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Our reference:	**2102027**
Prepared for:	**Queensland Coal Mining Board of Enquiry**
Client reference:	**RK:RK-181**
Date issued:	**11 March 2021**

REPORT

in the matter of

Explosion and Fire at Grosvenor Mine

Moranbah QLD on 6 May 2020

EXPERT WITNESS DECLARATION

I certify that I have read the Expert Witness Code of Conduct UNIFORM CIVIL PROCEDURE RULES 1999 - REG 428 and agree to be bound by it. To the best of my ability, this report has been prepared in accordance with the Code. I have carried out all the enquiries which I consider to be necessary in this case.

Investigator: **James William MUNDAY** **MIFireE, FSSDip, IAAI-CFI, FCSFS**

Signed: [redacted]

Reviewed by: **Vithyaa Dayalan** **BSc, MSc, Grad Dip FI, IAAI-FIT, NAFI-CFEI**

Signed: [redacted]

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1. INTRODUCTION

1.1. I am a consultant forensic scientist specialising in the investigation of fires, dispersed phase explosions and other combustion-related matters. I have been engaged in this profession for over forty years. A summary of my qualifications and experience forms Appendix A to this report. I have previously investigated and given expert evidence concerning incidents having features in common with this case.

1.2. Following initial telephone and email consultations with Ms Renae KIRK during February 2021, I was formally appointed on 26 February 2021 to review a quantity of documents relating to an explosion which occurred on 6 May 2020 at Longwall 104 of the Grosvenor Mine and involved injuries to a number of workers there. Subsequently, I was supplied with additional documents mainly comprising extracts from witness statements of the mine workers. A list of the material examined is at Appendix B to this report.

1.3. In the consultation letter dated 17 February 2021, I was asked to address the following specific questions:

What atmospheric conditions are necessary for methane explosion?
Temperature, or range of temperatures, at which methane will ignite.
Factors that would influence the consequences of a methane explosion.
Explanation of "deflagration"
How flame propagates when ignited.
What determines the speed of flame propagation?
How a blast wave is created.
What affects the magnitude of a blast wave?
How a blast wave propagates, and what determines the extent of its propagation.
How a blast wave would be manifested i.e., what would be experienced by persons in its path.

How the propagation of a flame front and pressure wave would be influenced by the location being a confined area, in this case an underground mine.

1.4. I was verbally requested to provide any additional comments which might assist the Board of Inquiry in its considerations.

1.5. The review was carried out as far as practicable in conformity with the requirements of NFPA 921: Guide for Fire and Explosion Investigations (current edition)[1] and other authoritative texts[2].

2. GENERAL NATURE OF METHANE GAS EXPLOSIONS

2.1. Methane is a colourless, odourless, flammable hydrocarbon gas which is less dense than air and is produced naturally in a number of settings, usually involving decomposition of organic materials such as vegetation. It is commonly present within coal deposits and presents a known hazard during mining operations.

Explosive concentration range

2.2. Like all hydrocarbon gases and vapours, methane is only flammable when mixed with air within a specific concentration range. The lower limit of this range is known as the lower flammability limit (LFL) or lower explosive limit (LEL). The upper limit of the range is known as the upper flammability limit (UFL) or upper explosive limit (UEL). In cases such as this, where an unintended and uncontrolled release of methane has occurred and become ignited, it is more usual to refer to explosive limits and I shall do so in this report.

[1] NFPA 921 – 2021, National Fire Protection Association, USA

[2] Including Kirk's Fire Investigation 7th Edition, JD DeHaan & D Icove, Brady 2012; Scientific Protocols for Fire Investigation 3rd Edition, J Lentini, CRC Press 2018; Ignition Handbook, V Babrauskas 2003, Fire Science Publishers; Investigation and Control of Gas Explosions, R Harris 1989, E&F Spon.

