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.

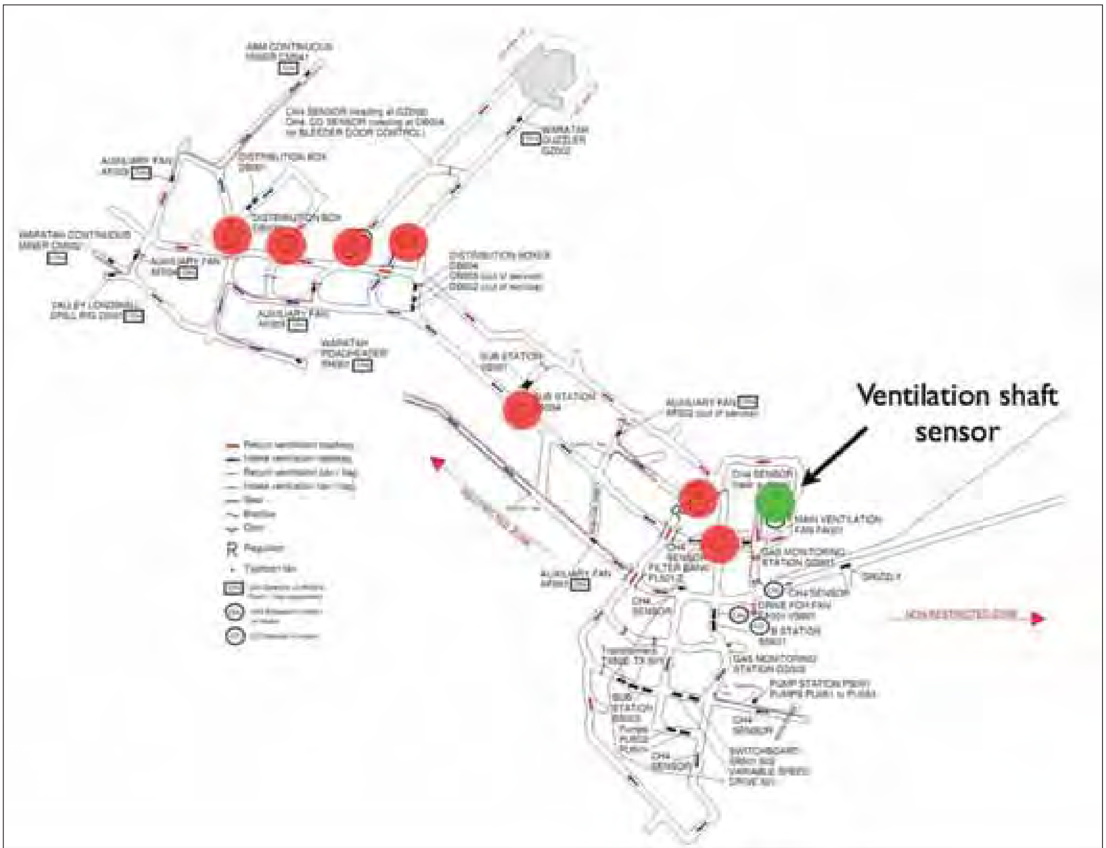


Figure 10.2: Plan of required gas sensors at Pike River under Queensland legislation[27]

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'.

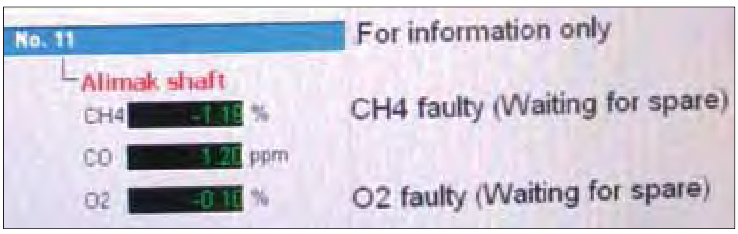


Figure 10.4: Control room operator's screen on the Safegas system[32]

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.

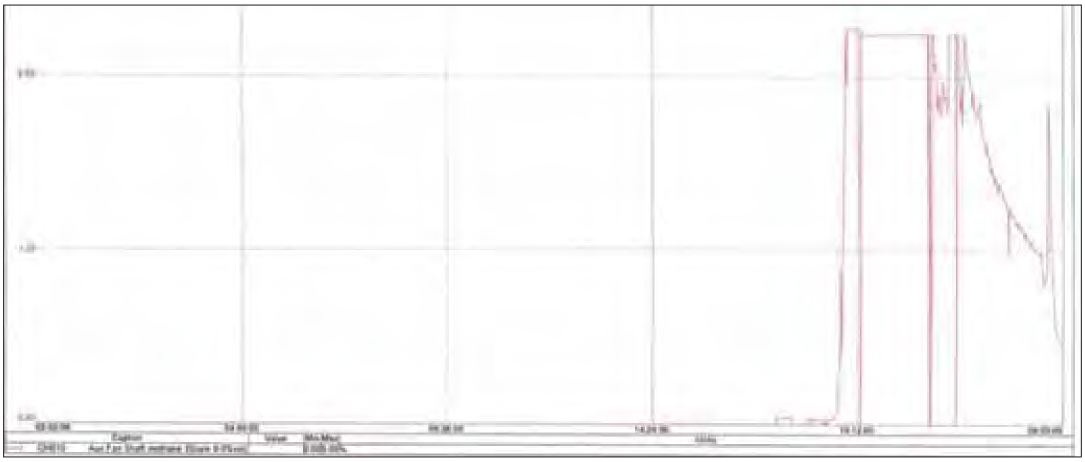


Figure 10.5: Auxiliary fan shaft methane – 6 October 2010[43]

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.

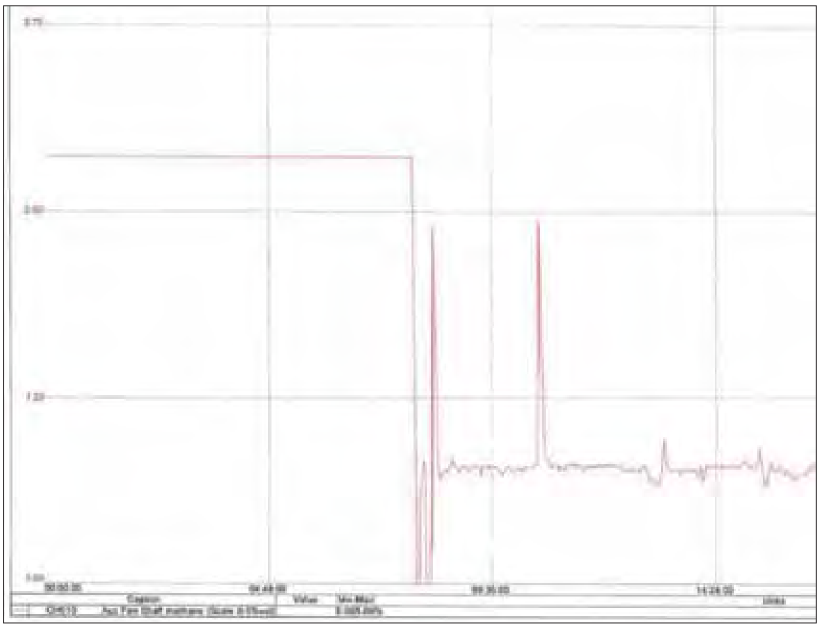


Figure 10.6: Auxiliary fan shaft methane – 8 October 2010[44]

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.

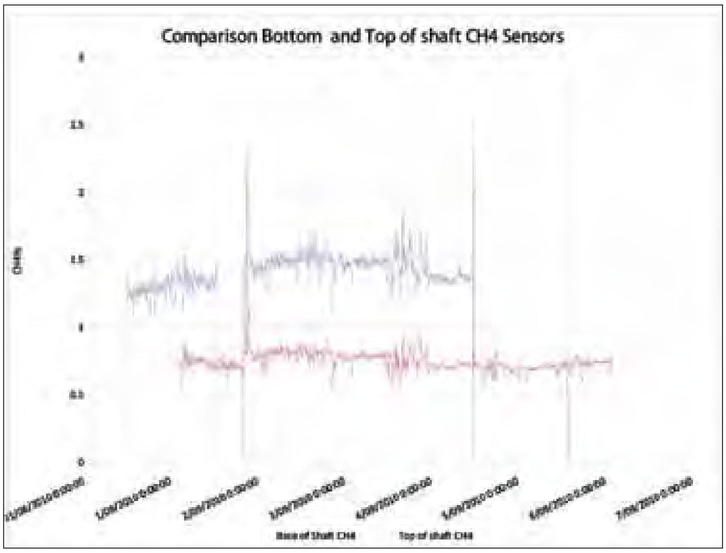


Figure 10.7: Comparison bottom and top of shaft CH_4 sensors[47]

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.

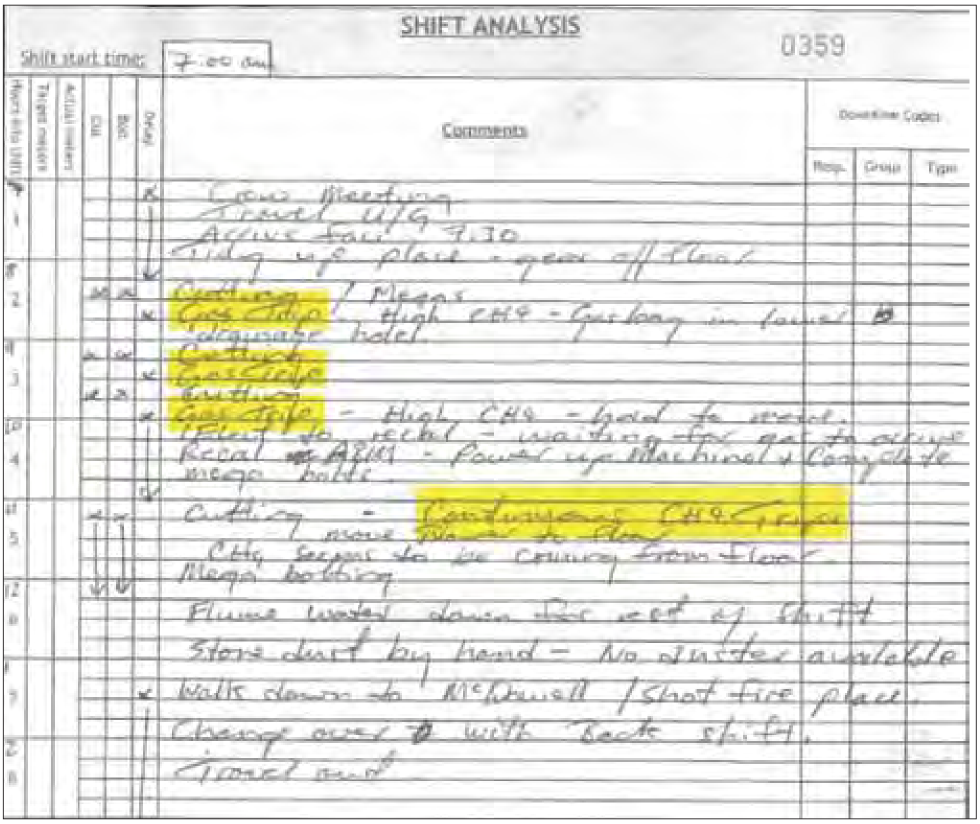
Machine-mounted and hand-held gas monitoring

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

0359

Shift start time: 7:00 am

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 / drainage hole			
						Cutting			
						Gas trip			
						Cutting			
						Gas trip – High CH4 – had to recut.			
						Flit to recut – waiting for gas to clear			
						Recut 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			

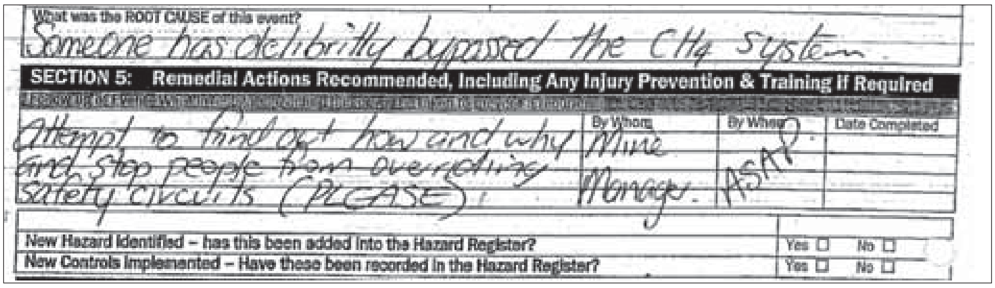
Figure 10.8: References to gas trips[93]

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]

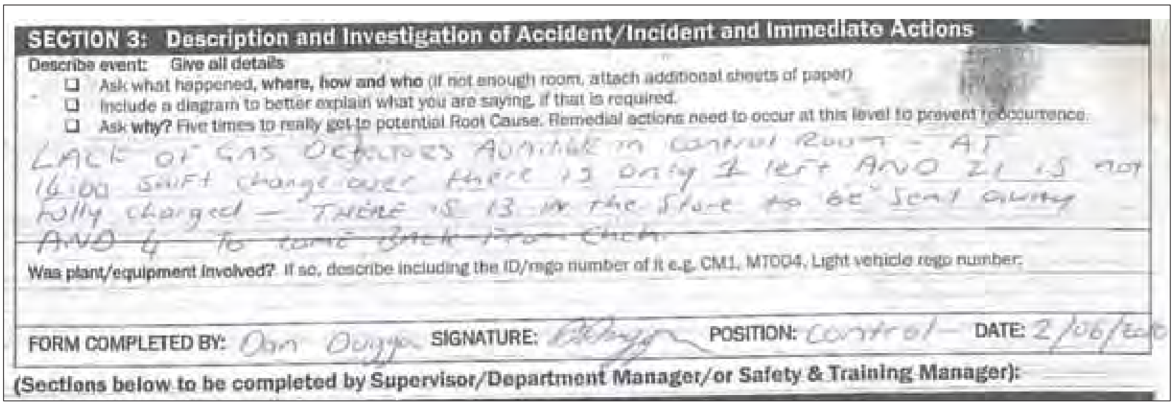
57. In many cases there was no management sign-off, and in other cases the solution was to speak to deputies and undermanagers, or issue a tool box talk. For example, Mr White signed off three incidents involving bypassing on 23 and 24 June 2010.[104] In each case the response was that Mr White had 'spoken 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 21 is not fully charged – There is 13 in the store to be sent away AND 4 to come back from Chch.

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: [illegible] SIGNATURE: [illegible] 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.

CHAPTER 11

Electrical safety

Introduction

1. This chapter considers the underground electrical system at Pike River. The integrity of parts of that system, and its potential to be a source of ignition for the first explosion, have been the subjects of conflicting evidence.

2. Relevant evidence and submissions have been received from many sources, including the Department of Labour (DOL); Anthony Reczek, an electrical expert engaged by DOL and the New Zealand Police; Rockwell Automation (NZ) Ltd, the supplier of key electrical components called variable speed drives (VSDs); and certain Pike directors, employees and contractors.

3. Because it has not been possible to access the underground parts of the mine in which significant electrical equipment is located, its installation and functioning, and its potential contribution to the explosion, cannot be determined. That is still being investigated by the health and safety regulator. Accordingly, the commission is compelled to limit its analysis.

Electrical systems at Pike River

4. Underground electrical systems are critical to mine safety and production. They must be designed, sited, installed and maintained so that they do not create hazards, including the risks of electric shock and sparking, which may provide an ignition source for flammable gas or material. These systems are complex, and use specialised equipment requiring expertise beyond that of a generalist electrician.

5. Their functions include powering the ventilation system of a mine, the monitoring and communications systems (including those for use in an emergency) and mining equipment. At Pike River that included the ABM, continuous miners and roadheader, the VLI Drilling Pty Ltd drill rig and the water pumps for the hydro monitor and coal transport systems. Although some parts of the electrical system, for example the surface fan, had back-up power supplies, those were often of limited duration.

6. Pike River's underground power supply came from two substations. One, at Logburn, stepped the voltage down 110kV to 33kV. It fed power to another substation near the portal entrance, which stepped that 33kV down to 11kV. From that substation, three 11kV lines delivered power into the mine through the main drift, two to the main electrical distribution board located in pit bottom in stone, identified as SB001 in Figure 11.1. Through that board power was supplied to much of the underground equipment. The third line delivered power to the main ventilation fan distribution board pit bottom south, at location SS601 in Figure 11.1. Pit bottom south extended to the coal reserves of the mine.

7. Those two areas, pit bottom in stone and pit bottom south, contained more substations to further step down the voltage, from 11kV to either 1kV, 690V or 400V, to power underground electrical equipment. Those areas also had the greatest concentration of fixed electrical equipment.

8. Generally, fixed electrical equipment could be controlled and monitored from the surface control room. Some of the equipment had methane sensors and safety cutouts, including in the event of overheating.[1]

9. The red line in Figure 11.1 marks the boundary between two underground zones, the restricted zone, which is to the left of the line and includes the coal workings, and the non-restricted zone to the right. That non-restricted zone includes Spaghetti Junction and much of pit bottom south. The zones are explained below.

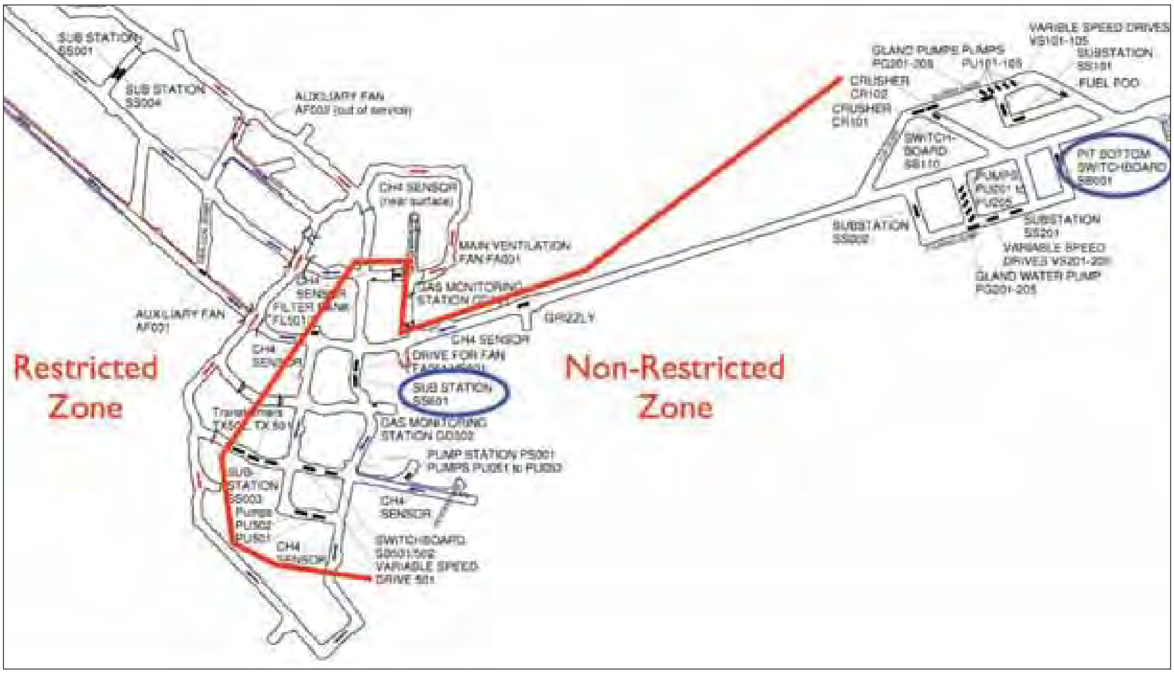


Figure 11.1: Main electrical area and zones underground[2]

The restricted and non-restricted zones

10. Because of the risk of an electrical system being a source of ignition, the Health and Safety in Employment (Mining – Underground) Regulations 1999 provide for restricted and non-restricted zones in gassy coal mines.

11. In gassy mines the restricted zone includes the working faces, the return, any area where flammable gas is likely to be 2% or more in the general body of air and any area containing electrical equipment that has not been shown to be free from flammable gas. Free from flammable gas means there is no more than 0.25% flammable gas in the general body of air.[3]

12. All practicable steps must be taken to ensure electrical equipment used in a restricted zone meets certain safety standards, so that it is not a source of ignition. Essentially, it must be intrinsically safe or flameproof.[4] Intrinsically safe equipment operates at such a low energy level that it is incapable of igniting methane. Flameproof equipment is enclosed in a special housing to ensure any ignition of methane is safely contained inside the enclosure.[5]

13. These requirements were reflected in Pike's detailed ventilation management plan. It contemplated that an 'electrical supervisor' would define any non-restricted zones, following a risk assessment. The zones were to be shown on a plan kept in the surface controller's office.[6] Electrical equipment had to meet legislative standards. Inspections were to occur with a frequency that differed according to the equipment.

14. The restricted and non-restricted zones were defined in August 2010, but the process outlined in the management plan was not followed. There was no risk assessment to define the location of the restricted zone.[7]

15. By then Pike had already installed a large amount of electrical equipment, some of which was neither intrinsically safe nor flameproof, in the pit bottom south and Spaghetti Junction areas of the mine. The motor for the main fan, numerous pumps and VSDs fell within that non-restricted zone as defined.[8]

16. Some electrical equipment was tested on the surface before being installed underground. In addition, before underground electrical equipment in pit bottom south was powered up, gas samples were taken in the vicinity over three days to ensure there was less than 0.25% methane. Methane sensors were placed at various parts of the non-restricted zone.[9]

17. Despite those precautions, the non-restricted zone in pit bottom south extended to the coal measures in the gassy mine and was close to the return. Michael Scott, an underground electrical co-ordinator at Pike, noticed that some of the methane sensors in the non-restricted zone in 'pit bottom south near switchboard SB501 would trip. This was because the tunnel where the header tank is located is a non-free ventilated stub, or dead end, and we did have methane coming out there in small amounts … very low concentrations, maybe 0.3%.'[10] The sensor was moved and ventilation of the area improved. Methane greater than 0.25% in the non-restricted zone was reported though the accident and incident reporting system on at least one occasion.[11]

18. The location of the non-restricted zone did not go without comment at the mine. One deputy said:

> *I asked one of the electrical engineers what [the main fan] motor was doing up there, right next to the main return and fan. He just said it was a non-restricted zone. I can't understand how it could be a non-restricted zone when it was within 10m of a temporary stopping into the main return where all the gas was leaving the mine.*[12]

19. A stopping failure or ventilation fan failure (which may be followed by the reversal of ventilation) could result in methane being introduced into the pit bottom south non-restricted zone.[13] Because some equipment in that zone was not intrinsically safe or flameproof, methane sensors and the associated safety cutouts had to be relied on if methane entered the area.

20. The location of the non-restricted zone concerned Mr Reczek, the electrical expert engaged by DOL and the police. In his view it did not make logical sense and the whole area inbye of the main drift should have been a restricted zone.[14] He stated that 'despite the fact that the presence of methane was possible, there was no explosion protection technology used on the major items of electrical equipment located in the designated "unrestricted" area of the mine's inbye workings at the end of the stone drift entry.'[15]

21. A risk assessment would likely have led to the view that the non-restricted zone, and thus non-flameproof or non-intrinsically safe equipment, ought not to be located within or so near to the coal measures of a gassy mine or, if it was, very good protection would be needed to prevent methane coming into contact with electrical equipment.

22. Such a risk assessment is not expressly required by the underground mining regulations. This contrasts with the Queensland legislation in which a risk assessment is required to define three types of zones, those with a negligible explosion risk (methane likely to be less than 0.5%), explosion risk 1 (methane likely to be 0.5 to 2%) and explosion risk 0 (methane likely to be greater than 2%).[16]

Proximity of non-restricted zone and electrical equipment to utility services

23. The inclusion of pit bottom south and Spaghetti Junction in the non-restricted zone led to another hazard. These areas contained roadways and significant utility services – water pipes, compressed air pipes and gas drainage pipes. To those were added 11kV lines. The sheer quantity, and lack of separation, of utility services at Spaghetti Junction is shown in Figure 11.2. The high-voltage cables are red.

24. Of that configuration mining consultant David Reece said:

> *This is quite unusual to have pipes like this, this sort of configuration in a mining situation. The other thing is the high-tension cables that are also interspersed with all these services in that particular area. So this is potentially an area where these could be hit by a diesel vehicle or something of that nature … it's certainly hazardous and the combination of services that you've got there with high-tension cables, and we're talking about 11,000 volts in those cables, if you damaged that at the same time as the pipeline, it is highly likely that you would get an ignition at that point.*[17]

Figure 11.2: Spaghetti Junction[18]

25. Consultant Comlek Electrical Engineering Contracting Ltd had raised the proximity of electrical cabling and equipment to other utility services and the roadways in a 30 October 2009 electrical audit report commissioned by Pike. Its purpose was to assess the compliance of electrical equipment located in a potentially explosive atmosphere with relevant Australian and New Zealand standards and to make corrective recommendations.

26. Comlek was concerned that high-voltage lines 'crossing the mine access road is considered dangerous due to it not specifying clearance heights by signage and not having indication of aerial location' and that standards of electrical equipment and location of storage needed 'major improvement'. An example was an item of electrical equipment (a starter) being located under water pipes, on the floor and without barrier identification.[19]

27. High-voltage cabling and electrical equipment should not be located close to gas, water and compressed air utility services. Where this is unavoidable, protective housing should be used, including protection against vehicle impact.

The variable speed drives

28. Pike used VSDs to allow the fixed speed motors for the main fan and underground pumps to operate at variable speeds. The VSDs do this by varying the frequency of the power supply to the motors.[20] This enables a softer start-up process and also allows the operating speeds of a motor to match its output demand, resulting in cost savings and improved performance.

29. Pike had 12 VSDs underground, at the locations circled in red in Figure 11.3. There were five VSDs in each of the locations to the top right of the plan and one at each of the locations to the bottom left of the plan.

30. There were concerns about the use of VSDs. Mr Reczek was aware of the use of VSDs underground elsewhere, but they were 'explosion protected. They're in flameproof enclosures and they're confined to the body of machinery.'[21]

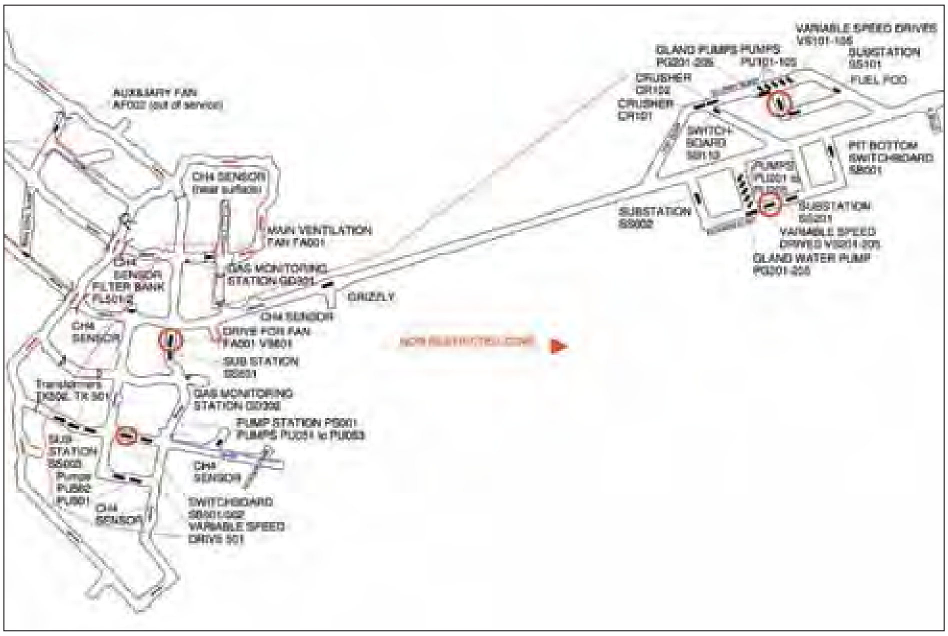


Figure 11.3: Plan showing VSDs underground at Pike River[22]

He had never seen a configuration such as that at Pike River, which was essentially a significant number of fixed VSDs underground.

31. Mr Reczek and Mr Nishioka gave evidence that VSDs need to be placed in a very clean, dust-free environment with a consistent temperature. Mr Reczek thought that 'unless you have a totally enclosed room which is dust free and filtered and separately ventilated, I don't think you could provide a satisfactory environment' underground in a coal mine.[23] Evidence indicates that Pike created, or sought to create, such an environment.[24]

32. VSDs have the potential to cause enough harmonic distortion to generate sparking within the earth system of the power supply. The extent to which harmonics occur depends on many matters, including the type of VSD, the manner in which it is installed and the cabling type, length and connection. The installation and cabling details at Pike River remain unclear.[25] There is conflicting evidence from Mr Reczek and Rockwell, the supplier of VSDs, about the extent and effect of harmonics. This is referred to in more detail in Chapter 14, 'The likely cause of the explosions'.

33. There were other problems associated with the use of VSDs. There was an overvoltage in the power supply to at least one VSD, affecting its performance; this was rectified on about 9 November 2010. Five VSDs failed and were removed. In one case a power structure exploded. On several occasions pre-charge resistors failed. This problem was to be solved by changing the ratings of protective fuses. New fuses had been ordered but not replaced by the time of the explosion.

34. During commissioning of the main underground fan there were intermittent and difficult problems with the associated VSD. On 27 October 2010 the VSD was replaced with an air-cooled model, which was placed within an enclosure to provide protection. It seems this led to overheating. Pike took steps to correct that, including leaving open the doors to the enclosure and installing ducting to direct air into it. On about 9 November 2010 Pike ordered an air conditioner to improve the cooling. It had not arrived by the time of the explosion.[26]

35. In summary, despite Pike's efforts and those of external experts, there was a range of problems associated with the use of VSDs, not all of which had been addressed by the time of the explosion.

Regular electrical inspections

36. Documents filed with the commission show that, as with much other plant, there were frequent inspections of and written reports on electrical plant and equipment. The frequency varied, but some were daily.[27] Despite containing information relevant to health and safety, those reports did not make it as far as the safety and training department.[28]

37. The timing of tests and inspections does not always seem to have been consistent. The October 2009 Comlek audit report shows, at that stage at least, no weekly and monthly tests on certain electrical equipment. A selection of work orders from October 2010 shows that daily electrical checks on some equipment were not always done. The reasons are unclear or not explained.[29]

38. Comlek also pointed out that there was no single line diagram of the underground and above-ground electrical reticulation and that reporting of events and transfer of information at shift handovers needed improvement.[30]

Electrical staffing at Pike River

39. Pike contracted in expert electrical advice,[31] and had its own electrical staff, usually including electrical engineers,[32] within the engineering department. Mr Scott, the underground electrical co-ordinator at the time of the explosion, noted '[w]e had trouble getting good electricians as they needed to be industrial electricians, but the majority of the electricians were up to standard in my view. A couple were beyond the standard.'[33] In October 2009 Comlek identified the lack of procedures for sign-off of electricians at Pike River as having certain certificates of competence.[34]

40. Mr Reczek envisaged an electrical engineer with an overview of the management and operation of electrical equipment and responsibility for the implementation of risk controls as part of an electrical management plan. The relationship with the mine manager would be close.[35]

41. Two early documents of Pike, a draft management plan of September 2008 and a draft electrical engineering management plan of November 2008,[36] contemplated an electrical engineer of some seniority. The final electrical engineering management plan dated 30 April 2010 provided for an electrical co-ordinator.[37] This appears to be a lesser, more maintenance orientated, position than that described by Mr Reczek. It is reflected in the structure of the engineering department before 24 August 2010 (Figure 11.4).

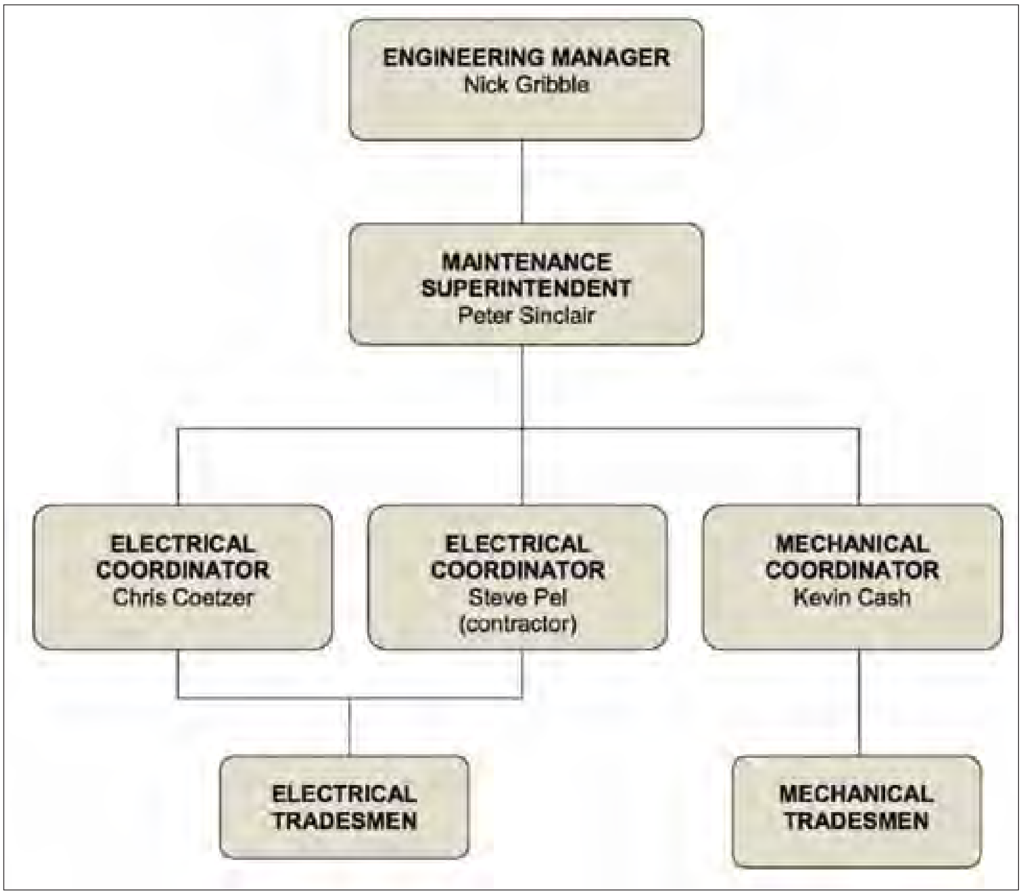


Figure 11.4: Structure of Pike engineering department before 24 August 2010[38]

42. In September 2010 that structure was reviewed by Robb Ridl, the engineering manager for Pike from 24 August 2010 to 30 September 2011.[39] A memorandum from Mr Ridl dated 22 September 2010 records the reasons for the review and resulting recommendations:

> *The current Pike River Engineering Department is currently unable to meet the needs of the business and a new engineering organisational structure has been developed to provide for the maintenance requirements of the business in an operational phase.*
>
> *… The current structure does not have clearly defined areas of responsibility and fixed plant is not being proactively maintained due to lack of supervisory resources.*[40]

43. A new structure with increased staffing was proposed and was approved by Douglas White and Peter Whittall (see Figure 11.5).[41] It included the position of electrical engineer.

44. This was not as senior as the position suggested by Mr Reczek but did include responsibility for many aspects of the electrical system, including risk management, ensuring maintenance in accordance with statutory requirements, electrical inspections and continuous improvement.[42]

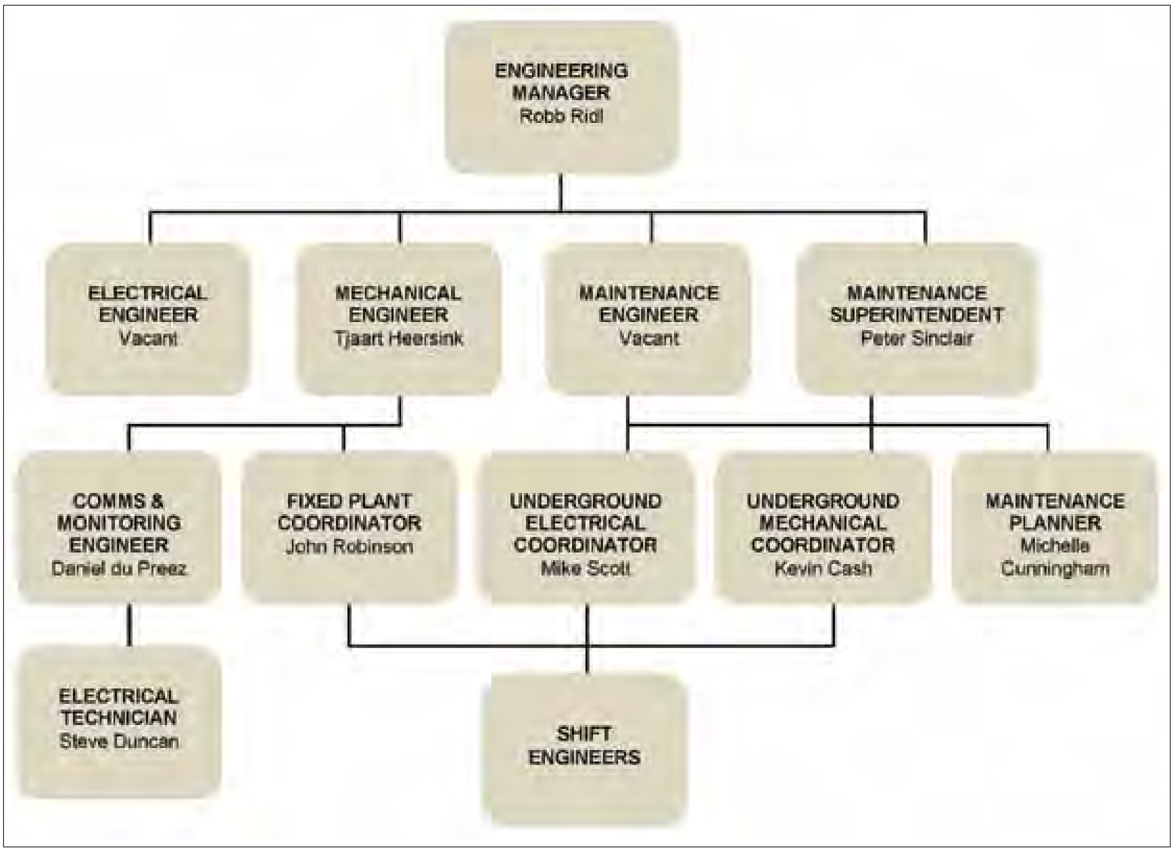


Figure 11.5: New structure for Pike engineering department[43]

45. By 19 November 2010 an electrical engineer, a contractor who had been an electrical co-ordinator, had been appointed but he had not started in the new position.[44]

Overall management of electrical safety at Pike River

46. All of the above issues call into question the extent to which Pike was properly managing electrical issues. The DOL investigation report states:

> *Taken together, it appears that [Pike] was experiencing an excessive number of issues with its electrical system and especially with its VSD operation. Each issue seems to have been explained and dealt with on an*

ad hoc basis, as and when it occurred. However, given the high risk environment [Pike] was operating in, and the number of unknown reasons for the electrical failures ***[Pike] management should arguably have approached the issues first and foremost as a safety matter. From this perspective, it may have been reasonable for [Pike] to have ceased operations and sought further third party expert advice to determine the causes of the electrical issues and the appropriate controls necessary.*** *[Emphasis in original]*[45]

47. The DOL investigation report also states that Pike had:

> *four departures from conventional electrical arrangements for an underground coal mine. These were the placement of the main fan underground, the use of VSDs to drive key infrastructure systems, the long single entry (the Drift) and use of non-hazardous zones and equipment. These four unconventional arrangements individually and together created an increased level of risk because they were largely untested and unusual.*[46]

Given the importance of a safe and efficient electrical system, Pike should have introduced 'compensatory processes to mitigate the higher risk.'[47] Those would include carrying out sufficient research to understand the risks those unconventional arrangements created in a hazardous environment, obtaining independent expert advice on the use and installation of VSDs underground, and a risk assessment.

48. Pike obtained significant advice about the VSDs. Experts were involved in designing and maintaining its electrical system. Assessments were undertaken for certain electrical equipment and there was some above-ground testing before installation. However, problems still occurred.

49. There does not appear to have been a comprehensive assessment of the potential risk of the electrical system. Mr Ridl thought such an assessment necessary but in the short time between his starting employment and the explosion he did not become aware of one.[48] Mr Scott thought the risk assessment process at Pike was more extensive than at other places he had worked, but did not recall an overall risk assessment concerning the use of electrical equipment underground.[49] Mr White was not sure of the extent of electrical risk assessments, and it was outside of his expertise.[50] The Pike board's health, safety and environment committee did not seek confirmation that the underground electrical systems were correctly installed and safe.[51]

50. A comprehensive risk assessment, in mid- to late 2010, would have taken into account the individual and cumulative risks raised by DOL and the problems with important components of the electrical system. The risks should have been considered in the context of Pike's move to hydro mining. This would have indicated the desirability of halting, or at least restricting, hydro-mining operations (because of its introduction of significant accumulated methane in the goaf), until all the electrical problems had been fixed.

Electrical inspections

51. Mr Reczek considered that the underground Pike electrical system warranted 'a significant amount of attention' from a regulator, because of its location in a hazardous area and its unconventional nature. The focus would be on the measures undertaken to assure safety.[52]

52. However, regulator oversight was limited. On 13 February 2007 Richard Davenport, from the Electrical Safety Service of the Ministry of Economic Development (MED), and Michael Firmin of DOL, inspected the electrical system. They approved the then installation, but at that stage the drift was still being developed and the underground electrical cabling and system had not been installed.[53]

53. On 26 November 2008 Mr Davenport, with Kevin Poynter of DOL, conducted another electrical inspection.[54] This concluded that all electrical installations were compliant.[55] At that stage the underground electrical equipment had not been installed.

54. From January 2009 MED no longer conducted electrical inspections in underground coal mines and DOL did not have the expertise to carry them out.[56] As a result, key underground electrical systems installed in 2010 were not scrutinised by an electrical expert from or on behalf of DOL.

Conclusions

55. The underground electrical system at Pike was unconventional in a number of ways:

- the main fan was underground;
- the non-restricted zone, which contained some non-flameproof and non-intrinsically safe electrical equipment, extended to the coal measures in this gassy mine;
- there was significant use of VSDs underground to drive key infrastructure and a range of problems was associated with their use; and
- high-voltage cables and utility services were intermeshed at Spaghetti Junction.

56. Individually, and in combination, these unconventional arrangements introduced significant risks to the underground environment. The location of the non-restricted zone, and the overall electrical system, ought to have been subject to comprehensive risk assessment, followed by any necessary actions. Within the overall context of the mine's development and operation in mid- to late 2010, that may have led to a halting or restriction of hydro-mining operations while electrical problems were being corrected.

57. A risk assessment conducted before creating the non-restricted zone at pit bottom south would likely have led to the view it ought not to be located in or near the coal measures in this gassy mine.

58. Pike had both external and internal electrical expertise, but did not have a sufficiently senior electrical engineer with responsibility for the whole electrical system.

59. There was inadequate regulatory oversight of the electrical system from 2009 onwards, owing to a lack of expertise within the DOL mines inspectorate.

60. The commission has significant concern about the electrical system and whether it played a role in the explosion.

ENDNOTES

1 For example the VSD for the main ventilation fan: Robb Ridl, witness statement, 14 March 2012, DAO.041.00009/28, para. 116. See also: Pike River Coal Ltd, Incident/Accident Form, 12 October 2010, DAO.001.00359/3–5.

2 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)

3 Health and Safety in Employment (Mining – Underground) Regulations 1999, reg 2.

4 Ibid., reg 55.

5 Anthony Reczek, witness statement, 7 February 2012, DOL3000160001/5, para. 16.

6 Pike River Coal Ltd, Ventilation Management Plan, 2008, DAO.003.07114/72, para. 242.

7 Douglas White, transcript, p. 4971.

8 Michael Scott states the electrical equipment for the hydro monitor was installed between June and August 2010: Michael Scott, witness statement, 30 May 2012, SCO7770010001/17, paras 64–66.

9 Michael Scott, witness statement, 30 May 2012, SCO7770010001/18, paras 68–69; Douglas White, transcript, pp. 4968–70.

10 Michael Scott, witness statement, 30 May 2012, SCO7770010001/36–37, para. 150.

11 Pike River Coal Ltd, Incident/Accident Form, 12 October 2010, DAO.001.00359/3–5; Douglas White, transcript, p. 4972.

12 Dene Murphy, witness statement, 2 December 2011, FAM00057/12, para. 60.

13 Michael Scott, witness statement, 30 May 2012, SCO7770010001/37, para. 151 (stopping failure); Dene Murphy, witness statement, 2 December 2011, FAM00057/11, para. 58 (ventilation fan failure).

14 Anthony Reczek, transcript, pp. 4774–75.

15 Anthony Reczek, witness statement, 7 February 2012, DOL3000160001/28, para. 108.

16 Coal Mining Safety and Health Regulation 2001, cls 286–91.

17 David Reece, transcript, p. 4485.

18 DR12 – Photo of Spaghetti Junction, DOL3000150019/1.

19 Comlek Electrical Engineering Contracting Ltd, Audit Report of Electrical Management Systems at Pike River Coal NZ, 30 October 2009, DAO.025.26626/6–7, paras 1.14–1.15.

20 Anthony Reczek, witness statement, 7 February 2012, DOL3000160001/16, para. 55.

21 Pike River Coal Ltd, Plant Location and Ventilation Plan, DAO.010.13140/1 (extract of the plan modified by the commission).

22 Anthony Reczek, transcript p. 4760. In a memorandum, Mr White referred to a VSD unit that he said was 'the only one of it's kind on site, and, we are lead to believe, the only one of it's kind in the Southern Hemisphere [sic]': Memorandum, Douglas White to Peter Whittall, 22 March 2010, DOL3000160011/1.

