

QUEENSLAND COAL MINING BOARD OF INQUIRY

REPORT

PART II

MAY 2021

Terry Martin SC
Andrew Clough

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ISBN 978-0-6489257-3-6 (print)
ISBN 978-0-6489257-4-3 (online)

Acknowledgement of Country

We acknowledge the Aboriginal peoples and Torres Strait Islander peoples as the Traditional Owners and Custodians of this Country. We recognise and honour their ancient cultures, and their connection to land, sea and community. We pay our respects to them, their cultures, and to their Elders, past, present and emerging.

The Honourable Scott Stewart MP
Minister for Resources
1 William Street
BRISBANE QLD 4000

31 May 2021

Dear Minister,

In accordance with the *Establishment of a Board of Inquiry Notice (No 01) 2020*, as amended, the Queensland Coal Mining Board of Inquiry presents Part II of its Report.

This is the final part of the report of the Inquiry.

Yours faithfully,



Terry Martin SC

Chairperson and Board Member

Queensland Coal Mining
Board of Inquiry



Andrew Clough

Board Member

Queensland Coal Mining
Board of Inquiry

Foreword

At the time of the serious accident at Grosvenor mine on 6 May 2020, there were five coal mine workers at the tailgate end of the longwall, between shields #100 and #133. Three of the workers were as far as 260 metres from the maingate. They were 390 metres underground. By drift runner, it would take about 30 minutes to reach the surface from the maingate area.

Unquestionably, the event was terrifying. There were two forceful pressure waves 15 seconds apart, sufficient to knock a person over. Without identifying the exact order of things, in the course of the tumult, the power dropped and there was a brief but intense methane explosion at the tailgate end of the longwall.

Each of the five workers was seriously burned. The only lighting then available came from the workers' cap lamps.

Notwithstanding their condition, they made their way, helping each other where they could, towards the maingate. Their courage and resilience is inspiring.

Workers at and near the maingate experienced the force of the two pressure waves involved in the event. They had not previously experienced pressure waves of this magnitude.

There was soon the call for help from the injured.

These workers were left in no doubt that a serious incident had occurred, and a potentially very dangerous situation still existed.

They immediately headed towards the area of danger, not away from it. Some went onto the longwall face and assisted the injured back to the maingate. Others were at the maingate providing first aid and comfort to the injured before their evacuation. Still others assisted with their evacuation. Each was exposed to potential danger.

All are acknowledged for their selfless efforts that day.

The Board particularly acknowledges the efforts of the longwall Deputy, Mr Adam Maggs. He continued on towards the tailgate and assisted the last of the injured workers back to the maingate and, before proceeding to the surface with other workers, satisfied himself that there was no one left behind.

Table of Contents

Executive summary	1
Summary of findings and recommendations	16
Chapter 1 – Introduction	41
Background.....	41
Part I of the Report.....	41
Part II of the Report.....	43
Anglo’s participation in the Inquiry	44
Future Boards of Inquiry	46
Grosvenor mine	46
Structure of this report	52
Chapter 2 – Grosvenor’s history	53
Introduction	53
Longwall 101	53
Longwall 102.....	55
Other gas management issues at the mine in 2018	58
Chapter 3 – 13 HPIs at Grosvenor Longwall 103 in 2019	60
HPI # 1 – 2 July 2019.....	60
HPI # 2 – 3 July 2019.....	66
HPI # 3 – 11 July 2019.....	70
HPI # 4 – 14 July 2019.....	71
HPI # 5 – 21 July 2019.....	74
HPI # 6 – 22 July 2019.....	76
HPI # 7 – 15 July 2019.....	77
HPI # 8 – 23 July 2019.....	79
HPIs # 9 & # 10 – 24 July 2019	80
HPI # 11 – 17 August 2019.....	83
HPI # 12 – 19 October 2019	87
HPI # 13 – 7 November 2019	89
General findings for LW 103 HPIs	92
Chapter 4 – LW 104 methane management	94
Introduction	94
The stratigraphy at LW 104.....	95

Pre-drainage for LW 104.....	96
Post-drainage planning.....	105
SGE at LW 104.....	118
Goaf drainage performance.....	121
Decision to undertake bi-directional mining.....	129
Findings.....	130
Recommendations.....	132
Chapter 5 – 14 HPIs at Grosvenor Longwall 104 in 2020.....	134
HPI # 14 – 18 March 2020.....	134
HPI # 15 – 19 March 2020.....	135
HPI # 16, # 17 & # 18 – 20 March 2020.....	136
HPI # 19 – 22 March 2020.....	139
HPI # 20 – 23 March 2020.....	140
HPI # 21 – 4 April 2020.....	146
HPI # 22 – 6 April 2020.....	150
HPI # 23 – 7 April 2020.....	151
HPIs # 24 – # 27 – 21 April 2020.....	155
The shield #149 sensor issue.....	161
Association between production and the HPIs.....	163
The Inspectorate’s responses.....	169
General findings for LW 104 HPIs.....	173
General recommendations arising from HPIs on LW 103 and LW 104.....	174
Chapter 6 – Gas Monitoring at Grosvenor mine.....	176
Introduction.....	176
The gas monitoring system.....	176
The locations of relevant gas and velocity sensors.....	177
Interpretation of gas monitoring data for indicators of spontaneous combustion.....	183
Graham’s Ratio.....	186
Carbon monoxide make.....	187
Carbon monoxide/Carbon dioxide Ratio.....	188
Methane-free calculations.....	189
Trigger Action Response Plans (TARPs).....	189
Findings.....	197

Recommendations	197
Chapter 7 – The serious accident	198
Introduction	198
Gas management	198
Strata issues	204
Delays for equipment maintenance	207
The day of the serious accident.....	208
Findings.....	228
Recommendation	228
Chapter 8 – The nature and cause of the serious accident: the first pressure wave	229
Introduction	229
Possible explanations for the first pressure wave.....	229
Possible cause one: strata collapse in the goaf.....	230
Possible cause two: methane explosion in the goaf.....	247
The presence of an explosible mix of methane	248
Ignition source.....	252
Indicators of spontaneous combustion as the ignition source	254
Discussion.....	279
Relative likelihood that the first pressure wave was a result of strata fall or methane ignition.....	281
Findings.....	284
Recommendation	284
Chapter 9 – The nature and cause of the serious accident: the second pressure wave	285
Introduction	285
The origin of the ignition and direction of travel of the flame front.....	285
Possible ignition sources for the methane explosion which caused the second pressure wave ...	287
Exothermic reaction from the curing of PUR	298
The explosion of 8 June 2020.....	326
Recognised standard 16	330
Coal dust explosions.....	330
Findings.....	332
Recommendations	333
Chapter 10 – Proactive inertisation of the active goaf, and strategies to limit oxygen ingress	334
Introduction	334

Some past fire or explosion events	335
Limitations of spontaneous combustion monitoring	338
The elements of combustion	341
Infrastructure requirements for inertisation of the active goaf	348
Interaction between inertisation and goaf drainage	351
The impact of nitrogen inertisation on spontaneous combustion indicators	353
Competing views on proactive inertisation	355
Strategies to limit oxygen ingress	356
Findings	367
Recommendations	368
Chapter 11 – Labour hire and contract employment arrangements	369
Introduction	369
A review of labour hire and contract employment arrangements, and their impacts on safety in the workplace	370
Evidence specific to the mines the subject of this Inquiry	384
Professor Quinlan’s observations and suggestions	404
Absence of cogent evidence of reprisal and ‘reprisal’ under the Act	406
Findings	408
Recommendations	410
Chapter 12 – Industry safety and health representatives	412
Appointment of ISHRs	412
ISHR functions and powers	412
Evidence	413
Brief history of the ISHR role	414
Issue 1 – The appointment model	415
Issue 2 – Relationship with SSHRs	417
Issue 3 – Alteration of powers	419
Other matters	423
Findings	425
Recommendations	426
Chapter 13 – Site safety and health representatives	427
SSHR functions and powers	427
Background	428
SSHR functions and powers: some SSHRs’ experiences	429

Notifications of high potential incidents.....	434
Relationship with ISHRs	435
Relationship with mine management.....	436
Combining the SSHR role with substantive position.....	437
Training	438
Findings.....	440
Recommendations	440
Glossary of terms	442
List of acronyms	453
Appendix 1 – Terms of Reference	456
Appendix 2 – Board of Inquiry team and subject matter experts	459
Appendix 3 – Experts’ qualifications and experience.....	461
Appendix 4 – Leave to Appear.....	466
Appendix 5 – Conduct of the Inquiry	468
Appendix 6 – Practice Guidelines and Protocols	473
Appendix 7 – Notices.....	488
Appendix 8 – Interviews, Statements and Submissions	491
Appendix 9 – Witnesses.....	495
Appendix 10 – Exhibits.....	497
Appendix 11 – Additional documents referenced	546
Appendix 12 – Acknowledgements.....	548

Executive summary

1. The Terms of Reference require the Board to inquire into the serious accident that occurred at Grosvenor mine (Grosvenor) on 6 May 2020, as well as 40 methane exceedance high potential incidents (HPIs) that occurred at various mines between 1 July 2019 and 5 May 2020. The mines at which the HPIs occurred were the Anglo American plc (Anglo) Grosvenor, Grasstree, and Moranbah North mines and the Glencore plc Oaky North mine.
2. Part I of the Report considered the HPIs that occurred at each of the mines except Grosvenor. This part of the report deals with the Board's inquiry into the HPIs that occurred at Grosvenor, and the serious accident. It also includes chapters relating to labour hire arrangements, and the functions of Industry Safety and Health Representatives and Site Safety and Health Representatives.
3. The findings and recommendations of the Board are collated in the next section of the report. What follows is a narrative summary of the important points that underpin them.

Background to Grosvenor's HPIs

4. A methane exceedance HPI occurs when methane is present in air in an underground coal mine in a concentration of at least 2.5%. The *Coal Mining Safety and Health Act 1999* (Qld) recognises that such HPIs have the potential to cause a significant adverse effect on the safety or health of a person.
5. In relation to Grosvenor, the Board is primarily concerned with the 27 HPIs that occurred during the period between 1 July 2019 and 5 May 2020. However, these were not the first such exceedances at Grosvenor. Mine Record Entries prior to that period provide background to earlier gas management issues.
6. The mine had experienced a number of floor heave events in the development of longwall 101 (LW 101). Production commenced at LW 101 in May 2016. An inspection in December that year revealed that a number of exceedances in the tailgate had not been reported. The Inspectorate issued a Directive to Grosvenor to ensure compliance with the control and management of methane in the longwall tailgate. Inspections on May and October 2017 identified there had been numerous floor heave events in the development of LW 103.
7. LW 101 was sealed in late 2017. LW 102 production commenced in December 2017. LW 102 was plagued with methane exceedance HPIs from the start. By early May 2018, there had been 32, representing 60% of all methane exceedance HPIs in Queensland. Most of them resulted from a failure of the gas drainage system to effectively remove methane from the goaf.
8. At a meeting between the Inspectorate and the mine in May 2018, the mine indicated that its goaf drainage system was approaching full capacity, but it was committed to reducing the occurrence of methane exceedance HPIs.

It was said that the 'lessons learned' from the mine's gas drainage difficulties during LW 102 would be used to ensure methane was properly managed on LW 103.

The methane exceedance HPIs that occurred on LW 103

9. LW 103 production commenced in December 2018. Production was still underway at the commencement of the period covered by the Terms of Reference.
10. Grosvenor experienced 13 HPIs on LW 103 between 2 July and 7 November 2019. Whilst the immediate causes of the HPIs varied, there were consistent underlying systemic causes.
11. HPI # 1 occurred on 2 July 2019. The immediate causes were the pausing of the shearer, partially obstructing longwall ventilation, coupled with a barometric low. The systemic causes were that the mine experienced high gas emissions as a result of the extraction of 158,000 tonnes of coal in the preceding week, and that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.
12. HPI # 2 occurred on 3 July 2019. The immediate causes were an accumulation of goaf gases in a tailgate cavity, coupled with a pressure variation which resulted in those gases being ejected into the tailgate. The systemic cause was that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.
13. HPI # 3 occurred on 11 July 2019. It resulted from an eruption of methane from a floor blower. The systemic cause was that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.
14. HPIs # 4, # 5 and # 6 occurred on 14, 21 and 22 July 2020 respectively. Their immediate causes are not clear. However, the systemic cause was, in each case, that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.
15. HPI # 7 occurred on 15 July 2019. It was caused by a ventilation change on a barometric low, coupled with a ventilation officer's error in opening a regulator too quickly. Contributing factors were that the ventilation change had originally been planned to be carried out on a barometric high, and no workplace risk assessment was conducted in respect of the re-scheduling.
16. HPI # 8 occurred on 23 July 2019. It was caused by a strata fall in a cavity above the longwall that partially obstructed ventilation on the longwall. The systemic cause was that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.

17. HPIs # 9 and # 10 both occurred on 24 July 2019. They resulted from a ventilation obstruction as a result of fallen strata from a cavity. The systemic cause continued to be that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.
18. HPI # 11 occurred on 17 August 2019. It was caused by a goaf fall which occurred on a barometric low, resulting in goaf gases being forced out of the goaf. The systemic cause remained the same.
19. HPI # 12 occurred on 19 October 2019. It was caused by the scouring of the goaf when the shearer paused during a barometric low. The systemic cause remained the same.
20. HPI # 13 occurred on 7 November 2019. It resulted from two floor blowers becoming active immediately behind the longwall shields. The systemic causes were inadequate pre-drainage of the lower seams and the fact that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.
21. In its own investigations of these HPIs, the mine found that its gas drainage system had repeatedly failed because its design capacity could not sustain the mine's production rate and that the gas make was greater than expected, resulting in gas emissions in excess of the capacity of the mine's gas drainage system. However, Grosvenor failed to take timely and meaningful action to control the hazard posed by methane.

LW 104 - Gas management

22. The presence of methane in an underground coal mine is not only a function of working the mined seam. Methane from seams above and below the working seam has the potential to emit to the working seam. Mine management at Grosvenor anticipated that most of the emissions to LW 104 would come from coal seams above and below the working seam.
23. At LW 104, the Goonyella Middle (GM) seam was being mined at a depth of 390 metres. There are significant coal seams above and below the GM seam, including (in ascending order above the GM seam) the P, QA and QB, and Fairhill seams. The Goonyella Middle Lower (GML) seam is situated immediately below the GM seam.
24. Prior to mining, Grosvenor successfully undertook a program of pre-drainage of the GM seam.
25. Grosvenor had been advised to anticipate that the P seam would contribute 43% of gas emissions to the longwall, and that it should consider undertaking pre-drainage of that seam. It was also advised to make provision for the prospect of emissions from the FH seam, which represented a large gas reservoir. The mine attempted underground in-seam pre-drainage of the P seam but this was unsuccessful. As an alternative, Grosvenor proposed to effect post-drainage of the P seam by means of two surface to in-seam lateral wells.

This strategy was also abandoned prior to production, in part because the wells could not be completed before the scheduled commencement of production. Consequently, Grosvenor undertook production at LW 104 having carried out no pre-drainage other than that conducted on the GM seam. No change management process or risk assessment was conducted consequent upon the abandonment of its plans for drainage of the P seam.

26. Another substantial part of Grosvenor's gas management strategy for LW 104 was to increase gas drainage capacity by doubling the number of goaf wells and reducing their spacing from 50 metres to 25 metres.
27. Management of the hazards of methane emission, and spontaneous combustion, represent a compromise. It was said in evidence that 'good practice in mining regarding one of the hazards generally represents bad practice concerning the other'. In particular, a post-drainage system will inevitably draw oxygen into the goaf. Greater extraction of methane from the goaf carries with it an unacceptable risk of spontaneous combustion if the resultant oxygen ingress to the goaf is not well managed.
28. Although Grosvenor noted on its own records that 'increased spontaneous combustion risk due to increased gas drainage' had not been assessed, a consequential risk assessment for spontaneous combustion was not scheduled for completion until 31 May 2020. This date was long after production commenced, and after the serious accident. Mining should not have been undertaken without first carrying out such a risk assessment.
29. When production commenced on LW 104 it quickly became apparent that gas emissions were in excess of predictions. Daily average gas make at LW 104 was at least 65% greater than on LW 103. As a consequence, Grosvenor was caught short, not having sufficient post-drainage capacity for its targeted rate of production. Additional infrastructure to improve goaf drainage capacity was on order, but not due until June 2020.
30. Despite the emergence of high gas emissions, beyond gas drainage system capacity, no adjustment to production was made. No limit was imposed on weekly or daily production.
31. The efficiency of emission capture by Grosvenor's post-drainage system could accommodate production on LW 104 of around 70,000 tonnes per week. This was regularly far exceeded.
32. High gas emission rates, absence of pre-drainage or other form of diversion of gas from surrounding seams, and a goaf drainage system not achieving the necessary capture efficiency for the rate of production pursued, made LW 104 susceptible to methane exceedances.

The methane exceedance HPIs that occurred on LW 104

33. LW 104 production commenced on 9 March 2020. The first methane exceedance HPI occurred on 18 March 2020, less than 10 days later. The mine experienced a further six HPIs in six days.
34. HPIs # 14 to # 20 occurred between 18 and 23 March 2020. HPI # 14 was likely to have been caused by the shearer scouring the goaf as it entered the tailgate. HPIs # 15, # 16 and # 17 were caused by a blockage in a goaf drainage well. HPIs # 18 and # 19 were caused by a temporary shut-down of the same goaf drainage well. HPI # 20 was likely to have been caused by reduced flow on another goaf drainage well. The systemic causes were the failure to undertake an adequate pre-drainage regime prior to commencing production and greater than predicted gas emissions.
35. HPI # 21 occurred on 4 April 2020. It was caused by a flushing of the goaf stream over the tailgate drive. The systemic cause was that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.
36. HPI # 22 and # 23 occurred on 6 and 7 April 2020 respectively. It is likely that the immediate cause of both incidents was ineffective or damaged ventilation control devices which allowed goaf gases to leak into C heading. The systemic cause was that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.
37. HPIs # 24, # 25, # 26 and # 27 occurred on 21 April 2020. In each case, the immediate causes were tailgate ventilation arrangements which failed to direct methane away from the sensor located on shield #149. The systemic cause was that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.
38. There is a strong correlation between the mine's production rates and the occurrence of the HPIs. Each of the HPIs occurred on days of production substantially in excess of 10,000 tonnes, with the exception of HPI # 15. HPI # 15 was preceded by several days on which production was significantly in excess of that figure.
39. Anglo American Metallurgical Coal Pty Ltd (AAMC) CEO, Mr Tyler Mitchelson, gave evidence demonstrating an awareness of the relationship between production rates and safety. He said that a conscious decision had been made, before production, to reduce budgeted production to 100,000 tonnes per week. This was (in part) so that the mine would not be pushed over its capacity for gas management.
40. He gave further evidence that his expectation was that senior management would reduce production rates where necessary, so as not to exceed the capacity of its gas drainage system. Contrary to Mr Mitchelson's declared expectation, this did not occur.

41. Producing coal at a rate that consistently exceeds the capacity of the critical control of gas drainage subjects coal mine workers to an unacceptable level of risk. It follows that coal mine workers on LW 104 were repeatedly subject to an unacceptable level of risk.
42. The Inspectorate did not have complete information about the conditions under which mining operations were being conducted during LW 104. However, even allowing for that, the Inspectorate did not give LW 104 the attention it warranted.

The serious accident

43. In early May 2020, LW 104 was progressing through unstable strata, and gas emissions were causing elevated methane levels in the tailgate. Both issues resulted in production delays and stoppages.
44. Gas Incident Management Teams were formed on 28 April and 2 May to try to address the gas delays. Subsequently, a number of goaf holes were put on venturi to maximise gas flow rate.
45. The difficulties with unstable strata included the Fooley fault, which was described in evidence as 'a fault zone with lots of smaller faults and shears in that zone'. The Fooley fault was then present at the tailgate end of the longwall, as were a number of roof cavities. Most of 2 and 3 May 2020 were taken up dealing with these issues, with resulting delays in production.
46. The Longwall Strata Trigger Action Response Plan (TARP) was escalated to Level 3 on the morning of 2 May. A Strata Management Review Team met at 2:30pm that day. It noted that there was delamination through a large area above shields #97 to #132, and a further cavity above shields #147 to #149. A consolidation plan was developed, involving the pumping of polyurethane resin (PUR) above shields #97 to #132 and cavity fill above shields #112 to #116.
47. The balance of 2 May 2020 was spent making preparations for the pumping of the PUR and void fill. There was no production on 3 May since most of the day was taken up with pumping the PUR.
48. Between 1 and 3 May 2020, emails exchanged between the Site Senior Executive (SSE) and senior mine leadership indicated that:
 - a. the view was held that gas emissions at LW 104 had reached a critical point, and were regarded as 'almost to the point of bordering on being unmanageable';
 - b. a question was raised, but not pursued, as to whether there should be a strategic reduction in mining; and
 - c. the SSE viewed the priority as being to 'keep cutting' in order to negotiate through the difficult strata conditions being experienced in the tailgate, and immediate action on increased goaf drainage was required to achieve this.

49. A further delay of about 28 hours occurred between 11:00pm on 4 May and 3:00am on 6 May whilst maintenance was carried out on the armoured face conveyor (AFC).
50. These various delays in production contributed to the risk of spontaneous combustion.
51. The events comprising the serious accident occurred at approximately 2:57pm on 6 May 2020. Certain electronically recorded data assists with timing of events, although different electronic systems had slightly different time stamps.
52. Data from the fixed gas sensors on the face and in the tailgate return show that methane levels were stable, at less than 1%, prior to the serious accident. During the incident, only the sensors on the tailgate drive and under the canopy of the #149 shield recorded increases in methane levels. Sudden increases were detected at 2:57:41pm, although there is a lag time associated with sensor response. The sudden, sharp rise in methane levels to 4.3% (and likely in fact to have been above 5%) recorded by the sensor on the #149 shield, indicates the entry onto the face of high concentrations of methane in an elevated position.
53. The five injured workers were at the tailgate end of the longwall at the time. Others were at the maingate and at various other locations. Most of those workers gave an account of their experience after the event. Although there are exceptions, the preponderance of those accounts was to the effect that the serious accident comprised two consecutive pressure waves (wind blasts), separated by about 10 to 15 seconds. Each occurred without warning. These pressure waves proceeded from the tailgate end of the longwall. Both were of considerable force. A flame front, which burned the five workers closest to the tailgate, accompanied the second pressure wave.
54. Telemetric data of fan pressures, recorded at Shaft No. 9 and Shaft No. 6, support the recollection of the majority of workers that there were two pressure waves separated in time. The fan pressure values show two significant drops and recoveries, approximately 15 seconds apart.

Nature and cause of the first pressure wave

55. The first pressure wave was of considerable force, well beyond the scale of the typical goaf fall that may be experienced from time to time. One of the injured workers, Mr Wayne Sellars, described it as being like 'standing in a cyclone'.
56. The Board does not consider that the first pressure wave could have been caused by a gas outburst from the underlying seam. The GML seam, within the extracted area of LW 104, is located approximately 1.8 metres below the GM seam and is approximately 30 cm thick, with an estimated gas reservoir of $4\text{m}^3/\text{m}^2$. This volume of gas appears too small to create an outburst that would result in a pressure wave of the magnitude experienced by the coal mine workers.

57. In the circumstances, the first pressure wave could only have been a result of:
- a strata collapse; or
 - a methane explosion.
58. A description of what is involved in wind blast caused by strata collapse was given by Fowler and Sharma, the authors of an Australian Coal Association Research Program study in 2000, called the *Dynamics of Wind Blasts in Underground Coal Mines*:
- In some underground coal mines where the roof comprises strong and massive rock, the roof strata do not cave regularly as extraction progresses but 'hang up', leading to extensive areas of unsupported roof. These areas can collapse, suddenly and often without warning, compressing the air beneath and forcing it out of the goaf through surrounding openings giving rise to a phenomenon known as wind blast.*
59. Arising from experience with this phenomenon in the Newcastle Coalfield, the New South Wales (NSW) Department of Primary Industries issued the *MDG 1003 Windblast Guideline* in November 2007. The Board accepts that the Guideline is a useful reference point.
60. Consultant geotechnical engineer, Dr Rob Thomas, undertook a review of the geotechnical environment and the prevailing ground conditions at Grosvenor in the lead up to 6 May 2020. He advanced a hypothesis that conditions were present that made one or both of the pressure waves explicable by strata collapse.
61. Dr Thomas identified the key geotechnical features associated with wind blast as:
- thick and competent rock types in the near-seam overburden that have the potential to span and fail en masse some distance into the goaf and*
 - a limited thickness of interburden between the extraction horizon and the base of the spanning unit, such that a pathway exists for the goaf gases to displace into the mine workings...*
62. He identified that a channel of sandstone above the GM seam at LW 104, described as the MP sandstone, was 'a thick and competent unit which would be expected to retain some spanning ability and so behave as a cantilever when located in the goaf'. The MP sandstone was '...between 15 and 22m thick, and...located 32 to 35m above the GM seam at the ignition site'.
63. He also identified a number of faults that he considered would have weakened the cantilever comprising the MP Sandstone, and also increased its tendency to fail in a sudden manner.
64. The criterion of a pathway for goaf gases to be forced onto the face relates to the thickness of the interburden between the GM seam and the base of the spanning unit. It requires a gap between the two, so that upon collapse of the spanning unit a pathway exists for gas to be forced from the goaf into the workings.