2.3. At concentrations below the LEL, there is too little gas in the mixture to ignite; above the UEL, there is too much gas for the available oxygen and again ignition will not occur. At standard temperature and pressure (0ºC, 100kPa), the LEL of pure methane is 5% by volume and the UEL is 15% by volume. The gas released from coal seams may contain small amounts of other hydrocarbon compounds e.g. ethane, ethylene and benzene but for practical purposes the LEL and ignition parameters of pure methane are considered to apply.

2.4. Other variations to the LEL and UEL may occur due to significant changes in temperature or pressure of the gas-air mixture. The ventilation system in the mine is presumed to maintain temperature above 0ºC but below 40ºC (suitable for human working) and the air pressure increases by approximately 10kPa per 1000m of depth below ground. For the purpose of this review, the LEL and UEL will be assumed to approximate to the stated values of 5% and 15%.

Ignition characteristics

2.5. Methane has an autoignition temperature (AIT) of 540ºC meaning that if the gas-air mixture between its explosive limits is heated to its AIT or contacts a surface at that temperature or above, then the gas will ignite. In practice, due to complex heat transfer considerations at the boundary, a hot surface such as a metal component or engine exhaust would usually need to be slightly above the AIT to ignite the gas.

2.6. More commonly, the gas-air mixture is ignited by an introduced ignition source. Examples include a flame, a friction or grinding spark (hot particle), electrical current arc or static electricity discharge. The minimum energy required to ignite a methane-air mixture is approximately 0.3mJ, which is a very small amount. For the purposes of this report, it is assumed that there would be no viable flame sources within the area of origin to cause ignition.

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Deflagration

2.7. When ignition occurs, a spherical flame front initially forms around the point of ignition and expands outwards through the gas-air mixture. The flame continues to expand spherically until all the fuel is consumed unless and until it interacts with some boundary materials, such as a tunnel wall or roof, or obstacles within the flame path which include equipment and persons in the vicinity. At this stage, the flame movement becomes turbulent which causes it to draw in unreacted gas-air mixture. From that time, the flame front is likely to move more rapidly in one or more linear directions than the original spherical flame front speed.

2.8. The phenomenon of the flame front moving through the previously unreacted gas-air mixture and igniting it is referred to as a deflagration. NFPA921-2021 defines a deflagration as follows: *3.3.43 Deflagration. Propagation of a combustion zone at a velocity that is less than the speed of sound in the unreacted medium.* The 'combustion zone' is what has been described above as a flame front. If the velocity of the flame front accelerates to beyond the speed of sound in the medium, then a detonation result. This is unusual but not impossible in gas-air ignitions and there is no evidence that it occurred in this case. The maximum flame speed for methane in air before turbulence-induced acceleration is 3.5m/s, approximately 10% of the speed of sound through the unreacted medium. Depending upon the amount of turbulence introduced, this can increase rapidly up to 50% or more of the speed of sound.

2.9. The interaction between the flame front and boundary surfaces or obstructions is further complicated by the effects of heat losses to the boundary surface and frictional drag of the gas movements, which may oppose the turbulence induced acceleration. In a situation such as a tunnel or shaft, this can result in the flame front being slowed close to the walls, floor and roof while accelerating rapidly in the open centre part of the enclosure. In effect, the overpressure and following flame front become a jet projecting along the centre line of the enclosure.

2.10 As the gas burns and generates heat, the air immediately adjacent to the flame front is heated rapidly and becomes pressurised. This forms a pressure wave, which moves ahead of the flame front and affects objects or surfaces which it encounters. The amount of heat generated and hence the magnitude of the pressure wave is directly related to the quantity of gas reacting with the oxygen from the air. The magnitude of the pressure wave is referred to as 'overpressure', that is the increase in air pressure above the pre-reaction base pressure. A larger quantity of gas will produce more heat and hence a larger overpressure, provided that it also has sufficient oxygen available to complete the reaction.

2.11 In the open, a deflagration may occur with no perceptible overpressure wave preceding the flame front. This is because the pressure generated by the hot gases can disperse in the atmosphere. In an enclosed or semi-enclosed environment, the deflagration causes a perceptible overpressure. The magnitude of the overpressure depends on a number of factors including the flame speed, quantity of fuel reacted, geometry of the enclosure and available venting.

