Kinross Revisited and the Introduction to SANS 1867

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Introduction

The Kinross mine in September 1986 disaster still ranks as the most devastating, in terms of number of fatalities in a single accident, in the South African gold mining industry. A total of 177 lives were lost in this accident, second only to the Coalbrook Colliery disaster of January 1960 where 437 persons lost their lives. These accidents led to the establishment of commissions of inquiry into health and safety at mines, the Coalbrook accident led to the Marais Commission and the Kinross accident was a major contributor to the Leon commission being established. The Leon commission culminated in the establishment of the Mine Health and Safety Act (Act 29 of 1996).

The Chief Inspector of Mines issued a prohibition notice in November 1988, in terms of section 3(2) (a) of the Mines and Works Act (Act 27 of 1956), effectively banning the use of polyurethane expanded foams in underground mines with the exception of isolated emergency work approved by the manager. This ban became effective on the 1st of January 1989 and remains effective to this day.

This accident also led to the development of Self Contained Self Rescuers (SCSRs) and the deployment thereof in the mining industry. The latest SANS (SABS) standard No. 1737 is considered the most stringent in the world. These SANS standards No. 1737 (SCSRs) and No. 1867 (sprayed plastic foams for use in mines) are soon to become compulsory standards.

The Kinross Disaster

The Chairman's Review in the Kinross Mines 1986 annual report, reported the disaster as follows "On the morning of 16 September 1986 a serious fire occurred in the 15 level haulage which connects No.1 and No. 2 shafts at an elevation of 1622 metres below surface. Resulting from the fire, smoke and fumes permeated the workings of No. 2 shaft. Tragically 177 persons lost their lives but thankfully, more than 2400 were successfully evacuated. The accident is now the subject of an official inquiry by the Government Mining Engineer"

The court proceedings and inquiry were completed by September 1988 and the following chain of events was pieced together:

A worker reported a broken rail on 15 level, No. 2 shaft. The pipe, tracks and ventilation team leader, working for the responsible ganger, was instructed to replace the rail. He took an oxy-acetylene torch cutting set to the relevant site. The area where the work was to be done was not watered down before cutting operations commenced, because the crew did not have a water hose, nor did they have a fire extinguisher with them. The sidewalls and hanging of this area were covered with polyisocyanurate foam.

The ganger commenced to cut off the fishplate bolts on the broken rail and on completion he closed the oxygen and acetylene valves on the cutting torch. A "plopping" sound was heard and a flame was seen coming from the acetylene cylinder's spindle valve. Due to the heat of the flame the spindle key could not be used to close the gas. The gas cylinders were not equipped with flashback arrestors. The burning acetylene cylinder was balanced upright against the sidewall of the haulage and a flame approximately 50cm long emanated from the cylinder. This flame ignited the foam-covered sidewall resulting in the formation of a thick black smoke. It was not possible to extinguish the fire due to the absence of a fire extinguisher and water at the scene of the fire. At this stage the foam, overhead electrical wires and PVC pipes were on fire.

The team leader ran towards number 1 shaft and reported the fire to the manager. Water hoses were connected to a tap and extended to the scene of the fire. The fire was extinguished about two hours after it had begun.

Physical damage caused by the fire

The mine overseer, who was in charge of the haulage, testified that the foam was sprayed onto the sidewalls and hanging wall over a distance of 490 metres, about six years previously. The reason for the foam covering was due to the fact that the haulage was covered with wire mesh and rock bolts for support purposes and, to prevent corrosion from affecting the wire mesh, a cement shotcreting was used as a cover. This haulage was a high speed tramming haulage and because of the slow rate at which shotcreting progressed, it was decided to use the foam instead, which was much quicker.

The Inquiry also established that the following regulations were transgressed:

1) **Regulation 11.3.4** – regulation not complied with, as no fire extinguishing means was immediately available.
2) **Regulation 15.9.1** read with regulation **3.12** - regulation not complied with, as no written permission was obtained for flame cutting work to be

done and this was also an act of disobedience (regulation 3.12) as the ganger was trained on these managerial instructions.

3) **Regulation 3.12** - regulation not complied with, as the ganger was disobedient in not wetting down the area for a 5-metre radius as described in the managerial instruction as well as not keeping the lighter on his person at all times.
4) **Regulation 2.9.1 and 2.9.3** – regulations not complied with, as management fell short of adhering to these regulations by not taking all reasonable measures to enforce the requirements of the regulations and any order given by an Inspector of Mines and also by not ensuring proper discipline among employees employed at the mine.
5) **Regulation 11.2** – regulation not complied with, as the number of employees exceeded 50 and management failed to ensure an immediate and adequate supply of water for fire extinguishing purposes.
6) **Regulation 11.1.2 (a)** – regulation not complied with, as management failed to provide and maintain suitable fire fighting equipment and material that would have been immediately available at the site of the fire.