65. Whether such a gap could have existed depends largely on an assessment of the bulking factor associated with that interburden. When the overlying material above the roof line collapses without the supporting influence of the shields, it can be expected to 'bulk up' i.e., to expand in volume compared with intact rock. The bulking factor can range between 1.1 and 1.3 for weak, mudstone and siltstone rock types and 1.5 for more competent sandstone rock types. Dr Thomas' hypothesis applied a low bulking factor having regard his assessment of the nature of the interburden above the GM seam. However, the higher the spanning unit, the less likely a sufficient air gap would exist to provide the necessary pathway for gases to be forced onto the face.
66. The Board considers the wind blast hypothesis as unlikely for several reasons:
- a. Given the estimated height of the spanning unit, at least 32 metres above the roof line, applying even a low bulking factor makes it unlikely that a sufficient air gap existed to account for the force of the pressure wave;
 - b. The lack of precedent for such an event in the long history of mining the GM seam militates against this cause; and
 - c. Given the indiscriminate expulsion of goaf gases onto the longwall face consequent upon a wind blast from strata failure, the Board considers it unlikely that only two gas sensors, at the tailgate drive and the #149 shield sensor, would detect an increased level of methane, and particularly that no increased level of methane would be experienced at either the inbye or outbye sensors in the tailgate return.
67. Having found that a strata fall in the goaf is an unlikely explanation of the first pressure wave, the Board reviewed the evidence indicating a methane explosion in the goaf, ultimately concluding that it is the likely explanation.
68. The Grosvenor mine atmosphere was monitored in the conventional way, using fixed telemetric sensors that transmitted information about the levels of oxygen, methane, carbon dioxide and carbon monoxide in real time, as well by way of a tube bundle system that identified the levels of the same four gases by a process of cyclically sampling from various points throughout the mine. Additionally, bag samples of gas were manually taken from locations that included the goaf stream, tube bundles, and goaf wells. The bag samples were analysed by a gas chromatograph, which was capable of detecting the full suite of gases, including ethylene, one of the harbingers of spontaneous combustion. Ethylene is liberated once GM seam coal is heated to a temperature of about 90°C, which is approaching the point at which thermal runaway of that coal is possible.
69. Careful analysis of the gas data reveals the presence of a number of subtle indicators of a small but intense heating in the goaf.
70. Over the period that the mine was in operation, the gas chromatograph regularly detected traces (sub-1 ppm) of ethylene in locations that included goaf seals, the goaf stream and goaf wells.

In addition, levels of oxygen consistent with fresh air were detected at goaf seals at the rear of the goaf for extended periods, suggesting that ventilation air was leaking through those seals into the goaf. Graham's Ratio is a calculation that measures the extent of oxygen depletion from coal oxidation. The calculated Graham's Ratio for the goaf seals demonstrated that self-heating was occurring in their vicinity during March and April 2020.

71. Undesirably high levels of oxygen, greater than 5% and as high as 17%, were detected in goaf wells in the days leading up to 6 May 2020, particularly in those that were within approximately 55 metres of the tailgate shields. Data from these wells also demonstrated increases in carbon monoxide, consistent with spontaneous combustion activity.
72. Analysis of the data from the tailgate return airway for that period shows increases in raw carbon monoxide as well as elevated Graham's Ratio, consistent with the occurrence of spontaneous combustion activity.
73. Early on the morning of 6 May 2020, a goaf well that was only a few metres behind the face was found to be drawing an explosive mixture of methane and oxygen (14% and 17% respectively) and was shut in. Elevated oxygen concentrations persisted at the two wells located within approximately 55 metres of the tailgate shields.
74. Gas data from those two goaf wells, taken immediately after the explosion, show clear signs of the combustion of methane.
75. When measured against the mine's TARPs, none of the indicators was present at levels that suggested a widespread spontaneous combustion event was occurring. Rather, they are consistent with a small but intense heating.
76. The Board concludes that on the afternoon of 6 May 2020, there was an explosible mixture of methane and air within 55 metres of the shields, on the tailgate side of the goaf, which is also where it is likely that spontaneous combustion activity was occurring.
77. In the circumstances, the Board concludes that a spontaneous combustion-initiated methane explosion was the probable cause of the first pressure wave.

Nature and cause of the second pressure wave

78. The workers' descriptions of the serious accident consistently associated the second pressure wave with the flame front that caused their injuries. Those descriptions clearly point to a methane explosion at, or propagating onto, the longwall face. Mr James Munday, a forensic fire and explosion investigator, gave evidence that the second pressure wave and associated flame front had all the characteristics of a methane deflagration.
79. On the footing that a methane explosion was the cause of second pressure wave, the real issue is determining the ignition source.

80. Another fire and explosion scene investigator, Mr Murray Nystrom, carried out an examination of the longwall, as well as items of clothing and equipment worn by the injured workers. His report was subsequently reviewed by Mr Munday. Fire damage was observable from shield #100 to the tailgate. Mr Nystrom concluded that the flame front which passed along the longwall face probably originated from, or entered the longwall face at, or near, shield #111. From there, the flame front travelled in two directions – towards the maingate and towards the tailgate.
81. Various of the possible ignition sources considered by the Board were regarded as unlikely. In summary, the reasons are:
- a. Lightning was not a realistic ignition source because there was no electric storm activity near Grosvenor on 6 May 2020;
 - b. Rock on rock, or rock on steel interactions can cause an ignition, but the key consideration is the incendive quality of the rock. Testing of rocks in the strata overlying the accident site showed that they were of low incendive quality. Grosvenor’s own assessment after the serious accident rated the risk of rock on rock friction from a roof fall or caving of the goaf as low;
 - c. The shearer and the cutting drums were stationary at the time of the accident, negating any possibility of frictional ignition by shearer picks striking rock;
 - d. The AFC and the shields do not operate with sufficient speed to generate incendive sparks or white-hot surfaces. In any case, no shields near #111 were moving at the time of the accident;
 - e. Generally speaking, a static electrical discharge will only occur if the relative humidity is below 50%. The relative humidity at the longwall was too high for any realistic possibility of a static electrical discharge;
 - f. Not all electrical equipment on the longwall could be examined and tested. However, testing of the most likely potential sources of electrical ignition was undertaken in a thorough way. No evidence was found that electrical components might have been the cause of the ignition;
 - g. The cap lamps and personal gas detectors worn by the injured coal mine workers were tested. Nothing was found to suggest these devices were an ignition source; and
 - h. The Inspectorate’s investigation into the serious accident did not reveal any evidence that any of the workers in the vicinity of the ignition point had contraband in their possession.
82. On 3 May 2020, approximately 5,600 litres of PUR was injected into 35 holes in the longwall face and roof, between shields #97 and #132.

The mixing of the components causes the PUR to expand and harden, but also generates heat as part of an exothermic reaction. Testing has shown that the curing temperature can reach 146.5°C. By virtue of the longwall retreat between then and 6 May 2020, some or all of that product was likely to be in the goaf, above or immediately behind the shields, at the time of the serious accident.

83. Dr Basil Beamish, whose speciality is characterising the spontaneous combustion potential of coal, carried out various incubation tests on GM seam coal from Grosvenor. Once the samples were step heated to 100°C, thermal runaway was achieved in time periods ranging between one and three days. The testing indicates that GM seam coal has the potential to undergo thermal runaway to a temperature sufficient to ignite a mixture of methane and air, if heated to 100°C.
84. Following the onset of spontaneous combustion of coal at North Goonyella in 1997, the Australian Coal Industry Research Laboratories conducted an investigation into the implications of the use of PUR and other cementitious grouts. The investigation considered whether the exothermic characteristics of those products had the capacity to trigger a heating of a coal mass that would not otherwise self-heat. Testing showed that in the right proportions, a PUR/coal mix could reach or exceed 100°C, the point at which GM seam coal will reach thermal runaway. Further, Dr Beamish's evidence to the Board was that the quantity of coal required to be heated so as to initiate such an ignition may be as small as the size of a tennis ball.
85. In addition to the above considerations:
 - a. the ignition occurred in the vicinity of the rear of shield #111, within the area of PUR injection;
 - b. an increase in carbon monoxide, indicative of coal heating, was detected at goaf well GRO4M001.5, which penetrated the goaf at about shield #100, on the morning of 6 May 2020; and
 - c. on 20 May 2020, after the serious accident, a heating was detected in the area immediately behind shield #96, proximate to the area of the PUR campaign on 3 May.
86. In the circumstances, the Board considers that the probable ignition source for the methane deflagration on the longwall face was the PUR-initiated heating of coal to thermal runaway, which ignited an explosible atmosphere behind the longwall in the vicinity of shield #111, resulting in a flame propagating onto the longwall face.
87. The level of stone dust maintained in the first 100 metres of the longwall return outbye the face was sufficient to prevent the methane ignition from initiating a coal dust explosion that could have propagated to other parts of the mine.

Proactive inertisation of the active goaf, and strategies to limit oxygen ingress

88. Grosvenor mines the GM seam in the typical manner, which involves leaving significant remnant coal in the goaf. This significantly increases the risk of spontaneous combustion.
89. Notwithstanding the sophistication of gas monitoring systems such as those in use at Grosvenor, there are practical limitations to the efficacy of monitoring regimes for spontaneous combustion, including the element of human error.
90. In the Board's view, spontaneous combustion was the probable cause of the serious accident. It was also the cause of an ignition that occurred at Grosvenor on 8 June 2020. The occurrence of these events, despite the use of conventional monitoring systems that did not clearly detect them, is of major concern.
91. The deficiencies of spontaneous combustion identification and monitoring systems provide reason to consider the role of proactive inertisation of the active goaf, in conjunction with those systems.
92. Active goaf inertisation involves creating an inert atmosphere in goaf areas by means of injecting an inert gas, such as nitrogen, to reduce oxygen concentrations to a low level that would effectively suppress or contain the onset of spontaneous heating.
93. Studies have shown that proactive inertisation can be successful in reducing oxygen concentrations in the active goaf in Australian mines. Technology has advanced to the point where the infrastructure is available for delivery of the required volumes of nitrogen. This particularly takes the form of Pressure Swing Adsorption plants.
94. The principal benefit lies in a significant reduction in the proportion of the goaf which is susceptible to spontaneous combustion or methane ignition. Safety risks and production losses are correspondingly reduced.
95. Notwithstanding some debate over the impact of inertisation on the utility of some traditionally used indicators of spontaneous combustion, such as Graham's Ratio, the design and implementation of proactive inertisation should be considered as a measure to deal with the risk of spontaneous combustion. This would be particularly so for mines working the GM seam.
96. Where proactive inertisation is practised, it should be done in conjunction with strategies to limit the ingress of oxygen to the goaf, such as:
 - a. limiting oxygen ingress at the maingate corner;
 - b. ensuring longwall face ventilation quantities are not excessive;
 - c. appropriate goaf perimeter road ventilation arrangements;
 - d. seal construction and monitoring; and
 - e. pressure balance chambers.

Labour hire and contract employment arrangements

97. The Board considered the nature and prevalence of labour hire and contract work at Queensland mines and the risks that such employment arrangements pose to safety at mines. It was assisted by a literature review by Professor Michael Quinlan, Emeritus Professor of Industrial Relations at the School of Management at the University of NSW.
98. The review provided a comprehensive overview of the impacts of the use of labour hire workers in a number of jurisdictions, both in Australia and overseas, and across a range of industries.
99. Labour hire and contract work are two forms of casual employment, both characterised by their precarious, temporary nature. Labour hire is a triangular employment arrangement. Under such an arrangement, a labour hire agency supplies a worker to another organisation (the host). The labour hire agency is the worker's employer, while both the labour hire agency and the host have responsibilities to the worker.
100. Since the 1990s there has been a substantial increase in the proportion of labour hire workers and contractors at Queensland coal mines, although the proportions vary between sites. At Grosvenor, 76% of its total site workforce were contractors and labour hire workers engaged in mining tasks. Lesser, but still significant, proportions were in existence at Moranbah North, Grasstree, and Oaky North mines. One Key is the dominant labour hire provider for the Anglo mines.
101. The Board considered the safety impacts associated with labour hire and contract work. One of the issues is the willingness, or reluctance, of labour hire and contract workers to raise safety concerns. In addition to Professor Quinlan's review of the research, the Board heard evidence from AAMC head of Human Resources, the Regional Director of One Key, and other stakeholders.
102. The Board's conclusion is that there is a perception among coal mine workers that a labour hire worker or contractor who raises safety concerns at a mine might jeopardise their ongoing employment at the mine. It has not been possible to assess how widespread that perception might be. However, the existence of a perception, no matter how widespread, creates a risk that safety concerns will not always be raised.
103. One significant conclusion the Board came to is that the imposition of a safety and health obligation on labour hire agencies which employ coal mine workers, such as that set out in section 19 of the *Work Health and Safety Act 2011* (Qld), would make coal mine operators and labour hire agencies mutually responsible for the safety and health of labour hire workers and add a layer of oversight of safe practices.
104. There is also scope to improve the mechanisms for safety issues to be raised by workers. Safety committees similar to those in the *Work Health and Safety Act 2011* (Qld) and the *Mining and Quarrying Safety and Health Act 1999* are not provided for under the *Coal Mining Safety and Health Act 1999* (Qld).
105. Accordingly, recommendations have been made to address these matters.

Industry Safety and Health Representatives and Site Safety and Health Representatives

106. Parts 7 and 8 of the *Coal Mining Safety and Health Act 1999* (Qld) deal with the functions and powers of Site Safety and Health Representatives (SSHRs) and Industry Safety and Health Representatives (ISHRs). These positions are based historically on the roles of the traditional check inspector, and district check inspector.
107. SSHRs are elected by coal mine workers at a site, while up to three ISHRs may be appointed by the CFMMEU after a ballot of members. One benefit of this model is that ISHRs are independent of both government and management at coal mines. ISHRs are required to hold at least a Deputy's Certificate, whereas SSHRs may be drawn from a wider range of occupations at the mine, with fewer technical competencies.
108. The Board heard evidence from two of the three ISHR's and a retired ISHR of long standing, as well as several of the SSHRs, concerning their experience of these functions. It was apparent from the evidence that in the main, the SSHR role is concerned with day-to-day site conditions and practices, rather than higher level safety issues. The ISHRs are in a position to bring to bear their independence from mine management, and potentially greater technical experience and competence.
109. It was also apparent that the functions of ISHRs and the SSHRs are most effective where a cooperative arrangement exists between the two, and that there are mutual benefits from a complementary working relationship.
110. Both positions continue to perform an important safety role at mines, and by and large the legislative model remains a sound one. The Board's recommendations are directed toward enhancing the effectiveness of both roles, and the development of relationships between them.

Summary of findings and recommendations

Context will disclose that some findings and recommendations in the report will apply only to underground coal mine, but others will apply to coal mines generally.

Chapter 3 – 13 HPIs at Grosvenor Longwall 103 in 2019

Findings for HPI # 1

Finding 1

The immediate causes of the incident were the pausing of the shearer at shield #115, partially obstructing longwall ventilation, coupled with the low barometric pressure.

Finding 2

Systemic causes were:

- a. high gas emissions as a result of the extraction of 158,000 tonnes of coal in the preceding week; and
- b. the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.

Findings for HPI # 2

Finding 3

The immediate causes of the incident were the accumulation of goaf gases in a cavity in the tailgate roadway inbye, coupled with a pressure variation that caused those gases to be ejected into the tailgate.

Finding 4

The systemic cause was that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.

Findings for HPI # 3

Finding 5

The immediate cause of this incident was a floor blower that became active at the rear of shield #55.

Finding 6

The systemic cause was that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.

Findings for HPIs # 4, # 5 and # 6

Finding 7

It is difficult for the Board to make findings about the causes of these three incidents. Each of them was ascribed to a pocket of gas in a tailgate cavity being ejected into the tailgate, however the Learning From Incidents (LFI) reports do not disclose the reasoning behind that conclusion.

Finding 8

It is possible that the flush of coal described in the hazard and incident report form regarding high potential incident (HPI) # 5 caused a partial obstruction to the longwall ventilation that resulted in goaf gases reporting to the tailgate.

Finding 9

In relation to HPIs # 4 and # 6, the Board is unable to reach a conclusion about the immediate causes.

Finding 10

The same systemic failing referred to with respect to the previous HPIs is nonetheless applicable to each of HPIs # 4, # 5 and # 6, in that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.

Findings for HPI # 7

Finding 11

The immediate causes of this incident were the undertaking of a ventilation change on a barometric low, coupled with an error by a ventilation officer who opened a regulator too quickly.

Finding 12

Contributing factors were that:

- a. the carrying out of the ventilation change was rescheduled to a time that coincided with a barometric low, rather than a high, as originally planned;
- b. no workplace risk assessment was conducted in respect of the rescheduling, and the issue of the barometric low was not addressed in the permit to change ventilation.

Findings for HPI # 8

Finding 13

The immediate cause of the incident was a fall of strata from a cavity above the longwall that partially obstructed ventilation on the longwall.

Finding 14

The systemic cause was that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.

Findings for HPIs # 9 and # 10

Finding 15

The immediate cause of both of these incidents was a ventilation obstruction as a result of material falling from a cavity above the last four tailgate shields.

Finding 16

The systemic cause was that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.

Findings for HPI # 11

Finding 17

The immediate cause of the incident was a goaf fall which occurred on a barometric low. This forced goaf gases onto the longwall and into the tailgate, overwhelming the mine's ventilation system.

Finding 18

The systemic cause was that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.

Findings for HPI # 12

Finding 19

The immediate causes of the incident were the barometric low, coupled with the paused position of the shearer at shield #140, which partially obstructed and diverted longwall ventilation so as to 'scour' the goaf. That resulted in goaf gases reporting to the tailgate.

Finding 20

The systemic cause was that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.

Findings for HPI # 13

Finding 21

The immediate cause of the incident was the activation of two floor blowers immediately behind the longwall shields.

Finding 22

Systemic failings that caused the incident were:

- a. inadequate pre-drainage of the lower seams;
- b. that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.

General findings for LW 103 HPIs

Finding 23

With the exception of HPIs # 4, # 5 and # 6, the LFI process resulted in a robust assessment of each incident, and a frank acknowledgement of the contributing factors. In respect of HPIs # 4, # 5 and # 6 the investigations were deficient, and the LFI reports used the same expressions to describe what had happened in each case without any attempt to identify the evidence for the conclusions reached. Given the state of the evidence, the Board is unable to reach any conclusions about those events, other than that, as the mine found, the incidents were symptomatic of inadequate gas drainage.

Finding 24

The Board accepts the mine's findings from its investigations that:

- a. its gas drainage system had repeatedly failed because its design capacity could not sustain the current production rate; and
- b. gas make was greater than expected resulting in gas emissions in excess of the capacity of the goaf drainage system.

These systemic factors, which substantially overlap, were the underlying cause of the majority of the HPIs on longwall 103 (LW 103).

Finding 25

Despite investigation and reporting processes that were, for the most part, robust and frank, and which identified the foregoing shortcomings, Grosvenor failed to take timely and meaningful action to control the hazard posed by methane.

Finding 26

The Inspectorate sought to engage with the mine on the issue of gas management, and requested and received minutes of meetings of mine staff who, in July 2019, were attempting to deal with the problems on LW 103.¹ There was no proposal in the minutes to moderate production, rather the minutes show that the purpose was to develop strategies 'to allow consistent longwall production in line with forecast'.² The minutes further show that the following concrete steps were identified to alleviate pressure on the post-drainage system:

¹ RSH.002.095.0001. As detailed earlier, the Inspectorate also had further engagement on 6 August 2019 and 15 October 2019.

² RSH.002.138.0001, .0005.

- a. drilling a mid-panel goaf hole at 1,522 metre chainage;
- b. bringing that and one other goaf hole online;
- c. reversing the ventilation in the perimeter road to lower methane levels entering the maingate; and
- d. the purchase and installation of four blower skids.

However, none of these steps, with the exception of the ventilation change, would have an immediate impact. Further, the installation of the blower skids was not slated for completion until 15 September 2019. By 15 September there had been a further nine methane exceedance HPIs on LW 103.

Finding 27

In communications with the Inspectorate about the cause of the HPIs, on multiple occasions, the mine acknowledged that:

- a. *gas make [was] greater than expected [and] in excess of system capacity; and*
- b. *[there had been] less than adequate methane recovery/dilution.*

Similarly, the solution, stated repeatedly, was to:

Develop a plan to increase goaf drainage capacity for peak SGE areas of Grosvenor to reduce tailgate methane concentrations to meet business plan productivity targets.

The 'solution' consisted of developing a plan, which was inadequate to address the problem in the short-term. The mine's management ought to have recognised this.

Finding 28

The proposed solution implicitly acknowledged that the mine was producing at a rate that was in excess of its goaf drainage capacity. Although Inspector Brennan made a suggestion on 2 July 2019 that the mine revert to uni-directional cutting, the rates of production associated with the HPIs ought to have been the subject of inquiry and investigation by the Inspectorate.

Finding 29

The Board reiterates the findings made in Part I of the Report that:

- a. a methane exceedance has the *potential* to result in an outcome with a level 4 or 5 consequence rating under the Anglo risk matrix;
- b. Anglo's use of a classification system that included so-called 'DNRM HPIs' created a sub-class of HPI that was likely to diminish the perceived seriousness of such events.

Chapter 4 – LW 104 methane management

Findings

Finding 30

The Board makes the following findings in relation to planning for gas management on longwall 104 (LW 104):

- a. The Goonyella Middle seam was adequately pre-drained before mining commenced;
- b. No pre-drainage of the Goonyella Middle Lower seam was undertaken;
- c. The P seam had been partly drained by Arrow Energy prior to mining, but Grosvenor’s advisors recommended further pre-drainage of the P seam;
- d. Grosvenor attempted pre-drainage of the P seam for LW 104. This was unsuccessful and was abandoned;
- e. By September 2019, the mine was aware of the potential for gas emissions to the LW 104 goaf from the Fairhill (FH) and QA seams, and had been advised to increase gas drainage capacity to provide for it;
- f. The Venting Trial resulted in close spacing (25 metres) of tailgate goaf wells becoming a central component of the gas management strategy for LW 104;
- g. In lieu of pre-drainage of the P seam, Grosvenor proposed utilising surface to in-seam lateral wells as a form of post-drainage, once mining commenced. These were intended to intercept P seam gas before entering the goaf. This was another central feature of gas management strategy for LW 104;
- h. The original proposal in the Grosvenor gas plan was for three lateral wells to the P seam. This was reduced to two by the time of the goaf drainage risk assessment;
- i. The P seam lateral well strategy was abandoned when the first attempt to drill a lateral well failed, and drilling of the second well did not fit the timetable for commencement of production on LW 104;
- j. Grosvenor was aware that increased emissions would occur in the early stages of retreat on LW 104 through the absence of pre-drainage of the P seam, and for other reasons;
- k. In the event, an important part of the gas management strategy decided upon was abandoned. Gas drainage management became fundamentally reliant on the effectiveness of the strategy of close spacing of the tailgate goaf wells, and on the operation of the goaf wells as a whole;

- i. A concern about the prospect of the close spacing of the tailgate goaf wells having implications for increased oxygen in the goaf was noted in the goaf drainage risk assessment but, to the knowledge of mine management, no specific spontaneous combustion risk assessment for the strategy was conducted prior to commencement of, or during, mining of LW 104;
- m. Mining on LW 104 should not have commenced without that spontaneous combustion risk assessment being conducted;
- n. Just prior to commencement of mining, a decision was made to use bi-directional mining instead of uni-directional, to increase production. That choice would have resulted in an increase in gas emissions;
- o. The mine's secondary extraction standard operating procedure and risk assessment were notified to the Inspectorate on 6 March 2020 (three days before commencement of mining). Both documents represented that the P seam lateral strategy would be implemented, although by that date this was no longer the case;
- p. Further, the Inspectorate was not told that there had been no re-evaluation of risk as a consequence of the P seam lateral drainage strategy being abandoned; and
- q. Although there was no obligation to do so, the Inspectorate was not advised at any time that no risk assessment for spontaneous combustion associated with increased goaf drainage at LW 104 had been conducted, nor that none would be conducted until the end of May 2020, well after production commenced.

Finding 31

Gas emissions at LW 104 were substantially greater than at LW 103 over the first 400 metres of retreat, and in excess of predictions.

Finding 32

Specific gas emission (SGE) at LW 104 was around 25 m³/t, and greater than anticipated.