2.12 At concentrations close to the LEL and UEL, the methane-air combustion reaction proceeds more slowly than when the concentration is close to the middle of the range. At a concentration of approximately 10%, the maximum burning velocity of the mixture is achieved (see Figure 1 below). Close to the LEL, the burning velocity is lower, and the gas is consumed quickly, resulting in a relatively low overpressure and minimal flame persistence. Radiant heat effects from the flame therefore tend to be minor. Close to the UEL, the burning velocity is also lower, but the combustion of the gas persists for much longer, resulting in a greater flame persistence and radiant heat exposure from the flame front behind the pressure wave.

2.13 Because the pressure generation is directly proportional to the burning velocity, the overpressure generated in a gas-air deflagration follows a similar pattern to that shown in Fig 1, with maximum pressure being generated at a methane concentration close to 10%.

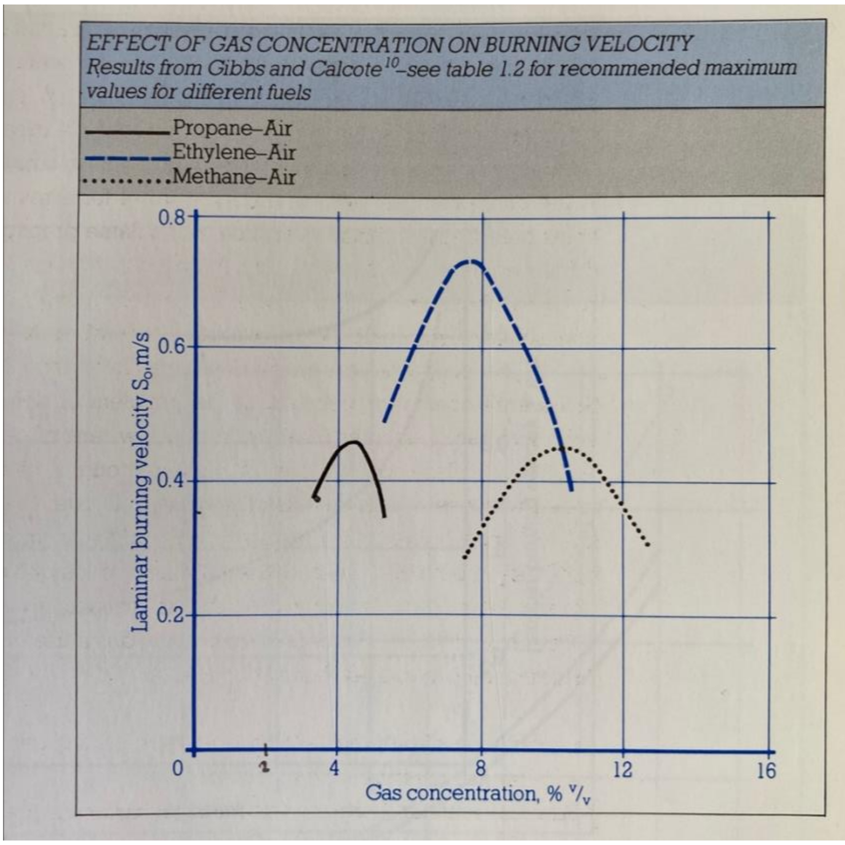

Figure 1 - effect of gas concentration on burning velocity

From Harris, RJ Investigation and Control of Gas Explosions p 13, fig 1.4

Pressure wave propagation and thermal effects

2.14 Unlike high explosives, which produce a supersonic pulse of pressure causing shattering or tearing damage, the subsonic pressure wave associated with most confined or semi-confined deflagrations has a pushing or heaving effect. Figure 2 below shows the difference in duration of the pressure pulse of an explosive charge and a vented confined gas explosion. The use of the terms 'blast' and 'blast wave' is technically limited to detonations rather than deflagrations, although common usage differs.