The **South African Bureau of Standards (SABS),** as part of the inquiry, analysed the oxy-acetylene equipment after the fire and made the following observations:

1. The acetylene regulator seal was loose, where attached to the valve, as a result of exposure to high temperature.
2. The regulator was so badly damaged that no useful inspection was possible about its condition before the fire.
3. The spindle valve seal disintegrated and no observation was possible.
4. The thread on the spindle valve was examined and found to be in good condition and did not leak.
5. The cutting torch was in a good condition.
6. Flashback arrestors were not fitted to the cutting torch or regulators.

7. It could not be ascertained whether a flashback did occur.

The findings of the commission of inquiry, led by the Assistant Government Mining Engineer- Western Transvaal region, into this accident found that:

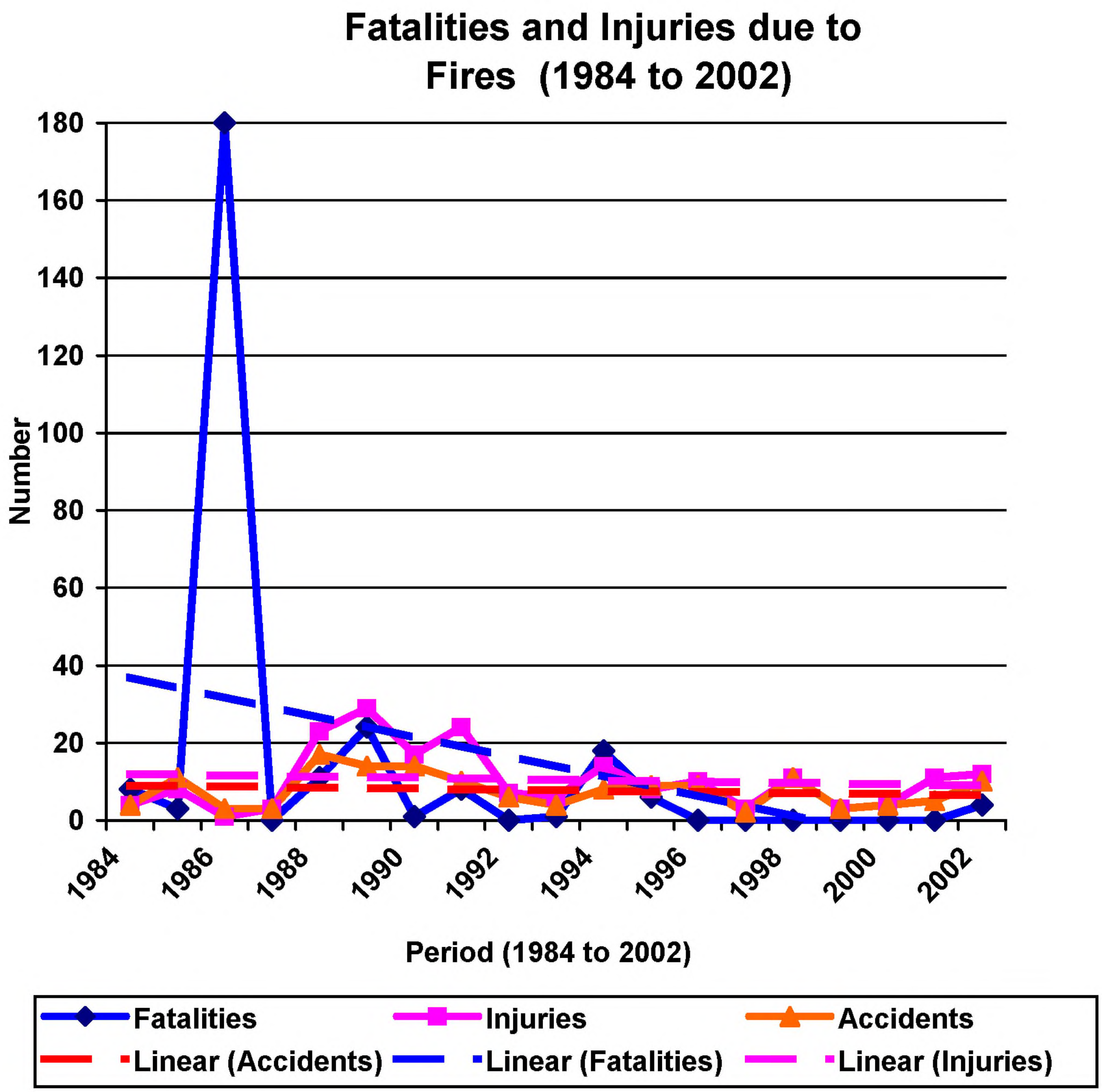
177 workers died in the Crosscut North and other working places in the No. 2 Shaft area of the Kinross Mines Limited, a controlled mine in the magisterial district of Hoeveld-rif, when they were exposed, at approximately 08:45 on 16th September 1986, to gases, which originated from a fire in the 15 Crosscut North. The fire was started after a gas cylinder containing acetylene caught fire and ignited plastic pipes and foam covering in the crosscut.

