CHAPTER 10

Gas monitoring

Introduction

1. All underground coal mines require gas monitoring to detect and help prevent explosive accumulations of gas. There are three main forms of gas monitoring: remote gas monitoring systems, machine-mounted sensors and hand-held sensors.[1] The first two systems may be used to isolate or 'trip' electric power if the concentration of flammable gas exceeds safe levels.[2]

Remote gas monitoring

2. Remote gas monitoring usually consists of tube bundle and/or real-time systems.[3] Industry practice in Australia is to have both in place, and in Queensland it is also standard to have a gas chromatograph at each mine.[4] A gas chromatograph provides the most comprehensive analysis of mine gases, and is particularly suited to manage spontaneous combustion events.[5]

3. Real-time or telemetric monitoring systems rely on underground electronic sensors that send a signal to the surface in real time. They provide rapid feedback to the control room about the underground conditions and are the best method for identifying a sudden event such as a methane plug or a fire. However, they require underground power, and the sensors must be located in underground conditions, which may be damp or dusty. The sensors tend to have limited measuring ranges; for example, methane can usually be detected only up to 5%. They are also prone to being 'poisoned', or shutting down when exposed to gas beyond their maximum level. They are not as useful as tube bundle systems for long-term trending or in oxygen depleted locations, and they require frequent recalibration. In addition, despite providing 'real-time' feedback, the signals are not instant. Energy New Zealand calculated the two systems at Pike River had lag times of up to 29 and 44 seconds each before results were reported to the control room.[6] There was also a lag time of eight to 13 seconds before power was tripped underground following a high gas reading.[7]

4. A tube bundle system uses plastic tubes that run from within the mine to the surface. A vacuum pump draws gas samples to the surface, where they are analysed for a range of gases – usually carbon monoxide, carbon dioxide, methane and oxygen. The advantages of a tube bundle system include the ability to measure several different gases from a single sample, the fact the system does not rely on underground power, and the ability to use more sensitive analysis equipment on the surface. A tube bundle system is also more likely to remain functional after an underground explosion. The surface analysis and pumping equipment should always survive, and if underground tubing is damaged, new tubes may be lowered into the mine and connected to the system. Because of its greater accuracy and flexibility, the system is ideally suited to long-term trending, as well as monitoring oxygen depleted goafs and sealed-off areas that are not suitable for real-time equipment. The main downside of a tube bundle system is the time taken to retrieve a sample from underground, which may be 20 minutes or more, depending on the distance the gas sample must travel. This delay is not relevant when monitoring trends.

The Pike monitoring system as planned

5. Consistent with Australian practice, both the Minarco Asia Pacific Pty Ltd ventilation report in 2006 and the ventilation management plan in 2008 proposed real-time and tube bundle systems for Pike River.[8] Under the ventilation management plan, the real-time and tube bundle systems were to run continuously.[9] The ventilation engineer was to identify the location of all sampling points, and ensure these were marked on a plan,[10] establish

alarm levels for each sample point, and review them monthly after a ventilation survey.[11] Alarm levels were to be posted on a ventilation plan in the surface controller's room,[12] and surface controllers were to acknowledge and record all alarms and the actions taken to investigate them.[13] There was to be a trigger action response plan (TARP) setting out the mandatory responses to various alarm levels.[14] Finally, any interruption in the electronic monitoring system was to be remedied as soon as practicable, and any delay was to be drawn to the attention of the mine manager and ventilation engineer.[15] These procedures were appropriate, but they were not followed at Pike River.

The Pike River remote gas monitoring system as built

6. Pike River had a real-time gas monitoring system, but not a tube bundle system. In the absence of a ventilation engineer, general manager Douglas White determined the location of the underground sensors for the real-time system.[16]

7. In June 2010 consultant electrical engineer Michael Donaldson recommended the locations for the sensors. It was a matter for the ventilation officer to determine the final locations.[17] Mr Donaldson's June 2010 plan had eight methane detectors, including two at the furthest inbye points in the mine as it existed at that time.[18]

8. Mr White said he sat down with Mr Donaldson approximately four or five weeks before the explosion to determine where the sensors would go.[19] However, as at 19 November 2010 there were no sensors beyond the ventilation shaft reporting to the surface from the return.

9. The ventilation management plan required the mine manager and ventilation engineer to sign and date accurate ventilation plans at least every three months. These were required to show all key features of the ventilation system, including the gas monitoring sample points, the restricted zone, the location of emergency escapeways, refuge bays and rescue facilities, boreholes and many other features. No accurate plan was ever produced at Pike showing all these features.

10. On 10 March 2010 the then mine manager, Michael Lerch, signed a ventilation plan and asked, 'Is this the ventilation plan as defined in vent management plan 5 3.1 (attached)?', 'Restricted zones?', 'Other information listed in 3.1 attached?'.[20] Over the following months no ventilation plan at Pike contained accurate records of the required matters. All pre-explosion plans were incomplete or inaccurate to varying degrees, and none provided an accurate record of the gas monitoring system.

11. As at 19 November 2010 there were eight fixed methane sensors connected to the surface control room,[21] shown in Figure 10.1.

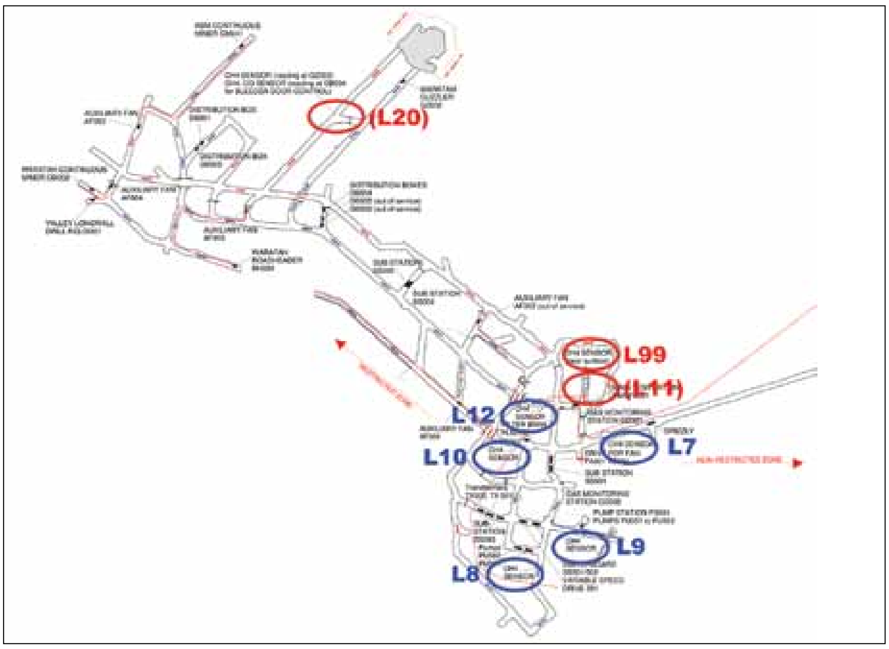


Figure 10.1: Location of fixed methane sensors[22]

12. The five sensors circled in blue were all located within the intake roadways, in areas expected to be ventilated by fresh air. These sensors were located at or near electrical equipment in an area Pike designated as the 'non-restricted zone'. Regulations require the non-restricted zone to contain no more than 0.25% flammable gas. The sensors in this area at Pike River were set to trip power at 0.25% methane.

