an Inquiry to continue with a reduced number of panel members.

COMMENTS

LEGISLATION

Several matters were raised during the hearings with a view to the Inquiry influencing the shaping of proposed new coal mining legislation for Queensland. The Inquiry, because of the limited information presented on the subject, wishes to do no more than make some comments in this regard.

The concept 'duty of care' is sound and should be promulgated by any new legislation. It rightly puts onus on every person in the work environment to take reasonable care to ensure their own safety and health and to not endanger the safety and health of others. However, the concept does not lead naturally to the conclusion that all persons are (or can be) equally responsible for safety, even for their personal safety. Responsibility implies authority and those with highest authority inevitably have the greatest responsibility, both to form rules and to ensure that they are complied with.

The Inquiry rejects the proposal (in one of the submissions to it) that the position of registered mine manager be dispensed with. The Inquiry believes that there has to be one person in overall authority at the mine who has a 'duty of care' to ensure that adequate rules and safeguards are in place and are being complied with. Safety must remain the highest priority at a mine, with all other activities subordinate to it. Conflicts of interest must always be resolved in favour of safety and this requires one person at the mine who has overall authority. Accordingly the position of mine manager, having essentially the same role as it has today, should continue. An underground coal mine needs a manager no less than a ship or an airliner needs a captain.

The requirement to appoint a statutory mine manager should not prevent or frustrate mine owners from making such other appointments as they see fit to deal with production, commercial and other matters, so long that it is clearly understood that such persons are subordinate to the mine manager.

The Inquiry also believes that the statutory hierarchy extending below the mine manager, namely the system of undermanagers and deputies, should likewise be retained in any new legislation. Their primary function is and always has been directed to securing and maintaining, on behalf of the manager, safe working places and practices in the mine.

The Inquiry recognises the need for and supports a revision of the existing Coal Mining Act and the regulations pertaining thereto. It further accepts that the revision needs to be a major one inculcating, as appears to be intended, fundamentally different philosophies and approaches in both its formulation and implementation. The objective of bringing about a cultural change in peoples attitudes to the purposes of legislation is accepted as a necessary and commendable goal.

In supporting the revision, however, we urge those responsible for it to be cautious. Mining legislation hitherto has, by and large, served the industry and its workers well. It embraces standards, rules and

guidelines that have been learned from hard lessons often at the cost of many lives. The term "a clean slate approach" has been used in the context of preparing the new legislation. If the term is intended to convey the message that all aspects of the existing legislation are subject to review, then we support this approach. If it means starting from scratch, then we do not support it.

The Inquiry sees no inherent objection to introducing self-regulation at mines. Indeed it is allowed for in existing legislation where managers are required, for example, to make support rules and transport rules. Any self-regulation must, however, be established within a framework of a legislation that prescribes minimum requirements in respect to safety. It seems that high probability, low consequence matters might be suitably addressed by self regulation but that low probability, high consequence matters should remain subject to prescriptive legislation.

We make one final observation with regard to legislation. The Kianga Inquiry of 1975 recommended that Queensland and New South Wales coal mine safety legislation be standardised. Progress in this direction over the subsequent twenty years appears to have been glacial. A number of personnel in positions of authority at Moura No 2 had come from New South Wales, the registered mine manager Schaus being a case in point. Learning and applying different legislation intended to manage the same hazards must be seen as unnecessarily wasteful of the time and effort of key industry personnel. It is, moreover, a hazard source of itself with State and Federal Mutual Recognition Acts of 1992 now overruling any requirement for a statutory official appointed from New South Wales to demonstrate knowledge of the Queensland coal mining legislation, and vice versa. There is a need for common legislation, finally, to be progressed into existence and at the Federal level if that is what it takes.

REMOTE SENSING AND EXPLORATION

After the first explosion, a vehicle known as the NUMBAT, which is a remotely operated vehicle, was transported to the mine but never used. This was due to the fact that there were several technical problems and then the second explosion occurred, which eventuated in the mine being sealed.

The loss of telephone communication with the 5 South crew at the time of the first explosion left no means of ascertaining the status of those persons without some form of entry to the mine. There appears a need to examine explosion resistant means of communication or other means of ascertaining the status of persons remaining underground after an explosion or other catastrophic event at an underground coal mine. This should include any current or emerging technology for remote controlled vehicular entry where this technology is reasonably likely to be of use.

MINES RESCUE

Although not deployed underground at Moura No 2 mine, members of the Mines Rescue Brigade were involved in various aspects of the incident after the first explosion. The Inquiry has identified a number of issues related to mines rescue which it wishes to mention as a means for leading to improvement of the effectiveness of this vital service. These are that:

· the important training role of mines rescue be formally recognised and that the service be adequately resourced to fulfil that role through the provision and maintenance of such things as: uniform, up to date literature; the further development of training expertise; and acquisition of appropriate training aids;

· the Mines Rescue Brigade be included in any risk evaluation exercises conducted at mines which may impact on the effectiveness of mines rescue;

· mines be required to draft, maintain, and supply to the Mines Rescue Brigade on at least a quarterly basis, up to date plans showing such things as: current workings; mine ventilation arrangements; roadway support methods; gas drainage, water reticulation, electrical and pumping installations; gas monitoring points; and any other aspects of mine infrastructure which may impact on the effectiveness of the operation of the brigade;

· mines draft, maintain, and make available to mines rescue on request, plans showing the location and status of surface boreholes to the mine workings; and

· periodic external review be conducted of mine disaster control arrangements as they impact on the effective operation of the mines rescue brigade.

RE-ENTRY

The Inquiry believes that an underground coal mine cannot be accepted as a suitable grave for mineworkers who are the victims of a disaster. However, where circumstances such as those surrounding Moura No 2 mine prevent any immediate recovery of the mine or personnel and lead to a mine being sealed from the outside atmosphere, then the passage of time must be taken into consideration. The most favourable opportunity for re-entry was lost because of the unstable underground atmosphere, the second explosion and the sealing of the mine.

Before re-entry is decided, the risks and benefits must be fully analysed. Only fully trained personnel should be involved in a re-entry. In the case of Moura No 2 the Inquiry believes that there would need to be compelling reasons to re-enter the mine including:

· would it be necessary in order to reach firm conclusions on the nature and cause of the initial explosion and thus fulfil that role of the Inquiry?

· is there a need to know, and would it resolve unknown factors, such as the precise fate of the victims and nature and cause of the second explosion?

The Inquiry, having considered the above, and in the light of the available evidence, finds no compelling reasons to re-enter the mine for the purposes of this Inquiry.

However, others may consider it desirable to re-enter the mine for a variety of reasons. If this is the case, other factors should be given serious consideration, such as:

· would the impact on families, friends and the community be desirable or undesirable?

· would the benefits to be gained outweigh any risk to the personnel engaged in such re-entry?

The Inquiry further believes that companies who operate mines have certain obligations to the mining industry, and to the community from which their workforce is drawn. These obligations are not written in law, but rather, take the form of an unwritten covenant which would expect companies operating mines to, in the event of a disaster:

· take all possible steps to recover bodies from mines, rather than abandoning those mines with bodies entombed; and

· take all possible steps to gain whatever evidence may be available with a view to preventing similar disasters.

METHANE DRAINAGE INSTALLATIONS

There was evidence that the first explosion damaged the mine's methane drainage pipework underground. This may have provided a source of fuel for the second explosion.

There is, therefore, a need to consider the engineering of methane drainage installations so as to minimise damage in the event of an explosion and to prevent contamination of mine airways should damage occur.

GAS DETECTION EQUIPMENT

As well as a general means of CO detection, gas detector tubes were used at Moura No 2 as a form of reference analysis for CO concentrations indicated by the mine's tube-bundle gas monitoring system. The CO concentrations involved were typically less than 10 ppm. The inherent accuracy of gas detector tubes, together with uncertainties arising from reading tube scales and the sampling process, mean that this technology is not a suitable reference tool for more accurate equipment.

There appears a need for mines to supplement the use of gas detector tubes with currently available alternate instruments, which are inherently more accurate and with increased readability, in situations where anything more than a rudimentary check of gas concentrations is required. This particularly applies to measurements which may subsequently be used to calculate such things as CO make.

THE INSPECTORATE

Evidence to the Inquiry indicated significant differences of opinion between field based inspectors and the Chief Inspector of Coal Mines (and, therefore, one might presume the Department of Minerals and Energy) regarding an appropriate role for the inspectorate and sufficient resourcing to support that role. An effective inspectorate is seen as a vital support to the coal industry and there is concern that the apparent lack of agreement regarding the role and resourcing of the inspectorate may compromise its effectiveness.

There is a need for the Department of Minerals and Energy to develop a common philosophy throughout the inspectorate with that philosophy becoming the basis for an agreed, clearly defined role for the inspectorate. That defined role may then provide a basis for decisions about the numbers of people and types of skills required by the inspectorate, and so to strategies to develop, or attract and retain those skills within the Department. Such strategies may include training, recruitment and remuneration arrangements.

THE ROLE OF SIMTARS

In addition, a significant body of evidence was heard about the utility of various gas chemistry based indicators for the detection and diagnosis of spontaneous combustion. There was difference of opinion in this evidence among the various experts who appeared as witnesses or whose reports were tendered as evidence. These differences The SIMTARS organisation has been instrumental in the development of support systems for on-site gas chromatographs at Queensland underground coal mines. Evidence indicated that there was a perception that those instruments are intended solely for emergency use and this was given as part justification for the non-deployment of the Moura No 2 instrument prior to the first explosion. A closely related matter to this is the failure of anyone at the mine to seek external advice from SIMTARS.

included attitudes to: the dependence of CO make on coal production rates; the utility of Graham's ratio after sealing; and differing opinion about whether absolute levels of CO make could be significant and what those levels might be.

