THE ROLE OF THE VENTILATION OFFICER

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SUMMARY

The ventilation system is arguably the most critical of the components of an underground coal mine. Of the hazards which exist those related to failure or inadequacy of ventilation present disaster potential unmatched by any other engineering aspect. The author will attempt to quantify the risk presented by ventilation system failure by reference to data derived from overseas industries in the interests of arriving at a statistically significant analysis. It will then be attempted to relate the consequence of failure to manage the ventilation system to a model of a ventilation management system and therefore define the duties of the manager of the system, the Ventilation Officer.

The analysis of ventilation system failure concentrates largely on explosions. Whilst there are many examples of failure of the ventilation system with a wide range of consequences the coal mine explosion is clearly the most devastating consequence of all and the focus on this aspect is intended to highlight the worst case situation.

INTRODUCTION

The position of the Ventilation Officer and his role in managing the ventilation system has been discussed at length in the context of events or incidents during the 1990's. This paper considers the need for a Ventilation Officer in the light of the consequences of failure to manage the ventilation system. Statistical analysis of disasters remains a potentially misleading science. This is because disasters are by definition, freak events which do not lend themselves to routine statistical analysis. No attempt has been made to draw statistical significance from a small number of high consequence events. However, an effort has been made to analyse the trend in events related to catastrophic failure of the ventilation system in Australia and overseas. Data relating to incidents in the Ukraine have been used to draw a comparison between the trend in Australia, where incidents are thankfully infrequent and a country where incidents are a more frequent experience. The Ukraine has been selected, not because that industry is considered particularly representative but simply because reliable data were made available relating to an industry with a sufficient number of incidents to support analysis.

The significance of disasters and their relevance to the role of the Ventilation Officer could be questioned. However, an explosion and other ventilation related incidents, for example outburst and spontaneous combustion, can only occur when there is failure of the ventilation system. In terms of mine safety therefore a fundamental part of the role of the Ventilation Officer must be to prevent such failures.

This paper outlines the requirements for a Ventilation Officer who is equipped with the knowledge, skills and aptitude to manage safely the ventilation system in the Australian context.

VENTILATION - THE IMPLICATIONS

The question must be asked, what is so special about ventilation? The science of ventilation has often been considered to be a black art, behaving in a manner which contradicts common sense and the laws of physics. The truth is that ventilation is an engineering discipline and is a straightforward and systematic method of achieving certain objectives, concerned mainly with the provision of a safe atmosphere in the underground workplace.

The evolution of increasingly sophisticated monitoring and planning tools should provide the Ventilation Officer with a powerful armoury in order to control the numerous hazards.

However, ventilation and its related hazards appears to have been causing major disruptions internationally for some considerable time.

In 1812 Sir Humphrey Davy invented the Flame Safety Lamp (FSL). He stated at that time '*...we have at last subdued this monster*'. Davy was talking about Firedamp, essentially methane gas. Whilst the FSL contributed

indubitably to management of methane, the monster shows no real signs of submission.
Explosions have been the subject of concern at Government level for a long time. As far back as 1835 a United Kingdom Government select committee was formed to investigate explosions in coal mines.

In 1869, John Atkinson, a noted Ventilation Engineer stated that '... to hope for immunity from loss of life through firedamp ignitions would be Utopian'. It took 100 years for events to prove him wrong and 120 years for zero loss due to explosions to be maintained with any consistency.

The following statement occurred in an Inquiry report on an explosion in the United Kingdom: *'A full-time mining engineer, with an intimate knowledge of mine explosions and fire hazards and highly qualified in the science and practice of mine ventilation, should be appointed ...'*

This statement has a certain familiarity to it, in intent if not the style of the prose. It relates to an explosion caused by a cuckoo shot which ignited methane and led to the death of 104 miners at Whitehaven Colliery in 1947.