Finding 33

In the absence of pre-drainage, or other effective strategy to divert gas from surrounding seams, management of gas emissions was wholly reliant on post-drainage and ventilation.

Finding 34

The actual daily production at LW 104 between March and May 2020 fluctuated. It was frequently in the range of 15,000–20,000 tonnes, and sometimes more, up to 28,000 tonnes.

Finding 35

Post-drainage capture efficiency (PDCE) of methane was not high enough to efficiently capture emissions produced at the rate of production pursued.

Finding 36

The PDCE achieved allowed production at the rate of around 10,000 tonnes daily for an SGE of 25 m³/t.

Finding 37

High gas emission rates, absence of pre-drainage or other form of diversion of gas from surrounding seams, and a goaf drainage system not achieving the necessary PDCE for the rate of production, made LW 104 susceptible to methane exceedances.

Recommendations

Recommendation 1

In light of the Board's finding that mining operations were repeatedly conducted in a manner whereby the gas emissions being generated by the rate of production were in excess of the capacity of the mine's gas drainage system, Grosvenor mine management:

- a. audits and reviews the effectiveness and implementation of the principal hazard management plans for gas management and methane drainage, to ensure that, in future, the risk to persons from coal mining operations is at an acceptable level;
- b. reviews the effectiveness of the mine's operational practices and management systems, to ensure that, in future, production rates are adjusted to match a realistic PDCE and the actual peak specific gas emissions; and
- c. carries out detailed gas reservoir analysis to identify opportunities for gas pre-drainage, or other means of capture of gas before entering longwall workings, and specifically that this analysis include the FH, QA and QB seams.

Recommendation 2

Prior to the commencement of each longwall panel, coal mines arrange a review, to be validated by a third party independent engineering study:

- a. to ensure that adequate gas pre-drainage has been implemented, taking into account a margin for error in any predictive modelling; and
- b. to ensure that adequate post-drainage capabilities are in place, taking into account a margin for error in any predictive modelling.

Recommendation 3

In light of the evidence that gas emission modelling is inherently flawed, with a high margin of error, coal mines, at the time of undertaking second workings risk assessments:

- a. Critically assess and scrutinise any gas emission modelling for an upcoming longwall panel. The assessment should include a review of the model's predictive accuracy for previous longwalls;

- b. Take steps to satisfy themselves that sufficient pre-drainage has in fact been undertaken to the extent reasonably necessary to reduce gas emissions to a safe level;
- c. Ensure post-drainage systems are designed:
 - i. with sufficient redundancy to cope with peak gas emissions, including a factor of safety in drainage capacity, and allowing for system failures; and
 - ii. in such a way that the risk of spontaneous combustion is not increased by oxygen ingress to the goaf;
- d. Ensure ventilation systems are designed in such a way as to ensure they work in combination with the post-drainage system to dilute predicted peak gas emissions to levels that achieve an acceptable level of risk.

Chapter 5 – 14 HPIs at Grosvenor Longwall 104 in 2020

Findings – HPIs # 14 – # 20

Finding 38

It is likely that the immediate cause of high potential incident (HPI) # 14 was the shearer scouring goaf gases as it entered the tailgate.

Finding 39

The immediate cause of HPIs # 15 – # 17 was a blockage in goaf drainage hole GRO4V002A which meant the goaf drainage plant was not able to sufficiently drain goaf gases for a period of time.

Finding 40

The immediate cause of HPI # 18 was a temporary shutdown of goaf drainage hole GRO4V002A which meant the goaf drainage plant was not able to sufficiently drain goaf gases for a period of time.

Finding 41

The immediate cause of HPI # 19 was a trip on goaf drainage hole GRO4V002A which meant the goaf drainage plant was not able to sufficiently drain goaf gases for a period of time.

Finding 42

It is likely that the immediate cause of HPI # 20 was reduced gas flow on goaf drainage hole GRO4V001.

Finding 43

Systemic causes were:

- a. the failure to undertake an adequate pre-drainage regime prior to commencing production; and
- b. greater than predicted gas emissions.

Findings – HPI # 21

Finding 44

The immediate cause of HPI # 21 was the flushing of the goaf stream over the tailgate drive.

Finding 45

The systemic cause was that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.

Findings – HPis # 22 & # 23

Finding 46

It is likely that the immediate cause of HPis # 22 and # 23 was that ineffective or damaged ventilation control devices allowed goaf gases to leak into C heading.

Finding 47

The systemic cause was that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.

Findings - # 24 - # 27

Finding 48

The immediate causes of HPis # 24 to # 27 were tailgate ventilation arrangements which failed to direct methane away from the shield #149 sensor.

Finding 49

The systemic cause was that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.

General findings for LW 104 HPis

Finding 50

The Learning From Incidents process resulted in a robust assessment of each incident, and a frank acknowledgement of the contributing factors, but there was a significant deficiency, in that the mine incorrectly concluded that the gas drainage system was not a critical control.

Finding 51

The mine experienced high gas emissions at longwall 104 (LW 104). These were a consequence of the specific gas emission (which was around 25 m³/t), and the mine's rate of production.

Finding 52

The mine's gas drainage system was inadequate to manage the high gas emissions.

Finding 53

The drop in production rate to 100,000 tonnes/week to manage gas emissions, referred to by Mr Mitchelson in evidence, was a budget, not a cap on production.

Finding 54

The mine did not limit its production to 100,000 tonnes/week.

Finding 55

The mine ought to have capped the rate of production at 10,000 tonnes/day, or 70,000 tonnes/week, to ensure the gas emissions could be managed by the gas drainage system.

Finding 56

Each of the HPIs that occurred on LW 104 took place on days of production substantially in excess of 10,000 tonnes, with the exception of that which occurred on 19 March 2020. However, that HPI was preceded by several days on which production was significantly in excess of that figure. That level of production contributed to the HPIs.

Finding 57

The mine should have reduced its level of production, once it understood the gas make to be significantly greater than had been predicted, so as to ensure that emissions could be captured by its gas drainage system. This is especially so after 3 April 2020, when the investigation in relation to the first seven HPIs was concluded.

Finding 58

Coal mine workers were repeatedly subject to an unacceptable level of risk at LW 104 through mining operations being conducted in a manner that exceeded the capacity of its gas drainage, a critical control for the management of methane.

Finding 59

Regional Inspector of Mines Mr Stephen Smith said, on behalf of the Inspectorate, that:³

While there had been issues with exceedances prior to July and in July 2019 on longwall 103, the interaction between the Inspectorate and the mine, and the history of HPIs from July 2019 onwards indicates to me that the mine's actions in managing these issues was generally effective. As a result, the Inspectorate had no reason to believe, prior to the startup of longwall 104 that the mine did not have the ability to take appropriate action to manage methane on the subsequent longwall.

In light of the mine's continual problems with gas management since 2016, the multiple methane exceedance HPIs on LW 103, and the mine's repeated acknowledgement that these exceedances stemmed from the continual underlying problems (identified above), such an appraisal of Grosvenor's capabilities with respect to methane management was inappropriate.

Finding 60

Grosvenor's history on previous longwalls was such as to require close attention by the Inspectorate to the mine's gas management systems and practices at LW 104. This did not occur, with the result that there was a lost opportunity to discover that the mine's production rate exceeded the capacity of its goaf drainage system. The Inspectorate should have been more proactive.

General recommendations arising from HPIs on LW 103 and LW 104

Recommendation 4

Coal mines regularly assess production rates and adjust them as necessary to ensure they do not result in gas emissions exceeding the capacity of the gas drainage system.

Recommendation 5

Resources Safety & Health Queensland (RSHQ) reviews its risk profiling and response practices with a view to ensuring that it operates as a proactive regulator.

Recommendation 6

The Board repeats its recommendation made in the Part I Report, Chapter 6, recommendation 19, that:

RSHQ take steps to amend the *Coal Mining Safety and Health Act 1999* (Qld) (the Act) and the *Coal Mining Safety and Health Regulation 2017* (Qld) to require a coal mine to develop a set of critical controls with performance criteria which must be incorporated into Principal Hazard Management Plans, and which require:

³ SST.002.001.0001, .0003.

- a. the Site Senior Executive (SSE) to notify the Regulator of a failure of a critical control to meet its performance criteria;
- b. the SSE to monitor the effectiveness of the critical controls, and report the results to the mine operator, on a monthly basis; and
- c. coal mine operators to audit critical controls as part of the audit prescribed by section 41(1)(f) of the Act.

Chapter 6 – Gas Monitoring at Grosvenor mine

Findings

Finding 61

There should have been, but was not, a Trigger Action Response Plan (TARP) for the goaf stream.

Finding 62

The existing goaf well TARP did not contain a requirement for regular bag samples to be taken under 'Normal' TARP conditions.

Finding 63

The TARPs in place for spontaneous combustion in the active goaf and the goaf wells, as at 6 May 2020, were unlikely to provide a timely warning of a small but intense heating in the goaf. Products of such a heating are likely to report to the goaf stream and/or the goaf wells.

Recommendations

Recommendation 7

Grosvenor develop a set of TARP triggers for spontaneous combustion in the active goaf with respect to the goaf stream.

Recommendation 8

Grosvenor review the TARPs for goaf wells and include a requirement for the taking of regular bag samples under 'Normal' TARP conditions.

Recommendation 9

Coal mines include the carbon monoxide (CO) reporting to the goaf wells with that measured in the longwall return when calculating the total CO Make for the active goaf.

Recommendation 10

Resources Safety & Health Queensland takes steps, through the consultative process provided by the Coal Mining Safety and Health Advisory Committee, to ensure that a Recognised standard based on best practice is developed for the monitoring and control of spontaneous combustion in underground coal mines.

Chapter 7 – The serious accident

Findings

Finding 64

The serious accident comprised two consecutive pressure waves, which proceeded from the tailgate end of the longwall and were separated by about 15 seconds.

Finding 65

No coal mine workers observed a flame front associated with the first pressure wave.

Finding 66

A flame front which burned the five coal mine workers closest to the tailgate end of the longwall face accompanied the second pressure wave.

Finding 67

The five coal mine workers were admitted to hospital as in-patients for treatment for the injuries they sustained as a result of the second pressure wave. Indeed, all five coal mine workers were seriously injured.

Recommendation

Recommendation 11

Coal mines provide all workers who go underground with personal proximity devices that allow location tracking, and are active, for the entire time the workers are underground.

Chapter 8 – The nature and cause of the serious accident: the first pressure wave

Findings

Finding 68

The probable cause of the first pressure wave was a methane explosion in the goaf, initiated by spontaneous combustion.

Finding 69

The combination of circumstances which supports this conclusion are:

- a. The magnitude of the pressure wave permits of only two explanations: a methane explosion or strata fall in the goaf;
- b. A strata fall in the goaf is an unlikely explanation;
- c. There was an explosible mixture of methane and air in the goaf on 6 May 2020, potentially as far back as 30 metres behind the tailgate shields;

- d. Throughout much of the operation of longwall 104, and in particular in the period leading up to 6 May 2020, undesirably high concentrations of oxygen were present in the goaf;
- e. There were increases in carbon monoxide concentrations, Graham's Ratio and CO/CO₂ Ratio, as well as traces of ethylene and higher hydrocarbon gases in the goaf, in the lead up to 6 May 2020. This is evidence of a heating in the goaf having reached at least 100°C, the point beyond which thermal runaway to a temperature sufficient to ignite an explosible mixture of methane and air is possible;
- f. The combination of the explosible mixture of methane and air, and a heating beyond the point of thermal runaway, can result in a methane explosion;
- g. The reporting of products of combustion to many of the goaf wells indicates that, at the time of the serious accident, there was an explosion of methane in the goaf; and
- h. The detection of methane after the serious accident at the shield #149 sensor and the tailgate drive sensor, but not on the two sensors in the tailgate roadway, is consistent with the mechanism of a methane explosion being the cause of the first pressure wave.

Recommendation

Recommendation 12

Coal mines implement a management practice for oxygen concentrations at goaf drainage wells to be maintained at no greater than 5%, and less if necessary, depending on site-specific conditions.

Chapter 9 – The nature and cause of the serious accident: the second pressure wave

Findings

Finding 70

The cause of the second pressure wave was a methane deflagration on the longwall face.

Finding 71

The probable ignition source for the methane deflagration on the longwall face was the PUR-initiated heating of coal to thermal runaway, which ignited an explosible atmosphere behind the longwall in the vicinity of shield #111, resulting in a flame propagating onto the longwall face. The combination of circumstances which support this conclusion are:

- a. The polyurethane resin (PUR) 'DSI Strata Bond HA' generates heat while curing, potentially achieving temperatures as high as 146.5°C;
- b. PUR has the capacity to heat adjacent coal;

- c. In certain proportions, a mixture of PUR and Goonyella Middle (GM) seam coal has the potential to reach 100°C as a result of the heat generated from the curing of the PUR;
- d. If heated to 100°C, GM seam coal has the potential to undergo thermal runaway to a temperature sufficient to ignite a mixture of methane and air;
- e. The quantity of coal required to be heated so as to initiate such an ignition may be as small as the size of a tennis ball;
- f. Approximately 5,600 litres of 'DSI Strata Bond HA' was injected into the face from shield #97 to shield #132 on 3 May;
- g. The ignition was in the vicinity of the rear of shield #111;
- h. PUR injected into the longwall face and roof on 3 May 2020 had the potential to initiate a heating of adjacent coal;
- i. The heated coal had the potential to reach thermal runaway once exposed to air, either in the roof after the injected area had been mined through, or after it caved into the goaf behind the longwall shields;
- j. The distance of retreat of the longwall over the days that intervened between the injection of PUR on 3 May and the ignition on 6 May 2020 was such that PUR-affected coal was likely to have been in the goaf immediately behind the shields on 6 May;
- k. In normal conditions, that residence time of the coal immediately behind the shields would not be sufficient for the coal to reach thermal runaway without an external heat source;
- l. An increase in carbon monoxide, indicative of coal heating, was detected at goaf well GRO4M001.5, which penetrated the goaf at about shield #100, on the morning of 6 May 2020;
- m. On 20 May 2020, after the serious accident, a heating was detected in the area immediately behind shield #96, proximate to the area of the PUR campaign on 3 May; and
- n. The other potential ignition sources are unlikely.

Finding 72

The mine's risk assessment for the change from Minova PUR to the DSI product did not address spontaneous combustion risk and concluded that there was no significant difference between the two products.

Finding 73

In light of the results of testing by the New South Wales Mine Safety Technology Centre and the Arnsberg Regional Authority, the DSI risk assessment report for its PUR product understated its curing temperature.

Finding 74

Recognised standard 16 does not address the risk of spontaneous combustion resulting from polymeric chemicals heating coal to thermal runaway. It is essential that this risk be addressed in the standard.

Finding 75

The level of stone dust maintained in the first 100 metres of longwall return outbye the face was sufficient to suppress a coal dust explosion and prevent it from propagating to other parts of the mine.

Recommendations

Recommendation 13

Coal mines conduct a thorough risk assessment for the use of polymeric chemicals, especially polyurethane resins, which includes a consideration of the risk of spontaneous combustion of coal being initiated by the product, before introduction and application at site.

Recommendation 14

The industry undertake research into polyurethane resins to determine the extent to which their use poses a risk of initiating spontaneous combustion of coal.

Recommendation 15

Resources Safety & Health Queensland takes steps to ensure that Recognised standard 16 is reviewed through the consultative process provided by the Coal Mining Safety and Health Advisory Committee, and that consideration is given to including a requirement within the standard that Site Senior Executives ensure a risk assessment is conducted in respect of the potential hazard arising from polymeric chemicals heating adjacent coal, resulting in spontaneous combustion.

Chapter 10 – Proactive inertisation of the active goaf, and strategies to limit oxygen ingress

Findings

Finding 76

Gas monitoring systems in use in Queensland underground coal mines are of a high standard, but there remain practical deficiencies, including human error, in reliance on gas monitoring to detect developing spontaneous combustion.

Finding 77

The principal benefit of proactive inertisation lies in a significant reduction in the proportion of the goaf which is susceptible to spontaneous combustion or methane ignition. Safety risks and production losses are correspondingly reduced.

Finding 78

Studies have shown that proactive inertisation can be successful in limiting oxygen ingress to the goaf in Australian mines.

Finding 79

The technology exists, for example through the use of membrane systems and Pressure Swing Adsorption units, for suitable quantities of nitrogen to be generated at a mine site.

Finding 80

Some of the traditional indicators of spontaneous combustion, derived from gas monitoring, would be disturbed by nitrogen inertisation. Others would be unaffected. The disturbance of some indicators is not sufficient to outweigh the advantage of minimising the opportunity for spontaneous combustion to develop in the first place.

Finding 81

Inertisation may deliver benefits to the operation of goaf drainage systems, as it leads to the replacement of oxygen in the goaf, allowing the goaf wells to safely run at lower methane purity.

Finding 82

Given there is a history of spontaneous combustion events in the Goonyella Middle (GM) seam, proactive inertisation may well be appropriate for a mine such as Grosvenor mine where significant quantities of remnant coal are left in the goaf. It is no longer sufficient to continue on the same path of substantial reliance on gas monitoring to manage the hazard of spontaneous combustion.

Finding 83

Achieving effective goaf inertisation in the first 200 metres of longwall retreat will be difficult due to the lack of consolidation, which permits oxygen ingress deep into the goaf.

Finding 84

Where proactive inertisation is practised, it should be done in conjunction with other strategies to limit the ingress of oxygen to the goaf, such as:

- limiting oxygen ingress at the maingate corner;
- ensuring longwall face ventilation quantities are not excessive;
- appropriate goaf perimeter road ventilation arrangements;
- seal construction and monitoring; and
- pressure balance chambers.

Recommendations

Recommendation 16

Coal mines, in particular those working the GM seam, assess the risk of spontaneous combustion and consider designing and implementing proactive inertisation as a measure to deal with that risk.

Recommendation 17

Coal mines review the ventilation arrangements it has in place around the active goaf, with the view to identifying opportunities to reduce oxygen ingress to the goaf.

Recommendation 18

The industry undertake research, including field studies, into the simultaneous operation of goaf drainage systems and continuous inertisation.

Chapter 11 – Labour hire and contract employment arrangements

Findings

Finding 85

There is a perception among coal mine workers that a labour hire worker or contractor who raises safety concerns at a mine might jeopardise their ongoing employment at the mine. It has not been possible to assess how widespread that perception might be. However, the existence of a perception, no matter how widespread, creates a risk that safety concerns will not always be raised.

Finding 86

The perception that a labour hire worker or contractor might jeopardise their employment by raising safety concerns at a mine creates a risk that safety concerns will not always be raised.

Finding 87

It is critical to safety at mines that all safety concerns are raised in a timely way.

Finding 88

It is critical that all workers believe that they can raise safety concerns at mines without fear that their employment may be in jeopardy as a result.

Finding 89

Coal mines must be vigilant to address the perception that labour hire workers and contractors might jeopardise their ongoing employment by raising safety concerns.

Finding 90

Production and safety bonuses largely based on lag safety performance indicators are not a reliable means of improving safety outcomes and may in fact lead to under-reporting of safety incidents and injuries.

Finding 91

An extensive study undertaken by the Coal Mining Safety and Health Advisory Committee (CMSHAC) on reporting culture in coal mines would benefit the industry in Queensland.

Finding 92

Neither coal mine operators nor Site Senior Executives (SSEs) presently have an obligation to report the occurrence of high potential incidents (HPIs) involving labour hire workers to the labour hire agency that supplied those workers.

Finding 93

In Queensland, labour hire agencies providing workers to the coal mining industry have no clear and express obligation to ensure that the workplaces into which they send their employees are as safe as reasonably practicable (such as that contained in section 19 of the *Work Health and Safety Act 2011* (NSW) (the NSW Act)), and may be entirely unaware of the occurrence of incidents that pose a risk of significant adverse effects to the safety and health of those employees. Even if a labour hire agency becomes aware of the occurrence of a reportable HPI, it has no obligation to report it to the Regulator.⁴

Finding 94

The imposition of a safety and health obligation on labour hire agencies which employ coal mine workers, such as that set out in section 19 of the *Work Health and Safety Act 2011* (Qld) (the WHS Act), would make coal mine operators and labour hire agencies mutually responsible for the safety and health of labour hire workers and add a layer of oversight of safe practices.

Additionally, a labour hire agency subject to such an obligation would be likely to develop a culture that encouraged its workers to report—to its own management—safety and health incidents and concerns. This may lead to the reporting of HPIs that might otherwise escape the attention of the Regulator.

Finding 95

There is scope to improve the mechanisms for safety issues to be raised by workers. Safety committees similar to those in the WHS Act and the *Mining and Quarrying Safety and Health Act 1999* (MQSHA) are not provided for under the *Coal Mining Safety and Health Act 1999* (Qld) (the Act).

Finding 96

The term 'detriment' in sections 275AA and 275AB of the Act is not defined.

⁴ Resources Safety & Health Queensland (RSHQ), of which the Coal Mines Inspectorate is a division, is the Regulator of the coal mining industry. Previously, the Regulator was the Department of Natural Resources, Mines and Energy (DNRME), formerly DNRM, the Department of Natural Resources and Mines.

Finding 97

Prompt and thorough investigation of reprisal complaints, and the provision of appropriate feedback to complainants, will reassure workers generally that such complaints are taken seriously, and will also enhance the prospects of success in a prosecution.

Recommendations

Recommendation 19

Coal mines review their site induction procedures to ensure that all new workers at the mine, including labour hire workers and contractors, are fully informed about the fundamental importance of the reporting of safety concerns, including occupational health hazards, and assured that reprisals will not be taken in response. This will include ensuring that all new workers at the mine are aware of and understand the operation of sections 274, 275, 275AA and 275AB of the Act.

Recommendation 20

RSHQ takes steps, through the consultative process provided by CMSHAC, to include a component in the generic induction for coal mine workers (*Recognised standard 11: Training in Coal Mines*) on the roles of the Industry Safety and Health Representative and Site Safety and Health Representative, so as to promote awareness of the functions of each.

Recommendation 21

Mine operators review their contracts with labour hire agencies and include, where necessary, provision for a documented process by which performance management issues, and grievance issues, in respect of labour hire workers are addressed.

Recommendation 22

The industry reviews its production and safety bonus structures and make any necessary changes to ensure that those structures do not inadvertently discourage the reporting of safety incidents or injuries.

Recommendation 23

Similarly to the SSE's obligations under sections 106(1)(a), (b) and (c) of the Act, RSHQ takes steps to amend the Act to require the SSE at a mine to inform the management of a labour hire agency which has employees at the mine when the following events occur, as soon as practicable after the event comes to the SSE's knowledge:

- a. an injury or illness to an employee of the labour hire agency from coal mining operations that causes an absence from work of the person;
- b. a high potential incident happening at the coal mine;
- c. any proposed changes to the coal mine, or plant or substances used at the coal mine that affect, or may affect, the safety and health of persons at the mine.

Recommendation 24

RSHQ takes steps to amend the Act to require labour hire agencies to notify the Regulator of a serious accident, an HPI of a type prescribed under a regulation, or a death at a coal mine, involving their employees.

Recommendation 25

Without diminishing the burden, or extent, of obligations imposed on others under the Act, RSHQ takes steps to amend the Act to impose a safety and health obligation on labour hire agencies which supply workers to a mine, in similar terms to section 19 of the NSW Act.

Recommendation 26

When submitting a panel of names of individuals experienced in coal mining operations as nominees for membership of CSMHAC under section 79 of the Act, organisations representing coal mine operators should ensure the panel includes representatives of labour hire agencies.

Recommendation 27

Consistently with Part 7 of the MQSHA and Part 5 of the WHS Act, RSHQ takes steps to amend the Act to enable the formation of safety committees upon request by an SSHR or when directed by the Chief Inspector.

Recommendation 28

As part of carrying out its functions under section 76A of the Act, CSMHAC considers including within its 5 year Strategic Plan activities that will facilitate improvements in the reporting culture in Queensland coal mines.

Recommendation 29

RSHQ takes advice, as required, and if necessary, takes steps to amend section 275AA of the Act to clarify the application of the reprisal offence, with a view to strengthening protections for workers. For example, this may involve including a definition of 'detriment'.

Recommendation 30

In relation to reprisal complaints, the Inspectorate undertakes prompt and thorough investigations, and provides appropriate feedback to complainants during the investigation and prosecution process.

Chapter 12 – Industry safety and health representatives

Findings

Finding 98

Industry Safety and Health Representatives (ISHRs) continue to have an important role in maintaining safety and health at coal mines, based on the historic role of district union inspectors.

Finding 99

The model for appointment of ISHRs under the *Coal Mining Safety and Health Act 1999* (Qld) (the Act) is the best available, in that it provides the opportunity for organised labour to participate democratically in the appointment process. It also guarantees that industry representatives are independent of both government and management at coal mines.

Finding 100

The ISHR function is best carried out where a cooperative arrangement exists between the ISHRs and the Site Safety and Health Representatives (SSHRs).