Arising from these matters there appears a need for SIMTARS to assume an industry education and supportive role in three respects:

· to more effectively promote the utility of existing gas chromatograph installations in routine (non emergency) analysis of gas samples at mines and to make industry more aware of its advisory capability, and availability, in relation to the interpretation of gas analysis results;

· to provide an industry advisory and support role in the development and selection of appropriate spontaneous combustion indicators for individual mines. This should include the identification of appropriate indicators other than those based on gas chemistry where these may have utility, and

· to assist mines in establishing trigger levels for spontaneous combustion indicators which will, in turn, result in some pre-defined response by the mine. An example of this may be trigger levels based on such things as CO make or Graham's ratio, but tailored for individual mine circumstances.

MAINTENANCE OF UP TO DATE KNOWLEDGE

A number of overseas experts contributed to the Inquiry both through evidence and tendered reports. It is a pity that such a contribution and the knowledge gained through it seems to rely on the occurrence of a disaster. The Inquiry believes that some more regular exchange with overseas experts should be fostered.

There is a need for the Queensland government to support the establishment and maintenance of effective links with appropriate overseas experts and organisations. It would seem natural that some arrangement of mutual and regular visits would be a necessary means of supporting such links.

OTHER MATTERS

The Inquiry has given close consideration to all the wide ranging suggestions put to it during the hearing and in the separate submissions made to it. Those issues falling clearly within the jurisdiction of the Inquiry have been dealt with and recommendations have been made where deemed appropriate.

There were, however, several recommendation issues submitted to the Inquiry that were deemed by the Inquiry to be either outside its terms of reference or not sustainable on the evidence before it. On some of these issues the Inquiry has seen fit to make comment rather than to make firm recommendations. In other cases it has been unwilling to take up an issue on the grounds of impropriety or irrelevance.

SIGNING OFF OF REPORT

.....
R.J. PARKIN

.....
P.J. NEILSON

.....
F.F. ROXBOROUGH

.....
C.W. ELLICOTT

I concur with the findings as to nature and cause.

Dated at Brisbane this 18th day of December, 1995.

.....
F.W. WINDRIDGE
MINING WARDEN.

ACKNOWLEDGMENTS

During the Inquiry it was necessary for a number of witnesses to spend some time away from their employment and families in the course of giving their evidence. A number of witnesses spent a considerable amount of time in the witness stand giving their testimony.

Evidence was also taken from expert witnesses from the United States. Those experts also spent a considerable amount of time at the Inquiry.

Staff from the Court Reporting Bureau namely Ms D Clark, Ms M Gray, Ms G Clark and Ms S Draper worked intensely and untiringly in recording the evidence and providing the running transcript.

Mr P Punter and Mr K Adolfson of the Information and Technology section of the Department of Minerals and Energy installed and maintained our computer and printer links.

Senior Inspector R Bancroft gave computer assistance and acted as Media Liaison Officer to explain technical and mining terms to members of the media.

To all these people, the Reviewers and myself express our thanks.

Our sincere thanks are extended to Counsel Assisting, Mr F Clair and his instructing solicitor Mr R Boiston of the Crown Solicitors Office Brisbane for their untiring efforts in placing the evidence before the Inquiry.

I extend my personal thanks to my clerk Mr K M Dahlke, to Mr N Barker (acting Registrar) and to Mr B Hibbett (acting Registrar) for their assistance during the Inquiry and post Inquiry.

I desire to record my expression of appreciation for the invaluable contribution made to the conduct of this Inquiry by my fellow Bench-members. They have each brought to the Inquiry a wealth of skilled expertise, practical knowledge and experience. They exhibited a keen interest in the evidence and issues of the investigation and discussed intelligently and responsibly their individual appreciation of the evidence as it unfolded.

F.W. WINDRIDGE
MINING WARDEN
3 January 1996

APPENDIX A –
LIST OF WITNESSES EXAMINED

1	BRIAN JOHN LYNE	- CHIEF INSPECTOR
2	MICHAEL ROBERT CADDELL	- DEPUTY
3	COLE CAMERON KLEASE	- DEPUTY
4	DOUGLAS SHANE STAMPA	- TECRETE WORKER
5	PETER McGREGOR	- POLICE SERGEANT
6	ALLAN GEOFFREY MORIESON	- VENTILATION OFFICER
7	GREGORY GRAIG EDELMAN	- MINER
8	KENNETH DOUGLAS MILLS	- DEPUTY
9	REECE WILLIAM ROBERTSON	- DEPUTY
10	RAYMOND CAMPBELL	- DEPUTY
11	KENNETH NEIL GUEST	- DEPUTY
12	NEIL MARTIN TUFFS	- DEPUTY
13	KENNETH SELFF	- MINER
14	BRIAN MARK KELLY	- MINER
15	MARK ADRIAN McCAMLEY	- UNDERMANAGER
16	STEPHEN MICHAEL BYRON	- DEPUTY & ACTING VENTILATION OFFICER
17	CRAIG CHARLES O'BRIAN	- MINER
18	PHILLIP WAYNE SHORTEN	- MINER
19	JOHN WILLIAM THOMAS BLYTON	- DEPUTY
20	JEFFREY JOHN TAYLOR	- FITTER
21	TERRY JOHN ATKINSON	- UNDERMANAGER
22	RODNEY FRANCIS HELANDER	- MINER
23	PETER ROSE	- DEPUTY
24	EDWARD JAMES BENTHAM	- DEPUTY
25	WAYNE JEFFREY BARNES	- MINER
26	RODNEY STAFFORD	- DEPUTY
27	NORMAN VINCENT CROSS	- MINER
28	GEORGE RONALD ZEIBELL	- MINER
29	JOHN RICHARD OWENS	- MINER
30	COLIN JAMES PARSONS	- MINER
31	PETER RAYMOND EIN	- MINER
32	ROBERT WILLIAM DAVIDSON	- MINER
33	GREGORY LESTER YOUNG	- MINER
34	BRIAN JAMES FRENCH	- ELECTRICIAN
35	DOUGLAS MARTIN MOODY	- MINER
36	PETER WILLIAM HUTCHINSON	- MINER
37	GEORGE LOUIS McCROHON	- DEPUTY
38	GREGORY BENNEDICK	- MINER
39	ALEXANDER HENDERSON	- DEPUTY
40	ANDREW LEONARD GRAHAM	- DEPUTY
41	PHILLIP HENRY AUSTIN DRAHEIM	- GEOLOGIST
42	DAVID CHARLES KERR	- RESCUE STATION SUPERINTENDANT
43	DENNIS JOHN EVANS	- MINE ELECTRICIAN
44	FRANCIS MAXWELL ROBERTSON	- ELECTRICIAN
45	GARY RONALD KUNST	- SENIOR MECHANICAL FOREMAN
46	JACQUES FRANCOIS ABRAHAMSE	- MINING ENGINEER
47	GENE NORMAN JOHNSON	- BOILERMAKER
48	IAN JOSEPH PEARSE	- ELECTRICIAN
49	JOSEPH BARRACLOUGH	- SAFETY /TRAINING UNDERMANAGER
50	MICHAEL ANDREW SQUIRES	- SHIFT UNDERMANAGER
51	EDWIN GEORGE LONG	- MECHANICAL ENGINEER
52	PHILIP JOHN REED	- QUALITY SUPERINTENDANT
53	GEORGE ARTHUR MASON	- UNDERMANAGER IN CHARGE

54	ROBERT WILLIAM REGAN	- MOURA MINE MANAGER
55	ALBERT HUBERT SCHAUS	- UNDERGROUND SUPERINTENDANT (REGISTERED MINE MANAGER)
56	ALAN EDGAR McMASTER	- ELECTRICAL INSPECTOR OF COAL MINES
57	MICHAEL PAUL WALKER	- SENIOR INSPECTOR OF COAL MINES
58	DAVID HUMPHREYS	- PRINCIPAL ENGINEER - SIMTARS
59	CLETE ROBERT STEPHAN	- PRINCIPAL MINING ENGINEER MSHA USA
60	JOHN EDWARD UROSEK	- SUPERVISORY MINING ENGINEER MSHA USA
61	COLIN JOHN HESTER	- SUPERVISING CHEMIST - SIMTARS
62	DAVID IAN CLIFF	- ACTING MANAGER - OCCUPATIONAL HYGIENE - SIMTARS
63	DONALD WILLIAM MITCHELL	- CONSULTANT USA
64	PAUL McKENZIE-WOOD	- MANAGER COAL TECHNICAL SERVICES SOUTHERN MINES RESCUE
65	ROBERT WAYNE VAN DOLAH	- CONSULTANT USA
66	ANDREW JOHN SELF	- CONSULTANT UK

APPENDIX B –
LIST OF EXHIBITS

NO OF EXHIBIT	NATURE OF EXHIBIT	TENDERED BY
1	PHOTOCOPY OF BRIAN LYNE'S REPORT DATED 6/10/94	MR CLAIR
1(A)	PHOTOCOPY OF BRIAN LYNE'S REPORT DATED 24/1/95	"
2	ORIGINAL OF INSPECTOR WALKER'S REPORT	"
3	PHOTOCOPY OF INSPECTOR MCMASTER'S REPORT	"
4	ORIGINAL OF INSPECTOR BELL'S REPORT	"
5	SIMTARS REPORT - OCTOBER 1994	"
5(A)	SIMTARS REPORT - JANUARY 1995	"
6	MSHA REPORT	"
6(A)	MSHA SUPPLEMENTARY REPORT	MR MACSPORRAN
7	REPORT ON FAULT TREE ANALYSIS	MR CLAIR
8	FOLDER OF MINE PLANS	"
9	EIGHT (8) BOXES OF DOCUMENTS	"
10	ORIGINAL OF DOCUMENT INVENTORY	"
11	PHOTOCOPY OF MINE MONITORING SYSTEM SAMPLING POINTS	"
11(A)	PHOTOCOPY OF MINE MONITORING SYSTEM SAMPLING POINTS	MR MORRISON QC
12	PHOTOCOPY OF UNDERGROUND POSITION DESCRIPTIONS	"
13	MINE MODEL - SMALL	MR MARTIN
14	MINE MODEL - LARGE	"
15	A MANUAL OF MINES RESCUE, SAFETY & GAS DETECTION	MR MORRISON QC
16	SIMTARS MAGAZINE FEB/MAR 1994	"
EX. "A" FOR IDENT	A MANUAL ON MINES RESCUE, SAFETY & GAS DETECTION 2ND EDITION *(EXHIBIT 27)	"
EX. "B" FOR IDENT	SIMTARS MAGAZINES MAY/JUNE 1994 & NOV/DEC 1993 *(EXHIBIT 28)	"
EX. "C" FOR IDENT	TRAINING OF OFFICIALS FOR THE UNDERGROUND COAL MINING INDUSTRY (VOLUME 1) *(EXHIBIT 29)	"
17	MINING & VENTILATION PRACTICE IN COAL MINES LIABLE TO SPONTANEOUS COMBUSTION	"
18	PHOTOCOPY OF BALANCE OF DOCUMENTS	
	WITNESS - DOUGLAS STAMPA	MR CLAIR
19	PHOTOCOPY OF STATEMENT - DOUGLAS STAMPA	MR MARTIN
20	STATEMENT - SGT PETER MCGREGOR	MR CLAIR