Following the Golborne explosion, in the United Kingdom in 1979 in which 10 miners died, the Chief Inspector made the following statement: *'The explosion at Golborne Colliery once again highlights the importance of properly planned systems of work and safe operational procedures.'*

The following statement appears in a report by the Westray Mine Public Inquiry, Nova Scotia: *'If the mine had been thoroughly ventilated and furnished with an adequate supply of pure air to dilute and render harmless inflammable and noxious gases, then the .... explosion could not have happened.'*

The statement was made with the benefit of hindsight, of course, and could be construed to state the obvious. However, the implications are that an inadequate or failed ventilation system played a significant part in the process leading to the explosion, titled by the Chairman of the Inquiry as *'A predictable path to disaster'*.

These statements were made in 1997, regarding a 1992 incident in which 26 miners were killed as a result of a combined gas and coal dust explosion at the Westray Mine in Canada. The training and qualifications of Westray managers were called into question in the Inquiry. This included the provision of a *provisional* certificate of competency to a member of mine management. The Inquiry report was extremely critical of Westray and stated:

'.... factors lead inexorably to the conclusion that Westray's management was either apathetic to or, through incompetence, unaware of the implications of its actions and decisions in these crucial matters.'

The crucial matters referred to in the text relate exclusively to ventilation matters and include the following:

- 55% of airflow was lost to leakage
- a broken anemometer led to failure to measure airflow for two weeks
- low airflow quantity at the working faces led to little or no air movement
- there was intake air past leaking plastic stoppings (seals).

One of the recommendations of the Inquiry was as follows:

'The mine operator should employ or retain the services of a qualified Ventilation Engineer ...'

The implications of the Moura No. 2 explosion have been well documented and have resulted in a wide range of actions intended to prevent recurrence of such a disastrous event. The need for competent Ventilation Officers was again made clear.

The Warden's Inquiry report stated:

'It is recommended that a position of Ventilation Officer be established as a statutory position at all underground coal mines.'

'If the Ventilation Officer has other duties at the mine, they would be subordinate to those of the Ventilation Officer.'

The events discussed above represent a fraction of the incidents which have occurred in coal mining history. The United Kingdom reported over the period of 1850-1980 that there had been 2,919 fatal explosions, causing the death of 14,428 miners. These figures are so large that the reader could be forgiven for thinking that there had been a typographical error. Approximately 8 fatal explosions per annum were reported in the period 1941-1950, accounting for approximately 44 miners per annum. In the following decade these numbers had reduced to 3 explosions and 25 deaths per annum.

It must be remembered, however, that there were approximately 1,700 underground coal mines in the United Kingdom in the 1940's and 1,400 in the 1950's. These figures relate therefore to a much larger industry than is current in Australia in operating unit terms and vastly larger in terms of numbers employed. It is likely that the annual output, however, was similar during that period to that of Australia in the 1990's. Comparisons therefore are subjective and should be treated in context.

The incidents and statements referenced above were chosen in part to highlight the importance of systematic management of the ventilation system. This may be acknowledged generally but there is no doubt that historical data support the viewpoint. There is a clear message that the management of the ventilation system in an underground coal mine must not be taken lightly.

The majority of the implied horror stories in this section took place many years ago. The question must be asked whether this analysis is outdated. That is, have lessons from the past already been learned and incorporated into management systems?

This could be claimed to be the case in the United Kingdom, albeit in a drastically downsized industry (circa 20 Mtpa). Nevertheless, there have been zero fatal accidents resulting from explosions in the United Kingdom in this decade.

The Polish State Mining Authority report that in the period of 1990-1997 there were zero fatalities due to incidents involving methane gas despite 70% of the mines extracting 'methane rich seams'. The Polish underground coal industry is large, producing circa 140 Mtpa. No hard data were available at the time of writing, but the indications are that the labour force would be many times larger than the Australian industry.

The conclusion drawn by the author from this discussion is that there has been an identified and documented need for a competent Ventilation Officer for the better part of a century. The evidence suggests that there remains a role for a competent Ventilation Officer.

VENTILATION SYSTEM FAILURE

In order to demonstrate that ventilation hazards remain capable of devastation, irrespective of the existence of modern technology, data sourced from the Ukrainian underground coal mining industry were analysed.