Sensors in the return

13. The three sensors circled in red were in the return of the ventilation system, and were intended to measure the concentration of methane in the contaminated air removed from the mine workings.[23]

14. The sensor at L11 stopped working on 4 September 2010,[24] and the sensor at L20 stopped working on 13 October 2010,[25] leaving Pike with no gas sensors reporting to the surface from further into the return than the ventilation shaft. This did not give the mine adequate information about the location, source and quantities of flammable gas within the mine. Surface controller Barry McIntosh said the controllers had raised the issue of the location of gas sensors, and in his view the gas sensors 'weren't up far enough' in the mine.[26]

15. By way of comparison, consultant David Reece provided on request a plan showing where Pike would have typically required gas sensors under Queensland legislation. His plan was not absolute and was subject to a number of technical qualifications including the proximity of other detectors, but on the basis of the plan, Pike would probably have required seven fixed sensors (marked in red) reporting to the surface from inbye of the ventilation shaft. As at 19 November Pike did not have any fixed gas sensors reporting to the surface in these areas. The only functioning sensor reporting to the surface from the return was at the position marked in green on the plan.

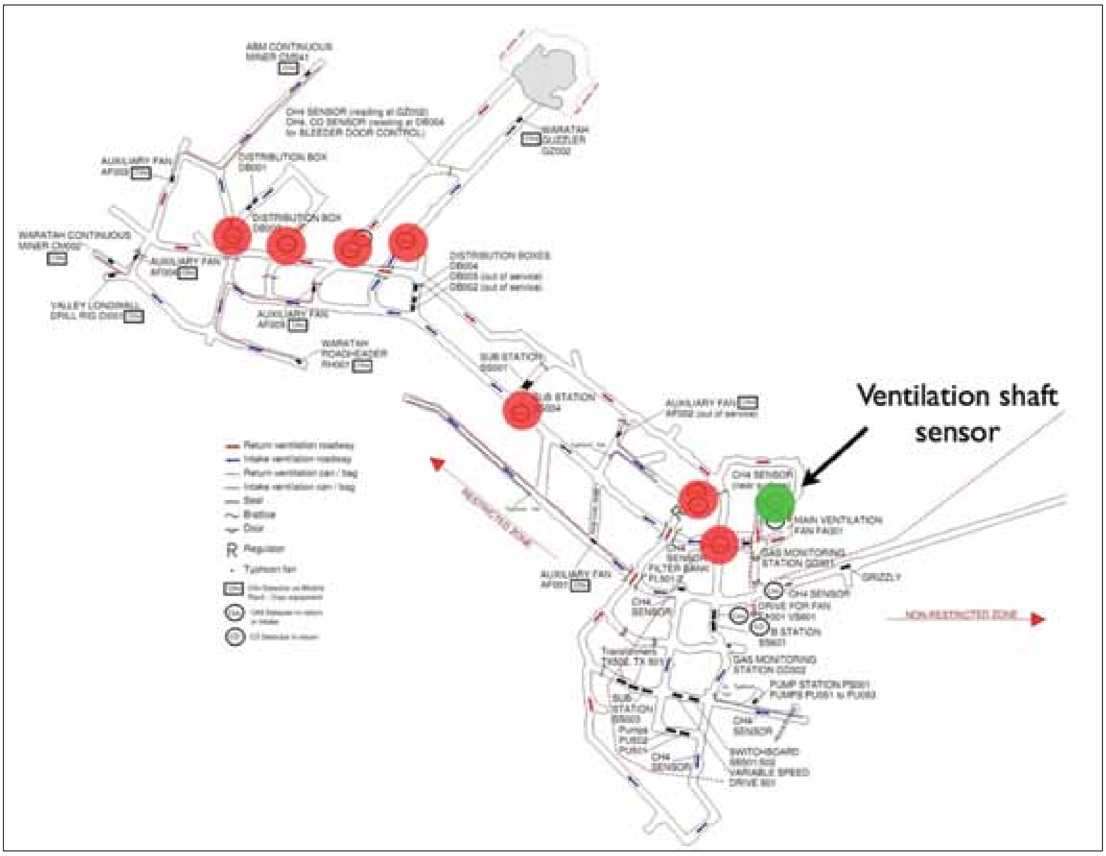


Figure 10.2: Plan of required gas sensors at Pike River under Queensland legislation[27]

16. The joint investigation expert panel said that the mine 'should not have operated' without at least two sensors in the return, connected to an alarm and set to trip the power supply for the underground fan.[28]

Hydro-panel sensors

17. There were two methane sensors located in the return from the hydro panel, circled in black on the diagram below.

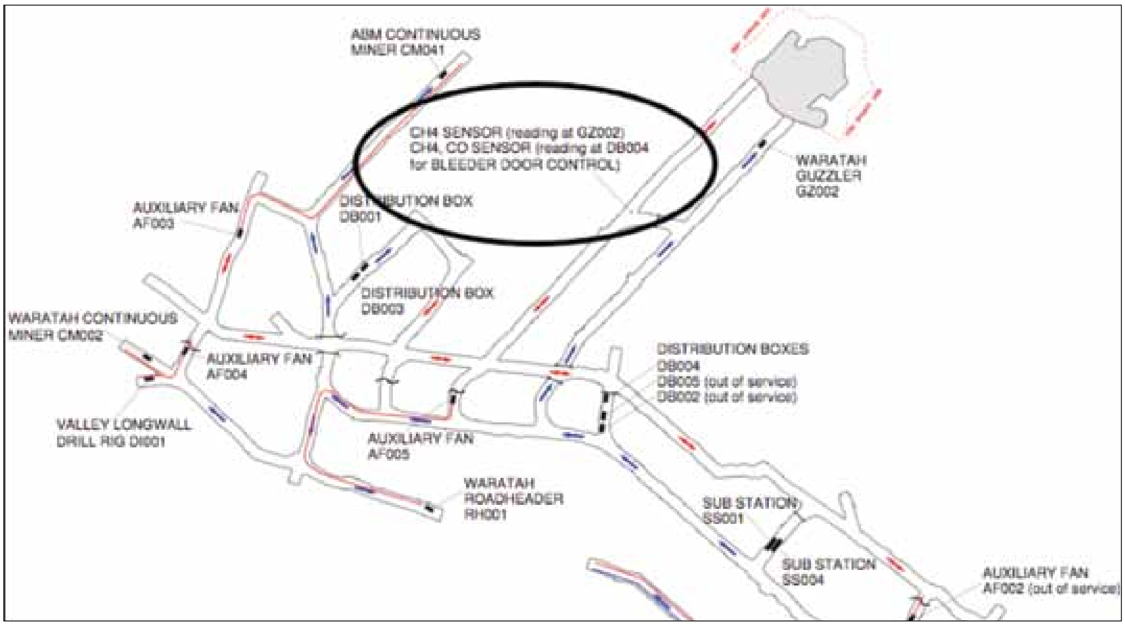


Figure 10.3: Location of hydro-panel sensors[29]

18. One provided a reading at the guzzler near the hydro monitor, but did not report to the surface or result in any permanent record of gas levels. The other sensor had been exposed to methane concentrations above 5%, and did not work after 13 October 2010.[30]

Problems with the sensors in the ventilation shaft

19. There were several problems with the gas sensors in the ventilation shaft. First, the sensor at the bottom of the ventilation shaft stopped working on 4 September 2010, nearly 11 weeks before the explosion, and was never repaired or replaced.[31] Indeed, the control room operator's screen on the Safegas system was permanently annotated to say the sensor was 'faulty' and 'waiting for spare'.