23 Anthony Reczek, transcript pp. 4760–61; Masaoki Nishioka, transcript, p. 3494.

24 Gregory Borichevsky, Police/DOL interview, 7 June 2011, INV.03.20410/30.

25 Department of Labour, Report on Electrical System Evidence, 8 June 2012, DOL7770050017.

26 Michael Scott, witness statement, 30 May 2012, SCO7770010001/26–28.

27 Karyn Basher, witness statement, 10 November 2011, CAC0117/3.

28 Neville Rockhouse, transcript, p. 4234.

29 Pike River Coal Ltd, Work Order No 17075, 26 October 2010,

DAO.004.05509/1; Pike River Coal Ltd, Work Order No 16856, 19 October 2010, DAO.001.07114/1; Pike River Coal Ltd, Work Order No 15936, 27 September 2010, DAO.001.07211/1; Kevin Poynter, transcript, pp. 3018–28.

[30] Comlek Electrical Engineering Contracting Ltd, Audit Report, DAO.025.26626/5, paras 1.7–1.9.

[31] Anthony Reczek, transcript pp. 4823–29.

[32] Douglas White, transcript, p. 4965.

[33] Michael Scott, witness statement, 30 May 2012, SCO7770010001/7, para. 20.

[34] Comlek Electrical Engineering Contracting Ltd, Audit Report, DAO.025.26626/4, para. 1.1.

[35] Anthony Reczek, transcript, pp. 4771–73.

[36] Pike River Coal Ltd, Roles and Responsibilities: Management Plan (Draft Document), 9 September 2008, DAO.002.00960/67; Pike River Coal Ltd, Electrical Engineering Management Plan: Management Plan (Draft Document), 2 November 2008, DAO.002.00662.

[37] Pike River Coal Ltd, Electrical Engineering Management Plan, 30 April 2010, DAO.003.07228/9.

[38] RJR1: Engineering Structure Before 24 August 2010, DAO.041.00006/1.

[39] Robb Ridl, witness statement, 14 March 2012, DAO.041.00009/3, para. 2. Mr Ridl had also been a mechanical co-ordinator at Pike from August 2006 to May 2007.

[40] Memorandum, Robb Ridl to Douglas White, 22 September 2010, DAO.043.00004/1.

[41] Robb Ridl, witness statement, 14 May 2012, DAO.043.00050/12.

[42] Pike River Coal Ltd, Engineering Department Areas of Responsibility, DAO.043.00001.

[43] Pike River Coal Limited Organisation Chart as at 19 November 2010, PW23a/1. (Extract with 'Note 2' removed from beside Robb Ridl's name by the commission)

[44] Pike River Coal Ltd, Manager's Promotion Recommendation, 4 November 2010, DAO.043.00049/1; Douglas White, transcript, pp. 4965–68.

[45] Department of Labour, Pike River Mine Tragedy 19 November, 2010: Investigation Report, [2011], DOL3000130010/161, para. 3.37.10.9.

[46] Department of Labour, Investigation Report, DOL3000130010/151, para. 3.37.4.6.

[47] Ibid., DOL3000130010/151, para. 3.37.4.7.

[48] Robb Ridl, witness statement, 14 May 2012, DAO.043.00050/9–10, paras 50–51.

[49] Michael Scott, witness statement, 30 May 2012, SCO7770010001/41, paras 169–170.

[50] Douglas White, transcript, p. 4967.

[51] John Dow, transcript, p. 4033.

[52] Anthony Reczek, transcript, p. 4770.

[53] Richard Davenport, Inspection Audit Report, 13 February 2007, DAO.025.42883/2–3.

[54] Kevin Poynter, witness statement, 19 October 2011, DOL7770040003/17, paras 84–86.

[55] Ministry of Economic Development, Energy Safety, ES Audit Report, 4 December 2008, MED3000010002/2–4.

[56] Michael Firmin, transcript, pp. 602–04, 684.

CHAPTER 12

Hydro mining

Introduction

1. This chapter summarises the hydro-mining systems used at Pike River, and assesses the management, safety and effectiveness of the company's hydro-mining operation.

The hydro-mining technique

2. Hydro mining is particularly suited to the West Coast, where coal seams are thick and geologically disturbed. Seams have steep variable gradients and are often severely faulted, which means the coal seam can be completely displaced, as shown in the simplified diagram of Pike River's Brunner seam below.[1] Minor faults are often present within areas separated by major faults, creating further variation. Such steeply dipping coal seams are unsuitable for conventional mining methods such as longwall mining, which may be unable to extract the full seam thickness.[2]

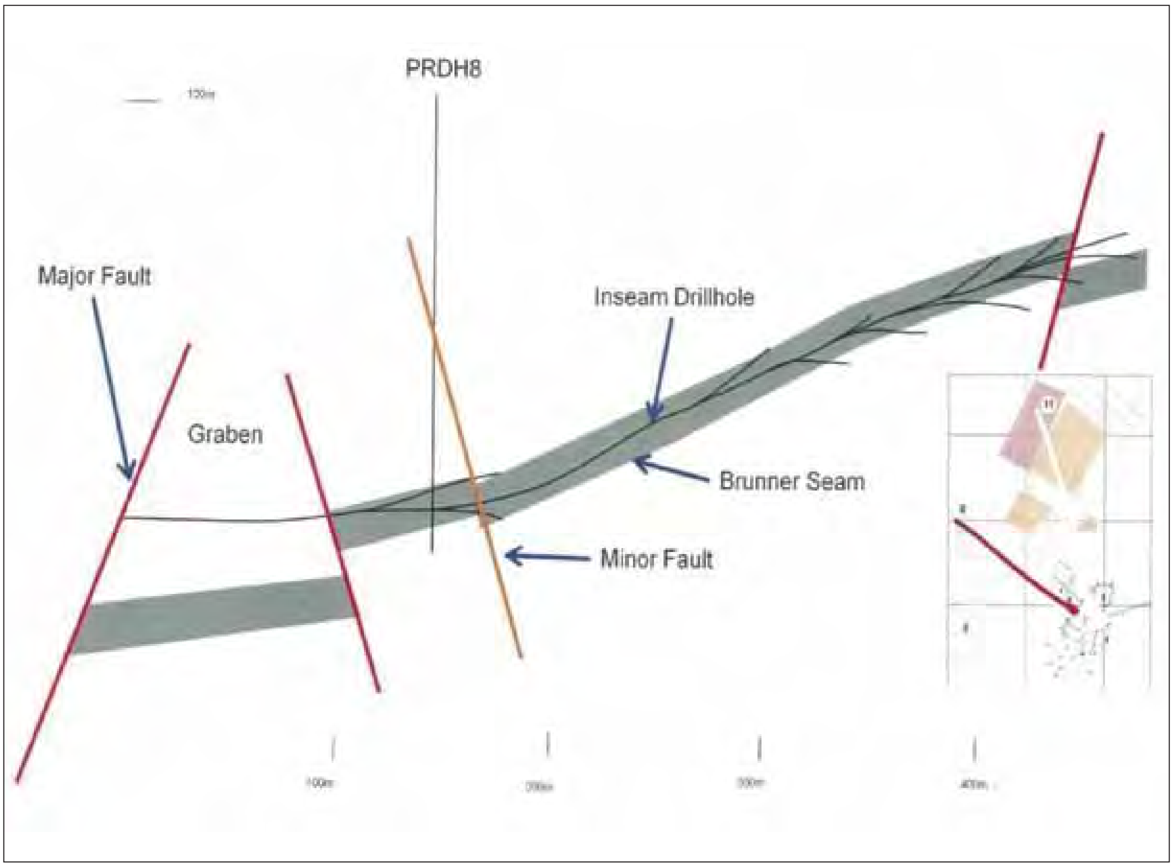


Figure 12.1: Pike River's Brunner seam

3. Hydro mining uses a high-pressure water jet from a hydro monitor to cut coal:

Figure 12.2: Hydro monitor at work[3]

4. The first hydro panel at Pike River followed a simple design: it had one intake roadway and one return roadway, with the hydro-monitor unit located at the top of the intake roadway under a supported roof. The hydro panel sloped uphill, with the return roadway higher than the intake roadway, as shown in the three-dimensional sketch below. Water from the hydro monitor flowed naturally downhill, carrying the extracted coal.

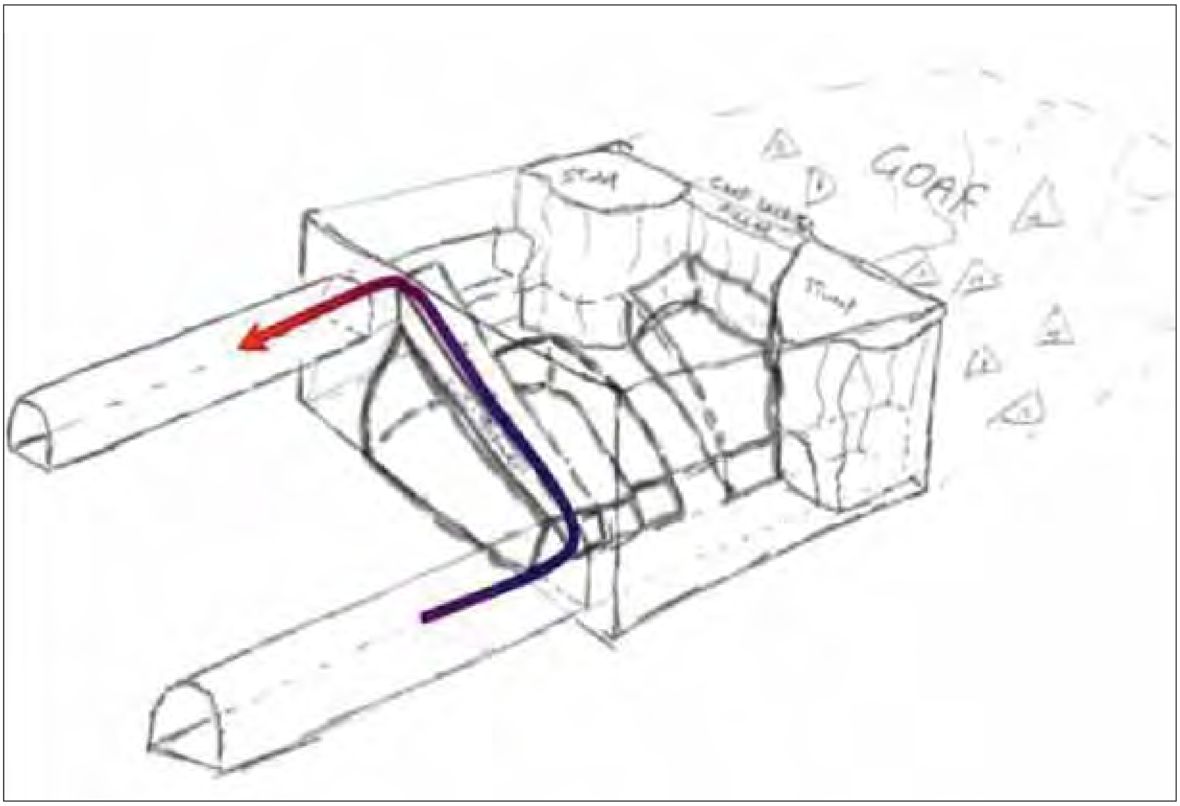


Figure 12.3: Three-dimensional sketch of hydro panel showing height difference between intake and return and ventilation path when panel idle[4]

5. At Pike River a machine called a guzzler was located 18m behind the hydro monitor, and directed the mixture of coal and water into the roadway flume system. The guzzler also crushed any large lumps of coal.[5] It is shown in the photograph with its 'wings' open ready to gather and direct the coal/water mixture.

Figure 12.4: Guzzler ready to gather and direct water/coal mixture[6]

6. Having passed through the guzzler, the coal and water slurry was flumed under gravity to the crushing station at pit bottom, where it was pumped down the 2.3km drift and on to the coal preparation plant approximately 10km away.[7]

7. Miners operated the hydro monitor from a series of controls at the guzzler. It was a cold, tedious job,[8] given the long periods spent operating levers to direct the water jet. Operators extracted coal in blocks of coal called lifts, following a set cutting sequence. After lifts were extracted across the full panel width, the monitor and guzzler retreated to a new position further in the intake roadway, and the process was repeated.[9]

8. The following diagram shows a bird's-eye view of the coal cutting sequence in place at November 2010 for each lift. The monitor position is marked M and operators cut coal in the areas defined as A to F, in that order, using the water jet within parameters bounded by the 'clock' numbering, i.e. for lift A the operator directed the water jet between 9 and 10 o'clock. Extracting coal first from A and B created the ventilation cut through between the intake and the return roadways. Areas X, Y and Z were designed to be temporary support pillars, called stumps, to keep the roof up until they, too, could be safely extracted and the roof allowed to fall.

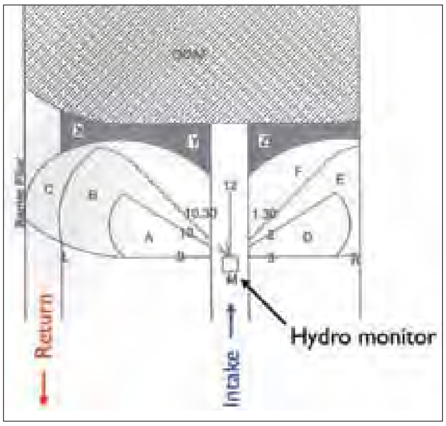


Figure 12.5: Bird's-eye view of the coal cutting sequence at Pike River[10]

9. The diagram below shows a cross-section of the seam in panel 1. The squares depict the return (left) and intake (right) roadways, with the return driven higher in the coal seam. Operators used the water jet to cut coal from the tops and bottoms of the seam as the hydro monitor was retreated, but were to avoid cutting into the rock in the roof and floor.

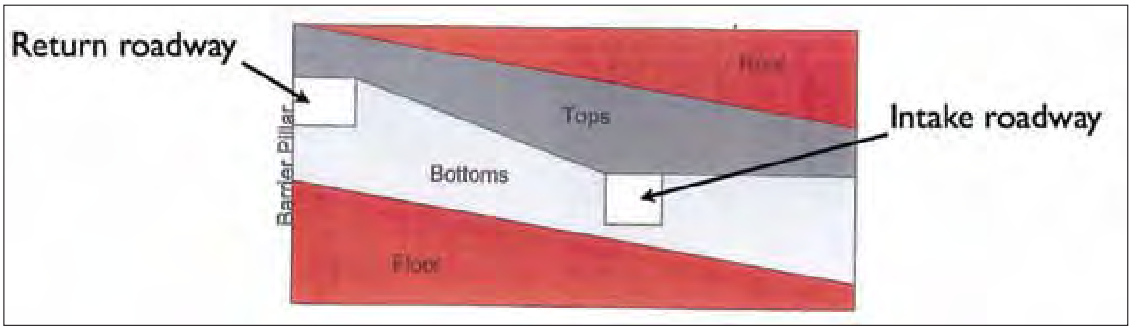


Figure 12.6: Cross-section of the seam in panel 1[11]

Hazards associated with hydro mining

10. Hydro mines must deal with specific risks and challenges, particularly in gassy West Coast conditions. Gas management can be particularly challenging. Hydro mining releases high volumes of methane as a result of extracting the full height of thick coal seams. That methane tends to build up in the goaf (the empty space left behind after coal extraction). The force of the water jet can disturb gas in the goaf and a roof fall can displace large amounts of gas. Rapid falls in barometric pressure can also draw methane out of the goaf.

11. Hydro-monitor operators face the risk of a windblast or high-velocity wind either injuring them directly, or surrounding them with irrespirable gas. Large volumes of coal slurry may also overwhelm the guzzler where the operator stands.[12]

12. A massive roof fall in the goaf is a major hazard. Such a fall may generate a blast of air that can injure people, damage stoppings and equipment, and send out a large plug of flammable gas. Panels should therefore be designed so the goaf collapses progressively after the coal has been cut.[13] If necessary, the roof can be made to fall by deliberately aiming the water jet at it in a controlled way. It is important to manage the risk by obtaining as much information as possible about the characteristics of the roof in the goaf, in order to avoid the creation of a large goaf and the potential for a massive roof fall.

13. For all these reasons, hydro mining calls for particular skill, experience and judgement on the part of the operator and management team. It is important that the operator can see the monitor nozzle to gauge the angle of the water jet when cutting, and to control the jet, so large amounts of methane are not displaced from the goaf. To cut coal productively and safely, an experienced operator relies on a constant assessment of factors, including the noise of the monitor jet, the size of the coal lumps in the slurry, changes to the water flow coming from the face, the noise of falling coal and stone, and gas readings in the return. There is little room for error unless all the back-up safety systems are well established.[14]

Development and production stages

14. Hydro mining is a two-stage process. The first stage involves development of the roadways and panels and the installation of infrastructure. The second stage is production – the extraction of coal using the hydro monitor. Development work generates some coal from the driving of roadways, but it is the production phase that produces large volumes of coal.[15]

The development of hydro mining at Pike River

15. Pike River was planned as a hydro mine from the early 1990s.[16] Later feasibility studies confirmed the proposal to use hydro mining,[17] and no other mining method was ever seriously considered.

The bridging panel

16. In 2004 Pike agreed with the Department of Conservation (DOC) that it would mine trial panels before beginning full hydro production. This was to enable monitoring of surface subsidence and roof caving characteristics underground.[18]

17. By late 2007 delays with the main drift had cost tens of millions of dollars, and Pike proposed the development of a 'commissioning panel' in advance of the trial panels. It was hoped that this would realise an additional $15 to $20 million for the company.[19]

18. In response to continuing delays,[20] the technical services department was told in May 2009 to locate coal for earlier production.[21] Pike identified six bridging panels that could be mined before the commissioning panel. These were designed with a narrow extraction width (30m) in order to test mining techniques in a controlled panel with 'low risk to the surface.'[22] In November 2009 DOC approved the concept and altered the access arrangement accordingly.[23]

19. In May 2010 DOC approved another variation for Pike to reduce the number of bridging panels and move the first panel closer to pit bottom.[24] This became known as panel 1 and is shown in Figure 12.7, as 'Bridging Panel'.

Figure 12.7: Pike's Four-year Plan for 2010–2014[25]

Ongoing delays

20. At the initial public offering in 2007, investors were told that hydro mining was scheduled to start in the first quarter of 2009.[26] By early 2010 the overall project was well behind schedule, and the planned start of the hydro monitor had been pushed out to at least July 2010.[27]

21. Problems with the design, manufacture, delivery and commissioning of equipment accounted for a major part of the delay in 2010. In 2004 and 2005 Pike had engaged Japanese company Seiko Mining and Construction Ltd (Seiko) to advise on the necessary equipment for hydro mining.[28] That advice was largely provided by Masaoki Nishioka, a world expert in hydro mining with more than 40 years of hydro-mining knowledge, including considerable experience on New Zealand's West Coast, and who had intermittent involvement with Pike.[29] Mr Nishioka said that although he had not been given proper design criteria, he provided Pike with a comprehensive quotation for all necessary hydro-mining equipment.[30] Seiko supplied some of the hydro-mining equipment, including the slurry pipeline.

22. Pike obtained other core hydro-mining equipment, including the track mounted monitor unit, from Australian companies who lacked expertise in hydro mining. Some of the equipment was essentially at the prototype stage.

23. Pike engaged a range of external consultants to assist with the development of the hyro-mining system.[31] In February 2010 a review of some of the equipment by external consultants found that the commissioning time frame for the equipment had been underestimated, software issues had plagued the commissioning stage, there was a significant problem with track clearances, re-engineering was required in part because of a contractual misinterpretation and there were insufficient trained service people available.

24. Against that background, Peter Whittall asked Mr Nishioka to come to Pike River in June 2010 to assist with the commissioning of the hydro-monitor system. Mr Nishioka arrived at Pike on 25 July and he soon had concerns about many aspects of the mine.

25. Mr Nishioka considered Pike's ventilation system insufficient for the hydro-monitor operation to begin before the commissioning of the main fan. He believed it was poor planning to have a large hydro goaf located so close to pit bottom and the Hawera Fault.[32] He was critical of Pike's equipment, including the monitor unit, which he thought was unwieldy and did not provide easy visibility for the operator.[33] The guzzler unit was also too big, heavy and complicated, and the pump units and high pressure pipe joints were unsuitable.[34]

26. Mr Nishioka also had other concerns. The hydro panel was too wide for the monitor jet; the proposed approach to roof caving was not good practice; there was a substandard work and safety culture underground; the workforce was inexperienced; and the mine was under obvious financial pressure. He said the system was generally not well engineered and not fit for a hydro-mining operation.[35]

The hydro bonus

27. In response to the increasing delays, in July 2010 the Pike board authorised the payment of a hydro-production bonus to staff when hydro extraction began. The bonus started at $13,000 if hydro production (defined as 1000 tonnes of coal) was achieved, together with 630m of roadway development, by 3 September 2010. After that date the amount of the bonus reduced each week, as shown in the following table that was presented to staff.


Hydro Mining Bonus Table

- In the event that hydro is achieved earlier than 24 September this rate will increase and in the event that we do not achieve it until after 24 September, the amount will decrease as set out in the table below:

Date Achieved										
Date	3 Sep	10 Sep	17 Sep	24 Sep	1 Oct	8 Oct	15 Oct	22 Oct	29 Oct	5 Nov
$	13,000	12,000	11,000	10,000	7,500	5,000	2,500	1,000	1,000	0
Metres	630	680	735	790	790	790	790	790	790	790

- The scheduled date for hydro start-up is 3 September 2010.

Figure 12.8: Hydro-mining bonus table[36]

28. The bonus, budgeted to cost Pike $2.3 million,[37] came when the board acknowledged internally it was facing credibility problems because of overpromising and underdelivering.[38] In April and May 2010 Pike had raised a further $50 million from the market,[39] but by 24 June 2010 it was forecasting a $5.8 million cash shortfall. In an email to directors on 5 July 2010, board chair John Dow said it was 'worth paying [the hydro bonus] to retain short-term market credibility'.[40]

29. At the commission's hearings, Mr Dow suggested the bonus was a response to poor work practices and in particular a lack of productivity and efficiency by workers. He said workers were not showing up for shifts, not looking after equipment and forgetting to fuel vehicles, and the bonus was 'about making sure people were thoughtful before they came to work'.[41] The board did not consider the potential impact of the hydro bonus on health and safety, but 'would have considered … There would be no reason why there'd be any relaxation in health and safety attention.'[42] Mr Dow believed the targets were 'modest enough and readily achievable'.[43]

30. Three points arise from the board's decision to implement the hydro bonus. First, the board did not give sufficient consideration to the ventilation requirements of the hydro monitor. Hydro mining began on 19 September 2010, two weeks before commissioning of the main fan started on 4 October 2010.[44] Because of the large amount of methane generated by the hydro monitor, Pike should have established robust ventilation from the main fan before starting hydro mining. Several people at Pike expressed that view.[45] Problems with methane recurred and on Friday 1 October, following the achievement of the hydro bonus, Pike agreed to stop monitor operations until the main fan became operational in booster mode the following week.[46]

31. Second, the board failed to address the risk that the bonus would place undue focus on production at the expense of safety.[47] Following the bonus, the mine pulled out 'all stops' to start hydro mining as quickly as possible.[48] Mr Nishioka reported that workers made 'strenuous effort' to produce 1000 tonnes of coal by midnight on 24 September, the due date for the $10,000 bonus,[49] although methane levels rose to explosive levels in the return twice in the days leading up to this deadline. It was hazardous to continue extraction in those conditions, and Mr Nishioka recommended that the operation stop until the main fan became operational.[50] This did not happen until the bonus had been achieved.

32. Although production bonuses are common in the coal mining industry, the hydro bonus at Pike created particular risks. Pike offered the bonus when there were known problems with equipment, ventilation, staff inexperience, and a lack of effective monitoring systems.

33. Third, the bonus was introduced when the board and senior management had not been assured that Pike's systems were ready for hydro mining. In early July 2010 the company had not undertaken the appropriate risk assessments, and it did not properly complete them before beginning hydro extraction.

Haste to begin hydro extraction

34. By mid-2010 Pike was committed to starting hydro production as soon as possible. The mine went through a number of exercises that identified major weaknesses in the mine's systems. These exercises identified that some critical systems were not yet in place, and others were not yet working properly.

Operational preparedness gap analysis

35. This exercise occurred during the third week of August 2010 (a month before the start of hydro mining), facilitated by Bob Dixon of Palaris Mining from New South Wales.[51] He prepared a report of the exercise in the following format:

Operational Preparedness Gap Analysis					
Specific Area	**Plan, Policy, Procedure**	**Priority**	**Status / Action**	**Who**	**When**
			Ventilation		
Spon Com		2	yes – exists and needs reviewing to encompass hydro mining	Doug	
Degassing procedure review			in place		
Gas plug		1	no procedure exists	Doug	
Sealing off panel			plan needs to be developed	Doug	
Ventilation network			plan needs to be developed	Doug	
Panel ventilation plan		[illegible]	plan needs to be developed	Doug	
Broad brush risk assessment		[illegible]	windblast, ventilation and gas, hydro mining, and fire fighting risk assessments to be reviewed or completed	DW	
Gas monitoring manual and automatic		[illegible]	plan needs to be developed	Doug/ Nick	
Ventilation TARP – operator requirements		2	needs to be reviewed	Doug	
Safety critical systems include dilution doors, CH4 protection, emergency stops, guarding,	Risk Assessment	1	need to be identified, checked, and implemented	Doug / NG / MC	
Mining plan		2	needs to be completed	PVR/Doug	
Hydro extraction plan - ATM		2	needs to be completed and updated with geotechnical, geological, strata control, and operating requirements	Doug /PVR	
Start-up strategy e.g. Day shift only		2	needs to be finalised	Doug/ Bernie	

Figure 12.9: Operational preparedness gap analysis[52]

36. The full document identified 15 'priority 1' actions, including creating or finishing plans for critical hazards such as gas plugs, panel ventilation and gas monitoring. The mine needed to complete risk assessments for windblast, ventilation and gas, hydro mining and fire fighting. Safety critical systems, including dilution doors (a mechanism to dilute large volumes of methane), gas protection and emergency stops needed to be identified, checked and installed.

37. The gap analysis provided a vital 'to do' list for the mine and a stocktake of the project's readiness, but was of little use without a mechanism to make sure these things were actually done before hydro start-up.

38. Pike supplied this document to external insurance risk assessor Jerry Wallace of Hawcroft Consulting International. On 23 August 2010 Mr Wallace emailed Mr Whittall to express concern about 'the lack of formal risk assessments [one] month out from the start-up of the first monitor panel.'[53] He was particularly concerned that so many priority 1 actions were unresolved in relation to ventilation and gas management, and that a risk assessment into windblast was yet to be conducted.[54] He considered it 'unfortunate' that Pike was beginning hydro mining 'with many controls currently being developed but not yet implemented.'[55]

39. In the 10 days following Mr Wallace's email, Pike did complete two risk assessments regarding hydro extraction, and ventilation/gas monitoring. Many other actions on the gap analysis list remained unaddressed, and were not completed even by the time of the explosion on 19 November 2010.

Panel 1 risk assessment

40. This risk assessment took place on approximately 3 September 2010, although the document filed with the commission is undated and in draft. The treatment of windblast and ventilation, and the risk of explosive mixtures in the return, are all significant.

41. Windblast is caused by a sudden plate-like roof fall in a goaf. This can push air and gas out of the goaf at high speed, and a windblast is technically defined as generating an air velocity greater than 20m/s. Such velocities can injure people by knocking them over or hitting them with airborne objects. They can also damage the mine and mining equipment, seriously disrupt ventilation and create potentially explosive mixtures. Wind velocities of less than 20m/s are not technically considered windblasts, but can still cause significant damage and displace large plugs of methane from a goaf into mine roadways.[56]

42. Pike's risk assessment report recorded a number of hazards arising from windblast, including a change in ventilation pressure, which was considered to have only relatively minor consequences because of four 'existing controls.'[57]

Hazard	Existing Controls	Assessment			
		Conse quenc	Likelih	Risk Score	Risk Rankin
Change in ventilation pressure due to windblast	Ventilation	2	A	16	
	Rated vent structures				
	Dilution doors				
	Windblast investigation (PRCL 2010)				

Figure 12.10: Hazards arising from windblast

43. However, it was not correct to refer to these four matters as 'existing' controls. The generic label 'ventilation' was not a meaningful control since ventilation in the hydro panel was not robust enough to deal with the effects of a windblast, particularly as hydro extraction started before the main fan was working. As noted in Chapter 8, 'Ventilation', Pike did not have rated ventilation structures, and the structures around the hydro panel were some of the weakest in the mine – as shown by the failure of the stopping in panel 1 after the roof fall on 30 October 2010. Similarly, dilution doors were never operational at Pike River, and the windblast investigation was, at best, a work in progress. The four 'existing controls' amounted to little or no protection, and the risk should have been rated 'high' or 'unacceptable'.

44. The risk assessment also considered the hazard of an explosive mixture of gas in the return/through the fan.

Explosive mixture through return / through fan	Fan design (electric installation on intake side)	[illegible]	[illegible]	[illegible]		Restricted access into return	5	D	19
	Dilution doors					Ventilation management plan review (TARP)			
	Monitoring					Ventilation procedures			
	Fan design (anti-spark)								
	Ventilation quantities								

Figure 12.11: Hazard of an explosive mixture of gas in the return/through the fan[58]

45. That hazard initially received a high (red) rating, but that was downgraded to medium because of three proposed additional controls. Neither the existing nor the additional controls were accurately described.

46. The planned dilution doors were not operational, and the monitoring system was not an effective control for the reasons set out in Chapter 10, 'Gas Monitoring'. The 'anti-spark' fan design did not stop sparks coming from the fan on 4 October 2010,[59] and 'restricted access into the return' did not stop contractors and employees working in the return, even in explosive range methane, on several occasions.[60] Moreover, the review of the ventilation management plan never took place, and the generic description 'ventilation procedures' did not translate into anything meaningful. This hazard should also have been rated 'high' or 'unacceptable'.

47. The remainder of the document contained similar problems. Although tasks were assigned to individuals, no dates were set for completion and none were signed off as completed. The exercise was an inaccurate and incomplete assessment of the existing risks and the effectiveness of Pike's proposed controls. It may have identified problems at the mine, but they were not properly addressed.

Ventilation and gas monitoring risk assessment

48. The third exercise was a ventilation and gas monitoring risk assessment dated 7 September 2010.[61] This also suffered from reliance on non-existent controls and relied on the ventilation management plan as a control for many risks. Yet, as discussed in Chapter 8, the company largely ignored this plan and it was not an effective risk control.

49. The risk assessment generated a list of actions, including some fundamental requirements, such as:

- *Specify construction requirements for [ventilation control devices];*
- *Ensure [gas] monitors are installed to a standard;*
- *Determine the capabilities of real time monitoring ;*
- *Control room operators to be trained in SafeGas; and*
- *Ensure regular auditing of ventilation system.*[62]

50. These actions were not allocated to individuals until 16 September 2010, three days before hydro extraction began. In emailing the list to key personnel, Mr White stated 'None of these issues are show stoppers and some will take time to implement.'[63] It is a revealing insight into the thinking at the mine that such fundamental requirements were not seen as 'show stoppers'. Many of these requirements had still not been attended to before the explosion on 19 November 2010.

The start of hydro extraction

51. On 19 September 2010 Pike operated the hydro monitor for the first time, and extracted approximately 140 tonnes of coal.[64] Over the next two months the hydro team encountered a catalogue of problems, including equipment issues, gas and ventilation problems, a lack of hydro experience, the departure of Mr Nishioka and continuing difficulty cutting coal. The hydro team did not achieve the targets it had been set.

52. Neither the hydro project manager (Terence Moynihan) nor the hydro co-ordinator (George Mason) had any hydro-mining experience.[65] Most of the crew lacked operational hydro-mining experience, and one study by Gregory Borichevsky indicated that operators were not following the cutting sequence up to a third of the time.[66] In particular, workers were spending too long mining the roof and the floor, diluting the coal with ash and stone.[67]

53. To help address its inexperience in hydro mining, Pike hired Mr Nishioka to help with the commissioning process. During a commissioning stage some teething issues can be expected, but in addition there were equipment and design issues.

54. Mr Nishioka's work record during the monitor's first week of operation noted that:

- the guzzler was too large and complicated;
- it was hard for the operator to see the direction of the monitor nozzle, because vision was blocked by the housing;
- methane in the return exceeded 5% as soon as the monitor began cutting;
- loose stoppings caused methane levels to rise above 5% on several occasions;
- every hour to hour and a half the monitor clogged up and stopped working;
- the slurry pipeline became blocked;
- the 30m panel was too wide for the water jet; and
- the flume leaked in many places.[68]

55. In mid-October Mr Nishioka left Pike. This was the scheduled time for him to depart, but he told the commission he did not feel comfortable staying.[69]

24-hour production

56. The original aim for the bridging panel was to have a single-shift operation conducting technical investigations and ensuring the equipment was fully operational and effective. However some weeks after hydro mining started, Pike moved to a 24-hour production cycle in the hydro panel, incorporating two 12-hour shifts. The change also required more hydro crews, which exacerbated the problems with operator inexperience.

Strata control in the hydro panel

57. Strata control is critical to ensure the roof and walls of a mine do not collapse. Within a goaf, roof collapse is often desired, in which case it must be managed in a controlled way. Good strata control requires a management plan, adequate geotechnical knowledge and a variety of techniques to manage and monitor underground stability. The three main hazards to be avoided are unplanned roof collapse, unwanted surface subsidence and windblast.

Pike's strata control management plan

58. MinEx produced guidelines in 2009 for the management of strata control in underground mines. The guidelines state that an employer is responsible for the development of a strata management plan. This outlines procedures for safe excavation of strata, for monitoring the effects and for managing strata control issues; it also defines the roles and responsibilities of personnel. Section 3.3 provides that a 'formal documented technical risk assessment … shall be performed for strata and geological hazards for all excavations prior to development' of its strata management plan.[70] Such risk assessments 'shall' consider a number of geological and geotechnical factors including the adequacy of the mine's exploration data and its interpretation of the data. The guidelines note that design of adequate strata control requires a geotechnical assessment of many factors, including assessment of the method of extraction, void or caving characteristics, in-situ stress and gas drainage and exploration data.[71]

59. There is no evidence of a risk assessment into strata and geological hazards before panel 1 excavation. In October 2010 Pike had a draft strata control management plan based on three stated principles: prediction, prevention and protection. Prediction required the mine to collect, analyse and maintain detailed geotechnical information, and set out the design process for planning strata control, support and pillar design. Prevention required regular evaluation and monitoring, with responsibilities assigned to a 'hydro-mining undermanager' and 'Strata Management Team'. Protection required permits to mine, a trigger action response plan (TARP) and staff training in strata control.[72]

60. Pike did not fully comply with these principles. It had insufficient geotechnical information on the strata in panel 1 and undertrained hydro crews. There was some monitoring and evaluation,[73] but no strata management team and no qualified hydro-mining undermanager. None of the qualified undermanagers at Pike had responsibility for the panel.[74]

Subsidence

61. Minimising surface subsidence was particularly important at Pike River because of DOC requirements under the access arrangement.

62. Consultant geotechnical engineer Dr John St George was Pike's principal adviser on subsidence. He prepared reports supporting the proposed designs of Pike River's bridging and commissioning panels, to ensure minimal surface subsidence and compliance with its access arrangement with DOC.[75] These reports focused largely on surface effects, rather than the underground safety of Pike's proposals.

Windblast

63. In July 2010, as part of its annual insurance risk assessment, Hawcroft Consulting 'strongly recommended' Pike undertake a thorough risk assessment into the potential for windblast before coal extraction began in panel 1.[76]

64. On approximately 3 September 2010 Pike carried out the 'panel 1' risk assessment, which dealt with many aspects of windblast. However, Pike had inadequate information to assess the likelihood of windblast occurring and, as noted above, many of the 'existing controls' relied on in the risk assessment did not exist or were ineffective.

65. There was no vertical borehole in the area of the hydro panel, so the only geotechnical data available was from vertical drillholes PRDH8 and PRDH37. These were some distance apart to the south and north of panel 1, as shown below circled in red. PRDH47 (shown below circled in blue) was not drilled until after the explosion.

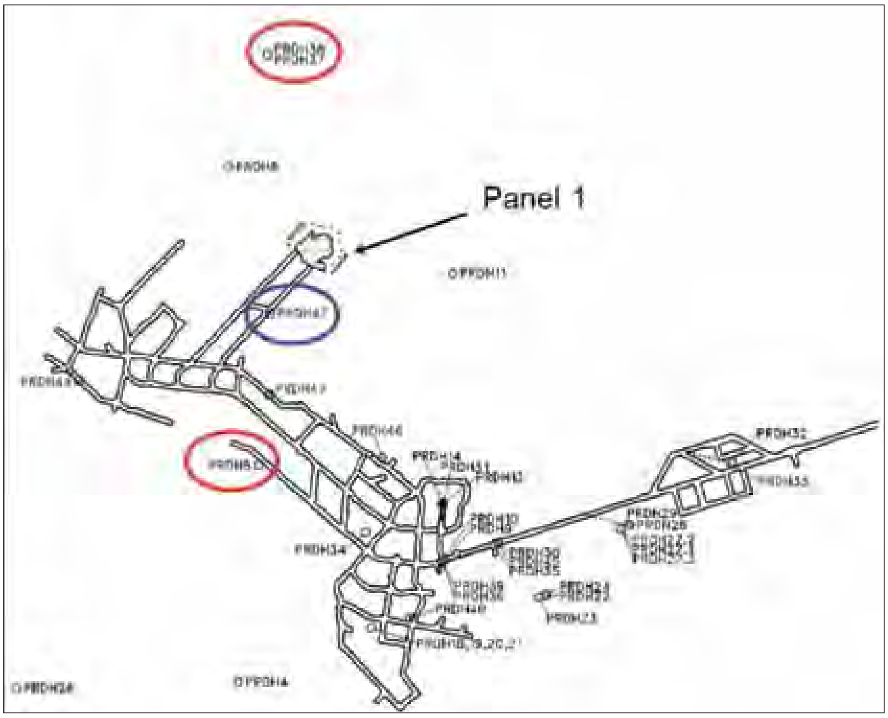


Figure 12.12: Drillholes in the vicinity of Panel 1[77]

66. Consultants Strata Engineering used information from drillholes PRDH8 and PRDH37 to provide Pike with windblast advice on 29 August 2010, and Pike relied on this advice repeatedly in the risk assessment. The advice noted that Pike River's bridging panels were planned to be 31m wide in the first instance, but might increase to 50m in the future, with an extraction height in the 10–13m range.[78] Pike generally took Strata Engineering's advice, based on modelling, as encouraging about the windblast hazard. The island sandstone was considered likely to bridge over panel widths of up to 30m, and although it might fail over larger distances, this was likely to be progressively in smaller blocks rather than a large plate-like fall associated with windblast.[79]

67. However, Strata Engineering tempered its advice, noting the areas of uncertainty, and emphasised the desirability of 'ongoing collection of structural data … to assess the structural environment on… a panel by panel basis'.[80] Moreover, Strata Engineering later stated that although it knew the Hawera Fault was to the east of panel 1, its advice to Pike would have been different if it had been asked about extending extraction 15m closer to the edge of the fault.[81] However, this was disputed by Mr van Rooyen. He noted Strata Engineering personnel were on site in September and October providing further advice on strata control issues for panels 1 and 2, had seen plans of the extension of panel 1 to the east, and had not altered their advice to Pike.[82]

Core logging

68. Pike had two main options to obtain more geological information. First, it could have drilled another vertical borehole from the surface above the hydro panel. This would have been expensive and further delayed the start of hydro extraction. Pike did not pursue this option.

69. As an alternative, Pike planned to use core logging. This involved drilling holes in the roof and floor and taking a core sample for geotechnical logging. The technical services department wanted to complete core logging to assess the risks identified by Strata Engineering, and to assess such things as the spontaneous combustion potential of the rider seam, the depth of the interburden layer and its characteristics and capabilities, whether there were weak zones in the strata, and the layering of the sandstone structure. Pike also wanted to develop a correlation between what was cored and the strata behaviour recorded before, during and after panel 1 was mined.[83]

70. Dr St George also supported core logging of all extraction zones. He emphasised it was essential that caving of the roof strata was 'monitored and managed since it presents a safety hazard as well as an influence on subsidence'.[84]

71. Pike did not achieve core logging before hydro mining began. On 10 September 2010 Pieter van Rooyen expressed his frustration in an email to Mr White and others, writing in capital letters 'CAN THIS ISSUE PLEASE BE ADDRESSED ASAP', noting the information was required to 'ensure the assumptions in strata control designs, windblast and caving characteristics is correct (or at least acceptable)'.[85]

72. The main obstacle was Pike's inability to supply enough air pressure to run the required drill rig. Despite the engineering department suggesting another option, that did not occur and extraction began in panel 1 without core logging being done.[86]

73. There was bore scoping done in panel 1 roadways, where holes were drilled and a bore scope inserted allowing the operator to view and log the strata and its geology.[87] But the results were of poor quality and Strata Engineering advised that they should be treated with some caution.[88]

74. Starting coal extraction in panel 1 before geotechnical core logging could be done meant the opportunity to obtain vital geotechnical data was lost. The importance of data from this area of the coalfield should not have been underestimated.

Further advice, and the widening of the panel

75. In early September 2010 Pike engaged an Australian geotechnical engineering consultant, Dr William Lawrence of Geowork Engineering Pty Ltd, to assist with strata issues. Among other tasks,[89] he was asked to consider and review work already done on the effects on the overlying strata of varying the proposed widths of bridging panels.[90]

76. On 27 September, a week after hydro extraction began, Pike asked Dr Lawrence to assess the ability of the island sandstone to form a bridging beam across both panels 1 and 2.[91] Dr Lawrence faced the same difficulties as Strata Engineering with the lack of data from Pike, and requested information that was not available.[92]

77. On 6 October 2010 the technical services department recommended widening panel 1 by up to 15m to the east to extract more coal. Pike estimated this would increase the recoverable coal by 50%.[93] This was authorised on 15 October 2010,[94] although Mr White did not formally sign off on widening panel 1 until 18 October 2010.[95]

78. On 25 October 2010 Dr Lawrence gave Pike his report summarising the characteristics, behaviour and spanning capability of the island sandstone. As with the earlier report by Strata Engineering, Pike drew comfort from Dr Lawrence's views. However, the report emphasised that the lack of data to date meant 'critical parameters have been assumed, which does result in some uncertainty'.[96]

A warning – roof fall on 30 October 2010

79. Five days later, on 30 October 2010, part of the roof in the panel 1 goaf collapsed. The resulting rush of air was strong enough to knock over the stopping in the hydro panel cross-cut, and result in an explosive accumulation of methane.[97]

80. There was no formal investigation into the roof fall, but visual examinations of the rubble found larger blocks of white stone had fallen but no coal, and there were different views on whether the roof collapse had extended up to the rider seam.[98]

81. Pike did not want a recurrence of stumps of coal left in the goaf that were unreachable by the monitor water jet. A 'best practice' monitor cutting technique was designed, directing the hydro crews to create only temporary stumps in the goaf, to be extracted last. This was intended to ensure a more controlled roof fall in future.[99]

Further assessment of risks

82. After receiving advice from Strata Engineering and Geowork Engineering that windblast and large goaf falls could not be excluded, given the lack of geotechnical data, Pike did not reconsider the potential for these hazards and the effectiveness of its possible controls and did not suspend hydro extraction to enable further data collection from panel 1. The unexpected large roof fall on 30 October also failed to trigger any further review, despite the methane plug released and the destruction of the panel ventilation stopping.

Ongoing problems

83. Pike's problems with the hydro-monitor production continued, and on 19 October 2010 Pike downgraded its production forecast for the period to 30 June 2011 from 620,000 tonnes to between 320,000 and 360,000 tonnes.[100]

84. By late October Pike internally described the lack of hydro output as 'untenable.'[101] Mr Mason instigated a productivity review group and Mr White sought advice by email from Mr Nishioka.[102]

85. Pike considered that the difficulties arose from the hardness of the coal, technical issues with the hydro monitor cutting performance and inconsistent operating standards. The first retreat of the monitor was authorised on 22 October 2010, meaning a month was spent attempting to extract its first lifts of coal.[103]

86. In its search for answers, the review group considered panel design issues, including extraction pillar dimensions, viable monitor cutting distances and repositioning of monitor and water jet orientation; the need for systematic collection of operational data; changes to management responsibilities; greater insistence on cutting sequences and standards from monitor operators; use of drill and blast methods within the panel to loosen up the coal; and the need for more testing, given the lack of 'raw data gathered to characterise the coal that we are cutting.'[104] The group identified changes to the process, but the explosion intervened.[105]

87. On 15 November 2010 Mr Whittall told Pike's annual general meeting:

> *I am very pleased with the way the process has gone. There have been no significant issues and the hydro system cuts and flows through the Coal Preparation Plant as it is supposed to.*[106]

Conclusions

88. Delays in achieving coal production resulted in a change of location for the hydro panel. This change was hurried and poorly managed in a number of respects:

   - Geotechnical knowledge of the bridging panel strata conditions was limited and the risks arising from hydro extraction were inadequately assessed.
   - The board initiated a staff bonus scheme based on reaching a coal production target promptly, with the bonus then reducing from week to week.
   - Hydro production was affected by equipment, crew inexperience, ventilation and methane problems. Coal production levels remained very low.
   - On 30 October a roof fall in the hydro panel goaf expelled a large volume of methane and damaged a nearby stopping, but there was no adequate management review and response to this event.
   - Generally, the hazards of hydro mining were not sufficiently understood and coal extraction at Pike River should have been suspended until a second egress and strata, ventilation and gas management problems were resolved.

ENDNOTES

1 Diagram provided by Peter Whittall, PW54/1.

2 Craig Smith, witness statement, 9 November 2011, SOL446723/9, para. 28.

3 Department of Labour, *Pike River Mine Tragedy 19 November, 2010: Investigation Report*, [2011], DOL3000130010/54.

4 David Reece, DR3 and DR4 Hydro Panel – Goaf Diagram, DOL3000150011/1. (Extract of diagrams modified by commission to remove caption from image)

5 George Mason, witness statement, 31 October 2011, MAS0001/9–11, paras 36–43.

6 Ibid., MAS0001/11.

7 Peter Whittall, witness statement, 22 June 2011, PW0/12, para. 45.

8 Stephen Wylie, transcript, pp. 3715–16.

9 Pike River Coal Ltd, Monitor Extraction Guidelines, 10 November 2010, DAO.010.00399/1–8; Craig Smith, transcript, p. 3405.

