PREVENTING METHANE EXPLOSIONS

**"Blast Kills Three Miners"**

Three miners were killed and 13 injured in a methane explosion almost 500m down a uranium mine near Welkom on Saturday night.

A spokesman for the Gencor group said that the accident took place at the Beisa mine at about 10.30 p.m.

Production has not been affected and repairs to the damaged areas are nearly complete.

(Rand Daily Mail, 24 April 1984)

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In April 1983 16 miners had lost their lives in a methane explosion at the same mine. In September of that year 68 persons were killed in a methane explosion at the Hlobane colliery. Gas explosions remain frequent occurrences in the South African mining industry, most particularly in coal mining. Up to the end of 1983, 1363 people had been killed *in gas explosions in South African coal mines.* Methane explosions can, on their own, or in combination with a coaldust explosion cause disasters of tragic proportions. The Hlobane disaster was the fifth explosion in the Natal coal fields to have a death toll in excess of 50. A coal-dust explosion at the Wankie Colliery in Zimbabwe in 1972 which was triggered by a methane explosion claimed over 400 lives.

The emmission of methane is an unavoidable part of coal mining. The earliest fatal methane gas explosion in this country occurred at the Elandslaagte colliery in Natal in 1891. In the early years of coal mining in Britain the death toll from methane explosions was particularly high. In the period between 1798 and 1816 there were 27 explosions causing 447 deaths in the coal mining districts of Northumberland and Durham. It was at this point that the flame safety lamp invented by Sir Humphry Davy was introduced as a method of

detecting the presence of methane. This lamp is the forerunner of the modern flame safety lamp which remains one of the major means of detecting methane. The presence of gas is discernible by a variation in the character of the flame of the lamp. Its introduction was not immediately successful in reducing explosions - in the eighteen years after its introduction there were 42 explosions causing 538 deaths.

Comments of the Government Mining Engineer.....

In the wake of the Hlobane disaster the Government Mining Engineer, Mr G P Badenhorst, (who heads the Mines inspectorate) has been forthright in his critism of the kind of practices that led to the accident. He has warned the coal mining industry to be on its guard against any complacency about the possibility of gas explosions occurring:

> There is no secret about the causes of a methane explosion. It is perfectly simple. Three elements are necessary. The first is an accumulation of gas, which can only occur if the ventilation is poor. The second element is a poorly conducted test, or no test at all, so that the presence of gas is not detected. The third element is an igniting source. There are plenty of these...the failure to detect an accumulation of gas...means either that testing has not been done properly or else it has not been done at all. Safety lamps have often been found not alight and, in fact, cold. This means that they have not been used.

In view of what has happened in the last three years this is almost unbelievable, but it is true - some people will just not take the trouble to test for gas. It is high time for the industry to begin using some of the electronic devices now available; some mines are already doing this. While these devices may not all be perfect, they are at least continuous and automatic and do not require any

> special effort from people who do not seem to be prepared to go to the trouble required for the proper use of a safety lamp.
> (SA Mining World, March 1984)

## The Regulations.....

While the Government Mining Engineer's criticisms are welcome it must be pointed out that the Regulations under the Mines and Works Act (which regulate safety on the mines) do not require the use of any instrument other than a flame safety lamp to detect the presence of methane. In terms of the Regulations the white miner is required to check the safety of all workplaces he is in charge of at the commencement of each shift. In a coal mine this check will include the testing for the presence of methane gas with a flame safety lamp. In terms of an exemption issued to many mines the pre-shift methane test may be conducted by a black team leader who is in possession of the requisite gas-testing certificate. Hlobane had previously had such an exemption but it had expired shortly before the accident and there was doubt as to whether it was being applied at the time of the accident.

In addition to the pre-shift examination, the miner is required to test in each working place for the presence of methane at least every three hours. Also, the shift boss (the white miner's immediate supervisor) has to carry out such a test once per shift. Miners operating electrical machines are also required to carry flame safety lamps and conduct tests with them before operating their machines.