Finding 101

The relationship between ISHRs and SSHRs is more easily formed when both are union members.

Finding 102

ISHRs should be more proactive in cultivating those relationships with SSHRs who are not union members.

Finding 103

ISHRs would be assisted by a mechanism whereby they are routinely informed of the outcome of SSHR elections at coal mines.

Finding 104

The powers afforded to ISHRs in section 119 of the Act are adequate, save that it appears anomalous that there is no power under section 119(1)(c) to copy all documents that may be examined under that provision.

Finding 105

Awareness of the role of SSHRs and ISHRs would be enhanced by ensuring that the Recognised standard 11 induction includes an information component on the functions of each.

Finding 106

Given the large number of coal mines, ISHRs would be assisted by continuation of the previous practice of email distribution of Mine Record Entries (MREs) from the Inspectorate.⁵

Recommendations

Recommendation 31

The current model of appointment of ISHRs be retained.

⁵ The Coal Mines Inspectorate is a division of Resources Safety & Health Queensland (RSHQ), the Regulator of the coal mining industry. Previously, the Regulator was the Department of Natural Resources, Mines and Energy (DNRME) and the Inspectorate was a division of that department. That department had formerly been titled DNRM, the Department of Natural Resources and Mines.

Recommendation 32

RSHQ takes steps to amend the *Coal Mining Safety and Health Regulation 2017* (Qld), schedule 1B 'Site safety and health representative election process', clause 13(6), to require the returning officer for a ballot in respect of the election of an SSHR to give notice of the result of the ballot to the ISHRs.

Recommendation 33

The ISHRs take a more proactive role in cultivating mutually beneficial relationships with SSHRs.

Recommendation 34

RSHQ takes steps to amend section 119(1)(c) of the Act to permit copying of all documents amenable to examination under that provision.

Recommendation 35

RSHQ takes steps, through the consultative process provided by the Coal Mining Safety and Health Advisory Committee, to include a component on the roles of SSHRs and ISHRs in the *Recognised standard 11: Training in coal mines*, so as to promote awareness of the availability of both functions.

Recommendation 36

The Inspectorate reinstates the practice of sending MREs to ISHRs.

Chapter 13 – Site safety and health representatives

Findings

Finding 107

Site Safety and Health Representatives (SSHRs) perform an important safety role at mines.

Finding 108

In the main, the SSHR role is, currently, concerned with day-to-day site conditions and practices, rather than higher level safety issues such as catastrophic risk mitigation.

Finding 109

The role is utilised as intended: to identify issues and address safety concerns.

Finding 110

Senior management at coal mines are supportive of the role, which includes facilitating some training and allowing time away from the SSHRs' substantive jobs.

Finding 111

SSHRs consider that it would be preferable for the SSHR role to be a full-time position.

Finding 112

The SSHRs make sparing use of the exercise of powers under the *Coal Mining Safety and Health Act 1999* (Qld) (the Act), although the existence of the powers appears to serve as an incentive for management to achieve outcomes cooperatively.

Finding 113

There are mutual benefits from a complementary working relationship between SSHRs and Industry Safety and Health Representatives.

Finding 114

SSHRs have been notified of high potential incidents as required by section 106(1)(b) of the Act.

Recommendations

Recommendation 37

The Construction, Forestry, Maritime, Mining and Energy Union and management at coal mines encourage coal mine workers to nominate for election as an SSHR.

Recommendation 38

Consistently with Recommendation 35, Resources Safety & Health Queensland (RSHQ) takes steps, through the consultative process provided by the Coal Mining Safety and Health Advisory Committee to include information about the importance and nature of the role of SSHRs in the generic induction for coal mine workers, *Recognised standard 11: Training in coal mines*.

Recommendation 39

Coal mines use their work order system to schedule and record the completion of an SSHR inspection to assist with incorporating the inspection activity into the mine's weekly plan, and to demonstrate management support for the SSHR function.

Recommendation 40

Site Senior Executives consider whether it would be advantageous to make the SSHR role at their mine a full-time position.

Chapter 1 – Introduction

Background

- 1.1 On 6 May 2020, a serious accident on the longwall 104 (LW 104) face at Grosvenor mine (Grosvenor) resulted in five workers sustaining life-altering injuries.
- 1.2 On 11 May 2020, the Minister for Natural Resources, Mines and Energy, the Honourable Dr Anthony Lynham MP, foreshadowed the government’s intention to establish a Board of Inquiry to conduct public hearings and otherwise make inquiries, findings and recommendations in relation to the incident.⁶
- 1.3 On 22 May 2020, the Queensland Coal Mining Board of Inquiry (the Board) was established.⁷ As foreshadowed by the Minister, the Terms of Reference required the Board to inquire into the serious accident of 6 May 2020, and determine its nature and cause, and any factors which materially contributed to its cause.⁸
- 1.4 The Board was also required to inquire into 27 high potential incidents (HPIs) involving methane exceedances that occurred at Grosvenor between 1 July 2019 and 5 May 2020. In addition, the Board was required to inquire into a further 13 methane exceedance HPIs that occurred at three other mines – Grasree mine (Grasree), Moranbah North mine (Moranbah North) and Oaky North mine (Oaky North) – between 1 July 2019 and 5 May 2020.
- 1.5 The Terms of Reference required the Board to assess and determine whether the operational practices and management systems in existence at each of the mines, or at corporate levels above them, at the time of the incidents were adequate and effective to achieve compliance with relevant safety laws and standards. The Terms of Reference also required the Board to make recommendations for improving safety and health practices and procedures and for mitigating against the risk of similar incidents occurring in the future.

Part I of the Report

- 1.6 Initially, the Board was required to furnish a report about its findings and recommendations by 30 November 2020.
- 1.7 Shortly after the Board was established, it became apparent that it would not be able to commence its inquiry into the serious accident immediately.

⁶ Media statement by The Honourable Dr Anthony Lynham, the Minister for Natural Resources, Mines and Energy, 11 May 2020 <<https://statements.qld.gov.au/statements/89809>>.

⁷ *Establishment of a Board of Inquiry Notice (No 01) 2020* in Queensland, *Government Gazette: Extraordinary*, No. 25, 22 May 2020, Volume 384, pages 173–174.

⁸ The Terms of Reference are set out in full in Appendix 1.

- 1.8 That was because the Coal Mines Inspectorate (the Inspectorate)⁹ was, by that time, also investigating the serious accident and it had engaged, or planned to engage, relevant experts for that purpose. It was neither practical nor possible for the Board to conduct a separate but parallel investigation into the serious accident.
- 1.9 Hence, the Board's inquiry into the serious accident was necessarily linked to the progress of the Inspectorate's investigation and depended, in particular, on the timing of the completion of the expert reports. Accordingly, the Board's inquiry into the serious accident was delayed pending the finalisation of the reports.
- 1.10 The Board considered that it was appropriate to delay the inquiry into the 27 HPIs at Grosvenor so that the inquiry into those matters could proceed at the same time as the inquiry into the serious accident at Grosvenor.
- 1.11 In those circumstances, the Board decided to commence with its inquiry into the 11 HPIs at Grasstree, and the single HPI at each of the Moranbah North and Oaky North mines, and delay its inquiry into the 27 HPIs and the serious accident at Grosvenor, until the expert reports were available.
- 1.12 The Board received and considered a large body of material and conducted a tranche of hearings between 4 and 21 August 2020 with respect to the 13 HPIs at Grasstree, Moranbah North and Oaky North.
- 1.13 At the conclusion of the first tranche of hearings on 21 August 2020, the Board scheduled hearings in respect of the 27 HPIs and the serious accident at Grosvenor to commence on 15 September 2020.
- 1.14 However, before those hearings commenced, the Inspectorate informed the Board that the expert reports would not be available to the Board until later in the year due to the complexity of the investigation.
- 1.15 In addition, Anglo American plc (Anglo) informed the Board that many of the witnesses the Board intended to call at the hearings in respect of the 27 HPIs and the serious accident at Grosvenor would be likely to refuse to answer questions if compelled to give evidence at the hearings, on the basis that doing so might tend to incriminate the witness. The Board accepted that such claims of privilege against self-incrimination would be justified.
- 1.16 The Board notified the Minister about the foreshadowed claims of privilege against self-incrimination and the Board's concern that its ability to inquire fully into the circumstances of the 27 HPIs and the serious accident at Grosvenor would be affected unless there was legislative change which would allow the Board to compel evidence from those witnesses while maintaining their privilege against self-incrimination.

⁹ The Inspectorate is a division of Resources Safety & Health Queensland (RSHQ), the Regulator of the coal mining industry. Prior to 1 July 2020, the Regulator was the Department of Natural Resources, Mines and Energy (DNRME) and the Inspectorate was a division of that department.

- 1.17 The Minister advised the Board that careful consideration would need to be given to the requested amendments. The Minister accepted that the Board's inquiry could not be completed in full by 30 November 2020 and extended the date by which the Board's report was to be provided to 31 May 2021.¹⁰
- 1.18 The Board was able to complete its inquiry into the 13 HPIs at Grasstree, Moranbah North and Oaky North. The Board provided its report in respect of those matters to the Minister on 30 November 2020 (Part I of the Report).
- 1.19 Part I of the Report also contained a consideration of various general matters, such as the role of ventilation and gas drainage in underground coal mines and the legislative meaning of 'high potential incident' (Chapter 2); the role of the Inspectorate (Chapter 3); issues relating to the training and competencies of those engaged in the coal mining industry (Chapter 5) and corporate governance matters (Chapter 6).
- 1.20 Those general matters are relevant to the contents of this part of the report. It should therefore be read in conjunction with Part I of the Report.

Part II of the Report

- 1.21 The first of the expert reports in relation to the serious accident was made available to the Board on 24 August 2020. Subsequently, many of the remaining reports were provided in the period December 2020 to late January 2021. The qualifications and experience of the experts referred to throughout this part of the report are listed in Appendix 3.
- 1.22 The Board also received and considered a significant body of statements, extracts of interviews with coal mine workers and other documentary material in relation to the 27 HPIs and the serious accident at Grosvenor.
- 1.23 A second tranche of hearings, at which evidence with respect to the Grosvenor HPIs and the serious accident was heard, occurred between 9 March and 9 April 2021. Three of the Inspectorate's inspectors gave evidence in that tranche of hearings. One of the injured coal mine workers, Mr Wayne Sellars, also gave evidence. The remainder of the witnesses were experts engaged by the Inspectorate or the Board.
- 1.24 In January 2021, the Minister's office informed the Board that there was unlikely to be a legislative amendment to allow the Board to require the witnesses, in respect of whom claims of privilege against self-incrimination had been accepted, to give evidence at the public hearings. There has been no amendment to the legislation. Accordingly, the Board did not hear evidence from any of those witnesses. That group of witnesses included Anglo executives, Grosvenor mine management, and other employees and contractors.

¹⁰ *Amendment of Establishment of a Board of Inquiry Notice (No 02) 2020* in Queensland, *Government Gazette: Extraordinary*, No.11, 17 September 2020, Volume 385, page 45.

- 1.25 This report comprises Part II of the Report. It contains a review of the evidence and the Board's findings and recommendations in respect of the 27 Grosvenor HPIs. It also contains a review of the evidence and the Board's findings with respect to the nature and cause of the serious accident.
- 1.26 In addition to the evidence, the Board has been assisted by detailed submissions from several parties. Whilst not all of the contentions in the submissions are referenced in the report, each has nonetheless been given careful consideration.
- 1.27 This report also includes chapters relating to the labour hire arrangements in place at each of the mines, and issues relating to Industry Safety and Health Representatives and Site Safety and Health Representatives. Each of the topics covered in these chapters is relevant to safety and health at coal mines.

Anglo's participation in the Inquiry

- 1.28 Anglo has submitted that it has not been 'possible for Anglo, or members of the Senior Leadership Team (**SLT**) at Grosvenor to participate properly in this Inquiry'. It says:¹¹

*That is because the Board is tasked with performing its function at the same time that Resources Safety and Health Queensland (**RSHQ**) is investigating the 6 May 2020 incident and determining whether a prosecution process may follow. Neither Anglo nor the SLT can or should be obliged to help RSHQ to formulate a criminal case against them. Meaningful participation in the Board's hearings carries that risk. So much was recognised by the Board's acceptance of privilege claims made by Anglo employees and contractors.*

- 1.29 Anglo submits that it, and its employees, 'have been forced to participate in these proceedings with their hands, in effect, tied behind their backs'. It says:¹²

In particular, they have not been able to put forward alternatives to the RSHQ theory of the case through cross-examination, calling witnesses, and making submissions, to the same extent that they might have done had they not been the subject of concurrent criminal investigations into the same subject matter as that which the Board is investigating. They have not been able to do so because doing so would have afforded the opportunity to RSHQ to be informed of the weaknesses in its theory of the case and of possible answers to that theory. Essentially, to participate fully would have meant potentially assisting an investigating agency to make its case.

¹¹ AGM.999.013.0001, .0003.

¹² AGM.999.013.0001, .0006–.0007. These submissions were made on behalf of several Anglo American plc (Anglo) companies, including Anglo Coal (Grosvenor Management) Pty Ltd, the operator of Grosvenor. Throughout Part II of the Report, all such submissions will be referred to as submissions received from Anglo.

1.30 In a further submission, Anglo stated:¹³

In many cases, the likelihood of prosecution is seen by prospective defendants as so great that those defendants see little point in drawing attention to exculpatory evidence in the knowledge that the likely effect of doing so will only lead to the prosecutor seeking to negate that evidence in what is, given the willingness with which prosecutions are taken by this regulator, a virtually certain prosecution. In cases of that kind, the “choice” faced by those prospective defendants is between insisting on their rights and prejudicing their defence. That is not a real choice.

1.31 Whilst, in fact, there is a choice, there is no doubt that the circumstances place Anglo and others in a position of having to make a difficult forensic decision as to the manner and extent of their participation in the Inquiry.

1.32 In opening remarks, the Chairperson made it clear that this Inquiry is not a prosecution, nor a witch-hunt. Given the concurrent investigation being run by the Inspectorate, this would have been of little comfort to Anglo.

1.33 Whilst Anglo has not fully participated in the Inquiry, it has nonetheless been cooperative. Compliance with notices to produce documents has been full and prompt.

1.34 In September 2020, Anglo also offered to allow the Board to consult with experts who had been engaged by Anglo to investigate the incident, but on a confidential basis, to the exclusion of other parties. This is a course that can only be taken in special circumstances, and subject to the requirement to act fairly to all parties.

1.35 The Board carefully considered the offer. However, there are problems with such a course, not the least of which is the use the Board could make of the information. Unlike the position with the experts who gave evidence in public hearings, the information from the Anglo experts would be before the Board untested by other parties, and without having given other parties the opportunity to do so. Derivative use of confidential material such as this would be highly problematic. Of course, this information could not form part of the report.

1.36 The Board decided that relying upon information received in this way to address the issues specified in the Terms of Reference was not appropriate having regard primarily to the need to afford procedural fairness to all parties.

1.37 Nonetheless, the Board has received the benefit of significant evidence from Anglo. It has received nearly three thousand documents in response to notices and requests for information relating to Grosvenor.

1.38 It may well have been helpful to have greater participation from Anglo in the course of the Inquiry. However, given the circumstances, the extent of Anglo’s participation in the Inquiry is understandable, and cannot give rise to any adverse inference.

¹³ Submission received from Anglo on 21 May 2021 in response to draft chapters, paragraph 12.

- 1.39 The Board is obliged, under the *Coal Mining Safety and Health Act 1999* (Qld) and the Terms of Reference, to inquire into the serious accident and the HPIs, and report its findings and recommendations to the Minister. That is so, irrespective of the extent of participation by Anglo in the Inquiry.
- 1.40 In the event, as will be seen, in light of the documents provided by Anglo, together with all other evidence produced to the Inquiry, the Board has solid evidence upon which to make the findings and recommendations set out in this report.

Future Boards of Inquiry

- 1.41 Whilst Anglo has been protective of its position, RSHQ has also been protective of its position, persistently wary that the conduct of the Inquiry may prejudice its current investigation into the serious accident and any future prosecutions arising from that investigation.
- 1.42 To avoid the problems encountered in this Inquiry by the Board, RSHQ and Anglo, serious consideration should be given to amending the *Coal Mining Safety and Health Act 1999* (Qld).

Grosvenor mine

- 1.43 Given that much of Part II of the Report relates to the 27 Grosvenor HPIs, and the serious accident that occurred there, it is convenient to commence this report with a brief overview of introductory matters relevant to that mine.
- 1.44 Grosvenor is an Anglo American mine.¹⁴ It is operated by Anglo Coal (Grosvenor Management) Pty Ltd.¹⁵ The ultimate holding company for the operating company is Anglo American plc.¹⁶ Relevant details relating to the Anglo company structure are set out in Part I of the Report.¹⁷

Location

- 1.45 Grosvenor is located approximately five kilometres north-west of Moranbah, and approximately 180 kilometres south-west of Mackay.¹⁸ It adjoins Moranbah North mine. Coal produced at Grosvenor is transported by conveyor to the shared coal handling and processing facilities at Moranbah North mine before being sent by rail to port.¹⁹

¹⁴ Anglo American plc, *2020 Results and Q2 Roadshows*, Anglo American Investor presentations (Presentation, April 2021) <<https://www.angloamerican.com/~media/Files/A/Anglo-American-Group/PLC/media/presentations/2021pres/2020-results-and-q2-roadshows.pdf>>, slide 21.

¹⁵ AAMC.100.002.0001, .0002.

¹⁶ ASIC.001.003.0001, .0003.

¹⁷ Part I of the Report, Chapter 1 (Introduction).

¹⁸ AGM.002.001.0818, .0823: *GRO-1435-PLAN-Grosvenor Mine Overview Plan*.

¹⁹ Anglo American plc, *Moranbah Grosvenor Complex: Socio-Economic Assessment Toolbox Report 2019-2021*, Anglo American Media Files (Report, March 2019) <<https://www.angloamerican.com.au/~media/Files/A/Anglo-American-Group/Australia/about-us/our-operations/angloamerican-moranbah-grosvenor-complex-report-web-ready.pdf>>; AAMC.001.022.0046, .0056.

1.46 Grosvenor's location, and proximity to Moranbah North mine, is depicted on the following map:²⁰



Figure 1: Grosvenor and Moranbah North mines

²⁰ Diagram supplied in the submission received from Anglo on 21 May 2021 in response to draft chapters.

Geology

- 1.47 Underground coal mining targets coal seams at various depths. Grosvenor's target seam is the Goonyella Middle (GM) seam. The depth of cover of the GM seam across the Grosvenor site varies from 100 to 500 metres, with depth increasing toward the north-north-east of the mine plan. The thickness of the GM seam varies from four to six metres.²¹ The seam gas composition is predominantly methane (more than 95%).²²
- 1.48 The GM seam is located within the Moranbah Coal Measures, the thickness of which ranges from 250 to 300 metres in the Grosvenor area.²³ The Moranbah Coal Measures comprise nine coal seams and their associated splits. They are, in ascending order, the Goonyella Lower, Dysart Rider, Harrow Creek Lower, GM, P, Goonyella Rider, Goonyella Upper, QB and QA seams.²⁴ The Moranbah Coal Measures also contain a tuffaceous marker bed known as the P-Tuff between the GM and P seams.²⁵
- 1.49 Above the Moranbah Coal Measures lies the Fort Cooper Coal Measures, the base of which is the Fairhill seam. Sediments overlying the Fort Cooper Coal Measures are predominantly comprised of sandstone, claystone, basalt, gravel and clays.²⁶

Mine design and layout

- 1.50 Grosvenor comprises two mining series: the eastern 100 series and the western 200 series.²⁷ LW 101 was the first longwall in the eastern 100 series.
- 1.51 The 100 series longwall blocks were designed with two headings per gateroad, with the gateroad lengths varying from approximately 1.1 to 6.3 kilometres in length.²⁸
- 1.52 Longwall panels average approximately four kilometres in length and are approximately 300 metres wide.²⁹ At Grosvenor, the longwall blocks are formed by developing two parallel roadways, known as gateroads, on either side of the proposed block. Each set of gateroads is joined every 125 metres with cross accesses called cut-throughs. The gateroads on one side of the block, called the maingate roadways, allow transportation of workers to the longwall face, the conveying of production coal, and the supply of intake ventilation. The gateroads defining the other side of the longwall block are called the tailgate roadways, and are chiefly used to carry the return air from the longwall face back to the main ventilation shaft.

²¹ RSH.002.395.0001, .0021–.0022.

²² RSH.002.394.0001, .0035.

²³ RSH.002.395.0001, .0019; RSH.002.394.0001, .0018.

²⁴ RSH.002.394.0001, .0018.

²⁵ RSH.002.394.0001, .0018. A 'tuffaceous marker bed' is a band of rock consisting of volcanic ash.

²⁶ RSH.002.394.0001, .0018.

²⁷ RSH.002.395.0001, .0013.

²⁸ RSH.002.395.0001, .0013.

²⁹ AAMC.001.006.0504, .0556.

- 1.53 At Grosvenor, coal has been typically cut by the shearer using a bi-directional cutting method, with approximately one metre of advance per shear.³⁰ The extraction height ranges from 3.8 metres to 4.7 metres.³¹
- 1.54 By 2019, when the first of the Grosvenor HPIs occurred, mining was underway in LW 103. The following diagram shows the mining activity which was then underway, as well as the mine's plans for future development:³²

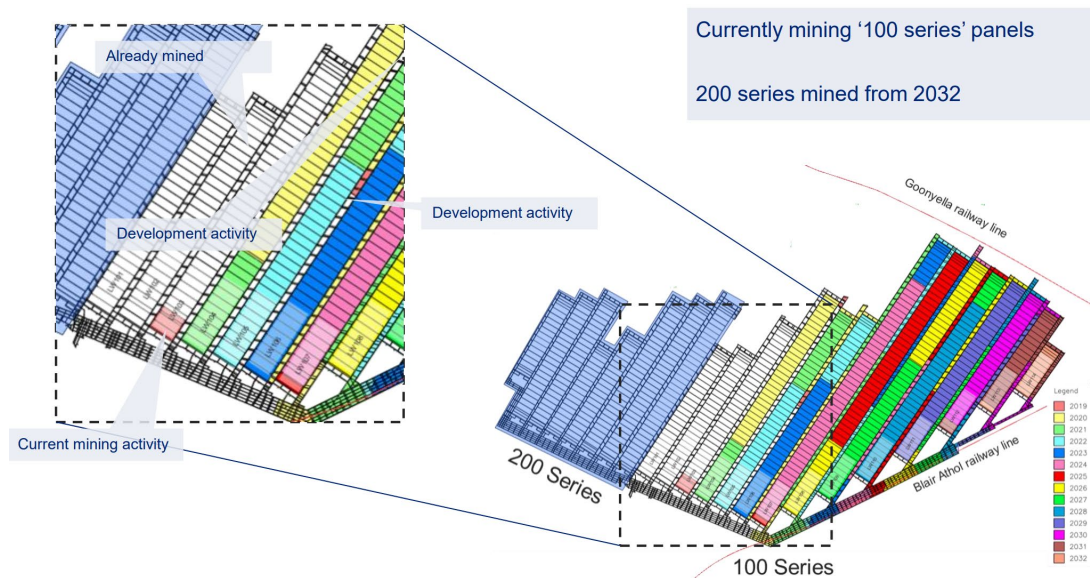


Figure 2: Grosvenor mine plan, 2019

Development and production

- 1.55 Anglo received government approval for a mining lease in June 2012. At the time, Anglo said that mining at Grosvenor was 'a major part of the group's strategy to triple metallurgical coal production by 2020'.³³
- 1.56 Surface construction at the mine site commenced in 2012, and construction of the drift commenced in October 2013.³⁴
- 1.57 LW 101 was the first panel to be mined. Production commenced in May 2016. LW 101 was sealed in late 2017.³⁵

³⁰ 'Bi-directional cutting', also referred to as 'bi-di', is a method of cutting the coal where the full height of the coal extraction is cut in both directions, forward and reverse. To be compared with 'uni-di' or 'uni-directional' cutting, which involves cutting the top portion of the coal extraction height in one direction and the remaining bottom portion when returning in the other direction.

³¹ AAMC.001.006.0504, .0556.

³² AAMC.001.006.0504, .0555.

³³ Media statement by Anglo American plc, 'Anglo American Receives Mining Lease for Grosvenor', (8 June 2012) <<https://australia.angloamerican.com/media/press-releases/pr-2012/anglo-american-receives-mining-lease-for-grosvenor->>.

³⁴ Media statement by Anglo American plc, 'Anglo American's Grosvenor Project Launches Its Tunnel Boring Machine' (21 October 2013) <<https://australia.angloamerican.com/media/press-releases/pr-2013/21-10-2013>>.

³⁵ AGM.010.002.0001.