10 Ibid., DAO.010.00399/8. (Diagram modified by commission)

11 Ibid.

12 Craig Smith, transcript, p. 3410; Craig Smith, witness statement, 9 November 2011, SOL446723/11, para. 34.3.

[13] Craig Smith, transcript, p. 3405; Masaoki Nishioka, transcript, p. 3491.
[14] David Stewart, transcript, p. 3339.
[15] Craig Smith, witness statement, 9 November 2011, SOL446723/7, paras 18–19.
[16] Masaoki Nishioka, transcript, p. 3478.
[17] CMS Ltd, Pike River Coal Mine Pre-feasibility Study, 25 May 1995, NZOG0002/6; Minserv International Ltd, Pre-feasibility of the Pike River Coal Mining Project, March 1998, NZOG0005; Graeme Duncan, witness statement, 31 January 2012, GD00/11, para. 26.
[18] Access Arrangement under Crown Minerals Act 1991, Mining Permit 41-453, Pike River Coal Company Ltd, 21 October 2004, NZOG0018/20–21.
[19] Department of Conservation, Meeting Notes, 21 December 2007, DOC3000010003/2.
[20] Pike River Coal Ltd, Concept Options to Increase Production Outputs Jan–Jun 09, 8 December 2008, DAO.004.10880/1–9.
[21] Petrus (Pieter) van Rooyen, witness statement, 27 January 2012, PVR001/19, para. 99.
[22] John St George, Technical Memorandum on Subsidence Related to the Commissioning of Bridging Panels at Pike River Coal Mine, 28 September 2009, DAO.003.10936/3.
[23] Department of Conservation, Departmental Decision Request Regarding Mining Operations at Pike River Coal Mine, 17 November 2009, DOC3000010011/1–2.
[24] Department of Conservation, Departmental Decision Request Regarding Mining Operations at Pike River Coal Mine, 24 May 2010, DOC3000010013/1–2. The approval was based upon an amended technical memorandum prepared by John St George, Subsidence Implications of Amended Design to the Commissioning and Bridging Panels at Pike River Coal Mine, 7 May 2010, DAO.004.10148/1–2.
[25] Pike River Coal Ltd, 4-Year Plan, 10 November 2010, EXH0008.
[26] Pike River Coal Ltd, New Zealand Prospectus: An Offer of Shares in a Major New Zealand Coal Company, 22 May 2007, DAO.012.02790/45.
[27] Hydro-Project Update, 24 February 2010, DAO.002.14285/1.
[28] Masaoki Nishioka, transcript, pp. 3485–86.
[29] Ibid., pp. 3476–77. Mr Nishioka was involved with Mitsui Mining Engineering Co. Ltd in the Spring Creek proposal in the 1980s, as well as the successful trial of hydro mining at the old Strongman mine in the 1990s, and the early exploration phase for Pike River mine: Report of the Ministry of Energy for the Year Ended 31 March 1983, MED0010040007/31.
[30] Masaoki Nishioka, transcript, p. 3486; Seiko Mining & Construction Ltd, Equipment & Material Specifications for Pike River Coal Ltd, March 2008, DAO.025.20325/1.
[31] Masaoki Nishioka, transcript, pp. 3606-07
[32] Ibid., p. 3490; Masaoki Nishioka, witness statement, 25 October 2011, NISH0001/11, para. 42.
[33] Masaoki Nishioka, transcript, p. 3487; Masaoki Nishioka, work record, NISH0002/21.
[34] Masaoki Nishioka, transcript, pp. 3492–94; Masaoki Nishioka, witness statement, 25 October 2011, NISH0001/6–8, paras 22–24. For example, the high-pressure joints were a prototype that had never been field tested, and when they were used they leaked and created a safety hazard.
[35] Masaoki Nishioka, transcript, pp. 3491, 3496, 3503, 3555.
[36] Pike River Coal Ltd, Performance Bonus 2009/10, 2010, DAO.001.13841/5.
[37] Email, Peter Whittall to John Dow, 5 October 2010, DAO.007.28453/1.
[38] John Dow, transcript, p. 4043.
[39] John Dow, witness statement, 9 June 2011, DAO.001.0003/6, paras 27–28.
[40] Email, John Dow to Gordon Ward, 5 July 2010, DAO.008.21575/1.
[41] John Dow, transcript, pp. 3934, 4056.
[42] Ibid., p. 3936.
[43] Ibid., p. 4055.
[44] At the time the Pike board of directors approved the bonus, internal documents said the commissioning of the main underground fan would not start until 6 September 2010, or more likely 11 September 2010: Hydro Project Update, 15 June 2010, DAO.002.14606/3; Masaoki Nishioka, work record, NISH0002/27; John Dow, witness statement, 9 June 2011, DAO.001.0003/47, para. 315.
[45] Masaoki Nishioka, transcript, p. 3490; Michael Scott, witness statement, 30 May 2012, SCO7770010001/15, para. 58; Petrus (Pieter) van Rooyen, transcript, pp. 5225–26; Drive Mining Pty Ltd, Pike River Coal Ltd – Gas Management Primary Report, 22 July 2010, DAO.001.04909/10–11.
[46] Masaoki Nishioka, work record, NISH0002/27.
[47] Masaoki Nishioka, transcript, p. 3620.
[48] Pike River Coal Ltd, Operations Meeting Minutes, 15 September 2010, DAO.002.14871/6.
[49] Masaoki Nishioka, work record, NISH0002/23.
[50] Ibid., NISH0002/22.
[51] Douglas White, transcript, p. 4883; Hydro Project Update, 17 August 2010, DAO.002.14796/11.
[52] Pike River Coal Ltd, Operational Preparedness Gap Analysis, August 2010, DAO.003.08875/1–5.
[53] Email, Jerry Wallace to Peter Whittall and Gregory Borichevsky, 23 August 2010, INV.04.00275/9.
[54] Email, Jerry Wallace to Gregory Borichevsky and Peter Whittall, 27 August 2010, INV.04.00849/1.
[55] Ibid., INV.04.00849/2.
[56] New South Wales Department of Primary Industries, Mine Safety Operations Division, Windblast Guideline: MDG 1003, November 2007, CAC0149.
[57] No additional controls were listed: Pike River Coal Ltd, Formal Risk Assessment, undated, DAO.011.00007/5–6.
[58] Ibid., DAO.011.00007/6–7.
[59] Masaoki Nishioka, work record, NISH0002/27.
[60] Pike River Coal Ltd, Incident/Accident Form, 6 May 2010, DAO.001.00885/1–2; Daniel Rockhouse, Police/DOL interview, 8 December 2010, INV.03.01747/12–13.
[61] Pike River Coal Ltd, Formal Risk Assessment, Ventilation and Gas Monitoring, 7 September 2010, DAO.011.00025/1.
[62] Email, Douglas White to George Mason, Pieter van Rooyen, Robb Ridl and Bernard Lambley,16 September 2010, INV.04.00712/14.
[63] Ibid., INV.04.00712/1.
[64] Masaoki Nishioka, work record, NISH0002/21.
[65] Terence Moynihan, witness statement, 25 May 2012, MOY7770010001/22; George Mason, witness statement, 31 October 2010, MAS0001/5, para. 14.
[66] Gregory Borichevsky, witness statement, 26 June 2012, BOR0001/47, paras 321–22.
[67] Ibid., BOR0001/47, para. 325.
[68] Masaoki Nishioka, work record, NISH0002/21–23.
[69] Masaoki Nishioka, transcript, p. 3545.
[70] MinEx Health & Safety Council, Guidelines for the Management of Strata in Underground Mines and Tunnels, October 2009, CLO0010014980/3.
[71] Ibid., CLO0010014980/9,11.
[72] Pike River Coal Ltd, Strata Control Management Plan: Management Plan (Final Document), 21 October 2010, DAO.025.38374/9–11, 13, 15.
[73]Strata Management/Control Monitoring, DAO.003.16430/1 (undated but believed to be November 2010); Petrus (Pieter) van Rooyen, transcript, pp. 5244–46.
[74] Stephen Wylie, transcript, pp. 3707–08. The hydro co-ordinator acted as the undermanager but did not hold the necessary certificate of competence for that role: George Mason, transcript, p. 3662.
[75] John St George, Subsidence Implications of Amended Design to the Bridging Panels at Pike River Coal Mine: Amendment 2, 23 August 2010, DAO.025.42050/1.
[76] Hawcroft Consulting International, Pike River Coal Limited, Pike River Mine – Risk Survey – Underground, CPP & Surface Operations: Draft Report: PRCL Comments, July 2010, DAO.003.08590/58. The draft report was first given to Pike by Jerry Wallace of Hawcroft on 4 August 2010: Email, Jerry Wallace to Peter Whittall, Colin Whyte, Gregory Borichevsky, 4 August 2010, INV.04.00392/4.
[77] Pike River Coal Ltd, Surface Boreholes, 30 August 2011, DAO.031.00004/1. (Extract of the plan modified by the commission)

[78] Strata Engineering (Australia) Pty Ltd, Windblast Potential for Panel 1 at Pike River Coal, 29 August 2010, DAO.001.11042/1. It seems that Strata Engineering was not aware, at least at that stage, that Pike already intended to widen panel 1 up to 50m to extract more coal.
[79] Ibid., DAO.001.11042/4–5.
[80] Ibid., DAO.001.11042/5.
[81] Email, David Hill to Jane Birdsall, 7 October 2011, DOL3000150007/1.
[82] Petrus (Pieter) van Rooyen, transcript, pp. 5165–67.
[83] Gregory Borichevsky, witness statement, 26 June 2012, BOR0001/40, paras 279–80.
[84] John St George, Workshop on Subsidence, 15 October 2010, DAO.025.38605/5.
[85] Email, Pieter van Rooyen to Douglas White, Robb Ridl, Peter Sinclair, Bernard Lambley and others, 10 September 2010, DOL3000150006.
[86] Petrus (Pieter) van Rooyen, transcript, pp. 5243–44.
[87] Ibid., pp. 5244–45.
[88] Strata Engineering (Australia) Pty Ltd, Secondary Roof Support Recommended for the Extraction of Panel 1, 5 October 2010, DAO.001.11049.
[89] On 18 September 2010 Dr Lawrence provided Pike with a report on interpanel barrier pillar widths: Geowork Engineering Pty Ltd, Production Panel Pillar Width – Initial Specification, 18 September 2010, DAO.001.10765/1–9.
[90] From 30m to 60m and 90m in width: Email, Huw Parker to William Lawrence, 21 September 2010, DAO.025.38932/1.
[91] Email, Huw Parker to William Lawrence, 27 September 2010, DAO.025.39088/1.
[92] Email, William Lawrence to Huw Parker, 21 September 2010, DAO.025.39010/1. He also asked whether Pike was aware of other areas where island sandstone bridging had occurred: Email, William Lawrence to Huw Parker, 12 October 2010, DAO.025.37384/1.
[93] Memorandum, Gregory Borichevsky to Douglas White, Pieter van Rooyen and Stephen Ellis, 6 October 2010, DAO.025.33968/2–4.
[94] Pike River Coal Ltd, Permit to Mine – 1 West 1 Right – Panel 1 Extraction CH189m, 15 October 2010, DAO.001.03568/1. This permit to mine was for chainage (position) 189m only, as Mr van Rooyen said he was not prepared to permit a full panel width extension until Pike had received the further report on caving and subsidence from Dr Lawrence – Petrus (Pieter) van Rooyen, witness statement, 27 January 2012, PVR001/22, para. 118.
[95] Memorandum, Gregory Borichevsky to Douglas White, Pieter van Rooyen and Stephen Ellis, 6 October 2010, DAO.025.33968/3.
[96] Geowork Engineering Pty Ltd, Production Panels 1 and 2 Layout Considerations – Summary of Numerical Modelling Outcomes, 25 October 2010, DAO.001.10780/10.
[97] Stephen Wylie, Pike River Coal – Deputy Statutory Report, 29 October 2010, DAO.001.02837.
[98] Stephen Wylie, written statement, 31 October 2011, WYL0001/10, para. 49; George Mason, written statement, 31 October 2011, MAS0001/16, para. 72.
[99] Pike River Coal Ltd, Monitor Extraction Guidelines, 10 November 2010, DAO.010.00399/1–8; Gregory Borichevsky, witness statement, 26 June 2012, BOR0001/49, paras 340–41; Terence Moynihan, witness statement, 25 May 2012, MOY7770010001/24, para. 9.1.18.
[100] David Salisbury, witness statement, 25 May 2011, NZOG0068/37, para. 148.
[101] Email, George Mason to Matt Coll, Terence Moynihan, Gregory Borichevsky, Robb Ridl, Huw Parker, Stephen Ellis and Douglas White, 31 October 2010, MOY7770010008/1.
[102] Emails between Douglas White and Masaoki Nishioka, 9–10 November 2010, MOY7770010008/3–4.
[103] Pike River Coal Ltd, Permit to Mine – 1 West 1 Right – Panel 1 Extraction CH 183m, 22 October 2010, DAO.001.13932/1.
[104] Email, Terence Moynihan to Douglas White, 17 November 2010, MOY7770010008/2, Email, Terence Moynihan to George Mason, Gregory Borichevsky, Tjaart Heersink and Huw Parker, 17 November 2010, MOY7770010008/6–8.
[105] Pike River Coal Ltd, Panel 1 Lift 3 Modified Mining Plan – Risk Assessment (Draft Document), 17 November 2010, DAO.025.38089/1.
[106] Pike River Coal Ltd, News Release, 2010 AGM – Chief Executive Address, 15 November 2010, NZX2422/3.

How did it happen?

+ Pike’s safety culture
+ The likely cause of the explosions
+ Regulator oversight at Pike River

CHAPTER 13

Pike's safety culture

Workplace culture

What is safety culture: is it tangible?

1. In considering safety culture, Neil Gunningham and David Neal, in their 2011 review of the Department of Labour (DOL)'s interactions with Pike River, stated that it was 'exceptionally difficult for the inspectors to address issues of safety culture', since their occasional visits provided only a snapshot and 'they were not equipped to investigate complex issues of safety culture (or the lack of such a culture), which are largely intangible and do not lend themselves to ready investigation'.[1] Dr Kathleen Callaghan strongly disagreed with the latter part of this statement. In her view the published literature shows that safety culture is not intangible, and that it may be evaluated. Moreover, she believed that for the commission 'to dismiss safety culture as too complex and intangible [would be] to ignore a core element of the disaster at Pike River'.[2]

2. This difference of opinion suggests the need to define what is meant by culture. The commission has found a discussion by Andrew Hopkins helpful.[3] He suggests that two common understandings about culture centre on 'mindset', and on 'the way we do things around here'. 'Mindset' involves a focus on individual values, while 'the way we do things' concerns collective behaviour. There is no conflict between the two ideas; rather they reflect a difference of emphasis. Both, in fact, go to make up culture – the way in which people both think and act.

3. Hopkins, however, stresses the importance of organisational practices because individual attitudes are more difficult to determine and unlikely to be capable of modification in a workplace unless the environment is conducive to change. James Reason suggests that the key may be conscious attention to safety systems and practices, in particular 'a safety information system that collects, analyses and disseminates the knowledge gained from incidents, near misses and other "free lessons"'.[4]

What organisational practices measure culture?

4. Operators in a high-hazard industries must establish structures that enable a response to the unexpected. These structures include safety, reporting, auditing, training and maintenance systems.[5] They require resources, which should be allocated at governance level. This essential leadership from the top begins to set the cultural tone.

5. A safety conscious organisation needs to involve people at all levels: management, supervisors and workers at the coal face. Take methane control, a critical safety concern in an underground coal mine. Methane levels must be monitored throughout a mine on every shift. This requires the input of many people, from miners using portable gas detectors to control room operators who receive periodic methane readings from fixed sensors. Management must establish systems to assess this data to determine whether there is a hazardous trend and, if so, decide on the appropriate response.

6. The methane readings, however, are backward-looking indicators. Equally important are forward-looking indicators, which test the worth of the monitoring regime itself. There must be verification that portable detectors are readily available and accurate, and that there are enough fixed sensors in appropriate positions and that their calibration and accuracy are assured. This requires the involvement of operational planners, managers, electricians and technicians, who test and report on the monitoring system. Ongoing review and verification of the system's adequacy are also necessary as the mine grows and develops.

7. An assessment of the methane monitoring systems and practices, including the resourcing provided, the level of reporting, the response to data, the testing of devices, and the ongoing review and oversight of the system as a whole, will provide a valuable insight into the organisational culture.

A number of cultural influences

8. Organisational culture is not one-dimensional. A mixture of behaviours and attitudes is to be expected in a workplace, and particularly in a large and diverse organisation like Pike. Nor will the cultural influences be consistent, or all point in a single direction. Other chapters identify a number of cultural strands that existed at the mine.

An environmental culture

9. Pike had a strong environmental culture. When the company received an award from the Department of Conservation (DOC) in September 2008, the minister of conservation shortly afterwards described the mine as a 'showcase development'.[6] Pike not only met the environmental requirements of its access agreement with DOC, but also initiated predator control programmes over and above its contractual obligations.

Production before safety

10. Coal production is, of course, the core objective of a mining company. But this imperative remains subject to an employer's statutory obligation 'to take all practicable steps to ensure the safety of employees'.[7] The commission considers that the way in which hydro mining began at Pike indicates a culture that put production before safety.

11. Chapter 12, 'Hydro mining', discusses the reasons for this conclusion. They include locating the panel next to pit bottom, beginning coal production before a second outlet from the mine was developed, introducing hydro mining without completing a comprehensive risk assessment process, not adequately understanding the roof strata, proceeding before the ventilation fan was commissioned, widening the panel despite a geotechnical deficit, and failing to reassess the operation in light of methane issues and the collapse of the goaf on 30 October 2010.

12. In addition, Pike had no previous experience in hydro mining, and used a largely inexperienced workforce and a co-ordinator who was neither qualified nor confident in the role. The Pike board approved a hydro-mining bonus payable to workers if a production target was met by a defined date, after which the bonus reduced progressively each week. These factors, in combination, compel the commission to conclude that, in September 2010 as hydro mining began, the pressure for production overrode safety concerns.

Recklessness underground

13. Chapter 6, 'The workforce', considers workforce matters, including the inexperience of many of the miners and the low ratio of experienced to inexperienced men in the crews. A witness with almost 40 years' mining experience, who was trained in an English colliery, recounted safety incidents at Pike that he attributed to a gung-ho attitude underground. Inexperienced workers could be overconfident, failed to understand how their actions endangered others and did not treat mining with respect.[8] He attributed these problems mainly to the experience ratio, saying that there were too few experienced miners to set and maintain the required standards.[9]

14. The commission accepts this opinion. It is supported by the evidence of contraband and bypassing incidents, conduct that seems inexplicable if viewed in isolation. There was clearly an attitude of recklessness in at least some quarters of the workforce.

The response to safety information

15. Many catastrophic accidents are preceded by situations in which warning signs are normalised, dismissed as intermittent or simply ignored.[10] At Pike, however, a lot of safety information was not assessed at all. It simply remained unnoticed in the safety management system.

16. These aspects are discussed in Chapter 7, 'Health and safety management'. Throughout the commission's hearings, witnesses disavowed knowledge of methane spikes, ventilation problems and a host of other signs that suggested all was not well underground. A repeated refrain from witnesses was that no one drew this or that report or data to their attention. Pike's safety management system lacked an essential component – procedures that made specific people responsible for collecting, assessing and responding to safety information. Nor was there a functioning process for communicating information to everyone on a need-to-know basis.

Was health and safety management taken seriously?

17. As Pike's health and safety manager told the commission, his brief from the company was to develop a world-class health and safety management system. Much time and effort was devoted to putting in place what was seen as a best practice system. Documents were drawn up, systems were prescribed and training programmes established.

18. But, as discussed in the chapters on health and safety management and the critical mine systems, commitment from others was lacking. The board and executive management did not lead the process. Most documents remained in draft, and many were not followed anyway. Systems were set up, but were not used as intended. Safety information was not well monitored, and internal and external review of the system was very limited.

19. Ultimately, the worth of a system depends on whether health and safety is taken seriously by everyone throughout an organisation; that it is accorded the attention that the Health and Safety in Employment Act 1992 demands. Problems in relation to risk assessment, incident investigation, information evaluation and reporting, among others, indicate to the commission that health and safety management was not taken seriously enough at Pike.

The risk of an explosion

20. Did culture affect the ability of decision makers at Pike to appreciate the risk of an explosion? A culture that put short-term production before safety as hydro mining began could well affect the ability to appreciate an explosion risk as well. The following aspects are also relevant to this question.

The emergency response management plan

21. This plan was prepared in 2009, and signed off by Peter Whittall as general manager. Section 6.5 of the plan described emergency response actions with reference to six emergency situations: earthquake, flood, pipeline rupture, major slope failure, underground fire, and explosion and outburst.

22. The risk posed by explosion and outburst was described at 6.5.6 in these terms:

> *The risk of outburst is considered as being low at PRCL [Pike River Coal Ltd] and gas build up is minimised via ensuring that ventilation is maintained at a level considered to be of sufficient quantity to dilute the methane content to more acceptable levels. Gas drainage is also conducted via in-seam drilling to pre-drain ahead of workings to further reduce the potential of outburst occurring and to reduce the gas make in active workings. Stone dusting practice is also maintained to reduce the risk of coal dust explosion potential. The use of hydro-extraction will minimise the risk of frictional ignition in the main coal extraction panels.*[11]

23. This is an optimistic assessment of the risk posed by an underground explosion. It assumes that good ventilation and in-seam drilling to reduce the gas make will prevent a methane accumulation. It anticipates only one potential ignition source, frictional ignition, an unlikely source during hydro mining. Given that Pike River was a gassy mine located in a region with a history of methane tragedies, the commission regards the description of the risk profile as understated.

An indifference to methane spikes

24. Chapter 10, 'Gas monitoring', contains a review of methane monitoring at the mine, including reference to the prevalence of methane spikes in the period from 1 October to 19 November.[12] Employees must be withdrawn from

a mine when the volume of flammable gas in the general body of air is 2% by volume,[13] and methane becomes explosive at a level of 5% in air.

25. Despite a paucity of well-positioned fixed methane sensors at Pike River, there were still numerous methane readings that provided ample warning of regular high methane accumulations in the period before the explosion. Deputies using hand-held detectors reported readings of 2% or higher on 48 occasions in 48 days, and 5% concentrations on 21 occasions. Readings of 5% were also routinely recorded in the hydro panel return, and the mine's remote monitoring system logged four methane readings of 2.5% or more in the final 26 days.[14] Together, these readings provided a graphic illustration of the extent of this problem.

26. The mine manager, Douglas White, was asked whether this evidence indicated that the occurrence of methane spikes had become 'normalised' at Pike River, to which he responded not normalised but 'certainly something that was happening frequently, more frequently than was desired.'[15]

Disbelief on 19 November 2010

27. The explosion occurred at 3:45pm. All reporting and communications from the mine ceased immediately. At 4:26pm, 41 minutes after the explosion, Mr White finally authorised a call to emergency services. By then, Mattheus Strydom had been into the mine and had confirmed that an explosion had occurred.

28. In Chapter 16, 'Search, rescue and recovery', the commission finds that the loss of power and of telemetric reporting from underground, and the absence of response to calls from the control room, were unprecedented and indicated a serious situation that should have been recognised straightaway.

Witness accounts of the perception of risk

29. In giving evidence Messrs White, Stephen Ellis and Whittall each indicated their perception of the risk of a methane explosion. Mr White, questioned about using the vent shaft as an escapeway and whether this was of concern, replied, 'I think it's fair to say that having never actually considered the possibility of the mine blowing up … it was not a matter that overly concerned me.'[16]

30. Mr Ellis, asked about confusion in the first few hours of the emergency response, responded, 'I've heard various statements around chaos, people running around and so on, and I would certainly argue against that … [but] it was hectic, it was busy. We don't expect an explosion of that magnitude at a mine site.'[17]

31. Finally, Mr Whittall was asked whether he had ever contemplated an explosion. He gave a long answer, which included these words: 'you always hope for the best and plan for the worst. … What I would say is that the – I would not expect rather than contemplate an explosion occurring …. So to say that it wasn't contemplated, not at all. The emergency response management plan was there for that. I had managed mines that had had explosions in them. I was familiar with explosions, Moura, many others.'[18]

32. In fact the emergency response management plan essentially discounted the risk of an explosion. The plan and the responses by the witnesses indicate a lack of appreciation of the explosion risk at Pike River, despite the history of methane explosions in mining and methane issues at Pike River.

Conclusions

33. The commission considers that as at November 2010, the emphasis placed on short-term coal production so seriously weakened Pike's safety culture that signs of the risk of an explosion either went unnoticed or were not heeded.

ENDNOTES

[1] Neil Gunningham and David Neal, Review of the Department of Labour's Interactions with Pike River Coal Limited, 4 July 2011, DOL0100010001/131, para. 471.

[2] Kathleen Callaghan, witness statement, 31 October 2011, FAM00042/55, para. 205.

[3] Andrew Hopkins, Failure to Learn: The BP Texas City Refinery Disaster, 2008, CCH Australia Ltd, p. 141.

[4] James Reason, 'Achieving a Safe Culture: Theory and Practice', Work and Stress, 1998, Vol. 12, No. 3, p. 302.

[5] Andrew Hopkins, Failure to Learn, p. 145.

[6] Pike River Coal Ltd, Activities Report: Quarter ended 31 December 2008*, DAO.008.04847/1.

[7] Health and Safety in Employment Act 1992, s 6.

[8] Albert (Alan) Houlden, witness statement, 14 November 2011, FAM00053/8, para. 39.

[9] Ibid., FAM00053/11–12, paras 58–61.

[10] Andrew Hopkins, 'A Culture of Denial: Sociological Similarities between the Moura and Gretley Mine Disasters', Journal of Occupational Health and Safety – Australia and New Zealand, 2000, Vol. 16, No. 1, pp. 29–36.

[11] Pike River Coal Ltd, Emergency Response Management Plan, 20 February 2009, DAO.001.08110/39.

[12] Chapter 10, 'Gas monitoring', para. 43.

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

[14] Chapter 8, 'Ventilation', paras 140–141, 143.

[15] Douglas White, transcript, p. 4945.

[16] Ibid., p. 1259.

[17] Stephen Ellis, transcript, p. 2228.

[18] Peter Whittall, transcript, p. 2791.

CHAPTER 14

The likely cause of the explosions

Introduction

1. The commission is required to report on the cause of the explosions at Pike River on and after 19 November 2010. Because the mine has not been re-entered, the cause of the first, and subsequent, explosions can be based only on the evidence available without a scene examination.

2. The commission accessed work undertaken by a team of investigators and a panel of experts established by the Department of Labour (DOL).[1] The panel was co-ordinated by David Reece, a Brisbane-based mining consultant with a wealth of experience in mine management, mine inspection and advising the mine industry. The other panel members are Professor David Cliff, an expert in gas analysis and mine explosions, Dr David Bell, a mining geologist, Tim Harvey, a ventilation engineer, and Anthony Reczek, an electrical engineer. In October 2011 the panel provided the department with a report on the nature and cause of the first explosion. In February 2012 the investigation team leader, Brett Murray, and Messrs Reece and Reczek gave evidence at a commission hearing. The commission acknowledges DOL's co-operation in making the main investigation and the expert reports available and also in providing oral evidence.

3. Determination of the cause is complex. As will be seen, the commission is confident that the explosions were caused by the ignition of methane. But to determine why and where they occurred required expert analysis and assumptions. One of the most important estimates the experts had to make was the volume of methane that ignited; this then allowed the circumstances surrounding the explosion to be inferred. Estimates of the amount of methane varied depending on the assumptions adopted.[2]

4. The following discussion about the causes of the explosions is not intended to be definitive. If, and when, the mine is re-entered, any conclusions about the causes of the explosions will need to be re-evaluated.

The cause of the first explosion

Activities in the mine on the day

5. The DOL investigation report contains a close description of the mine workplaces and an intricate analysis of all known events that occurred during the morning shift and into the afternoon shift on 19 November.[3] The following discussion does not replicate this level of detail, but reviews the essential facts.

6. On the afternoon of 19 November there were eight places in the mine where workers were engaged in different activities. These areas are best explained by reference to a mine map drawn to indicate the last-known position of all the men underground at 3:45pm.

The ABM20

7. The ABM20 continuous miner was driving a roadway at the north-west extremity of the mine. An eight-man morning crew cut 3m of new roadway during the shift. Progress was slow because branches of an in-seam borehole were intersected, resulting in methane emissions that caused the continuous miner to trip out. Readings of up to 3.5% methane were recorded in the general body of air, until the gas was dispersed using a typhoon fan and the transected branches of the borehole were plugged.

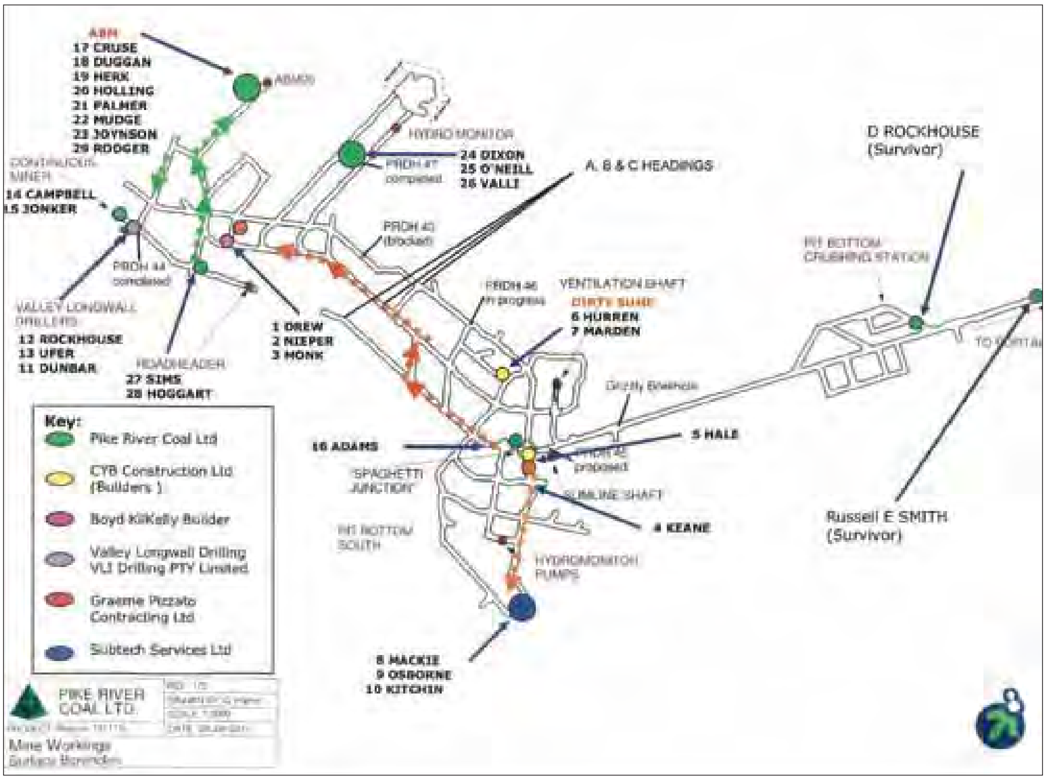


Figure 14.1: Last known position of the 29 deceased and two survivors[4]

The three main roadways running in parallel from pit bottom in a north-westerly direction are known as headings A, B and C from the bottom of the plan, with A heading still incomplete.

8. At 12:20pm mining ceased because fluming water to carry coal from the face was lost owing to a planned shutdown. The afternoon crew reached the face about 2:00pm, and were stocking up the ABM20 and carrying out roadway maintenance while waiting for mining to recommence. Some men may have begun stone dusting or been on a crib break at 3:45pm. Mining could not have resumed because the fluming pumps were still in start-up mode at the time of the explosion.

The roadheader

9. The roadheader was located in A heading, mining in an easterly direction to link up the two branches of this heading. The morning shift experienced some methane layering, although the air readings were steady at 0.8% up to 1:00pm. A fan was operated to control the methane level.

10. The afternoon crew was undermanned, so the roadheader was not scheduled to work until Monday 22 November. Two men moved the roadheader back from the face to ready it for operation after the weekend. It is unclear whether they were still at the roadheader at the moment of the explosion.

Continuous miner CM002

11. This machine was located in a stub at the western end of A heading, but had not been operational for some time and was being serviced on 19 November. Two men, an engineer and a fitter, were working on the machine during the afternoon. Daniel Duggan, the control room operator, was speaking to Malcolm Campbell, the engineer, at the time of the explosion. Gas readings taken at this location during the day were unremarkable.

VLI Drilling Pty Ltd drilling rig

12. This in-seam drilling rig was at drill stub 3 near the western end of A heading. The two-man crew began a day shift at 7:00am. The night shift experienced a malfunction with the drilling rig, as a result of which the connection to 16 drilling rods in the borehole was lost. The day shift endeavoured to reconnect to the rods and retrieve them. Whether they succeeded is not known. An observer, who was to start work the next week, was also with the crew that afternoon.

13. Gas readings, and a measure of the methane flow rate from the borehole taken during the morning, were normal for a drilling rig stub.

Cross-cut 4, B–C headings

14. Three contractors were working a day shift in an inbye cross-cut between B and C headings. They were constructing a board and brattice stopping required for ventilation control. Comparatively little was observed of their progress during the day. By 3:45pm they may have finished work in preparation for catching the 4:00pm taxi out of the mine from Spaghetti Junction.

The hydro-monitor panel

15. The three-man hydro-mining crew began a 12-hour shift at 7:00am. The night shift had experienced a water leak while operating the monitor. However, the day shift used it to cut coal until 12:20pm, when the supply of fluming water to the mine was halted. Little was seen of the crew throughout the day, but they likely used the downtime to undertake maintenance work, including fixing the monitor leak. The three men were probably in the hydro panel at the time of the explosion. Video footage obtained via a drill hole into the hydro panel cross-cut (PRDH47) confirmed the presence of one body in that location.

The dirty water sump heading

16. Two contractors were working in this heading using a bucket excavator, known as a brumby, to excavate an area in readiness for the construction of a concrete sump. This machine did not have a fixed methane detector or an automatic shutdown system, and nor did the men remember to take a portable gas detector with them into the mine. At 3:45pm the men may still have been at work in the heading, or preparing to leave on the 4:00pm taxi.

Pit bottom south

17. Four contractors were working a day shift installing a water pipeline at this location in the southern extremity of the mine. The contractors used a dump loader to cart and dump excavated material at the grizzly. The machine broke down several times during the day and was last seen at Spaghetti Junction where the operator, Riki Keane, was working on it. It is not known whether the other three contractors remained at their workplace at 3:45pm or were en route to catch the taxi.

Four workers in transit

18. An underviewer, Conrad Adams, drove a driftrunner into the mine at 3:15pm and was last seen near Mr Keane's broken-down dump loader. The taxi driver, John Hale, was also in the Spaghetti Junction area ready to take miners and contractors out of the mine at 4:00pm.

19. Daniel Rockhouse was a member of the ABM20 afternoon crew, but at the time of the explosion he was parked at pit bottom in stone, refuelling a vehicle. Russell Smith was late for work and driving inbye up the drift at the time of the explosion.

The fuel consumed in the first explosion

What was the fuel type?

20. An explosion is a violent release of energy resulting from a rapid chemical reaction, which produces a pressure wave, substantial noise, heat and light. An explosion requires an explosive fuel source, oxygen and contact with an ignition source.

21. Methane occurs naturally in coal seams and is released by mining activity. It is explosive in the range of 5–15% methane in air. The coal measures at Pike River had a gas content of approximately $8m^3$/tonne of coal. The gas composition of the seam was at least 95% methane, with small quantities of carbon dioxide and ethane.[5] Methane

was the suspected fuel source as soon as the explosion occurred.

22. The other possible fuel type was airborne coal dust, although wet mining conditions at Pike River suggested it was not likely to be the primary fuel source. It could, however, have been a minor contributor to a methane-fuelled explosion.

23. Professor Cliff analysed the results of gas samples obtained from about 9:00pm on 20 November, principally from the top of the fan shaft. The ratio of gases found in these post-explosion samples is 'consistent with methane being the primary cause of the first explosion'.[6]

24. The only potential evidence that implicated coal dust as a contributor to the explosion was some coking located at the exhaust infrastructure at the top of the vent shaft. Samples were sent to the University of New South Wales for analysis, specifically to establish if coking had occurred. If it had, this would indicate the conversion of coal dust into coke as a result of explosion temperatures. Only a very small percentage of coked particles were found, consistent with a minor involvement of coal dust, if any. Coal dust explosions are extremely violent and the first explosion at Pike River was sluggish. The joint investigation expert panel concluded that it was a methane explosion.[7]

What quantity of methane?

25. To determine the source of the methane consumed in the explosion, the panel first assessed the likely volume of methane required to produce an explosion of the kind recorded on the portal closed circuit television (CCTV) footage. This footage was the starting point from which to work back and endeavour to extrapolate the initial methane volume.

26. The blast exited the portal for approximately 52 seconds,[8] with most energy expended in the first 30 seconds. The cross-sectional area of the stone drift at the portal was approximately $22m^2$. To estimate the velocity of the blast, the speed at which debris passed through the 7.5m field of vision of the camera was calculated. The camera recorded four frames per second and debris cleared the field of vision in less than one frame. This indicated a blast velocity greater than 30m/s (metres per second) and within a range up to 70m/s.[9]

27. The expert panel's analysis of the blast enabled the volume of gas ejected at the portal to be estimated. Then followed the extrapolation process:

Explosion products ejected at the portal	30–70,000m^3
Double this for a similar volume of products ejected at the vent shaft	60–140,000m^3
Divide by 5 (the assumed expansion factor of the explosion) to establish the volume of mine atmosphere which exploded	12–28,000m^3
Reduce explosive mine atmosphere volume to 5% (the lower limit of the explosive range of methane) to establish the minimum volume of methane consumed in the explosion	600–1400m^3.

28. However, the expert panel concluded that the methane consumed in the explosion was more likely to be at least 1000m^3, and possibly a much higher amount. This reflected the high concentration of carbon monoxide in the post-explosion gases, as confirmed by the two survivors' prolonged loss of consciousness and the analysis of early samples from the vent shaft. High post-explosion concentrations of carbon monoxide indicate a fuel rich explosion.[10]

Some revised thinking

29. In light of points raised in the cross-examination of Mr Reece, and following subsequent discussions between experts, Professor Cliff revised some aspects of his explosion calculations. He discussed these aspects in a transcribed telephone conference on 13 March 2012, to which an expert adviser to the commission, Darren Brady of Queensland's Safety in Mines Testing and Research Station (SIMTARS), contributed.

30. The first change related to the methane content of the first explosion. After discussion and consulting experts from the United States, Professor Cliff (supported by Mr Brady) concluded that it was likely the explosion consumed even more than 1000m^3 of methane. Although the pressure wave at the portal was significantly long, the explosion was not particularly powerful; rather it was slow and weak. It was also described as a 'deflagration' (explosive burn), rather than a 'violent detonation'. This supported a methane rich mixture greater than 10%, and perhaps approaching the upper limit of the explosive range, 15%.[11]

31. The previously adopted expansion factor of five was also revised. Discussion with other experts led Professor Cliff and Mr Brady to conclude that the expansion factor could have been as low as two and was not likely to be as high as five. A lower expansion factor indicated that the volume of the explosive atmosphere in the mine was likely to be larger than previously thought, in order to still produce the gas volume.

32. The combination of the two factors, a higher methane concentration and an increased volume of explosive atmosphere, pointed to an even larger methane volume than the previously favoured 1000m^3. In the course of the discussion, Professor Cliff favoured 2000m^3 of methane as the upper end of the likely range.[12]

Possible sources of the methane

The goaf

33. The expert panel concluded that there were few potential locations within the mine capable of producing the required volume of methane. One possible location was the hydro panel goaf.

34. Hydro mining at Pike River had created an irregular goaf approximately 30m wide, 40m deep and up to 9m high. The void volume was approximately 6000m^3. The goaf was not ventilated. Methane would have continued to bleed from the coal seam into the goaf.[13] It also contained an in-seam borehole drilled to explore the limits of the seam and also pre-drain methane. The borehole had been intersected during hydro mining, and therefore provided an additional potential source of methane.[14] The diagram below illustrates the area of the goaf (top right corner) and the intersecting borehole. The gas drainage lines are marked in red.

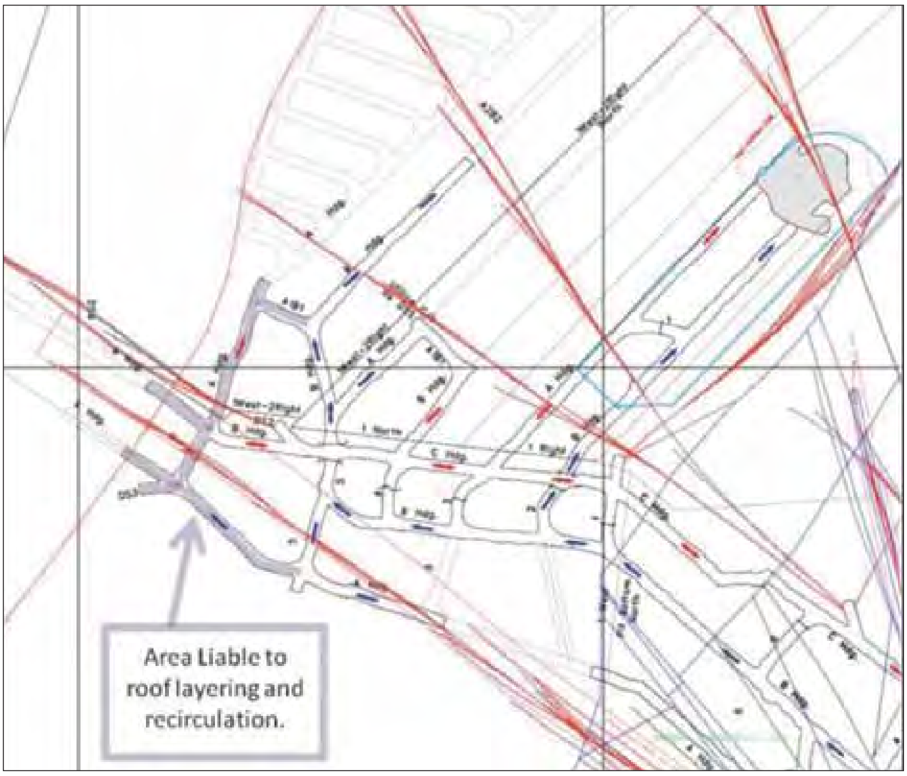


Figure 14.2: The area of the goaf and the intersecting borehole[15]

There was also a rider seam above the goaf which, after disturbance of the roof strata during mining activity, could leach further methane into the goaf.

35. The panel considered that up to 5000m^3 of methane could have built up in the goaf.[16] Methane is buoyant and would not move unless disturbed and flushed out during mining or expelled by a significant roof fall. The goaf was unsupported, so strata failure and roof falls were to be expected. Indeed, the mine had experienced a large goaf fall in October, and a flushing out of methane by the monitor during mining on 17 November. Both events expelled significant volumes of methane into the adjacent roadways.[17]

36. In cross-examination, Mr Reece was asked whether a drillhole into the goaf would confirm the occurrence of a roof collapse large enough to have expelled the required volume of methane, but his answer demonstrated that this is a highly problematic issue.[18]

37. The expert panel favoured the goaf as the most likely source of the methane and a roof fall as the likely expulsion mechanism.[19]

Three explosion scenarios

38. The expert panel suggested three potential ways in which an explosive atmosphere of between 5 and 15% methane in air may have formed to become the fuel source consumed in the explosion. Scenarios one and two implicated the goaf, with methane emitted by a goaf fall as the initiating event, but with different transmission paths outside the hydro panel as the methane was diluted to within the explosive range. The difference between these scenarios was one of degree. The third scenario, however, envisaged a layered accumulation of methane in the western working areas of the mine.

39. Scenarios one and two are best explained by reference to the following diagram.

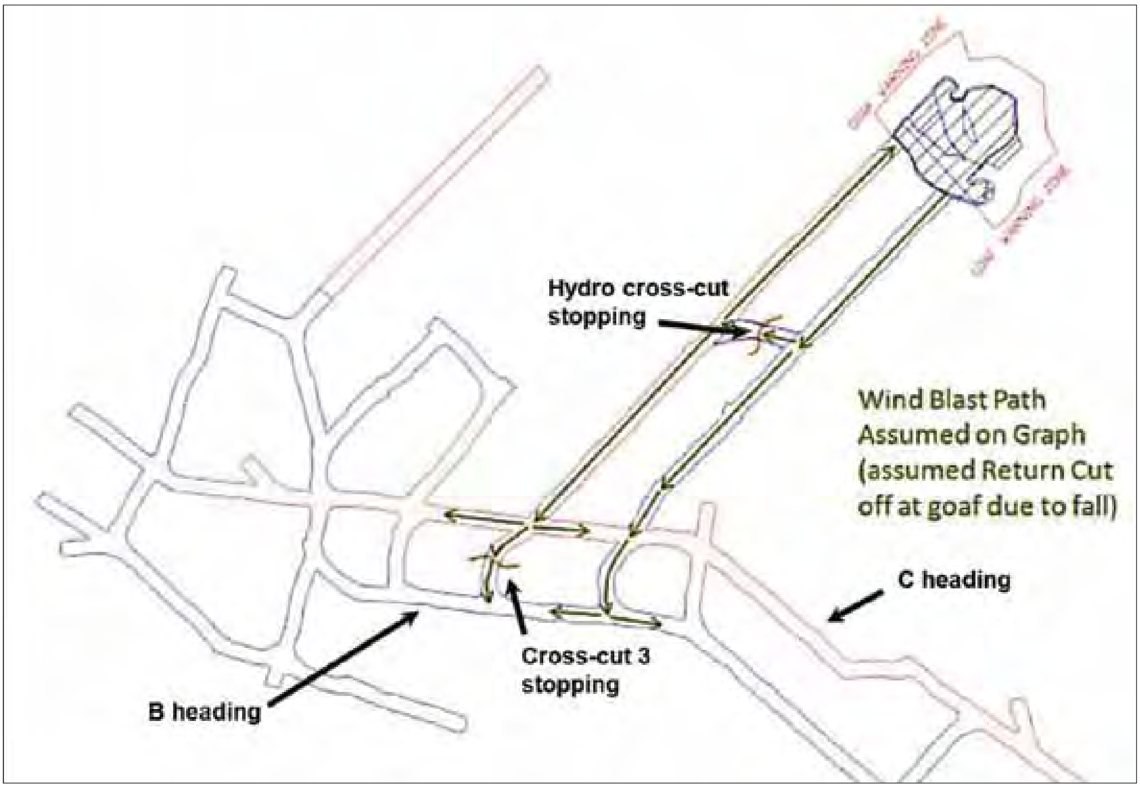


Figure 14.3: Gas flow path due to goaf fall[20]

40. The expert panel assumed that the return roadway from the hydro panel (left side of the diagram) would have been 'cut off at the goaf due to (the roof) fall'. Hence, the diagram depicts only methane expelled along the intake roadway (right side of the diagram) as far as B heading, and then flowing both inbye and outbye. In addition, it was thought that methane would be forced into the hydro panel cross-cut, would breach the stopping in this cross-cut

and travel in both directions along the return (left-hand) roadway. The southern flow was assumed to have crossed heading C, then breached the stopping in cross-cut 3 to reach B heading.