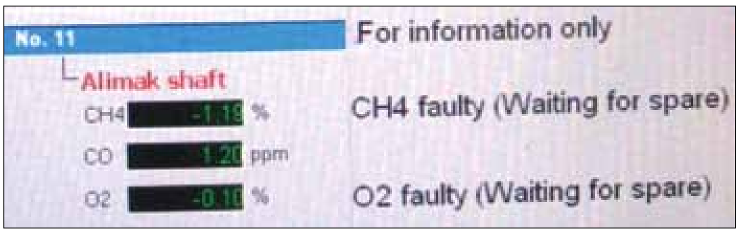


Figure 10.4: Control room operator's screen on the Safegas system[32]

20. Mr White was not aware the sensor was not working and could not explain why the sensor was broken for two and a half months without his knowledge.[33] The problem appears to have been discussed at the review of the surface fan failure on 7 October 2010, at which Mr White was present.[34] It was resolved to 'Set up Gas Monitoring [at] shaft bottom',[35] but was still to be done at the time of the explosion.

21. With the bottom sensor broken, there was just one sensor in the return reporting to the surface. The expert panel described this situation as 'hard to comprehend' in a gassy mine.[36]

22. Second, the sensor at the top of the ventilation shaft was incorrectly installed and unreliable. The sensor was hanging on a 2m piece of rope at the top of the shaft, and was wet and muddy when inspected on 4 November 2010.[37] A gas sensor is a sensitive instrument that should not be blocked or obstructed, much less covered in mud.

23. Further, Energy New Zealand concluded the sensor was installed in such a way that 5% methane (the upper limit of the sensor) would have reported as 2.96%.[38] This problem was not detected at the mine. Mr White said he was not aware of it,[39] and he agreed it raised serious issues about the reliability and accuracy of the sensor.[40] The sensor did go through a calibration exercise on 4 November 2010,[41] but this was carried out with a concentration of 2.5% methane, 'which was within the functional operating range of the system.'[42] Accordingly, the issue was not uncovered during the calibration process.

24. The ventilation shaft sensor also 'latched' or was poisoned on a number of occasions, causing a flat line to show on the surface controller's system. The flat line phenomenon indicated the sensor had been exposed to greater than 5% methane. This occurred during the 'gassing out' of the mine on Wednesday 6 October 2010, after the failure of the surface fan.

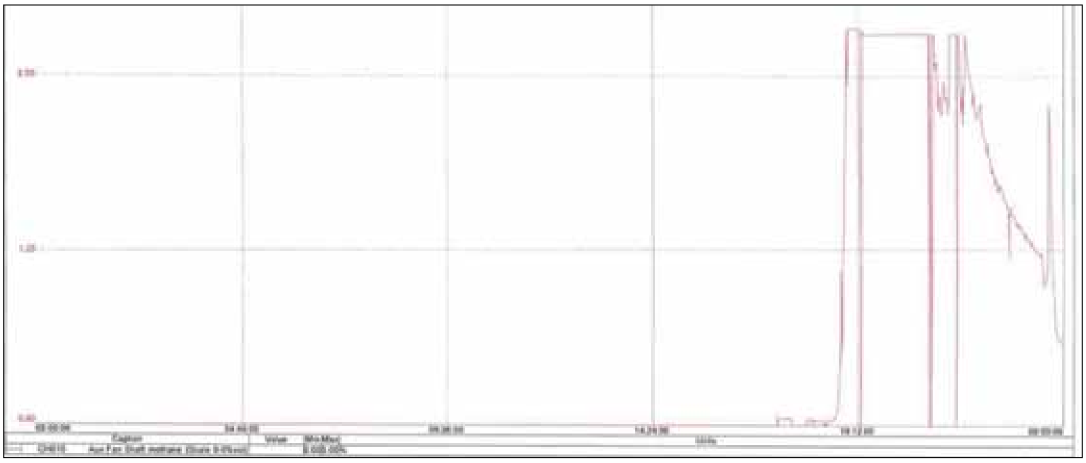


Figure 10.5: Auxiliary fan shaft methane – 6 October 2010[43]

25. There was no data from the sensor from the time of the fan failure on 5 October. The control room system then showed a flat line around 2.5% during the evening of 6 October. Despite a review and a notification to the Department of Labour (DOL) about the incident, nothing was done about the flat line issue.

26. There was then a second flat line that started late on Thursday 7 October and continued through to Friday 8 October 2010 during the degassing procedures.

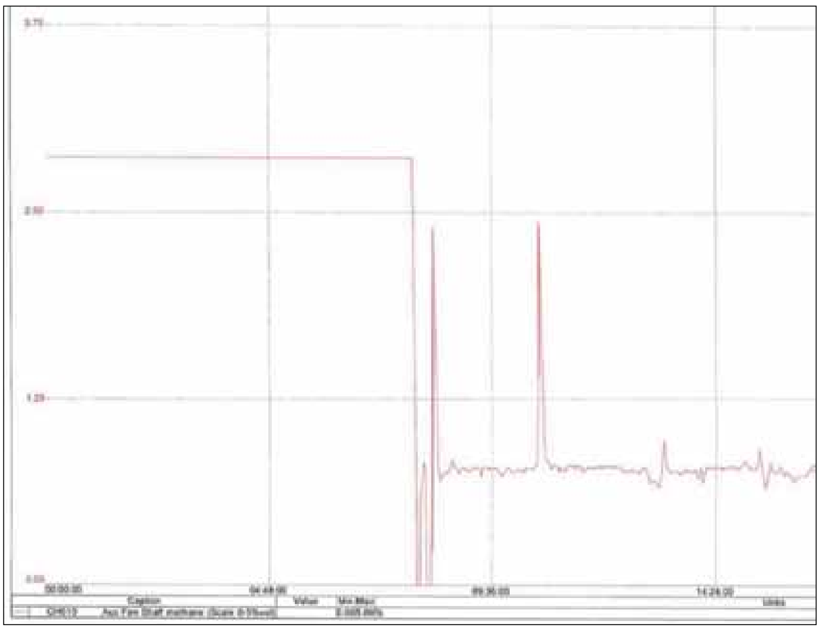


Figure 10.6: Auxiliary fan shaft methane – 8 October 2010[44]

27. Mr White told the commission he was not aware of any flat lines, and if he had been, it would have been a cause for investigation.[45] However, he accepted that he signed a ventilation survey dated 7 October 2010 that said in red capital letters 'Had a spike of 2.8% at vent shaft – monitor stuck on this reading.'[46]

28. Third, while the sensor at the bottom of the shaft was operational, there was an obvious discrepancy between the readings at the top and bottom of the shaft. The discrepancy is shown in the following graph prepared by DOL, which shows the reading from the top of the shaft in red, and the reading from the bottom of the shaft in blue.