## The Inquest.....

A significant proportion of the evidence at the inquest was concerned with matters related to testing for methane. It was for instance conceded by the company that its system of issuing flame safety lamps to miners was "chaotic". The mine's records

showed that in June 1983 there were 138 safety lamps and 5 methanometers in use at the mine. In November 1983 (after the accident) there were 255 safety lamps and 7 methanometers in use. Methanometers were however never used in the crucial pre-shift tests. Flame safety lamps alone were used at Hlobane in this examination. They can only detect methane when it is present in quantities in excess of around 2% (methane is explosive between the levels of 5 -15%).

The court, at the conclusion of the inquest, held that the final act of negligence in the chain of causation that led to the accident was failure of a deceased white miner (Bezuidenhout) to test for the presence of methane. Had he done so, the court held, he would have detected the gas. The court did not deal pertinently with expert evidence to the effect that it was possible to fail to detect gas when using a lamp without what is known as a "probe attachment" or "aspirator". Methane, being lighter than air can, under certain circumstances, accumulate in layers on the roof of the mine. It is generally accepted that unless a flame safety lamp is fitted with a probe attachment it is often impossible to detect these layers of methane. The lamp Bezuidenhout had been issued with on the morning of the accident did not have such an attachment.

Dr Herbert Eisner, former director of the Flame and Explosion Laboratory of the British Safety in Mines Research Establishment, gave evidence as to the inadequacy of testing for methane with flame safety lamps without probes:

> This traditional belief (that methane layers could be detected without the use of a probe) was shown to be erroneous by research carried out at the Safety in Mines Research Establishment in the United Kingdom. The results of this research have been published in many mining journals.

In fact an article had appeared in a leading South African mining journal noting that the use of a flame safety lamp without a probe had been discredited twenty years ago as a method of testing for the presence of methane. The author (the group ventilation engineer of one of the major mining houses) concluded that:

> The only reliable way of using a safety lamp to detect methane layers is to use a lamp adapted for use with a probe and aspirator bulb.

It had taken a number of tragic explosions in Western Europe and the United Kingdom due to methane layers going undetected for the industry to develop and introduce the use of the probe (prior to this method of detection being replaced by the more sophisticated methanometer).

Under cross-examination the mine manager of the Hlobane colliery stated:

> Our lamps all have a fitting for probes. The men carry probes with them, so when they're testing for gas against the roof they use a probe.

He was however not sure if any of the four lamps found in the area affected by the explosion had fittings and agreed to check during an adjournment of the hearing. When the hearing was resumed, the cross-examination continued as follows:

> - You said that yesterday that most of the lamps at the time were fitted with an attachment for the use of an aspirator but we have four lamps (i.e., those found in the area affected by the blast) here, only one of which has the attachment?
> - That's correct. Yesterday I said I thought that the lamps on the mine had probe attachments. I did say that I hadn't checked it. I did say that I hadn't gone into it. I was not sure and I did say that and it was

> true. I must say that when I got the lamps I was a bit disappointed to see only one had a probe attachment on it.

The use of probes on safety lamps is not required by regulation although all lamps must be approved by the Government Mining Engineer.

**Safety Lamps and Methanometers.....**

Other aspects of the evidence concerned the usefulness of flame safety lamps relative to methanometers. The mine manager was at one point asked by Mr D Kuny SC (counsel for the dependents of a number of the black miners killed in the accident) whether he considered the methanometer to be a satisfactory method of testing for methane. He replied:

> We do not consider them or I don't consider them (methanometers) as reliable as the flame safety lamps. The flame safety lamps are simple, they are very reliable; they are common - everybody knows how to use them; is trained in them. The methanometer...the various types of methanometer we have found at time that they are subject to breakage.

In evidence to the inquest, Dr Eisner stated that:

> In the United Kingdom pre-shift inspections of the type carried out on the day of the explosion at the Hlobane Colliery are nowadays always performed by the deputy (the equivalent of the South African miner) with a flame safety lamp. He also usually carries a methanometer. The flame safety lamp ensures that he does not enter a zone in which there is a lack of oxygen; the methanometer tells him the methane content both in the general body of the air at the working face as well as in roof layers, if any. Possible drawbacks of the methanometer (battery failure, poisoning of the detector element) are avoided by a continous calibration and maintenance service

available in the lamp-rooms of the mine from which both lamps and methanometers are issued daily.
The main advantage of the methanometer is the possibility of detecting a build-up of methane long before this reaches dangerous proportions. Detection of 0.5% concentrations is commonplace and even smaller amounts can be reliably detected.
*Had methanometers been used to test for gas on* a regular basis by the miner and those active in the working faces, and had the results of such tests been carefully logged, all those concerned with mining operations in a particular area would have had information on trends at their disposal. This would have alerted them to changes in gas concentrations as work proceeded, and allowed for the adoption of aditional remedial measures had circumstances so required.