41. The difference between the two scenarios appears to lie in the extent of the methane spread. In scenario one the methane was more localised, while scenario two contemplated a greater spread of methane, including inbye towards the working areas of the mine.[21]

An inbye gas accumulation

42. The third, and 'less likely', scenario was a gas accumulation centred in the most inbye and western area of the mine, where the two continuous miners, the roadheader and the in-seam drilling rig were located. This area is depicted in Figure 14.2 and labelled 'area liable to roof layering and recirculation'. There had previously been ventilation and gas management problems in this area, which triggered the shutdown of machinery and the initiation of various methane control measures. In giving evidence, Mr Reece said scenario three was considered less likely because of the significant volume of methane required, which experienced workers, and statutory officials, should have detected and reacted to.[22]

Difficulties concerning the possible sources of the methane

43. The commission considers that there are some contentious issues relating to the source of the methane.

44. First, the CCTV footage showed that the blast at the portal was variable, being at its strongest for only the first 30 seconds. This variation, however, was not taken into account in calculating the volume of gas emitted. Mr Reece explained that the fall off in the pressure wave could affect the calculation of methane consumed in the explosion.[23] Second, in arriving at the total volume of gas expelled by the explosion it was assumed that equal volumes were emitted from the portal and up the vent shaft. Again, Mr Reece explained that a lesser volume may have been ejected from the vent shaft, given its smaller dimensions and the absence of video evidence at this location.[24]

45. In a working paper dated 16 September 2011 Professor Cliff included a schedule of times recorded on various of the mine's systems in relation to the explosion, including a time reference: '15.45.36–15.46.22, explosion visible at portal for this duration – 47 seconds'.[25] Although only a difference of five seconds, this shortening of the duration of the blast would still reduce the methane volume required to produce the explosion. It is apparent, when viewing the CCTV footage, that assessment of the exact duration of the blast is no easy matter; a value judgement is required.

46. Lastly, Mr Brady pointed out that the standard dimensions of the mine roadways were 5m by 3.5m,[26] although these exact measurements were not consistently achieved. An explosive atmosphere volume of 12,000m^3, for example, would occupy between 686 and 1600m of standard roadway. This represents a significant distance in a small mine, which may suggest that the explosive atmosphere consumed in the explosion was not as voluminous as the panel calculated.

The source of ignition

The amount of energy required

47. Mr Reczek described methane as 'very easily ignited' by an ignition source that is 'intimately engaged', or comes into contact, with the fuel source.[27] The actual energy requirement to ignite methane at its most explosive point (9.8% of methane in air) is 0.29 millijoules. This means that a wristwatch battery has 'many times the amount of energy' required to ignite methane (hence the prohibition on using battery-powered watches underground).[28]

48. The expert panel identified a range of potential ignition sources. The most favoured was an electrical ignition at any one of numerous points in the mine's electrical infrastructure.

A timing coincidence

49. The supply of fluming water to the mine was cut about 12:20pm on 19 November owing to a planned service shutdown at the surface coal preparation plant. Very shortly before 3:45pm the plant advised Daniel Duggan, the control room operator, that the water supply was back on. He switched on the number one fluming pump and made a call to the working faces, using the digital access carrier (DAC) system. Malcolm Campbell, the shift engineer who was repairing a continuous miner at the most western inbye point of the mine, answered the call, but communication to the mine was lost as the two men were speaking. Simultaneously, all telemetric reporting from the mine to the control room also stopped.[29]

50. Data subsequently obtained from the mine electrical system confirmed that the start-up signal from the control room initiated the number one fluming pump start-up sequence at between 3:45:14pm and 3:45:18pm (GPS time). Seconds later, at 3:45:26pm, all power to the mine was lost when circuit breakers at the portal substation tripped.[30] The coincidence of the switching on of the pump followed so soon by an explosion persuaded the expert panel that an electrical cause was the most likely ignition source.

Potential electrical sources

51. The timing coincidence, coupled with some operational problems in the lead-up to 19 November, resulted in a focus on variable speed drives (VSDs) installed in the mine. VSDs enable fixed speed motors to operate at continuously variable speeds. By varying the frequency of the power supply to a motor, VSDs can achieve a softer start-up process with a consequent power saving. And by varying the operating speed of the motor to match its output demand, further savings and improved performance are achievable. VSDs were installed underground at Pike River in conjunction with the main ventilation fan, and pump, motors.

52. However, in varying the frequency of the power supply, VSDs can cause an electrical waveform distortion, termed harmonic distortion. Harmonics are a normal characteristic of a VSD's operation. The distorted waveform can flow back into the power supply grid and into the motor, and from there into the mine earthing system.[31] Harmonics may also flow into metal works, such as a pipeline, that are connected to electrical equipment powered by a VSD.[32]

53. Mr Reczek considered that 'harmonic currents flowing in the earth circuits of the underground power supply would be capable of generating incendive sparking across any mechanical surface connection in the earth circuit'.[33] This incendive sparking, also termed arcing, could 'basically light the entire electrical system up like a Christmas tree' and produce sufficient energy to ignite an explosive methane mixture, should there be one at the point of an arcing.[34] Mr Reczek stated the phenomenon of arcing occurred in many underground coal mines when machines made contact, causing shocks to men who were in contact with mobile machinery and the ground.[35] This risk extended to metal infrastructure connected to a VSD-powered motor, and could, in Mr Reczek's view, have caused arcing anywhere on a pipeline, for example, particularly at a joint.

54. Mr Reczek was supplied with correspondence and other documents relating to the underground electrical installations at Pike River. He considered that technical issues raised in the documents indicated a heightened risk from harmonics.

55. Loadflow studies suggested to Mr Reczek that the main power supply to the mine was insufficient to meet the demands of the underground fans, pumps and other electrical installations. A soft power supply may cause motors to achieve less than their specified output, leading to overheating, 'hot joints' at connections to conductors and drive instability.[36] In these circumstances, VSDs also produce higher currents in an attempt to compensate for the inadequate power supply, and higher currents are a cause of increased harmonics.[37]

56. Documentary evidence confirmed that overheating and instability had affected the main fan and the monitor pump at Pike River.[38] Mr Reczek also highlighted harmonic analysis reports,[39] which showed high levels of waveform distribution and in areas of the mine where this should not have been found.[40]

57. He also relied on photographs that he concluded showed physical evidence of arcing.[41] These depicted pitting caused by arcing to the metal surface of a component of the methane sensor located near to the surface in the vent shaft, but connected to the underground power supply.

58. Before the explosion, the VSD driving the motor of the main fan was replaced because of a circuit breaker problem that caused intermittent tripping of the fan.[42] Other VSDs were also to be replaced by the supplier at a cost of $140,000 because of various failures, including the failure of pre-charge resistors.[43]

59. Although his evidence contained a considerable emphasis on harmonics, Mr Reczek considered that arcing was only a 'potential' ignition source at Pike River. He acknowledged that the lack of access to the VSD units in the mine, limited information about the way electrical equipment was installed and the non-availability of information following the forensic analysis of the failed resistors in the United States all limited the weight that should be placed upon his opinions.[44] Indeed, in another answer, Mr Reczek described his report as 'incomplete' because it involved 'drawing conclusions or inferences, if you like, based on information which is available [but] which isn't conclusive.'[45]

Rockwell Automation (NZ) Ltd

60. This company supplied the Powerflex 700L model VSDs installed at Pike River, and the replacement 700H model for the main fan. The company filed an institutional statement with the commission in which it strongly disputed Mr Reczek's views concerning harmonics. Although Rockwell sought and was given interested party status at an early stage, it did not actively participate in the inquiry until the commission drew its attention to Mr Reczek's witness statement.

61. Rockwell described Mr Reczek's conclusions as 'implausible.'[46] It maintained that he had not taken account of modern VSD technology, which ensures:

> *VSD Input voltage and current waveforms contain very little low frequency harmonics due to active wave shaping of the line current with embedded AC line filters. Modern VSD input voltage and current waveforms meet IEEE [Institute of Electrical and Electronics Engineers] standards which therefore cannot create hot joints and possible resulting methane ignition.*[47]

62. Further, Rockwell conducted a simulation study based on the actual specifications for the number one fluming pump, a 700L model VSD and any associated componentry, including the cabling between the pump motor and the VSD. The essential conclusions reached were that a 700L model VSD generates only low-level harmonic currents, that these are contained in the cabling system and that the energy level of any stray currents going into the earthing system would be insufficient to ignite methane. Rockwell also contended that the overheating of motors at Pike River was caused by defective resistors, and that it was incorrect to attribute the overheating problem to a soft power supply, which could lead to hot joints as a potential ignition source.[48]

63. Since March 2012, when Rockwell filed its institutional report with the commission, there has been ongoing communication between it and the DOL investigation team resulting in a number of outcomes:

- DOL accepts that 'the simulation work in the Rockwell report is detailed and thorough for the cases it considers.'[49]
- However, DOL draws attention to the substitution of a 700H model VSD at Pike to power the main fan,[50] while its investigations have not revealed a sample of the actual cable used at Pike River,[51] but have confirmed the cable termination arrangements used in connecting VSDs to electric motors at the mine.[52] DOL asked Rockwell to undertake further simulation work based on a 700H model VSD, the actual Pike cable termination arrangements and, if possible, cabling of the kind described by Pike's underground electrical co-ordinator.[53] The cable and termination arrangements can affect harmonics.
- Rockwell responded that the scenarios it was requested to simulate were 'speculative', would not be of assistance and it declined to undertake them.[54]

64. There have also been four developments of relevance to the evidence Mr Reczek gave to the commission. He had understood that the number one fluming pump motor was very large, 10 times the size of the main fan motor.[55] This was not the case, meaning that the VSD starting this pump would not have generated a very high level of harmonics. In addition, it is now 'less certain' whether the VSD had actually started, or whether it remained in

start-up mode, at the time of the explosion.[56] If the latter, the scope for harmonic generation is removed, or at least minimised. Thirdly, investigators are now unsure whether there is a 'direct pipework' connection between number one fluming pump and the inbye area of the mine. The number one pump replenished the fluming water supply before another pump in the sequence pumped water inbye. This may eliminate pipework as a connection route, leaving the mine earthing system as the only path for harmonics to travel from pit bottom in stone to an inbye ignition location.[57] Finally, Mr Reczek's view that the power supply to the mine was soft has been contested by Pike's electrical co-ordinator.[58]

65. In June 2012 DOL observed that it had 'not been able to confirm or to rule out' harmonics generated by a VSD as the ignition source of the explosion. Its investigation was described as 'continuing'. When he gave evidence, Mr Reczek acknowledged the constraints he was under. The wisdom of his warning has been borne out by subsequent developments.

Other potential ignition sources

66. In addition to an electrical cause, the expert panel considered a range of different, 'less likely' potential ignition sources. These alternatives included spontaneous combustion, frictional ignitions (from metal on rock, or metal on metal, sparking), a conveyor belt heating or fire, diesel vehicle 'hot surface' ignition and ignition from the introduction of contraband into the mine.

67. Some of these potential sources were discounted for lack of evidence. For example, testing indicated that the Pike River coal seam was not prone to spontaneous combustion and there was no history of its occurrence, and that the conveyor belt was not in service at 3:45pm.

A diesel engine 'hot surface' ignition

68. The expert panel concluded that a fault in the protection system of a diesel engine could not be ruled out as the ignition source. The diesel-powered vehicles and machines used underground at Pike River were fitted with flameproof enclosures designed to prevent an overheated engine from becoming an ignition source. But component failure, incorrect settings and poor maintenance can compromise these safety systems.[59]

69. In addition, throughout Pike River's short history there were instances of the deliberate bypassing of various safety devices designed to counter the risk of methane explosions. Some incidents of this kind were recorded in statutory reports, which were subsequently summarised in a schedule compiled by the commission.[60] The schedule included several instances of interference with vehicle shutdown systems, so that an engine would not cut out in the event of an overheating.

70. This history also influenced the panel in concluding that an engine hot surface ignition remained a potential ignition source.

Contraband

71. Regulations prohibit taking any device or material likely to cause a spark or flame into an underground coal mine.[61] Devices powered by a battery (including wristwatches or cameras) must not be used underground, unless the device is fitted with an intrinsically safe battery system. Matches and cigarette lighters are also banned and smoking is of course prohibited. Aluminium cans are another contraband item, because contact between aluminium and other metals can produce sparking.

72. Again, there had been instances at Pike River of contraband both taken and used underground.[62] In particular, aluminium cans, cigarette butts and unsafe battery-powered devices featured in incident/accident reports that covered the period from August 2008 to October 2010. Although management had taken significant steps to deal with contraband, the expert panel concluded it remained a potential ignition source.

Frictional ignition

73. Although there was no mining activity at the time of the explosion, maintenance and building work was taking place. Machines, including scrapers and diggers, were being used, as were vehicles to transport workers. Frictional ignition from these activities, such as a spark caused by a metal to metal contact, cannot be ruled out. Machinery related sparks had previously been reported.[63]

The main fan

74. The main fan was located underground with its non-flameproofed motor in fresh air in the intake airway and the fan impeller in the return airway. As explained in Chapter 8, 'Ventilation', there had been sparking problems with the fan, and changes had been made, but there was an increased potential for contaminated air to reach the motor.

The site of the ignition

Introduction

75. Pike River was still in a development phase at the time of the explosion. The area of the workings was small, by comparison with a mature mine. Developed mines typically have a number of sections where coal extraction has finished, plus current working sections. Despite the small size of the mine, the information available to the expert panel was limited, meaning it could offer only an indicative conclusion about the likely ignition site.

Some indicative factors

76. The panel concluded that three factors indicated the most likely site: the absence of a reflective explosion wave, the temperature levels experienced by the survivors in the drift and the duration of the explosion wave at the portal.[64]

77. Only one pressure wave was discernible from the CCTV portal footage. Had the explosion occurred close to the inbye western side of the mine, a reflective wave at the portal would have been expected. An initial explosion wave would be transmitted through the workings and down the drift, followed soon after by a reflected wave that had hit and rebounded from the western parts of the mine.[65]

78. An explosion that emanated in the middle of the mine workings, or even outbye of this point, would not be expected to produce a discernible reflective wave. Any such effect would be absorbed or weakened by the web of roadways, intersections and cross-cuts that make up the mine workings.[66]

79. Neither of the survivors, Daniel Rockhouse or Russell Smith, experienced significant ill effects from excessive heat when the pressure wave struck them in the drift. Had the explosions occurred near to the inbye end of the drift, the expert panel expected the hot post-explosion atmosphere would have expanded well along the drift, to the point 800m outbye where Mr Smith was hit by the pressure wave. By contrast, in the panel's view, gases and heat generated by an explosion significantly inbye of the drift would be dissipated and cooled before reaching the survivors, particularly in a wet mine.[67]

80. The third factor was the duration of the explosion pressure wave at the portal. The duration of about 52 seconds was more than twice the duration of the pressure waves generated by the three subsequent explosions, all of which were more likely to have occurred at pit bottom than further inbye. The panel therefore concluded that the longer duration of the first explosion was consistent with a more inbye location, although there were other possible explanations.[68]

Explosion modelling

81. In order to verify that the explosion probably occurred inbye of pit bottom, computational fluid dynamic modelling undertaken by engineering consultant BMT WBM was used to test the panel's assumption. The model replicated the layout of the entire mine, and testing was then conducted using different figures for the volume, and the methane concentration, of the explosive atmosphere consumed in the explosion.[69]

82. Two ignition site locations were chosen: an auxiliary fan next to the intake roadway to the hydro panel and the main fan.[70]

83. The modelling suggested that an explosion located at the main fan was 'less likely', while a location further into the mine appeared 'plausible'. The modelling also indicated that a 10% methane concentration and an explosive atmosphere volume of about 25,000m^3 best matched the explosion footage. These parameters were also considered consistent with the heat exposure experienced by, and the survival of, Messrs Rockhouse and Smith, but less consistent with a blast duration of 52 seconds.

Conclusions concerning the first explosion

84. Based on the evidence available to date, and without a scene examination, the commission finds that:

- methane fuelled the explosion, with no or very little contribution from coal dust;
- the volume of methane consumed in the explosion was substantial;
- the actual volume can only be estimated, but could have been as high as 2000m^3;
- the hydro goaf probably contained approximately 5000m^3 of methane;
- a roof fall in the goaf could have expelled sufficient methane to have fuelled the explosion;
- a layered accumulation of methane in the roof of the western workings of the mine was another possible methane source, either alone or in combination with methane from the goaf;
- the ignition source remains contentious, but a number of possible sources exist, including:
  - an electrical cause, given the timing coincidence between the switching on of the fluming pump and the explosion
  - a diesel engine hot surface ignition
  - contraband taken into the mine
  - frictional ignition from activities that were continuing in the mine
  - sparks from the non-flameproofed underground fan; and
- the possible site of the ignition, and resulting explosion, was in the centre area of the mine workings.

85. Despite the level of uncertainty surrounding several aspects of this exercise, there is no doubt that a large explosive methane atmosphere existed in the mine at the moment of the explosion. This shows that methane control at Pike was not adequate. Ultimately, all explosions are a manifestation of the failure of an organisation's health and safety management system.[71]

The subsequent explosions

Introduction

86. The commission received less detailed evidence concerning the three subsequent explosions, but there was also less conjecture about their nature. Their occurrence was predicted by many of the experts gathered at the mine, who stressed the need to seal the mine to avoid further damaging explosions.

87. There were three subsequent explosions. The second occurred on Wednesday 24 November at 2:37pm, five days after the first explosion. The next explosion was on Friday 26 November at 3:39pm, after a gap of only two days. The fourth explosion was on Sunday 28 November at 1:50pm, also after a two-day gap.

88. The later explosions differed from the first. The second and third explosions had a duration of 30 and 23 seconds at the portal, respectively. Both caused a much more forceful pressure wave than that from the first explosion. Following the pressure wave, air was initially drawn into the drift and then there was a reversal or expulsion of air.[72]

89. The fourth explosion was different again. It caused a billow of black smoke, followed by a fire ball out of the vent shaft and, subsequently, flames that diminished over time, but continued to be visible until 8 December.[73]

Figure 14.4: Fire coming from the ventilation shaft following the fourth explosion[74]

The fuel type and source

90. It is clear that all three explosions were fuelled by methane. A build-up of methane in the workings was expected as soon as the ventilation system was disabled on 19 November.

91. Mr Brady provided a comprehensive overview of gas data gathered at the mine between 20 November 2010 and March 2011.[75] Samples obtained at 4:00pm on 22 and 23 November contained an explosive gas mixture, and there was a methane concentration of over 6% before the explosion on 24 November. The methane concentration rose and fell depending on the time of day, changes Mr Brady considered were related to the natural ventilation flow between the portal and the vent shaft. Predominantly the flow was up the vent shaft, but there were reversals driven by a variable pressure differential that changed according to the temperature and barometric pressure.[76]

92. In the two-day gap before the third explosion there were similar fluctuations in the methane concentration, which climbed to a high of almost 12% at one point. Following the third explosion, few samples were collected owing to damage to the sampling lines and the danger involved in re-establishing them.[77]

93. However, it can be inferred that there was a similar build-up of methane, which ebbed and flowed with ventilation changes, until an ignition source and an explosive fringe coalesced to cause the fourth explosion on 28 November.

The ignition source and the ignition site

94. The most likely ignition source for each of the subsequent explosions was 'hot coal'.[78] Following the heat generated in the first explosion, conditions in the mine were ripe for coal fires or for spontaneous combustion to occur and

provide an ignition source, leading to an explosion once an explosive atmosphere gathered and came into contact with that source.

95. The expert panel concluded that the ignition site of each of the subsequent explosions was probably close to, or a little inbye of, the vent shaft. Logically, there would be an accumulation of methane within the workings and the development of a fringe where oxygen from the natural ventilation circuit mixed with the methane rich atmosphere to reduce it to within the explosive range. When a hot coal ignition source and an explosive atmosphere combined, each of the further explosions occurred.

ENDNOTES

1 This work was part of the joint investigation, but DOL led the explosion analysis aspect.

2 Including (1) the estimated velocities and quantities of gas ejected at the portal; (2) the volume of gas ejected through the ventilation shaft; (3) the percentage of methane (somewhere between 5 and 15%) in the air when ignition occurred; (4) the expansion factor of 5, being how many times the volume of flame was greater than the original explosive mix; (5) the assumed location of the ignition; (6) the dimensions, area and resistance of the mine's roadways; and (7) the path taken through the mine by the explosion.

3 Department of Labour, Pike River Mine Tragedy 19 November, 2010: Investigation Report, [2011], DOL3000130010, pt. 2, sections 3–4.

4 Department of Labour, Last Known Position of Deceased and Two Survivors. Final Version, 28 January 2011 (DOL Investigation Report, Appendix 3), DOL3000130004/2. ('A, B, & C headings' locations added to the map by the commission).

5 Darren Brady, Review of Gas Data Following Pike River Explosion 19th November 2010: For New Zealand Police – Operation Pike, 5 May 2011, SOE.008.00001/14.

6 David Reece, witness statement, 2 February 2012, DOL3000150001/8, paras 29–30.

7 David Reece, transcript, pp. 4454–56.

8 See para. 45 for discussion concerning the accuracy of this time duration.

9 The upper limit of the range was viewed as consistent with the evidence of Russell Smith, who survived the blast 1500m inbye of the portal and suffered significant deafness, but not ear drum damage: David Reece, witness statement, DOL3000150001/10, para. 36.3.

10 David Reece, transcript, pp. 4458–60.

11 Notes from Pike River Discussion, 13 March 2012, MEM0001/8, 11, 17–19.

12 Ibid., MEM0001/9.

13 David Reece, transcript, p. 4467.

14 Ibid., pp. 4467–68.

15 Department of Labour, Investigation Report, DOL3000130010/74.

16 David Reece, witness statement, 2 February 2012, DOL3000150001/11, para. 41.

17 David Reece, transcript, pp. 4465–66.

18 Ibid., pp. 4616–18.

19 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, DOL3000130007/7.

20 David Reece, DR5 – Gas flow Path Due to Goaf Fall, DOL3000150012/1. (Plan modified by the commission)

21 David Reece, witness statement, February 2012, DOL3000150001, paras 20–22.

22 David Reece, transcript, p. 4478.

23 Ibid., p. 4604.

24 Ibid., pp. 4604–05.

25 David Cliff, An Evaluation of Elements Relating to the Cause of the First Explosion at Pike River Coal Mine: Draft, 16 September 2011, DOL3000140009/33.

26 Darren Brady, witness statement, 2 April 2012, SIM0003, para. 2.5.

27 Anthony Reczek, transcript, pp. 4706, 4835.

28 Ibid., pp. 4732–33.

29 Daniel Duggan, transcript, p. 1581.

30 Anthony Reczek, transcript, p. 4733.

31 David Cliff et al., Investigation for Nature and Cause, DOL3000130007/76.

32 Anthony Reczek, transcript, p. 4792.

33 Anthony Reczek, witness statement, 7 February 2012, DOL3000160001/17, para. 60.

34 Anthony Reczek, transcript, p. 4737.

35 Anthony Reczek, witness statement, 7 February 2012, DOL3000160001/14, para. 45.

36 Anthony Reczek, transcript, pp. 4742–45.

37 Ibid., p. 4746.

38 Anthony Reczek, transcript, p. 4731; Rockwell Automation service records, iPower Ltd, Australia Rockwell Automation to Pike River June 2009–October 2010, DOL3000160006.

39 Email, Cosmin Cosma to Mike [no surname], 13 October 2010, DOL3000160012.

40 Anthony Reczek, transcript, p. 4727.

41 AAR10 (photographs), DOL3000160013.

42 Michael Scott, witness statement, 30 May 2012, SCO7770010001/26–27, paras 101–06.

43 Energy NZ Ltd, Department of Labour – Pike River Coal Audit Report for November 19, 2010, 25 January 2012, DOL3000140001/27.

44 Anthony Reczek, transcript, pp. 4765–67.

45 Ibid., p. 4785.

46 Rockwell Automation (NZ) Ltd, Institutional Report of Rockwell Automation (NZ) Ltd in Response to the Statement of Anthony Arthur Reczek for Phase Three (Dated February 7, 2012), 15 March 2012, ROC.001/2, para. 8.

47 Ibid., ROC.001/22, para. 67.

48 Ibid., ROC.001/4, 6–8.

49 Department of Labour, Department of Labour Report on Electrical System Evidence, 8 June 2012, DOL7770050017/4, para. 6.

50 Ibid., DOL7770050017/4, para. 6.1.

51 Ibid., DOL7770050017/8–9, paras 17–23.

52 Ibid., DOL7770050017/9–10, paras 24–30.

53 Rockwell Automation (NZ) Ltd, Memorandum (Second) Regarding the Institutional Report of Rockwell Automation (NZ) Limited and Further Enquiries Received from the Department of Labour, 23 July 2012, ROC. M40001. (Department of Labour letters annexed to memorandum)

54 Ibid., with Rockwell Automation letter annexed.

55 Anthony Reczek, transcript, p. 4737.

56 Department of Labour, Report on Electrical System Evidence, DOL7770050017/7, para. 14.2.

57 Ibid., DOL7770050017/10, para. 33.

58 Michael Scott, witness statement, 30 May 2012, SCO7770010001/39, para. 161.

59 Mine Safety, New South Wales, recently issued a safety warning on the

failure rate of explosion-protected diesel engine systems. A lengthy study indicated that, although reliability had improved, the annual failure rate probability for each system was 23%, meaning it was 90% certain that about six failures per annum coincided with a reportable methane accumulation in a mine: NSW Trade and Investment, Mine Safety Operations Branch, Safety Bulletin: In-Service Failures of Explosion Protected Diesel Engine Systems During 2010 and 2011 (Mine Safety Report No. SB12-01), 19 March 2012, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/428614/SB12-01-ExDes-report1.pdf

[60] 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.

[61] Health and Safety in Employment (Mining – Underground) Regulations 1999, reg 35.

[62] Royal Commission on the Pike River Coal Mine Tragedy, Summary of the Reports, CAC0114/29–30.

[63] Ibid., CAC114/27–28.

[64] David Reece, witness statement, DOL3000150001/27–28, para. 118.

[65] Department of Labour, Investigation Report, DOL3000130010/76, para. 2.49.1.

[66] David Reece, transcript, pp. 4453–54.

[67] Ibid.

[68] David Reece, witness statement, 2 February 2012, DOL3000150001/28, para. 118.5.

[69] Ibid., DOL3000150001/27, para. 117.

[70] Department of Labour, Investigation Report, DOL3000130010/76–77, para. 2.49.3, figure 24.

[71] United Nations, Economic Commission for Europe, Best Practice Guidance for Effective Methane Drainage and Use in Coal Mines (ECE Energy Series No. 31), 2010, p. 3, http://www.unece.org/fileadmin/DAM/energy/se/pdfs/cmm/pub/BestPractGuide_MethDrain_es31.pdf

[72] New Zealand Police, Sequence of Events: Search, Rescue and Recovery, SOE.014.00001/76, 88, 104.

[73] Darren Brady, Review of Gas Data, SOE.008.00001/81.

[74] New Zealand Police, Pike River Coal Mine – Sequence of Events: Search, Rescue and Recovery, SOE.014.00118/64.

[75] Darren Brady, Review of Gas Data, SOE.008.00001.

[76] Ibid., SOE.008.00001/77.

[77] Ibid., SOE.008.00001/81.

[78] David Reece, witness statement, 2 February 2012, DOL3000150001/25, para. 105.

CHAPTER 15

Regulator oversight at Pike River

Introduction

1. This chapter considers the oversight of the mine by the Department of Labour (DOL) inspectorate. The commission has received good co-operation from DOL in providing both historical information concerning the mining inspectorate and direct evidence and records relevant to the inspections conducted at Pike River.

2. Both inspectors gave candid evidence, Michael Firmin at two separate hearings and Kevin Poynter at one for which he returned from Australia. DOL also commissioned an internal operational review of its inspectors' interactions with Pike River Coal Ltd.[1] Conclusions from the Gunningham and Neal review are sometimes referred to in the chapter. In assessing these, and any different views expressed by the commission, it should be borne in mind that the review was based on departmental files (excluding health and safety investigations) and written without access to Pike managers or any post-tragedy documents.[2]

The statutory background

The functions of inspectors

3. The Health and Safety in Employment Act 1992 defines the functions and powers of the inspectorate with reference to all health and safety inspectors, not just mines inspectors. The inspectors have three functions:

   - to provide information and education to promote workplace health and safety;
   - to ascertain whether the act has been, and is likely to be complied with; and
   - to take all reasonable steps to ensure that compliance is being achieved.[3]

   Other functions may be conferred on inspectors in the act, or by other enactments.

The powers of inspectors

4. Inspectors enjoy extensive powers of entry and inspection at any workplace, and may require an employer to provide assistance, preserve a scene for examination, produce and allow examination of records and provide witness statements. An inspector may take photographs or other forms of enduring records and may also seize anything of evidential value.

5. There is a hierarchy of compliance and enforcement options: an improvement notice, a prohibition notice, an infringement notice and, lastly, an inspector may charge an employer with an offence.[4]

6. An improvement notice identifies a non-compliance, which must then be addressed. The notice may also specify the steps to be taken. A prohibition notice, reserved for failures likely to cause serious personal harm, prohibits an activity until measures to eliminate or minimise the hazard are put in place.

7. Enforcement using an infringement notice is restricted to lesser offences, while an information may be laid in relation to serious harm offences, which carry a maximum penalty of two years' imprisonment, a fine of up to $500,000, or both.[5]

Duties owed to inspectors

8. The HSE act imposes duties on everyone in a workplace to assist the inspectorate and not to obstruct an inspector in the course of their duties. Anyone in charge of a workplace must maintain a register of accidents that caused

personal harm or might have done so, and an incident register of events that caused serious harm. Serious harm includes significant injuries and illnesses, and conditions that result in hospitalisation for 48 hours or more.[6]

Duties specific to mining

9. The Health and Safety in Employment (Mining – Underground) Regulations 1999 impose specific duties in relation to coal mines. An inspector must be notified of the commencement and cessation of a mining operation and of the installation of a shaft.[7] Details of the time, place and management of the operation, and contact details, must be notified. Different notification time limits apply, according to the nature of the operation.[8]

10. Regulation 10 defines accidents that must be notified to DOL. They are accidents involving an explosion or ignition, a fire or spontaneous heating, an outburst of gas or water, contact with harmful chemicals, a winding plant event, loss of control of a vehicle, the trapping of an employee, a structural failure, an unplanned fall of ground, a major collapse, an uncontrolled gas accumulation, a main fan failure for more than 30 minutes or an electric shock requiring medical treatment.

11. Regulation 11 requires that mine plans are kept for every operation, are updated at least once every six months and are 'copied to an inspector' at regular intervals. Mine owners must also keep certain other records onsite, which an inspector may inspect as necessary.

The mining inspectorate personnel

12. From May 2005 to November 2010 two inspectors, Michael Firmin and Kevin Poynter, separately had responsibility for the Pike River mine.

13. Mr Firmin obtained a bachelor of science degree in mineral technology from the Otago School of Mines in 1977. After graduating, he joined the Mines Department and over the next 15 years held various office, surface and underground positions. In 1984 Mr Firmin obtained a first class coal mine manager's certificate and subsequently held statutory positions, including about three months as an underground mine manager at Moody Creek near Greymouth. In 1995 Mr Firmin joined the Ministry of Commerce as a health and safety inspector with responsibility for inspecting mines and quarries. In 1998 he transferred to DOL, where he has since worked as a mines inspector.[9]

14. Mr Poynter worked in the coal mining industry from 1977 for about 30 years, from time at the coal face through to management positions in Australia. In 1985 he obtained a first class mine manager's certificate and subsequently held the position of mine manager in three New Zealand mines. He became a trainee health and safety inspector in April 2008 and obtained a certificate of appointment (warrant) in June 2009.

15. The commission considers that both inspectors were adequately qualified and sufficiently experienced. Mr Firmin had limited experience as a mine manager, but this would not have been a difficulty if the inspectorate worked in a supportive environment, was properly resourced and had been able to access specialist advice from other experts. Unfortunately, Messrs Firmin and Poynter faced fundamental difficulties in performing their role, as discussed in Chapter 22, 'The decline of the mining inspectorate'.

The operational methods of the mines inspectors

16. The inspectors' workload was formidable. They were required to inspect all coal mines, metalliferous mines, quarries and tunnels in New Zealand.[10] In early 2010, for example, there were eight underground coal mines, 21 open cast coal mines, 11 metalliferous mines, 925 quarries and four tunnels under construction.[11]

17. The South Island was divided by the Rakaia River, with Mr Firmin living in Dunedin and responsible for the south, and Mr Poynter based in Westport with responsibility for the north. They shared responsibility for the North Island,

and conducted inspections as time permitted. Quarries were viewed as the last priority, and many North Island quarries were not inspected at all.[12]

18. An 'inherent risk' assessment form was used to set the frequency of inspections to the various workplaces.[13] However, underground coal mines were automatically classified as high risk, to be inspected every three months.[14] Inspections were either proactive, initiated by DOL, or reactive, in response to an event notified from a particular workplace. Proactive visits (hereafter called inspections) were arranged with the mine operator, not unannounced.[15] Responding to requests for technical information and advice was a further significant aspect of the inspector's role. The Pike managers often raised concerns and sought input from the inspectorate. These contacts were conducted electronically, through meetings or a combination of the two.

19. From June 2009 until the time of the explosion Mr Poynter conducted five proactive inspections at Pike River. He made a similar number of reactive visits to the mine in relation to accidents or other mining incidents. In addition there were numerous attendances concerning technical mining issues raised by the company.[16] A record of interactions was maintained in an information database named INSITE.

Three representative interactions

Introduction

20. An assessment follows of three interactions between the inspectorate and Pike River mine personnel between February 2007 and November 2010. These cover important aspects of the mine's development and provide an insight into the inspectorate's relationship with the company. The commission accepts the assessment that the nature of these interactions was consistent with DOL policy.[17]

Location of the main fan underground

21. The first contact with Pike was in May 2005. Peter Whittall phoned Mr Firmin, introduced himself and explained that he wished to develop the access tunnel into the mine without using flameproof machinery, given that the development would be in rock, not coal. After conferring with an Auckland-based colleague, Mr Firmin advised Mr Whittall that designation of the drift as a hard rock tunnel was acceptable, at least until the approach to the Hawera Fault, at which point a coal mine designation might be required.[18]

22. The first mine inspection took place on 13 February 2007. Mr Firmin, accompanied by Richard Davenport, a senior technical officer with the energy safety service of the Ministry of Economic Development, visited the mine. Mr Whittall first provided a PowerPoint presentation at the company's Greymouth office. He outlined progress to that time: construction of the access road, establishment of an electrical supply to the mine and development of the drift to 320m. Mr Whittall also explained that the main ventilation fan was to be located underground, with a back-up diesel fan situated at the top of the ventilation shaft. At this point the shaft was to be located in stone to the east of the Hawera Fault. He said this would provide ease of maintenance, whereas there was no space and it was too steep for the fan to be located on the hillside above the shaft.[19]

23. Following the presentation, Messrs Firmin and Davenport went to the mine. Mr Firmin inspected the tunnel, focusing on the gradient, roof stability and the adequacy of strata control. Mr Davenport audited the safety of the electricity supply to the mine, which at that stage was an 11kV supply, to be upgraded to a 33kV supply later. He approved the existing installation in a written report that included a request for the ministry to be kept informed about the installation of the upgraded supply.[20]

24. Mr Firmin prepared handwritten notes of his inspection. These included a simple diagram depicting the intended configuration of the main fan, with the motor located in the intake in fresh air, and the fan separated in the ventilation return and expelling exhaust up the vent shaft.[21] This proposal concerned Mr Firmin. He had experience of main fans located underground in hard rock tunnels, but never in an underground coal mine. He noted that

the regulations required employers to take all practicable steps to ensure the provision of fresh air in every place in a mine where employees could go.[22] The location of the main fan underground was not expressly prohibited. Still not convinced, Mr Firmin said he checked regulations in other countries, but found none that prohibited an underground location. He concluded that 'fans were put outside for ease of maintenance'.[23]

25. On 28 February 2007 Mr Firmin wrote to the company about the inspection. He recorded matters relevant to roof support in the drift and also enclosed a copy of Mr Davenport's audit report. The letter made no reference to placement of the main fan underground.[24] Mr Firmin neither spoke to anyone about his unease nor considered seeking expert advice.[25] On 6 November 2007 Mr Firmin inspected the mine, was told that the fan would now be located to the west of the Hawera Fault and asked for further operational details.[26] These were not available.[27]

26. Mr Poynter became responsible for the Pike River mine in 2008. He, and occasionally Johan Booyse, the high hazards adviser, visited the Pike mine but DOL took no action in relation to the location of the main fan underground. Mr Poynter said that he did not inspect the fan after its installation, or obtain information about its performance.[28]

Assessment

27. In the commission's view, DOL's actions in relation to this issue were inadequate. Although not expressly prohibited in New Zealand, location of a main ventilation fan underground was at odds with established practice throughout the mining world. Mr Firmin needed to confront the issue in 2007, particularly in November, when he was told that the fan was to be located west of the fault. Failure to question the proposal at that point made it more difficult for Mr Poynter to do so later. Even so, given the delay until mid-2010 when the fan was installed, there was ample time to have dealt with the matter.

28. Nor does the commission accept that the regulatory position in other countries is obscure. An International Labour Organisation (ILO) code treats the location of ventilation fans on the surface as a given: stating the 'surface ventilating fan' is to be 'offset from the nearest side of the mine opening at least 5 metres' in order to avoid explosion forces.[29] In addition, regulations in the United States, Canada, Queensland and New South Wales expressly provide,[30] or take it for granted, that main fans (as opposed to auxiliary and booster fans) must be installed above ground.

29. This failure not only allowed a highly questionable ventilation system at Pike River, but also set the tone for subsequent interactions between the company and the inspectorate.

Frictional ignitions

30. By October 2008 the drift was developed to a point close to the Hawera Fault. Pit bottom in stone was completed and it was expected that methane levels would increase as the drive towards the fault continued. Because control of the mine had passed from McConnell Dowell to the company, Pike deputies managed the McConnell Dowell crews.[31]

31. On 11 November several methane ignitions occurred in a stub under development off the main drift. A roadheader was cutting when methane was released, which was ignited when the cutter head struck the hard rock floor. Pike's production manager, Kobus Louw, investigated the ignitions and prepared a memorandum containing preventative actions that were to be communicated to crews at tool box talks. The actions included the use of an air mover at the face to assist ventilation, the application of extra water on the cutter head to prevent ignitions and increased methane monitoring at the face before cutting started.[32]

32. On 13 November Mr Louw notified Mr Poynter of the ignitions by telephone.[33] The next day Mr Louw emailed a copy of the investigation memorandum to Mr Poynter and they discussed the ignitions and agreed that use of the roadheader would cease, with development to continue using a drill and blast method. Workers would withdraw from underground when blasting occurred. Mr Poynter sent an email to Mr Louw seeking further information and recording that 'the mine should [now] be deemed to be a Gassy Mine'.[34] Mr Louw also confirmed by email that an explosive which could not ignite methane would be used for blasting.

33. Mr Poynter discussed the ignitions with Mr Firmin. They agreed the hazard was 'a significant one', but agreed that the steps implemented by the company were adequate.[35] Sometime over the next few days Mr Poynter was rung by Harry Bell, a former chief inspector of coal mines, who had assisted McConnell Dowell as a tunnel supervisor in the early development of the drift. Mr Bell had been told of the ignitions by a senior McConnell Dowell employee, who referred to '10 ignitions in the past fortnight'.[36] Mr Bell considered the essential problem was the inadequate ventilation from a forcing fan near the portal.[37] He told Mr Poynter that work in the drift should be prohibited until the ventilation was improved. He added that he did not mind if the company was told that he was 'the whistle blower', since to his mind the matter was extremely serious.[38]

34. Mr Poynter considered the matter, but concluded that he could not intervene because 'there is no legislative requirement that determines the method of ventilating coal mines' and 'forcing ventilation when using explosives or developing in stone is an acceptable method'. [39] Mr Poynter consulted Mr Booyse, and on 19 November emailed Mr Louw requesting the supervisors' reports for each ignition, weekly ventilation recordings and a ventilation plan to show recording positions. The email continued: 'Have you considered the adequacy of the ventilation. Given that the mine is now in coal and that the amount of gas emissions will only increase as you advance it is my opinion that the ignitions are probably caused by insufficient ventilation at the face.' The situation was termed a matter of extreme concern to be dealt with 'urgently'.[40]

35. On 20 November Mr Poynter again phoned Mr Firmin and discussed whether work should be stopped while an assessment was obtained from a ventilation engineer but they decided to wait for a new risk assessment.[41] Nothing happened for several days until 28 November, when Mr Poynter received an email from Mr Louw to which was attached a McConnell Dowell procedure for the use of explosives in a gassy mine, together with deputies' reports for 24 and 25 November and a ventilation plan.[42] Mr Poynter responded immediately by email: 'I am still waiting on the shift reports of each of the ignitions and any investigations undertaken.' [43]

36. On 3 December Mr Louw replied by email, attaching incident/accident and accident investigation reports, both of which related to another methane ignition on 15 November.[44] Nothing more occurred for three weeks when, on 24 December 2008, Mr Poynter sent a further email to Mr Louw: 'I have been working on this file and noted that I have only received advice of two ignitions. I have been told by a number of people now that there were at least 10.' He requested information on the other incidents.[45]

37. Mr Louw replied the same day: 'Don't know who feed [sic] you information but there was a few ignitions on 4 shifts that I know of and that you should have the information, (including the one at hawera fault [sic]). If there is more then supervisors chose not to report them hence I don't know of them and is not been investigated.' [46]

38. Finally, on 13 February 2009 Mr Poynter recorded in an INSITE entry that the matter was closed.[47] By then the focus of attention was west of the Hawera Fault, where mine development was under way.

Assessment

39. The commission notes that the Gunningham and Neal review includes an analysis of the inspectors' actions in relation to this aspect.[48] The authors said that Pike voluntarily provided a detailed flow of safety information, which Mr Poynter cross-checked for completeness. This, they concluded, 'was a sound approach and provides a good basis for concluding that the inspectors discharged their duty to satisfy themselves about the level of compliance by the mine.'[49]

40. In the commission's view, the inspectorate's performance in relation to this aspect was positive in some respects, but not in others. Mr Poynter was decisive when the methane ignitions were first drawn to his attention: he required Pike River to be deemed a gassy mine and secured an agreement not to use the roadheader. He took a consultative approach by discussing matters with Mr Firmin on two occasions and with the high hazards adviser on at least one. This was probably to be expected, given that Mr Poynter had still not obtained a certificate of appointment. He also persisted in contacting Mr Louw when requested information had not been provided.

41. On the other hand, his approach to the interpretation of the regulations was odd. Mr Bell said the underlying

problem was the use of forcing ventilation and said work must stop. Mr Poynter decided he could not act because the regulations did not require the use of exhausting, as opposed to forcing, ventilation. Regulation 28 requires an employer to take all practicable steps to ensure a supply of fresh air in every workplace.[50] No one ventilation method is prescribed over another. Instead a standard is imposed, leaving it to the mine operator to select an appropriate work method. It should have been obvious to an inspector that he had to decide whether the company had taken all practicable steps to supply fresh air to the face and, if not, what response was appropriate. To decide there was no breach because the regulation did not prevent the use of forcing ventilation was to misunderstand the regulation.

42. The commission does not regard the actions of the company as those of a motivated and compliant employer. The initial report to Mr Poynter came two days after the event. Thereafter, information was sometimes provided only after a follow-up request. The production manager's final response to Mr Poynter bordered on being truculent. There were clear indications that Pike was not properly investigating and reporting notifiable incidents. A reappraisal of the company's compliance status was needed, but did not occur. Instead DOL persevered with a low-level compliance strategy based on negotiated agreements.

Second means of egress

43. The background to this aspect is discussed in Chapter 16, 'Search, rescue and recovery', paragraphs 134–45.

44. In brief, in the mid-1990s Pike planned to have two stone drives into the mine. By 2000 a vertical ventilation shaft was planned, serviced by an electric hoist. In 2005, when the final mine plan was approved, a ventilation shaft remained the proposed second means of egress, but with a ladder system rather than an electric hoist. This was to be a short-term solution until a walkout egress could be developed to exit in the valley of the Pike River stream.

45. The inspectorate first considered a second egress during an inspection on 27 May 2008. This was Mr Poynter's first visit to the mine; he accompanied Mr Firmin. Mr Louw took them underground. The drift was about 20m from the Hawera Fault. Work had begun at the surface to sink the vent shaft. This prompted discussion in which Mr Louw said that a ladderway was to be installed in the shaft to be used for about seven months.[51] His reference to this period was consistent with the longstanding plan to establish a second egress during the early development of the mine.

46. Development of the mine proved slower than predicted. By January 2009 boring of the ventilation shaft was completed, and installation of a construction hoist required to finish development of the shaft was under way. But on 2 February the bottom 30m of the ventilation shaft collapsed and blocked the connection between the shaft and the mine, also causing a loss of ventilation.[52]

47. On 12 February 2009 Mr Poynter visited the mine, was flown to the surface and lowered down the shaft in the construction hoist. He wanted to understand the issues relevant to recovering the shaft.[53] Mr Poynter conducted a further inspection on 8 April, by which time the company had decided to bypass the collapsed portion of the shaft and install the Alimak raise, which took several months to construct.