In May 1999 an explosion occurred on an advancing longwall face at the Zasaidko Mine in which 48 miners were killed. This focussed attention on the Ukrainian mining industry and its safety record. A personal contact working in the Ukraine has supplied data which form the basis of the following discussion.

The Ukrainian underground coal mining industry is of a similar size in terms of output to that of Australian underground mines, producing around 80 Mtpa.

During the current decade there have been more than 40 fatal explosions, killing more than 300 miners. In comparison, Australia has experienced two explosions in that period with 11 fatalities recorded.

A comparison of the three year moving average of explosion related fatalities is included as Figure 1.

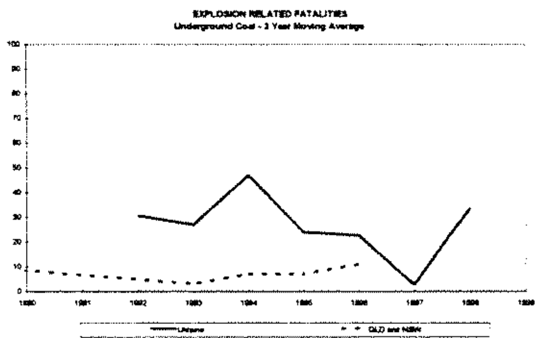

Figure 1

The graphs of Ukrainian statistics and those of Australia are clearly substantially different, but are they sufficiently disparate to allow us to be comfortable?

It can be seen that the Ukrainian industry was experiencing a downward trend on a moving average basis to 1997 when zero fatal explosions were recorded. However, four explosions were recorded in 1998, resulting in 95 fatalities in that year. There is a lesson in this that a declining trend meant little in this context. The fact that no explosions occurred in 1997 did not prevent a substantial loss of life in the next year. The lesson is that vigilance must be continuous and enduring and that an apparently improving situation can rapidly be negated.

A comparison between the number of fatalities caused by explosion events in the Ukraine and Australia is shown in Figure 2.

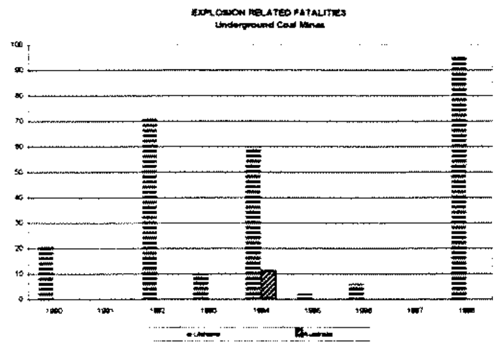

Figure 2

The fact that the Ukrainian coal mining industry employs a considerably larger number of people than that in Australia could be expected to contribute to the large number of fatalities. However, the graph shown in Figure 3 indicates that the trend in the number of explosion events implies a similar conclusion. In fact, the Ukraine experienced approximately 4.5 explosion events per annum in the period 1990-1998 compared to the Australian figure of 0.2. The Ukrainian industry has suffered up to 9 fatal explosions per annum in the current decade.

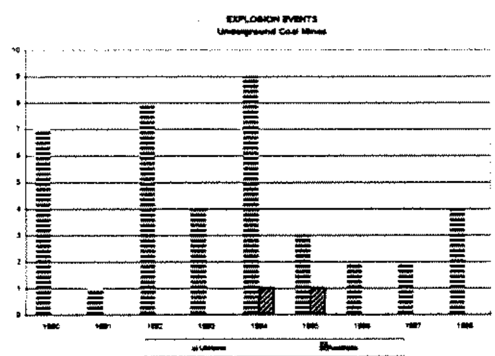

Figure 3

The disaster potential of failure to manage the ventilation system is acknowledged throughout the Australian industry but is illustrated graphically by these data. There may be a temptation to consider that the evolution of technology will protect the industry from ventilation hazards and there is no doubt that the tools available to the engineer have been developed extensively. However, the evidence here suggests that technology alone is not enough to render ventilation hazards to an acceptable level of risk.

The question must by addressed whether Australia manages ventilation and its attendant hazards appropriately and adequately.