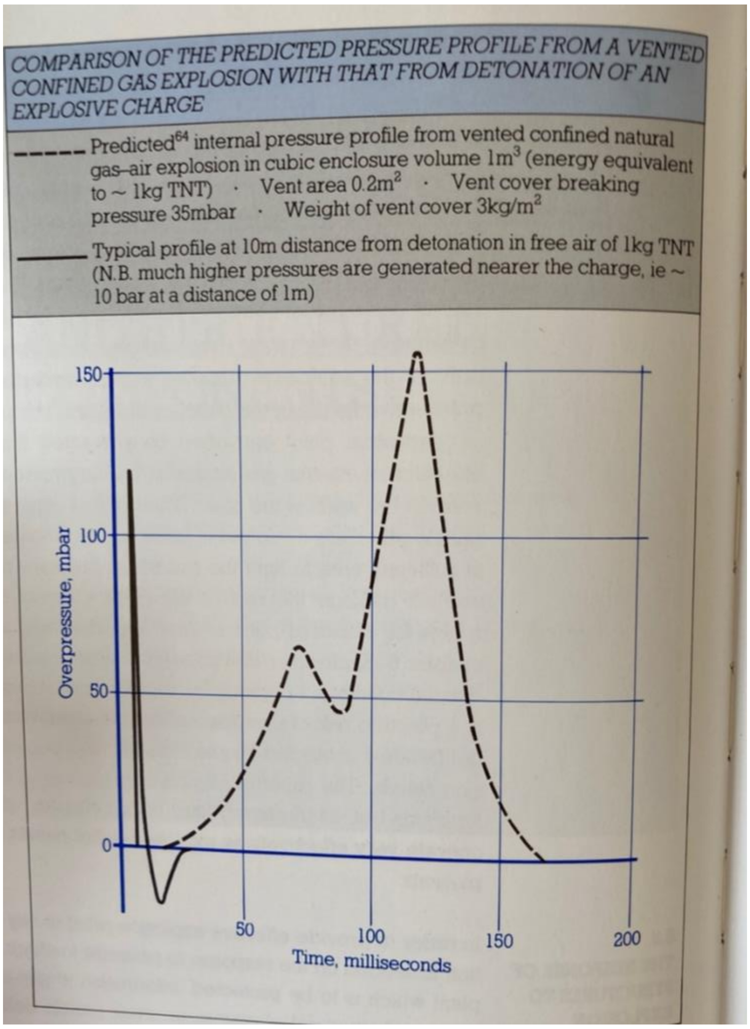

Figure 2 - comparison of high explosive and gas deflagration pressure profiles
From Harris, RJ Investigation and Control of Gas Explosions p. 82, fig 5.1

2.15 The longer duration pressure wave from a deflagration is likely to displace objects in the direction of its travel rather than breaking them apart. In buildings, it may push out windows, doors or walls, lift roofs and displace contents. This releases the overpressure and when the pressure inside and outside the building equalise, no more displacement occurs.

2.16 In an environment such as a mine or tunnel, the pressure cannot be vented in that way and the pressure wave extends in an almost linear fashion in either direction from the point of origin. If the origin is at or close to a closed end of the tunnel or shaft, then effectively all of the overpressure is dissipated towards the open end. It is commonly experienced as similar to a brief but extremely strong wind gust, which may cause a person to move, stagger or fall over.

2.17 The flame front following immediately behind the pressure wave can produce either superficial heat damage (often referred to as ‘flamewash’) or more significant radiant heat effects up to and including ignition of combustibles which it encounters e.g. clothing and personal effects. Exposed skin and hair are likely to be affected and there may be significant burns.

Hyrbid Explosions

2.18 The situation is made more complex when the deflagration occurs and then involves and ignites other airborne fuels such as combustible dusts, mists or aerosols. In a coal mining situation, where there is usually some airborne dust already present and further dust can be raised into the atmosphere by the pressure wave effects, the additional fuel is likely to make the methane flame front more energetic and more persistent (i.e. burn longer with more radiant heat) which will exacerbate the burning effects of the flame front as it encounters other combustibles, skin etc.