- 1.58 LW 102 production commenced on 28 December 2017. LW 102 was sealed in late 2018.³⁶
- 1.59 LW 103 production commenced in December 2018. Production was still underway on 1 July 2019.³⁷
- 1.60 Development of LW 104 and LW 105 began in December 2018. The development of those longwalls was still underway in July 2019, when the first of the Grosvenor HPIs the subject of inquiry occurred.
- 1.61 Production from LW 104 commenced on 9 March 2020.

Methane management

- 1.62 The presence of methane is a serious safety concern which needs to be carefully managed in any underground coal mine. Gas drainage and ventilation are both critical controls for the management of methane.³⁸
- 1.63 As will be seen, Grosvenor's management of methane (and, in particular, its gas drainage system) assume a central focus of this report. For that reason, what follows is intended as a brief introduction to topics relevant to gas drainage.
- 1.64 There are two types of gas drainage. 'Pre-drainage' removes some of the *in situ* gas ahead of mining. 'Post-drainage' captures and removes some of the methane, which has reported to the goaf after being liberated by mining operations, before it enters the ventilation system. The mine's ventilation system should be capable of diluting the remaining methane emissions to safe levels and exhausting it to the surface.
- 1.65 Pre-drainage of the *in situ* gas content reduces the extent to which a mine will have to rely on its post-drainage system to effectively manage the methane which reports to the goaf during mining operations. Working seams generally need to be drained to a low level, less than 3 m³/tonne, to effectively control gas emissions from that seam.
- 1.66 However, it is difficult to accurately predict the amount of gas that seams other than the working seam will emit to the goaf during mining operations. The seam's proximity to the working seam, its gas reservoir size (its gas content in m³(gas)/m³(coal), multiplied by the vertical thickness of the seam), and the gas saturation and desorption pressure all have a bearing on the amount of gas it will emit to the goaf.
- 1.67 The amount of post-drainage that is required to be carried out depends on the extent to which pre-drainage has been successful in reducing the methane from the working seam, as well as any other seams from which methane would, during mining operations, be emitted to the goaf.

³⁶ AGM.010.002.0001.

³⁷ AGM.010.002.0001.

³⁸ This is discussed in greater detail in Part I of the Report, Chapter 2 (Methane in coal mines).

1.68 In this report, discussion of the amount of gas produced during mining operations will variously be done by reference to ‘specific gas emission (SGE)’, ‘gas make’, and ‘emissions’. The first two terms appear to be given slightly different meanings by different experts, and in some cases to be used interchangeably. ‘Emissions’ refers to the total quantity of gas emitted during mining operations for any specified period.

1.69 With reference to the term SGE, Dr Ray Williams said in his report:³⁹

It’s a term almost universally misunderstood in the coal industry and confused with gas make. It is a static “specific” parameter – the total quantity of gas emitted by a longwall, including tail down emission after mining, divided by the total tonnes mined. Units are in m³/t.

Thus, it is a term involving a calculation of gas emissions per tonne mined, expressed as a figure over the life of the longwall.

1.70 For clarity, in this report SGE is used to describe the total quantity of gas emitted by a longwall during mining operations divided by the total tonnes mined, to determine an average emission per tonne.⁴⁰ Efforts can be made to predict SGE for a longwall but, as there are so many variables that affect the amount of gas produced by longwall operations, SGE predictions must be treated with caution.

1.71 Dr Williams regarded a calculation of ‘gas make’ as more useful. Gas make is ‘the relationship between gas generated from all sources in m³/t and related production in tonnes’.⁴¹ The figure for gas make is more useful because it can be calculated, as Dr Williams did, on a daily basis by dividing the methane emissions (on a seven day moving average), by tonnes mined per week (again, over a seven day moving average). It will thus inform mine management of the rate of gas emissions per tonne mined on a daily, or other time-specific, basis.

1.72 The actual emissions generated by mining operations must be managed by the mine’s post-drainage and ventilation systems. Post-drainage systems often, and in Grosvenor’s case did, include goaf drainage holes drilled into the goaf to drain the liberated methane. The ventilation system is designed to manage the methane which is not removed by the post-drainage system from the goaf.

1.73 When a mine’s post-drainage system does not have the capacity to remove sufficient methane in the goaf, methane exceedance HPIs can occur. Unless goaf drainage capacity can be safely increased, reducing the rate of production may become necessary so that gas emissions do not exceed that capacity (and the risk of methane exceedances can be mitigated).

³⁹ WRA.001.001.0001, .0057.

⁴⁰ WRA.001.001.0001, .0057.

⁴¹ WRA.001.001.0001, .0057.

Structure of this report

- 1.74 This report is primarily concerned with the 27 methane exceedance HPIs that occurred at Grosvenor between 1 July 2019 and 5 May 2020, and the nature and cause of the serious accident on 6 May 2020.
- 1.75 Chapter 2 involves a consideration of the methane exceedances at Grosvenor prior to 1 July 2019, in order to provide context for the HPIs that occurred from that date.
- 1.76 On 1 July 2019, LW 103 was in production. Chapter 3 considers the 13 HPIs that occurred during production of LW 103, and the causes of them.
- 1.77 As a result of the HPIs during LW 103, Grosvenor was aware that it would need to plan for adequate gas drainage to avoid further HPIs on LW 104. Chapter 4 considers the planning undertaken by the mine for gas drainage on LW 104, the management of methane during production from LW 104, and the relationships between the rates of production and the performance of the gas drainage system on that longwall.
- 1.78 Chapter 5 considers the 14 HPIs that occurred during production from LW 104, and their causes.
- 1.79 Chapter 6 considers the mine's gas monitoring system and the gas monitoring data generated during the life of LW 104.
- 1.80 Chapter 7 reviews the events of the days leading up to the serious accident, and the serious accident itself.
- 1.81 Chapters 8 and 9 consider the nature and cause of the serious accident, in particular the likely causes of the first and second pressure waves respectively, and their relationship to the methane explosion on the longwall face that injured the five workers.
- 1.82 Chapter 10 considers measures to reduce the risk of spontaneous combustion in the goaf, particularly the role of proactive inertisation.
- 1.83 Chapters 11, 12 and 13 consider issues related to labour hire arrangements at mines, Industry Safety and Health Representatives, and Site Safety and Health Representatives.

Chapter 2 – Grosvenor’s history

Introduction

- 2.1 The Terms of Reference require the Board to inquire into the 27 methane exceedance high potential incidents (HPIs) that occurred at Grosvenor mine (Grosvenor) between 1 July 2019 and 5 May 2020, and the serious accident that occurred on 6 May 2020.
- 2.2 It is not possible to appreciate the significance of the HPIs on longwall 103 (LW 103) and LW 104 without an understanding of the circumstances of methane exceedance HPIs on earlier longwalls at Grosvenor, which, as will be seen, were a persistent occurrence.
- 2.3 This chapter reviews the Mine Record Entries (MREs) issued by the Coal Mines Inspectorate (the Inspectorate)⁴² for Grosvenor for the period between the commencement of production at the mine in May 2016 and 1 July 2019.
- 2.4 The information contained in these MREs does not paint a complete picture of the gas management issues encountered by Grosvenor, nor of the work Grosvenor undertook in respect of the matters raised by the Inspectorate in them.
- 2.5 However, the MREs provide background information about the issues that were encountered, and the type of work undertaken by Grosvenor in respect of those known problems.

Longwall 101

- 2.6 LW 101 production commenced in May 2016.⁴³
- 2.7 Grosvenor had experienced at least one methane exceedance even before LW 101 commenced production. On 9 February 2016, the Inspectorate attended at Grosvenor in response to a report that the mine had experienced an ‘elevated gas emission’ the previous day.⁴⁴ The mine had experienced a floor heave event on 8 February 2016 which resulted in a methane exceedance of 2.85%, the limit being 2.5%.⁴⁵ Workers had been withdrawn from the area. The mine advised that it had experienced other floor heaves previously but it had not kept records of the gas fluctuations that had occurred on those earlier occasions.⁴⁶

⁴² The Inspectorate is a division of Resources Safety & Health Queensland (RSHQ), the Regulator of the coal mining industry. At the time, the Regulator was the Department of Natural Resources, Mines and Energy (DNRME) and the Inspectorate was a division of that department. That department had formerly been titled DNRM, the Department of Natural Resources and Mines.

⁴³ AGM.010.002.0001.

⁴⁴ RSH.002.241.0001.

⁴⁵ Methane exceedance HPIs are discussed in the Part I Report, Chapter 2 (Methane in coal mines).

⁴⁶ RSH.002.241.0001, .0003.

- 2.8 About six months after LW 101 production commenced, the Inspectorate became aware that the mine had experienced a number of methane exceedances on the longwall that had not been reported to it as HPIs.⁴⁷
- 2.9 At a mine inspection on 15 December 2016, the Inspectorate observed that mine records appeared to demonstrate that methane concentrations in the longwall tailgate had exceeded 2.5% ‘on a number of occasions’, in circumstances where those exceedances were not reported to the Inspectorate as HPIs.⁴⁸
- 2.10 On further inquiry by the Inspectorate, it became apparent that the mine had experienced at least three methane exceedances which had not been reported as HPIs – one on 2 August 2016 and two on 6 September 2016. It is not clear from the relevant MRE how long the August exceedance lasted, but it appears those on 6 September lasted for approximately 30 minutes and 15 minutes respectively.⁴⁹
- 2.11 In response to this information, on 21 December 2016, the Inspectorate issued a Directive to the mine ‘to ensure compliance with the control and management of methane in the Longwall Tailgate’. The Directive was closed out by the Inspectorate nearly three months later, on 14 March 2017.⁵⁰
- 2.12 Non-reporting of methane exceedances was not confined to Grosvenor. On 30 January 2017, the then Chief Inspector of Coal Mines issued a letter to all Site Senior Executives (SSEs) and Underground Mine Managers at underground coal mines in Queensland, advising that the Inspectorate had identified methane exceedances in longwall tailgates which had not been reported as required.⁵¹
- 2.13 The letter advised that such occurrences ‘are prescribed under Schedule 1C of the *Coal Mining Safety and Health Regulation 2001* (the Regulation) as high potential incidents which SSEs must, under section 198 of the *Coal Mining Safety and Health Act 1999* (the Act), report to an inspector’.⁵² The letter further advised that the Inspectorate would be undertaking audits of gas management systems at all underground coal mines.⁵³

⁴⁷ RSH.002.255.0001, .0007.

⁴⁸ RSH.002.255.0001, .0003; .0007.

⁴⁹ RSH.002.255.0001, .0007.

⁵⁰ RSH.002.238.0001.

⁵¹ RSH.002.289.0001.

⁵² Note the 2001 Regulation has since been repealed and replaced by the current *Coal Mining Safety and Health Regulation 2017*. The content of schedule 1C of the Regulation, titled ‘Types of high potential incidents for section 198(2)(b) of the Act’, remains unchanged.

⁵³ RSH.002.289.0001, .0002.

- 2.14 In May 2017, the Inspectorate conducted an inspection at Grosvenor at which it learned that the mine had experienced numerous floor heave events in the maingate 103 development road, one of which, on 1 May 2017, had resulted in ‘off scale’ alarms for methane concentrations.⁵⁴ The Inspectorate noted there were ‘numerous reports’ of floor heaves among the statutory reports for the previous two-month period with a lack of follow up investigation done by the mine.⁵⁵
- 2.15 Consequently, the Inspectorate issued the mine with a Directive to investigate the cause of the floor heave events and identify controls to reduce the risk of uncontrolled methane releases during such events. The Directive was closed out on 16 June 2017.⁵⁶
- 2.16 In July 2017, a gas plant shutdown caused a methane spike of 3.1% in the LW 101 tailgate return. An Incident Cause Analysis Method (ICAM) investigation was completed by the mine and forwarded to the Inspectorate in respect of that incident.⁵⁷
- 2.17 In September 2017, the Inspectorate reviewed the mine’s management of the general body contaminant Trigger Action Response Plan (TARP).⁵⁸ It issued a Directive to the mine to review the TARP.⁵⁹ The Directive was closed out on 14 November 2017 when the mine provided evidence that the TARP had been reviewed and the ‘ability to move shearer with Methane greater than or equal to 2.5%’ had been removed.⁶⁰
- 2.18 On 26 October 2017, the Inspectorate attended at the mine for an inspection and was informed of a further three floor heave events that had occurred in the maingate 103 development road since May 2017.⁶¹ One of the incidents, on 29 August 2017, had resulted in a methane exceedance of 4.64%. The relevant MRE noted that the mine had instigated a Floor Heave and Gas Release Management Team which was working on identifying causes and solutions for the floor heaves.⁶²

Longwall 102

- 2.19 The MREs indicate that the methane exceedances experienced by the mine increased during production of LW 102. LW 102 was longer and deeper than LW 101.
- 2.20 LW 102 commenced production in December 2017.⁶³ It appears that LW 102 was plagued by methane exceedances from the outset.

⁵⁴ RSH.002.257.0001; RSH.002.258.0001, .0002. A reference to an ‘off scale’ alarm indicates that the concentration of methane was higher than the measuring capability of the instrument. In this case, that means it exceeded 5%, the lower explosive limit for methane.

⁵⁵ RSH.002.258.0001, .0002.

⁵⁶ RSH.002.239.0001.

⁵⁷ RSH.002.264.0001, .0003.

⁵⁸ RSH.002.261.0001, .0001–.0002.

⁵⁹ RSH.002.240.0001.

⁶⁰ RSH.002.240.0001.

⁶¹ RSH.002.264.0001, .0001–.0002.

⁶² RSH.002.264.0001, .0002; .0004.

⁶³ AGM.010.002.0001.

- 2.21 On 18 January 2018, the Inspectorate attended at the mine to review the ‘series of methane exceedances’ that had occurred since production of LW 102 had commenced. During the inspection, the mine reported that another methane exceedance, with a reading of 2.7%, had occurred the previous day.⁶⁴
- 2.22 The reasons given for the exceedances included the difficulties of providing for effective gas drainage as a result of the face start position being under the Isaac River.⁶⁵
- 2.23 The relevant MRE records that the Inspectorate gave the mine the following feedback about the work being done by other mines in the Bowen Basin in respect of gas drainage:⁶⁶

Inspector Marlborough made reference to other experiences in the Bowen Basin at mines where exceedances had occurred. Following exerted pressure from the Department and greater recognition by Mines of the hazard of elevated methane levels, substantially more effort and investment had been made into methane drainage capacity and efficacy. This was clearly increasing the amount of gas drained, decreasing operational downtime by early intervention to avoid exceedances rather than cutting to trigger trip events. Most importantly risk was being reduced.

- 2.24 That MRE also recorded that:⁶⁷

The mine had done some good work in analysing the gas data to try to predict the time when a goaf drainage hole is likely to come on line. This work will assist in the planning of effective goaf drainage to maintain a high level of control over the level of methane produced during production operations on the Longwall.

- 2.25 Subsequently, between 14 and 16 March 2018, the Inspectorate had a number of discussions with the mine about the management of methane in the LW 102 tailgate, including the ‘numerous’ methane exceedance HPIs the mine had experienced since LW 102 had commenced production.⁶⁸
- 2.26 The MRE with respect to those discussions noted that, by that time, most of the HPIs were a result of the failure of the gas drainage system to effectively remove methane from the LW 102 goaf. It noted that the mine had had five goaf drainage holes immediately behind the longwall face fail to come online and draw gas from the goaf. The mine had formed an Incident Management Team to address the problem, but methane exceedances continued.⁶⁹

⁶⁴ RSH.002.266.0001, .0001–.0002.

⁶⁵ RSH.002.266.0001, .0002.

⁶⁶ RSH.002.266.0001, .0002.

⁶⁷ RSH.002.266.0001, .0006.

⁶⁸ RSH.002.269.0001.

⁶⁹ RSH.002.269.0001.

- 2.27 At a meeting on 19 March 2018, it was noted that there had been 27 exceedances on LW 102 since production had commenced.⁷⁰ During the discussions, the Inspectorate raised numerous mitigation techniques for consideration by the mine, including reverting to uni-directional cutting⁷¹ and reducing the shearer cut rate during low barometer periods.⁷²
- 2.28 The Inspectorate made it clear that it considered the ‘basic problem’ was that the mine did not have sufficient gas drainage capacity. The MRE noted:⁷³
- It was appreciated by the Inspectors that the Mine were continually seeking solutions but the basic problem was that methane holes were not sufficiently productive. The longwall needs to retreat further before the currently revised borehole design changes can be seen if they are effective.*
- 2.29 The Inspectorate had planned to commence the gas management audit flagged in the letter of 30 January 2017⁷⁴ that day, but decided to postpone it until the mine had overcome its gas management problems.⁷⁵ The gas management audit was later conducted by the Inspectorate between 17 and 19 April 2018.⁷⁶
- 2.30 On 9 May 2018, the Inspectorate attended a meeting at the mine and delivered the audit report. It included two mandatory corrective actions and six recommended corrective actions.⁷⁷
- 2.31 At that meeting, there were also discussions about the mine’s ongoing methane exceedance HPIs. There had been 32 such HPIs at the mine since the commencement of production from LW 102 in January 2018, which represented 60% of all methane exceedance HPIs in longwall tailgates in Queensland.⁷⁸
- 2.32 The mine explained that it had done a lot of work in respect of goaf drainage since the last meeting on 19 March 2018, including making changes to goaf drainage hole design and method of drilling and reducing face ventilation quantity.⁷⁹ It provided the Inspectorate with the following information with respect to the work it was doing to investigate a connection between gas drainage and methane exceedances:⁸⁰

⁷⁰ RSH.002.270.0001.

⁷¹ ‘Uni-directional cutting’, also referred to as ‘uni-di cutting’, means to cut the top portion of the coal extraction height in one direction and the remaining bottom portion when returning in the other direction. To be compared with ‘bi-directional’ or ‘bi-di cutting’ which is a method of cutting the full extraction height in both directions, forward and reverse.

⁷² RSH.002.270.0001, .0001–.0002. Reducing the cut rate lowers the face emissions which can partially offset the increased emissions coming from the goaf during a falling barometer (that is, when the atmospheric air pressure is decreasing).

⁷³ RSH.002.270.0001, .0003.

⁷⁴ See paragraphs 2.12–2.13 above.

⁷⁵ RSH.002.270.0001, .0003.

⁷⁶ RSH.002.271.0001.

⁷⁷ RSH.002.272.0001.

⁷⁸ RSH.002.273.0001.

⁷⁹ RSH.002.273.0001.

⁸⁰ RSH.002.273.0001, .0002.

The Mine had conducted significant analysis of goaf drainage performance and had significant success with angled goaf drainage holes and a maingate drainage hole. The goaf drainage had reached a total of 8,200 l/s of total gas (approx. 5,500 l/s Methane) from the 102 goaf with a further 800 l/s being drained from the adjacent 101 goaf. This level is approaching the full capacity of the goaf drainage plant. The Mine is injecting Nitrogen into the 101 goaf in order to try to minimise methane migrating from the 101 goaf to 102 goaf, as had been successfully achieved at Grasstree Mine. The Mine had submitted all of the goaf drainage data, including hole depths, diameters, casing, hole performance data, shearer positions, TG gas levels, production rates etc. to 3 independent statistical analysis companies to do in depth data analysis to try to identify trends and similarities between gas drainage and methane exceedances.

- 2.33 The MRE in relation to the meeting on 9 May 2018 noted that the HPIs were occurring in circumstances where the mine had calculated that the residual gas content of the Goonyella Middle seam coal was approximately 2 m³/t. Relevantly, the MRE noted:⁸¹

The residual gas content of the coal in 102 LW, where the face position is currently is [sic] approximately 2 m³/t. This is not particularly high and mines with higher gas content are having very few or no methane issues in the TG resulting in HPI's with methane greater than 2.5%.

- 2.34 The MRE concluded with the following observations:⁸²

It was acknowledged that the Mine has conducted a significant amount of work to manage the gas in the LW TG and should be congratulated on the improvements in goaf drainage that have resulted from this. The lessons learned from this work will be utilised in managing methane in LW103 which has significant challenges with its position under the Isaac River and the difficulty this imposes on goaf drainage hole positioning.

It was also acknowledged that continued HPI's with Methane greater than 2.5% was not satisfactory and the mine must ensure that such HPI's are minimised, and preferably eliminated going forward.

Other gas management issues at the mine in 2018

- 2.35 On 6 August 2018, the Inspectorate conducted a general inspection at the mine. The relevant MRE records that 'ongoing exchanges with methane exceedances' was 'briefly referenced' in the discussions between the Inspectorate and the mine that day.⁸³

⁸¹ RSH.002.273.0001, .0002.

⁸² RSH.002.273.0001, .0003.

⁸³ RSH.002.274.0001, .0006.

- 2.36 On 11 December 2018, the Inspectorate conducted an announced inspection at the mine. The mine informed the Inspectorate about a floor heave event that had occurred in the LW 104 development panel on 1 December 2018 which tripped power to the continuous miner.⁸⁴ One detector recorded 1.1% methane while the other presented with an 'off-scale reading'.⁸⁵
- 2.37 That incident was only one of five similar incidents since 29 October 2018. The other incidents had occurred on 29 October 2018, 3 November 2018, 9 November 2018 and 23 November 2018. The mine believed that methane from the seam below had migrated up and been trapped in minor pockets created by geological disturbances.⁸⁶
- 2.38 The Inspectorate noted that the issue would continue to receive particular attention.⁸⁷
- 2.39 Such floor heave and gas release issues continued into the new year. On 13 March 2019, the Inspectorate conducted an inspection at the mine. At that time, development of the LW 105 panel had commenced but was halted while the mine worked through floor heave and gas release issues. Work was not expected to restart until April 2019.⁸⁸
- 2.40 As noted at the outset of this chapter, this review of the MREs contains only some history of gas management issues experienced on LW 101 and LW 102. The HPIs which are the subject of the Terms of Reference, and their relationship to gas management issues, are considered in following chapters.

⁸⁴ RSH.002.276.0001, .0002.

⁸⁵ RSH.002.276.0001, .0003.

⁸⁶ RSH.002.276.0001, .0003.

⁸⁷ RSH.002.276.0001, .0003.

⁸⁸ RSH.002.277.0001.

Chapter 3 – 13 HPIs at Grosvenor Longwall 103 in 2019

3.1 Between 2 July and 7 November 2019, there were 13 methane exceedance high potential incidents (HPIs) at longwall 103 (LW 103) at the Grosvenor mine (Grosvenor). The summaries that follow are derived from the mine’s own investigation reports which comprise the hazard and incident report forms (HIRFs) and the Learning From Incidents (LFI) reports. Neither of these reports was provided to the Coal Mines Inspectorate (the Inspectorate).⁸⁹ It is not suggested that they should have been. The Inspectorate was provided with the oral report of the notifier and a Form 1A when an HPI was reported, and a Form 5A approximately one month later.

HPI # 1 – 2 July 2019

- 3.2 On 2 July 2019, as the shearer was cutting towards the tailgate, it was automatically stopped at shield #115 at 12:03pm because of a reading which exceeded 1.9% methane at the inbye tailgate sensor.⁹⁰ The methane concentration remained at about that level for a little over two hours, until 2:13pm, by which time it dropped to 1.87%. This permitted production to resume a few minutes later, at 2:17pm. However, seven minutes later, at 2:24pm, the inbye sensor reached 2.2%, and the shearer was stopped at shield #139. Methane levels in the tailgate continued to rise, with the inbye sensor peaking at 2.36%. At 2:35pm, the outbye sensor⁹¹ reached 2.5%, tripping power to the shearer. It peaked a minute later at 2.52%.⁹²
- 3.3 The Form 1A that was later submitted to the Inspectorate set out that the incident had initially been reported by Mr Wouter Niehaus, the Underground Mine Manager, to Inspector Keith Brennan at 2:35pm. It was reported to the Industry Safety and Health Representative (ISHR), Mr Stephen Woods, a few hours later at 5:09pm.⁹³
- 3.4 The Explosion Risk Zone (ERZ) controller who filled out the HIRF described the ‘actual consequence’ of the incident as ‘insignificant’, and the ‘potential consequence’ as ‘minor’.⁹⁴ The HIRF included a table which allowed the risk posed by the HPI to be assessed and characterised. As will become apparent, those completing the HIRFs for the HPIs on LW 103 and LW 104 took inconsistent approaches to the assessment and characterisation of that risk.

⁸⁹ The Coal Mines Inspectorate is a division of Resources Safety & Health Queensland (RSHQ), the Regulator of the coal mining industry. At the time, the Regulator was the Department of Natural Resources, Mines and Energy (DNRME) and the Inspectorate was a division of that department. That department had formerly been titled DNRM, the Department of Natural Resources and Mines.

⁹⁰ Located approximately 400 metres outbye of the face. ‘Inbye’ means in a direction away from the surface entry of the mine, ‘outbye’ means in a direction towards the surface entry.

⁹¹ Located at 3–4 cut-through, approximately four kilometres outbye of the face.

⁹² AAMC.001.003.0219, .0225.

⁹³ AAMC.001.009.0255.