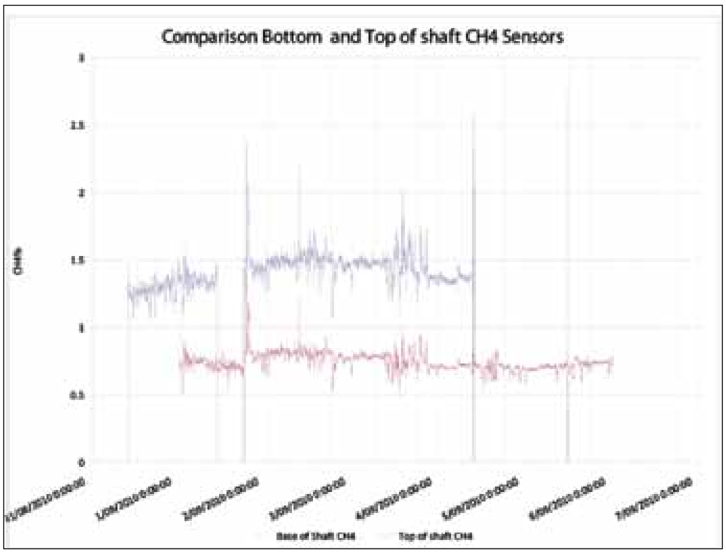


Figure 10.7: Comparison bottom and top of shaft CH_4 sensors[47]

29. There was an obvious question to be answered given that two sensors in the same air stream were reading so differently.[48] The discrepancy was not investigated.[49]

30. Fourth, the sensor at the top of the ventilation shaft was not connected to the Safegas monitoring system.[50] Safegas includes a control room operator's screen, multi-level alarms and an audit trail of all actions taken. It requires the operator to acknowledge all alarms, and helps to ensure that the appropriate actions are taken.

31. Pike installed Safegas in 2008 and the mine's remote gas sensors were connected to it. On 8 October 2010 the engineering manager, Nicholas Gribble, emailed Mr White and said that the mine should use Safegas for all gas monitoring, because 'when we get alarms Safegas requires the alarm to be accepted and [instructs] what action has to be taken.'[51] Mr White agreed. By 19 November 2010 the gas sensor at the top of the ventilation shaft was still not connected to Safegas.

Maintenance and calibration of gas sensors

32. In November 2010 underground electrical co-ordinator Michael Scott took over responsibility for the fixed gas sensors following a reorganisation of engineering roles at the mine. He found the fixed sensors were not being calibrated on a regular basis as they should have been, and responsibility for the sensors in the ventilation shaft was 'falling through the cracks.'[52] He said it was 'kind of a haphazard…maintenance programme,'[53] and although six-monthly calibrations were done, the more frequent weekly or monthly calibrations were not being completed.[54] The detector at the top of the ventilation shaft was calibrated in early November, but the other sensors were due to be looked at the weekend after the explosion.[55] Mr Scott did not know whether the management level above him was aware of the problem.

33. On 22 September 2010 Robb Ridl wrote to Mr White stating that the Pike engineering department was 'currently unable to meet the needs of the business,'[56] and fixed plant was 'not being proactively maintained due to lack of supervisory resources.'[57] He noted that three members of the engineering team had been seconded to the hydro project, and 'the maintenance of fixed and mobile plant is currently insufficiently covered due to the absence of these individuals.'[58]

34. Mr White was asked whether he looked at maintenance or calibration records as a lead indicator of safety. He said he did not check the preventative maintenance programme; it was a matter he delegated to the maintenance department. He did take steps to encourage better maintenance of equipment.[59]

Control room monitoring

35. The role of the surface controller is critical to the operation of a mine's gas monitoring system. Following recommendations from the Moura No. 2 inquiry,[60] Queensland regulations require standard procedures for acknowledging gas alarms.[61] The control room operator is the first to respond to a gas alarm, and it is essential that person is well trained and able to perform the role.

36. Under Pike's ventilation management plan, surface controllers were required to acknowledge and record all gas alarms and notify the production deputy of any active alarms.[62] However, Pike did not train the controllers adequately, ensure they were aware of their responsibilities, or keep them informed of developments in the monitoring system. There had been a meeting shortly before the explosion, when the control room officers requested training in gas monitoring and Safegas.[63] Mr McIntosh told investigators it was 'pretty bloody difficult' in the control room, because 'we were never given any training.'[64] He described the meeting with management and said the controllers 'spelt out a lot of things that we weren't happy about', including the way the controllers were treated, the lack of training and paucity of information.[65] Mr White said that after the meeting Mr Ellis was asked to organise training for surface controllers in the gas monitoring system.[66] No training had occurred before the explosion.

37. Pike had a TARP dealing with gas alarms,[67] which was signed off by the mine manager on 5 December 2008. The TARP was not in use or known to key people and the document itself was confusing and internally inconsistent. The first part dealt with three trigger levels, but the section relating to methane identified four, making it unclear which responses applied to methane. The plan referred to gas accumulations at 'lower levels' and 'higher levels', but these terms were not defined. A level three trigger was a gas accumulation at high levels over a 'prolonged period,'[68] but that was not defined. These ambiguities undermined the purpose of a TARP, which is to give clear and precise rules.

38. In October 2010 Pike was in the process of drafting a standard operating procedure (SOP) to deal with methane alarms in the return.[69] The draft relied on several things that did not exist, including a ventilation officer, an underground text messaging service and a gas alarm log book. Although a log book was being drafted in October 2010,[70] neither this, nor the methane alarm SOP, had been introduced by 19 November 2010.

39. There was no effective process to make sure that gas alarms were monitored and then acted upon within the control room.[71]

Management oversight of gas monitoring

40. Although the mine manager and ventilation engineer were responsible for gas monitoring under the ventilation management plan, there was no reliable process to ensure that the results from the gas monitoring system, or problems with the system, were communicated to them.

41. Mr White said he 'made [himself] available every day at the start of the shift for the process of passing on information.'[72] However, relying on informal feedback of that sort is a flawed approach, as demonstrated by the fact that Mr White remained unaware that a critical gas sensor was broken for 11 weeks before the explosion. Mr Ridl was also unaware of the broken sensor and the problems with the sensor at the top of the ventilation shaft.[73] Effective oversight requires an active system to make sure information is identified and passed on, rather than a passive system relying on senior managers being 'available'.