2.19 It has been established that a mixture of combustible dust and methane can be ignitable and hence explosive, even if the concentration of each of the components is less than its individual LEL[3]. Under such circumstances, e.g. in a very dusty coal mine, an explosion could potentially occur with the methane concentration below 5%.

Multiple or cascade explosions

2.20 In some circumstances, there can be physically separated volumes or ‘pockets’ of gas-air mixture within the explosive range. This is most common

[3] Babrauskas V, 2003. Ignition Handbook Chapter 5, p143. Fire Science Publishers.

in buildings, where separate rooms may contain explosive gas concentrations sealed off from each other but can also happen in other environments. In such situations, the initial deflagration may proceed through a region where there is little or no gas in the air and then into another region where there is again an explosive mixture. Under these circumstances, the moving flame front can ignite the gas in the second region causing a further deflagration to occur. The pressure effects of this can be close together and cumulative or separated in time, depending on the unique environmental factors. Where this happens more than twice in succession, it is sometimes referred to as a cascade explosion and often results in extremely high overpressures with consequently greater damage.

2.21 Multiple hybrid or multi-fuel explosions can also occur, for example an initial gas explosion may disturb combustible dust in one or more locations where there was previously little or no airborne fuel. The moving flame front can then ignite the raised dust, causing dust explosion(s) to follow the gas explosion.

3 THERMAL INJURIES AND DAMAGE

3.1 Transient exposure to a relatively low-energy deflagration has the effect of briefly raising materials which it encounters to temperatures sufficient to melt synthetic fibres and scorch natural fabrics. It is also likely to singe hair and may produce superficial burning or reddening (erythema) to exposed skin. This effect is commonly referred to as “flamewash”; the damage to clothing is often only visible by microscopic examination and is characteristic of exposure to a burning gas or vapour cloud.

3.2 However, when the flame front is more energetic there is a corresponding increase in radiant heating from it. This can result in direct ignition of materials which it contacts while passing and may also cause skin burns on non-exposed areas covered by thin clothing, such as cotton shirts, which do not themselves become ignited. Exposed skin and hair is likely to be strongly affected by heat, resulting in significant burning and blistering.

3.3 I have examined eight (8) colour images depicting injuries and, in my opinion, they are entirely consistent with exposure to a high-energy deflagration flame front. Unaffected areas of skin appear to coincide with likely positions of thicker or multiple layer clothing and/or personal equipment e.g. belts, straps.

4 WITNESS ACCOUNTS

4.1 The extracts provided have a number of features in common. Personnel at the main gate and elsewhere describe two separate pressure waves, the first of which reversed the ventilation but did not appear to be accompanied by flame. The second was perceived as being more powerful but no flash, light or fire was observed at the main gate.

4.2 Workers 1, 3, 4 and 5 within the longwall area describe two distinct pressure events, the second of which appeared more powerful and was accompanied by heat and flame. I have not seen an account from Worker 2 and I understand that he was the most severely injured person.

5 REPORT OF AUSTRALIAN FORENSIC (MR NYSTROM)

5.1 I have reviewed the Australian Forensic report dated 17 August 2020. I consider it to be thorough and well-reasoned, with sufficiently detailed observations to support the conclusions.

5.2 In particular, I agree with Mr NYSTROM's interpretation of the directional fire pattern indicators on the clothing and personal equipment which he examined. I also agree with his interpretation of the directional fire and heat exposure patterns on the mine equipment, shown in his images 12-26. Specifically, there appear to be localised areas of greater heat and fire damage separated by areas of less intense damage, with generally less damage closer to the maingate end of the longwall.

5.3 As Mr NYSTROM explains, this is relatively common in gas deflagrations and can result from local variations in concentration of the gas-air mixture. For that reason, I agree that it is not possible to determine from the severity of the injuries alone which of the workers was closest to the point of ignition.

