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).

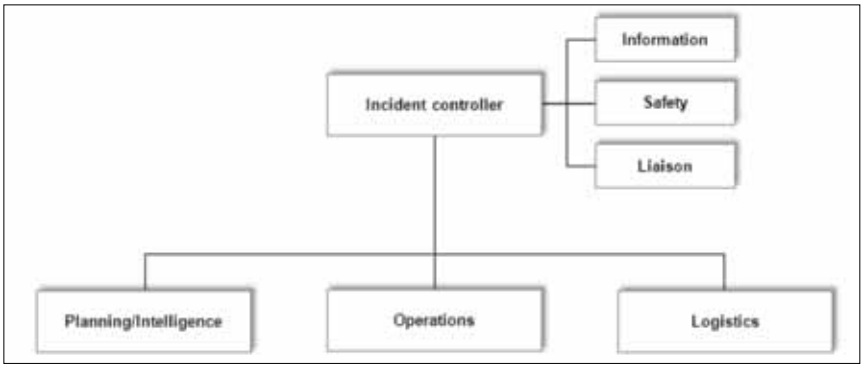

Figure 16.1: Co-ordinated incident management system

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

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