48. Mr Poynter did not consider the second egress during inspections he made on 9 October 2009 and 22 January 2010. During his next inspection, on 8 April 2010, Douglas White accompanied Mr Poynter underground and the latter raised the matter of a second means of egress. He was told that the workforce had also asked about it. Mr Poynter viewed the shaft, saw a climbing wire and was told that wires extended to the top of the shaft. There was also reference to safety harnesses for use in an escape up the ladder system. Mr Poynter said that although somebody could technically climb up the shaft, and it therefore constituted an egress, in his view it was not a suitable emergency escapeway.[54] He asked the company to provide a plan and timeline for developing the additional walkout egress and associated elements.[55]

49. Mr Poynter subsequently considered whether enforcement action was required. He decided that 'a prohibition or improvement notice had the possibility of failing if Pike challenged it in the court because technically a person could climb up the shaft and exit the mine', so he favoured a voluntary compliance approach.[56]

50. On 12 April 2010 Neville Rockhouse emailed an action plan to Mr Poynter. The document recorded a risk assessment

meeting conducted by the company on 5 March 2010, at which various actions were agreed about use of the ventilation shaft as an escapeway. One was that the shaft should not be deemed a second egress 'unless another full risk assessment is completed'.[57] The document did not refer to development of a second walkout egress.

51. Mr Poynter made a further inspection on 12 August 2010. While underground with Mr White he again raised the second egress and recorded the discussion on INSITE: 'The existing second egress is through the shaft. This allows the evacuation of employees one at a time up the ladderway and while this meets the minimum requirement it is agreed that a new egress should be established as soon as possible.'[58] On 31 August Mr Poynter wrote to Mr White and stated that, given the plan to start coal extraction and the increased underground population, another egress was required 'as soon as possible. Please provide a plan and time line for this work.'[59]

52. Again, nothing occurred until Mr Poynter's next inspection on 2 November 2010. By then, hydro mining had begun and Mr Poynter inspected the hydro panel with Stephen Ellis. At the mine Mr Poynter was given a memorandum prepared by the technical services co-ordinator, Gregory Borichevsky, which outlined a second egress development plan. There was no time to read and consider the memorandum onsite.[60] The memorandum, addressed to Mr White, proposed a walkout second egress, which would double as a second air intake for the mine, 250m north-west of the existing workings. However, access to the site required building 1400m of roadway, which was estimated to take over 50 weeks, subject to obtaining conservation approvals and resolving any geological problems. Yet it was thought the egress could be completed 'by June to September 2011'.[61]

53. Mr Poynter read the memorandum and understood that there would be no development of the second egress/intake until after full hydro coal extraction (as opposed to trial extraction) had begun. He regarded this as unsatisfactory, wanted further details and resolved to discuss the matter with the company, but the explosion occurred before he could do so.[62]

Assessment

54. The attention given to this issue was clearly inadequate. Providing a second egress from an underground mine is a matter of fundamental importance. The workers recognised this and communicated their concern to senior management. Yet the company took no decisive action to ensure that it met its legal obligation.

55. Decisive action was also required from DOL. Construction of the ventilation shaft and the installation of a ladder system was completed in mid-2009. Pike should have been required to provide its plan for a proper second egress then. When, in 2010, the focus turned to starting hydro extraction the issue of a prohibition notice was the only appropriate response.

56. This was put to Mr Poynter in cross-examination. He referred to the difficulty in interpreting Regulation 23, the need for a decision from someone more senior in DOL if a prohibition notice was issued, and his perception that Pike's management viewed this matter as 'a priority', meaning that a negotiated agreement remained a preferable approach.[63] The commission cannot accept this.

Use of the inspectorate's powers at Pike River

The Department of Labour policy

57. As in many countries DOL used a risk-based regulatory approach. Inspectors were to assess the compliance risk posed by individual employers, and tailor a suitable compliance response. If an employer was co-operative and compliant, then informal methods or lesser powers would ordinarily be used rather than intervention.

58. DOL used three broad approaches regarding intervention. The first involved 'negotiated agreements', where inspectors discussed a required improvement with the employer and sought an agreement by negotiation. Next was 'directed compliance', where an improvement notice or a prohibition notice was used to secure compliance. These were appropriate where an employer had a history of non-compliance or where prompt intervention was

needed to prevent immediate serious harm.

59. The third approach involved enforcement action via an infringement notice or a prosecution. These options were appropriate where a workplace failure warranted a deterrent approach.[64] Enforcement action often had to be preceded by a written warning.

60. Procedure required that negotiated agreements had to be recorded in writing and include a completion date for the agreed actions. If the agreement was not honoured, ordinarily the inspector would need to move on to directed compliance.[65]

61. Improvement notices identified a regulatory breach and, if obvious, the required remedial steps, together with a compliance date.[66] Prohibition notices had to both identify a breach and why it was likely to cause serious harm. Inspectors were advised to consult if in doubt.[67] Written warnings were to be given where a non-compliance was found during an inspection, but was immediately remedied. The warning meant an infringement notice for a similar non-compliance could be issued without further warning.[68]

Gunningham and Neal review

62. The authors of the external review considered whether the inspectorate's enforcement approach at Pike River was appropriate. They thought it 'striking' that the inspectors only ever used negotiated agreements in their dealings with the company. This, they noted, could raise the concern that the 'inspectors had been captured' and had acted with undue sympathy towards the company's interests.[69] But the authors concluded that 'over the period of the Pike River mine's operation, there was no single occasion where the inspectors had needed to take a … robust stance because they never met resistance in any form.'[70]

The compliance approach adopted at Pike River

63. Because Mr Firmin and Mr Poynter regarded the company as a responsible and compliant operator, their preferred approach was to conclude negotiated agreements with Pike, but they did not include a deadline for the performance of agreed actions. Indeed Mr Firmin said that 'just about all my letters don't have a timeframe and they should have really but as soon as you stick down a time often, you know, they might be a week later or something and it presents its own problems.'[71]

64. The frictional ignitions in November–December 2008 raised a number of concerns, particularly in relation to Mr Poynter's interpretation of the regulations and to the company's attitude towards compliance. The interactions regarding a second egress demonstrate even more clearly the potential pitfalls of negotiated arrangements. Initially there was no written agreement, then an agreement with no date for completion. There was no sense of authority or urgency.

65. In the view of the commission, and contrary to the conclusion reached in the external review, DOL did meet with resistance from the company and should have taken a much stronger stance. Pike may have expressed good intentions, but its actions were another matter. There was no option but to issue a prohibition notice in relation to the second egress and, generally, firmer compliance methods should have been used at Pike, as shown in the next example.

The roadheader investigation

66. At 4:30am on Sunday 14 February 2010 a miner sustained a serious injury to his foot, which was crushed, causing a bone fracture, some 'degloving' and lacerations. He was flown by helicopter to Greymouth hospital. Mr Poynter arrived at the mine at 9:30am, went underground and inspected the roadheader involved in the accident. Subsequently, he prepared an investigation report.[72]

67. A roadheader bores mine roadways and is equipped to install roof bolts as it moves forward. Holes are drilled into the roof, bolts are inserted and glued in position and tightened to provide strata support. A bolting rig is part of the roadheader and is hydraulically operated. The miner climbed onto the rig to provide manual assistance when the

automatic bolter encountered difficulties owing to excessive roof height. The bolter auto-retracted, crushing the miner's foot between it and the surface of the rig on which he was standing.

68. Mr Poynter's investigation report was detailed and reached a number of key conclusions. These included the victim's actions being contrary to the mine rules, a mine deputy observing a similar action earlier in the shift and doing nothing to prevent a recurrence, the faulty bolter rig not being withdrawn from service and an apprentice fitter operating the machine without authorisation at the time of the accident. The mine deputy was subsequently dismissed. Mr Poynter concluded that the company, the victim and the mine deputy had committed 'a number of possible breaches', but he recommended against prosecutions. He reasoned that the dismissal of the deputy, the serious injuries suffered by the victim and the company's corrective actions justified 'that no further action will be taken.'[73]

69. This recommendation was approved by Mr Poynter's manager and on 22 September 2010 the matter was closed by an INSITE entry that included this comment: 'further inspection found that the Deadman lever on the opposite bolter had been tied down with an electrical cable tie. Although this had no impact on the incident.'[74] In cross-examination Mr Poynter accepted that tying down the deadman lever disabled the bolting rig safety device and that this was of itself a serious matter. There was no investigation into this aspect, although Mr Poynter said he had a number of contacts with Mr White concerning workforce briefings about the risk of overriding safety devices.[75]

Assessment

70. The Gunningham and Neal review included discussion of this investigation.[76] The authors concluded that Mr Poynter's approach was 'entirely consistent with the precepts of responsive regulation, which was the formal approach of DOL to compliance and enforcement.'[77]

71. It is difficult to fathom why there was no prosecution or, at the very least, a written warning issued to Pike. The investigation exposed a serious safety incident involving the miner, a maintenance fitter and a mine deputy. Serious harm resulted and the incident had no mitigating features. Mr Poynter also discovered a disabled safety device on the same machine, which should have increased concern about the safety culture at Pike and called into question the need for a much firmer compliance approach from the inspectors.

The inspection of mine records

Introduction

72. The mine kept comprehensive records compiled by employees throughout the company. Most concerned production and operational issues, but both these and incident and accident reports contained information directly relevant to workplace safety. The records included incident reports, deputy statutory reports, machine and equipment inspection reports, gas data and charts, control room reports, the incident/accident register, the hazard register and the near-hit register.[78]

73. The commission analysed a large part of the available information and data, and compiled schedules that grouped safety-related information according to subject matter.[79] The topics included mine ventilation, methane spikes, the bypassing of safety devices, tag board issues, emergency equipment, and actual and potential ignition sources.

74. Mr Poynter was questioned by counsel assisting the commission with reference to numerous excerpts from the schedules. Mr Poynter was unaware of most of this relevant safety-related information. Some examples of his answers and reactions follow.

Methane spikes

75. Gas charts recorded methane readings obtained from a sensor at the top of the main vent shaft. Numerous spikes, where the methane reading was 1.25% or more, were recorded in the weeks before the explosion. Mr Poynter agreed that these readings indicated an even higher methane content somewhere in the mine, given that methane

would be considerably diluted by the time it reached the top of the vent shaft. Mr Poynter observed that these spikes were occurring because of uncontrolled gas incidents and 'each one of those, in my view, should've been notified.' He added that the extent of the spikes suggested 'an issue with the ability of the mine to control the gas, and that's a ventilation issue.'[80]

76. Another indicator of methane control problems was the tripping of the main fan or machines when a safety device shut off an engine in response to a high methane level. Mr Poynter was asked whether at any time before the explosion he was aware of the extent of tripping, including tripping of the main fan. He responded: 'not the frequency that I'm being shown here. I was aware of one scenario where I was rung by a deputy to get a clarification of when it was appropriate to, what the regulation said about exiting the mine but not to this extent.'[81]

Bypassing and contraband

77. Mr Poynter was also questioned about the practice of bypassing methane sensors or safety devices and confirmed that he was unaware of this practice and that had he known of it an investigation and compliance action would have followed.[82] Similarly, Mr Poynter did not know about problems with contraband, including the discovery of cigarette butts, cigarette lighters and aluminium drink cans underground. Had he been aware of this conduct occurring in 2009 and 2010 he would have required the mine to 'carry out a retraining programme, like a re-induction around this particular issue and that there would be random daily, random checks every day, every shift, so people were searched before they went underground'. He would also have considered enforcement action against the company.[83]

A provision of safety data

78. On 22 January 2010, while conducting an inspection at the mine, Mr Poynter saw information from the accident register displayed onscreen. He requested the details for the last three months and received 41 pages by email the same day.[84] He had not, however, reviewed the information because of time and other work pressures.[85]

79. The commission observed that, in giving evidence, Mr Poynter was obviously disturbed when the extent of the safety issues at the mine was revealed to him. He said that 'there just wasn't enough time' to peruse mine records, that there was no system provided by DOL to facilitate obtaining and analysing documents, that the inspectors were not 'trained in auditing' and agreed that the mine inspectors were essentially there to conduct physical inspections.[86]

Conclusions

80. The commission has reached a number of conclusions:

- The inspectors acted in accordance with DOL policy and largely met the operational requirement to conduct mine inspections at three-monthly intervals.
- They also collaborated and responded well to requests from the company for technical advice and approvals.
- The inspectors obtained only a limited snapshot of the mine's physical systems during inspections, and possessed insufficient information to make an informed judgement concerning the level of compliance at Pike River.[87]
- It was also essential to conduct targeted audits of the documented mine systems and operational information, but the inspectors had no system, training or time to undertake this work.[88]
- Nonetheless, the inspectors assumed that the mine was compliant and indeed that Pike was a 'best practice' company.
- The inspectors used only negotiated agreements and then did not always record agreed actions in

accordance with DOL's operating procedures; nor did agreements stipulate a date for the performance of such actions.

- If the inspectors had properly understood the level of compliance at the mine, they would not have used only negotiated agreements but a range of compliance/enforcement options.
- The inspectors found the requirement that employers use 'all practicable steps' to comply with their obligations under Regulations 23 and 28 of the Health and Safety in Employment (Mining – Underground) Regulations 1999 difficult to interpret, and feared that any compliance action could result in a successful court challenge.[89]
- The provision of a second egress from the mine was so serious as to require the issue of a prohibition notice.

81. These conclusions should be viewed in the context of the environment within which the inspectors were forced to operate. In an answer under cross-examination Mr Poynter said, 'We were dysfunctional in that we reported to separate managers. We had one advisor who had no coal background, although he was technically very good … and there was no co-ordinated approach even … we weren't resourced and we weren't particularly well set up to be able to provide the service that we were expected to provide.'[90] The commission agrees with these comments, and emphasises the need to consider this section alongside Chapter 22, 'The decline of the mining inspectorate'.

82. The above conclusions represent an assessment of the DOL's actual oversight of the mine. Another question is whether a well led and operationally competent regulator would have acted more decisively at Pike River. The commission considers it is probable that an effective regulator would have issued a prohibition notice when Pike commenced hydro mining in September 2010 without a usable second outlet (egress) from the mine. The notice would have stopped hydro mining until the planned second intake (to double as a walkout egress) was developed and importantly would have provided the opportunity for the development of improved ventilation and methane control within the mine.

ENDNOTES

1 Neil Gunningham and David Neal, Review of the Department of Labour's Interactions with Pike River Coal Limited, 4 July 2011, DOL0100010001.
2 Ibid., DOL0100010001/11.
3 Health and Safety in Employment Act 1992, ss 29(a), 30(b), 30(c).
4 Ibid., ss 31, 39, 41, 56(B), 54(A).
5 Ibid., s 49(3).
6 Ibid., ss 47, 48, 25, sch 1.
7 Health and Safety in Employment (Mining – Underground) Regulations 1999, reg 8.
8 Ibid., reg 8(1).
9 Michael Firmin, transcript, pp. 605–07.
10 Ibid., p. 590.
11 Memorandum, Department of Labour Mining Steering Group to Workplace Services Management Team, 12 February 2010, DOL0020020022/3.
12 Michael Firmin, transcript, p. 598.
13 Department of Labour, Mines Quarries and Tunnels – Indication of Inherent Risk, DOL0020020003/1.
14 Michael Firmin, transcript, pp. 590, 667.
15 Ibid., p. 628.
16 Kevin Poynter, witness statement, 19 October 2011, DOL7770040003/2–3.
17 Alan Cooper, witness statement, 21 October 2011, DOL7770040001/2.
18 Michael Firmin, witness statement, 19 October 2011, DOL7770040002/4–5, paras 11–18.
19 Michael Firmin, transcript, p. 2898.
20 Richard Davenport, Inspection Audit Report, 13 February 2007, DOL3000070190/2–3.
21 Michael Firmin, notes, DOL3000070008/1.
22 Health and Safety in Employment (Mining – Underground) Regulations 1999, reg 28.
23 Michael Firmin, witness statement, 19 October 2011, DOL7770040002/7, para. 29.
24 Letter, Michael Firmin to Neville Rockhouse, 28 February 2007, DOL3000070190/1.
25 Michael Firmin, transcript, pp. 2863, 2896–97.
26 Michael Firmin, witness statement, 19 October 2011, DOL7770040002/16, para. 82.
27 Michael Firmin, transcript, p. 2895.
28 Kevin Poynter, transcript, p. 3092.
29 International Labour Organisation, Code of Practice on Safety and Health in Underground Coalmines, May 2006, p. 129, para. 21.5.2., http://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---safework/documents/normativeinstrument/wcms_110254.pdf
30 United States: Code of Federal Regulations, Safety and Health Standards – Underground Metal and Nonmetal Mines, 30 CFR § 57.22202(a)(1); Canada: Coalmining Occupational Health and Safety Regulations, 1990, reg 114(1)(b); Queensland: Coal Mining Safety and Health Regulation, 2001, reg 353(1), (3); New South Wales: Coal Mine Health and Safety Regulation 2006, reg 118.
31 Jonathan (Joe) Edwards, witness statement, 24 May 2011, MCD0001/18–19, paras 70–73.
32 Memorandum, from Kobus Louw, to all staff, 13 November 2008, DAO.025.34372.
33 Kevin Poynter, witness statement, 19 October 2011, DOL7770040003/14, para. 66.

[34] Email, Kevin Poynter to Kobus Louw, 14 November 2008, DOL3000010087/1.
[35] Michael Firmin, notes, 14 November 2008, DOL3000070204/1.
[36] Henry (Harry) Bell, witness statement, 23 June 2011, FAM0001/10–11, para. 34.
[37] Kevin Poynter, witness statement, 19 October 2011, DOL7770040003/15, para. 76.
[38] Henry (Harry) Bell, witness statement, 23 June 2011, FAM0001/10–11, paras 35–36.
[39] Kevin Poynter, witness statement, 19 October 2011, DOL7770040003/15, para. 76.
[40] Email, Kevin Poynter to Kobus Louw, 19 November 2008, DOL3000010086/1.
[41] Michael Firmin, notes, 20 November 2008, DOL3000070205/1.
[42] Email, Kobus Louw to Kevin Poynter, 28 November 2008, DOL3000020037.
[43] Email, Kevin Poynter to Kobus Louw, 28 November 2008, DOL3000010085/1.
[44] Email, Kobus Louw to Kevin Poynter, 3 December 2008, DOL3000020036.
[45] Email, Kevin Poynter to Kobus Louw, 24 December 2008, DOL3000010084/1.
[46] Email, Kobus Louw to Kevin Poynter, 24 December 2008, DOL3000020035/1.
[47] Kevin Poynter, INSITE file detail report, 13 February 2009, DOL3000070077/1.
[48] Neil Gunningham and David Neal, Review, DOL0100010001/65, paras 211–35.
[49] Ibid., DOL0100010001/103, para. 369.
[50] Health and Safety in Employment (Mining – Underground) Regulations 1999.
[51] Michael Firmin, witness statement, 19 October 2011, DOL7770040002/26–27, paras 150–56.
[52] Kevin Poynter, witness statement, 19 October 2011, DOL7770040003/18–20, paras 91–102.
[53] Ibid., DOL7770040003/20–21, paras 104–07.
[54] Kevin Poynter, transcript, p. 3076.
[55] Kevin Poynter, INSITE file detail report, 8 April 2010, DOL3000070155/3.
[56] Kevin Poynter, witness statement, 19 October 2011, DOL7770040003/38, para. 220.
[57] Email, Neville Rockhouse to Kevin Poynter, 12 April 2010, DOL3000010009/7.
[58] Kevin Poynter, INSITE file detail report, 12 August 2010, DOL3000070169/3.
[59] Letter, Kevin Poynter to Douglas White, 31 August 2010, DOL3000070170/1.
[60] Kevin Poynter, witness statement, 19 October 2011, DOL7770040003/47, paras 280, 282.
[61] Memorandum, Gregory Borichevsky to Douglas White, 29 October 2010, DOL3000070172/1–2.
[62] Kevin Poynter, witness statement, 19 October 2011, DOL7770040003/47, para. 282.
[63] Kevin Poynter, transcript, pp. 3080–82.
[64] Department of Labour, Operating Procedure: Improvements and Improvement Notices, 17 October 2005, DOL3000100031/1.
[65] Ibid., DOL3000100031/2.
[66] Ibid., DOL3000100031/4–7.
[67] Department of Labour, Operating Procedure – Prohibition Notices, 5 May 2003, DOL3000100034.
[68] Department of Labour, Operating Procedure – Written Warnings, 5 May 2003, DOL3000100039.
[69] Neil Gunningham and David Neal, Review, DOL0100010001/122, para. 447.
[70] Ibid., DOL0100010001/127, para. 463.
[71] Michael Firmin, transcript, p. 2854.
[72] Department of Labour, Crush Incident: Pike River Coal, 14 February 2010, DOL3000070137.
[73] Ibid., DOL3000070137/13, paras 8.1–8.4.
[74] Kevin Poynter, INSITE file detail report, 22 September 2010, DOL3000070134/3.
[75] Kevin Poynter, transcript, p. 3014.
[76] Neil Gunningham and David Neal, Review, DOL0100010001/125–26, paras 459-60.
[77] Ibid., DOL0100010001/127, para. 464.
[78] Karyn Basher, witness statement, 10 November 2011, CAC0117.
[79] 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; Royal Commission on the Pike River Coal Mine Tragedy (Karyn Basher), Summary of Pike River Coal Mine Deputies Production Reports for March and October 2010, November 2011, CAC0116; Royal Commission on the Pike River Coal Mine Tragedy (Katherine Ivory), Summary of Pike River Coal Limited Deputy Statutory Reports for March and October 2010, November 2011, CAC0115; Royal Commission on the Pike River Coal Mine Tragedy (Katherine Ivory), Summary of Pike River Coal Mine Deputies Production Reports for November 2010, January 2012, CAC0116A; Royal Commission on the Pike River Coal Mine Tragedy (Katherine Ivory), Summary of Pike River Coal Mine Deputy Statutory Reports for November 2010, January 2012, CAC0115A; 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.
[80] Kevin Poynter, transcript, pp. 3030–31.
[81] Ibid., p. 3033.
[82] Ibid., pp. 3033–36, 3043–44.
[83] Ibid., pp. 3040–43.
[84] Ibid., p. 3011.
[85] Pike River Coal Ltd, Incident Registers – Site Summary – Pike River Mine: Report Period 1/09/2009 to 31/12/2009, 22 January 2010, DOL3000020014/2–42; Kevin Poynter, transcript, p. 3037.
[86] Kevin Poynter, transcript, p. 3038.
[87] Ibid., p. 3018.
[88] Kathleen Callaghan, witness statement, 31 October 2011, FAM00042/46, 57.
[89] As provided for in s 46 of the Health and Safety in Employment Act 1992, and as a result made ineffectual decisions about the location of the underground fan and the adequacy of egress from the mine.
[90] Kevin Poynter, transcript, p. 3040.

After the explosion

+ Search, rescue and recovey
+ The families of the men

CHAPTER 16

Search, rescue and recovery

Deployment of Pike's emergency response management plan (ERMP)

1. This section examines the effectiveness of Pike's emergency response management plan (ERMP), with particular emphasis on the immediate reaction to the emergency, and what lessons can be learnt. Because the police took control of the emergency response almost immediately the analysis of what happened subsequently is covered from paragraph 19 onwards, 'Police control of the emergency'.

Pike's ERMP

2. Pike had prepared a plan to manage emergencies at the mine, which was part of a wider corporate safety management plan being developed by the safety and training manager, Neville Rockhouse, and is described in Chapter 7, 'Health and safety management'.

3. The core of the ERMP is in a document dated 18 February 2009, written by Mr Rockhouse, and approved by Peter Whittall, as general manager mines.[1] The document appears to be a work in progress. It contains material applicable to Australia but not to New Zealand. The ERMP had not been reviewed as at 19 November 2010.[2]

Detail of the ERMP

4. The ERMP describes three levels of emergency response according to the seriousness of the event that has occurred. On 19 November 2010 Pike faced a Level 1 incident – an emergency beyond the resources of the mine to manage and requiring external help.

5. The ERMP is centred on the concept of one incident controller, usually the mine manager, who takes control of the emergency and establishes an incident management team (the Pike IMT) that prepares a series of incident management plans. The aim is to have clear responsibilities and good decision-making in an environment of great stress and confusion. The ERMP defines the organisational structures and summarises the duties of the participants on 12 duty cards, which are held in the control room at the mine. These cards are issued as the key positions are filled.

The process of activating the ERMP

6. The process for activating the ERMP is as follows:

- The control room operator receives information suggesting an emergency and assesses the situation. He or she follows the instructions on Duty Card 1. He or she contacts the most senior manager available and issues Duty Card 2 to that person, who then becomes the incident controller, at least until a more senior manager arrives.
- The incident controller, using Duty Card 2:
  - evaluates the nature of the emergency and the appropriate level of response (including whether to call for external assistance);
  - forms and leads the Pike IMT to operate from a designated location on site;
  - oversees the incident management plans, including the goals, objectives, priorities and decision-making processes;
  - notifies the Department of Labour (DOL); and
  - issues or ensures the issue of the remaining 10 duty cards to other managers.

- Those remaining 10 duty card holders assume a variety of responsibilities including site access control, operations management (advises the board, notifies families and liaises with the media), equipment control and distribution, provision of mine information, and portal control.

How the ERMP was activated on 19 November 2010

7. Douglas White, the site general manager, says he began to implement the ERMP about 4:30pm, almost 45 minutes after the explosion. His first steps were to allocate the duty cards and recall the senior staff who had left.[3] Mr White says that he does not know exactly which cards were issued or to whom or when, 'but the system was fulfilled with respect to ensuring we had enough people to manage the emergency at the time.'[4]

8. Neville Rockhouse had left the mine about 4:30pm, not realising that there was anything wrong. He was called back. On his return he arranged for the incident management room to be established and arrived in the control room shortly before 5:00pm. He says Mr White was holding the red emergency clipboard, which signified to Neville Rockhouse that the emergency procedures had been activated. Mr White said there had been an explosion. He decided to go up the mountain by helicopter to check on the auxiliary fan. Mr White says that before leaving he delegated some actions to Robb Ridl and Terence Moynihan, but he cannot remember what these were. He says he gave instructions that no one was to leave the site. In his absence, Neville Rockhouse became the incident controller and issued duty cards to various people as they arrived.

9. At 5:26pm the two survivors, Daniel Rockhouse and Russell Smith, emerged from the mine. No one was waiting there to provide immediate assistance. Daniel Rockhouse called the control room for help. Neville Rockhouse answered the call, but did not recognise his son's voice.

10. Production manager Stephen Ellis soon arrived in the control room and Neville Rockhouse handed over to him as incident controller, briefing him on events to that stage.[5] Neville Rockhouse then took a team and equipment to the portal to assist the two survivors.

11. Mr White says: 'Regrettably due to the fact that so much else was going on, I accept that I overlooked sending someone to the portal specifically to meet Daniel and Russell when they came out.'[6] He added that this caused no actual harm. It is correct that help was made available within minutes but only because Daniel Rockhouse had sufficient strength left after his ordeal to make his second call.

12. Under the ERMP Neville Rockhouse as safety manager should have been given Duty Card 7, which includes responsibilities for co-ordinating emergency services. Because one of his sons, Ben Rockhouse, was one of the 29 workers still in the mine, Neville Rockhouse was unable to assume the role. Mr White does not remember allocating it to anyone else.[7] He had given no thought to how the police or other emergency services would relate to the Pike IMT.[8]

Douglas White's view

13. Mr White believes he led the emergency response effectively until the police imposed their own incident management structure. When asked to comment on how the emergency structure set out in the ERMP worked, he said, 'None other than the fact that relatively speaking that's exactly how it worked on the day.'[9]

14. Throughout his evidence Mr White maintained that only hindsight revealed a major event had occurred. It was put to him that there was cause for concern from about 4:00pm based on five factors:[10]
    - communications (all telemetric information was down);
    - power was out throughout the mine;
    - no communication with the men underground;
    - the unusual smell; and
    - Daniel Duggan's view of events (discussed in Chapter 1, 'Friday afternoon, 19 November 2010').

    He answered, 'I would accept that there was cause for concern, in hindsight, but that concern also has to be verified.'[11]

Conclusions

15. Mr White was faced with a very difficult situation but it would have been more manageable had he started by following the company's ERMP. He was unfamiliar with its principles and detail. He did not take control of the incident. He handed over the incident controller's role to a more junior manager and went off to carry out an investigation of the ventilation shaft that he could have delegated.

16. Although time was of the essence Mr White was reluctant to call out the Mines Rescue Service (MRS) and the emergency services. He could have ordered this soon after the explosion, when he entered the control room and saw that all telemetric information had been lost, the power was off and there was no response to Mr Duggan's attempts to contact people underground. This was unprecedented and had serious implications

17. Only when Mattheus Strydom, the electrician who went underground after the explosion, left the mine at 4:25pm and reported in were the MRS and emergency services called. These delays appear to have made no difference to the survival of the 29 men, but Mr White was not to know that. Further, the delays could potentially have adversely affected the survival of Daniel Rockhouse and Russell Smith.

18. However, Mr White took the stance that an emergency had to be proved before external help was sought. The commission considers that it would have been better to activate the ERMP, including calling emergency services and the MRS as soon as it was clear that the situation was unprecedented, in that all information from the mine was lost and no contact could be made with the men underground. If the situation somehow proved to be not serious, then the MRS and emergency services could have been stood down.

Police control of the emergency

19. The police consider they took the lead agency role at the mine in line with the co-ordinated incident management system (CIMS) model, that they applied that model, albeit with some necessary amendments, and that it worked well.[12] This section summarises the CIMS model and tests the police viewpoint, then assesses the effectiveness of the police-led response and identifies lessons for the future.

CIMS

20. CIMS was designed in 1998 on the initiative of the New Zealand Fire Service (NZFS). Its overall purpose is 'Safer Communities through integrated emergency management'.[13] It is aimed at the various agencies that provide emergency services, especially the police, ambulance, fire and Civil Defence. It provides a common management structure, principles and terminology which enable the production of consolidated incident action plans (IAPs). These, in turn, allow effective use of the total resources across the agencies.

21. CIMS is built around the concept of one incident controller and three managers acting under his or her authority, as the diagram below shows. These are the manager planning/intelligence, the manager operations and the manager logistics. These four people make up the incident management team (IMT). Under the CIMS model there is only one incident controller and only one IMT, which operates from one incident control point (ICP).

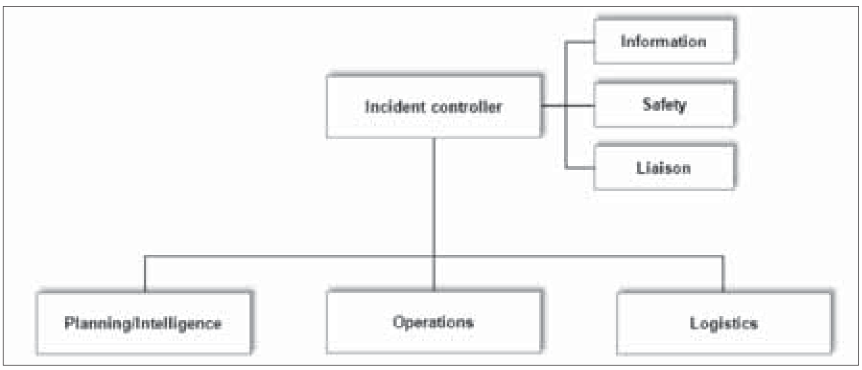


Figure 16.1: Co-ordinated incident management system

22. The incident controller provides the overall direction and co-ordination of the emergency response. There are two concepts used – control and command.

23. 'Control' is exercised horizontally across agencies through a consolidated IAP approved by the incident controller. 'Command' operates vertically within a single agency, at a level below the IMT. The incident controller does not command those agencies.

24. The manager planning/intelligence gathers and evaluates information and creates the consolidated IAP, which defines response activities and the use of resources. The IAP is for a specific time period (usually of hours) and is regularly renewed. The manager operations contributes to the IAP and implements it. The manager logistics also contributes to the IAP and provides facilities, material, equipment, services and resources, including people, as required to implement the plan.

25. Incidents that occur at multiple sites require an incident controller and IMT at each. This may in turn require overall co-ordination, in which case a response co-ordinator is appointed to provide higher level support. He or she works from a separate emergency operations centre, usually an existing facility. The response co-ordinator does not have an operational function but may provide support in planning/intelligence, logistics, liaison with others involved, and communications. In that event he or she is responsible for approving an incident co-ordination plan that aligns the individual IAPs.

26. The CIMS manual appears to suggest that a response co-ordinator may be necessary for a major incident at a single site, but this is not explicit. Regardless, the manual stresses that incident controllers remain in control of their incidents.

27. The CIMS model assumes one agency will lead the response and other agencies will provide support. The lead agency is determined either by legislation or by agreement among the agencies. The CIMS manual and the NZFS manual assume that the incident controller will come from the lead agency. The manual does not contemplate the involvement of private enterprise and individuals.

So much for the principles. How were they applied in practice?

The police decide to take control

28. The first policeman at the scene was Sergeant David Cross, the duty sergeant at the Greymouth police station. He arrived at 5:13pm. He was accompanied by Constable Shane Thomson. Soon after arrival Sergeant Cross says he met Mr White and Mr Ridl and received brief information. Sergeant Cross says that after the meeting he:

- advised Police Southern Communications that he 'had command and control', that the MRS would be the lead agency for any re-entry or rescue attempt and that ambulance services would be the lead agency for any injured miners;
- established an incident control point in the conference room in the administration building; and
- assumed the role of incident controller.[14]

Sergeant Cross 'did not ask Mr White what plans they had in the event of an explosion in the mine, or for a rescue, as I knew we had to wait for the MRS to arrive and start that process.'[15]

29. From that point on Sergeant Cross directed police staff at the mine and had various dealings with Mr White and Pike River Coal staff, the MRS, the NZFS and DOL. He stated:

> *At no time were police involved in making any decision about promoting or preventing a rescue. We were relying on the advice being supplied by Mines Rescue staff and Pike River Coal senior management, in particular Mr White regarding this issue.*[16]

It is clear that the police had not set up a CIMS structure.

30. At 5:40pm, Deputy Commissioner Rob Pope at Police National Headquarters (PNHQ) advised Superintendent Gary Knowles that the police would be the lead agency for the emergency. There is no evidence that other emergency agencies or Pike were consulted.

31. Superintendent Knowles was commander of the Tasman Police District. He was instructed to go to the mine and take control of the operation. Superintendent Knowles had already instructed Inspector John Canning in Greymouth to go to the mine and 'take command'[17].

32. Inspector Canning arrived at the mine at 7:40pm on 19 November and left at 2:30am on 20 November. He attended a number of meetings and issued some instructions to Sergeant Cross. His role under the CIMS structure is unclear: he did not take over as incident controller and does not appear to have assumed the command function.

33. Sergeant Sean Judd arrived at the mine at 11:30pm. He took over from Sergeant Cross as police incident commander at 12:30am on 20 November.[18] He requested the participants meet hourly in the incident control room.

> *It was apparent to me that that it was time to put in place a more formal Incident Management Team system under the Coordinated Incident Management System model which Sergeant Cross had started.*[19]

34. Meetings were then held approximately hourly, attended by representatives of the police, the NZFS, St John Ambulance, the MRS and Pike management. There was some confusion about the roles of the participants because the IMT structure was not applied. At the 3:00am meeting Sergeant Judd tried to clarify the situation. According to the MRS:

> *The Police Incident Controller Shaun [sic] Judd then said that the Police were the lead agency in charge of the search and rescue operation … [He] emphasised the importance of having a strong IMT structure on-site. He stated that the Police were not experts in mining and would be taking advice on mining related matters (including from MRS) but their role was to ensure that there was an effective IMT and that decisions were documented.*[20]

35. The first IAP was developed early on 20 November and covered the period from midnight to 8:00am. Although incomplete regarding objectives, it did bring together situation reports prepared by the police, ambulance, the NZFS and Pike. The IAP noted that '[t]he Police and supporting Emergency Services are working with Mine Management team to provide a comprehensive Incident Action Plan.'[21] An IMT based on CIMS principles was not established; rather, the control and command functions were fused.

36. Later that morning Inspector Canning arrived with Senior Sergeant Allyson Ealam and Sergeant Judd formally handed over to Inspector Canning as 'forward commander', the police officer in charge at the mine, with Senior Sergeant Ealam as second in charge.[22] An IMT based on CIMS principles was not established.

Clarity of decision-making structure in the first 24 hours

37. It is unclear at this stage who belonged to the IMT in terms of the CIMS model. Sergeants Cross and Judd and Inspector Canning appear to have been forward commanders in line with the police command structure, but not incident controllers.

38. Certainly the decision-making structure set up by the police was unclear to some key participants, at least initially. Mr White stated that he realised the police were in charge when he returned to the mine at 6:00pm on 20 November.[23] He was not familiar with CIMS, although he had heard of it.[24]

39. Mr Ellis says he was chairing the IMT at night and Mr White during the day. He says this continued through the emergency period, though by 20 November he was aware the police had taken charge. For reasons unknown to Mr Ellis, on Tuesday 23 November the police decided to chair the 11:00am and 1:00pm IMT meetings, but then the police asked him to resume chairing later meetings.[25]

40. Neither Mr White nor Mr Ellis understood at first that key decisions were to be made elsewhere. This became apparent as the emergency continued. Mr White says he knew by 6:00pm on 20 November that all decisions were being channelled back to Wellington and he concentrated on participating in the police process.[26]

41. The lack of a clear CIMS structure complicated the emergency response at the mine. This was exacerbated by the roles taken by senior police officers and DOL at Greymouth and at PNHQ. This resulted in a hierarchy with at least three levels, slowing down decision-making.

Greymouth

42. Superintendent Knowles had no formal training on the CIMS model but did have experience in it.[27] He described the response arrangements as follows:[28]

- Inspector Canning was the forward commander, based at the mine. His function was 'tactical';
- Superintendent Knowles was incident controller, based in Greymouth. His function was 'operational'; and
- Assistant Commissioner Grant Nicholls was the response co-ordinator, based at PNHQ in Wellington. His function was 'strategic'.

43. On his initial four- to five-hour visit to the mine on the night of 19–20 November Superintendent Knowles did not personally clarify to people at the mine who was the incident controller under the CIMS model. He explained:

> *I didn't because prior to my arrival I told Inspector Canning to take command and do that, and also when I arrived it was obvious to me that Sergeant Judd was wearing a fluro [sic] jacket which said 'Incident Commander' and everyone can see it.*[29]

44. In any event, after that initial visit Superintendent Knowles operated from Greymouth. He says he visited the mine 'three or four times' over the first two days but stepped back so he could make decisions outside the emotional environment prevailing there.[30]

45. It follows that Superintendent Knowles did not lead the IMT. He spent his time mainly on communications, including regular briefings of families, media, liaison with other agencies and liaison with PNHQ. These activities were onerous and took six to eight hours a day, including preparation.[31] Superintendent Knowles had 17 people to assist him at Greymouth but lacked the benefit of expert mining advice, unlike the forward commander at the mine.[32] He did not appoint an officer to run the separate information function envisaged by CIMS, which is a dedicated resource for communications with the media.

46. Superintendent Knowles could also have appointed an officer to brief the families, but did not do so initially because he had not realised how complex and lengthy the operation would be. Once committed to the regular family meetings, he did not delegate the responsibility to someone else as he felt that would be seen as having 'backed away' from the families.[33]

47. Superintendent Knowles was the public face of the police operation but did not perform the incident controller role as described in CIMS.

Wellington

48. Assistant Commissioner Nicholls, based at PNHQ, described his role as follows:

> *It is the job of the Response Coordinator, operating at a strategic level, to also ensure that the staff on the ground have what they need to act and to ensure that the decision making process includes a robust risk assessment. The problem solving (working out what is to be done) comes from those at the scene (Forward Command and the Incident Controller) while Police National Headquarters provides the means to ensure that what is required is available … The strategy is the domain of the Response Coordinator while the Incident Controller manages the incident at a direct level working closely with Forward Command.*[34]
>
> *The Risk Assessments were completed at Forward Command with the input of the various experts and agencies on the ground at the mine site. The plans were then forwarded to the Incident Controller who reviewed them with the group of experts he had available. The Assessments [sic] were then sent to the*

Response Coordinator for checking and final approval … I liaised with other agencies involved in the operation … As the operation progressed I drew on a core panel of experts who provided a review of the risk assessments.[35]

Power to decide

49. Although Superintendent Knowles had been told at the outset that he had overall command of the operation, that role was in reality assumed by Assistant Commissioner Nicholls at PNHQ. This became clear as difficult issues relating to re-entering and sealing the mine came to the fore. On Monday 22 November Superintendent Knowles received detailed instructions from Assistant Commissioner Nicholls about what he could and could not decide. Superintendent Knowles said, 'I personally didn't need it … I felt someone in higher command probably thought it was an aid to me.'[36]

50. Assistant Commissioner Nicholls agreed that, with the benefit of hindsight, many of the decisions he took should have been left with the incident controller. However he maintained that two key decisions – entry to the mine by rescuers and sealing the mine – were correctly made in Wellington.[37]

51. It is clear that the police regarded those decisions as too weighty for one person and as having national and international significance, and therefore requiring approval at the very top of the police structure.

Functioning of the IMT

52. The police filled all the IMT positions with their own people. The police started what were described as IMT meetings, although neither the police incident controller nor the police forward commander chaired them. Several participants have commented on the large numbers of attendees.[38]

53. Darren Brady is a senior manager from Queensland's Safety in Mines Testing and Research Station (SIMTARS) and heads the SIMTARS emergency response team. In that capacity, he has experience in responding to mine emergencies and attending state-wide emergency exercises using the mine emergency management system (MEMS), Queensland's mining equivalent of CIMS. Mr Brady was at the mine to provide expert advice on gas monitoring and interpretation. He commented:

In my opinion far too many people were attending these meetings with several organisations over-represented. … If structured planning, logistics and operation groups had been formed there would be no need for many of those attending the IMTs to be there.[39]

Activities in these areas appeared to be done by individuals assigned the task, often directly from the incident management team meetings. … The process would operate differently in Queensland under the Mine Emergency Management System … with each of the three groups having their own meetings and generally only the co-ordinator of each group attending the IMT meetings. … This lack of structured groups under each of the co-ordinators may be attributed to the fact that the police were filling these roles.[40]

Access to expert advice

54. The numerous technical matters (for example, on the mine's atmosphere) arising from the emergency were complex and required expert advice. Contrary to Assistant Commissioner Nicholls' understanding, Superintendent Knowles did not have a separate group of experts to assist him at Greymouth. Superintendent Knowles described himself, rightly, as 'the meat in the sandwich' between the mine and PNHQ.[41]

55. The group of experts at the mine available to assist the forward commander included a range of highly qualified and experienced people drawn from New Zealand and overseas. For example, at least seven of the 13 mine managers in New Zealand with first class coal mine manager's qualifications were at Pike River.[42] Those qualifications require knowledge of emergency response in underground coal mines.[43] The rescue/recovery plans being prepared at the mine had varying degrees of input from the experts there, including those mine managers, representatives of the mines rescue services of New Zealand, Queensland and New South Wales, and SIMTARS.

56. Risk assessments prepared at the mine were reviewed by Superintendent Knowles and DOL staff elsewhere in Greymouth. Superintendent Knowles then sent the assessments to Wellington to be signed off by Assistant Commissioner Nicholls. Neither Superintendent Knowles nor Assistant Commissioner Nicholls has mining expertise.

57. Assistant Commissioner Nicholls did not appreciate the level of the expertise available at the mine,[44] and was seeking other expert advice before he signed off the risk assessments. From the morning of 20 November he was in regular contact with James Stuart-Black, national manager, special operations, NZFS. But it was not until 24 November, nearly five days after the first explosion, that Assistant Commissioner Nicholls convened a panel to assist him. The panel was drawn from the national offices of DOL and the NZFS, together with Dr John St George, a mining geologist. Although these people were obviously of assistance, they lacked the relevant mining expertise already available at the mine. By the time of the second explosion on 24 November PNHQ were still trying to find other experts to assist Assistant Commissioner Nicholls.[45] Dr St George had already told him that the experts at the mine were the best available.[46]

Conclusions

58. The police were faced with a major emergency that did not appear to be under control. They clearly created some initial order by, for example, setting up meetings and starting to prepare IAPs.

59. The police were unaware of Pike's ERMP and there was no discussion about melding the ERMP structure and the police command structure.

60. The PNHQ decision to take control was almost immediate. It was made with no reference to Pike or other agencies. Although this speed was entirely understandable, it was essential that the police confirmed to others their assumption of control and incorporated mining expertise into their decision-making.

61. Filling one or more of the three subordinate positions in the IMT from organisations other than the police would have made up for their lack of mining expertise and experience in responding to emergencies in underground coal mines. Instead the police imposed their normal command structure (operational command and forward command) plus a remote decision-making function based in Wellington.

62. The commission does not accept that the police correctly implemented the principles of the CIMS model at Pike River. It is fundamental that there be one incident controller, located at the incident control point, who controls the direction and co-ordination of the emergency response. He or she decides whether to approve response actions contained in IAPs formulated by the IMT. A response co-ordinator, if one is appointed, does not have an operational function, but may approve a co-ordination response plan. Instead of following the CIMS model, the police set up a complicated three-tiered structure that removed control from the incident controller to a Wellington-based response co-ordinator, who made decisions with assistance from a non-expert panel. The CIMS model is not inflexible, but in this case it was stretched beyond breaking point.

63. The consequences of the police's structure included:

- an inability for the IMT and the incident controller to act quickly and decisively;
- decision-making divorced from the reality of the situation at the mine;
- key decisions, including those about re-entering and sealing the mine, being seen as matters for the police hierarchy, rather than decisions for experts at the mine;
- a lack of early parallel planning on such vital issues as the survivability of the 29 men and the steps required had they not survived, such as procuring equipment to seal the mine;
- a bureaucratic approach to the risk assessment process; and
- non-experts trying to review expert findings on such matters as gas analysis or a drilling proposal.

Role of the Department of Labour (DOL)

64. DOL administers the Health and Safety in Employment Act 1992 (HSE Act). During emergencies, DOL retains its ability to prohibit activities if they may result in serious harm to any person. It also has a role in investigating accidents to determine if there has been a breach of the HSE legislation.