21	PHOTOCOPY OF CO MAKE 512 FRIDAY 5/8/94 - 7/8/94	"
22	PHOTOCOPY OF CARBON MONOXIDE MAKE IN LITRES PER MINUTE -V- WEEKLY INTERVALS	"
23	SPONTANEOUS COMBUSTION IN UNDERGROUND COAL MINES (RED)	MR MARTIN
24	SPONTANEOUS COMBUSTION IN UNDERGROUND COAL MINES (BLUE)	"
25	PHOTOCOPY OF CO MAKE 512 GRAPH	MR MORRISON QC
26	PHOTOCOPY OF SUMMARY OF STAFF TRAINING & QUALIFICATIONS - ALLAN GEOFFREY MORIESON	"
27	A MANUAL ON MINES RESCUE, SAFETY & GAS DETECTION 2ND EDITION (FORMERLY EX. A FOR IDENTIFICATION)	"
28	SIMTARS MAGAZINES MAY/JUNE 1994 & NOV/DEC 1993 (FORMERLY EX. B FOR IDENTIFICATION)	"
29	TRAINING OF OFFICIALS FOR THE UNDERGROUND COAL MINING INDUSTRY (VOLUME 1) - (FORMERLY EX. C FOR IDENTIFICATION)	"
30	PHOTOCOPY OF BHP AUSTRALIA COAL MEMORANDUM DATED 10 NOVEMBER 1993	"
31	PLAN - MOURA NO. 2 UNDERGROUND WORKSHOPS & BATHROOMS	"
32	PLAN - MOURA NO. 2 UNDERGROUND	"
33	PHOTOCOPY OF PRINTOUTS - MONITOR POINT 16	
	28/10/93 TO 7/8/94	"
34	PHOTOCOPY OF PRODUCTION DEPUTIES REPORT - 19/6/94	"
35	PHOTOCOPY OF PRINTOUTS - MONITOR POINT 5 28/10/93 TO 7/8/94	"
36	PHOTOCOPY OF PRINTOUTS - MONITOR POINT 16 22/7/94 TO 29/7/94	"
37	PHOTOCOPY OF PRINTOUTS - MONITOR POINT 16 27/7/94 TO 10/8/94	"
38	PHOTOCOPY OF PRINTOUTS - MONITOR POINT 16 5/8/94 TO 7/8/94	"
39	QUEENSLAND COAL ASSOCIATION UNDERGROUND INDUCTION TRAINING MANUAL	"
39(A)	PHOTOCOPY OF THEORY ASSESSMENT SHEETS	"
EX. "D" FOR IDENT	PHOTOCOPY OF STATEMENT OF D.C. KERR - (SUPERINTENDENT) (SEALING AND RE-ENTRY OF THE 5NW PANEL NO.4) *(EXHIBIT 115)	MR HARRISON
40	PHOTOCOPY OF WITNESS REFRESHER TRAINING RECORDS (DATA CORRECTED 14/10/94)	MR MORRISON QC
41	PHOTOCOPY OF PRODUCTION DEPUTIES REPORT 17/6/94 NO. 4000	MR CLAIR
42	PHOTOCOPY OF PRODUCTION DEPUTIES REPORT 7/6/94 NO. 3970 PHOTOCOPY OF PRODUCTION DEPUTIES REPORT 9/6/94 NO. 3976	"

43	PHOTOCOPY OF PRODUCTION DEPUTIES REPORT 11/5/94 NO. 3983	"
44	PHOTOCOPY OF PRODUCTION DEPUTIES REPORT 17/6/94 NO. 3401	"
45	PHOTOCOPY OF PRODUCTION DEPUTIES REPORT 24/6/94 NO. 3423	"
46	PHOTOCOPY OF PRODUCTION DEPUTIES REPORTS NOS.3456,3462, 3469,3473,3707,3726,3729,3735,3746,3749,3752	"
47	PHOTOCOPY OF PRODUCTION DEPUTIES REPORT 25/6/94 NO. 3424	MR MORRISON QC
48	PHOTOCOPY OF PRODUCTION DEPUTIES REPORTS (VARIOUS - FOR WEEKEND FOLLOWING 24/6/94)	"
49	PHOTOCOPY OF PRODUCTION DEPUTIES REPORTS (VARIOUS - IN PLASTIC FOLDER)	"
50	STATEMENT - RAYMOND CAMPBELL	MR CLAIR
EX. "E" FOR IDENT	PHOTOCOPY OF PRODUCTION DEPUTIES REPORT 11/6/94 NO. 3984 *(EXHIBIT 192)	MR MARTIN
51	BHPAC - MOURA NO. 2 UNDERGROUND MANNING 5/8/94 TO 7/8/94	MR CLAIR
52	PHOTOCOPY OF OUTBYE DEPUTIES REPORTS NOS. 1479 & 1488 PRODUCTION DEPUTIES REPORT 28/6/94 NO. 3435	"
53	PHOTOCOPY OF PRODUCTION DEPUTIES REPORT 18/6/94 NO. 3405	MR MACSPORRAN
54	PHOTOCOPY OF PRODUCTION DEPUTIES REPORT 13/6/94 NO. 3990	MR MORRISON QC
55	PHOTOCOPY OF PRODUCTION DEPUTIES REPORT 17/7/94 NO. 3717	"
56	PHOTOCOPY OF PRODUCTION DEPUTIES REPORTS NOS. 3082,3906,3920,3923,3963,3966,3990,3405,3408,3422,3432, 3435,3447,3450,3717,3725,3756,3759	"
57	PHOTOCOPY OF GAS DRAINAGE PROCEDURE - BHP AUSTRALIA COAL LIMITED - MOURA MINE"	
58	PHOTOCOPY OF METHANE DRAINAGE DETAILS AND PROCEDURES	"
59	PHOTOCOPY - NEIL TUFFS NOTEBOOK - CO MAKE 512 8-30PM	MR CLAIR
60	SKETCH MAP - DRAWN BY NEIL TUFFS	MR CLAIR
61	CHROMATOGRAPH RECORDS - 3/9/92 TO 29/7/94	MR MORRISON QC
62	STATEMENT/INTERVIEW - KENNETH JOHN SELFF	MR CLAIR
63	STATEMENT/INTERVIEW - BRIAN MARK KELLY"	
64	VIDEO CASSETTE - "FIGHT THAT FIRE"	MR MORRISON QC
65	VIDEO CASSETTE - "YOUR SELF RESCUER"	"
EX. "F" FOR IDENT	FOUR (4) VIDEO CASSETTES - (1) CAUSES & PREVENTION OF MINE FIRES & EXPLOSIONS (2) A GUIDE TO MAJOR INCIDENTS	

	(3) A SAFE START (4) HOLYWELL STOPPINGS TRAINING VIDEO	"
66	PHOTOCOPY OF UNDERGROUND SHIFT REPORT - 17/6/94	MR CLAIR
67	PHOTOCOPY OF UNDERGROUND SHIFT REPORT - 24/6/94	"
68	PHOTOCOPY OF PRODUCTION DEPUTIES REPORT NO. 3402 - 17/6/94	MR MARTIN
69	PHOTOCOPY OF MANAGER'S REPORTS - SUPERVISION DATED 13/9/91 AND 20/9/91	"
70	PHOTOCOPY OF MOURA 512 PANEL EXTRACTION RISK REVIEW MINERISK	"
71	PHOTOCOPY OF UNDERGROUND SHIFT REPORTS DATED 30/5/94 (AFTERNOON SHIFT) AND 31/5/94 (NIGHT SHIFT)	"
72	PHOTOCOPY OF PRODUCTION DEPUTIES REPORT NO. 3950 31/5/94	"
73	PHOTOCOPY OF SUMMARY OF STAFF TRAINING & QUALIFICATIONS - MARK MCCAMLEY	MR MORRISON QC
74	PHOTOCOPY OF UNDERGROUND SHIFT REPORTS 10/6/94 TO 28/6/94 UNDER MANAGER - MARK MCCAMLEY	"
75	PHOTOCOPY OF PRODUCTION DEPUTIES REPORT NO. 3838 24/7/94	MR MARTIN
76	PHOTOCOPIES OF PRODUCTION DEPUTIES REPORTS NOS. 3911,3914, 3404(+ORIGINAL),3406,3429,3442,3451,3701(+ORIGINAL), 3738, 3740(+ORIGINAL),3771	MR MORRISON QC
77	PHOTOCOPY OF UNDERGROUND SHIFT REPORT DATED 16/6/94	"
78	PHOTOCOPY OF MINUTES OF SAFETY MEETINGS HELD 16 & 17/6/94	"
79	PHOTOCOPY OF CO MAKE 512 GRAPH	MR NEILSON
80	PHOTOCOPY OF MOURA 512 PANEL RISK REVIEW (RISK = PROBABILITY X CONSEQUENCE)	MR MORRISON QC
81	PHOTOCOPY OF PRODUCTION DEPUTIES REPORT NO. 3774 3/8/94	MR CLAIR
82	PHOTOCOPY OF MEMORANDUM - SIGNED M.P. WALKER, SENIOR INSPECTOR OF COAL MINES	MR MORRISON QC
83	PHOTOCOPY OF PRODUCTION DEPUTIES REPORT NO. 3438 29/6/94	"
84	PHOTOCOPY OF 512 HAZARD IDENTIFICATION PLAN (ROOF & RIBS)	"
85	PLAN OF MOURA NO. 2 UNDERGROUND 512 PANEL RETREAT DATES & SEQUENCE (DRAWING NO. 45/43)	"
EX. "G" FOR IDENT	GRAPH (CO LITRES/MIN)	MR MARTIN
86	DIAGRAM DRAWN BY WITNESS JOHN BLYTON	"
87	PHOTOCOPY OF PAGE 32 OF 80 SIMTARS REPORT -	