An analysis of ventilation related fatalities in Australia is shown in Figure 4.

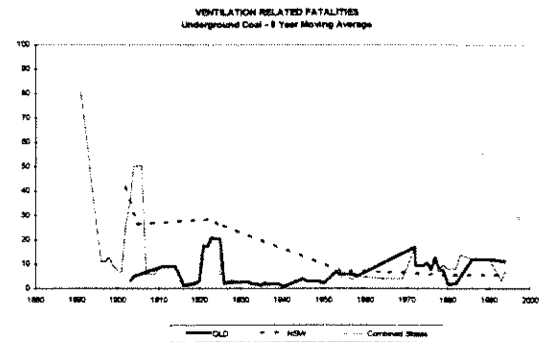

Figure 4

The data have been presented as Queensland and New South Wales in order to identify the different trends representing the underground coal industry in Queensland developing more rapidly than that in New South Wales. The presentation of data in this format is not intended to provoke any particular comparison between the two states. Also, these figures do not take into account the size of the industry at any one time.

The early years in New South Wales were affected dramatically by the Bulli and Mount Kembla Colliery explosions in which 81 and 95 fatalities were recorded. There is a clear downward trend in the moving average in more recent times but with very little change from approximately 1955 onwards. The Queensland figures indicate a more variable trend, but at a higher rate. The production data indicate that the underground output of Queensland is currently less than half that of NSW.

It could be argued that these figures are biased by the fact that the underground industry has been increasing in size. Despite this, the data do not provide any strong evidence that the industry has solved the ventilation problem.

Clearly, there are more factors which influence mine explosion frequency and consequence than bulk output. However, a limited analysis of the explosion related fatalities per million tonnes mined is illustrated in Figure 5.

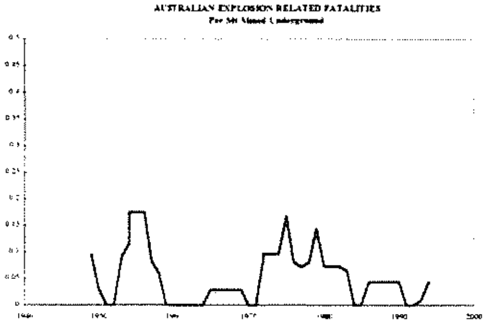

Figure 5

Since the coal industry is aiming towards a zero loss situation the data indicate that we still have a problem related to ventilation system failure. The indications are that the increase in output of the industry generally cannot be used as an explanation of the accident data. The fatal incidents are mainly concerned with explosion but includes outburst and spontaneous combustion.

The conclusion is drawn that despite an absence of fatal explosion events in Australia since 1994, fatalities incurred due to explosions remain a significant risk to the Australian industry. This opinion is held irrespective of whether the data are considered raw, on a unit of production basis or on numbers employed.

CONDITION MONITORING

One of the reasons that ventilation is a misunderstood science which appears to produce catastrophic results apparently unexpectedly is that when a ventilation system is healthy and well managed, there are few recognised indications that this is the case.

When a maintenance system, for example, is managed well the availability of machinery is high. In contrast, whilst there are indicators of ventilation system performance such as volumetric efficiency, there are no performance indicators for other aspects, for example explosion and outburst, other than the fact that they have not occurred.

The inability to measure the performance of a Ventilation Officer is partly due to the fact that a Ventilation Officer in a modern mine has a wide range of responsibilities and hazards under his jurisdiction.

THE VENTILATION OFFICER

It has long been recognised that the Ventilation Officer is a fundamental component in the mine management system. Unfortunately, the evidence indicates that despite this being recognised for a century or more there is a general impression throughout the industry that the competency of the Ventilation Officer is a distinct threat to safe operation.

In order to be competent a Ventilation Officer must have underpinning knowledge, theoretical understanding and the ability to apply this knowledge and skill to practical situations.

There are differing requirements, however, at different mines. There is a perception that some mines need a professional engineer as the Ventilation Officer, dedicated solely to tasks concerned with ventilation, whereas other mines have a lesser requirement, either in terms of skills, qualifications or devotion of time.