Dr Eisner's evidence accorded with comments made by Dr Robert van Dolah, former Research Director of the United States Bureau of Mining, Research Centre of Pittsburgh, who also attended the inquest:

> At Hlobane only flame safety lamps were used to test for methane...In the United States, the pre-shift examiner must test for methane with a methanometer, oxygen sufficiently with a flame safety lamp and air velocity and volume with an anemoneter...The advantage of a methanometer, in this regard, is its ability to measure fractional percentages of methane and to monitor increases in concentration as the methane emission increases. Detection of such increases provides advance warning of potential problems and allows for timely remedial action. Due to its inability to measure small amounts of methane a flame safety lamp cannot perform such a function.

This scepticism about the use of a methanometer

which emerges in the manager's evidence and is also found in the testimony of an inspector is not novel in the mining industry. A report on coal mining accidents in the United Kingdom in 1843, spoke of how:

> practical men, wedded to the early practice of their professions, have a decided repugnance to change and introduction of new modes or suggestions in any department of their works, even though sustained by the discoveries of science of improvements in the arts. (quoted in A. Bryan, The Evolution of Health and Safety in Mines 1975).

Interestingly enough, the Commission used this attitude as a reason for the introduction of a "well organised system of Government inspection".

**Comparative Safety of Methane Explosions.....**

Dr Eisner, has made a comparative study of the frequency of gas explosions in coal mines. His comments are that:

> In order to compare coalmine explosion experienced in different countries various methods could be used. Most countries report the number of gas ignitions per annum, South Africa included. However, it is well known that such ignitions are almost certainly under-reported to varying extents. Reporting injuries from explosions, is fraught with the problem that different countries have different requirements for the reporting of injuries in mine accidents. We are thus left with "fatalities" as our yardstick. Apart from being accurately reported, explosions which cause fatalities are, on the whole larger and more indicative of major defect in the mining system than mere ignitions. The disadvantage of using explosion fatalities statistically lies in their relatively small number. In the table below we relate

## Explosions

fatalities incurred in coalmine explosions to the underground labour force (since gas explosions do not occur on the surface of a mine nor, in opencast mining), for the last 11 years.

Table: Fatalities and rates (per 1000 underground miners) in coalmining explosions.

| | USA | UK | W-Germany | SA |
|---|---|---|---|---|
| 1982 | - | - | - | 12 (Ø.2) |
| 1981 | 36 (Ø.3) | Ø | - | 15 (Ø.27) |
| 1980 | 5 (Ø.Ø4) | Ø | 2 (Ø.Ø16) | Ø |
| 1979 | Ø | 1Ø (Ø.Ø5) | 7 (Ø.Ø6) | Ø |
| 1978 | Ø | 2 (Ø.Ø1) | Ø | Ø |
| 1977 | 1 (Ø.ØØ8) | Ø | Ø | Ø |
| 1976 | 23 (Ø.19) | Ø | 2 (Ø.Ø2) | 1 (Ø.Ø2) |
| 1975 | Ø | 5 (Ø.Ø3) | Ø | Ø |
| 1974 | Ø | Ø | Ø | 13 (Ø.29) |
| 1973 | 2 (Ø.2) | Ø | Ø | Ø |
| 1972 | 5 (Ø.Ø5) | 3 (Ø.Ø16) | Ø | Ø |
| average | Ø.Ø6 | Ø.Ø1 | Ø.Ø1 | Ø.Ø8 |

The averages of the rates over a decade show that South Africa's explosion experience is significantly worse than that of the UK and West Germany but about level with the USA. If, of course, we include the deathtoll of the Hlobane explosion in 1983 the average fatality rate over the last ten years amounts to 0.2, significantly worse than the USA experience.*

(Paul Benjamin, Centre for Applied Legal Studies, May 1984)

*(From H. Eisner, A note on South African Coal Mining Accident Statistics with Special Reference to Explosions, 1984).