5.4 cannot confirm from the photographs alone that the deflagration originated around Chock 111, as Mr NYSTROM concludes. He has had the benefit of seeing the physical evidence first-hand and is in a better position to make that determination. I have seen no photographic or documentary evidence to make me dispute this finding.

6 EVALUATION & INTERPRETATION

6.1 The witness descriptions of two pressure events are supported by the graphical data reproduced at Images 2 and 3 of the Australian Forensic report, which indicates two pressure peaks maximising at 14:57:31 and 14:57:46, i.e. 15 seconds apart.

6.2 From the witness accounts, a deflagration appears to have been responsible for the second pressure wave and associated thermal effects. Based on the available information, I cannot say for certain whether this was a methane-air deflagration, a coal dust-air ignition or a hybrid event.

6.3 In my opinion, based on flame front speed, the time interval between the two pressure waves is too great for an initial methane or hybrid deflagration to have directly initiated a second event, in the manner of a cascade. It is possible that the first pressure event did not result from a deflagration but from some other cause, e.g. a goaf failure, releasing methane and/or disturbing dust which then became ignited.

6.4 The ignition mechanism was not determined by Mr NYSTROM's examination and I have seen no other evidence which could indicate it. As previously stated, the minimum ignition energy for a methane-air mixture is very low and can be supplied by such sources as static electrical discharge and low-voltage electrical equipment.

6.5 I have previously been involved in the investigation of a methane explosion in a New South Wales longwall mine where a chock controller was suspected of providing the ignition source, but this was unable to be confirmed.

6.6 Static electrical charge can build up on items such as synthetic clothing, equipment pouches etc. and then discharge to earth or to other clothing or equipment but will only produce a sufficiently energetic discharge arc if the relative humidity of the surrounding air is below approximately 40%.

6.7 If the first overpressure event resulted from a goaf incident or rock fall, it is possible that the ignition source was a friction spark caused by rock on metal impact or an arc from compromised electrical cables or equipment.

7 CONCLUSIONS

7.1 Two overpressure events occurred within Longwall 140, the second of which involved a gas-air deflagration, a dust-air deflagration or a hybrid event.

7.2 I have seen no witness evidence to indicate that the first pressure wave was also caused by a deflagration but cannot eliminate it based on physical evidence alone.

7.3 The thermal damage and injuries depicted and described are wholly consistent with exposure to a deflagration event.

END OF REPORT

APPENDIX A

Summary of Qualifications and Experience

James William Munday

MIFireE, FSSDip, IAAI-CFI, FCSFS

Consultant in Forensic Fire & Explosion Investigation

and related areas of Forensic Science

Academic and Vocational Qualifications

UNIVERSITY OF DUNDEE

Associate Degree equivalent in Chemistry 1978

INSTITUTION OF FIRE ENGINEERS

Member by examination (MIFireE) 1985

CITY & GUILDS (UK)

Electrical Wiring Theory and Practice 1986

FORENSIC SCIENCE SOCIETY (with UNIVERSITY OF STRATHCLYDE) Diploma in Fire Investigation (FSSDip) (accredited post-graduate diploma) 1996

INTERNATIONAL ASSOCIATION OF ARSON INVESTIGATORS

Certified Fire Investigator (IAAI-CFI) 2001 (renewed every five years)

CHARTERED SOCIETY OF FORENSIC SCIENTISTS Practitioner Fellow (FCSFS) in the discipline of fire and explosion investigation 2007

Employment History

2020 – present

Senior Investigator (Part Time), Fire Forensics Pty Ltd

2017- 2020

Director and Senior Investigator, Fire Forensics Pty Ltd.