65. DOL provided assistance to the emergency response at the mine, at Greymouth and in Wellington. From a statutory viewpoint DOL had no role in making decisions on the emergency response but was drawn into doing so at Pike River.

DOL assistance

66. DOL Deputy Chief Executive (Labour Group), Lesley Haines, was told about the explosion about 5:00pm on 19 November 2010. She sent to the mine DOL employees who might be able to assist. The first to arrive was mines inspector, Kevin Poynter, about 7:30pm. Ms Haines said:

> *The department's role in the search, rescue and recovery operation was in the provision of technical information and advice about mining and safety issues. My own role was leadership of the department's activities relating to the incident. In the search and rescue phase ... the department made available two mines inspectors, both of whom had technical expertise in mining, held a first class mine manager's certificate and were familiar with the mine.*[47]

67. Other staff were also made available at the mine and a temporary office was set up in Greymouth, headed by the DOL regional manager. Ms Haines also assisted with decision-making at PNHQ in Wellington. Thus DOL was represented at the three levels of the structure established by the police. Ms Haines says DOL participated in the risk assessment process at the request of the police.[48]

68. DOL staff, sent to the mine with the vague mandate to provide 'technical information and advice', got drawn into decision-making. Their role caused confusion for other participants. For example, the police thought that 'the Mine's Inspector had ultimate responsibility for authorising any plan.'[49] This misunderstanding may have been caused by DOL's power to issue a prohibition notice. DOL inspectors had referred to this during discussions about sealing the mine.[50]

69. Ms Haines accepted that 'our role wasn't that clear at the frontline' and that the confusion extended beyond the police.[51] In fact there was confusion beyond the frontline. Ms Haines considered that DOL people were not involved in decision-making,[52] but documentary evidence of DOL 'approving' risk assessments showed otherwise.[53] Ms Haines is correct, though, when she says that the ultimate decisions lay with the police.

Regional manager

70. On 23 November DOL regional manager, Sheila McBreen-Kerr, tried to define the decision-making process for risk assessments flowing through the three levels.[54] This appears to have been driven by suggestions of delays on DOL's part. The elements of the process she described were:

- MRS staff and others at the mine formulate plans and risk assessments. DOL people at the mine provide input.
- The police command centre at Greymouth receives a risk assessment and asks for a DOL review. DOL staff at Greymouth review it, advise police and copy to DOL in Wellington.
- PNHQ receives the risk assessment for approval. DOL's national office provides consent or seeks a review.
- PNHQ approves the assessment (or not) and advises the mine.

Conclusions

71. DOL had no people with relevant mining expertise, other than those at the mine. Other DOL staff at Greymouth and Wellington became part of the cumbersome three-tiered response structure. The DOL staff in Wellington were too far from the action and did not have the expertise to understand the issues and make quick decisions.

72. DOL is to be commended for seeking to help with the emergency response but, along with the police, became part of a bureaucratic process that slowed down decision-making.

The risk assessment process

73. An integral aspect of the search and rescue operation was the assessment of the risks associated with intended actions. The police, as the lead agency, required a risk assessment for all hazardous activities. It was prudent to adopt such a strategy.

74. The commission received extensive evidence concerning the effectiveness of the risk assessment process. This included evidence of people from all the agencies involved in the search and rescue operation at the mine, and from the police, DOL and the NZFS.

Conclusions

75. The commission concludes that:

- The risk assessment structure was cumbersome, involved too many levels and had the potential to cause delay. The actions being assessed for risk required prompt decision-making.
- The police did not effectively harness the abundance of Australasian mining expertise at the mine. This included members of the New Zealand, Queensland and New South Wales mines rescue services, SIMTARS representatives and Solid Energy New Zealand Ltd and Pike employees. Several held New Zealand first class mine manager's qualifications and similar Australian qualifications.
- Under CIMS, decision-making should happen at the incident control point where the incident controller is stationed. Risk should be assessed onsite using the services of experts who have both the necessary technical knowledge and a first-hand understanding of the incident. Some experts became disillusioned as operational decisions were made at a distance without their input. One expert left the mine on the evening of 21 November after concluding he could not make a positive contribution, given the structural arrangements and the focus of the rescue effort.[55] Others contemplated withdrawing from the operation.[56]

Assessment of survivability

76. Discussion of the cause and timing of the men's deaths begins at paragraph 160. The following discussion concerns the process of assessing survivability.

77. When and how should survivability have been assessed during the search and rescue operation? The commission received much evidence that showed the assessment of survivability must begin very early in an operation.

78. A decision about survivability is of fundamental importance. It determines whether an operation focuses on rescue or recovery. But it also affects other operational decisions, including whether the mine should be sealed.

79. At Pike River survivability was not properly confronted until after the second explosion, on the afternoon of 24 November. The assessment should have begun at the first reasonable opportunity, i.e. during the morning of

Saturday 20 November. Suitably qualified experts onsite should have evaluated the available mine information and suitably qualified medical practitioners should have been placed on standby to provide medical opinions as soon as sufficient information was available.

80. Although a decision about survivability would not necessarily have been possible early on, it was essential for the process to begin, so that the matter could be progressively assessed as further information came to hand. The police as lead agency did not fully comprehend the importance of that decision. Had there been advance interagency planning for a catastrophic mine disaster, the question of survivability would have been identified as crucially important and there would have been a process for its evaluation. This is an essential requirement for the future.

Sealing the mine

81. After an underground coal mine explosion there is an ever-present risk of secondary explosions. Their occurrence is likely to damage the mine infrastructure, increase the risk of roof collapse and decrease the chances of body recovery. One possible defence is to seal the mine and starve the underground atmosphere of oxygen. Sealing and inertisation may stop the dilution of methane to explosive levels and prevent further explosions. However, depending on the underground conditions, sealing may also promote an explosion. Sealing will change those conditions, which may bring an explosive fringe and an ignition source into contact.[57] The other dilemma is that sealing is not an option while life underground remains even a possibility. As one witness said, it is a 'damned if you do and damned if you don't situation'.[58]

82. The commission received consistent evidence from mining experts, including the MRS and Solid Energy, that like survivability, the associated question of sealing the mine should have been considered earlier at Pike River. Everyone agreed that a decision to seal the mine was extremely difficult, given the possibility of survivors underground. But they all expressed concern that a plan and the means to seal the mine should have been in place, ready to be implemented as soon as it was decided there were no survivors.

83. The origin of this problem appears to have been in events that occurred over the first weekend. On the evening of 20 November MRS personnel met and discussed survivability and whether the portal and main vent shaft should be sealed. The group concluded there was only a remote possibility anyone had survived the blast and investigation of the sealing option should begin immediately.[59]

84. At an incident management meeting after midnight, Seamus Devlin, the state manager of the New South Wales Mines Rescue Service, raised the need to consider sealing the mine. This was rejected until there was zero chance of survival.[60]

85. The next day the MRS recommended a sealing plan at the 6:00pm meeting of the IMT. However, DOL officers David Bellett and Johan Booyse indicated they had been advised that any decision to seal the mine would not be approved unless it was clear no one was alive in the mine.[61]

86. It seems that the police and DOL reactions to a sealing recommendation inhibited further discussion. Douglas White, however, approached the executive director of SIMTARS, Paul Harrison, concerning deployment of the Queensland Górniczy Agregat Gaśniczy (GAG) inertisation unit at Pike River. He also met the police at the Greymouth police station on 23 November, accompanied by Mr Brady of SIMTARS. They explained the capability and deployment of the GAG at the meeting. The response was to begin preparations to bring it to New Zealand, but 'we don't want it in the car park'. This was because the presence of the GAG would send a message that the operation was moving from rescue to recovery.[62] This was not in line with effective parallel planning, which requires concurrent planning for alternative courses of action.

87. Structured planning to seal, and inertise, the mine was delayed until after the second explosion on 24 November.[63] A decision to bring the GAG to New Zealand was made, and the unit and an operating crew left Mackay on the

evening of 25 November and arrived at the mine site the next day. Had there been parallel planning this timeframe would have been shorter. There were two more explosions on 26 and 28 November 2010, before the GAG was commissioned on 1 December, following the construction of a seal and docking station at the portal.

88. The police accepted the need for the GAG, but were reluctant to bring it to New Zealand while the recovery phase continued. However, as Superintendent Knowles acknowledged, better parallel planning is desirable in the future.[64] There is also a need for advance planning at mine sites, so that an inertisation unit can be readily deployed.

The availability of information on 19 November 2010

The number of men in the mine

89. There is a regulatory requirement to maintain a record of all employees underground, which is to be 'kept at the entry point.'[65] At Pike River two systems were used to record employees' entry into, and exit from, the mine: a tag board system, and an electronic system known as Northern Lights.

90. The tag board was the main means of tracking who was underground. All Pike employees and contractors were given an individual tag that incorporated a personal photograph and identifying information. Each worker had to hang their tag on the tag board immediately before going underground and retrieve it as soon as they returned to the surface. Initially the tag board was placed at the portal of the mine, but it was later moved to a position outside the lamp room at the administration area, about 1km from the portal entrance.

91. Workers did not always hang or retrieve their tags. Between July 2007 and October 2010 there were 15 incident reports listing instances of non-placement and non-removal of tags, and other irregularities that compromised the reliability of the tag board system.[66] On 19 November 2010 there were 34 tags on the tag board. The correct number of men underground could not be verified for several hours. This complicated the rescue operation and caused distress to anxious friends and family.

92. The Northern Lights system was acquired in 2008 before the mine reached the coal measures. A microchip was located within intrinsically safe battery packs attached to the men's belts. A scanner was installed at the portal to track the entry and exit of men from the mine. The plan was to install further scanners at additional locations inside the mine as it developed.

93. Neville Rockhouse said the scanner could not detect the microchip if men were 'sitting inside a steel cage' as they travelled on a vehicle into the mine. He said engineering staff were made aware of the problem and were working with the manufacturers to obtain a solution. Despite the problems, he believed the system was still in use at the time of the explosion.[67]

94. The Northern Lights scanner reported to the Pike River control room. Those who had access to the control room computer could check and establish who was underground. An incident report dated 8 November 2010 recorded that the Northern Lights system 'needs new parts and hasn't been running for a long time.'[68]

95. The commission is satisfied the Northern Lights system was not in use on 19 November and that the tag board was not always accurate.

The atmosphere in the mine

96. In an underground emergency, being able to obtain reliable and representative samples of the mine atmosphere is essential. Mines rescue crews depend on this information to determine whether it is safe to enter the mine, and other crucial decisions, including human survival, depend on its availability. The emergency response was impeded by the inability to obtain representative gas samples from the mine and the inadequacy of the available pre-explosion gas data.

97. Fixed sensors were located underground at Pike River. The problems with their location and functioning are described in Chapter 10, 'Gas monitoring'. After the first explosion reporting from all sensors was lost. Although the

sensors were fitted with uninterrupted power supply units, it is likely the sensors or their wiring were damaged in the explosion.[69] Pike did not have alternative equipment designed to obtain gas samples from within the mine, should the sensors fail and access be restricted. Makeshift methods had to be developed.

98. During the early evening of 19 November Mr White authorised employees to fly to the main vent shaft with hand-held monitoring devices and sample bags to obtain atmospheric samples. This was hazardous, as the men had to enter the fan housing to gain access to the top of the shaft. Another, more fruitful initiative was to position flexible tubes down the vent shaft and connect those to a stomach pump, lent by ambulance personnel, which could suction samples from lower down in the shaft.[70]

99. Bag samples obtained by hand or by use of the stomach pump were flown to the mines rescue station at Rapahoe. A gas chromatograph analysed the samples. By about 9:30am on 20 November a SIMTARS team from Queensland arrived at the mine, armed with two gas chromatographs. This allowed concurrent analysis of samples at two sites, followed by a comparative evaluation of the results across a significant spectrum of gases.[71]

100. Samples were mainly taken from the vent shaft and were unlikely to be representative of the atmosphere in the mine. There was a natural ventilation flow from the portal up the vent shaft and vice versa following a ventilation reversal. This meant that the gas readings from vent shaft samples were probably diluted by the ventilation flow. The readings obtained could represent half or even less of the actual gas concentrations in the mine workings.

101. In addition to real-time telemetric gas monitoring systems, many mines install a tube bundle system. It does not require sensors, which are susceptible to damage in an explosion. The disadvantage is a time delay between taking and analysing each sample. At Pike River this delay would have been at least 20 minutes – the time required to draw a sample from the mine to the surface.

102. The company had budgeted to install a tube bundle system by mid-2011. Had this happened before 19 November 2010, it is likely that atmospheric monitoring from at least some locations in the mine would have continued after the explosion. SIMTARS sourced a 10-point tube bundle system, which was commissioned on 13 December and used extensively from then on.

Additional bore holes

103. During the rescue the only surface-to-mine access points were the vent shaft, the slimline shaft and the grizzly borehole. The latter was of limited value because of its location in the drift, where there was a natural ventilation flow. The limited number of, and problems with, the available sampling locations resulted in a decision to drill additional boreholes into the heart of the mine. The preferred location for the first drillhole, PRDH43, was a short distance outbye of the hydro panel to intersect the main return roadway back to the area of the underground fan and vent shaft.

104. Once this location was chosen, a helicopter transported a drilling rig to the hillside site. Drilling began on 21 November and strenuous efforts were made to work as quickly as possible. About 5:00am on 24 November the drillhole reached the required depth, but it had struck the rib wall rather than the roof of the roadway. Within a few hours, however, there was confirmation that gas from the mine was entering the borehole and sampling could begin.

105. After analysis of the first samples, Mr Brady of SIMTARS concluded that 'this data was enough to indicate that an ignition source existed, possibly where an explosive mixture could form so the decision was made that it was not safe to send mines rescue teams into the mine.'[72] That ended any notion that the underground atmosphere had improved sufficiently to consider re-entering the mine that day. A short time later, at 2:37pm on 24 November, the second explosion occurred.

Use of robots

106. The New Zealand Army provided robots and support crew for use at Pike River. Atmospheric testing equipment was installed and a robot was sent into the drift on 23 November. It travelled 550m before failing, probably

through contact with water. A second robot was obtained and deployed on 24 November. It provided audio-visual information to 800m and then failed. However, power was restored to the first robot and it travelled to 1050m before power was again lost. Both robots remain in the mine.

107. The use of the army's robots in an underground coal mine had not been contemplated before the explosion at Pike River and considerable ingenuity was required to modify the robots for use in a mine.

108. A robot belonging to the Australian Water Corporation was also flown to New Zealand and sent into the mine on the night of 25–26 November. It was equipped to monitor gas levels and transmit audio and visual data. The robot penetrated to 1570m, encountered Mr Smith's abandoned loader and then retreated, having confirmed that the atmosphere in the drift was normal.

Was there a 'window of opportunity'?

109. Immediately after the first explosion there was high public expectation that MRS teams would enter the mine and endeavour to rescue the men, or at least recover their bodies. When a rescue operation did not eventuate, there was disappointment, even frustration.

110. This was probably understandable. Following the Strongman mine disaster near Greymouth in 1967, which claimed the lives of 19 men, a rescue team entered the mine and within 14 hours recovered all but four of the bodies. Similarly, in the 1926 Dobson mine disaster, rescuers entered the mine soon after the explosion and recovered the bodies of four of the nine victims. These, and other, mine tragedies gave rise to a belief that, after an explosion, there was a window of opportunity within which it was possible to enter the mine safely. The assumption was that the explosion would have consumed the methane in the mine atmosphere, and that there was time to re-enter before the methane built up again.

111. There are, however, just as many examples of second explosions that claimed the lives of would-be rescuers. In August 2010 a rescue team entered the Raspadskaya coal mine in Western Siberia before a second explosion, which occurred about four hours after the first one and killed 19 rescuers. In other mines secondary explosions have occurred within even shorter periods, sometimes within only minutes of the first explosion.[73]

112. The commission had the benefit of expert evidence concerning the so-called window of opportunity, and it all pointed one way. Mines rescue experts from both Australia and New Zealand agreed that, even with the benefit of hindsight, there was no window within which the Pike River mine could have been entered.[74] The witnesses also explained the basis for their view.

113. First, all mines are different and even sections within a mine may differ. Without accurate and representative information, the atmosphere in an underground coal mine cannot be predicted. That difficulty is particularly acute when the mine ventilation system is not functional as the coal seam continues to produce methane. Damage to the methane drainage system may also add to the accumulation of methane. After an explosion there is also a significant risk of a continuing ignition source, or fire, within the mine. These factors create an unpredictable situation, during which secondary explosions are commonplace.

114. Before re-entry is a safe option there must be reliable and representative information about the conditions underground, especially the make-up of the mine atmosphere and the risk of fire or an ignition source. No information of this kind was available at Pike River. Throughout, the experts onsite were unanimous that, without better information, a safe re-entry was not possible.

115. Second, the concept of a window of opportunity presupposes a time of known duration within which rescuers may safely remain within the mine. Trevor Watts, the general manager of the MRS, gave evidence concerning the time required to enter Pike River and inspect the areas where the men were believed to be working. He explained that ideally a rescue team would have been able to drive the first 1600m into the drift in a driftrunner. At this point the team would have encountered the abandoned loader and if possible, moved it.[75] Even so, from the end of the

drift a reconnaissance on foot would have been required. The rescuers would have worn long duration breathing apparatus. This was rated to provide four hours of oxygen, but rescuers operate to a one-third rule. That is, the duration of the breathing unit is divided into three: a third for search activity, a third to leave the mine and a third in reserve. This would provide a period of 80 minutes to search the mine workings. Mr Watts considered it would take much longer than this for a team to conduct a search, particularly if there was explosion damage. He thought that more than one entry into the mine would be required.[76]

116. The commission finds that there was no window of opportunity to enter the Pike River mine in the days following the first explosion. There was little or no reliable and representative evidence of atmospheric conditions within the mine to determine whether there was a fire or an ignition source underground. There could be no assurance of safe re-entry, and the decision not to enter the mine was correct.

Self-rescue

117. The term self-rescue refers to the ability of someone to escape from an underground mine after an emergency, without direct assistance from others. History has shown that after an underground fire or explosion very few miners worldwide are saved by mines rescue teams. If miners cannot self-rescue, it is likely that rescuers will not be able to go underground in time to save them. In order to escape miners need immediate access to breathing units and other equipment and aids, as well as emergency training.

Self-rescuers

118. Miners and contractors at Pike River were provided with Dräger Oxyboks K self-rescuers, contained in a canister that can be attached to the user's belt. The self-rescuers contain a chemical substance, which reacts with exhaled carbon dioxide and water vapour to liberate respirable oxygen. It supplies oxygen for about 30 minutes, depending upon the wearer's level of activity and breathing rate.

119. It was standard practice at Pike River for employees to carry a self-rescuer when going underground. The company also provided an underground store of spare self-rescuers. There were 108 self-rescuers stored in two large heavy-duty plastic boxes located in the slimline shaft stub, also known as the upper fresh air base (FAB). Some of the stored self-rescuers were one-hour units.

120. The Dräger self-rescuers were fit for purpose and should have enabled a trained person who survived the explosion to walk to the slimline shaft, obtain a spare unit and escape from the mine via the drift.

121. Concerns about the adequacy of the self-rescuer training arose out of the evidence of two of the three men who were in the mine after the explosion. Despite his concern that there had possibly been an explosion underground, Mattheus Strydom did not carry a self-rescuer with him when he drove into the mine at 4:11pm. He was forced to retreat when he encountered the fringe of an irrespirable atmosphere.

122. Daniel Rockhouse did have a self-rescuer, but found on 19 November that using one in a real emergency was a 'different story' to training with a dummy self-rescuer.[77] He donned the device but could not make it work. He then removed and discarded the self-rescuer, succumbing to the irrespirable atmosphere a short time later. Daniel Rockhouse had not participated in an emergency drill in his two and half years at the mine.

123. Training in self-rescuers should include participation in regular exercises using self-rescuers. Those exercises must simulate, as much as possible, the conditions and stress of an actual emergency. Workers must also receive regular refresher training in use of self-rescuers. That did not happen at Pike River.

Compressed air breathing apparatus (CABA)

124. CABA is similar to underwater scuba diving gear. Strapped to the user's back is a compressed air oxygen cylinder that is connected to a positive pressure full face mask. CABA has several advantages over self-rescuers. It is easier to

use, allows its wearer to speak to others and rehydrate, and enables the wearer to undertake other activities such as fire fighting and helping others to escape.

125. There were no CABA units at Pike River. Self-rescuers were the only breathing units available to the workers, although the introduction of CABA was being contemplated.

Changeover stations/fresh air bases/refuge chambers

126. To use self-rescuers and CABA units workers must have a safe place to which they can go in the course of an evacuation. Workers will ordinarily need to exchange their self-rescuers for fresh ones, or exchange them for CABA. A safe place may be a changeover station, an FAB or a refuge chamber.

127. A changeover station is the least sophisticated option and could be as simple as a small space created in a stub using brattice. Fresh air is introduced permanently or temporarily. It is at higher risk of contamination than FABs or refuge chambers. A FAB is generally a constructed and maintained room-like facility properly sealed to maintain a respirable atmosphere inside, even during emergency conditions. Communication and escape equipment are also available. Refuge chambers are the most sophisticated option. They are purpose-built steel rooms, which are usually moveable and provide a continuous source of fresh air from the surface. They contain replacement breathing units (self-rescuers or air cylinders), a communication link to the surface, first aid equipment, food and water.

128. In a coal mine the first objective is always for workers to rescue themselves given the risks of explosions and a toxic atmosphere. If for some reason they cannot do so a refuge chamber provides a place where they may wait in relative safety for rescuers to arrive. Refuge chambers are more commonly used in metal mines, where there is normally no gas and the major risk is of a roof collapse.

129. Pike did not have a refuge chamber. Although Neville Rockhouse raised the purchase of one in late 2009, nothing came of his suggestion.

130. Two locations in the Pike River mine were described as FABs. The first, referred to as the lower FAB, was in the stone drift 1500m inbye of the portal. The second, known as the upper FAB, was in the stub containing the slimline shaft near Spaghetti Junction.

131. The lower FAB was installed by McConnell Dowell during the development of the drift. Located in a stone stub, it was a converted container with sealable double doors. At the time of the explosion it had been decommissioned and was no longer supplied with compressed air. The telephone connection to the surface was not working and replacement self-rescuers, first aid equipment and fire-fighting equipment had been removed.

132. The upper FAB was developed in March 2010 following a risk assessment which found that the main vent shaft was not suitable as a second means of exit from the mine. The slimline stub was 15m deep, 5m wide and 5m high. The methane drainage line passed through the stub and vented through a gas riser to the surface. A roll-down brattice door was installed so the stub could be isolated in an emergency. Fresh air was available from the surface through the 600mm diameter slimline shaft. The stub contained a cache of 108 self-rescuers (60 of 30 minutes' duration and 48 of 60 minutes' duration), first aid equipment, fire-fighting equipment, a digital access carrier (DAC) and three telephones, one of which was connected to the surface. Pike had planned improvements to the slimline stub, such as increasing its size, installing concrete walls and double doors incorporating an air lock system. The improvements were meant to have been completed by June 2010 but had not been done by the time of the explosion.

133. The roll-down brattice screen would not have prevented the FAB being polluted with the toxic atmosphere. Following the explosion, the failure of the underground fan resulted in a reversal of the air circuit, meaning the slimline shaft became a chimney through which noxious explosion products were drawn into the stub and up to the surface. The upper FAB was not a place of safety and was not functional as an FAB at 19 November 2010. It was not even fit as a changeover station.

Figure 16.2: View of the upper FAB from outside[78]

Figure 16.3: View of the upper FAB looking inside[79]

Figure 16.4: Inside the upper FAB looking towards the entrance[80]

Second means of egress

134. Underground mining has a long history of multiple fatalities caused by fire, explosion and roof collapse. Legislation was enacted throughout the mining world making two means of egress from underground mines mandatory.

135. A statutory requirement for a second means of egress existed in New Zealand until 1993 when the Coal Mines Act 1979 was repealed. A replacement provision was included in the Health and Safety in Employment (Mining – Underground) Regulations 1999. Regulation 23 requires employers to take all practicable steps to ensure their mines have suitable and sufficient outlets for entry and exit. Suitability and sufficiency are determined according to the size of the mine, the maximum number of employees, 'the need to have at least two outlets that are separate from each other but that interconnect',[81] and the requirement to have at least one outlet that can be traversed on foot and another that has a mechanical means of entry and exit.

136. When the Pike board approved the final mine plan in 2005 the ventilation shaft was the proposed second means of egress with a ladder system to be installed. This was an interim solution. As the mine was developed into the coal measures nearer to the western escarpment, the mine plan contemplated the development of another near-horizontal walkout egress termed an adit, which would also double as a second ventilation intake into the mine.

137. Development of the ventilation shaft in 2009 in its eventual location is described in Chapter 3, 'The promise of Pike', paragraphs 47–49. In summary, the shaft located at pit bottom comprised a 2.5m square bypass to a height of 45m, known as the Alimak raise, and a 4.5m diameter shaft to the surface, a total height of 110m.

138. Neville Rockhouse was adamantly opposed to the use of the vent shaft as an escapeway, even as an interim measure. In October 2009 he initiated a risk assessment and invited members of the risk assessment team

to participate in a test climb up the main shaft. Mr Whittall was invited to participate, but on the day another commitment took priority.[82] The first two men to attempt the climb, Adrian Couchman and Nicholas Gribble, reached the top of the Alimak raise and then abandoned the exercise, doubting their ability to get to the surface. The group concluded that the vent shaft was entirely unsuitable as a second egress.

139. A lengthy risk assessment process followed and in March 2010, a representative group, including Messrs Watts, White and Neville Rockhouse, concluded that the vent shaft was unsuitable as a second means of egress in an irrespirable atmosphere. By the time of the explosion planning for a second egress was under way.

140. Neville Rockhouse also researched the purchase of a coal-safe refuge chamber from Western Australia, at a cost of approximately $300,000,[83] as an interim and partial solution to the second egress problem. The proposal was not taken up, so he proposed the development of the slimline stub as an FAB. Approval was given and some work was undertaken to establish the upper FAB.[84]

141. Mr Poynter raised the adequacy of the vent shaft as a second egress in the course of an inspection visit on 8 April 2010. His actions are reviewed in Chapter 15, 'Regulator oversight at Pike River'. Although he contemplated issuing an improvement or prohibition notice, in the end he took no formal action. On a further visit to the mine on 12 August 2010, when he found no progress had been made, Mr Poynter said that the second egress should be established as soon as possible, and before full coal extraction began.

142. In 29 October 2010 Gregory Borichevsky addressed the development of the second egress in a technical services memorandum to Mr White.[85] The proposed location of the egress was identified 250m north-west of the then most western margin of the workings. 'High level investigations' were required into numerous aspects, including flooding risk, slope stability, strata control and portal construction, as well as Department of Conservation (DOC) approval. Mr Borichevsky predicted that the egress could be established by June to September 2011.

143. As at 19 November 2010 the ventilation shaft remained the designated second egress. Using it as an escapeway was a fundamentally flawed concept. It was very physically demanding to climb the 105m ladder system in normal conditions. Wearing a self-rescuer it would have been even more difficult, probably impossible. Injured men would have had no chance. After the explosion the vent shaft became a chimney for flame and noxious gases.

144. Development of the hydro panel, and coal extraction, took priority over construction of a proper second egress. That was in spite of the workers' extreme concern that the interim egress was not adequate. Establishment of the second egress should have been prioritised over extraction. Neville Rockhouse agitated for this but with little result.

145. Given the nature of the explosion, and the timing of the men's deaths soon after the event, it is likely the absence of a second egress was not of any practical consequence. But emergencies can take many forms and had the drift been blocked there would not have been an alternative escapeway out of the mine. Extraction should not have been allowed to continue while there was no effective second egress.

Other self-rescue aids

146. Workers may face visibility problems when, in an emergency, a mine becomes filled with smoke. This can cause disorientation and loss of direction. Smoke lines are a simple but useful tool for guiding workers out of the mine or to escape facilities.

147. The lines are attached to the roadway walls or roof, or to mine equipment such as pipelines within reach, and directional cones guide miners in the right direction. Walking canes can be hooked onto the smoke lines, or used to feel for obstructions. Reflective signs may also be used to identify locations or provide directions.

148. Smoke lines and reflective signs were used at Pike River, but there were installation and maintenance problems. The installation of smoke lines did not match development of the mine,[86] and some lines were inaccessible,[87] or damaged and not promptly repaired.[88] There were also concerns about the adequacy of signage installed in the mine.[89]

Use of vehicles in self-rescue

149. Mine personnel transport vehicles designed for use in an emergency provide a faster means of escape and enable injured workers to be rescued.

150. There was a shortage of personnel carriers at Pike in 2010. Men sometimes walked out of the mine because of delays in the taxi service caused by breakdown and maintenance problems. On at least one occasion a group of miners walked off the job because of their concern that the lack of vehicles meant they would be unable to escape quickly enough in an emergency. Pike River's personnel carriers did not incorporate self-escape features.

Self-rescue training and readiness

151. Training is integral to successful self-rescue in an actual emergency. There are three aspects to a best practice training programme:

- self-rescue training for new miners, usually as part of an induction process;
- periodic refresher training; and
- onsite evacuation exercises during which the workforce evacuates the mine in simulated emergency conditions.

152. Pike gave trainee miners induction training spread over a 12-week period. The men worked for three days and spent two days, generally offsite, undergoing training. The spread of the course was considerable, including a self-rescue component provided by the MRS over two separate days. There was instruction in the use of self-rescue units, which included donning a self-rescuer in the dark. There was also tuition about the use of changeover stations and a blind walkout exercise in the MRS training tunnel and a further evacuation exercise at Pike River. The induction training included competency assessments and culminated in the award of an underground extraction certificate.

153. There was little refresher training. Mr White introduced refresher training at the mine in August 2010. It was to be conducted by experienced West Coast miner Harry Bell, and was intended to include self-rescue, but the initiative was not successful. There was one three-hour training session in early October, but the following week only three men were available to attend the session owing to production pressures. The training was put on hold.

154. Contractors made up a significant proportion of the Pike workforce and comprised almost half of the men underground at the time of the explosion. Initially there was no induction training for contractors. During development of the drift McConnell Dowell used its own health and safety programme, and from late 2008 Pike River Coal provided training for the employees of smaller contractors. This induction training included the two-day self-rescue component provided by the MRS. It is doubtful that the entire contractor workforce received training.

155. The commission accepts that the company took steps to provide self-rescue training for its employees and for contractors working at the mine. However, it doubts that training covered the whole workforce.

156. Following development of the workings in coal, there was one drill in October 2009 and a further emergency drill was planned for December 2010. This meant that not all shifts had participated in an evacuation drill. Regular drills covering every shift were planned when the mine attained steady state coal production, but this did not occur.

157. The evidence from the two survivors, and from the electrician who was sent underground, does not encourage confidence in the adequacy of the training these men had been given. The commission also notes that there is no regulatory requirement governing self-rescue training in New Zealand.

Accident/incident reports

158. Pike's accident and incident reports show that there was a range of issues reported on Pike's emergency preparedness through to November 2010. These included: tags not being removed from the tag board, a worker not tagging in when he went underground and too many tags being placed on the board; phones not placed in the right locations, the DAC not being answered by surface control or being faulty; inadequate smoke lines; missing

self-rescuers; damaged or missing fire fighting equipment and fire hoses being used for non-emergency reasons; and medical equipment missing.

159. The reasons given for these incidents included lack of knowledge and training; being unaware of hazards; inadequate work standards; forgetfulness; laziness; misconduct; safety rules not being enforced; inadequate leadership and supervision; and inadequate purchasing and stock.[90]

The deaths of the men

Introduction

160. The timing and cause of the men's deaths is an important issue relevant to several aspects of the search and rescue operation. At an inquest in Greymouth on 27 January 2011 Chief Coroner Judge A.N. MacLean found that:

> *the death of all 29 men occurred on the 19th of November either at the immediate time of the large explosion which occurred in the mine or a very short time thereafter. It is also clear that the cause of death, although it may well vary in degree between individuals depending on their location, was the result of a substantial explosion and the combination of concussive and thermal injuries due to the explosive pressure wave, together with acute hypoxic hypoxia through exposure to toxic gases and lack of oxygen.*[91]

This section will evaluate whether the chief coroner's finding needs to be revisited in light of the extensive additional evidence available to the commission.

Expert evidence as to survivability – evidence presented at the inquest

161. The chief coroner's finding was based upon reports from mining experts and medical opinions from three highly qualified doctors. As well as these, the commission heard extensive evidence relating to the mine systems, the search and rescue operation and the views of mining experts on survivability in light of all the information now available.

162. None of the expert evidence was given in person. Instead, Superintendent Knowles produced a number of expert reports.

163. Kenneth Singer, the deputy chief inspector of coal mines in Queensland, Australia, prepared two of the reports. The first, entitled *Explanation of Gas Analysis and Interpretation*,[92] dated 24 November 2010, explained the analysis of samples obtained at the main shaft after the first explosion, the rate of production of methane from the coal seam in the mine ('methane make') and the impacts of an explosion overpressure. The second report, entitled *Prospects of Survival Pike River Mine*,[93] dated 26 November 2010 at 6:00pm, reflected the views of a group of experts who considered survivability at the mine following the second explosion on 24 November. This report assessed survivability by reference to four likely causes of death – blast-wave injuries, burns, oxygen depletion asphyxiation and carbon monoxide poisoning – and in relation to four districts into which the mine was divided for the purposes of the analysis. The group concluded there was no prospect of survival in any part of the mine. However, by the time this report was written, the third explosion had occurred at 3:49pm on 26 November 2010.

164. Another report was prepared by Professor David Cliff, the operations manager of the Minerals Industry Safety and Health Centre, University of Queensland, Australia,[94] entitled *A Preliminary Evaluation of the Situation at Pike River Coal Mine, as at Sunday 12 December, 2010.*[95] This concentrated on the physiological impact of a post-explosion gas atmosphere. In particular, Professor Cliff analysed carbon monoxide readings obtained at the main shaft following the explosion. These peaked at a concentration of over 3000ppm (parts per million) and he concluded that it was not unreasonable to assume concentrations more than twice this amount within the mine immediately after the first explosion.

165. Three doctors provided medical opinions, which were produced at the inquest. Dr Andrew Veale, an Auckland respiratory physician, Dr Robin Griffiths, director of occupational and aviation medicine at the University of Otago, and Dr Alan Donoghue, director of health and chief medical officer of a mining company in Perth, all specialise in

the question of survival in oxygen-deprived environments. All three doctors independently concluded that none of the men would have been alive on 26 November, following the third explosion.

166. This was hardly surprising. By then a week had passed with no sign of life from within the mine. However, the reports from the three doctors also included a focus on survivability at the time of, and immediately after, the first explosion. It is clear that this evidence influenced the chief coroner in reaching his conclusion about the immediacy of the deaths.

167. Dr Veale's report was representative of the views of his colleagues. He identified four likely causes of death:

- He considered the men close to the explosion would have been subject to an immediate concussion impact and thermal injuries, with secondary shrapnel effects, which would have been fatal.
- He thought the compression and expansion wave caused by the explosion would, in the confines of a small mine, have caused internal tear injuries, including to the lungs and sinuses. Associated bleeding, particularly into the lung, would have caused immediate, or delayed, death to men within the main roadways of the mine.
- He concluded that exposure to carbon monoxide (CO) produced in the explosion would have produced a progressive CO build-up in the bloodstream, which prevents the absorption of oxygen. In a confined environment and without an air source this, too, would have been fatal.
- Then there was lack of oxygen (hypoxia) caused by the burning of oxygen in the course of the explosion and any subsequent fire. Fresh air contains 20.9% oxygen. An oxygen level less than 10% leads to unconsciousness, and a level less than 6% results in death within minutes. And in combination, CO absorption and hypoxia are a more lethal mix.

An open box at the slimline shaft

168. To recap, the stub containing the slimline shaft, called the FAB, contained various items of equipment to facilitate self-rescue or for use in providing first aid.

169. The equipment included three sizeable boxes sitting on the floor next to the right-hand rib as viewed from the drift. Two of the boxes were of solid blue plastic construction, measured 1100 x 550mm, and 450mm in height, and contained self-rescuers. The third box, made of plywood, was slightly smaller and contained canisters of fire-fighting foam.

170. The blue plastic boxes had an overlapping lid, which could be secured using three metal locking mechanisms on the front. An Environmental Science and Research (ESR) scientist, who examined an identical box at the request of the police, concluded that the locking mechanisms would have been effective against an explosive force, provided they were in the clamped position. If they were unclamped, she was unsure whether the lids might open in an explosion.

171. The three boxes were last examined on 18 November by Mr Couchman, a Pike River safety training co-ordinator. He opened the blue cache boxes, calculated that they contained 108 self-rescuers, then closed and secured the lids.

172. About 2:00pm on 19 November Gary Campbell and Joe Verberne, VLI Drilling Pty Ltd employees, checked the mine methane drainage line, including its entry into the slimline stub. They used a self-rescue box as a step to inspect the gas riser that vents to the surface. They replaced the box with its lid in the closed position.

The C-ALS images

173. On Wednesday 24 November the area at the bottom of the slimline shaft was scanned using a C-ALS (Cavity Auto Scanning Laser System) laser device. The scans were taken before the second explosion. A Solid Energy mining engineer, John Taylor, was in charge of the scanning crew, which is probably the world's most experienced in this work.

174. The probe has a cable back to the surface through which data is recorded from underground. The motorised scanning head can rotate in all directions. It fires a laser beam that travels through the underground void until it hits a solid object. The beam rebounds off the object back to the receiving port and after multiple rotations of the scanner a three-dimensional (3D) image of the void is obtained.

175. Analysis of the data obtained indicated that the scanned images were affected by the presence of airborne water droplets, which interfered with the laser beams and the quality of the images. However, equipment in the stub was still clearly visible, and in Mr Taylor's opinion the lid of one of the large blue boxes was open.

176. On 17 February the crew rescanned the slimline shaft. This revealed that there had been a major roof collapse in the drift, which caused spoil to spill into the stub over the area where the three boxes were positioned, so no further evidence was obtained.

Enhancement of the images

177. At Mr Taylor's suggestion the original scans were sent to Adelaide-based James Moncrieff, an expert in the interpretation of 3D laser images. He enhanced the images and agreed that the lid to one of the blue boxes was open.

178. He found one factor that differed from the conclusions of the ESR scientist in New Zealand. The blue plastic box that she examined could open to only 105° from its closed position. Mr Moncrieff calculated that the C-ALS image showed the lid open to 156° from the closed position.

179. Mr Moncrieff considered that there was only a limited view into the open box, which revealed an object of 'high intensity' in the back corner. This was probably 'a reflective object (shiny or bright).'[96] Self-rescuers are kept in shiny metal canisters.

180. Mr Moncrieff also enhanced an indistinct image of something lying at floor level in front of the boxes. The data quality of this image was inferior to other images. He concluded that '[t]he size, shape and intensity changes appear … to be consistent with that of an upper torso shape. However the shape is not consistent with it being a complete body.'[97] However, he considered that the shape could equally be fallen coal or rock, brattice lying crumpled on the floor or a bucket containing rescue items that had been lowered down the slimline shaft on the evening of 19 November.

181. The last possibility can be discounted. The bucket was retrieved by the scanning crew before C-ALS images were obtained on 24 November and the contents were found to be undistributed.

Conclusions concerning the open lid

182. The commission accepts that one of the blue plastic boxes containing self-rescuers was probably open when scanned on 24 November. However, how it was opened remains unclear. There are at least three possible explanations all of which are conjecture:

- If the box was not securely latched before the explosion, the lid could have been blown open. The overlapping construction of the lid would make it difficult for an explosive force to blow it open. On the other hand, the extent to which the lid was open, 156°, might support this possibility.
- Someone opened the box and left the lid open before the explosion. However, it is difficult to envisage why anyone would consciously do this, and there was a window of only about an hour and three-quarters from when Messrs Campbell and Verberne saw the boxes with lids closed to the moment of the explosion.
- Someone survived the first explosion, made his way to the slimline shaft and opened the lid in search of a self-rescuer, but was unable to escape the mine. However, that no one called the control room from the FAB may tell against this possibility.

183. In brief, how the lid was opened remains unexplained and there are at least three possible explanations, one of which could be consistent with a period of survival. Unfortunately, further C-ALS images taken on 17 February 2011 indicate that spoil from a major roof collapse has eliminated any possibility of obtaining further evidence about the open lid.

Expert evidence as to survivability – evidence before the commission

184. Much of the additional evidence before the commission was direct evidence, as opposed to written reports. The commission also heard a personal account of the effects of the first explosion from one of the survivors, Daniel Rockhouse, plus evidence from mining experts, who expressed opinions about survivability after the first explosion.

185. Mr Watts, the general manager of the MRS, concluded that most of the men would have been killed, or rendered unconscious, by the first explosion. Those rendered unconscious would have died from noxious gases, or lack of oxygen, within minutes. If anyone had been able to don a self-rescuer he may have survived for the duration of the device.[98] He highlighted some relevant factors:[99]

- Pike River was a very small mine, the video evidence showed the intensity and duration of the explosion, suggesting that the initial shock wave was probably immediately fatal or that it rendered the men unconscious.
- The workforce was trained to self-rescue by walking out of the mine, not to take refuge in the mine, but no one walked out from within the workings.
- Anyone who survived the immediate effects of the blast and had time to don a self-rescuer would have had 30 minutes of oxygen and time to walk no more than 700m to the FAB, where there were spare self-rescuers.
- A natural ventilation circuit existed into the mine soon after the first explosion, which probably saved Messrs Rockhouse and Smith and would have enabled a survivor who got to the same location to walk out of the mine.
- There was no communication from anyone within the mine (apart from Daniel Rockhouse), including from the FAB into which air was downcasting when a telephone was lowered down the shaft at 8:00pm on 19 November.
- Air pockets would not have existed because Pike River was a gassy mine and methane would have risen to fill the higher inbye areas of the mine as air was displaced. Following an earlier failure of the main fan the mine gassed out in about nine hours.[100]

186. Mr Devlin, the New South Wales Mines Rescue Services manager, supported Mr Watts' assessment. He said it was 'almost certain' that the men died, if not immediately, then within the first hour after the explosion.[101] His experience, based on other mine disasters, was that if the explosion did not result in instantaneous death, then the subsequent contaminated atmosphere and lack of oxygen would have been fatal. Mr Devlin formed this assessment when he reached Pike River, and by the time he gave evidence nothing had occurred to change his view.

Conclusions

187. The chief coroner found on the basis of medical evidence that the men died at the time of the explosion, or a short time after it. The evidence of the mining experts was generally supportive of this finding. The open box lid in the slimline stub could indicate that someone survived for a period, but this is conjecture and only one of at least three possible explanations.

188. The commission finds that the 29 men probably died instantly, or from the effects of noxious gases and oxygen depletion soon after the explosion on 19 November. It heard no evidence sufficient to displace the chief coroner's findings concerning the timing, or cause, of the deaths.

The recovery operation

Introduction

189. Recovery of human remains from the mine became the principal objective following the second explosion on 24 November. There has been limited progress towards achieving this objective. Understandably this is a source of great concern and frustration to many of the men's families. In this section the commission reviews the key developments to the present time.

The period to 31 December

190. Between 2:37pm on 24 November and 1:50pm on 28 November three further explosions occurred. The risk of still more explosions, and the need to bring fires burning in the mine under control, made sealing the mine the first priority. This was the key objective for the balance of the year.

191. In early December a temporary seal was constructed, after two shipping containers were inserted into the portal and a seal effected around them. This enabled the GAG brought from Queensland to be commissioned and it began pumping gas and steam into the mine to extinguish any fires. The vent shaft was also sealed using a fabricated metal cap. Subsequently, the Floxal, a nitrogen generating unit from Australia, was substituted for the GAG. However, atmospheric readings from the mine deteriorated and the GAG was recommissioned.

192. On 13 December Pike River Coal Ltd went into in receivership, with John Fisk, Malcolm Hollis and David Bridgman appointed joint receivers. Before Christmas, the company in receivership presented a draft re-entry plan to the police, which envisaged stabilisation of the mine over 45 days at a cost of $3.87 million, and recovery of the remains over 70 days at a cost of $6.99 million.[102] Earlier, the MRS had also provided a draft re-entry plan to the police and the company.[103] Neither plan was adopted.

Key events in 2011

193. Early in the new year fires and heatings in the mine were brought under better control. Ongoing monitoring using a tube bundle system allowed for an improved understanding of the mine atmosphere. The focus became to stabilise the atmosphere, finalise a plan and effect a staged re-entry into the mine.

194. On 9 March the police relinquished control of the recovery operation to the receivers,[104] who assisted by an expert panel formed by them, the MRS, SIMTARS, DOC, DOL, Solid Energy and others, continued recovery-related work. This included nitrogen injection using the Floxal, drilling new boreholes, thermal imaging to identify gas leaks from the mine, further sealing and scanning inside the mine from boreholes.

195. The families were frustrated at the lack of progress, and in May their counsel convened a meeting of interested parties in Christchurch to discuss means of advancing the recovery operation. The main agreed outcome was that a working group should begin immediately to plan for re-entry into the mine beyond the rock fall at the inbye end of the drift.

196. A difference of view developed over the best approach to re-entry into the mine. In August the MRS proposed a 'reconnaissance walk' up the drift to the rock fall.[105] The drift atmosphere was irrespirable, with less than 3.5% oxygen detected, and the re-entry team would need to use breathing apparatus. The objective was to establish the conditions in the drift from pit bottom in stone to the rock fall, and whether there were any bodies in this area.

197. The mine manager, Mr Ellis, disagreed with this approach. He favoured establishing a remote seal near the rock fall, by drilling a borehole at that location and injecting an expandable foam (Rocsil). The Rocsil would create a seal and enable the drift to be reventilated using a forcing fan at the portal. MRS teams could then enter the drift in a respirable atmosphere.[106] Mr Ellis presented this option for approval by the expert panel, but not the MRS proposal.[107] Pressed in cross-examination at the September hearings, he said, 'We will reclaim that tunnel before Christmas, I'm quite confident of that.'[108] In the event, re-entry proved more complex than expected.

198. Some progress has been made towards re-entry. The MRS constructed temporary seals at 170m, and then at 108m and 70m into the drift. A nitrogen buffer zone was established between the 108m and 70m seals. This enabled the December 2010 seal at the portal to be removed. The company then installed permanent steel doors at 35m and 5m inbye, to provide an airlock entrance into the mine.[109] In December drilling of the Rocsil borehole began, but it was not completed until January 2012.