The accident was caused as a result of negligence, and violation of Section 15 (a) of the Mines and Works Act (Act No 27 of 1956) by the tracklayer who was in charge of flame cutting in the Crosscut, and who failed to adhere to the safety regulation 11.3.4 before the shift commenced.

The primary inquiry revealed several other offences, which have no bearing on this accident. The Witbank Regional Court could not find any of the 7 people prosecuted, legally responsible for the death of the 177 mineworkers. During a later investigation no new evidence on Section 15 (a) was revealed. Section 15 (a) deals with the offence of any person who is guilty of an act or omission that endangers or is likely to endanger the safety of any person in or at a mine.

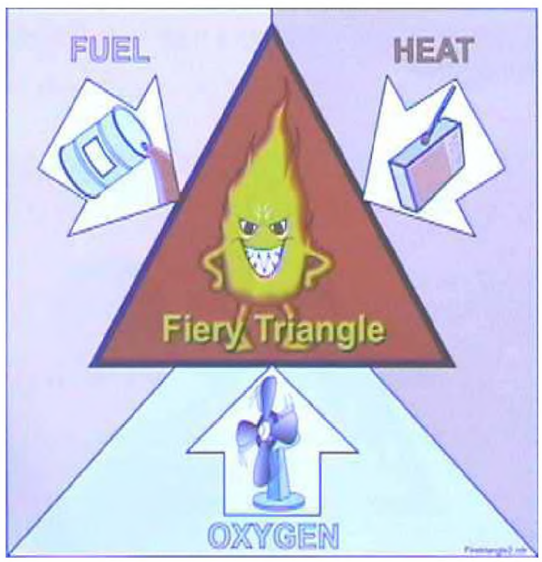
Back to Basics

Analyses of the current statistics on fires that have been reported entered into the SAMRASS database by the mines revealed the following information that is represented here graphically:



During a 19-year period (1984 to 2002), a total of 147 fire accidents occurred with 198 injuries and 264 fatalities. The trend line for the number of fatalities due to fires has steadily decreased, whilst the trend for the number of injuries has remained constant at an average of 10 fire related injuries per year and the number of fire accidents at an average of 8 per year. Of concern is last year (2002) when 10 fire accidents with 12 injuries and 4 fatalities, the highest since 1996, were reported. Hopefully this is an outlier and not indicative of a future trend.

As the above case study on the Kinross mine disaster has revealed, numerous system failures had occurred that degenerated into this multi-fatality fire. Better systems on fire prevention and detection can be designed and implemented when the basics are understood and applied. The anatomy of a fire has traditionally involved three components i.e. **fuel** (the combustible substance need to feed the fire), **heat** (source of ignition, and maintained by the fire itself once started), **oxygen** (required to sustain the combustion process and is generally available as part of the mine air). These three components are known as the fire triangle and is depicted in the diagram below:



A fourth condition that relates to the difficulty of extinguishing certain types of fires is now recognized as the flame chain reaction through free radicals (a chemical reaction that produces free radicals which allows the flame to spread by feeding on itself). An abundance of information exists on fire detection and control; also within Inspector of Mine investigations and inquiries, this needs to be consulted when designing health and safety systems.

Section 11 of the Mine Health and Safety Act (Act 29 of 1996) requires that risk assessments be conducted by the employer on all health or safety hazards and the hierarchy of controls applied in eliminating or reducing the risk to employees. To this end a new SANS (SABS) standard has been developed to assist in the risk assessment process, also to assist the original equipment manufacturer (OEM) to comply with section 21 of the Mine Health and Safety Act (Act 29 of 1996). This standard is the SANS (SABS) 1867 on Sprayed plastic foams for use in mines.