⁹⁴ AAMC.001.003.0219, .0229.

3.5 The risk matrix was completed as follows:⁹⁵

Refer to attached Grosvenor Risk Matrix for below:					
Actual Consequence: Not Applicable for Hazards	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.05% annual revenue)	Moderate (lost time injury, damage 0.1- 1.0% annual revenue)	High (permanent disability/ fatality, Anglo HPI)	Major (numerous permanent disabilities/fatalities, Anglo HPI)
Potential Consequence:	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.05% annual revenue)	Moderate (lost time injury, damage 0.1- 1.0% annual revenue)	High (permanent disability/ fatality, Anglo HPI)	Major (numerous permanent disabilities/fatalities, Anglo HPI)
Has the hazard, defect or incident been effectively controlled on shift?				YES <input checked="" type="checkbox"/>	NO <input type="checkbox"/>

Figure 3: HIRF Risk Matrix for HPI on 2 July 2019

3.6 As discussed in Part I of the Report, Anglo American plc (Anglo) adopted a classification system that identified HPIs, as either 'DNRM HPI' or 'Anglo HPI'.⁹⁶ This incident was classified by the mine as a 'DNRM HPI'.

3.7 Grosvenor's investigation of this and the other incidents followed a standard procedure, resulting in a report entitled Learning From Incidents (LFI) for each incident.⁹⁷ The LFI report for this incident described it and its causes in plain and direct terms.⁹⁸

3.8 The investigation identified a number of factors as contributing to the incident, including:⁹⁹

- a. *Due to the time of day and falling barometer, the goaf was breathing out leading to an increase in CH4 reporting to the tailgate roadway;*
- b. *[Pausing] [t]he shearer position on the face (#115) [which] contributed to additional ventilation scouring the goaf into the mine general body atmosphere; and*
- c. *...production from the week prior of 83 Shears and 158kt [of coal] contributed to the methane generated within the goaf and face levels.*

3.9 The investigation included a 'Control Analysis', which found that the gas drainage system had failed because it provided 'less than adequate methane recovery/dilution'. Although described as an 'outcome' of the failure, the Control Analysis concluded that the 'design capacity [of the gas drainage system] cannot sustain current production rate'.¹⁰⁰

⁹⁵ AAMC.001.003.0219, .0229.

⁹⁶ Part I of the Report, Chapter 2 (Methane in coal mines). A 'DNRM HPI' or 'DNRME HPI' refers to a high potential incident (HPI) under the legislation, which was reported to the Regulator. An 'Anglo HPI' is a HPI defined in Anglo's internal *Incident Reporting Standard* as an incident where it is reasonable to expect a Level 4 or 5 potential consequence. At a corporate level, 'DNRM HPIs' were treated by Anglo as lesser incidents than 'Anglo HPIs' as far as investigating, recording and reporting were concerned.

⁹⁷ AAMC.001.004.0002, .0009–.0011.

⁹⁸ AAMC.001.003.0219. At times, multiple incidents would be dealt with in the one LFI report.

⁹⁹ AAMC.001.003.0219, .0222.

¹⁰⁰ AAMC.001.003.0219, .0226.

The 'Change Analysis' section of the LFI report also found that whilst the goaf drainage system had a capacity of 10,000 l/s, the 'gas make (SGE)' was greater than expected and in excess of system capacity:¹⁰¹

Normal Practice	Situation or practice at the time of the incident	Gap (difference)	Impact of Difference
Goaf drainage system	Normal operation (~10,000 l/s capacity)	Gas make (SGE) greater than expected in excess of system capacity	General body concentrations of CH ₄ exceeding 2.5% in tailgate roadway

Figure 4: LFI Change Analysis for HPI on 2 July 2019

3.10 These conclusions were also found in the 'Why Tree Analysis', where it was said:¹⁰²

- a. *Gas Drainage and Ventilation System [was] LTA;*
- b. *Shearer displaces ventilation into goaf when in vicinity of tailgate;*
- c. *Ventilation and Gas Management System unable to accommodate sudden spikes in general body concentration; and*
- d. *Ventilation and Gas Management System [was] designed for Specific Gas Emissions (SGE) lower than current conditions.*

3.11 Grosvenor identified a number of actions to prevent recurrence, including:¹⁰³

- a. *Develop a plan to increase goaf drainage capacity for peak SGE areas of Grosvenor to reduce tailgate methane concentrations to meet business plan productivity targets;*
- b. *Review the shearer stop position in [the] Tailgate from [shield] #115 towards the Maingate to reduce the effect of the shearer flushing gas into the mine general body atmosphere when stopped during periods of low barometer; and*
- c. *Complete ventilation change(s) to reverse [the] TG101 perimeter road as per IMT direction.*

3.12 Grosvenor uses a system known as Enablon to, amongst other things, manage its responses to health and safety issues. The plan to increase goaf drainage capacity was completed on 27 August 2019 and proposed the addition of four blowers/flares¹⁰⁴ as well as a sixth vacuum pump.¹⁰⁵

¹⁰¹ AAMC.001.003.0219, .0227.

¹⁰² AAMC.001.003.0219, .0228. 'LTA' means less than acceptable.

¹⁰³ AAMC.001.003.0219, .0223.

¹⁰⁴ 'Blowers' are mobile gas extraction plants that utilise either a liquid ring pump or a fan to create a vacuum on the goaf well head. All associated pipework, flame arrestors and control systems are incorporated onto a movable sled or skid. The extracted gas is either free vented (released to the atmosphere) or flared (burned).

¹⁰⁵ AGM.003.001.0126; AGM.003.001.0128. A 'vacuum pump' pumps gas into the gas extraction infrastructure.

According to the plan, the first actual change would be the installation of a flare in August. This was to be followed by the additional vacuum pump in December. Three more flares were to be in place for the commencement of production on LW 104 in March 2020.¹⁰⁶

- 3.13 Although requested by the Board, no documents were provided by Grosvenor with respect to the review of the shearer stop position.¹⁰⁷ The ventilation change, which itself caused an HPI when executed, was addressed in the documents provided with respect to that HPI.
- 3.14 The LFI report also proposed a test for effectiveness ‘to ensure that the above actions to prevent recurrence have worked as intended’.¹⁰⁸ An Enablon entry dated 18 September 2019 set out that ‘[a]ll actions reviewed and have been completed to requirement’, with no follow up required.¹⁰⁹ This was technically correct, given that all that was required was a plan. Until implemented, the plan did nothing to address the ongoing problem. As will be seen, methane exceedances continued in the tailgate of LW 103 until November.
- 3.15 The mine lodged the required Form 5A with the Inspectorate on 30 July 2019.¹¹⁰ In it, Grosvenor identified the causes of the event in the same or similar terms as specified in its own LFI report, including:¹¹¹

‘Gas make (SGE) greater than expected in excess of system capacity...’

- 3.16 The proposed preventative actions set out in the Form 5A also accorded with those which were specified in the LFI report:¹¹²

Preventative action

25 Give details of any control measures/actions being considered and/or implemented to prevent recurrences

Develop a plan to increase goaf drainage capacity for peak SGE areas of Grosvenor to reduce tailgate methane concentrations to meet business plan productivity targets. Review shearer stop position in Tailgate from #115 towards the Maingate to reduce the effect of the shearer flushing gas into the mine general body atmosphere when stopped during periods of low barometer. Complete ventilation change(s) to reverse TG101 perimeter road as per IMT direction.

Figure 5: Form 5A Preventative Action for HPI on 2 July 2019

- 3.17 As will be seen, the words used in the description of the plan to increase goaf drainage capacity were repeated several times in subsequent Form 5As.

¹⁰⁶ AGM.003.001.0128.

¹⁰⁷ AGM.010.001.0127.

¹⁰⁸ AAMC.001.003.0219, .0223.

¹⁰⁹ AGM.003.001.2449.

¹¹⁰ AAMC.001.009.0336.

¹¹¹ AAMC.001.009.0336, .0338.

¹¹² AAMC.001.009.0336, .0338.

Findings for HPI # 1

Finding 1

The immediate causes of the incident were the pausing of the shearer at shield #115, partially obstructing longwall ventilation, coupled with the low barometric pressure.

Finding 2

Systemic causes were:

- a. high gas emissions as a result of the extraction of 158,000 tonnes of coal in the preceding week; and
- b. the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.

Inspection at Grosvenor by Inspector Brennan on 2 July 2019

- 3.18 As it turned out, Inspector Brennan had arrived at Grosvenor at 6:45am on the morning of 2 July 2019 and was underground in a separate part of the mine at the time of the HPI.¹¹³
- 3.19 Inspector Brennan's visit had been prompted by the LW 103 methane exceedances, as well as the introduction of the use of iPads for the recording of statutory inspections. Together with Mr Niehaus, Inspector Brennan reviewed CITECT data concerning the numerous prior exceedances.¹¹⁴ It was explained to him that controls had been implemented on the longwall that would prevent the shearer from cutting towards the tailgate beyond shield #115 unless the tailgate methane sensor was below a certain level. That level would change for every shear depending upon the gas concentrations detected by both the inbye and outbye sensors.¹¹⁵
- 3.20 Inspector Brennan was also advised that a gas drainage hole drilled laterally because of the Isaac River location was due to come online, and that gas drainage capacity was presently 10,000 l/s.¹¹⁶
- 3.21 Inspector Brennan attended a meeting with Mr Glen Britton (Head of Underground Operations at Anglo American Metallurgical Coal Pty Ltd (AAMC)), Mr Rob Knowles (Production Manager at Grosvenor) and Mr Niehaus. Mr Britton advised that substantial funding had been made available for gas drainage and the trialling of infra-red methane detectors.¹¹⁷

¹¹³ AAMC.008.017.0003.

¹¹⁴ CITECT is the brand name of a SCADA (Supervisory Control and Data Acquisition) software solution. It is a system for gathering data and controlling various mining processes.

¹¹⁵ RSH.002.138.0001, .0001–.0002.

¹¹⁶ RSH.002.138.0001, .0003.

¹¹⁷ RSH.002.138.0001, .0003.

- 3.22 Inspector Brennan visited LW 103 where he noted a cavity on the face between shields #143–#149. He observed the CITECT screen located on the beam stage loader at the maingate and noted that the methane parameter that would permit the shearer to proceed past shield #115 was set at a maximum of 1.5%. Whilst at the longwall, he was advised that a worker had been injured in the mains development section of the mine and went with Grosvenor staff to investigate. Whilst there, he was informed by the Undermanager that there had been a methane HPI on the longwall.
- 3.23 Inspector Brennan engaged in discussions with Mr Niehaus about actions that could be taken, including that the mine should consider reversing the ventilation in the perimeter road to reduce the levels of methane that were being brought onto the face before production had commenced, and that the mine should consider whether they should employ uni-directional cutting to assist in reducing their gas emissions. Mr Niehaus, after those discussions, determined that the longwall would be stood down for 36 hours whilst an Incident Management Team (IMT) was formed to review methane management strategies.¹¹⁸
- 3.24 On 4 July 2019, Inspector Brennan was sent a copy of the minutes of the IMT, which had identified the objective of ‘develop[ing] and implement[ing] strategies to assist in reducing the methane emissions in the TG roadway and the LW face to adequate levels to allow consistent longwall production in line with forecast’.¹¹⁹ To achieve that objective the following matters were considered or proposed:¹²⁰
- *Gas and Shearer positioning trends were reviewed*
 - *Gas Drainage Report Update - All holes running at 100%*
 - *Barometric effects goaf tailgate emissions*
 - *Plans to drill Mid panel Goaf hole GR03V055 at 1522 metre chainage (97 metres from MG rib- line)*
 - *Installing Infra-Red CH₄ sensors at 3-4ct adjacent to currently installed sensors (comparison purposes only). Continue investigations with baffle setup to drop moisture and dust prior to reaching sensor.*
 - *Short Term Ventilation Strategy:- Model, plan and execute the perimeter road ventilation reversal to lower CH₄ levels entering the MG • Predicted low pressure weather system to significantly lower barometric pressure over the next 2 days • Maintain face ventilation quantity (review post vent change to minimise changing too many variables)*

¹¹⁸ RSH.002.138.0001, .0003; .0005.

¹¹⁹ RSH.002.138.0001, .0005.

¹²⁰ RSH.002.138.0001, .0005. ‘LRP’ means liquid ring pump, a piece of equipment that pumps gas into the plant. ‘SIS’ and ‘UIS’ refer to types of drainage holes – surface to in-seam and underground in-seam respectively.

- *Short Term Goaf Drainage Strategy • GR03V055 – Targeted Ch1530 90m from MG (additional infill hole) • GR03V053 – Expected to come online at Ch1690 (P seam MG) • GR03V056 – to be scoped and designed for ~Ch1100 • Review gas compliance cores for GM and P Seams for remainder of LW103*
- *Long Term Goaf Drainage Strategy • Install 6th LRP at Gas Plant • Purchase and install blowers • All SIS gas currently plumbed to Arrow • UIS currently 8% of gas plant capacity. Purity of UIS will result in disconnections from Arrow if below 94% CH4. (UIS to Arrow not ideal) • Venting restricted emergency situations only • Identify potential goaf gas sources and areas for LW104. • Complete review of SGE model against actuals • Increase SGE resolution to identify areas with predicted higher goaf gas.*
- *Long Term Goaf Drainage Strategy • Install 6th LRP at Gas Plant • Purchase and install blowers • All SIS gas currently plumbed to Arrow • UIS currently 8% of gas plant capacity. Purity of UIS will result in disconnections from Arrow if below 94% CH4.*

HPI # 2 – 3 July 2019

- 3.25 The next day, 3 July 2019, production was stopped at midnight when the inbye sensor registered a methane concentration in excess of 1.69%. Cutting resumed at 3:08am after methane levels reduced and continued until 5:01am, when the inbye sensor reached 2.2%, causing the shearer to stop at shield #144 in accordance with the applicable Trigger Action Response Plan (TARP). At 5:02am, the reading hit 2.5%, tripping power to the shearer. The concentration of methane peaked a minute later at 2.7%. The shearer was then moved to a place of safety towards the maingate, and production recommenced about forty minutes later, at 5:43am.¹²¹
- 3.26 The incident was reported to Inspector Brennan at 6:26am, and to ISHR Woods at 8:13am.¹²² The ERZ controller who completed the HIRF assessed the actual and potential consequences of the incident as ‘insignificant’. The risk matrix was completed as follows:¹²³

Refer to attached Grosvenor Risk Matrix for below:					
Actual Consequence: Not Applicable for Hazards	Insignificant (lost time injury, damage <0.01-0.1% annual revenue) etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/fatality, Anglo HPI)	Major (numerous permanent disabilities/fatalities, Anglo HPI)
Potential Consequence:	Insignificant (lost time injury, damage <0.01-0.1% annual revenue) etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/fatality, Anglo HPI)	Major (numerous permanent disabilities/fatalities, Anglo HPI)

Figure 6: HIRF Risk Matrix for HPI on 3 July 2019

- 3.27 The notation ‘DNRM HPI’ was made on the top of the form.¹²⁴

¹²¹ AAMC.001.003.0235, .0241.

¹²² AAMC.001.009.0257.

¹²³ AAMC.001.003.0235, .0245.

¹²⁴ AAMC.001.003.0235, .0245.

- 3.28 It is notable that in the section on the HIRF headed ‘Additional Actions to prevent reoccurrence’, someone wrote ‘*REVIEW GOAF DRAINAGE STRATEGY FOR LONGWALL*’, although this was subsequently crossed out, as can be seen below:¹²⁵

Action Description	By Whom	Action Due (date)	Enablon ID #
REVIEW GOAF DRAINAGE STRATEGY FOR LONGWALL	LOGAN MOHR	10-7-19	
		61059020	
		61059021	
		01059022	
Conduct LFI investigation	R Murdoch	61059023	
		01059024	
Is a Banner Alert required to be issued? Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>	R Murdoch	5/07/19	
If yes, which Banner Alert: Green <input type="checkbox"/> Orange <input type="checkbox"/> Red <input type="checkbox"/>			

Figure 7: HIRF additional actions to prevent reoccurrence for HPI on 3 July 2019

- 3.29 The LFI report dated 17 July 2019¹²⁶ described what occurred as a ‘non-prescribed legislative HPI’ involving methane concentrations that rose above 2.5% for one minute. This occurred because:¹²⁷

The goaf in the tailgate roadway was hanging up, allowing a pocket of goaf atmosphere to accumulate, and a variance to pressure enabled a short duration plug of goaf atmosphere to be ejected into the tailgate general body atmosphere.

- 3.30 A graph derived from data collected by the CITECT system, depicting various parameters, including atmospheric pressure, confirms a drop in pressure immediately prior to the exceedance.¹²⁸
- 3.31 The investigation also concluded that the shearer speed when entering the tailgate created a ‘bow wave’ which pushed the accumulated pocket of gas from the void into the mine ventilation system. It was observed that the CITECT system had failed to prevent the shearer moving past shield #115, despite the level of methane that was already detected in the tailgate.
- 3.32 Notwithstanding the somewhat different aetiology of this event from that which occurred the previous day, it was again noted:¹²⁹

*Gas make (SGE) greater than expected and in excess of system capacity; and
Less than adequate methane recovery/dilution.*

- 3.33 The Control Analysis in the LFI report concluded that the gas drainage system had failed, and that the design capacity could not sustain the current production rate.¹³⁰ The

¹²⁵ AAMC.001.003.0235, .0246.

¹²⁶ AAMC.001.003.0235.

¹²⁷ AAMC.001.003.0235, .0238.

¹²⁸ AAMC.001.003.0235, .0248.

¹²⁹ AAMC.001.003.0235, .0238.

¹³⁰ AAMC.001.003.0235, .0242.

control logic on the shearer had also failed, in that there was an insufficient buffer between the amount of methane present during normal operations and 2.5%, so as to prevent an exceedance of that figure. According to the authors of the report, no critical control had failed.

- 3.34 The Change Analysis likewise concluded that gas make was greater than expected and in excess of system capacity. The Why Tree Analysis resulted in the same conclusions as for HPI # 1.
- 3.35 The preventative actions and recommendations were the same as for the previous HPI, namely to:¹³¹
- *Develop a plan to increase goaf drainage capacity for peak SGE areas of Grosvenor to reduce tailgate methane concentrations to meet business productivity targets; and*
 - *Complete ventilation change(s) to reverse TG101 perimeter road as per IMT direction.*
- 3.36 The plan to increase goaf drainage is described in Enablon as having been completed by 27 August 2019, and is the same plan devised in response to HPI # 1.¹³²
- 3.37 The 'Test for Effectiveness' section of the LFI report did not deal with the goaf drainage plan, but did address the ventilation change, which was said to have been completed by 18 September 2019.¹³³
- 3.38 The Form 5A was lodged with the Inspectorate on 31 July 2019. It conformed to the LFI report in its conclusions and recommendations:¹³⁴

Preventative action

25 Give details of any control measures/actions being considered and/or implemented to prevent recurrences

Develop a plan to increase goaf drainage capacity for peak SGE areas of Grosvenor to reduce tailgate methane concentrations to meet business plan productivity targets. Complete ventilation change(s) to reverse TG101 perimeter road as per IMT direction.

Figure 8: Form 5A Preventative Action for HPI on 3 July 2019

Findings for HPI # 2

Finding 3

The immediate causes of the incident were the accumulation of goaf gases in a cavity in the tailgate roadway inbye, coupled with a pressure variation that caused those gases to be ejected into the tailgate.

¹³¹ AAMC.001.003.0235, .0239.

¹³² AGM.003.001.0126.

¹³³ AGM.003.001.2510.

¹³⁴ AAMC.001.009.0340, .0342.

Finding 4

The systemic cause was that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.

Anglo's response to the first two HPIs

3.39 Anglo reacted promptly to what it plainly recognised as a problem. In an email at 9:37am on 11 July 2019, Mr Dieter Haage (AAMC Head of Technical) emailed Mr Britton and Mr Trent Griffiths (Grosvenor SSE) outlining a 'Grosvenor Gas Plan', the essential components of which were:¹³⁵

Establish where the elevated SGE's are coming from:

1. *Review again the gas emissions from Arrow history from the GM and P seam to correlate against the current experience. (Jul / Aug 19 - Russel Packham)*
2. *Drill and measure subsided potential target seams (P seam, Fairhills Seam) to establish post mining gas content for accurate mining process emissions. Mid August 19. (Exploration)*
3. *Drill and measure pre-drainage gas content and permeability at 3 positions (Inbye, Mid Panel, Outbye for panels 104, 105, 106). (H2 2019 and H1 2020) (Plan to be finalised by Casper Badenhorst and included in the 2020 BP)*

Dealing with elevated SGE's:

1. *Increased Tailgate Goaf Gas holes with infill holes to bring spacing down from current 50m to 25m. (Commencing August and continuing through 2019 – 2020.) Casper Badenhorst*
2. *Reduce spacing of Maingate holes from current 300m to 150m, commencing outbye of riverbed undermining, Q4 2019. (Casper Badenhorst)*
3. *Prepare plan and provide budget for 3 X 12' lateral goaf drainage holes in the P seam for LW104 and beyond, drill in 2019 Q4 (New idea, partially successful previously, will be refined for 104. (Russel Packham)*

...

3.40 However, there had already been another methane HPI on LW 103 in the early hours of that same morning; gas exceedances in the tailgate roadway on LW 103 continued.

¹³⁵ AGM.005.002.0434.

HPI # 3 – 11 July 2019

- 3.41 Whilst the shearer was mining towards the maingate from shield #78 to shield #44, a floor blower¹³⁶ became active at the rear of shield #55 after the area had been mined and the shields advanced. At 1:35am the tailgate drive sensor exceeded 2%, causing a production stoppage. It went on to read as high as 2.7%. One minute later the outbye tailgate sensor reached 2.5% and tripped power to the face. That sensor subsequently peaked at 2.79%. A very substantial quantity of methane was released, estimated at 2,463 m³ during the first hour, and a total of about 4,790 m³ after seven hours.¹³⁷
- 3.42 The incident was reported by Mr Niehaus to ISHR Woods at 7:42am and to Inspector Brennan at 7:44am that day.¹³⁸
- 3.43 The HIRF completed by the ERZ controller assessed that the actual and potential consequences of the incident were each 'moderate'. The risk matrix was completed as follows:¹³⁹

Refer to attached Grosvenor Risk Matrix for below:					
Actual Consequence: Not Applicable for Hazards	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/fatality, Anglo HPI)	
Potential Consequence:	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/fatality, Anglo HPI)	
Has the hazard, defect or incident been effectively controlled on shift?				YES <input checked="" type="checkbox"/>	NO <input type="checkbox"/>

Figure 9: HIRF Risk Matrix for HPI on 11 July 2019

- 3.44 The notation 'DNRME HPI' was made on the top of the form.¹⁴⁰
- 3.45 The LFI report dated 25 July 2019 concluded that '[m]ining past the area had stimulated the release of gas...from a reservoir from beneath the target mining seam'.¹⁴¹ The organisational factors identified were:¹⁴²
- Gas make (SGE) greater than expected in excess of system capacity;
 - Less than adequate methane recovery / dilution; and
 - LTA pre-drainage program in lower seam(s).
- 3.46 The Control Analysis determined that the gas drainage system had failed because its design capacity could not sustain the current production rate.

¹³⁶ A 'floor blower' is a gas emission released from fractures in the coal seam floor.

¹³⁷ AAMC.001.003.0254, .0257; .0260.

¹³⁸ AAMC.001.009.0259.

¹³⁹ AAMC.001.003.0254, .0264.

¹⁴⁰ AAMC.001.003.0254, .0264.

¹⁴¹ AAMC.001.003.0254, .0257.

¹⁴² AAMC.001.003.0254, .0257.

There was also a conclusion that the gas pre-drainage process had failed, with the result that '[m]ethane reported to the general body atmosphere greater than acceptable limits from adjacent seam/strata'.¹⁴³ The Why Tree Analysis reached similar conclusions, including 'Gas Drainage and Ventilation System LTA'.¹⁴⁴

- 3.47 The identified preventative action/recommendation was to '[i]dentify areas of high-risk floor gas release and implement action plan for floor gas drainage to remediate future areas of concern'.
- 3.48 The Test for Effectiveness was completed on 25 October 2019, with the Enablon entry recording that '[m]odeling [sic] of expected floor gas area has been completed with a neural network and is updated when new information becomes available'.¹⁴⁵
- 3.49 The Form 5A was lodged on 6 August 2019. It conformed to the LFI report in terms of the cause of the incident and the preventative measures taken.¹⁴⁶

Findings for HPI # 3

Finding 5

The immediate cause of this incident was a floor blower that became active at the rear of shield #55.

Finding 6

The systemic cause was that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.