Key events to date in 2012

199. During January the outbye area of the drift was degassed and ventilated up to the MRS temporary seal at 170m.

200. In March, Solid Energy reached a conditional agreement with the receivers to purchase the mining assets of Pike, and in May the agreement became unconditional. On 17 July 2012, a subsidiary of Solid Energy, Pike River Mine (2012) Ltd, took ownership of the assets. That day the government, Solid Energy and the subsidiary signed a deed relating to body recovery. It requires Solid Energy to 'take all reasonable steps to recover the remains' provided this 'can be achieved safely, is technically feasible and is financially credible'. The Crown agreed to contribute to recovery costs over and above those 'required for commercial mining purposes'. No timeframe is prescribed, and recovery of the remains hinges on a resumption of 'commercial mining operations'.[110]

201. Before the deed was concluded, emeritus professor Jim Galvin, University of New South Wales, gave Solid Energy advice concerning the risks associated with, and the likelihood of, body recovery. He considers there are very substantial risks involved in re-entering the old workings, as opposed to the drift area of the mine. These include drowning if water has accumulated, explosion if air enters the workings and hot spots exist, fire from spontaneous combustion, roof fall owing to the absence of strata maintenance, and exposure to carcinogens (products from underground coal fires), fungi and bacteria which can flourish in an unventilated mine environment. In addition, there is likely to be a need to clear rock falls within the mine using mining machinery in an irrespirable atmosphere. Working in these conditions, wearing breathing apparatus, would be particularly hazardous. Accordingly, Professor Galvin concluded it was 'extremely unlikely' that the risks could be managed, 'irrespective of the level of expenditure',[111] so he views recovery of the remains as a remote possibility.

Keeping the mine safe

202. The commission is required to recommend what ought to be done to ensure the safety of the mine and the surrounding areas if the mine is not reopened. This proviso poses a difficulty because it is uncertain whether the mine will be reopened and any decision concerning reopening may be some years off. The safety of the mine in the meantime, and in the long term, requires separate consideration.

203. Pending a decision concerning a resumption of mining, Solid Energy obtained an independent review of security at the mine site. Arrangements in place to safeguard the mine and its surrounds include continuous monitoring of the underground atmosphere using a tube bundle system, controlling access to the mine site by a series of security gates, remote camera surveillance of the approach road and site and an immediate response arrangement in the event the area is entered by intruders. Trained personnel also oversee the onsite facilities on a regular basis.[112] The commission considers these arrangements are adequate. If control of the mine is transferred to a new owner similar arrangements should apply. This could be done by way of a condition attaching to the transfer of the permit, or imposed if a new permit is issued.

204. If the mine is not to be reopened it will need to be permanently sealed. At present the shafts into the mine are capped and multiple steel doors are installed at the mine entrance.[113] These seals will have to be made permanent, probably using concrete. The commission considers that arrangements to make the mine safe on a permanent basis should be agreed in consultation between the mine owner, the regional or local authorities and the land owner or administrator.

ENDNOTES

1 Pike River Coal Ltd, Emergency Response Management Plan (ERMP), 18 February 2009, DAO.001.00096.
2 Douglas White, transcript, p. 1263.
3 Ibid., p. 1129.
4 Ibid., p. 1317.
5 Neville Rockhouse, transcript, p. 1374.
6 Douglas White, transcript, p. 1138.
7 Ibid., p. 1326.
8 Ibid., p. 1299.
9 Ibid.
10 Ibid., pp. 4865–66.
11 Ibid., p. 4866.
12 Simon Moore, transcript, p. 1632.
13 New Zealand Fire Service Commission, The New Zealand Coordinated Incident Management System (CIMS): Teamwork in Emergency Management, 1998, SOE.001.00027/2.
14 David Cross, witness statement, 1 July 2011, POLICE.BRF.11/3–6, paras 9–28.
15 Ibid., POLICE.BRF.11/5, para. 23.
16 David Cross, witness statement, 1 July 2011, POLICE.BRF.11/15, para. 106.
17 Gary Knowles, witness statement, 1 July 2011, POLICE.BRF.18/14, para. 63.
18 David Cross, witness statement, 1 July 2011, POLICE.BRF.11/15, para. 104.
19 Sean Judd, witness statement, 1 July 2011, POLICE.BRF.14/6, para. 27.
20 New Zealand Mines Rescue Service, Brief of evidence of New Zealand Mines Rescue Service, 1 August 2011, MRS0030/12, para. 62.
21 Sean Judd, Incident Action Plan, 20 November 2010, PIKE.00505/3.
22 Allyson Ealam, witness statement, 1 July 2011, POLICE.BRF.16/7, para. 37.
23 Douglas White, transcript, p. 1178.
24 Ibid., p. 1264.
25 Stephen Ellis, transcript, p. 2250.
26 Douglas White, transcript, p. 1156.
27 Gary Knowles, transcript, p. 2151.
28 Gary Knowles, witness statement, 1 July 2011, POLICE.BRF.18/8, para. 28.
29 Gary Knowles, transcript, p. 2115.
30 Ibid., pp. 2101–02.
31 Ibid., p. 1896.
32 Gary Knowles, witness statement, 1 July 2011, POLICE.BRF.18/62, para. 320.
33 Gary Knowles, transcript, p. 1893.
34 Grant Nicholls, witness statement, 1 July 2011, POLICE.BRF.29/11–12, paras 32–33.
35 Ibid., POLICE.BRF.29/13, para. 36.
36 Gary Knowles, transcript, p. 2104.
37 Grant Nicholls, transcript, p. 1681.
38 Seamus Devlin, transcript, p. 2037; Darren Brady, transcript, p. 1970.
39 Darren Brady, transcript, p. 1970.
40 Ibid., p. 1969.
41 Gary Knowles, transcript, p. 1886.
42 Grant Nicholls, transcript, p. 1738.
43 Ibid., p. 1856.
44 Ibid., p. 1660.
45 Ibid., pp. 1727–28, 1826.
46 Ibid., p. 1799.
47 Susan (Lesley) Haines, transcript, p. 2341.
48 Ibid., p. 2342.
49 Stephen Christian, witness statement, POLICE.BRF.12/14, para. 56.
50 David Bellett, witness statement, DOL7770020004/5, para. 24.
51 Susan (Lesley) Haines, transcript, pp. 2354, 2356.
52 Ibid., p. 2372.
53 Sheila McBreen-Kerr and Brett Murray, Approval of Down-hole Video, 23 November 2010, DOL7770020002_10/1.
54 Sheila McBreen-Kerr, Pike River Mine Disaster Risk Assessment Approval Process Chart, 23 November 2010, DOL2000010032/2.
55 Craig Smith, transcript, p. 2651.
56 Timothy Whyte, witness statement, 28 June 2011, CFMEU0001/18, para. 69 referring to Clive Hanrahan's advice to police that the Queensland Mines Rescue Service team would return to Australia if Pike's management did not start sharing information and providing assistance.
57 Darren Brady, transcript, p. 1975.
58 Trevor Watts, transcript, p. 2509.
59 New Zealand Mines Rescue Service, Brief, MRS0030/17, para. 82.
60 Seamus Devlin, transcript, p. 2053.
61 New Zealand Mines Rescue Service, Brief, MRS0030/22, para. 109.3.
62 Darren Brady, transcript, p. 1973.
63 Ibid.
64 Gary Knowles, transcript, p. 1917.
65 Health and Safety in Employment (Mining – Underground) Regulations 1999, reg 15.
66 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, 7 November 2011, CAC0114/31–32.
67 Neville Rockhouse, transcript, pp. 1340–41.
68 Royal Commission on the Pike River Coal Mine Tragedy, Summary of the Reports, CAC0114/31 (Incident number 1126).
69 Trevor Watts, transcript, p. 2519.
70 Douglas White, witness statement, 19 August 2011, WHI001.1/12, para. 107.
71 Darren Brady, witness statement, 24 August 2011, SIM0001/6, paras 4.4–4.5.
72 Ibid., SIM0001/8, para. 5.16.
73 New Zealand Mines Rescue Service, Brief, MRS0030/93, para. 491.
74 These experts included Trevor Watts, General Manager New Zealand Mines Rescue Service; Douglas White, Site General Manager, Pike; Seamus Devlin, State Manager, New South Wales Mines Rescue Services of Coal Services Pty Ltd; Darren Brady, Manager SIMTARS Occupational Hygiene, Environment and Chemistry Centre; and Kenneth Singer, Deputy Chief Inspector of Coal Mines. Messrs Brady and Singer work for the Queensland government.
75 Trevor Watts, transcript, p. 2483.
76 Ibid., pp. 2483–91, 2550–53.
77 Daniel Rockhouse, transcript, pp. 1067–68.
78 Fresh Air Base (FAB) photographs (Phase Three Hearing exhibit 44, produced by Neville Rockhouse), EXH0044/3.
79 Ibid., EXH0044/4.
80 Ibid., EXH0044/7.
81 Health and Safety in Employment (Mining – Underground) Regulations 1999, reg 23.
82 Peter Whittall, transcript, p. 2686.
83 Neville Rockhouse, transcript, p. 1363.
84 Email, Neville Rockhouse to Adrian Couchman, 17 March 2010, DAO.011.21810/2–3.
85 Memorandum, Gregory Borichevsky to Douglas White, 29 October 2010, EXH0024/1–2.
86 Email, Adrian Couchman to Neville Rockhouse, 3 March 2010, DAO.011.21810/1.
87 New Zealand Mines Rescue, Pike River Emergency Response August Audit, 12 September 2010, DOL7770030096/2.
88 Michael Smit, Police/DOL interview, 19 December 2010, INV.03.07753/42; Russell Smith, Police/DOL interview, 9 February 2011, INV.03.13092/64–65.
89 Lyndsay Main, Police/DOL interview, 17 December 2010, INV.03.06096/50, 52.
90 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, CAC0114/31–38.
91 Counsel's Submissions and Coroner's Findings, 27 January 2011, INV.01.27510/8.
92 Kenneth Singer, Explanation of Gas Analysis and Interpretation, 24 November 2010, PIKE.17762.
93 Kenneth Singer, Prospects of Survival Pike River Mine, 26 November 2010, PNHQ.16398.

[94] Professor Cliff later joined the expert panel engaged by DOL and the police during their investigations.
[95] David Cliff, A Preliminary Evaluation of the Situation at Pike River Coal Mine, as at Sunday 12 December, 2010, PIKE.15383.
[96] James Moncrieff, witness statement, 29 August 2011, POLICE.BRF.51/15, para. 42.
[97] Ibid., POLICE.BRF.51/26–27, para. 72.
[98] Trevor Watts, transcript, p. 2450.
[99] Ibid., pp. 2450–51.
[100] Ibid., p. 2452; New Zealand Mines Rescue Service, Brief, MRS0030/13, para. 64.
[101] Seamus Devlin, transcript, p. 2044.
[102] Pike River Coal Ltd, Pike River Coal Mine Re-entry Plan to Facilitate Recovery of Deceased Miners (Draft), 22 December 2010, DAO.007.20116/2–3.
[103] New Zealand Mines Rescue Service, New Zealand Mines Rescue Service Mine Re-entry Action Plan for Pike River Mine, 5 December 2010, MRS0066.
[104] New Zealand Police, Pike River Coal to Implement Mine Stabilisation Plan, 9 March 2011, SOE.003.00104/1.
[105] New Zealand Mines Rescue Service, Reconnaissance of the Main Drift at the Pike River Mine: Risk Assessment, 16 August 2011, PRCL.1284.
[106] Stephen Ellis and Gregor Hamm, Tunnel Reclamation Proposal, 29 August 2011, PRCL.1908.
[107] Stephen Ellis, transcript, p. 2302.
[108] Ibid., p. 2305.
[109] Ibid., p. 2299.
[110] Deed relating to body recovery at the Pike River Coal Mine, 17 July 2012, SOL0503445.001.
[111] Jim Galvin, Attachment 'B' – Potential Risks Associated with Body Recovery at Pike River Coal Mine, 10 June 2012, FAM0061, pp. 21–26.
[112] Letter, Catherine Schache to James Wilding, 18 September 2012, CAC0176.
[113] Ibid.

CHAPTER 17

The families of the men

Introduction

1. Many people were affected by the Pike River tragedy, and none more so than the families and friends of the 29 men. Some filed witness statements detailing concerns about the search and rescue operation and seven family members appeared before the commission. This chapter reviews the initial contact with family members following the explosion, the conduct of family briefings, and the manner and extent to which the families were kept informed of subsequent developments.

Initial contact with family members

2. After the explosion Pike needed to establish who remained underground. As discussed in Chapter 16, 'Search, rescue and recovery', there were problems with both the placement and removal of tags from the tag board.

3. At 4:40pm the police communications centre was told that 25 to 30 people remained in the mine. At 5:55pm Douglas White told police officers that 33 men were thought to be underground. At 6:00pm a count of the tags on the board indicated that 32 men were in the mine. At 7:30pm Peter Whittall told the media he understood 27 men were underground – 15 Pike employees and 12 contractors. By 4:30am on 20 November that number had been revised to 29 missing. This figure was further revised to 28 a few hours later, and then at an 8:00am media briefing Mr Whittall confirmed the correct numbers; 29 men were missing underground – 16 Pike employees and 13 contractors.

4. Pike had required its employees and contractors to supply details of next of kin who were to be contacted in the event of an emergency. The health and safety induction checklist, completed before employees and contractors began work at the mine, provided space for the contact details of one person nominated as next of kin. There was no space for alternative contacts.[1] Pike asked workers to inform it of any changes to their next of kin details.[2]

5. After the explosion, the company decided not to contact next of kin until accurate information was available. As noted, that took about 16 hours. Meanwhile, media reports of the explosion were broadcast in New Zealand and overseas as early as 5:00pm, New Zealand time. Families were immediately desperate for confirmation of the whereabouts of their men. The explosion had occurred 15 minutes before a number of workers were to finish at 4:00pm with, in some cases, a new shift ready to go underground. There was much uncertainty. Family members phoned the company and the police in search of information, but neither could give them information. By mid-evening the Red Cross had established a facility in Greymouth where families could register their contact details.

6. At 7:30am on Saturday 20 November the first family meeting was held at the welfare centre in Greymouth. This was followed by a media briefing, at which it was confirmed that 29 men were still in the mine, but names were not released.

7. By this time families living in the Greymouth area had sufficient information to know whether their man was missing. The failure of a worker to return home the previous night was stark confirmation of the worst. But the families had not received formal advice from the company concerning who was underground.

8. More distant family members were left in the dark. For example, Richard Valli, brother of Keith Valli, lived in Southland but was named as his brother's next of kin in Pike's records. On learning of the explosion, he spoke to his brother's partner, who thought that Keith had worked a day shift on 19 November. Phone calls were made to Pike, but these were either not answered or the person who answered could provide no information.

9. The Valli family arrived in Greymouth on Saturday towards the end of the 4:30pm family meeting. Richard Valli asked Mr Whittall to confirm whether his brother was missing. Mr Whittall could not do so. Richard Valli then asked the proprietor of the hotel where his brother stayed in Greymouth and '[h]e confirmed that Keith was on day shift and that he had left for work that [Friday] morning. This was the first confirmation he was down the mine.'[3]

10. The witness statements of other family members contained similar accounts. The families of the two Australians, two British citizens and one South African among the 29 men experienced particular difficulty in obtaining information.

11. Some of Pike's next of kin details were out of date, which contributed to the difficulties contacting the families.[4] However, there were also family members correctly listed as next of kin who were never formally notified by Pike that their men were still underground.[5]

Communications with family during the rescue phase

Communication methods used

12. From Saturday 20 November family meetings were held each day to brief the families on developments in the search and rescue operation. Typically the meetings took place at 7:30am and 4:30pm.

13. There were two principal speakers at the meetings: Superintendent Gary Knowles spoke on behalf of the police and Mr Whittall on behalf of Pike. Before each meeting Mr Whittall was briefed on recent developments by company staff, particularly Messrs White and Stephen Ellis, who initially worked alternating 12-hour shifts at the mine. Commendably, a 'families first' policy applied throughout the search and rescue so that families received information before it was given to the media.

14. The police set up an 'e-text tree',[6] which was used to send messages to the cellphones of family members. These messages informed families of meeting times and significant developments. An 0800 number provided 24-hour access to the on-duty inspector, who was either Inspector Wendy Robilliard or Inspector Mark Harrison.

15. Some family members experienced difficulties obtaining information directly from the police in the first few days of the rescue operation because they were not listed as next of kin in Pike's records.[7]

Family meetings: were false hopes raised?

16. A consistent theme in the witness statements filed by the families was that they were given false hope about the chances that the men had survived the initial explosion and about the prospects of their rescue.

17. The flavour of what the families were told emerges from a sample of the information they were given, including comments made to the media on the evening of Friday 19 November. About 7:30pm on Friday Mr Whittall told media representatives in Wellington there was 'no evidence of fatalities at this stage',[8] but nor had there been any communication from the men still in the mine. Later that evening, while Mr Whittall travelled to the mine, Pike chairman John Dow told the media that all the men were equipped with portable self-rescuers and knew where additional air was stored in the mine.[9]

18. About 5:30am on Saturday 20 November Mr Dow told the media it was possible that those underground could have made their way to the mine's safety refuge, where fresh air could be available.[10] At an 8:00am media briefing meeting in Greymouth Mr Whittall said he hoped the state of the ventilation in the mine would be known by 2:00pm, so a rescue could proceed.[11] He referred to a compressed air line and said:

> *We have kept those compressors going and we are pumping fresh air into the mine somewhere so it is quite conceivable that there is a large number of men sitting around the end of that open pipe waiting and wondering why we are taking our time getting to them.*[12]

19. At the morning media briefing on Sunday 21 November Superintendent Knowles said that the focus was still on a rescue operation, but the risks were too great to allow rescuers underground.[13] One of the risks was the possibility of a fire in the mine.

20. Experts at the mine had debated the existence of a fire as early as Saturday. They considered a fire a real possibility, if not a likelihood. At family meetings, Mr Whittall described a possible ignition source in the mine as a 'heating'.[14] By way of explanation he referred to 'smouldering rags' or a 'gas hob burning in a kitchen'.[15] Generally, the tone of the information supplied at family meetings throughout the weekend conveyed that all or at least some of the missing men could still be alive.

21. This contrasted with what some others were told. Over the weekend Mr Ellis visited Daniel Rockhouse, who was suffering from 'survivor guilt'. He assured Daniel Rockhouse that in his view the shock wave from the first explosion would have killed the men further into the mine.[16] Mr Ellis did not, however, share this with Mr Whittall, and when questioned at the commission's hearings he said this was because he also believed there was still a slim chance that some men survived until the second explosion.[17] This is more likely evidence of Mr Ellis trying to help Daniel Rockhouse rather than withholding information from Mr Whittall.

22. At the hearings Mr Whittall was questioned about survivability. Counsel for the families drew attention to the impact of explosive forces upon men in such a small mine, the lack of oxygen without a functioning ventilation system and questioned how the men could have escaped the effects of carbon monoxide poisoning. Mr Whittall responded that Pike continued to pipe compressed air into the mine and that men could have found refuge in stubs and used brattice to create a barrier to prevent their exposure to noxious gases.[18] The commission found that answer to be unduly optimistic in the circumstances.

23. That said, the commission does not consider Mr Whittall was dishonest about the information he supplied at family or media briefings. His state of mind was captured in an answer he gave under cross-examination with reference to the witness statements of next of kin: 'while their heads believed that the men may have gone, their hearts still wanted to hope for that miracle and I was in exactly the same position'.[19]

24. By Monday 22 November, it was recognised that the information being provided at family meetings lacked balance. That day Mr Whittall told the media that while it remained a rescue operation, 'the reality is, it's been three days. The reality is we haven't heard anything from anyone since the two guys came out of the pit. The reality is for the families now it's becoming more and more grave with every hour that goes past.'[20]

25. On Tuesday 23 November Police Commissioner Howard Broad visited Greymouth. One of several matters he raised with Superintendent Knowles was the tone of communications with the families. The need for a change of approach was accepted.

26. The commission generally accepts the criticism made in many of the families' witness statements that the information provided at family meetings, particularly over the weekend, stimulated false hopes. Some family members had accepted the loss of their men at an early stage. They were familiar with coal mining or knew others who understood the realities of methane explosions in coal mines. But many of the families did not come from a coal mining background and relied very much on the information received during family meetings. This emphasises the need to be careful about how information is conveyed to families. A person who is emotionally involved in the events may not be the right person to act as spokesperson.

Advice of the second explosion

27. On Wednesday 24 November the gas levels in the mine improved and a rescue attempt by Mines Rescue Service (MRS) members was being considered. Superintendent Knowles and Mr Whittall were at the mine at the time of the second explosion at 2:37pm. After discussion, and viewing video footage, it was clear that no one could have survived the second explosion. Both men returned to Greymouth for the family meeting to be held later in the afternoon. Next of kin were sent a text message about 3:00pm: 'OPERATION PIKE – there will be a significant update at the 4.30 family meeting. It is recommended that all families attend.'[21]

28. Superintendent Knowles and Mr Whittall met briefly in the recreation centre car park before the meeting. The Honourable Gerry Brownlee, the Minister of Energy and Resources, was also present. Mr Whittall saw it as his responsibility to tell the families about the second explosion. There were up to 500 people in the recreation centre,

including young children and a significant police contingent. Mr Whittall spoke first. He began by saying that earlier in the day the gas levels had shown improvement, and he had been called to the mine because the MRS was preparing to go in. People began to cheer and clap. Mr Whittall, Superintendent Knowles and Mr Brownlee raised their arms and motioned for silence. Then Mr Whittall told the audience of the second explosion. The reaction was one of extreme distress; people began to wail and sob. Superintendent Knowles explained that the second explosion was not survivable, so the operation had moved to a recovery phase.

29. Recollections differed about whether Mr Whittall or Superintendent Knowles revealed the fact of the second explosion. This is of no moment. The important point is the initial comments Mr Whittall made about a possible rescue attempt. These words were the subject of strident criticism in many of the families' witness statements. They complained that the meeting was mishandled and that the ill-chosen opening words raised the families' hopes, only to have them dashed.

30. The commission accepts the key announcement was mishandled, or, as one witness put it, that matters 'went horribly wrong,'[22] and that this caused added distress for family members. That said, the commission accepts Mr Whittall's evidence that this outcome was unforeseen and entirely unintended. He was under great pressure and, in the agony of the moment, he sought to begin on a positive note. This led to extra anguish for next of kin, but in all the circumstances, it would be unfair for the commission to criticise him.

Were there deficiencies in updating the families?

31. The witness statements filed by some family members raised concerns about the provision of information, including an apparently unreasonable delay in providing information, and claimed that in one instance the information was misleading.

CCTV recording

32. The first concern related to the closed-circuit television (CCTV) recording of the first explosion, taken at the portal. This was not viewed in the control room as the explosion occurred, but was retrieved later and a number of people saw the recording during the evening of 19 November. However, it was some days before this information was shared with the families.

33. Curiously, at the outset no one drew the existence of the recording to the attention of either Superintendent Knowles or Mr Whittall. Mr Whittall first learnt of the camera at the portal when he visited Russell Smith on 21 November. That evening he asked Mr White to obtain a copy of the recording. On 22 November, at an interagency briefing, Mr Whittall showed the recording to Superintendent Knowles. On the afternoon of 23 November Mr Whittall showed it at a family meeting.

34. Some family members considered they should have seen it much earlier. They felt they would then have had a better appreciation of the size of the first explosion and been more able to assess the reliability of the information they were given.

35. The commission understands the concern but does not find anything sinister about the delay in playing the recording. The delay was a result of the two spokespeople not becoming aware of its existence for some days. Once Mr Whittall became aware of the recording, prompt action was taken and it was soon shown to the families. Importantly, the families viewed the recording before it was shown to the media.

36. The second concern was whether the recording shown to the families depicted the full duration of the explosive blast recorded at the portal. The original recording showed an explosion that lasted 52 seconds. Bernard Monk told the commission his wife, Kathleen, timed the recording as it was shown by Mr Whittall at 32 seconds.

37. Mr Whittall said he had not sought to mislead anyone about the duration of the explosion. After his call to Mr White on 21 November, a memory stick was delivered to him in Greymouth the following day. He did not have the 'technical capability of editing a video like that,'[23] and simply used the memory stick he was given. The commission accepts Mr Whittall's evidence. Nor is there evidence to suggest that anyone else edited the recording. Danie du Preez, the communications and monitoring engineer at Pike River, provided the recording. He did not edit it.[24]

C-ALS images

38. Another concern of the families related to the images taken by the Cavity Auto Scanning Laser System (C-ALS) device on 24 November at the foot of the slimline shaft. Mr Monk said that neither the families nor their counsel were made aware of the images until the inquest on 27 January 2011, and even then their potential significance was not explained. The written evidence given to the chief coroner included a one-line reference to 'evidence of a self-rescuer box open' in the fresh air base.[25] After the inquest, Mr Ellis arranged for Solid Energy New Zealand Ltd's John Taylor to show the C-ALS images to some family members, but this demonstration did not draw attention to the open box. As a consequence, counsel for the families, oblivious to the potential significance of the images, had already invited the chief coroner to find that the men died at, or about, the time of the first explosion.

39. In late March 2011 counsel for the families received confidential advice about the open box. An approach to the police resulted in a meeting at the Hornby police station, at which Mr Monk and counsel were shown an image of the open box in a manner that enabled them to grasp its potential significance. This prompted an approach to counsel assisting the commission. As a result, Mr Taylor and others gave evidence at the Phase Two hearings. The C-ALS images were fully explored.

40. The commission considers that beyond recording this concern and setting out the background, it is not necessary to consider the matter further. Having seen and understood what is involved in producing an understandable C-ALS demonstration, the commission is not surprised that the potential significance of the images remained shrouded for some time. Although the delay was unfortunate, thanks to the vigilance of the families and their counsel, the matter has been addressed.

Communications during the recovery phase

41. Immediately after the second explosion, recovering their men became of the utmost importance to many of the effected families. Not everyone shared this viewpoint. The mother of one of the men stated that 'not all families want the recovery of the remains, preferring their loved one to be left to rest in peace. That millions would be spent to achieve recovery I find untenable.'[26] A majority of family members, however, remain committed to recovery of the remains.

Police communication

42. Following the change from a rescue to recovery operation, family meetings continued to be held but with decreasing frequency from December 2010. After the police withdrew from the operation and handed the mine to the receivers, the police family liaison officers continued to attend meetings with the families. Communication through the e-text tree and the 0800 number continued.

43. On 16 January 2011, the police set up a secure, private website accessible only by registered family members. It contains a range of information and is a forum for families to ask questions. The website remains online.

November to December 2010

44. In late November 2010, Prime Minister John Key visited Greymouth and met the families. Following the company going into receivership in December 2010 he said, 'I gave a commitment to the families at Pike River I'd do everything I could to get their men out. I stand by that.'[27]

45. The MRS asserted in an institutional statement to the commission that 'once it had been decided that it was a recovery operation Mr Whittall made comments to the media that "the boys" would be brought home for Christmas.[28] This, MRS suggested, was foolhardy because no one could provide a timeline for recovery.

46. The commission, however, received no evidence confirming that Mr Whittall had spoken of a recovery by Christmas. On 29 November 2010 he was quoted as saying that the families had asked if they would get their men home by Christmas, but that he responded 'it could be some weeks before the bodies were returned' and 'without being too

blunt, Christmas is another X on the page as far as what the rescue teams are working towards. They've got to look at the actual time it takes them to do their job.'[29]

47. These comments probably explain the source of the assertion contained in the MRS statement. Mr Whittall did not endorse a recovery by Christmas, but his reference to a period of 'some weeks' was unfortunate. Understandably, the families listened with an optimistic ear and believed that recovery of the men was not too far off.

Developments in 2011

48. Throughout 2011 the families pursued recovery of the remains, including convening the meeting of interested parties in May 2011 (discussed in Chapter 16, paragraph 195) and questioning witnesses during the commission's hearings, including Mr Ellis when he gave evidence in September 2011. Although there was only modest progress towards re-entry into the drift, there were no signals that the chances of recovery were remote.

49. With a commitment to plan for re-entry made at the meeting in May 2011 and Mr Ellis' comments in September that the tunnel would be reclaimed by Christmas 2011, the message was that progress was being made toward re-entry and ultimately, potential body recovery. But by late January 2012 an adequate plan to seal, reclaim and re-enter the tunnel had not been developed.

Sale of the mine in 2012

50. The mine was sold to Solid Energy in mid-2012 (discussed further in Chapter 16, paragraph 200). As part of the sale process, Solid Energy carried out due diligence and met with the families several times. Solid Energy has explained they 'can see no way to safely carry out a standalone re-entry of the abandoned workings as part of a body recovery'. Solid Energy's position, made clear to the families, is that recovery can be attempted only as part of a wider commercial mining operation.

51. A briefing received by the families from Solid Energy chief executive Dr Donald Elder in May 2012 was based on advice Solid Energy had received from Professor Jim Galvin. The families were provided with a copy of Professor Galvin's report, and obtained an independent review of it from their own expert. It was made clear that successful recovery of the remains was very unlikely, and that if recovery did occur it may be many years away (See Chapter 16, paragraph 201). This seems to have been the first time the families were given a realistic appraisal of the situation based on evidence and in a manner that could not support their hopes.

Impact on the families

52. As noted earlier, the commission received both written and oral evidence in 2011 from members of the families. Many spoke of their dismay that the bodies had not been recovered and that no end was in sight. A high level of frustration, even anger, was evident concerning the delay in finalising and effecting a recovery plan.

53. In April 2012 the commission received evidence from Kathryn Leafe, chief executive of the Focus Trust, which provides social services to the West Coast community. The trust gave support after the tragedy and has continued to do so. Ms Leafe stated:

> *In most post-disaster situations by the six month point, the primary stressor or event is usually over and it is the secondary stressors that are the cause of concerns. However, with Pike River, the primary event is still in many ways ongoing as there remains the possibility of the recovery of human remains. Therefore families have been in a prolonged stage of grief and are still dealing with the primary stressor.*[30]

Her statement also explained that this has not only increased the demand for support, but also made providing it more complex.

54. In July 2012, senior counsel for the families filed a submission contending that the families received 'information which proved hopelessly optimistic throughout 2011', and that they were left 'to find their own way' because there was a 'lack of authoritative leadership over this period.'[31]

55. He said that the families attended the briefing in May 2012 with excitement, anticipating that re-entry and recovery may

be likely given the sale of the mine to Solid Energy. Instead, they were 'shocked by the harsh realities' outlined, of which they had 'no forewarning', so the outcome was devastating.[32] As a result, the families' present focus is upon re-entry into the drift where they believe there may be remains in the section between pit bottom in stone and the rock fall.

Conclusion

56. The commission accepts that communications with the families concerning body recovery have not been well managed. Statements made in the period following the explosions raised expectations that the remains would be recovered within a modest timeframe. When this did not happen the families were naturally frustrated, and eventually angry. The management of communications is a matter of concern because it affected the families' ability to cope with the loss of their men.

57. The modest progress made in 2011 was, in the commission's view, a reflection of the complexities that confronted the receivers, MRS and others. The mine represented a unique re-entry challenge, given the combination of a single entry into the mine, the four explosions in late 2010, a major fire in the workings, at least one significant rock fall and limited knowledge of the underground conditions.

58. It seems it was not until the mine sale in 2012, when the government required that the terms of sale include a commitment from the purchaser to recover the bodies, that the hazards were fully assessed. This perhaps explains some of the communication deficiencies in 2011. After that assessment, Solid Energy confronted the problem, promptly met with the families and told them of the realities of the situation, unwelcome as the news proved to be.

Responsibility for recovery

59. The families underlined to the commission the isolation they have felt since the explosion. They have had to push for recovery and have felt on their own. The families seek a recommendation relating to who will retain responsibility for pursuing the question of recovery as far as reasonably possible because their 'abandonment has been deep seated and plagued them every day since the 19th of November.'[33]

60. In Queensland and New South Wales, the company, through mine management, has control of the recovery operation and would be responsible for the costs. The company works in co-operation with other organisations, such as mines rescue and the mines inspectorate. Once the mine is safe and re-entry possible, the police are responsible for recovery of the remains. In practice, the police take control of the remains on behalf of the coroner only after the remains are retrieved by other specialty organisations, such as mines rescue. In both Queensland and New South Wales most coal mines are run by large companies who have the resources to cope with a recovery operation. There does need to be clarity about who is responsible for recovering the remains in New Zealand, especially where the mining company has limited funds or is in receivership. The pursuit of recovery should not be left solely to the friends and families of those who have died.

61. Recovery of the remains from Pike River now lies within the control of Solid Energy and the other parties to the July 2012 body recovery deed (discussed in Chapter 16, paragraph 200). The deed defines the new owner's obligations in relation to body recovery and contains mechanisms that enable the government to exercise some oversight. The commission is not in a position to influence these matters.

Welfare support provided to the families

Unstinted praise for welfare support

62. Criticisms contained in the families' witness statements about communication with them were balanced by unstinted praise of the support services made available.

63. One mother, for example, said: 'I cannot fault, or speak highly enough of the way we were treated by the personnel

of Pike River Coal, NZ Police, Mine Rescue, the Government, Air NZ, the Mayor and people of Greymouth, and the many voluntary groups we were helped and supported by during this time.'[34]

64. The spokesperson for some of the families, Mr Monk, said this about the support services:

> *The support offered, taken up and provided by Air New Zealand was outstanding. Many family members say [sic] great value in the liaison they had with Air New Zealand staff. The Air New Zealand support person for us was a constant prop.*
>
> *Our police support liaison officer, Constable Terri Middleton, was simply excellent. She had so much empathy towards the family and was a wonderful communicator.*
>
> *We received fantastic support from the Red Cross. They provided food, cups of tea, their facilities and as much information as they were able to give. There was a huge support from the local churches, the Greymouth community and the businesses, the local polytech, Victim Support and as time went on, the wider New Zealand community.*
>
> *I also found great support and leadership from Greymouth Mayor Tony Kokshoorn. In those early days before the family group was organised, he was the voice for the families.*[35]

65. Other witness statements mentioned the assistance provided by John Robinson as the family liaison officer for Pike. He was assisted by Adrian Couchman, and also Denise Weir, previously human resources manager at Pike. She flew to Greymouth from Australia and for over three weeks voluntarily helped to co-ordinate Pike's support efforts.

66. On the evening of 19 November Air New Zealand sent its special assistance team to Greymouth and within 48 hours as many as 30 airline staff were based in the town. A liaison person was assigned to each of the 29 families who, as necessary, were given support in relation to travel, accommodation, obtaining passports and other immediate needs. The team remained until 29 November, when a staged departure began.

67. The police also established a Greymouth-based family liaison team to provide information on the rescue and recovery operations, and gather information as necessary. Two inspectors managed the team, which comprised 22 police staff at its height. Each family was assigned a liaison officer.

68. An online survey subsequently conducted by the police indicated that family members were highly satisfied with the performance of the liaison officers, the facilitation of family meetings and the quality of their secure website. The police plan to train 40 police staff who will undertake victim liaison duties on an as required basis in response to major disasters. The police are also developing written liaison guidelines to promote national consistency in relation to major crisis management.

69. The commission acknowledges the outstanding level and value of the support offered to the families by numerous agencies and individuals including (in addition to those already mentioned) St John Ambulance, Tai Poutini Polytechnic, the Grey District Council, the Accident Compensation Corporation, Work and Income New Zealand, the Salvation Army and the ministries of Social Development and Health. It also commends the police initiative to further develop its crisis liaison capacity.

Some early difficulties

70. As noted in paragraph 11, the identification of 'next of kin' caused some difficulties in terms of communication with family members. It also had an impact on who received welfare support services in the first few months following the explosion. When the Focus Trust became aware, in December 2010 and January 2011, of family members who had received little or no contact from support services, it set about building a better picture of individual family profiles. The trust found there were 'significantly more than 29 separate family units and a number of families where "next of kin" is complicated'.[36] All were entitled to access support services.

Conclusions

71. The experiences undergone by the families of the deceased men suggest that the strategies and processes for communicating to them need improvement. Some recommendations are made in Chapter 32, 'Improving the emergency response'.

ENDNOTES

[1] Pike River Coal Ltd, PRCL H & S Induction Checklist, 27 November 2008, DAO.001.08679/4.

[2] See Pike River Coal Ltd, Employee Handbook: Induction Training, 2008, DAO.002.05609/15.

[3] Richard Valli, transcript, p. 2595.

[4] Gary Knowles, transcript, p. 2111.

[5] See for example, Tammie O'Neill (wife of Peter O'Neill), witness statement, 18 July 2011, FAM00010/2, paras 3–4.

[6] Wendy Robilliard, witness statement, 1 July 2011, POLICE.BRF.54/4, para. 12.

[7] See for example, Carol Rose (mother of Stuart Mudge), transcript, p. 2582.

[8] 'Pike River Coal Mine CEO', Close Up [Televison broadcast], 19 November 2010, http://tvnz.co.nz/close-up/mining-disaster-3904365/video?vid=3904435

[9] One News, New Zealand Press Association and Newstalk ZB, Pike River Mine Explosion Updates: First 48 Hours, 19 November 2010, http://tvnz.co.nz/national-news/pike-river-mine-explosion-updates-first-48-hours-3904262

[10] Ibid.

[11] Ibid.

[12] One News, Newstalk ZB and New Zealand Press, Miners Spend Second Night Underground, 21 November 2010, http://tvnz.co.nz/national-news/miners-spend-second-night-underground-3905380

[13] One News, New Zealand Press Association and Newstalk ZB, Pike River Mine Explosion Updates: First 48 hours.

[14] Barbara Dunn, Operation Pike Barb's Notes: Fri 19 Nov – Wed 24 Nov, 19–24 November 2010, PIKE.01842/14.

[15] Peter Whittall, transcript, p. 2778.

[16] Stephen Ellis, transcript, pp. 2289–90.

[17] Ibid., p. 2294.

[18] Peter Whittall, transcript, p. 2755.

[19] Ibid., p. 2774.

[20] Peter Whittall, as cited by Stacey Shortall, transcript, p. 2797.

[21] Wendy Robilliard, witness statement, 1 July 2011, POLICE.BRF.54/4, para. 12.

[22] Gary Knowles, transcript, p. 2145.

[23] Peter Whittall, transcript, p. 2720.

[24] Danie du Preez, witness statement, 2 April 2012, DUP0001, para. 6.

[25] Bernard Monk, transcript, p. 2613.

[26] Marion Curtin, letter to the editor, The Press, 21 January 2012.

[27] Radio New Zealand, Who Will Pay for Mine Recovery Operation Unclear, 14 December 2010, http://www.radionz.co.nz/news/pike-river-2010/64183/who-will-pay-for-mine-recovery-operation-unclear

[28] New Zealand Mines Rescue Service, witness statement, 1 August 2011, MRS0030/77, para. 424.

[29] Andrea Vance, Michael Fox and Amy Glass, 'New Blast Makes Mission More Difficult', The Press, 29 November 2010, http://www.stuff.co.nz/the-press/news/pike-river-disaster/4399940/New-blast-makes-mission-more-difficult

[30] Focus Trust West Coast, Royal Commission of Inquiry Pike River Mine Coal Mine Tragedy: Submission, FOC0001/13, para. 94.

[31] Nicholas Davidson, Counsel for the Families of Men Who Died in Pike River Mine – Submissions for Families in Response to Minute No. 14, 19 July 2012, FAM0061/9, paras 37–38.

[32] Ibid., FAM0061/8, paras 29, 31, 33.

[33] Nicholas Davidson, transcript, p. 5607.

[34] Marion Curtin, witness statement, 20 July 2011, FAM00030/2, para. 2.

[35] Bernard Monk, transcript, p. 2606.

[36] Focus Trust West Coast, Submission, FOC0001/11–12, paras 79–86.

Part 2

+ Proposals for reform

History

+ Major change is required
+ Coal mining in New Zealand
+ A failure to learn

CHAPTER 18
Major change is required

Introduction

1. In this part of the report the commission sets out in detail its proposals for reform and makes its recommendations. This chapter brings together a number of key conclusions that are contained in later chapters.

2. The proposals arise from the commission's review of health and safety in underground coal mining but may often have relevance to other industries. They are based on an assessment of the evidence the commission received during its inquiry, a review of best practice overseas and research into past disasters in New Zealand and elsewhere.

New Zealand's poor health and safety performance

Injury and fatality rates

3. New Zealand's rate of work-related injury and fatality is far above that of the best-performing countries. The rate is about one third greater than Australia's. Country-specific differences in industry and hazards may account for some differences in performance, but it is clear that New Zealand performs poorly.

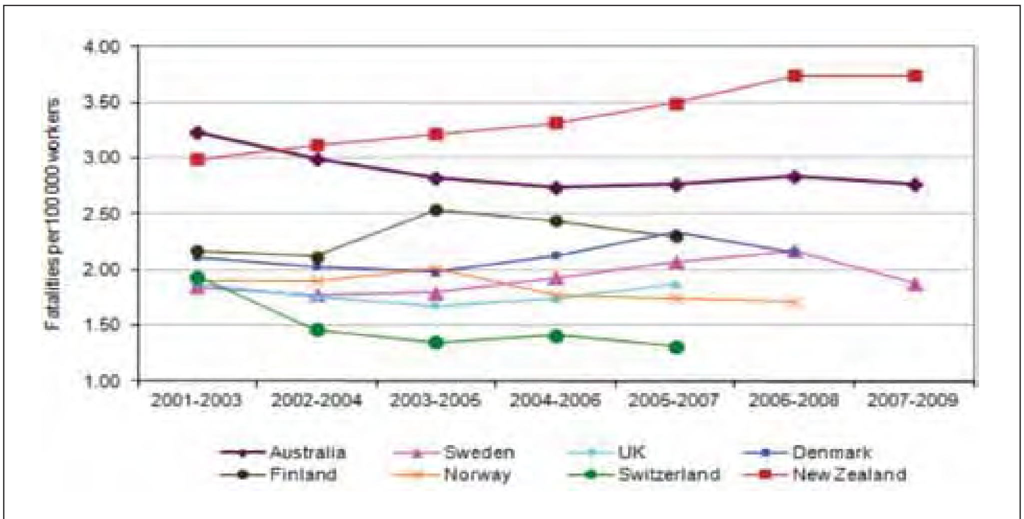


Figure 18.1: Comparison of work-related injury fatality rates with best-performing countries[1]

4. The Department of Labour (DOL)'s *State of Workplace Health and Safety in New Zealand* of June 2011 paints a bleak picture. It is the first time key statistics have been brought together and it is intended that they be published annually.[2]

5. There were approximately 85 workplace deaths in 2008[3], 445 serious injuries in 2009 and 228,300 accident compensation claims in 2008. The notified fatalities for 2010, including those at Pike River, are described as indicating a likely increase in the death rate.[4]

6. Data from the International Labour Organisation (ILO) shows that New Zealand's fatality rates are worse than those in many other advanced countries.

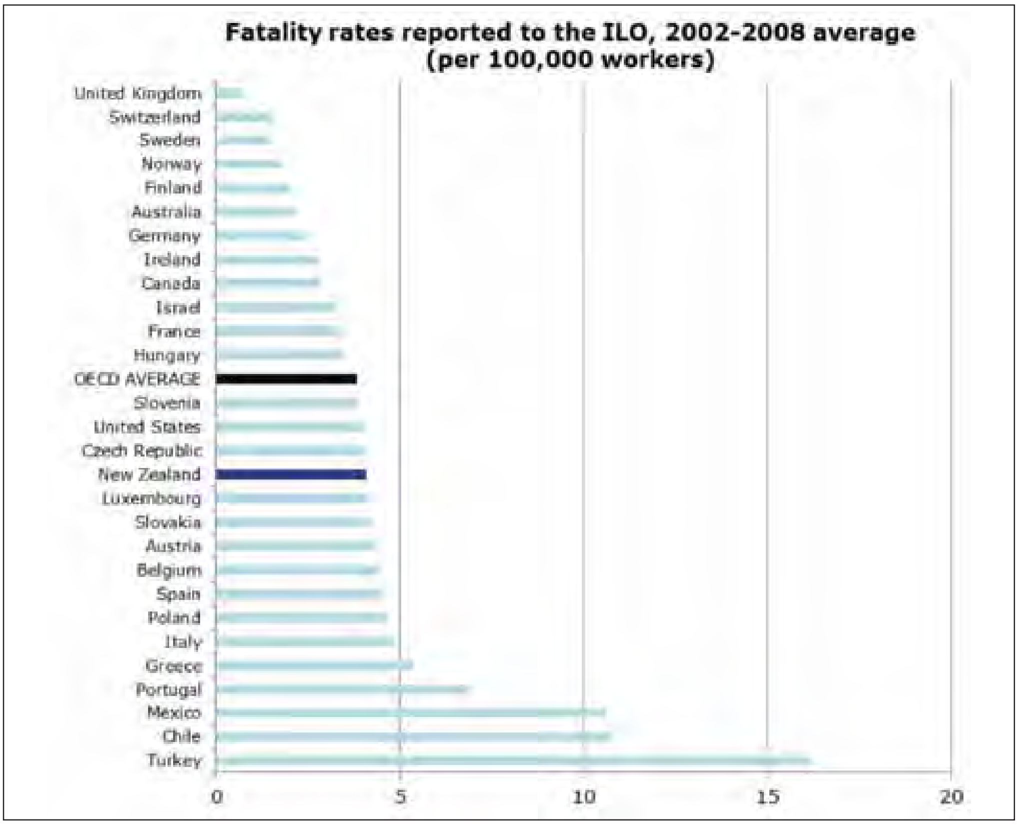


Figure 18.2: Fatality rates notified to ILO [5]

7. Australia's fatality rates have reduced significantly over the last 10 years.[6] Rates in the United Kingdom have reduced substantially since it introduced modern health and safety legislation in 1974.[7]

Occupational disease

8. Accident compensation claims for workplace disease were 27,000 in 2008, an increase of 26% over six years. Workplace disease accounts for an estimated 700–1000 deaths annually. There are inadequate measures of occupational disease, but *State of Workplace Health and Safety* mentions the development and piloting of a model for the surveillance of occupational cancer, respiratory diseases and dermatitis.[8]

Industry and worker involvement

9. New Zealand has about 470,000 workplaces and two million workers. Eighty-nine per cent of businesses say they have processes in place to manage health and safety in the workplace and 85% of employees consider that health and safety risks are being well managed; 39% of small and medium enterprises say they have difficulty dealing with or setting up health and safety systems; 66% of businesses say that they train their staff in health and safety.[9] The number of people completing ACC-funded health and safety representative courses dropped from 9735 in 2008–09 to 4153 in 2010–11 mainly as a result of a 44% funding cut in 2009–10.[10]

Overseas health and safety regimes

10. The commission has looked at the health and safety regimes that apply to mining in other countries. The most relevant and useful regimes have proved to be in Australia, especially the major mining states of Queensland and New South Wales. These regimes are recognised as representing best practice.[11]

11. Further, those states have kept pace, legislatively and administratively, with modern developments in a way that New Zealand has not. Much of the comparative analysis by the commission has therefore focused on Queensland and New South Wales.