	3.4 ALARM LOG DATA	"
88	PHOTOCOPY OF PRODUCTION DEPUTIES REPORT NO. 3959 3/6/94	"
89	PHOTOCOPIES OF PRODUCTION DEPUTIES REPORTS NOS. 1796,3028, 3086,3092,3926,3932,3956,3959,3964,3780	MR MORRISON QC
90	PHOTOCOPY OF SIMTARS MOURA #2 ALARM LOG (27/7 - 9/8)	MR CLAIR
91	PHOTOCOPY OF NO. 2 UNDERGROUND MINE VENTILATION SURVEY (FB 700 008 ISSUED BY A G MORIESON)	MR ELLICOTT
92	PHOTOCOPY OF PAGES 16,661 & 16,662 - MINING & PETROLEUM LEGISLATION SERVICE - PART 5 - DEPUTIES	MR MORRISON QC
93	PHOTOCOPY OF CO MAKE 512 GRAPH	MR CLAIR
94	ORIGINAL OF CO MAKE 512 DOCUMENT	"
95	PHOTOCOPY OF CO MAKE 512 GRAPH & PHOTOCOPY OF PRODUCTION DEPUTIES REPORT NO. 3748 28/7/94	MR MARTIN
96	PHOTOCOPIES OF CO MAKE 512 DOCUMENT & ATTACHED PRODUCTION DEPUTIES REPORTS	MR MORRISON QC
97	ORIGINAL OF PRODUCTION DEPUTIES REPORT NO. 1205 4/8/94	MR HARRISON
98	ORIGINAL OF PRODUCTION DEPUTIES REPORT NO. 3695 1/8/94	"
99	ORIGINAL OF PRODUCTION DEPUTIES REPORT NO. 3686 29/7/94	"
100	ORIGINAL OF PRODUCTION DEPUTIES REPORT NO. 3697 1/8/94	"
101	ORIGINAL OF PRODUCTION DEPUTIES REPORT NO. 3700 2/8/94	"
102	COPY OF PLAN SHOWING RETURN AIR IN 510 & 5 SOUTH	"
103	PHOTOCOPY OF PLAN - VENTILATION STATION 64 (VIEWED FACING INBY) - 23/6/94	MR MORRISON QC
104	PHOTOCOPY OF 512 PANEL EXTRACTION (DOCUMENT NO. 110 (A)(B)(C))	"
105	PHOTOCOPY OF VENTILATION SURVEY DATED 27/6/94	MR MARTIN
106	PHOTOCOPY OF PLAN SHOWING BORE HOLE WHERE GAS SAMPLE TAKEN	MR HARRISON
107	ORIGINAL PRODUCTION DEPUTIES REPORT NO. 1209 5/8/94	"
108	PHOTOCOPY OF PLAN SHOWING VENTILATION IN 5 SOUTH	"
109	BUNDLE OF ORIGINAL CO MAKE 512 DOCUMENTS	MR CLAIR
110	BUNDLE OF CO MAKE 512 GRAPHS ISSUED BY A.G. MORIESON	"
111	PHOTOCOPY OF ENLARGEMENT OF DRAWING NO. 45/20	"

112	PHOTOCOPY OF DRAWING NO. 45/19 SHOWING RETURN & INTAKE AIR (PRE-SEALING) - TENDERED THROUGH WITNESS MORIESON	MR MORRISON QC
113	ORIGINAL OF PRODUCTION DEPUTIES REPORT NO. 3696 1/8/94	MR HARRISON
114	PHOTOCOPY OF PRODUCTION DEPUTIES REPORT NO. 3773 5/8/94	MR CLAIR
115	PHOTOCOPY OF REPORT OF I. KRAEMER (ACTING MANAGER)	MR MARTIN
	PHOTOCOPY OF REPORT OF J.P. BRADY (INSPECTOR OF COAL MINES)	"
	PHOTOCOPY OF STATEMENT OF D.C. KERR (SUPERINTENDENT) - (FORMERLY EX. D FOR IDENTIFICATION)	MR HARRISON
116	PHOTOCOPY OF PRODUCTION DEPUTIES REPORT NO. 3755 30/7/94	MR MORRISON QC
117	COPY OF MINUTES OF UNION MEETING - KIANGA MEMORIAL HALL - 7/8/94	MR CLAIR
118	PHOTOCOPY OF U.M.W MEMBERS ATTENDING MONTHLY MEETING - 7/8/94	MR MARTIN
119	DRAWING NO: 45/33 - MOURA NO. 2 UNDERGROUND 1ST NORTH WEST SECTION	MR MACSPORRAN
120	PHOTOCOPY OF THE CAUSES OF SPONTANEOUS HEATING (PAGES 19 & 20 - PERFORMANCE TRAINING PTY LTD)	MR MARTIN
121	EMERGENCY PROCEDURE 1993 - (UNDERMANAGER'S OFFICE COPY) BHP AUSTRALIA COAL LIMITED - MOURA NO. 2 UNDERGROUND	MR MORRISON QC
122	PHOTOCOPY OF UNDERGROUND SHIFT REPORT - 6/8/94 (U/M - SQUIRES)	"
123	COPIES OF CO MAKE 512 GRAPHS, MINE VENTILATION SURVEYS & PLAN RETRIEVED FROM UNDERMANAGER'S OFFICE, MOURA	MR CLAIR
124	STATEMENT/INTERVIEW - SHANE MICHAEL BISHOP - 9/11/94	"
125	STATEMENT/INTERVIEW - RODNEY MOSTYN SONTER - 9/11/94	"
126	STATEMENT/INTERVIEW JOHN RAYMOND POTTER - 9/11/94	MR CLAIR
127	PHOTOCOPY OF SIMTARS MOURA #2 ALARM LOG (27/7 - 9/8) (HIGHLIGHTED IN GOLD & GREEN)	"
128	PHOTOCOPY OF LIST OF SAMPLES AS THEY ENTERED THE UNOR ANALYSERS	MR MORRISON QC
129	PHOTOCOPY OF LETTER FROM BRUCE WILSON DATED 11/10/94	MR CLAIR
130	PHOTOCOPY OF LETTER FROM CSIRO (DIVISION OF EXPLORATION & MINING) DATED 19/10/94	"

131	ORIGINAL VIDEO TAPE OF 511 FROM WHICH DISTRIBUTION COPIES WERE MADE ORIGINAL VIDEO TAPE OF 512 FROM WHICH DISTRIBUTION COPIES WERE MADE ORIGINAL VIDEO TAPE OF 512 (NOT USED FOR DISTRIBUTION) NOT REVERSED	"
132	PHOTOCOPY OF 511 PANEL VIDEO CAMERA LOG PHOTOCOPY OF 512 PANEL VIDEO CAMERA LOG	"
133	PHOTOCOPY OF PLAN - MOURA NO. 2 UNDERGROUND 511 VIDEO - NO.1 ROAD SEAL	"
134	PHOTOCOPY OF PLAN - MOURA NO. 2 UNDERGROUND 512 VIDEO - NO.2 ROAD SEAL	"
135	PHOTOCOPY OF SUMMARY OF OPERATIONS 511 NO.1 HEADING SEAL 21/11/94	"
136	VIDEO TAPE - MOURA NO.2 MINE - BOREHOLE VIDEOS (EDITED VERSION)	"
137	PHOTOCOPY OF RUNNING ORDER OF EDITED VIDEO - MOURA NO.2 UNDERGROUND	"
138	PHOTOCOPY OF PRODUCTION DEPUTIES REPORT NO.3999 DATED 16/6/94	"
139	PHOTOCOPY OF PRODUCTION DEPUTIES REPORT NO.3402 DATED 17/6/94	"
140	PHOTOCOPIES OF PRODUCTION DEPUTIES REPORTS NOS. 3761, 3764, 3767 AND 3770	MR MARTIN
EX."H" FOR IDENT	DATA GRAPH FROM 23/7/94 TO 6/8/94	"
141	PHOTOCOPIES OF A BUNDLE OF PRODUCTION DEPUTIES REPORTS - DOUGLAS MARTIN MOODY	MR MORRISON QC
142	MOURA NO.2 UNDERGROUND 512 NO.2 ROAD SEAL PRE EXPLOSION (DRAWING NO. 45-48)	MR CLAIR
143	PHOTOCOPY OF PRODUCTION DEPUTIES REPORT NO. 3776 DATED 6/8/94	"
144	PHOTOCOPIES OF A BUNDLE OF PRODUCTION DEPUTIES REPORTS GEORGE LEWIS MCCROHON	MR MORRISON QC
145	PHOTOCOPIES OF A BUNDLE OF PRODUCTION DEPUTIES REPORTS ANDREW LEONARD GRAHAM	MR MORRISON QC
146	PLAN (DRAWING NUMBER 45/23) - MOURA NO. 2 UNDERGROUND GAS DRAINAGE LAYOUT	MR HARRISON
147	(1) TAFE COURSE SYLLABUS - MINE DEPUTIES STUDIES (2) TAFE COURSE STUDIES - MINING ENVIRONMENT & HAZARDS (3) TECHNICAL CORRESPONDENCE SCHOOL - MINE DEPUTY STUDIES (4) EXAM. PAPER 2ND SEM. 1990 - MINING ENVIRONMENT & HAZARDS	MR CLAIR