2010 – current

Senior Associate, Fire Investigation Global LLC (London, UK)

2003-2017

Principal of JW Munday & Associates (Australasia)

1999-2003

Principal of JW Munday & Associates UK

1996-1998

Senior Court Reporting Officer, UK Home Office Forensic Science Service

1972-1996

Forensic Scientist, Metropolitan Police Forensic Science Laboratory

Relevant training and experience

Joined the Metropolitan Police Forensic Science Laboratory (MPFSL) in 1972. Received training in many techniques relating to drugs and toxicology, criminalistics, crime scene examination and evidence retrieval. Took part in a wide range of casework including many complex and difficult cases such as organised violent crime, terrorist offences and murders.

In 1979, transferred into the Fire Investigation Unit (FIU), a small group of forensic scientists within the MPFSL specialising in the investigation of fires, dispersed phase explosions and other combustion-related phenomena including carbon monoxide poisoning and thermal injury.

On merger with the Forensic Science Service in 1996 remained with the FIU until the end of 1998. Was then one of the most experienced public sector fire investigators in the UK, having examined the scenes of around 1600 incidents (many of which were complex and/or high profile and including over 300 fatalities) and carried out laboratory tests on items and materials from many others, including incendiary and pyrotechnic devices and human tissue samples. Was the nominated Safety Officer for the FIU and a quality assurance checker for colleagues' casework. Deputised as Unit Manager on several occasions 1992-1998.

Set up J.W. Munday & Associates (UK) in January 1999, J.W. Munday & Associates (Australasia) in 2003. Clients to date include solicitors, insurers, prosecutors, police and fire services in the United Kingdom and Australia together with legal officers and public bodies in a number of European countries. Registered as specialist adviser with the UK National Crime Faculty and Australian police services, listed on numerous expert witness databases. Has given evidence as an expert witness on many occasions in legal proceedings, including criminal and Coroners courts and also military and civil hearings.

Specialist Experience

Extensive knowledge and experience in:

- fire and explosion scene examination
- fatal and serious injury incidents
- interpretation of thermal injury distribution
- gas and vapour explosions
- electrical systems and causes of fire
- self-heating and 'spontaneous combustion'
- assessment and interpretation of documentary and photographic evidence
- road vehicle, heavy industrial vehicle and other transport fires
- process and equipment failures
- laboratory testing and analysis of all types of fire-related evidence
- computer modelling and visualisation techniques
- relevant legislation

Special areas of personal interest include:

- improving fire engineering knowledge of forensic scientists
- training of police, scenes-of-crime, fire service and forensic science personnel in fire investigation
- health and safety requirements for investigators
- quality assurance systems
- development of professional accreditation and registration schemes

Lectures and Publications

Instructor, Gardiner Associates theory and practical training programmes. Frequent lecturer on other police, fire service and forensic science training courses and at meetings of IAAI Chapters, Forensic Science Society and Institution of Fire Engineers. Instructor, Hong Kong Government Gas Standards Office explosion investigation training 2004 onwards. Instructor, Malaysian Fire and Rescue Service Fire Investigation courses 2008 onwards.

Often invited to address professional bodies in UK and overseas; speaker at FBI arson symposium (USA) 1995, New South Wales Association of Fire Investigators conferences 1996 & 99, CFPA (France) symposium 1997, UK Anglo-American conferences 1997, 98, 99, 2001 & 02, Queensland AFI 2002, Australasian Claims Expo (Sydney) 2004, IAAI ATC Denver 2008; NSW Mines Safety seminars 2012 & 2013.

Visiting lecturer at University of Leeds (UK) Fire Safety Engineering courses 1999-2002. Tutor, Graduate Diploma programme, Charles Sturt University (NSW). Current Adjunct Lecturer in Fire and Explosion Investigation in University of Technology Sydney Forensic Science modules at BSc and MSc level.

Author of "Safety at Scenes of Fire and Related Incidents" (pub. Fire Protection Association, 1994 – second edition in progress).