Resources available to the regulator

12. New Zealand generally has fewer resources allocated to policing health and safety than the Australian states.

Figure 18.3: Field inspectors (excluding mining inspectors) per 10,000 employees by jurisdiction, 2009–10[12]

13. The total of 145 inspectors employed by DOL in 2009–10 equates to 0.8 inspectors per 10,000 employees. As shown in Figure 18.3, Western Australia was the lowest of the Australian jurisdictions, but still had a ratio of inspectors to employees almost 20% higher than New Zealand's.[13]

14. The latest benchmarking data shows that New Zealand also has the second lowest government expenditure on health and safety regulation per employee (at a little over two-thirds the Australian average).[14] This comparison is illustrated in Figure 18.4.

Figure 18.4: Occupational health and safety expenditure per employee by jurisdiction, 2008–09[15]

15. New Zealand is not well resourced on a per employee basis compared with Australian jurisdictions. In 2008–09 DOL spent approximately $19 (Australian) per employee, compared with more than $40 for the highest two jurisdictions. The average across all Australian states was $30 per employee.[16]

The 1972 Robens committee[17]

Principles still relevant

16. In 1972 the Robens committee reviewed the entire framework of health and safety in the United Kingdom and recommended far-reaching changes. The recommendations heavily influenced health and safety developments across the Commonwealth, including the 1992 legislative changes in New Zealand. Thinking has developed over the last 40 years but the commission has found that the core principles remain relevant.

17. The Robens committee recognised that health and safety standards cannot be improved without the contribution of employers, workers and the government regulator. More self-regulation was required, under which everyone accepts appropriate responsibilities for health and safety. This includes the board of directors and senior managers, who should, as part of their normal functions, set the policies and promote the right attitudes to health and safety throughout the company.

18. The committee recommended the replacement of 'prescriptive' legislation and regulation, which had tended to focus on specific hazards, with legislation based on principles that could be flexibly applied to the health and safety issues facing employers. But it also stressed that the new legislative approach would not be effective without the right approach to implementation.[18] Three aspects are especially relevant.

Implementation

19. First, employers should be provided with more prescriptive guidance through regulations and codes of practice which could be easily amended. Such guidance was expected to be necessary for general matters relating to most forms of employment, specific types of hazards and particular industries such as agriculture, mining or construction.

20. Second, worker participation was essential when designing and monitoring health and safety policies in the workplace. Without worker co-operation and commitment real progress was impossible.[19]

21. Third, the regulator should be a single purpose, professional organisation. Robens recommended an autonomous authority whose functions should include both policy advice and operational delivery (including advice and inspections), administering standards (including codes of practice), working with industry and employee associations and conducting research, education and training. A forward-looking and systematic approach to accident prevention was needed, rather than relying wholly on backward-looking injury rates.

22. The Robens committee considered that the regulator should focus solely on health and safety. It should be subject to broad policy direction by a minister. It should be headed by a senior executive reporting to an executive board chaired by a person publicly recognised in the field. The committee warned against the board being merely advisory on the grounds that its advice may not be followed.[20]

23. The executive board would be supported by expert advisory and technical bodies. The authority should not be placed within a government department because it would not have a separate identity. As the Robens committee noted, 'responsibility is diffused vertically in departmental hierarchies that eventually culminate in senior civil servants and ministers who devote to the subject whatever time they are able to spare from other competing preoccupations'.[21] The eventual result was the establishment of the United Kingdom Health and Safety Executive Agency.[22]

The Health and Safety in Employment Act 1992 (HSE Act)

24. Twenty years after the Robens committee report, most of its legislative recommendations were included by New Zealand in the HSE Act. This legislation imposed a general duty on employers to 'take all practicable steps' to ensure the health and safety of workers.

25. Administration of the legislation was placed in the multi-functional DOL (now part of the Ministry of Business, Innovation and Employment),[23] but the department lost focus and did not keep up with modern thinking in policy, regulation, strategy and operations. This deterioration was not restricted to administration in respect of underground coal mining.

26. Long-term health and safety strategy was based mainly on backward-looking injury rates and took little account of lead indicators or the special features of high-hazard industries. In the mining context employers were left alone with little guidance or oversight, and no approved codes of practice. There was little emphasis on worker participation and no routine contact between the inspectorate and employee representatives.

27. The inspectorate lost its capacity and focus. Resource allocation was not based on solid risk analysis and data. Compliance strategy, including enforcement, was outdated. Only two inspectors were left to service the underground coal mining industry and they had other duties as well.

Recent government initiatives

The High Hazards Unit

28. Following the Pike River tragedy, in September 2011 the government established the High Hazards Unit within DOL. Its focus is health and safety in the mining and petroleum and geothermal sectors.

29. The unit has been a welcome improvement, but some problems remain. These are discussed in Chapter 24, 'Effectiveness of the health and safety regulator'.

Funding increases

30. In May 2012 the New Zealand government announced an extra $37 million funding over four years for the health and safety regulator. The purpose is to increase the number of field inspectors by 20%, from 148 to 180, by 2015. At the same time, the minister of labour ordered a fundamental review of the health and safety system by an independent taskforce.[24]

What should be done

31. It is primarily in the implementation and administration of the health and safety legislation that New Zealand has lost its way, with knock-on effects on industry performance. In Part 2 of the report the commission analyses what needs to be done about it. The starting point is reform of the regulator.

32. Major and rapid change is required. The Pike River tragedy is a wake-up call for all industries, not just for those in underground coal mining. It is also a wake-up call for the government and for regulators.

33. There are 16 primary recommendations in this report, which are supported, where necessary, with more detailed recommendations. The commission trusts that those charged with responding to this report will also attach weight to the views and conclusions in the text. Those recommendations couched directly in terms of the underground coal mining industry may have wider relevance.

34. Recommendations are found at the end of the relevant chapters that follow and are reproduced in Volume 1.

ENDNOTES

1 Safe Work Australia, Comparative Monitoring Report: Comparison of Work Health and Safety and Workers' Compensation Schemes in Australia and New Zealand, October 2011, p. 5, http://www.safeworkaustralia.gov.au/AboutSafeWorkAustralia/WhatWeDo/Publications/Documents/609/Comparative_Performance_Monitoring_Report_13th_Edition.doc

2 Department of Labour, The State of Workplace Health and Safety in New Zealand, June 2011, p. 1.

3 The document does not provide the same categories of data for any one year.

4 Department of Labour, State of Workplace Health and Safety, p. 3.

5 Kate Wilkinson (Minister of Labour), Cabinet Paper – Proposal to Increase Investment in Safe Skilled Workplaces Using Unallocated Revenue from the Health and Safety in Employment Act Levy, 4 April 2012, DOL7770060003/7, paras 31–32.

6 Ibid., DOL7770060003/1, para. 32.

7 Ragnar E. Löfstedt, Reclaiming Health and Safety for All: An Independent Review of Health and Safety Legislation (Cm 8219), 2011, http://www.dwp.gov.uk/docs/lofstedt-report.pdf

8 Department of Labour, State of Workplace Health and Safety, p. 3.

9 Ibid.

10 Department of Labour, Response of the Department of Labour to Request for Information, June 2012, DOL7770060067/5, paras 10–11.

11 Gunningham and Associates Pty, Underground Mining Information: Contextual Advice on International Standards and Literature Review (RFP 234) – Report for the Department of Labour, 2009, DOL0010020402/3; Michael Quinlan, Report Comparing Mine Health and Safety Regulation in New Zealand with Other Countries, DOL4000010001/3, para. 4.

12 Department of Labour, Phase Four Paper, 16 March 2012, DOL4000010005/90.

13 Ibid.

14 Ibid., DOL4000010005/73, para. 310.2.

15 Ibid., DOL4000010005/89.

16 Ibid.

17 Lord Robens (Chairman), Committee on Safety and Health at Work, Safety and Health at Work: Report of the Committee 1970–72, 1972, HMSO, 1972.

18 Lord Robens (Chairman), Safety and Health at Work, pp. 49–50.

[19] Ibid., pp. 21–23.

[20] Ibid., pp. 36–39.

[21] Ibid., p. 35.

[22] For information on the agency see: http://www.hse.gov.uk

[23] Aviation and maritime health and safety are administered by Crown agents, the Civil Aviation Authority and the Maritime Safety Authority, which are close to the Robens model.

[24] Kate Wilkinson, (Minister of Labour) Media Release: Workplace Safety to Get Funding Boost, 2 May 2012, http://www.beehive.govt.nz/release/workplace-safety-get-funding-boost

CHAPTER 19

Coal mining in New Zealand

Introduction

1. This chapter gives an overview of the characteristics of the coal resource and the coal mining industry in New Zealand and in Australia.

New Zealand coal fields

Main characteristics

2. New Zealand's coal resources are estimated to be over 15 billion tonnes, 80 to 85% of which are South Island lignites. The recoverable quantities of the 10 largest deposits are estimated at over 6 billion tonnes. Sub-bituminous and bituminous resources are estimated to be 3.5 billion tonnes; the recoverable quantity is uncertain.[1] The coal basins generally range in size from 150km^2 to 1500km^2. They often contain small coal fields.

3. New Zealand straddles the Pacific and Indo-Australian tectonic plates. Consequently coal seam geology can be complex, with changes in thickness and dipping over short distances. There can be marked structural disturbance, including multiple partings or splits, normal and reverse faulting and overfolding. The quality, thickness, structure and integrity of the seams can vary significantly over short distances. The faulting and complexity at the Pike River mine are not unusual.

4. The coals vary from lignite to semi-anthracite. They can be prone to spontaneous combustion and gas outburst. Gas content can vary within and between mines and ranges from non-gassy to highly gassy. The coals can have high water content. Some fields are located in areas of high rainfall. Inundation can occur, sometimes from old workings.

5. Many coal fields lie near regions of high ecological significance. Rock may be sulphur bearing, with potential for acid mine drainage and subsequent environmental damage. Streams and other natural resources require protection in accordance with environmental legislation.[2] Additional protections and consents are required to mine in land administered by the Department of Conservation (DOC).

6. The topography is often difficult, making access challenging and requiring mines to have relatively self-contained infrastructure and rescue facilities. The weather is variable, with many areas prone to high rainfall, fog and cloud cover. The weather can impede search and rescue operations, as was the case at the Pike River mine.

7. The complex geology, especially faulting and steep dipping, means that conventional mechanised mining methods are sometimes not very effective. Solid Energy New Zealand Ltd, the largest New Zealand underground coal mine operator, has responded by using hydro mining on the West Coast. This method was also used at the Pike River mine. A technique uncommon in most of the world, it requires specialised equipment and training. Combined with the geological conditions of the West Coast, hydro mining provides challenges for safety management.[3]

8. Some countries, especially those on the Pacific Rim, have coal fields similar to those in New Zealand. But those distant from tectonic plate boundaries, including Australia, South Africa, India, Western Europe and the eastern United States, are often of much greater lateral extent, and have simpler and more predictable geology.

Production

9. The large lateral seams found overseas can accommodate substantial underground coal mines with high production rates. By contrast, underground coal mines in New Zealand are small and have not been able to sustain

high production rates. The highest reported production by a New Zealand underground coal mine in one year was 500,000 tonnes, from the Spring Creek mine. Initial expectations had been up to 1.8 million tonnes per annum.[4] Production at Pike River was initially estimated to be up to 1.3 million tonnes per annum,[5] but that was revised downwards. By October 2010 the production forecast to June 2011 was 320,000–360,000 tonnes.[6]

10. Difficult geology, low production rates and New Zealand's distance from international markets make mining here economically challenging. Two factors offset these problems: the high quality of some New Zealand coal, especially that from the West Coast, and the commodities boom over the last decade and consequent increase in international coal prices.[7]

Planning

11. Great care is needed when planning, developing and operating underground coal mines. Detailed exploration is required. Insufficient resource definition has resulted in many mines being uneconomic or facing unforeseen health and safety risks. Three of the six large underground coal mines commissioned in New Zealand in the last 35 years have failed.[8]

12. Even successful mines have had problems. Solid Energy gave the example of its Spring Creek mine, situated about 20km as the crow flies from the Pike River mine. There was exploration in the 1980s and 1990s but the joint venture partners were not prepared to commit the major capital required to develop a large mine. Instead they adopted the less costly option of accessing a high-quality seam nearer the surface. The preliminary plan and budget were approved in 1999, 'under time pressures, with too little geological and resource investigation completed and with only a short-term view of the future mine plan. These combined decisions compromised the mine for the next 12 years, resulting in challenges for safe and economic mining that have had to be overcome with difficulty ever since and are still felt today.'[9]

13. Spring Creek did not achieve its initial production targets. Costs escalated. By 2001 the mine was placed on care and maintenance. This means that production is halted but the site is managed so that it remains safe and stable, ready to be reopened if circumstances alter.

14. In 2002 Solid Energy became the sole owner. It reopened the mine and carried out further drilling to improve the resource information. As Dr Donald Elder, chief executive officer of Solid Energy, said, '[i]n mining, where certainty of geological information is the key to good mine planning and operations, the unexpected only ever has negative consequences. So it was with Spring Creek. For the next six years the mine struggled and repeatedly failed to meet its production and financial plans.'[10]

Observations

15. This leads to three observations. First, the economics, the timeframe from design to production, and the technical and legal requirements of underground coal mining in New Zealand cannot be directly determined by overseas experience.

16. Second, New Zealand operators may require knowledge and expertise, including in hydro mining, that overseas operators may not have. Everyone involved – miners, supervisors, management, the board, training institutions, advisers and regulators – must possess this specific and specialised background. Similarly, particular mining equipment may be required. Some overseas equipment may not be suitable.

17. Third, the principles underlying safe mining in New Zealand are the same as those overseas. Mine operators need to control the risks of the unforgiving underground environment by comprehensive measures including hazard identification and safety management, strata control, ventilation and gas management systems and equipment. Suitable equipment, trained workers and expert advisers are essential.

New Zealand coal mining industry

18. New Zealand has produced coal since the late 1840s. It was a major energy source, but from the 1950s to the 1970s hydro power, cheap imported oil and then gas from the Taranaki region became significant energy sources. There was a general decline in demand for coal and many small and inefficient mines began to close.[11] The number of coal mines reduced from 216 in 1952 to 78 in 1973. Currently there are approximately 22 coal mines, five of which are underground. Production has been suspended at two underground mines, including Pike River, and two open cast mines.[12] The industry is dominated by Solid Energy and otherwise comprises very small operators.

19. Correspondingly, the number of people employed in the industry decreased from approximately 5000 in the 1950s to 1500 by the 1970s. In 2010 coal mining employed between 1030 and 1700 people,[13] of a total New Zealand workforce of approximately 2 million.

20. Over the last few decades annual coal production has grown, to about 5 million tonnes in 2011 (see Figure 19.1). That trend is predicted to continue.

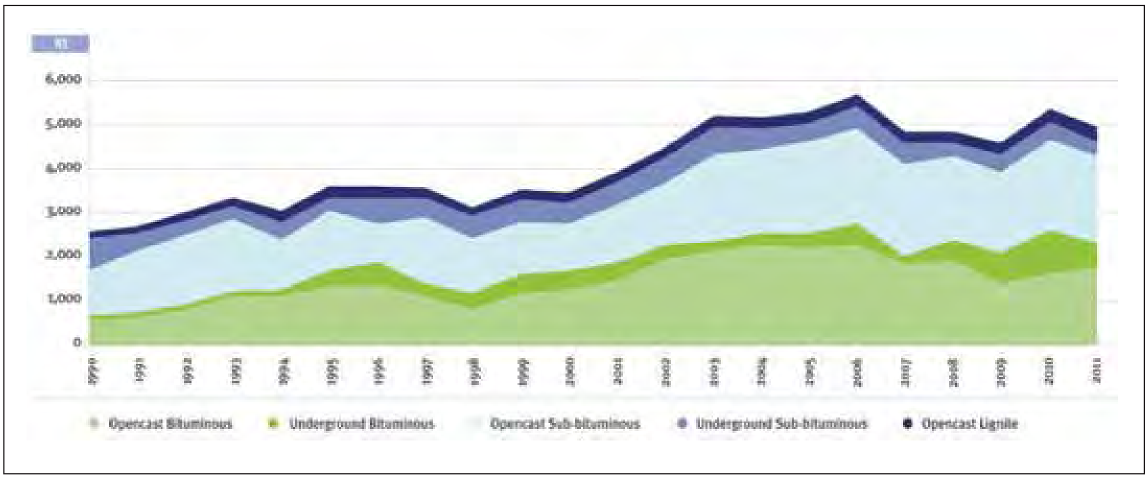


Figure 19.1: New Zealand coal production[14]

21. There have been significant changes in the way in which coal is mined in New Zealand. Up to the 1940s coal was mined almost exclusively using underground methods. Since the Second World War open cast mining has been in the ascendancy (see Figure 19.2). By the 2000s only about 20% of annual coal production came from underground mines.

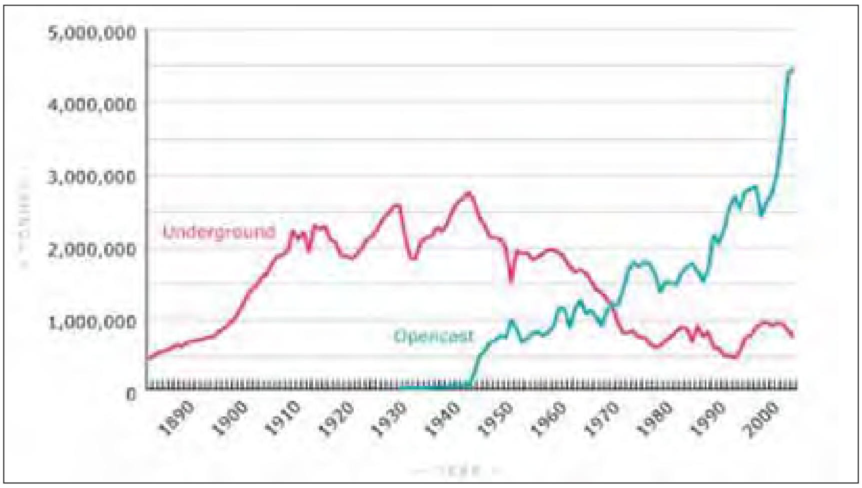


Figure 19.2: Open versus underground mining[15]

22. Underground coal mining still has a place in New Zealand. It is practised by several operators, including Solid Energy at its Huntly East mine in the North Island and at Spring Creek.

Australian coal mining industry

23. New Zealand's largest coal mining neighbour is Australia. It is one of the largest producers in the world and has the fourth largest coal reserves. In 2010–11, Australia produced 347.6 million tonnes of saleable coal, approximately 22% (76.1 million tonnes) of which was produced by underground methods and approximately 72% (271.5 million tonnes) by open cast methods. New Zealand's total coal production represents less than 2% of Australian coal production.

24. Approximately 97% of Australian saleable coal is produced in Queensland and New South Wales.[16] In the 2010–11 year Queensland produced 179.8 million tonnes from 59 mines, 15 of which were underground. The industry directly employed 32,453 people. New South Wales produced 156.9 million tonnes from 61 mines, 30 of which were underground. The industry directly employed 21,126 people. Western Australia, South Australia and Tasmania produced approximately 11 million tonnes in seven mines employing about 1000 people. The Northern Territory does not produce coal.[17]

25. The industry includes large multinationals, some of which own several mines. Many mines are large scale, using high production methods such as longwall mining. Hydro mining is not used.

26. Australian coal industry workers tend to be paid more than their New Zealand counterparts. That attracts New Zealand workers, contributing to a shortage of experienced coal mine workers on this side of the Tasman. As a result New Zealand operators may be required to train workers or source them from overseas.

Conclusions

27. Coal mining in New Zealand has some unique characteristics, which must be accommodated at all stages of mine design, development and operation. But the need for careful health and safety management, and the systems required to achieve this, are the same as overseas.

28. Despite the differences in scale, New Zealand can benefit from close co-operation with Australia, especially the main mining states of Queensland and New South Wales. That theme is reflected in this report.

ENDNOTES

1 Ministry of Economic Development, New Zealand Petroleum and Minerals, Coal Resources, 14 March 2012, http://www.nzpam.govt.nz/cms/coal/coal-resources

2 See the Resource Management Act 1991.

3 Donald Elder, transcript, p. 6.

4 Ministry of Economic Development, Phase Four, 16 March 2012, MED4000010001/29, para. 101.

5 Ibid. This was to come from a combination of production and roadway development.

6 Pike River Coal Ltd, Activities Report: Quarter ended 30 September 2010*, DAO.007.11332/2.

7 Donald Elder, witness statement, 8 June 2011, SOL306956_1/16, para. 32.

8 Huntly West mine exploded in 1992, producing little further coal before being closed. Mount Davy suffered rock, coal and gas outbursts and fatalities before closing three years after first development and the Pike River mine exploded before any significant production. Ministry of Economic Development, Phase Four Paper, 16 March 2012, MED4000010001/26, para. 91.

9 Donald Elder, witness statement, 8 June 2011, SOL306956_1/19, para. 44.

10 Ibid., SOL306956_1/21, para. 52.

11 Ministry of Economic Development, Tier Two Paper, 6 May 2011, MED0000010001/10–11, paras 18–19.

12 Ministry of Economic Development, New Zealand Petroleum and Minerals, Operating Coal Mines, 16 March 2012, http://www.nzpam.govt.nz/cms/coal/coal-resources/operating-coal-mines

13 It has not been possible to ascertain the exact number of people employed in the industry, in part due to conflicting data and, it is assumed, different definitions of the categories of people that should be included, e.g. whether contractors should be included.

14 Ministry of Economic Development, New Zealand Petroleum and Minerals, graph, http://www.med.govt.nz/sectors-industries/energy/image-library/energy-data-and-modelling/coal/Coal-1.gif/image_view_fullscreen

15 Alan Sherwood and Jock Phillips. 'Coal and Coal Mining', Te Ara: The Encyclopaedia of New Zealand, 24 September 2011, http://www.TeAra.govt.nz/en/coal-and-coal-mining/6/5

16 Australian Coal Association, Coal Production, http://www.australiancoal.com.au/coal-production.html

17 Data sourced from the Queensland Department of Natural Resources and Mines and Coal Services Pty Ltd.

CHAPTER 20

A failure to learn

Introduction

1. This chapter discusses previous tragedies and the failure to learn from them.

New Zealand coal mine tragedies

2. New Zealand's main New Zealand main coal mine tragedies, not including the Pike River mine tragedy, are set out below.[1]

DATE	WHAT HAPPENED	DEATHS	INQUIRY	MAIN PROBLEMS
21 February 1879	Explosion of methane at Kaitangata coal mine, Otago	34	Coronial inquest	Warnings about dangerous practices were not heeded. Insufficient gas record keeping and ventilation. Use of naked light (open lamp) despite previous detection of methane.
26 March 1896	Explosion of methane and coal dust at Brunner coal mine, West Coast	65	Royal commission of inquiry	The explosion was the result of ignition of coal dust from 'blown out shot' fired contrary to rules of the mine, in a part of the mine where no one should have been working. Miners believed there had been an accumulation of methane and inadequate ventilation, which was not accepted by the commission.
28 January 1900	Substantial fire at Westport-Cardiff coal mine, Mokihinui. (The mine had been closed in September 1899 due to a failure to produce marketable coal and lack of funding.)	0	Royal commission of inquiry	Presence of conditions supportive of spontaneous combustion. The mine was not adequately monitored. (During operation of the mine, there was inadequate ventilation and insufficient enforcement of statutory requirements.)

DATE	WHAT HAPPENED	DEATHS	INQUIRY	MAIN PROBLEMS
21 June 1907	Fire burning at Nightcaps colliery, Southland	3	Royal commission of inquiry	The management of the mine was poor, there was inadequate ventilation during the shift and inadequate daily examinations. Naked lights were used instead of safety lamps and workers were not withdrawn when conditions were dangerous. There was also lax enforcement by the inspector.
12 September 1914	Explosion of methane and coal dust at Ralph's colliery, Huntly	43	Royal commission of inquiry	Inadequate examinations for gas in old workings and inadequate ventilation. Naked lights were used instead of safety lamps. Failure to report injury caused by a previous explosion. Shot-firing in dusty mine. The inspector failed to ensure strict and immediate compliance with recommendations, failed to require use of safety lamps and did not properly examine old workings.
3 December 1926	Explosion of coal dust at Dobson colliery, Dobson	9	Royal commission of inquiry	Laxity in issue of oil safety lamps. Lamps were left unattended in the mine. There was inadequate stone dusting despite the requirement by the inspector to stone dust all roads.
15 November 1929	Explosion of methane and coal dust at Linton coal mine, Ohai	3	Royal commission of inquiry	Inadequate ventilation, stone dusting, supervision of shot-firing (which was non-compliant) and detection of contraband (matches taken underground).
24 September 1939	Fire at Glen Afton No. 1 coal mine, Huntly	11	Royal commission of inquiry	Fire initially caused by cigarette or naked light, not completely extinguished. Inadequate reporting at mine of fire. Ventilation fan not on while men in mine.
6 November 1940	Explosion of methane at Kayes coal mine, Ten Mile Creek, Greymouth	5	Commission of inquiry	Methane ignited by worker lighting cigarette.

DATE	WHAT HAPPENED	DEATHS	INQUIRY	MAIN PROBLEMS
31 August 1955	Inrush of mud and water at Renown colliery, Huntly	1	Commission of inquiry	The majority considered the tragedy was unforeseeable in light of existing knowledge and previous experience. Management was efficient and up to accepted standard. The minority considered the accident was foreseeable. Mine manager failed to inspect the surface following a large roof fall beneath a watercourse. The deputy and underviewer were not told of the watercourse above the pillaring operation.
17 January 1958	Explosion of methane at Westhaven coal mine, Collingwood	4	Commission of inquiry	Inadequate ventilation, failure to search for contraband (matches and lighter taken underground) and failure to carry out examinations. Mine manager made untrue entries of searches and examinations and presence of fifth man working the mine concealed.
19 January 1967	Explosion of methane and coal dust at Strongman coal mine, West Coast	19	Commission of inquiry	Insufficient pre-shift examinations, insufficient gas testing, failure to report occurrences of gas, non-compliant shot-firing and inadequate ventilation. The district and chief inspectors had failed to take action despite being aware of dangerous practices, including the non-compliant shot-firing and ventilation problems.
18 September 1985	Fire caused by spontaneous combustion at New Imperial (Boatmans No. 4) coal mine, Reefton	4	Court of inquiry[2]	Pillaring conducted too close to return airway, failure to detect signs of spontaneous combustion due to lack of examinations, mine plans not submitted to the inspector and poor ventilation management practices – main fan not running and ventilation door connecting the intake and return was kept open. Inspector not able to make frequent inspections of mines in his area due to workload.

DATE	WHAT HAPPENED	DEATHS	INQUIRY	MAIN PROBLEMS
23 September 1992	Explosion of methane caused by spontaneous combustion at Huntly West coal mine, Waikato	0	Investigation by mines inspector	Insufficient reporting to mines inspector and mines rescue service, failure to adequately extinguish fire and failure to immediately withdraw workers when smoke encountered.
4 June 1998	Outburst of coal, mudstone and methane at Mount Davy coal mine, West Coast	2	Coronial inquest	Unforeseeable and unavoidable event in light of industry knowledge at the time.
8 March 2006	Inrush of water at Black Reef (Tiller) coal mine, Greymouth	1	Coronial inquest	No effective health and safety system in place, no risk assessment undertaken, inadequate information, inaccurate mine plans, the knowledge and experience of the underground manager was insufficient and no training plan was established for him, and failure to plan for possibility of inundation.
8 September 2006	Unplanned goaf fall at Roa coal mine, Blackball	1	Coronial inquest	Manager's support rules not followed, no strata management plan and no review of pillaring operations.

Figure 20.1: New Zealand coal mine tragedies

3. Recurring themes include:

- an insufficient regulatory framework;
- the health and safety regulator not properly conducting inspections nor ensuring legislative compliance;
- operators not identifying and managing hazards, including inadequate ventilation and gas management systems;
- operators not providing miners with proper training, equipment and oversight; and
- miners not following safe practices.

Overseas tragedies

4. Similar themes are apparent in overseas coal mining tragedies, some of which are outlined below.

Westray

5. On 9 May 1992 a methane and coal dust explosion in the Westray mine, Pictou County, Nova Scotia, Canada killed all 26 miners underground. The mine had been open for nine months. Sparks from the cutting parts of a continuous miner provided the source of the ignition. There was inadequate ventilation, treatment of coal dust and training. Westray was a 'stark example of an operation where production demands resulted in the violation of the basic and fundamental tenets of safe mining practice.'[3] Management failed to instil a safety mentality in its workforce. It ignored or encouraged a series of hazardous or illegal practices. The body responsible for the mine planning

approval process did not perform its duties properly. The body most responsible for regulating the safety of the mine failed to enforce the law.

Moura No. 2

6. On 7 August 1994 a methane explosion at Moura No. 2 mine, Queensland, Australia, killed 11 miners. Ten survived. A second explosion two days later led to the mine being sealed. The bodies of the miners have never been recovered. The investigation found that the ignition was caused by spontaneous combustion in a sealed panel.[4] Factors contributing to the first explosion included failing to prevent heating in the panel, failing to capture and evaluate signs of heating over an extended period, failing to identify that sealing the panel could result in accumulation of methane within it and failing to withdraw people from the mine when there was potential for an explosion. Management did not ensure that all miners underground were aware the panel had been sealed. It did not inform miners that they could choose not to go underground.

7. In 1996 the Moura No. 2 investigation report was reviewed by a New Zealand task force led by the Ministry of Commerce, which was then responsible for health and safety in underground coal mines.[5] It made recommendations directed at managing spontaneous combustion, training, the need for underground coal mines to have ventilation officers, gas monitoring, sealing and emergency facilities.

Sago

8. On 2 January 2006 an explosion at the Sago coal mine in West Virginia, United States, killed 12 miners. Sixteen miners survived. The Mine Safety and Health Administration (MSHA) report dated 9 May 2007 identified the likely immediate cause of the explosion as a lightning strike, which transferred energy to an abandoned pump cable within a sealed area of the mine, igniting accumulated methane. The explosion destroyed the seals and filled parts of the mine with carbon monoxide. Failings included not building the seals in accordance with the approved plan and not immediately notifying the MSHA and mines rescue of the accident. Even so, rescue teams would not have been allowed underground immediately because of the high levels of toxic gases and the risk of a further explosion. An internal review into the MSHA's actions identified weaknesses in its performance, including a failure to follow established inspection procedures, poor and uncorrected performance of the inspectors, weaknesses in enforcement actions, a failure to recognise a deficiency in the approved emergency plan and outdated and unclear procedural instructions.

Upper Big Branch

9. On 5 April 2010 a coal dust explosion that resulted from a methane ignition at the Upper Big Branch coal mine, West Virginia, United States, killed 29 workers and injured two others. The MSHA found that the operator 'promoted and enforced a workplace culture that valued production over safety, including practices calculated to allow it to conduct mining operations in violation of the law.'[6] In the four years before the explosion, miners did not make health and safety complaints to the MSHA because they were intimidated by management and told that raising safety concerns would jeopardise their employment. Because health and safety inspectors had given prior notice of visits, violations could be hidden. The operator had two sets of health and safety hazard records. One was required by law and available to miners and inspectors. The other, not available to miners or inspectors, contained internal production and maintenance reports. It included hazards not noted in the first set.

10. Basic safety measures could have prevented the explosion. The longwall shearer was not maintained safely and was, therefore, an ignition source. The methane monitoring, ventilation and stone dusting were inadequate and ventilation and roof control plans were not followed. Mine examinations were not properly performed and obvious hazards were not identified. Workers were not adequately trained and refreshed about their tasks, health and safety, and hazard recognition. The MSHA inspectors failed to follow established policies and procedures, compromising enforcement efforts. In the 18 months before the explosion, the Upper Big Branch mine received 684 citations for violations, yet the MSHA failed to use other enforcement mechanisms. The inspectors did not identify many of the mine's failings. There was inadequate review of the operator's record books.

11. International coal mining tragedies have received significant media coverage, including the Upper Big Branch mine tragedy, which occurred only six months before the Pike River tragedy. Domestic and international mining tragedies provided a strong warning about the need for strict management of underground coal mine hazards and effective regulation. Non-coal mining tragedies also provided relevant lessons.

Non-coal mining tragedies

Erebus Flight 901

12. On 28 November 1979 Air New Zealand flight TE901 crashed into Mount Erebus in Antarctica, resulting in the death of all on board. A royal commission of inquiry analysed the organisational factors that contributed to the accident by allowing human error or failing to negate it. It led to the creation of a specialist New Zealand Civil Aviation Authority (CAA). The CAA establishes standards, monitors adherence to standards, and investigates accidents and incidents. A scientific approach is used. It 'collects data on error and violation producing conditions, supervisory and organisational issues and reports on these formally on a quarterly basis.'[7] That data underlies safety initiatives, including education campaigns, monitoring and compliance action. This scientific approach has still not been fully reflected in the Department of Labour's regulatory approach.

BP Texas City oil refinery

13. On 23 March 2005 an explosion at the BP Texas City oil refinery, United States, killed 15 people and injured more than 170 others. The BP US Refineries Independent Safety Review Panel (the Baker panel, as it was known) identified it as a process safety accident. BP had neither effective safety leadership nor adequate safety systems to address the risk of catastrophe. Process safety was not established as a core value across its US refineries nor effectively incorporated into management decision-making. The Texas City refinery had 'not established a positive, trusting, and open environment with effective lines of communication between management and the workforce',[8] a required part of a good process safety culture. The process safety education and training at BP was inadequate. The Baker panel found 'significant deficiencies existed in BP's site and corporate systems for measuring process safety performance, investigating incidents and near misses, auditing system performance, addressing previously identified process safety-related action items, and ensuring sufficient management and board oversight.'[9] Many of the deficiencies were identifiable in lessons from previous process safety incidents. The issue of process safety had been highlighted as long ago as the Piper Alpha oil rig tragedy in 1998, when 167 people lost their lives.

Cave Creek

14. On 3 July 1995 a viewing platform collapsed at Cave Creek, on New Zealand's West Coast. Fourteen people died. There had been significant failings by the relevant regulatory agency, the Department of Conservation. The commission of inquiry recommended that the government institute a combined regional disaster and trauma plan for the West Coast, to provide for unambiguous overall leadership of emergency responses, the prior resolution of all likely conflicts and the co-ordination of all services involved. Following Cave Creek, the co-ordinated incident management system (CIMS), described in Chapter 16, 'Search, rescue and recovery' was developed. The 2005 West Coast regional plan provided for the control of mine emergencies (by the police). But underground coal mine emergencies were not included in CIMS training and the 2010 West Coast regional plan did not state who would control them.

15. The Cave Creek commission also recommended that a family liaison officer be appointed immediately after a tragedy to make all appropriate information available to those with an interest greater than that of the general public. The aim was to allay as much as possible the fear and anxiety of the victims' friends and family.

Conclusions

16. As its inquiry proceeded the commission noted the extent to which the themes identified by inquiries into previous tragedies were repeated at Pike River. History demonstrates that lessons learnt from past tragedies do not automatically translate into better health and safety practice for the future. Institutional memory dims over time. This confirms that good health and safety performance is only achievable with the effective, continued involvement of the three key participants: employers, employees and the government regulator.

ENDNOTES

[1] For a history of coal mine tragedies see W.P. Brazil, A Summary of the Evolution of Coal Mining Safety Legislation Together with a Traditional Viewpoint, May 1995, DOL0010010001. There are other tragedies not listed that resulted in coronial inquiries. See CAC0177.

[2] Under s 181 of the Coal Mines Act 1979, the minister of energy could direct a formal investigation be held into accidents resulting in death or injury where a mines inspector believed the accident was caused by the owner, mine manager, engine driver or any other person employed at the coal mine. The investigation would be held before a court of inquiry, consisting of a magistrate appointed by the minister.

[3] K. Peter Richard, 'Prelude to the Tragedy: History, Development, and Operation', in The Westray Story: A Predictable Path to Disaster: Report of the Westray Mine Public Inquiry, November 1997, http://www.gov.ns.ca/lae/pubs/westray/summary.asp#prelude

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

[5] Ministry of Commerce, Mining Inspection Group, Review of the Recommendations from the Wardens Inquiry into the Accident at Moura No 2 Mine, Queensland on Sunday August 7 1994, 1996, EXH0003.

[6] United States Department of Labor, Mine Safety and Health Administration, Coal Mine Safety and Health, Report of Investigation: Fatal Underground Mine Explosion April 5, 2010 – Upper Big Branch Mine-South, Performance Coal Company, 12 November 2011, p. 2, http://www.msha.gov/Fatals/2010/UBB/FTL10c0331noappx.pdf

[7] Kathleen Callaghan, witness statement, 31 October 2011, FAM00042/19, para. 69.

[8] BP U.S. Refineries Independent Safety Review Panel, The Report of the BP U.S. Refineries Independent Safety Review Panel, 2007, p. xii, http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/SP/STAGING/local_assets/assets/pdfs/Baker_panel_report.pdf

[9] Ibid., p. xiv.

The regulators

+ Collaboration between government agencies
+ The decline of the mining inspectorate
+ Management of the mining inspectorate
+ Effectiveness of the health and safety regulator
+ A new regulator

CHAPTER 21

Collaboration between government agencies

Introduction

1. The mid-1980s and early 1990s were a time of significant change in New Zealand. The economy was deregulated and major reforms were introduced in the state sector. It is within this context that a new legislative framework was established for health and safety. The Crown Minerals Act 1991, the Resource Management Act 1991 and the Health and Safety in Employment Act 1992 all came into force. Industry-specific legislation applying to mining was repealed.

2. This chapter provides an overview of the Coal Mines Act 1979 and of the changes that led to separate regimes for permitting, resource management and health and safety in coal mining. It then covers some of the consequences of the separation of functions. Of most concern is the lack of consideration given to health and safety during the various approval processes. This is a significant gap in regulatory oversight.

Law reform

Coal Mines Act 1979

3. Before the changes the Coal Mines Act 1979 was the main statute governing mining activities. It provided a prescriptive set of rules and regulations specific to the coal mining industry and was administered by one government agency. It covered coal prospecting, mine licensing and the regulation of coal mines, including coal mine management, certificates of competence, safety, employment, and accident notification and investigation. This act and other legislation – the Coal Mines (Licensing) Regulations 1980, the Coal Mines (Mine Management and Safety) Regulations 1980 and the Coal Mines (Electrical) Regulations 1980 – treated coal mining as a specialist area requiring highly prescriptive standards. The act was administered by the Mines Division of the Ministry of Energy.

4. The minister of energy granted coal mining licences over defined areas. Applications for licences were made to the Mines Division and their assessment included review by mines inspectors. Notice that a licence application had been lodged was served on landowners and occupiers and publicly notified. Local authorities had to report on environmental effects. Copies of applications were forwarded to the commissioner of Crown lands and to the relevant catchment boards or the Soil Conservation and Rivers Control Council for review and comment.

5. After consultation, the minister approved a work programme and set the conditions of the licence. These covered many matters, including resource extraction, environmental effects and mine safety.[1] The chief inspector of mines had input into the application and licence conditions. The mines inspectors were involved from the outset.

6. It was a standard condition of all mining licences that mining operations be carried out in accordance with an approved work programme. This covered the proposed development of the mine, extraction of coal and general plans for future development. As well as these site specific conditions, licences contained general conditions such as rents and royalties and supplying information. Operators were also required to use the licence land 'only for coal mining purposes in accordance with the Act and any regulations issued under the Act'.[2] That included compliance with health and safety provisions.

7. Coal mine owners had a statutory duty to make financial provisions and ensure the coal mine was managed, worked, planned and laid out in accordance with the Coal Mines Act. This included requirements on safety matters such as shafts and outlets, removal of pillars and control of dust. The act allowed for workmen's inspectors. The regulations had detailed provisions relating to certificates of competence and qualifications, conduct of the people

employed and the duties of mine managers. They included standards for mine systems and equipment such as ventilation and use of explosives.

Changing times – the 1990s

8. Both the Coal Mines Act 1979 and the Mining Act 1971, which applied to gold and silver mining, emphasised the use of land for mineral development over other uses. During the 1980s this became 'increasingly unacceptable' as the legislation governing mining was 'seen to unreasonably override the rights of land owners.'[3]

9. In 1986 the Ministry of Energy released a discussion document on mining legislation. One of its purposes was to find a better balance between the interests of the mining industry and the concerns of other parties, including local authorities and landowners. Many other parts of the mining legislation were in need of change because of matters concerning mineral ownership, mining titles, environmental protection, public participation, complex licensing procedures, and the roles and responsibilities of the various authorities.[4]

10. A major review of natural resource management, including mining, started in the late 1980s, and led eventually to the separation of the allocation of mining permits from management of the environmental effects of mining. This was reflected in the Crown Minerals Act 1991 and the Resource Management Act 1991.

11. The environmental reforms, which also resulted in the Environment Act 1986 and the Conservation Act 1987, and the establishment of the Ministry for the Environment and the Department of Conservation (DOC), changed the balance between environmental protection and economic production and the shape of the government agencies managing natural resources.

12. In 1992 the Health and Safety in Employment Act (HSE Act) was passed. It imposed general duties on all employers, including mine operators, to take all practicable steps to ensure health and safety. The prescriptive Coal Mines Act was repealed. Mine operators were to determine how to manage health and safety using appropriate hazard management practices. The drive to deregulate the economy and improve business competitiveness was evident in the new act. Initially the legislation lacked some key elements, such as strong employee participation provisions, and the delays in developing new regulations can be traced in part to a belief that the HSE Act was operating effectively without them.[5]

13. Like some other hazardous industries, including construction, geothermal energy, petroleum and quarries and tunnels, mining was no longer subject to a separate legislative scheme. Regulation regarding permitting, health and safety and environmental issues was allocated to various national and local government organisations, which were expected to act independently and impartially. It was expected, too, that the potential for conflicts of interest would be minimised, for example between the Crown's commercial interest in mining and its role in preserving the environment or making decisions about health and safety. This did not mean agencies should not work cooperatively.

The regulatory framework

Mining permits and land access

14. The Crown Minerals Act 1991 deals with the way in which rights to extract minerals and petroleum resources are allocated by the government. It sets out the rights and responsibilities of resource users and the functions and powers of the minister of energy. Exploration and mining permits are issued in accordance with government policies set out in the minerals programmes, which were prepared by the Ministry of Economic Development on behalf of the minister and issued by the governor-general.

15. New Zealand Petroleum and Minerals (formerly Crown Minerals) is the operating division of the ministry responsible for granting permits, monitoring compliance with permit work programmes and collecting royalties. It also promotes new investment in the minerals estate.

16. New Zealand Petroleum and Minerals aims to allocate resources efficiently and to generate a fair financial return for the Crown. It does not consider health and safety matters.

17. The Crown Minerals Act 1991 and Conservation Act 1987 together regulate mining on the conservation estate.

18. If mining is to occur on conservation land, the minister of conservation authorises access, taking into account the need to preserve and protect the area. Mining activities can be approved, irrespective of whether they are contrary to conservation purposes, provided there are safeguards against the potential adverse environmental effects of mining.[6]

19. When assessing applications for land access, DOC looks principally at the above ground effects of the operation. Ongoing monitoring of operations has a similar purpose. DOC does not consider whether a mining proposal involves workplace health and safety risks.

Resource management

20. The purpose of the Resource Management Act 1991 is to promote the sustainable management of natural and physical resources.

21. Local councils are responsible for its implementation. They grant land use and resource consents required for mining operations to proceed. The focus is on managing the actual and potential effects of an activity on the environment. Health and safety can be considered, but in practice the emphasis is on public, not workplace, health and safety.[7]

Health and safety

22. The HSE Act promotes prevention of harm to all employees. DOL helps employers to meet their obligations, determines whether they are complying, or likely to comply, with the act and takes enforcement action if necessary.

23. No approvals are required from DOL before mining operations start. DOL's oversight begins as soon as there is a workplace and may therefore include the exploration phase. However, despite the preventative approach of modern health and safety law, DOL has no involvement in the consenting stages of a mining operation. It does not contribute to decisions on granting mining permits, access arrangements or resource and land use consents. It is not required to approve mining activities before operations start.

The need for collaboration

24. The commission has not found anything to suggest fundamental flaws in the separation of permitting, mining safety and environmental law. It is common practice in other jurisdictions, such as New South Wales and Queensland, and in the main Canadian coal mining state of Alberta. New Zealand is not out of step.

25. The problem is not so much with the law, though there are weaknesses that are addressed later in this report, but with the way the laws were administered after the reforms. The benefits of the unified approach of the Coal Mines Act and mining inspectorate were lost.

26. The local councils – Buller, Grey and West Coast – worked together on resource consents. They appointed a lead agency and relied on reports, such as the annual planning document required by DOC, for monitoring purposes.

27. But sharp demarcation lines developed between the central agencies. The Ministry of Economic Development and DOL in particular interpreted their responsibilities narrowly, and there appears to have been little dialogue or sharing of relevant information during Pike's development.[8] Similarly, while DOC worked diligently to fulfil its statutory obligations it did not engage with either the ministry or DOL. Information collected about mining operations during approval and monitoring processes was therefore not shared.

Conclusions

28. Collaboration is required to make the system work and ensure that high-risk operations are adequately monitored. There should be closer contact between agencies, or business units within agencies, during the approval, planning and design of new mines and the production and decommissioning stages.