148	(1) SPONTANEOUS COMBUSTION (RED BOOK) (2) SPONTANEOUS COMBUSTION (BLUE BOOK) (3) PROCEEDINGS OF A SEMINAR ON "MINES FIRES" - 12/11/93 (4) IGNITIONS, EXPLOSIONS & FIRES BY A.J. HARGRAVES (5) MINING & VENTILATION PRACTICE IN COAL MINES LIABLE TO SPONTANEOUS COMBUSTION (6) PROCEEDINGS OF A SYMPOSIUM ON "DANGERS ASSOCIATED FIRES IN MINES" (7) 1990 E.K. HEALY CUP REPORT (8) 1987 E.K. HEALY CUP REPORT (9) THE PREVENTION AND CONTROL OF SPONTANEOUS COMBUSTION (10) UNIVERSITY OF QUEENSLAND - SPONTANEOUS COMBUSTION OF COAL BY D. ROWLANDS (11) UNIVERSITY OF QUEENSLAND - FLAMMABILITY OF MIXED GASES IN MINES BY D. ROWLANDS	"
149	GRAPH - CO VS AIR QUANTITY	MR MARTIN
150	PHOTOCOPY OF LIST OF PERSONNEL TRAINED BY DAVID CHARLES KERR	MR MORRISON QC
151	PHOTOCOPY OF GRAPHS - BAROMETRIC PRESSURE & AIR PRESSURE DATA	"
152	SCHEDULE OF EVIDENCE COMPILED BY MR MORRISON	"
153	PHOTOCOPY OF EXTRACTS FROM "DRAGER DETECTOR TUBE HANDBOOK - 8TH EDITION"	MR CLAIR
154	PHOTOCOPY OF TABLE 1 - COMPUTER ACKNOWLEDGE OPERATION	MR MORRISON QC
155	PHOTOCOPY OF LETTER FROM B.J. LYNE DATED 12 SEPTEMBER 1990 PLUS PHOTOCOPY OF COAL MINE ANALYSIS AUDIT	"
156	REPORT DATED 01 FEBRUARY 1995 BY B HIGHTON	MR CLAIR
157	BUNDLE OF ORIGINAL PLANS AND PHOTOCOPIES WITNESS J ABRAHAMSE	MR MORRISON QC
158	CO MAKE ANALYSIS - ALL DATA AND ORIGINS COMPILED BY SIMTARS	MR MACSPORRAN
159	MAIHAK AUSTRALIA - MOURA #2 - COMPUTER OPERATIONS MANUAL	MR MARTIN
160	PHOTOCOPIES VARIOUS MANAGER'S REPORTS FOR PERIOD 31.03.94 TO 05.04.94	MR MARTIN
161	DIAGRAM PREPARED FOR COUNSEL ASSISTING INQUIRY ILLUSTRATING GAS SAMPLING EXAMPLES (PLUG THEORY)	MR CLAIR
162	LETTER TO MR SCHAUS FROM PROFESSOR GALVIN	"
163	LETTER TO MR SCHAUS FROM MR WALKER, SENIOR INSPECTOR OF MINES REGARDING PROFESSOR GALVIN'S LETTER	"
164	PHOTOCOPY OF SEQUENCE OF POINTS AS ANALYSED	MR MORRISON QC
165	PHOTOCOPY OF ALARM LOG - POINT BY POINT	"
166	LETTER & NOTICE OF APPOINTMENT OF ACTING MANAGER JOSEPH BARRACLOUGH FOR PERIOD 11.07.94 TO 31.07.94 INCLUSIVE	MR CLAIR
167	PHOTOCOPY OF ATTACHMENT "B" JOE BARRACLOUGH - TRAINING COURSES	MR MORRISON QC
168	PHOTOCOPY OF REPORT ON KIANGA INQUIRY	MR MACSPORRAN

169	PHOTOCOPIES OF VARIOUS PRODUCTION DEPUTIES REPORTS 23/7/94 TO 31/7/94	MR MARTIN
170	CHIEF INSPECTOR'S APPROVED SCHEMES OF PERSONNEL TRAINING - 1991	MR MORRISON QC
171	THEORY ASSESSMENT SHEETS - NEIL TUFFS DATED 21.8.90 - A G MORIESON DATED 14.8.91	"
172	MINES RESCUE SERVICE NSW - PROFICIENCY CERTIFICATE - A MORIESON	"
173	SPREADSHEET OF TRAINING FOR PERSONNEL	"
174	PHOTOCOPY OF UNDERGROUND SHIFT REPORT DATED 28/7/94 (U/M D SIM)	"
175	GRAPH - POINT 16: 512 TOP RETURN	"
176	GRAPH - POINT 5: 512 SEALS	"
177	QUEENSLAND MINERAL INDUSTRIES STUDIES CENTRE - 1995 COURSE BOOKLET HAZARD MANAGEMENT - UNDERGROUND COAL MINES FLUID FLOW, SURVEYS & NETWORK ANALYSIS AIR FLOW VENTILATION MONITORING OCCUPATIONAL HEALTH & SAFETY MINE SAFETY BASIC VENTILATION PRACTICE	"
178	GRAPHS - POINT 5 - 512 SEALS 7/8/94 - GRAHAMS RATIO POINT 5 - 512 SEALS 7/8/94 - CH4 - C02	MR CLAIR
179	PHOTOCOPY OF UNDERGROUND SHIFT REPORT DATED 24.06.94 (AFTERNOON SHIFT) - U/M M SQUIRES	MR CLAIR
180	PHOTOCOPY OF UNDERGROUND SHIFT REPORT DATED 5/8/94 (U/M M SQUIRES)	"
181	PHOTOCOPY OF PRODUCTION DEPUTIES REPORT NO. 3775 DATED 6/8/94	"
182	PHOTOCOPY OF UNDERGROUND SHIFT REPORT DATED 6/8/94 (U/M SQUIRES)	"
183	PHOTOCOPY OF PAGE 257 (SECTION 8.34) OF A MANUAL ON MINES RESCUE SAFETY & GAS DETECTION (1985)	MR HARRISON
EX. "I" FOR IDENT	GRAPH - OF DEPUTY AND UNOR PARTS PER MILLION 30/7/94 TO 7/8/94	MR MARTIN
184	PHOTOCOPY OF WEEKEND WORK SHEETS 6-7/8/94	MR MORRISON QC
185	PHOTOCOPY OF POINT 5 - 512 SEALS RECORDED VALUES 7/8/94	"
186	PHOTOCOPY OF REVERSE SIDE OF UNDERGROUND SHIFT REPORT SUNDAY 7/8/94	"
187	PHOTOCOPY OF EXTRACT FROM DOCUMENT 121 (B) - EXTRACT FROM MINE RECORD BOOK ENTRY REGARDING 5N SEALING	MR MACSPORRAN
188	PHOTOCOPY OF UNDERGROUND PROCEDURES & WORK INSTRUCTIONS	"
189	PHOTOCOPY OF UNDERGROUND VENTILATION PROCEDURE	"

190	PHOTOCOPY OF SCHEDULE OF ASSESSMENTS FOR "FIRES, FIRE FIGHTING AND EXPLOSIONS IN COAL MINES" FROM THE INDIVIDUAL EMPLOYEE TRAINING FILES FOR EMPLOYEES AS AT 7/8/94	MR MORRISON QC
191	PHOTOCOPY OF QUALIFICATIONS AND TRAINING COURSES ATTENDED BY GEORGE A MASON	"
192	PHOTOCOPY OF DEPUTY NEWTON'S REPORT NO. 3984 FORMERLY EX. "E" FOR IDENTIFICATION)	"
193	HANDWRITTEN NOTES BY G MASON AND M SQUIRES	MR MARTIN
194	PHOTOCOPY OF UNDERGROUND SHIFT REPORT - 5/8/94	"
EX. "J" FOR IDENT	HANDWRITTEN VENTILATION FORMULA	"
195	PHOTOCOPIES OF BLANK DEPUTIES REPORTS (NSW)	MR HARRISON
196	PHOTOCOPY OF 512 VENTILATION DATA FROM EXHIBIT 21	MR CLAIR
197	PHOTOCOPY OF LETTER OF APPROVAL TO TECRETE INDUSTRIES PTY LTD DATED 20/6/89 FROM CICM QUEENSLAND	MR MORRISON QC
198	PHOTOCOPY OF LETTER OF APPROVAL TO TECRETE INDUSTRIES PTY LTD DATED 11/5/90 FROM CICM QUEENSLAND	MR MORRISON QC
199	PHOTOCOPY OF LETTER OF APPROVAL TO TECRETE INDUSTRIES PTY LTD DATED 27/9/83 FROM CICM QUEENSLAND	"
200	PHOTOCOPY OF PART 3 OF "GENERAL RULES FOR UNDERGROUND COAL MINES"	"
201	LOCATION MAP - MINES AND MINING LEASES IN THE MOURA AREA	"
202	PHOTOCOPY OF MOURA MINE SAFETY PLAN 1994	"
203	LETTER OF APPOINTMENT OF ALBERT SCHAUS AS MANAGER OF MOURA NO. 2 UNDERGROUND MINE DATED 8/12/92	MR CLAIR
204	PHOTOCOPY OF QUALIFICATIONS AND TRAINING COURSES ATTENDED BY A. SCHAUS	MR MORRISON QC
205	PHOTOCOPY OF MINE RECORD BOOK ENTRY DATED 21/10/93	"
206	PHOTOCOPY OF UNDERGROUND SHIFT REPORT - DAY SHIFT 3/8/94	"
207	PHOTOCOPIES OF EXTRACTS OF ENTRIES IN THE MINE RECORD BOOK - MOURA NO. 2 UNDERGROUND	"
208	MOURA NO. 2 INSPECTIONS 1994 - M. WALKER	MR CLAIR
209	MOURA NO. 2 INCIDENT - SUMMARY OF RECORD BOOK ENTRIES 1988 TO 1994	MR MACSPORRAN
210	PHOTOCOPIES OF AN EXTRACT FROM A SPEECH BY J. TORLACH AND COMMENTS FROM CENTRAL DIVISION INSPECTORATE THEREON	MR HARRISON
211	PHOTOCOPY OF EXTRACT FROM MONTHLY REPORT - JUNE 1993 M WALKER	"
212	PHOTOCOPY OF MEMORANDUM FROM D MACKIE TO B LYNE DATED 5/8/93	"
213	PHOTOCOPY OF A B/C MEMORANDUM FROM B LYNE TO M WALKER DATED 10/8/93	"