HPI # 4 – 14 July 2019

- 3.50 Whilst the shearer was producing from maingate towards the tailgate, its speed was slowed at shield #60 due to elevated methane in the tailgate roadway. At 11:15am, the shearer stopped at shield #82 when the inbye sensor reached 2.3%. At 11:25am, the outbye sensor reached 2.52%.¹⁴⁷
- 3.51 The incident was reported to Inspector Graham Callinan at 12:56pm the same day, and later to ISHR Woods at 1:05pm.¹⁴⁸
- 3.52 According to the HIRF completed by the ERZ controller, the concentration of methane continued to move above and below 2.5% consistently with the barometer. In a section marked 'Equipment', the ERZ controller noted 'inadequate goaf drainage'. The actual and potential consequences were both described as 'moderate', although 'insignificant' had been circled for each and crossed out.¹⁴⁹

¹⁴³ AAMC.001.003.0254, .0261.

¹⁴⁴ AAMC.001.003.0254, .0263.

¹⁴⁵ AGM.003.001.2593.

¹⁴⁶ AAMC.001.009.0344.

¹⁴⁷ AAMC.001.009.0462, .0465.

¹⁴⁸ AAMC.001.009.0263.

¹⁴⁹ AAMC.001.009.0462, .0472.

In a section marked ‘Additional Actions to prevent re-occurrence’, someone wrote ‘SAME ACTIONS AS PREVIOUS EXCEEDANCE’, however that was also crossed out.

3.53 The risk matrix was completed as follows:¹⁵⁰

Refer to attached Grosvenor Risk Matrix for below:

Actual Consequence: Not Applicable for Hazards	Insignificant (first aid only, damage <0.5% annual revenue, etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/fatality, Anglo HPI)	Major (numerous permanent disabilities/fatalities, Anglo HPI)
Potential Consequence:	Insignificant (first aid only, damage <0.5% annual revenue, etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/fatality, Anglo HPI)	Major (numerous permanent disabilities/fatalities, Anglo HPI)
Has the hazard, defect or incident been effectively controlled on shift?				YES <input checked="" type="checkbox"/>	NO <input type="checkbox"/>

Figure 10: HIRF Risk Matrix for HPI on 14 July 2019

3.54 The notation ‘DNRME HPI’ was made on the top of the form.¹⁵¹

3.55 The LFI report for this incident also addresses HPIs # 6 & # 7 (which occurred on 21 and 22 July 2019 respectively). The findings and conclusions in the LFI report (for each of the three incidents) were in these terms:¹⁵²

The goaf in the tailgate roadway was hanging up, allowing a pocket of goaf atmosphere to accumulate, and a variance to pressure enabled a short duration plug of goaf atmosphere to be ejected into the tailgate general body atmosphere.

3.56 It is difficult to understand how this conclusion was reached. Nothing in the LFI report or the attachments to it concerning this event refer to the tailgate hanging up, nor to any pocket of goaf atmosphere. Furthermore, although pressure data recorded by CITECT are referred to in some of the LFI reports concerning other incidents,¹⁵³ no such data are referred to in this LFI report.

3.57 The conclusion referred to above is expressed using a formula of words that is identical to that reached in the LFI Findings and Conclusions section for HPI # 2.¹⁵⁴ Further, the LFI report did not purport to separately analyse what had happened in respect of each incident; rather, what appears to be a ‘boilerplate’ conclusion was expressed for all of them.

3.58 The Control Analysis concluded that the gas drainage system had failed, because its capacity could not sustain the current production rate. The general body contaminant TARP¹⁵⁵ and the shearer methane controls also failed to maintain a sufficient buffer between normal operation and an exceedance of 2.5%.

¹⁵⁰ AAMC.001.009.0462, .0472.

¹⁵¹ AAMC.001.009.0462, .0472.

¹⁵² AAMC.001.009.0462, .0465.

¹⁵³ For example, HPI # 2 on 3 July 2019.

¹⁵⁴ AAMC.001.003.0235, .0238.

¹⁵⁵ AGM.002.001.0470: GRO-750-TARP-General Body Contaminant.

3.59 The key action identified to prevent recurrence was:¹⁵⁶

Develop a plan to increase goaf drainage capacity for peak SGE areas of Grosvenor to reduce tailgate methane concentrations to meet business plan productivity targets.

3.60 The Form 5A was lodged with the Inspectorate on 14 August 2019.¹⁵⁷ It identifies the same cause and proposed solutions as the LFI report, including that gas make was greater than expected and in excess of system capacity, as well as development of the same plan:¹⁵⁸

Preventative action

25 Give details of any control measures/actions being considered and/or implemented to prevent recurrences

Develop a plan to increase goaf drainage capacity for peak SGE areas of Grosvenor to reduce tailgate methane concentrations to meet business plan productivity targets.

Figure 11: Form 5A Preventative Action for HPI on 14 July 2019

Grosvenor meeting about tailgate methane levels

3.61 At 10:00am the next day, 15 July 2019, a meeting was attended by a number of senior Grosvenor staff, including Mr Niehaus, Mr John Agustin (Longwall Superintendent), Mr Garth Zerner (Ventilation Officer), Ms Elisabeth Marnane (Ventilation and Gas Superintendent), and Mr Logan Mohr (A/Technical Services Manager). The title of the meeting was 'LW TG Level 2 General Body Methane Levels ($\geq 2.50\%$)', and its objective was said to be:¹⁵⁹

Develop and implement strategies to assist in reducing the methane emissions in the TG roadway and the LW face to adequate levels to allow consistent longwall production in line with forecast.

3.62 The meeting commenced with a discussion about two events that had occurred over the weekend, namely HPI # 4 and an event that had occurred the day prior to that where the methane concentration in the tailgate at the 3–4 cut-through reached, but did not exceed, 2.5%. Short-term ventilation strategies were discussed to:¹⁶⁰

- a. *Model, plan and execute the perimeter road ventilation reversal to lower CH₄ levels entering the MG [planned for later that day]; and*
- b. *Maintain face ventilation quantity (review post vent change to minimise changing too many variables).*

3.63 In terms of goaf drainage, the short-term strategies were some new goaf wells and drainage from the P seam in the maingate. The long-term goaf drainage strategy involved the installation of new surface infrastructure.

¹⁵⁶ AAMC.001.003.0235, .0239.

¹⁵⁷ AAMC.001.009.0352.

¹⁵⁸ AAMC.001.009.0352, .0354.

¹⁵⁹ AGM.005.002.0426.

¹⁶⁰ AGM.005.002.0426, .0429.

There was also a discussion about the underground in-seam (UIS) gas being plumbed to Arrow Energy (Arrow),¹⁶¹ although the point was made that Arrow would disconnect if the gas was less than 94% methane. It was observed that piping UIS gas to Arrow was not ideal, suggesting that the required minimum purity of 94% might not have been consistently achievable.

- 3.64 The ventilation change referred to above proceeded earlier than planned, but it resulted in a methane HPI in the longwall tailgate. No UIS drainage of the P seam was implemented.
- 3.65 It is worth noting that these HPIs occurred despite actual production being only 71% of the target figure for the first two weeks of July 2019.¹⁶² Grosvenor was plainly aware that gas management was an issue.

HPI # 5 – 21 July 2019¹⁶³

- 3.66 At 1:15pm,¹⁶⁴ whilst the shearer was cutting towards the maingate, the conveyor stopped on two occasions, causing a flush of coal that obstructed the ventilation. This coincided with a sudden drop in barometric pressure, and gas concentrations rose in the tailgate roadway, peaking at 2.51% at the outbye sensor, but only reaching 2.27% at the inbye sensor.¹⁶⁵
- 3.67 The incident was reported to Inspector Creswick Bulger at 2:36pm, and to ISHR Jason Hill at 2:40pm the same day.¹⁶⁶
- 3.68 The ERZ controller who completed the HIRF, specified the actual consequence as ‘minor’, but the potential consequence as ‘high’. That was crossed out, and ‘moderate’ was circled. The risk matrix was completed as follows:¹⁶⁷

Refer to attached Grosvenor Risk Matrix for below:

Actual Consequence: Not Applicable for Hazards	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/fatality, Anglo HPI)	Major (numerous permanent disabilities/fatalities, Anglo HPI)
Potential Consequence:	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/fatality, Anglo HPI)	Major (numerous permanent disabilities/fatalities, Anglo HPI)
Has the hazard, defect or incident been effectively controlled on shift?				YES <input checked="" type="checkbox"/>	NO <input type="checkbox"/>

Figure 12: HIRF Risk Matrix for HPI on 21 July 2019

- 3.69 The notation ‘DNRME HPI’ was made on the top of the form.¹⁶⁸

¹⁶¹ Arrow is a petroleum and gas producer capturing methane gas for commercial purposes.
¹⁶² AGM.003.001.0025.
¹⁶³ Note that the HPIs are not all in chronological order.
¹⁶⁴ AAMC.001.009.0462, .0474.
¹⁶⁵ AAMC.001.009.0462, .0465.
¹⁶⁶ AAMC.001.009.0269.
¹⁶⁷ AAMC.001.009.0462, .0474.
¹⁶⁸ AAMC.001.009.0462, .0474.

3.70 Additional actions specified to prevent recurrence included 'IMT actions in place to investigate source of increased gas make':¹⁶⁹

Additional Actions to prevent reoccurrence: (ERZ Controller/ Supervisor to complete)

Action Description	By Whom	Action Due (date)	Enablon ID #
Complete HPI INV.	L MORIA	as per LFI actions	
IMT ACTIONS IN PLACE TO		01071333	
INVESTIGATE SOURCE OF		01071334	
INCREASED GAS MAKE		01071336	
		01071337	
		01071338	
Is a Banner Alert required to be issued? Yes <input type="checkbox"/> No <input type="checkbox"/>			
If yes, which Banner Alert: Green <input type="checkbox"/> Orange <input type="checkbox"/> Red <input type="checkbox"/>			

MANDATORY LFI ACTIONS L MORIA

Figure 13: HIRF additional actions to prevent reoccurrence for HPI on 21 July 2019

3.71 The same light blue coloured pen was also used to write 'DNRME HPI' at the top of the page: The LFI report, which is the same report as was prepared in relation to HPI # 4, concluded that:¹⁷⁰

The goaf in the tailgate roadway was hanging up, allowing a pocket of goaf atmosphere to accumulate, and a variance to pressure enabled a short duration plug of goaf atmosphere to be ejected into the tailgate general body atmosphere.

3.72 As noted above, there is scant evidence in the LFI report of any analysis of what actually occurred, and only a single set of conclusions and recommendations was provided in respect of all of the three HPis.

3.73 The Form 5A was lodged with the Inspectorate on 14 August 2019.¹⁷¹ It sets out the same causes and recommendations as the LFI report, including that gas make was in excess of system capacity, and the same plan to increase goaf drainage capacity:¹⁷²

Preventative action	
25	Give details of any control measures/actions being considered and/or implemented to prevent recurrences
	Develop a plan to increase goaf drainage capacity for peak SGE areas of Grosvenor to reduce tailgate methane concentrations to meet business plan productivity targets.

Figure 14: Form 5A Preventative Action for HPI on 21 July 2019

¹⁶⁹ AAMC.001.009.0462, .0475.

¹⁷⁰ AAMC.001.009.0462, .0465.

¹⁷¹ AAMC.001.009.0356.

¹⁷² AAMC.001.009.0356, .0358.

HPI # 6 – 22 July 2019

- 3.74 At 12:37pm the following day, a large cavity above the canopies fell whilst the tailgate shields were being advanced (and the shearer parked at shield #135), flushing the goaf into the tailgate roadway. The inbye sensor exceeded 2.5%, peaking at 2.85%, whilst the outbye sensor peaked at 2.89%. Methane concentrations remained above 2.5% for 13 minutes.¹⁷³
- 3.75 The incident was reported to Inspector Brennan at 4:42pm, and ISHR Hill at 4:45pm the same day.¹⁷⁴
- 3.76 The ERZ controller who completed the HIRF assessed the actual consequence as ‘minor’, but the potential consequence as ‘high’, although someone crossed out ‘high’ and circled ‘moderate’.¹⁷⁵ In addition to the factual matters set out above, the ERZ controller also mentioned a ‘sudden decrease’ in barometric pressure. The risk matrix was completed as follows:¹⁷⁶

Refer to attached Grosvenor Risk Matrix for below:

Actual Consequence: Not Applicable for Hazards	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/fatality, Anglo HPI)	Major (numerous permanent disabilities/fatality, Anglo HPI)
Potential Consequence:	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/fatality, Anglo HPI)	Major (numerous permanent disabilities/fatality, Anglo HPI)
Has the hazard, defect or incident been effectively controlled on shift?				YES <input checked="" type="checkbox"/>	NO <input type="checkbox"/>

Figure 15: HIRF Risk Matrix for HPI on 22 July 2019

- 3.77 The notation ‘DNRME HPI’ was not made on the top of the form.¹⁷⁷
- 3.78 The LFI report that addressed HPIs # 4 and # 5 also addressed this incident. As has been noted already, a single set of findings and recommendations were made in relation to each of the HPIs.
- 3.79 The Form 5A was forwarded to the Inspectorate on 14 August 2019. Again, the findings and recommendations set out in it reflected the LFI report, including that gas make was in excess of system capacity and the same plan to increase goaf drainage.¹⁷⁸

Preventative action

25 Give details of any control measures/actions being considered and/or implemented to prevent recurrences

Develop a plan to increase goaf drainage capacity for peak SGE areas of Grosvenor to reduce tailgate methane concentrations to meet business plan productivity targets.

Figure 16: Form 5A Preventative Action for HPI on 22 July 2019

¹⁷³ AAMC.001.009.0462, .0465.

¹⁷⁴ AAMC.001.009.0769.

¹⁷⁵ AAMC.001.009.0462, .0476.

¹⁷⁶ AAMC.001.009.0462, .0475.

¹⁷⁷ AAMC.001.009.0462, .0476.

¹⁷⁸ AAMC.001.009.0360, .0362.

Findings for HPis # 4, # 5 and # 6

Finding 7

It is difficult for the Board to make findings about the causes of these three incidents. Each of them was ascribed to a pocket of gas in a tailgate cavity being ejected into the tailgate, however the Learning From Incidents (LFI) reports do not disclose the reasoning behind that conclusion.

Finding 8

It is possible that the flush of coal described in the hazard and incident report form (HIRF) regarding high potential incident (HPI) # 5 caused a partial obstruction to the longwall ventilation that resulted in goaf gases reporting to the tailgate.

Finding 9

In relation to HPis # 4 and # 6, the Board is unable to reach a conclusion about the immediate causes.

Finding 10

The same systemic failing referred to with respect to the previous HPis is nonetheless applicable to each of HPis # 4, # 5 and # 6, in that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.

HPI # 7 – 15 July 2019

- 3.80 The ventilation change that was discussed in the Grosvenor meeting on 15 July 2019 involved the reversal of the perimeter road, and had been planned for when the barometric pressure was high. In the event, it was moved forward and undertaken on the diurnal low.¹⁷⁹
- 3.81 The change included opening a regulator on the 3–4 cut-through at 1:35pm, which was done over the relatively short period of five minutes, resulting in the inbye sensor peaking at 2.5% at 1:49pm, and the outbye sensor at 2.71% at 2:08pm.¹⁸⁰ Prior to the incident, the workers had been withdrawn from the tailgate and perimeter road, and the shearer parked at shield #100.
- 3.82 The LFI report concluded that the incident had occurred because:¹⁸¹
- a. the change to the timing of the ventilation change meant that it was conducted on a barometric low rather than a high as originally planned;
 - b. the process documents for a permit to change ventilation did not include any reference to barometric pressure;

¹⁷⁹ AAMC.001.009.0509, .0512.

¹⁸⁰ AAMC.001.009.0509, .0515.

¹⁸¹ AAMC.001.009.0509, .0512.

- c. no workplace risk assessment or control process was undertaken in respect of the revised timing of the ventilation change; and
 - d. the ventilation officer had opened the regulator at a rate that did not allow any additional methane to dilute.
- 3.83 Recommendations arising out of the investigation included reviewing the process documents to include consideration of barometric pressure and liaising with ventilation officers concerning the rate at which regulators are opened during a barometric low.¹⁸² A further recommendation was to:¹⁸³

Develop a plan to increase goaf drainage capacity for peak SGE areas of Grosvenor to reduce tailgate methane concentrations to meet business plan productivity targets.

- 3.84 According to Enablon documents supplied by Grosvenor, the plan was completed by 12 December 2019, which was after extraction of the LW 103 panel had concluded.¹⁸⁴
- 3.85 The Form 5A was submitted on 14 August 2019. It contained the same causes and recommendations as set out in the LFI report, including the development of the same plan referred to in respect of earlier incidents:¹⁸⁵

Preventative action

25 Give details of any control measures/actions being considered and/or implemented to prevent recurrences

Review and update GRO-1316-FRM-Permit to Change Ventilation to include consideration to barometric pressure
Develop a plan to increase goaf drainage capacity for peak SGE areas of Grosvenor to reduce tailgate methane concentrations to meet business plan productivity targets. Liaise with VO Officer regarding the pace of which regulators are opened during a barometer low

Figure 17: Form 5A Preventative Action for HPI on 15 July 2019

Findings for HPI # 7

Finding 11

The immediate causes of this incident were the undertaking of a ventilation change on a barometric low, coupled with an error by a ventilation officer who opened a regulator too quickly.

Finding 12

Contributing factors were that:

- a. the carrying out of the ventilation change was rescheduled to a time that coincided with a barometric low, rather than a high, as originally planned;

¹⁸² Opening the regulator at the same time as a barometric low increases the size of the pressure drop.

¹⁸³ AAMC.001.009.0509, .0513.

¹⁸⁴ AGM.003.001.0151.

¹⁸⁵ AAMC.001.009.0348, .0350.

- b. no workplace risk assessment was conducted in respect of the rescheduling, and the issue of the barometric low was not addressed in the permit to change ventilation.

HPI # 8 – 23 July 2019

- 3.86 At 3:44pm, whilst the shearer was cutting uni-directionally from the tailgate towards the maingate, a roof fall occurred above shields #27–#45, which had already been double-chocked to manage a cavity that had developed during a six hour production pause for maintenance. Some of the rock fell onto the shearer, causing a partial obstruction to the flow of air along the longwall face and a subsequent methane spike in the tailgate roadway. The inbye sensor peaked at 2.54% at 3:44pm and the outbye sensor at 2.71% at 3:52pm. Methane concentrations remained above 2.5% for 21 minutes.¹⁸⁶
- 3.87 The incident was reported to Inspector Paul Brown at 5:07pm and to ISHR Hill at 5:12pm the same day.¹⁸⁷
- 3.88 The HIRF, marked ‘DNRM HPI’, is signed by the ERZ controller, who specified the actual consequence as ‘insignificant’ and the potential consequence as ‘minor’. The risk matrix was completed as follows:¹⁸⁸

Refer to attached Grosvenor Risk Matrix for below:					
Actual Consequence: Not Applicable for Hazards	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/ fatality, Anglo HPI)	Major (numerous permanent disabilities/ fatalities, Anglo HPI)
Potential Consequence:	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/ fatality, Anglo HPI)	Major (numerous permanent disabilities/ fatalities, Anglo HPI)
Has the hazard, defect or incident been effectively controlled on shift?				YES <input checked="" type="checkbox"/>	NO <input type="checkbox"/>

Figure 18: HIRF Risk Matrix for HPI on 23 July 2019

- 3.89 The LFI report concluded that:¹⁸⁹
 - a. The obstruction caused by the cavity material on the shearer displaced mine ventilation into the goaf atmosphere enabling a flushing event where CH4 entered the tailgate roadway general body to a peak of 2.71%;
 - b. The cavity had developed over a short duration during the planned maintenance period and shears thereafter;
 - c. Face mapping conducted at 9am on the same day did not identify the formation of a cavity in the region; and
 - d. The longwall was mining through Domain A – a region of Grosvenor susceptible to a higher risk of roof integrity issues.

¹⁸⁶ AAMC.001.009.0444, .0446.

¹⁸⁷ AAMC.001.009.0273.

¹⁸⁸ AAMC.001.009.0444, .0454.

¹⁸⁹ AAMC.001.009.0444, .0447.

- 3.90 Relevant event factors included that the mining domain was susceptible to delamination, but also those identified with respect to earlier events, namely:¹⁹⁰
- a. *Gas make (SGE) greater than expected in excess of system capacity; and*
 - b. *Less than adequate methane recovery / dilution.*
- 3.91 The Control Analysis concluded that the gas drainage system had failed, because:¹⁹¹
- a. *Design capacity cannot sustain current production rate; and*
 - b. *Background CH₄ levels higher than as low as reasonably achievable.*
- 3.92 The action to prevent reoccurrence was, once again, to:
- Develop a plan to increase goaf drainage capacity for peak SGE areas of Grosvenor to reduce tailgate methane concentrations to meet business plan productivity targets.*
- 3.93 The Test for Effectiveness to ensure that the above action had worked as intended was apparently completed on 26 November 2019.¹⁹²
- 3.94 The Form 5A was lodged on 14 August 2019.¹⁹³ Once again, the mine noted in it that gas make was in excess of system capacity and proposed the same plan to increase goaf drainage.¹⁹⁴

Findings for HPI # 8

Finding 13

The immediate cause of the incident was a fall of strata from a cavity above the longwall that partially obstructed ventilation on the longwall.

Finding 14

The systemic cause was that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.

HPIs # 9 & # 10 – 24 July 2019

- 3.95 These two incidents occurred within the space of about 90 minutes. At about 12:15pm, whilst the shearer was parked at shield #128, the last four tailgate shields were advanced in circumstances where a cavity had formed above shields #145–#149, and there was a goaf overrun beside the last shield. This caused a flushing of the goaf into the tailgate roadway. The inbye sensor peaked at 3.39% at 12:17pm, and the outbye sensor at 3.1% at 12:24pm.¹⁹⁵

¹⁹⁰ AAMC.001.009.0444, .0447.

¹⁹¹ AAMC.001.009.0444, .0451.

¹⁹² AGM.003.001.0209.

¹⁹³ AAMC.001.009.0372.

¹⁹⁴ AAMC.001.009.0372, .0374.

¹⁹⁵ AAMC.001.009.0478, .0481.

Production resumed at 1:13pm, however a similar incident occurred at 1:54pm, when the inbye sensor tripped at 2.5%, subsequently peaking at 2.71%.

- 3.96 Both incidents were reported to Inspector Geoff Nugent at 3:18pm and ISHR Hill at 3:49pm the same day.¹⁹⁶
- 3.97 The ERZ controller who completed and signed each of the two HIRFs, assessed the actual consequence for each as 'insignificant' and the potential consequence as 'minor', although someone circled and then scratched out 'moderate', regarding the latter. It is of some significance that in a section headed 'Has the defect or incident been effectively controlled on shift?', the 'No' box was ticked, and someone wrote 'incidents keep occurring' by way of explanation.
- 3.98 The risk matrix was completed as follows:¹⁹⁷

Refer to attached Grosvenor Risk Matrix for below:					
Actual Consequence: Not Applicable for Hazards	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1- 1.0% annual revenue)	High (permanent disability/ fatality, Anglo HPI)	Major (numerous permanent disabilities/fatalities, Anglo HPI)
Potential Consequence:	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1- 1.0% annual revenue)	High (permanent disability/ fatality, Anglo HPI)	Major (numerous permanent disabilities/fatalities, Anglo HPI)
Has the hazard, defect or incident been effectively controlled on shift?				YES <input type="checkbox"/>	NO <input checked="" type="checkbox"/>
If not, why not? <i>incidents keep occurring.</i>					

Figure 19: HIRF Risk Matrix for HPIs on 24 July 2019

- 3.99 The notation 'DNRM HPI' was made on the top of the form.¹⁹⁸
- 3.100 The comment 'incidents keep occurring' was written in the same section for the second of the two incidents.¹⁹⁹
- 3.101 The LFI report recorded that the cause of the incident was:²⁰⁰

Cavity formation in the Tailgate above 148 and 149 shield resulted in rock/roof material falling into the ventilation circuit of the Longwall resulting in a goaf flushing event.
- 3.102 The LFI report, however, went on to state that:

The outcome of the strata delamination event was amplified due the [sic] Gas make (SGE) [being] greater than expected [and] in excess of system capacity and less than adequate methane recovery/dilution.
- 3.103 The Control Analysis led to a conclusion that the gas drainage system had again failed because 'design capacity cannot sustain current production rate'.

¹⁹⁶ AAMC.001.009.0275; AAMC.001.009.0277.

¹⁹⁷ AAMC.001.009.0478, .0488.

¹⁹⁸ AAMC.001.009.0478, .0488.

¹⁹⁹ AAMC.001.009.0478, .0488; .0490.

²⁰⁰ AAMC.001.009.0478, .0481.

A further failure was of operational horizon control because operators were changing the pitch/grade too aggressively, thereby compromising the integrity of the roof.²⁰¹

3.104 Consistently with earlier reports, the Why Tree Analysis resulted in a finding that the:²⁰²

Ventilation and Gas Management System [was] unable to accommodate sudden spikes in general body concentration...[and was] designed for Specific Gas Emissions (SGE) lower than current conditions.