Introduction to SANS (SABS) 1867

The SANS (SABS) 1867 standard for sprayed plastic foams for use in mines is a product safety specification for single and multiple component foams applied in mines for the purpose of ventilation control, for the insulation of refrigeration installations and for tamping. This standard is currently a draft document.

Some of the fire safety requirements are that:

a. The product shall be non-punking i.e. the product shall not continue to further thermally decompose once the fire source has been removed.
b. The flame spread, when a large-scale horizontal flame spread test is done, shall not exceed 2,3 metres of the test channel, which is 7,4 metres in length. This test indicates the distance of sustained burning, disregarding surface flashing.
c. The toxicity index of the combustion gases shall be less than 5, when tested in accordance with Naval Engineering Standard (NES) 713.
d. The product shall not exceed 200 ^{0}C in the exothermic heat generation test.

Some of the Chemical and Environmental Requirements:

- The toxicological information of the product shall be included in the safety data sheet, as required by SABS ISO 11014-1, and shall include at least the acute toxicity, chronic or long term toxicity and specific effects.
- The formulation of the product and the blowing agent shall be identical to the original formulation for the product and the blowing agent when checked by a verifying laboratory
- The formulation of the product and the blowing agent shall be such that the levels of any gases, vapours or mist emitted during application shall comply with the national regulations and statutory requirements for hazardous chemical substances (see foreword). The propellants in the product shall not contain ozone depleting substances as listed in the Montreal Protocol. In practice, submission to an independent laboratory that has toxicology experts to verify the nature of the emissions is likely to be necessary

	
Large-scale horizontal flame spread test	**Large-scale vertical flame spread test – mine tunnel simulation.**

Recommendations

The recommendations, and in essence future challenges, with regard to fire prevention and detection can be summarized as follows:

1) To conduct comprehensive risk assessments in terms of section 11 of the Mine Health and Safety Act (Act 29 of 1996) and effective control measures implemented. The philosophy of “Better to treat the cause than the symptoms” should be the foundation of any risk mitigation applied.
2) To maintain the zero fatalities experienced from 1996 to 2001, and to further reduce the number of fire accidents and related injuries currently being experienced. As we are aware that accidents tend to occur when complacency sets in and we tend to adopt a less vigilant attitude.
3) To insist on accurate and comprehensive information on products sold to the mining industry from all OEMs, in terms of section 21 of the Mine Health and Safety Act (Act 29 of 1996), to enhance the quality of the risk assessment.
4) To ensure that adequate, immediate and effective means of fighting a fire is available to any site on your mine.
5) To ensure that an efficient means is available to detect a mine fire and also provide an early warning to all affected employees.
6) To ensure that all employees are adequately trained on fire prevention, detection and actions to be taken to safeguard themselves e.g. the use of self contained self rescuers in the event of an irrespirable atmosphere.
7) To develop detailed Fire Procedure Manuals or Codes of Practice and ensure that all role players are fully conversant with their roles, duties and/or functions.
8) To conduct regular and unannounced fire drills involving all employees.
9) To ensure immediate access to specially trained mine rescue personnel.

10) To ensure that the Section 12.1 (Mine Health and Safety Act, Act 29 of 1996) appointee is consulted on all issues relating to the rescue of employees changes to the ventilation flow etc.

Resources / Acknowledgments

1) The Kinross Inquiry documents and Exibits – Department of Minerals and Energy, Pretoria.
2) SANS (SABS) 1867, Draft standard on Sprayed plastics for use in mines, Edition 1.
3) SAMRASS database, Department of Minerals and Energy, Pretoria.
4) Commission of Inquiry into Safety and Health in the Mining Industry, The Honourable R.N Leon, Prof. M.D.G Salamon, Prof. A.W Davies, Prof. J.C.A Davies.
5) Frictional Ignitions, Published by SIMTARS, Queensland, Australia.
6) The Mine Ventilation Society, Workbook 4 for The Certificate in Mine Environmental Control, June 2000.
7) Photographs from product approval tests conducted by the CSIR, Building Technology Section.
8) Kinross Mines Annual Report, December 1986.
9) The Mines and Works Act, Act 27 of 1956.
10) The Mine Health and Safety Act, act 29 of 1996.

11) Mr J.C Vermaak, Mr. A.Hunt and Ms K Narsai for assistance in translating the Afrikaans language text of the Inquiry proceedings.