214	PHOTOCOPY OF MEMORANDUM FROM M WALKER TO B LYNE DATED 20/8/93, PHOTOCOPY OF MEMORANDUM FROM M WALKER TO B LYNE DATED 22/6/92 AND PHOTOCOPY OF MEMORANDUM FROM B LYNE TO M WALKER DATED 6/7/92	"
215	PHOTOCOPIES OF HANDWRITTEN AND TYPED EXTRACT FROM MINE RECORD BOOK - MOURA NO. 2 FOR 4/8/93	MR MARTIN
216	PHOTOCOPY OF BHP OCCUPATIONAL HEALTH AND SAFETY POLICY DATED 2/2/94 AND PHOTOCOPY OF LETTER FROM J W GRUBB DATED 10/3/94	MR MORRISON
217	TWO (2) GRAPHS - PT14 PUMP ROOM OXYGEN 6/8/94 AND PT14 PUMP ROOM OXYGEN 7/8/94	MR MACSPORRAN
218	GRAPH OF 512 EQUIVALENT CO AT 15, 20 AND 40 CU METRES/SECOND	MR MACSPORRAN
219	GRAPH OF 512 CO MAKE 27/4/94 TO 5/8/94 (BHP @ 5/8/94)	"
220	GRAPH OF CO MAKE 27/4/94 TO 5/8/94 (DRAGER TUBES)	"
221	GRAPH OF 512 CO MAKE 27/4/94 TO 20:30 6/8/94 (BHP REPORTS PLUS EXHIBIT 152)	"
222	GRAPH OF GRAHAM'S RATIO VS OXYGEN	"
223	GRAPH - 512 SEALS - GRAHAM'S RATIO 7/8/94 SHOWING EFFECT OF OXYGEN ERROR	"
224	GRAPH 401-402 SEALING FEBRUARY 1994 (O2,CO2 & CH4(%))	"
225	DETAILS OF CAMGAS AND FIREGAS TRAINING AND PUBLICATION OF COAL TESTING RESULTS	"
226	PHOTOCOPY OF LETTER DATED 14/3/95 FROM L F WALTERS OF MAIHAK PTY LTD TO MS M GIBNEY AND ATTACHMENTS	MR MORRISON QC
227	POINT 14 DAILY AVERAGES 25/10/93 TO 29/7/94	"
228	GRAPHS (4) OF POINT 14 DAILY AVERAGES DATA	"
229	PRODUCTION ANALYSES OF THE 512 SECTION BY MONTHS PART OF DOCUMENT 168)	"
230	SEQUENCE OF SAMPLES INTO THE ANALYSERS COMMENCING AT POINT 1 ON 7/8/94 AT 2251 HRS AND ENDING AT POINT 6 ON 8/8/94 AT 610 HRS	"
231	RESUME OF CLETE R STEPHAN	MR MACSPORRAN
232	PLAN OF MOURA UNDERGROUND NO 2 SHOWING BOREHOLE SAMPLING LOCATIONS USED BY MSHA	"
233	RESUME OF JOHN E UROSEK	"
234	HOURLY AVERAGES FOR POINT 16 BETWEEN 27/10/93 AND 27/7/94 (RELATES TO EXHIBIT 158)	MR MACSPORRAN
235	HOURLY AVERAGES FOR POINT 13 BETWEEN 21/2/94 AND 20/3/94 WHICH RELATES TO 401-402 SEALING (EXHIBIT 224)	"
236	RESUME OF DR. DAVID I CLIFF	"
237	REVIEW OF DIAGNOSTIC TECHNIQUES	

	FOR DETECTION AND MONITORING OF MINE FIRES CARRIED OUT IN JANUARY 1992"	
238	GRAPH 401_402 SEALING FEBRUARY 1994 (GRAHAM'S RATIO TREND)	"
239	PUBLICATION - "MINE FIRES" - DONALD W MITCHELL, P.E.	MR MARTIN
240	RESUME OF DONALD W MITCHELL, P.E.	"
241	ANALYSIS OF MOURA NO. 2 MINE EXPLOSION - DONALD W MITCHELL	"
242	GRAHAM'S RATIO CALCULATION BY DONALD W MITCHELL	"
242(A)	GRAHAM'S RATIO CALCULATION ("AMENDED") BY DONALD W MITCHELL	"
243	PHOTOCOPY OF A LETTER FROM MR PAUL MACKENZIE-WOOD DATED 21/9/94	MR CLAIR
244	PHOTOCOPY OF AN ARTICLE BY MR FUNKEMEYER AND MR KOCK ENTITLED "FIRE PREVENTION IN WORKINGS WITH RIDER SEAMS PRONE TO SPONTANEOUS COMBUSTION"	MR MORRISON QC
245	PHOTOCOPY OF GRAPH FOR 512 PANEL WEEKLY TONNAGES + U/G WEEKLY PRODUCTION & BONUS FIGURES WEEK ENDING 7/8/94	"
246	PHOTOCOPY OF PRODUCTION ANALYSIS SUMMARY OF MINING SECTIONS DATED 24/8/94	"
247	TRAINING OF OFFICIALS FOR THE UNDERGROUND COAL MINING INDUSTRY VOLUME 3	MR CLAIR
248	PHOTOCOPY OF GRAPH POINT 5 - 512 SEALS 7/8/94	MR MORRISON QC
249	PHOTOCOPY OF COMPARISON OF MAKE FIGURES LISTED IN EX 152 AND LISTED AND PLOTTED IN EX 158	"
250	ARTICLE IN SIMTARS MAGAZINE MAY/JUNE 1994 - "THE USE OF GAS ANALYSIS TO AID IN THE EARLY DETECTION AND MONITORING OF FIRES AND HEATINGS IN UNDERGROUND COAL MINES"	MR CLAIR
251	GRAPH - CO2 CORRECTION FOR POINT 16 REFERENCE PT 14	MR MORRISON QC
252	PHOTOCOPY OF CURRICULUM VITAE - ROBERT WAYNE VAN DOLAH PH D	"
253	PHOTOCOPY OF STUDY OF MOURA NO. 2 INCIDENT OF 7-9 AUGUST 1994 - ROBERT W VAN DOLAH PH D"	
254	GRAPH - CO CORRECTION FOR POINT 16 REFERENCE PT 14	"
255	GRAPH - CO/CO2 RATIO CORRECTION FOR POINT 16 - REFERENCE PT 14	MR MORRISON QC
256	GRAPH - CO PRODUCED/CO2 PRODUCED RATIO CORRECTED (PT 16) - REFERENCE PT 14	"
257	GRAPH - SCHEMATIC OF CO - DRAWN BY VAN DOLAH	"
258	GRAPH - PT 16 512 TOP RETURN - GRAHAMS RATIO - OXYGEN CORRECTION - 0.4%	"
259	GRAPHS - RATIO CARBON MONOXIDE TO	

	REACTED OXYGEN, PT 16 (X 100) CORRECTED TO MONITOR POINT 14	"
260	GRAPH - COMPARISON OF OXYGEN READINGS	"
261	METHANE LAYERING SCENARIO IN 512 - DRAWN BY PROF. ROXBOROUGH	MR CLAIR
262	DOCUMENTS ILLUSTRATING CO MAKE PRODUCTION RELATIONSHIP FOR 512	"
263	THEORETICAL EXAMPLE - CO MAKE & PRODUCTION RATE GRAPHS & DATA	MR MORRISON QC
264	PHOTOCOPY OF U/G WEEKLY PRODUCTION & BONUS FIGURES 27/3/94 TO 17/4/94	"
265	PHOTOCOPY OF MONTHLY USAGE OF COAL PICKS FOR CONTINUOUS MINERS	"
266	BOREHOLE DATA - MOURA NUMBER 2 UNDERGROUND	"
267	PHOTOCOPY OF CURRICULUM VITAE - ANDREW JOHN SELF	"
268	REPORT - MOURA NO. 2 INQUIRY - VENTILATION SYSTEM (PREPARED BY INTERNATIONAL MINING CONSULTANTS PTY LTD - 24/1/95)	"
269	PED COMMUNICATION AND CONTROL SYSTEM PAMPHLET	MR CLAIR
270	GENERAL INFO. - ORGANISATIONAL STRUCTURE OF MHSA EXTRACTS FROM THE FEDERAL MINE SAFETY & HEALTH ACT 1977 - USA EXTRACTS FROM THE CODE OF FEDERAL REGULATIONS EXTRACTS FROM THE BELT AIR ADVISORY COMMITTEE REPORT (2 BUNDLES) REPORT FROM THE VENTILATION DIVISION OF MSHA ON MONITORING SYSTEMS IN UNDERGROUND COAL MINES PHOTOCOPY OF COMPANY REQUEST FOR PETITION - PROPOSED DECISION PHOTOCOPY OF PETITION FOR MODIFICATION - PROPOSED DECISION & ORDER PHOTOCOPY OF SECTION 5.0, BLEEDER ENTRY SYSTEM	MR MACSPORRAN
271	PHOTOCOPY OF CURRICULUM VITAE - BRIAN JOHN LYNE	"
272	PHOTOCOPY OF COAL MINE GAS ANALYSIS AUDIT 1992	"
273	DIAGRAM DRAWN BY B LYNE - 7.1.1 SURFACE ACCESS	"
274	DIAGRAM DRAWN BY B LYNE - 7.1.2 AIRLOCK	"
275	REPORT OF STUDY TOUR ON INERTISATION OF MINES FIRES + VIDEO	"
276	REPORT - CMI INERT GAS MINE FIREFIGHTING SYSTEM - FEBRUARY 1992	"
277	DIAGRAM DRAWN BY B LYNE - 7.1.8 INERTISATION OF UNDERGROUND WORKINGS	"
278	DISCUSSION DRAFT - COAL MINING BILL 1994	MR HARRISON
279	PHOTOCOPY OF COMPARISON OF QLD AND NSW COAL MINES INSPECTORATE	"
280	PHOTOCOPY OF CORRESPONDENCE TO DIRECTOR-GENERAL SUBJECT: STAFF SHORTAGES - INSPECTORATE	"