42. The company did make a concerted effort to record and communicate gas results to ensure compliance with the Emissions Trading Scheme (ETS). An email from technical services co-ordinator Gregory Borichevsky in October 2010 noted the ETS requirements were 'mandatory' and had 'significant commercial implications.'[74] He said 'because of our statutory compliance requirements for an accurate measure of methane emissions, it is critical that you put in place an accurate measure of … the volume of methane produced.' [75]

43. Because of the ETS, and the need to monitor methane levels during the free venting of gas drainage lines,[76] Mr Borichevsky paid attention to the gas monitoring results in the control room.[77] After the explosion he produced a document that said methane levels at the ventilation shaft 'routinely exceeded 1 per cent', 'regularly exceeded 1.5 per cent', 'occasionally exceeded 2.0 per cent' and 'had exceeded 3 per cent on more than one occasion in the weeks prior to the disaster'.[78] He said 'methane levels at the face would be expected to be at least 2 to 3 times those measured in the main return ventilation shaft due to the dilution factors involved', and that, on that basis, 'potentially explosive levels of methane would have been present in the active mine workings on a number of occasions'.[79] Mr White could not argue with Mr Borichevsky's observations.[80]

44. Mr Borichevsky said at one stage he reported on methane spikes to morning production meetings.[81] To do so, he obtained printouts of methane records, made a note of any spikes, reviewed the deputies' reports and other documents to try to establish the cause, and discussed the spikes in the meetings. However, Mr Borichevsky maintains that when Mr Ellis took over the morning meetings the agenda changed to focus on production, and Mr Ellis was not interested in methane spikes.[82]

45. Mr Ellis rejected Mr Borichevsky's comments and said that although he did not recall Mr Borichevsky discussing gas levels at the production meetings, there was nothing to prevent him doing so.[83] What is clear is that methane spikes were no longer discussed at production meetings from late 2010. Coal extraction from the hydro panel had started, and there was an increased need to discuss and resolve high methane levels.

46. The failure of the surface fan on 6 October 2010 should have alerted senior managers to problems with the gas monitoring system. The review on 7 October 2010 noted, among other things, a need to '[s]et up/review Gas Monitoring procedures as per QLD', '[d]efine ownership of … gas monitoring', address 'gas monitoring spares and procedures', and '[s]et up Gas Monitoring [at] shaft bottom'.[84] Both Mr White and Mr Ellis were present at the review, and received the report. This should have alerted management to the need for urgent action.[85]

Inappropriate equipment

47. Five of the six functioning fixed gas sensors were located within the non-restricted zone. These sensors were required to establish there was no more than 0.25% methane, in order to comply with the Health and Safety in Employment (Mining – Underground) Regulations 1999. However, the sensors had a margin of error of plus or minus 0.25%. Accordingly, they were not fit for purpose.[86]

48. The sensor in the hydro return was not capable of reading greater than 5%[87] methane, although concentrations above that occurred frequently in the return. This should have been capable of reading greater than 5%. Such a need was recognised in October 2010.

No tube bundle system

49. Another deficiency was the lack of a tube bundle system. Mr White made it clear he wanted such a system installed, plus a gas chromatograph.[88] He exchanged correspondence with the Safety in Mines Testing and Research Station (SIMTARS) in Queensland to investigate leasing a tube bundle system in 2010.[89] But in October 2010 Mr Whittall told the bank, who were to provide lease finance, that a decision about the tube bundle system was 'some way off',[90] January 2011 being a possible purchase date for the system.[91]

50. Pike River should have had a tube bundle system before coal mining began. Such a system would have provided important gas information and highlighted the serious problems with methane control.

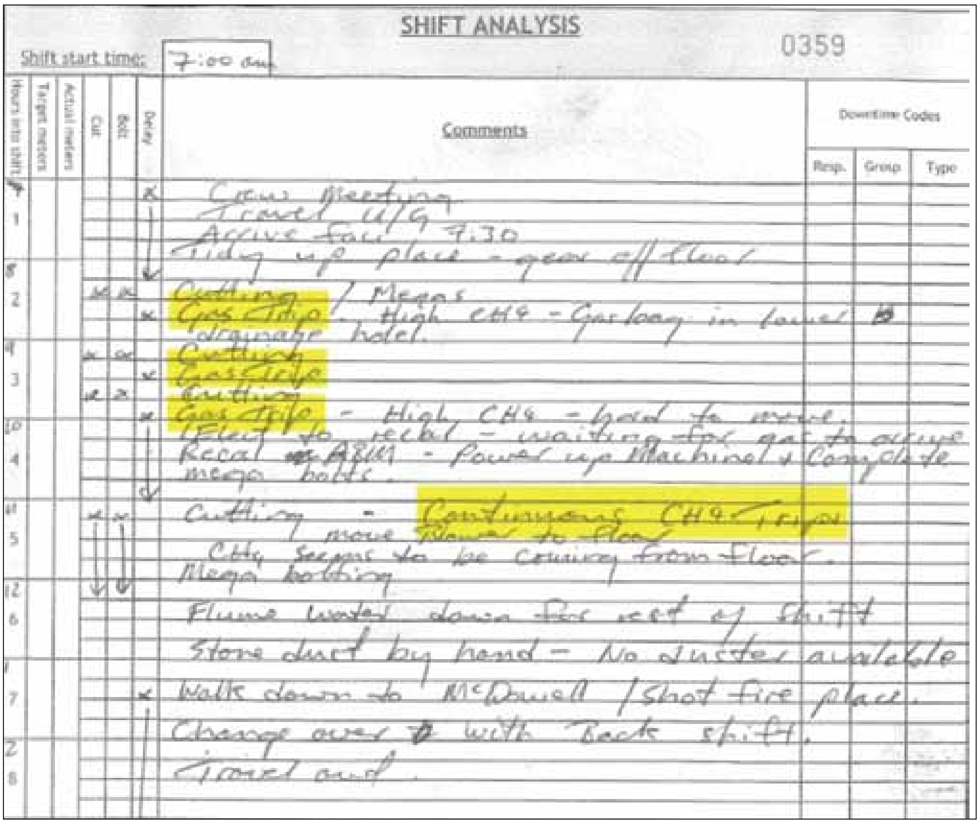
Machine-mounted and hand-held gas monitoring

Machine-mounted sensors

51. A number of mining machines at Pike River were fitted with gas sensors. These were set to cut power to the machines if they detected methane concentrations above 1.25%. None of the sensors reported to the surface. The

sensors underground on 19 November 2010 had been maintained and calibrated appropriately.[92] The sensor on the VLI Drilling Pty Ltd (VLI) drill rig was faulty and was scheduled for replacement.

52. The records of deputies underground noted numerous examples of gas trips activated by machine-mounted sensors. For example, the ABM production report for the day shift on 19 November 2010 referred to three individual gas trips, then 'continuous CH4 trips', apparently caused by mining over a gas drainage hole. The references to gas trips are highlighted in the following image.


SHIFT ANALYSIS
Shift start time: 7:00 am
0359
Hours into shift | Target meters | Actual meters | Cut | Bolt | Delay
Comments
Downtime Codes
Resp. | Group | Type

Crew Meeting
Travel U/G
Arrive face 7.30
Tidy up place - gear off floor
Cutting / Megas
Gas Trip - High CH4 - Gas bag in face / B
drainage hole.
Cutting
Gas Trip
Cutting
Gas Trip - High CH4 - hard to move.
Elect to recal - waiting for gas to [illegible]
Recal ABM - Power up Machine / + Complete
mega bolts.
Cutting - Continuous CH4 Trips
move Power to Floor
CH4 Seems to be coming from floor.
Mega bolting
Flume water down for rest of shift
Stone dust by hand - No duster available
Walk down to McDowell / Shot fire place.
Change over with Back shift.
Travel out

Figure 10.8: References to gas trips[93]

53. Machine-mounted sensors have an important role in an underground mine. However, workers may continue working in the face of gas trips, or be tempted to bypass the detectors, particularly under significant production pressure. Such behaviour defeats the purpose of the sensors.