The question is, what does the industry need in the Ventilation Officer role? Is the Ventilation Officer an air measurer with the qualifications of a deputy, or a graduate engineer with strong computer skills? In the case of mines where the perceived need is for a lesser qualified Ventilation Officer how do we determine that secondary qualified Ventilation Officer is adequate for the assigned tasks? There is a track record in underground coal mining of incidents which occur in mines where the perceived risk is low or non existent. Witness to this are explosions in Class B (non gassy) mines in NSW and spontaneous combustion fires in mines with little or no recognised propensity (both states).

The case for two levels of Ventilation Officer competency is not straightforward. There are no distinctions made for managers of low risk mines and in the interests of safety perhaps a competent Ventilation Officer is just that, with no allowance being made for perception of lower risk.

Perhaps the issue of tailoring the role of the Ventilation Officer to suit the circumstances is best managed by variation of the proportion of time devoted to ventilation duties. If a

Ventilation Officer is to be instructed that he devotes a certain proportion of his time to ventilation then there is a clear need for prioritisation of effort and time and certainly discretionary skills.

The role model for a competent Ventilation Officer may be a person with the following attributes:

- thorough technical knowledge in ventilation engineering
- sound practical background in underground coal
- ability to apply technical solutions to practical problems
- ability to seek assistance where required
- analytical skills
- tendency to look for problems
- recognition of shortcomings.

COMPETENCY

Determination of competency is a current topic. Competency standards have been developed which identify what a Ventilation Officer should know and be able to do in order to be competent. The question is how to test this competency and to test it sufficiently thoroughly that the candidate is genuinely competent, rather than having demonstrated an ability to learn by rote and provide text book responses.

This issue is one facing the industry in all disciplines and time will tell us whether we were successful in the implementation of genuine competency based training.

Having taken the first steps to train potential Ventilation Officers to be competent, the industry will be faced with the problem of those who do not demonstrate competency by whatever process is developed. That is, this could leave a mine in a position whereby it is clear that it does not have a competent Ventilation Officer. Since the industry is unlikely to be able to train Ventilation Officers in large numbers and will definitely not be capable of training a Ventilation Officer quickly, that mine and the regulatory authorities would be placed in a difficult position.

Having developed a competent Ventilation Officer, the industry must then ensure that he remains competent, including maintenance of currency in the selected discipline.

RESPONSIBILITIES

History indicates that there is a need for a competent Ventilation Officer and the evidence is that this will continue to be the case.

The industry must therefore provide itself with Ventilation Officers capable of managing the ventilation system and its components. Competency standards have been set but there is a need to define specifically the requirements for these people.

This will include the following:

- provision of competency based training and demonstration of competence in ventilation engineering
- competence in hazard identification and management
- documentation of job description
- provision of workable management plans and systems
- provision of resources
- prioritisation of other duties where relevant
- documentation of performance criteria
- performance appraisals
- accountability.

The specific role of the Ventilation Officer will vary from mine to mine dependent upon a number of contributing factors. The role will include:

- knowledge and compliance with statutory requirements
- implementation, review and modification of relevant management plans
- management of gas drainage programs

- management of atmospheric monitoring systems
- liaison with other disciplines
- hazard identification
- maintenance of ventilation control devices.

CONCLUSION

The industry needs to define the role and develop individuals to be Ventilation Officers. There has been a tendency to make the Ventilation Officer position a temporary or training role at many mines. The implementation of competency based training will limit the people that can be appointed statutorily as a Ventilation Officer.

This means that the industry will need professionals who are dedicated to a career as a Ventilation Officer or Ventilation Engineer. The industry must then train these people to be and remain competent.

The career options for a ventilation professional will be limited and it must be remembered that the Ventilation Officer competency will be required in addition to other competencies. This will call for a person with the underpinning skills and competency who has chosen ventilation as a career rather than a stepping stone to other things. The industry must then ensure that the need for such people remains fulfilled in the future.

The road to zero fatalities will require that this challenge is met. We would be remiss if we failed to learn the lessons of history and address this issue.

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