281	INJURY FREQUENCY RATES - ALL COAL MINES 1993 - 1994 OPENCUT MINES 1993 -1994 UNDERGROUND COAL MINES 1993 - 1994	"
282	COAL MINING ACT 1925-1981 (WITH AMENDMENTS)	MR MARTIN
283	PHOTOCOPY OF PAGE 23 OF THE INCIDENT CONTROL TEAM LOG	MR MORRISON QC
284	CONSULTANCY REPORT - 3D RECONSTRUCTION OF BOLTS - MOURA NO 2	"
285	BOREHOLE NATURAL GAS ANALYSIS (BUNDLE OF DOCUMENTS)	"
286	PHOTOCOPY OF EXTRACTS FROM "THE AUSTRALIAN COAL JOURNAL" - NUMBER 44 1994 - FINAL ISSUE	MR CLAIR
287	ORGANISATIONAL STRUCTURE - DEPARTMENT OF MINERALS AND ENERGY	"
288	PHOTOCOPY OF POSITION DESCRIPTION - INSPECTOR OF MINES	"
289	PHOTOCOPY OF LETTER FROM THE MINISTER FOR MINERALS AND ENERGY TO COAL INDUSTRY WORKERS	"
290	PHOTOCOPY OF EXTRACT FROM DEPARTMENT OF MINERALS AND ENERGY CORPORATE PLAN 1995-2000 "	
291	PHOTOCOPY OF LETTERS TO CHIEF INSPECTOR OF MINES UK DATED 20/1/95 FROM M WALKER AND REPLY TO M WALKER DATED 7/2/95	"
292	PHOTOCOPY OF MEMORANDUM DATED 14/11/94 TO ALL U/G MANAGERS FROM M P WALKER	MR MACSPORRAN
293	PHOTOCOPY OF FACSIMILE MESSAGE DATED 3/4/95 FROM DR D CLIFF TO DR P GOLLEDGE/MR P CLARKE	MR MORRISON QC
294	SUBMISSIONS ON BEHALF OF COUNSEL ASSISTING	MR CLAIR
295	SUBMISSIONS BY A J MACSPORRAN	MR MACSPORRAN
296	SUBMISSIONS ON BEHALF OF W A MARTIN	MR MARTIN
297	SUBMISSIONS ON BEHALF OF BHP AUSTRALIA COAL PTY LTD AND BHP MITSUI COAL PTY LTD	MR MORRISON QC
298	SUBMISSIONS ON BEHALF OF THE AUSTRALIAN COLLIERIES STAFF ASSOCIATION	MR HARRISON
299	NO. 2 UNDERGROUND BOREHOLE 20028 (A4 SIZE)	MR MORRISON QC
300	NO. 2 UNDERGROUND BOREHOLE 20028 (A3 SIZE)	"

APPENDIX C – MANAGEMENT AND TECHNICAL PERSONNEL AT MOURA NO 2 MINE

THE following information in relation to the experience of personnel at the mine and periods of absence from the mine was given in evidence to the Inquiry. It is not intended to be exhaustive and only covers some of the more prominent witnesses at the Inquiry.

R W Regan	Moura Mine Manager (Regan was, in effect, the 'General Manager' for the Moura mining operations with responsibility for both the open cut and underground mines and had assumed that position in May 1994).
A H Schaus	Underground Superintendent and Registered Mine Manager (Schaus had been the Registered Mine Manager of the Moura No 2 underground mine from December 1992. He was formerly Deputy Manager of the Charbon underground coal mine in New South Wales. He was absent on leave from the Moura mine from 11 July through 1 August 1994).
G A Mason	Undermanager in Charge (Undermanager in charge at Moura No 2 since 1988. Prior to that Mason had been an undermanager at the Moura 1,2 and 4 underground mines since 1976).
T J Atkinson	Shift Undermanager (Undermanager at Moura No 2 since 1990).
M A McCamley	Shift Undermanager (Undermanager and relief manager since 1988. Left Moura No 2 in early July 1994 to accept position at Crinum mine).
M A Squires	Shift Undermanager (at Moura No 2 since 1984 and as an undermanager since 1987. Squires was absent from the mine from 11 through 19 June and 21 through 31 July 1994).
J Barraclough	Safety/Training Undermanager (joined Moura No 2 as an undermanager in 1992 and became Safety/Training Undermanager in 1993. Barraclough acted as Registered Mine Manager in the absence of Schaus over the period 11 through 31 July 1994).
J F Abrahamse	Mine Engineer (employed at the Moura No 2 mine since February 1992).
A G Morieson	Ventilation and Fire Officer (appointed Ventilation and Fire officer in July 1990 but had worked at Moura No 2 since 1979. Morieson was on annual leave from 15 July through 4 August 1994).

APPENDIX D –
GLOSSARY

THE following terms and abbreviations appear in this report. This glossary has been prepared in order to clarify the use or meaning of those terms. Except where otherwise indicated, or the context requires, these terms should be interpreted as follows:

CO - carbon monoxide.

CO make - a measure of the volume of carbon monoxide gas being produced by an area in a mine. This is normally expressed in litres per minute of CO and is derived from a measurement of the CO concentration and air velocity at a particular part of a mine.

gassing out - the process by which a sealed area fills with methane gas which is progressively desorbed from the remains of the coal seam mined or from adjacent seams and strata (hence: gassed out).

heating - a condition under which the low temperature oxidation of coal is such that the heat generated is not sufficiently dissipated by any cooling factors, such as the mine ventilation, to prevent the temperature of a coal mass increasing. This increase of temperature in turn results in an increase in the rate of oxidation, which results in an increase of temperature, and so on. This is analogous to the previously, and often still used term 'self heating'. The term 'heating' may cover a range of conditions: from the start of a coal mass becoming warmer; to a condition when that same mass could provide a source of ignition.

H/C Index - an index based on the gaseous products of an explosion which allows judgements to be made about the fuel for the explosion.

l/min - litres per minute, a measure of gas volume with time.

low temperature oxidation - analogous to ambient temperature oxidation. Coal has the capacity to react with oxygen in the air at 'normal' temperatures. The products of this reaction are, variously, carbon monoxide, carbon dioxide, and importantly heat. The heat so generated, if it is not effectively removed, may result in an increase in the rate of oxidation, and so an increase in the rate of generation of heat, and so on (see heating).

MSHA - Mine Safety and Health Administration of the United States Department of Labor.

ppm - parts per million. This is a commonly used measure of low gas concentrations. One part per million is equivalent to 0.0001%

SIMTARS - Safety in Mines Testing and Research Station of the Queensland Department of Minerals and Energy.

registered mine manager - a person appointed pursuant to Section 50 of the Coal Mining Act 1925 by the owner of a mine, such manager being responsible for the control, management and direction of the mine.

source of ignition - something which has sufficient heat energy (is hot enough) to ignite a mixture of a combustible gas (methane) in air.

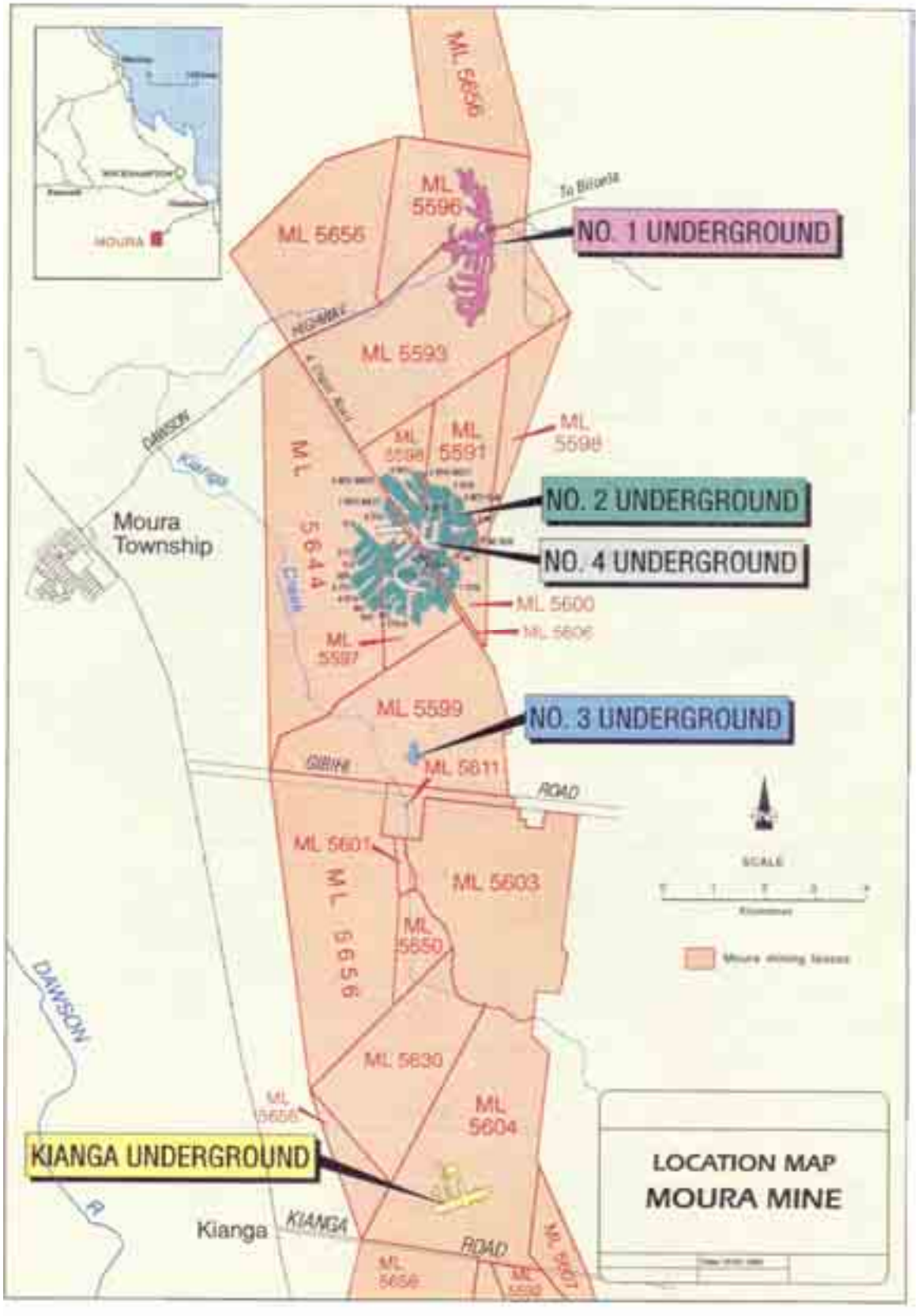
spontaneous combustion - means 'heating'