54. The joint investigation revealed many reports of underground workers at Pike bypassing machine-mounted sensors by various means. One worker admitted he covered a gas sensor with a plastic bag.[94] He did that 'just to save it tripping and havin' to wait around for an electrician … and save the boys' legs'.[95] He heard of gas detectors being covered on other machines including loaders, and he thought every miner knew how to do it.[96] Another miner saw compressed air being blown onto gas sensors to keep the machine cutting, and miners using metal clips to override machine-mounted sensors.[97] He saw machines overridden following gas trips 'quite a few times illegally'.[98] Indeed, 'it happened so often' that he would come on shift and find the previous shift had left the metal clip in place, because 'everyone – not everyone, but a lot of people did it'.[99] He said in his view workers bypassed gas detectors 'out of frustration' because of the poor standard of equipment at Pike River and the need to get the job done.[100]

55. Unless there is a concerted effort by management to collect, monitor and respond to information about gas trips and safety bypassing, that information is likely to be lost or overlooked. Senior managers did not have an adequate system to identify and respond to the bypassing of sensors. One worker told investigators that written reports of sensors being bypassed would just 'disappear' without any response from management.[101]

56. Pike's incident/accident reporting system did contain at least 14 reports of gas sensors being bypassed.[102] One such report in March 2010, shown here, was a plea to the mine manager to 'stop people from overriding safety circuits'.

What was the ROOT CAUSE of this event?
Someone has delibritly bypassed the CH4 System

SECTION 5: Remedial Actions Recommended, Including Any Injury Prevention & Training if Required

	By Whom	By When	Date Completed
Attempt to find out how and why and stop people from overriding safety circuits (PLEASE)!	Mine Manager.	ASAP	

New Hazard Identified – has this been added into the Hazard Register? Yes ☐ No ☐
New Controls Implemented – Have these been recorded in the Hazard Register? Yes ☐ No ☐

Figure 10.9: Plea to stop overrides of safety circuits[103]

57. In many cases there was no management sign-off, and in other cases the solution was to speak to deputies and undermanagers, or issue a tool box talk. For example, Mr White signed off three incidents involving bypassing on 23 and 24 June 2010.[104] In each case the response was that Mr White had 'spoken to' statutory officials.

58. Given the heightened production pressure in 2010, and problems with safety culture, it was not enough to assume that talking to staff and officials would result in proper compliance. That lesson has emerged clearly from other disasters, which have shown that instructions to comply are no substitute for auditing and enforcement.[105]

59. Previous disasters have also shown the importance of setting up systems to ensure managers are regularly informed of non-compliance.[106] The incident/accident system did not achieve that, and managers were not adequately informed of the scale and frequency of the problems at Pike River. For these reasons the effectiveness of machine-mounted gas sensors as a control against the risk of an explosion was compromised.

Hand-held sensors

60. Deputies and underviewers at Pike were given hand-held personal gas monitors. These were used to take gas readings for the deputy statutory reports, and to inform the miners underground. However, there were frequently shortages of hand-held gas detectors at Pike. Hydro-mining consultant Masaoki Nishioka said 'almost all [the] time' there was no methane detector for him to take underground.[107] The lack of gas detectors featured several times in incident reports.

SECTION 3: Description and Investigation of Accident/Incident and Immediate Actions

Describe event: Give all details
❑ Ask what happened, where, how and who (if not enough room, attach additional sheets of paper)
❑ Include a diagram to better explain what you are saying, if that is required.
❑ Ask why? Five times to really get to potential Root Cause. Remedial actions need to occur at this level to prevent reoccurrence.

LACK OF GAS DETECTORS AVAILABLE IN CONTROL ROOM – AT 16:00 SHIFT CHANGE OVER THERE IS ONLY 1 LEFT AND IT IS NOT FULLY CHARGED – THERE IS 13 IN THE STORE TO BE SENT AWAY AND 4 TO COME BACK FROM CHECK.

Was plant/equipment involved? If so, describe including the ID/rego number of it e.g. CM1, MT004, Light vehicle rego number:

FORM COMPLETED BY: Dan Duggan SIGNATURE: [signature] POSITION: Control DATE: 2/06/2010

(Sections below to be completed by Supervisor/Department Manager/or Safety & Training Manager):

Figure 10.10: Report of lack of gas detectors[108]

61. Mr White said he was not aware of any shortage and said, 'We'd actually just increased the number of gas detectors quite significantly.[109] Given the frequency with which the issue featured in written reports at the mine, Mr White should have been aware of the problem.[110] The fact he was not emphasises a weakness in the information management system.

62. Because methane is lighter than air and accumulates in the roof areas within a mine, it is important that deputies and underviewers are able to use methane detectors anywhere likely to contain gas. Pike did not have extension probes available, which would have given deputies a better understanding of the extent of methane layering in the higher areas of the mine.[111]

63. Detection of methane with gas detectors was not necessarily comprehensive. DOL noted that high levels of gas were recorded in the ventilation shaft in the period 11 to 13 November 2010.[112] However, the deputies' statutory

reports did not record correspondingly high readings anywhere in the mine in that period. The expert panel noted there would have been levels greater than 5% somewhere in the mine to get the concentrations seen at the main ventilation shaft.

64. Miners are required by law to withdraw from the mine if flammable gas reaches 2% or more in the general body of air.[113] One miner encountered methane over 2% 'quite a lot', and more than 5% on two occasions.[114] One occasion involving over 5% was approximately two weeks before 19 November, after the commissioning of the main fan. He informed his deputy, who said, 'We'll be right, just quickly get [the job] done.'[115] They remained working in the explosive atmosphere for at least 10 minutes,[116] and 'there was no investigation because I never reported it'.[117] He said there were times when they continued working in 2% methane contrary to the regulations.[118] On another occasion, three contractors were found working in the ventilation return without gas detectors.[119] These examples demonstrate the vulnerability of any system that simply assumes workers will comply with procedures, even those of such importance.

65. Mr White was asked whether he had any system to make sure that significant information from the deputies' statutory reports was being identified by undermanagers and filtered up to him as mine manager. He said he would 'on occasion' read the deputies' reports, and he had regular contact with the deputies and undermanagers which gave opportunity for feedback from them.[120] He said he did not see all the written reports, but 'relied on the face-to-face transfer of information'.[121] For someone in Mr White's position, burdened with numerous responsibilities beyond the ventilation system, reliance on 'being available' meant he was not properly informed of the gas results recorded by the deputies. Mr White acknowledged that a more systematic approach to analysis of the deputies' statutory reports 'may well have helped',[122] but reiterated that he made himself available to be informed of issues at the mine. Mr White acknowledged it was 'absolutely certain' that a ventilation officer, if the mine had one, would have looked at the information contained in the deputies' reports.[123]

Deputies reports

66. The commission prepared a number of summaries of events, drawn from the deputy statutory reports and the deputies production reports, for each shift. A list is contained in Chapter 15, 'Regulator Oversight at Pike River' (see the footnote for paragraph 73). In relation to gas monitoring, one schedule compares readings of methane at the ventilation shaft with methane levels contained in the reports of the deputies. See Appendix 8 for an extract from that schedule, limited to November 2010.[124] It gives an insight into some of the issues that the deputies were managing in the 19 days before the tragedy.