Co-author (with F.A.S. Lewis) of "The Investigation of Vehicle Fires" (pub. Fire Protection Association, 1990). Contributor to "Kirk's Fire Investigation", 4th & 5th Editions, by Dr J. DeHaan (pub. Brady, 1997 & 2002), FM Global Pocket Guide to Fire & Arson Investigation (UK edition pub. FM Global Insurance, 2000), Disaster & Emergency Management Handbook (pub. Butterworth Tolley 2003), Handbook of Forensic Science (pub. Willan 2010).

During career to date has personally investigated more than 4000 fire and explosion scenes, including over 350 fatal incidents. Has been intimately aware of, and performed quality assurance checks on, hundreds more investigations carried out by colleagues. Has also carried out numerous reviews of investigations into fatal and other high profile fire incidents, both for defence legal representatives and for police and prosecution authorities. Is qualified and experienced in fire scene examination and interpretation, together with the laboratory analysis of materials recovered from fires and victims thereof and the interpretation of such results.

Has been involved in training fire officers, crime scene investigators and forensic scientists in all aspects of fire and explosion investigation for over twenty years. Sets and marks examination questions for Chartered Society of Forensic Sciences Diploma examinations and Institution of Fire Engineers Membership fire investigation examination papers. Examiner for IAAI-CFI candidates outside USA.

Since 1998 has been closely involved with a company providing fire investigation training and competency assessment to some 80% of the British fire service and over 60% of the police service, together with all of the major forensic science providers in the UK. Is also involved in worldwide education and training programmes provided by Charles Sturt University based in New South Wales; when required writes module syllabus, acts as on-line tutor and marks assignments for Graduate Diploma program. Is an approved assessor for the Chartered Society of Forensic Sciences (CSFS) University Accreditation Scheme.

Roles with these organisations are: to design and deliver training covering a number of areas including fire investigation methodology, the effects of fire on structures, origin and cause determination, fatal fires, laboratory analysis and presentation of evidence; and to design and deliver practical training modules, including investigation of real compartment fires, and assess the competency of the trainees in carrying out investigations. Was commissioned by Hong Kong Government to design and deliver specialist gas/vapour explosion investigation training to engineers within Gas Standards Office.

Holds British qualifications in electrical theory and practice and has lectured on electrical causation of fires to numerous fire service, police and forensic science training courses. Is the author of a document currently used to instruct Fire Service investigators in England and Wales on electrical fire causes and the interpretation of electrical damage indicators.

Has made a special study of the way in which distribution of skin burns and other thermal injuries relates to the location, position and activities of the person involved and has lectured on that subject to fire investigators and forensic pathologists in several countries.

Has given evidence as an expert witness on numerous occasions in all of the above areas of expertise in criminal, civil, military and coronial courts throughout the UK and Australia. Has also been qualified as an expert by courts in New Zealand, Ireland, Cyprus, Germany, Sweden and Malaysia. Has given evidence for both defence and prosecution in criminal trials, and for plaintiffs and defendants in civil cases.

In January 2007 was made a Fellow of the Forensic Science Society, now the Chartered Society of Forensic Sciences, a category of professional membership awarded only to individuals who have achieved distinction in forensic science and related areas over a significant period. Criteria for this award include extensive casework experience, significant contribution to research and development, significant contribution to policy and practice, extensive peer recognition and significant qualifications.

Is a member of the Chartered Society of Forensic Sciences and the Australia & New Zealand Forensic Science Society and is bound by their Codes of Ethics, together with the ethical requirements of the Institution of Fire Engineers. Is aware of the duty to provide impartial and objective evidence to the Court at all times. Is also a member of the International Association of Arson Investigators and the NSW Association of Fire Investigators and subject to their Codes of Professional Conduct. Has at various times been a committee member and office holder of the NSWAFI. Is a member of the Fire Protection Association of Australia (FPAA) and the UK Fire Protection Association (FPA).

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APPENDIX B

List of material used

Letter from Queensland Coal Mining Board of Inquiry dated 17 February 2021 with attachments:

Report of Mr Murray Nystrom, Australian Forensic Pty Ltd

Summaries of accounts from coal mine workers

Colour images depicting injuries

Additional extracts from workers' accounts