stook - the remnant of a coal pillar after coal has been extracted by mining.

Tecrete - a cement/cellulose material which is applied to a steel mesh framework to form either stoppings, or in a more substantial application, seals in coal mines.

APPENDIX E - MAPS & ILLUSTRATIONS

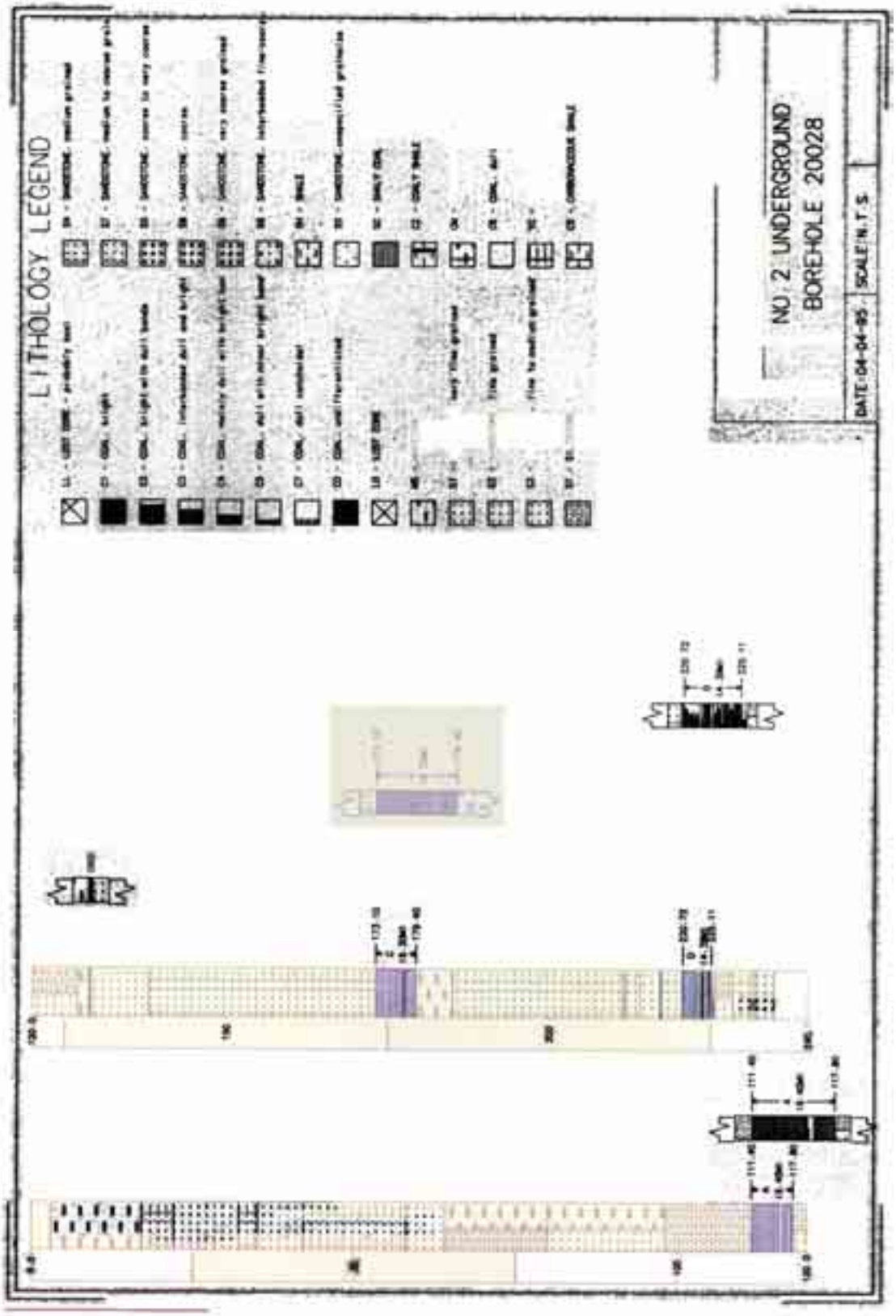
Figure 1 (Note: Figure 4 is separate map enclosed)



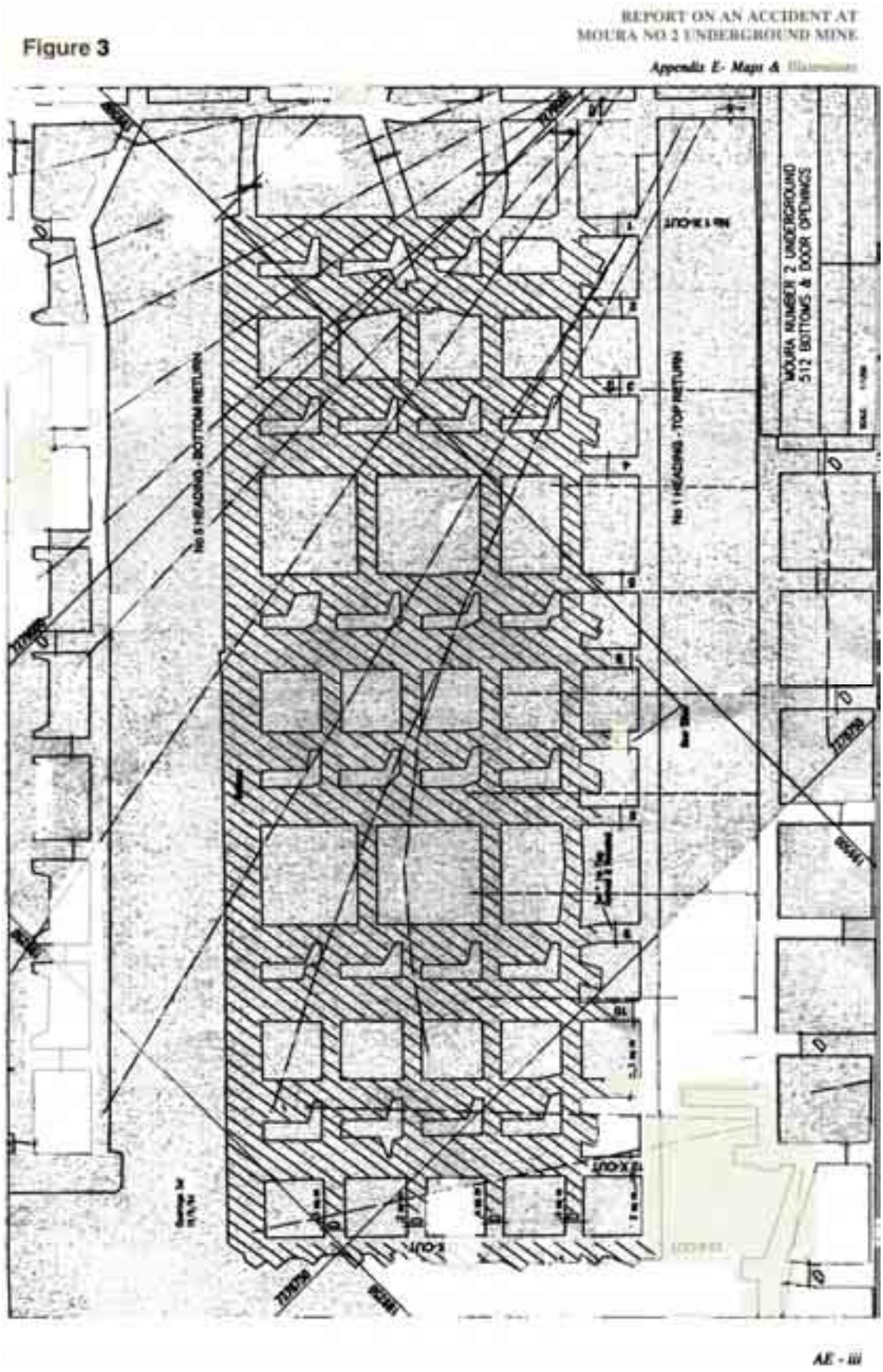
REPORT ON AN ACCIDENT AT MOURA NO 2 UNDERGROUND MINE

Appendix E- Maps & Illustrations

Figure 2



AE - ii


REPORT ON AN ACCIDENT AT
MOURA NO 2 UNDERGROUND MINE
Figure 3
Appendix E- Maps &
MOURA NUMBER 2 UNDERGROUND
512 BOTTOMS & DOOR OPENINGS
No 5 HEADING - BOTTOM RETURN
No 1 HEADING - TOP RETURN
AE - iii