Conclusions

67. Pike's gas monitoring system was deficient in several respects at the time of the explosion:

- There was only one working fixed methane sensor reporting to the control room that measured contaminated air in the ventilation return. This was not capable of showing a methane level above 2.96%, and did not report to the main Safegas system.
- The mine should not have operated without multiple methane sensors located throughout the main return.
- The maintenance and calibration of the fixed methane sensors was inadequate, at least in November 2010.
- Machine-mounted sensors, which were well maintained and calibrated, were sometimes bypassed, resulting in men working in unsafe conditions.
- Reporting by underground workers disclosed significant methane management problems, and there was no effective system to respond to this.

- The mine lacked a tube bundle system and was short of hand-held gas monitors.
- The poor standard of gas monitoring at the mine was a very serious problem throughout the period leading up to the explosion.

ENDNOTES

1 The purpose of gas monitoring systems is discussed in: David Cliff, David Bell, Tim Harvey, Anthony Reczek and David Reece, Pike River Coal Mine Explosion: Investigation for Nature and Cause (DOL Investigation Report, Appendix 6), October 2011, DOL3000130007/18, para. 7.2 and John Rowland, witness statement, 22 October 2011, ROW001/3, para. 10. Douglas White agreed with Mr Rowland's comments: Douglas White, transcript, p. 4892.

2 Health and Safety in Employment (Mining – Underground) Regulations 1999, reg 58, requires electricity to be disconnected if the concentration of flammable gas exceeds 1.25% in the general body of air.

3 Darren Brady, 'The Role of Gas Monitoring in the Prevention and Treatment of Mine Fires', in N. Aziz (Ed.), Coal 2008: Coal Operators' Conference, University of Wollongong & the Australasian Institute of Mining and Metallurgy, 2008, pp. 202–08.

4 Ibid., p. 202.

5 Ibid., p. 204.

6 Department of Labour, Pike River Mine Tragedy 19 November, 2010: Investigation Report, [2011], DOL3000130010/64, para. 2.39.1; Energy NZ Ltd, Department of Labour – Pike River Coal Audit Report for November 19, 2010, 25 January 2012, DOL3000140001/52.

7 Department of Labour, Investigation Report, DOL3000130010/140, para. 3.26.17.

8 Minarco Asia Pacific Pty Ltd, Pike River Coal Company: Ventilation Report, June 2006, DAO.012.02277/21, para. 5.2; Pike River Coal Ltd, Ventilation Management Plan, 2008, DAO.003.07114/33, para. 6.1.

9 Ibid., DAO.003.07114/34–35, paras 6.2.1.1–6.3.2.

10 Ibid., DAO.003.07114/78–79, para. 282.

11 Ibid., DAO.003.07114/38, para. 48.

12 Ibid., DAO.003.07114/59, para. 136.

13 Ibid., DAO.003.07114/38, para. 54.

14 Ibid., DAO.003.07114/38 para. 55.

15 Ibid., DAO.003.07114/59, para. 135.

16 Douglas White, transcript, p. 4894.

17 Michael Donaldson, Police/DOL interview, 14 April 2011, INV.03.17838/17, 32.

18 Pike River Coal Ltd, P&ID Gas Monitoring, 5 June 2010, DOL7770050005/4.

19 Douglas White, witness statement, 24 May 2012, WHI004/3, para. 15.

20 Pike River Coal Ltd, Mine Ventilation & Gas Drainage: PB-Vent-024, 10 March 2010, DAO.032.00163. (Plan annotated by Michael Lerch)

21 Energy NZ Ltd, Coal Audit Report, DOL3000140001/55.

22 Pike River Coal Ltd, Plant Location and Ventilation Plan: Rescue 101119_181, 22 March 2011, DAO.010.13140/1. (Extract of the plan modified by the commission based on source information from Energy NZ Ltd, Coal Audit Report, DOL3000140001, Robb Ridl, witness statement, 14 March 2012, DAO.041.00009 and Keith Stewart, witness statement, 9 August 2012, MBIE3000010011.)

23 This was accepted by Douglas White: Douglas White, transcript, p. 4899.

24 Department of Labour, Investigation Report, DOL3000130010/124 para 3.16.2; Pike River Coal, Trend Friday, 3 September 2010–Saturday 4 September 2010, DAO.001.03907/1.

25 Keith Stewart, witness statement, 9 August 2012, MBIE3000010011/2, para. 6.

26 Barry McIntosh, Police/DOL interview, 2 August 2011, INV.03.28697/6.

27 David Reece, plan annotated with gas sensor locations, MBIE3000010009/1.

28 David Cliff et al., Investigation for Nature and Cause, DOL3000130007/48.

29 Pike River Coal Ltd, Plant Location and Ventilation Plan: Rescue 101119_181, 22 March 2011, DAO.010.13140/1. (Extract of the plan modified by the commission)

30 Department of Labour, Investigation Report, DOL3000130010/139, para. 3.26.7; Keith Stewart, witness statement, 9 August 2012, MBIE000010011/2, para. 6.

31 Department of Labour, Investigation Report, DOL3000130010/124, para. 3.16.2; Pike River Coal Ltd, Trend Friday, 3 September 2010–Saturday 4 September 2010, DAO.001.03907/1.

32 David Cliff, An Evaluation of Elements Relating to the Cause of the First Explosion at Pike River Coal Mine: Draft, 16 September 2011, DOL3000140009/12.

33 Douglas White, transcript, p. 4902.

34 Pike River Coal Ltd, Review of Surface Aux Fan Failure 05/10/10, 7 October 2010, DAO.001.00359/17–25.

35 Ibid., DAO.001.00359/21. (The entry reads 'Set up Gas Monitoring and shaft bottom', but presumably 'and shaft bottom' should read 'at shaft bottom'.)

36 David Cliff et al., Investigation for Nature and Cause, DOL3000130007/48.

37 Department of Labour, Investigation Report, DOL3000130010/145, para. 3.32.12.

38 Energy NZ Ltd, Addendum 1: Surface Methane System Report, Version 1.1, January 2012, DOL3000140002/6.

39 Douglas White, transcript, p. 4899.

40 Ibid., p. 4901.

41 Department of Labour, Investigation Report, DOL3000130010/145, para. 3.32.12.

42 Energy New Zealand, Surface Methane System Report, DOL3000140002/7.

43 Pike River Coal Ltd, Auxiliary Fan Shaft Methane, CAC0112/7. (Gas reports compiled by the commission)

44 Ibid., CAC0112/9.

45 Douglas White, transcript, p. 4898.

46 Pike River Coal Ltd, Mine Ventilation & Gas Drainage: PB-Vent-028, 7 October 2010, DAO.001.05378.

47 Department of Labour, Investigation Report, DOL3000130010/146.

48 David Reece, transcript, p. 4573; Douglas White, transcript, p. 4897.

49 Douglas White, transcript, p. 4897.

50 Safegas is a system designed by Queensland's Safety in Mines Testing and Research Station (SIMTARS) for underground coal mines.

51 Email, Nicholas Gribble to Douglas White, 8 October 2010, INV.04.00676/1.

52 Michael Scott, Police/DOL interview, 3 October 2011, INV.03.28829/4–5.

53 Ibid., INV.03.28829/5.

54 Ibid., INV.03.28829/4, 30.

55 Ibid., INV.03.28829/6–7.

56 Memorandum, Robb Ridl to Douglas White, 22 September 2010, DAO.043.00004/1.

57 Ibid.

58 Ibid.

59 Douglas White, transcript, pp. 4988–4989.

60 Queensland Warden's Court, Wardens Inquiry: Report on an Accident at Moura No 2 Underground Mine on Sunday, 7 August 1994, 1996, CAC0152/1.

61 Coal Mining Safety and Health Regulation 2001, ss 224–26.

62 Pike River Coal Ltd, Ventilation Management Plan, DAO.003.07114/74, paras 250–51.

63 Ibid.

64 Barry McIntosh, Police/DOL interview, 2 August 2011, INV.03.28697/33.

65 Ibid., INV.03.28697/34.

66 Douglas White, transcript, p. 4924.

67 Pike River Coal Ltd, Acknowledgement of Gas Alarms: TARP (Trigger Action

Response Plan), 5 December 2008, DOL7770030078.

[68] Pike River Coal Ltd, Acknowledgement of Gas Alarms, DOL7770030078/1.

[69] Email, Nicholas Gribble to Douglas White and Stephen Ellis, 19 October 2010, SOE.024.00323.

[70] Grey Star–James Print, Proof Sign-off: Control Room Gas Log Book, 21 October 2010, DOL5000010018.

[71] Douglas White, transcript, p. 4915.

[72] Ibid., p. 4925.

[73]Robb Ridl, witness statement, 14 March 2012, DAO.041.00009/18–19, paras 70–76.

[74] Email, Gregory Borichevsky to Danie du Preez, 27 October 2010, INV.04.01375/1.

[75] Ibid.

[76] Petrus (Pieter) van Rooyen, transcript, p. 5151; Email, Gregory Borichevsky to Danie du Preez, 18 June 2010, INV.04.00354; Memorandum, Gregory Borichevsky to Pike River operational staff, 27 July 2010, DAO.001.04566.

[77] Petrus (Pieter) van Rooyen, transcript, p. 5151; Gregory Borichevsky, witness statement, 26 June 2012, BOR0001/33–34, paras 225–29; Email, Gregory Borichevsky to Danie du Preez, 18 June 2010, INV.04.00354/1–2; Memorandum, Gregory Borichevsky to Pike River operational staff, 27 July 2010, DAO.001.04566.

[78] Gregory Borichevsky, Pike River Coal Mine Disaster, 19 November 2010, INV.04.00001/7.

[79] Ibid.

[80] Douglas White, transcript, p. 4946.

[81] Gregory Borichevsky, Police/DOL interview, 26 April 2011, INV.03.18954/87.

[82] Ibid., INV.03.18954/89–91.

[83] Stephen Ellis, witness statement, 14 March 2012, DAO.041.00042/3–4, paras 8–13.

[84] Pike River Coal Ltd, Review of Surface Aux Fan Failure, DAO.001.00359/19–21.

[85] Email, Nicholas Gribble to Douglas White, Stephen Ellis, Neville Rockhouse, Peter Sinclair, Chris Coetzer, Danie du Preez and Robb Ridl, 7 October 2010, SOE.024.00287.

[86] Department of Labour, Investigation Report, DOL3000130010/137, para. 3.24.8.

[87] Ibid., DOL3000130010/142, para. 3.28.7.

[88] Douglas White, Operation PIKE Investigation: Summary of Interview, 5 May 2011, INV.03.17891/10.

[89] Email, Paul Harrison to Douglas White, 28 October 2010, EXH0042/1.

[90] Ibid.

[91] Douglas White, transcript, p. 1294.

[92] Department of Labour, Investigation Report, DOL3000130010/141, figure 45.

[93] Pike River Coal Ltd, Pike River Coal Mine: Deputies Production Report, 19 November 2010, DAO.001.02568/1.

[94] Police/DOL interview, 8 April 2011, INV.03.17556/15–16. (The commission decided, by majority, to withhold the name of the worker concerned. Commissioner Bell dissented.)

[95] Ibid., INV.03.17556/16.

[96] Ibid., INV.03.17556/16–17.

[97] Police/DOL interview, 29 April 2011, INV.03.20794/3. (The commission decided, by majority, to withhold the name of the worker concerned. Commissioner Bell dissented.)

[98] Ibid., INV.03.20794/7.

[99] Ibid., INV.03.20794/8.

[100] Ibid., INV.03.20794/10.

[101] Ibid., INV.03.20794/4.

[102] Royal Commission on the Pike River Coal Mine Tragedy (Katherine Ivory), Summary of the Reports of Certain Incidents and Accidents at the Pike River Coal Mine, November 2011, CAC0114/20–24.

[103] Pike River Coal Ltd, Incident/Accident Form, 2 March 2010, DAO.002.09871/2.

[104] Pike River Coal Ltd, Incident/Accident Forms: DAO.001.00754/2 (10 June 2010); DAO.001.00746/2 (9 June 2010); DAO.001.00777/2 (6 June 2010).

[105] Andrew Hopkins, Failure to Learn: The BP Texas City Refinery Disaster, 2008, CCH Ltd, p. 15.

[106] Ibid., pp. 107–20.

[107] Masaoki Nishioka, transcript, p. 3546.

[108] Pike River Coal Ltd, Incident/Accident Form, 2 June 2010, DAO.001.00826/2.

[109] Douglas White, transcript, p. 5000.

[110] See the following Pike River Coal Ltd incident/accident forms: DAO.001.00359/28 (11 October 2010); DAO.001.00682 (13 July 2010); DAO.001.00826 (2 June 2010).

[111] Department of Labour, Investigation Report, DOL3000130010/142, para. 3.29.5.

[112] David Cliff et al., Investigation for Nature and Cause, DOL3000130007/39.

[113] Health and Safety in Employment (Mining – Underground) Regulations 1999, reg 21.

[114] Police/DOL interview, 8 December 2010, INV.03.01747/13–15. (The commission decided, by majority, to withhold the name of the worker concerned. Commissioner Bell dissented.)

[115] Ibid., INV.03.01747/43.

[116] Ibid., INV.03.01747/47.

[117] Ibid., INV.03.01747/43.

[118] Ibid., INV.03.01747/47–48.

[119] Pike River Coal Ltd, Incident/Accident Form, 7 May 2010, DAO.001.00885/2.

[120] Douglas White, transcript, p. 4994.

[121] Ibid., p. 4995.

[122] Ibid., p. 4999.

[123] Ibid., p. 5002.

[124] Royal Commission on the Pike River Coal Mine Tragedy (Karyn Basher), Instances of Methane Recorded in 'CH610 Aux Fan Shaft Methane' Graphs, Deputy Statutory Reports and Deputies Production Reports (30 September – 19 November 2010), February 2012, CAC0145/7–11.