3.105 The preventative actions and recommendations again included:²⁰³

Develop a plan to increase goaf drainage capacity for peak SGE areas of Grosvenor to reduce tailgate methane concentrations to meet business plan productivity targets.

3.106 The Test for Effectiveness section specifies a particular Enablon task that, according to other documents supplied, was completed on 26 November 2019.²⁰⁴

3.107 The Form 5As for each incident were forwarded to the Inspectorate on 14 August 2019. Both forms set out the causes and recommendations contained in the LFI report, repeating the earlier statements about the inadequacy of the gas drainage system capacity and the development of the same plan.²⁰⁵

Preventative action

25 Give details of any control measures/actions being considered and/or implemented to prevent recurrences

Develop a plan to increase goaf drainage capacity for peak SGE areas of Grosvenor to reduce tailgate methane concentrations to meet business plan productivity targets. Pitch alarms set to Citect, add the requirement for acknowledgement and time stamp when accepted

Figure 20: Form 5A Preventative Action for HPI on 24 July 2019

Findings for HPIs # 9 and # 10

Finding 15

The immediate cause of both of these incidents was a ventilation obstruction as a result of material falling from a cavity above the last four tailgate shields.

Finding 16

The systemic cause was that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.

²⁰¹ AAMC.001.009.0478, .0486.

²⁰² AAMC.001.009.0478, .0487.

²⁰³ AAMC.001.009.0478, .0482.

²⁰⁴ AGM.003.001.0300.

²⁰⁵ AAMC.001.009.0364, .0366; AAMC.001.009.0368, .0370.

Inspection by Inspector Brown on 6 August 2019

- 3.108 On 6 August 2019, Inspector Brown visited Grosvenor to participate in the ‘Safety Reset’²⁰⁶ meeting. After that meeting, Inspector Brown met with staff from the Grosvenor Technical Services department to receive an update on gas drainage activities as part of follow-up concerning the methane exceedances.
- 3.109 The Mine Record Entry (MRE) notes that Inspector Brown was satisfied that ‘plans [were] progressing to improving the gas drainage system in a staged and controlled manner’ and that he also discussed the ‘fine balance between reducing or eliminating methane exceedances and not creating another hazard involving spontaneous combustion’.²⁰⁷

HPI # 11 – 17 August 2019

- 3.110 Production had resumed after a maintenance break of one hour’s duration, with the shearer cutting towards the maingate. At 3:28pm, when the shearer was between shields #30 and #51,²⁰⁸ the inbye sensor reached 2.5%, peaking a minute later at 2.79%. The tailgate dogleg sensor reached a peak of 2.43%. Although the source of the methane was not immediately able to be identified, subsequent enquiries with a ventilation crew working nearby revealed that they had heard a goaf fall at the same time.²⁰⁹
- 3.111 The incident was reported to Inspector Laurence Crisp at 4:55pm and to ISHR Hill at 5:05pm that day.²¹⁰
- 3.112 The ERZ controller who completed the HIRF, assessed the actual and potential consequences as both ‘minor’, although someone had circled ‘high’ before that was crossed out. Someone also selected ‘No’ in response to the question, ‘Has the hazard, defect or incident been effectively controlled on shift?’, but that was also crossed out. The risk matrix was completed as follows:²¹¹

Refer to attached Grosvenor Risk Matrix for below:

Actual Consequence: Not Applicable for Hazards	Insignificant (first aid case, damage +0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1- 1.0% annual revenue)	High (permanent disability, fatality, compensation)	Major (serious permanent disability/fatality, Anglo HP)
Potential Consequence:	Insignificant (first aid case, damage +0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1- 1.0% annual revenue)	High (permanent disability/ fatality, Anglo/HP)	Major (serious permanent disability/fatality, Anglo HP)
Has the hazard, defect or incident been effectively controlled on shift?				YES <input type="checkbox"/>	NO <input checked="" type="checkbox"/>

Figure 21: HIRF Risk Matrix for HPI on 17 August 2019

²⁰⁶ Part of action taken by the Minister to ‘reset’ safety in Queensland mines after six deaths occurred in the 12 months to July 2019.

²⁰⁷ RSH.002.141.0001.

²⁰⁸ This is the location specified in the HIRF and the LFI description: AAMC.001.009.0517, .0520; 0526, but in the chronology annexed to the LFI report shield #6 is mentioned.

²⁰⁹ AAMC.001.009.0517, .0520.

²¹⁰ AAMC.001.009.0279.

²¹¹ AAMC.001.009.0517, .0526.

3.113 The notation 'DNRM HPI' was not made on the top of the form.²¹²

3.114 The LFI report, dated 26 August 2019, concluded that the incident occurred because:²¹³

- a. *A [sic] the time of the incident the Barometer was at the bottom of the cycle and flat lined, with the gas fringe close to the shields with slight changes having larger effects on the TG goaf stream;*
- b. *[The] large sudden emission of gas out the of the [sic] goaf and loud noise heard from 15ct seal site indicates goaf fall displacing gas into TG Roadway; and*
- c. *The displacement of gas was substantial enough to overcome the gas drainage system and to trip power to the face when gas levels exceeded 2.5% in the tailgate return.*

3.115 The Control Analysis concluded that, amongst other things, the gas drainage system had failed because:²¹⁴

- a. *[the] [d]esign capacity could not sustain the current production rate; and*
- b. *[m]ethane [had] reported to [the] general body atmosphere... from the adjacent seam or strata.*

3.116 The Preventative Actions and Recommendations were:²¹⁵

- a. *Identify areas of high-risk roof collapse and implement action plan;*
- b. *Install additional goaf drainage capacity to reduce the likelihood of goaf falls impacting the tailgate gas levels...;*
- c. *Purchase additional Gas Monitoring Skids;*
- d. *VPS upgrade including 6th vac pumps;*
- e. *Purchase blower skids to >5000L capacity with flaring; and*
- f. *Additional reticulation lines if required by modelling to accommodate additional gas drainage capacity.*

²¹² AAMC.001.009.0517, .0526.

²¹³ AAMC.001.009.0517, .0520.

²¹⁴ AAMC.001.009.0517, .0524.

²¹⁵ AAMC.001.009.0517, .0521. 'VPS' refers to the gas vacuum plant system, or gas drainage plant system. The gas drainage plant is a fixed centralised gas extraction unit usually consisting of a number of liquid ring pumps. Individual goaf wells are connected to the gas drainage plant via a gas reticulation pipe network.

3.117 A review of the various Enablon task numbers assigned to the specified preventative actions reveals the existence of an Action Plan, which appears to have been brought into existence at about the same time as this incident, and which contained multiple items with respect to goaf drainage in both LW 103 and LW 104. Those items included:²¹⁶

- a. Contingency not in place for additional gas drainage resulting in a potential for elevated gas emissions leading to delays in mining. This refers to the use of decommissioned goaf holes as well as local compressed air venturi ejectors;
- b. Identifying individual zones in LW 103 and LW 104 for additional gas drainage;
- c. Developing a horizontal goaf hole contingency plan if the goaf drainage strategy is unsuccessful. Two goaf laterals were to be drilled into the P seam in LW 104;
- d. Investigating under cross block drilling to relief zones of floor blowers;
- e. Investigating a strategy for additional goaf drilling capacity. This involved using three Lucas Rigs and one Mitchell Rig;²¹⁷
- f. Decreasing ventilation across the face;
- g. Expand capacity of gas drainage infrastructure;
- h. In-fill wells to be used in high gas areas. This refers to a reduction in spacing of goaf well holes to 25 metres. It is said, however, that whilst those holes are planned, they will only be drilled if there is high gas in the tailgate due to goaf emissions. In sections where the risk is lower, the interval was to remain at 50 metres;
- i. Setting up potential offsets for maingate drainage. Drill pads were planned at 150 metre spacing, subject to surface infrastructure and the Isaac River;
- j. Ensuring the installation of butcher's flaps on the chocks at start-up;
- k. Investigating how stress fractures affect goaf holes;
- l. VPS upgrade, including sixth vacuum pump;
- m. Purchasing blower skids to which 'exceeded 5000L' (presumably litres/second) capacity with flaring;
- n. Adding reticulation lines if required by modelling to accommodate additional gas drainage capacity; and
- o. Purchasing additional gas monitoring skids.

²¹⁶ AGM.003.001.0342.

²¹⁷ Lucas Drilling Pty Limited and Mitchell Drilling International Pty Ltd are drilling contractors.

- 3.118 These tasks, with the exception of the last four items above, are recorded on the Action Plan as having been completed by mid-November 2019.
- 3.119 The Form 5A was sent to the Inspectorate on 16 September 2019.²¹⁸ The cause of the incident was said to be a large goaf fall as well as gas make being in excess of system capacity. The preventative actions specified were:²¹⁹

Preventative action

25 Give details of any control measures/actions being considered and/or implemented to prevent recurrences

Identify areas of high-risk roof collapse and implement action plan Install additional goaf drainage capacity to reduce the likelihood of goaf falls impacting the tailgate gas levels. (This action already exists in the system from action plan AP.00746137 LW103 LW104 Goaf Drainage) Purchase additional Gas Monitoring Skids VPS upgrade including 6th vac pumps Purchase blower skids to >5000L capacity with flaring Additional reticulation lines if required by modelling to accommodate additional gas drainage capacity

Figure 22: Form 5A Preventative Action for HPI on 17 August 2019

Findings for HPI # 11

Finding 17

The immediate cause of the incident was a goaf fall which occurred on a barometric low. This forced goaf gases onto the longwall and into the tailgate, overwhelming the mine's ventilation system.

Finding 18

The systemic cause was that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.

Inspection by Inspectors Brownett and Nugent on 15 October 2019

- 3.120 On 15 October 2019, Inspectors Malcolm Brownett and Geoff Nugent attended Grosvenor.²²⁰ They met with Mr Mohr, Mr Hayden Hearne (Ventilation and Gas Superintendent), and Mr Neal Bryan (Undermanager). At that meeting, Mr Mohr provided an overview of the mine's current operational status. He advised that the methane content of panels 101–103 was 2–3 m³/t, whereas panels beyond 104 had methane content which exceeded 6 m³/t and was as high as 15 m³/t in the deepest part of the mine.²²¹
- 3.121 According to the MRE, Mr Mohr went on to advise that gas emission hazards were expected in LW 104 because 'gas management treatment had not been developed and implemented at the time of development'. He advised that '[r]isk-based controls would be pro-actively applied for effective gas management...to ensure an acceptable level of risk'.²²²

²¹⁸ AAMC.001.009.0376.

²¹⁹ AAMC.001.009.0376, .0378.

²²⁰ RSH.002.144.0001.

²²¹ RSH.002.144.0001.

²²² RSH.002.144.0001.

HPI # 12 – 19 October 2019

3.122 In the course of the day, the logic control on the shearer that stopped production if the shearer sensor reached 1.9% at shield #115 had caused several stoppages, including between 3:43pm and 4:10pm. At 4:25pm, as the shearer reached shield #115, the methane concentration was 1.75%, and the shearer continued towards the tailgate. At 4:30pm, when the shearer was at shield #140, the inbye sensor reached 2.2%, stopping the shearer.

The sensor reading continued to rise, however, peaking at 2.67% at 4:32pm. Methane concentrations at the outbye sensor peaked at 2.61%, and remained above 2.5% for about three minutes. The incident coincided with the daily barometric low of 984 hPa, which was the lowest recorded during the previous 13 weeks.²²³

3.123 The incident was reported to Inspector Callinan at 6:11pm and to ISHR Woods at 6:17pm on the same day.²²⁴

3.124 The ERZ controller who completed the HIRF identified the actual and potential consequences of the incident as being 'insignificant'. Although not referred to in the LFI report, the HIRF refers to the goaf hanging up in the tailgate.²²⁵

3.125 The risk matrix was completed as follows:²²⁶

Refer to attached Grosvenor Risk Matrix for below: *cutting @ 5:55pm*

Actual Consequence: Not Applicable for Hazards	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/fatality, Anglo HPI)	Major (numerous permanent disabilities/fatalities, Anglo HPI)
Potential Consequence:	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/fatality, Anglo HPI)	Major (numerous permanent disabilities/fatalities, Anglo HPI)
Has the hazard, defect or incident been effectively controlled on shift?				YES <input checked="" type="checkbox"/>	NO <input type="checkbox"/>

Figure 23: HIRF Risk Matrix for HPI on 19 October 2019

3.126 The notation 'DNRM HPI' was not made on the top of the form.²²⁷

3.127 The LFI report, which called the incident 'a non-prescribed legislative HPI',²²⁸ attributed the incident to the following causes:²²⁹

- a. *The barometer at the time of the methane exceedance was at the lowest point for the day (984hPa), this period was the lowest barometric pressure for the previous 13 weeks;*

²²³ AAMC.001.009.0534, .0537; .0540.

²²⁴ AAMC.001.009.0281.

²²⁵ AAMC.001.009.0534, .0543.

²²⁶ AAMC.001.009.0534, .0543.

²²⁷ AAMC.001.009.0534, .0543.

²²⁸ AAMC.001.009.0534, .0537.

²²⁹ AAMC.001.009.0534, .0537.

- b. *The shearer position on the face (#140) contributed to additional ventilation scouring the goaf into the mine general body atmosphere combined with a low barometer.*
- 3.128 The LFI report also identified that the duration of the stoppage between 3:43pm and 4:10pm was sufficient to dilute methane so as to permit the shearer to pass shield #115, but insufficient to reduce the gas levels in the tailgate roadway.
- 3.129 Organisational causes were:²³⁰
- a. *Gas make (SGE) greater than expected in excess of system capacity; and*
 - b. *Controls in place not sufficient to react fast enough with change in barometric pressure.*
- 3.130 The Control Analysis concluded that the gas drainage system had failed because the design capacity could not sustain the current production rate.²³¹
- 3.131 The Preventative Actions and Recommendations were:²³²
- a. *Implement a reduction of the ceiling setting [in terms of shearer logic] from 1.9 to 1.6, until review of barometric pressure influence on T/G gas make; and*
 - b. *Review relationship between the rate of change during the main[gate] to tail[gate] cut run and develop a dynamic set point for shield 115 stop.*
- 3.132 The tasks were completed by 12 and 18 November 2019, respectively.²³³
- 3.133 The Test for Effectiveness was completed by 16 January 2020.²³⁴
- 3.134 The Form 5A was forwarded to the Inspectorate on 12 November 2019. It identified the causes of the incident as being:²³⁵
- a. *Gas make (SGE) greater than expected in excess of system capacity;*
 - b. *Controls in place were not sufficient to react fast enough with change in barometric pressure; and*
 - c. *Shearer control system did not react fast enough or have suitable buffers in place to prevent the unwanted event from occurring.*
- 3.135 The proposed preventative action was to implement a reduction of the gas ceiling setting on the shearer sensor from 1.9% to 1.6%.²³⁶

²³⁰ AAMC.001.009.0534, .0537.

²³¹ AAMC.001.009.0534, .0541.

²³² AAMC.001.009.0534, .0538.

²³³ AGM.003.001.0401, AGM.003.001.0403.

²³⁴ AGM.003.001.0406.

²³⁵ AAMC.001.009.0380.

²³⁶ AAMC.001.009.0380, .0382.

Preventative action

25 Give details of any control measures/actions being considered and/or implemented to prevent recurrences

Implement a reduction of the ceiling setting from 1.9 to 1.6, until review of barometric pressure influence on T/G gas make
Review relationship between the rate of change during the main to tail cut run and develop a dynamic set point for 115 stop.

Figure 24: Form 5A Preventative Action for HPI on 19 October 2019

Findings for HPI # 12

Finding 19

The immediate causes of the incident were the barometric low, coupled with the paused position of the shearer at shield #140, which partially obstructed and diverted longwall ventilation so as to ‘scour’ the goaf. That resulted in goaf gases reporting to the tailgate.

Finding 20

The systemic cause was that the gas emissions being generated by the mine’s rate of production were in excess of the capacity of the mine’s gas drainage system.

HPI # 13 – 7 November 2019

3.136 Whilst the shearer was at shield #9, cutting towards the maingate, a floor blower became active at shields #22 and #55 after mining past the area and advancing the face. At 3:04am, the tailgate drive sensors registered above 2.0%, tripping power to the face, and the outbye sensor in the tailgate roadway peaked at 2.73% four minutes later at 3:08am.²³⁷

3.137 The incident was reported to Inspector Nugent at 6:46am and ISHR Woods at 6:48am on the day of the incident.²³⁸

3.138 The ERZ controller who completed the HIRF described the actual and potential consequences of the incident as ‘minor’. The risk matrix was completed as follows:²³⁹

Refer to attached Grosvenor Risk Matrix for below:					
Actual Consequence: Not Applicable for Hazards	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (first aid case, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/fatality, Anglo HPI)	Major (serious permanent disability/fatality, Anglo HPI)
Potential Consequence:	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (first aid case, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/fatality, Anglo HPI)	Major (serious permanent disability/fatality, Anglo HPI)
Has the hazard, defect or incident been effectively controlled on shift?				YES <input checked="" type="checkbox"/>	NO <input type="checkbox"/>

Figure 25: HIRF Risk Matrix for HPI on 7 November 2019

3.139 The notation ‘DNRM HPI’ was made on the top of the form.²⁴⁰

²³⁷ AAMC.001.009.0552, .0555.

²³⁸ AAMC.001.009.0283.

²³⁹ AAMC.001.009.0552, .0563.

²⁴⁰ AAMC.001.009.0552, .0563.

- 3.140 The LFI report addressed the issue of floor emissions, concluding that modelling showed that the greatest depth below the floor that a seam might emit gas is between 29 and 40 metres. Whilst geological structures such as faults can contribute to floor emissions, there was no such structure in the area where the incident occurred. The report observed that underlying seams up to 40 metres below the Goonyella Middle (GM) seam should be considered for the potential to emit gas into the longwall working section.²⁴¹
- 3.141 Other evidence received by the Board suggests that the Goonyella Middle Lower seam is in this area situated much closer to the GM seam than 40 metres. The face chainage at the time of the incident was a little under 250 metres. According to the mine's own assessment of the seam characteristics, the interburden thickness at that point in the longwall panel was in the order of nine metres.²⁴²
- 3.142 The investigation concluded that:
- a. *The floor blowers located at #22 and #55 roof support released approximately 1,504m³ [of methane] after two hours;*
 - b. *Mining past the area [had] stimulated the release of gas...from a reservoir beneath the target mining seam; and*
 - c. *The release...was substantial enough...to exceed 2.5% in the tailgate return.*
- 3.143 The LFI report also found that pre-drainage of the lower seams was less than adequate, and that gas make was greater than expected and in excess of system capacity.²⁴³
- 3.144 The Control Analysis concluded that gas pre-drainage had failed. According to that analysis, pre-drainage is not a critical control.²⁴⁴
- 3.145 The Form 5A was forwarded to the Inspectorate on 6 December 2019.²⁴⁵ It identified the causes of the incident as less than adequate pre-drainage of the lower seams, gas make in excess of system capacity, and 'less than adequate pre-drainage/recovery/dilution'. The proposed preventative action was specified as:²⁴⁶

Preventative action

25 Give details of any control measures/actions being considered and/or implemented to prevent recurrences

Trial of GML holes underway in LW105 to target immediate Gas Reservoir in floor horizon. Conduct a detailed investigation to try and identify the source of the methane

Figure 26: Form 5A Preventative Action for HPI on 7 November 2019

²⁴¹ AAMC.001.009.0552, .0556.

²⁴² AGM.002.001.0019, .0030.

²⁴³ AAMC.001.009.0552, .0558.

²⁴⁴ AAMC.001.009.0552, .0557; .0561.

²⁴⁵ AAMC.001.009.0384.

²⁴⁶ AAMC.001.009.0384, .0386.

Findings for HPI # 13

Finding 21

The immediate cause of the incident was the activation of two floor blowers immediately behind the longwall shields.

Finding 22

Systemic failings that caused the incident were:

- a. inadequate pre-drainage of the lower seams;
- b. that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.

General findings for LW 103 HPIs

Finding 23

With the exception of HPIs # 4, # 5 and # 6, the LFI process resulted in a robust assessment of each incident, and a frank acknowledgement of the contributing factors. In respect of HPIs # 4, # 5 and # 6 the investigations were deficient, and the LFI reports used the same expressions to describe what had happened in each case without any attempt to identify the evidence for the conclusions reached. Given the state of the evidence, the Board is unable to reach any conclusions about those events, other than that, as the mine found, the incidents were symptomatic of inadequate gas drainage.

Finding 24

The Board accepts the mine's findings from its investigations that:

- a. its gas drainage system had repeatedly failed because its design capacity could not sustain the current production rate; and
- b. gas make was greater than expected resulting in gas emissions in excess of the capacity of the goaf drainage system.

These systemic factors, which substantially overlap, were the underlying cause of the majority of the HPIs on longwall 103 (LW 103).

Finding 25

Despite investigation and reporting processes that were, for the most part, robust and frank, and which identified the foregoing shortcomings, Grosvenor failed to take timely and meaningful action to control the hazard posed by methane.

Finding 26

The Inspectorate sought to engage with the mine on the issue of gas management, and requested and received minutes of meetings of mine staff who, in July 2019, were attempting to deal with the problems on LW 103.²⁴⁷ There was no proposal in the minutes to moderate production, rather the minutes show that the purpose was to develop strategies 'to allow consistent longwall production in line with forecast'.²⁴⁸ The minutes further show that the following concrete steps were identified to alleviate pressure on the post-drainage system:

- a. drilling a mid-panel goaf hole at 1,522 metre chainage;
- b. bringing that and one other goaf hole online;
- c. reversing the ventilation in the perimeter road to lower methane levels entering the maingate; and
- d. the purchase and installation of four blower skids.

²⁴⁷ RSH.002.095.0001. As detailed earlier, the Inspectorate also had further engagement on 6 August 2019 and 15 October 2019.

²⁴⁸ RSH.002.138.0001, .0005.

However, none of these steps, with the exception of the ventilation change, would have an immediate impact. Further, the installation of the blower skids was not slated for completion until 15 September 2019. By 15 September there had been a further nine methane exceedance HPIs on LW 103.

Finding 27

In communications with the Inspectorate about the cause of the HPIs, on multiple occasions, the mine acknowledged that:

- a. *gas make [was] greater than expected [and] in excess of system capacity; and*
- b. *[there had been] less than adequate methane recovery/dilution.*

Similarly, the solution, stated repeatedly, was to:

Develop a plan to increase goaf drainage capacity for peak SGE areas of Grosvenor to reduce tailgate methane concentrations to meet business plan productivity targets.

The ‘solution’ consisted of developing a plan, which was inadequate to address the problem in the short-term. The mine’s management ought to have recognised this.

Finding 28

The proposed solution implicitly acknowledged that the mine was producing at a rate that was in excess of its goaf drainage capacity. Although Inspector Brennan made a suggestion on 2 July 2019 that the mine revert to uni-directional cutting, the rates of production associated with the HPIs ought to have been the subject of inquiry and investigation by the Inspectorate.

Finding 29

The Board reiterates the findings made in Part I of the Report that:

- a. a methane exceedance has the *potential* to result in an outcome with a level 4 or 5 consequence rating under the Anglo risk matrix;
- b. Anglo’s use of a classification system that included so-called ‘DNRM HPIs’ created a sub-class of HPI that was likely to diminish the perceived seriousness of such events.

Recommendations arising from LW 103 HPIs

Recommendations concerning the LW 103 HPIs will be made at the conclusion of the chapter dealing with the LW 104 HPIs.

Chapter 4 – LW 104 methane management

Introduction

- 4.1 The presence of methane in an underground coal mine is not only a function of working the mined seam. Methane gas from seams above and below the working seam has the potential to emit to the working seam. This was recognised in Grosvenor’s secondary extraction standard operating procedure (SOP) for longwall 104 (LW 104) which states that ‘most of the gas that needs to be managed during second workings comes from coal seams above and below the working seam’.²⁴⁹ As Dr Ray Williams explained, ‘gas can enter the goaf from the higher seams...by migration along bedding planes, into fractures bounding the caved/relaxed area above the extracted GM seam’.²⁵⁰
- 4.2 Part I of the Report made reference to the two types of gas drainage, namely:²⁵¹
- a. *pre-drainage systems, where some of the gas in coal seams is drained ahead of mining; and*
 - b. *post-drainage systems, where some of the gas that has been liberated by mining is captured before it is entrained in ventilation streams.*
- 4.3 It was also described in Part I that gas drainage systems, along with ventilation, form fundamental services critical to safe and cost-effective mining.²⁵² Given the gas management issues that dogged Grosvenor mine (Grosvenor) in LW 101 to LW 103, the need for effective gas drainage systems for the purpose of undertaking mining on LW 104 must have been acutely apparent to the mine’s management.
- 4.4 This chapter considers what pre-drainage was undertaken for the mining of LW 104, and what preparation had been made for post-drainage once mining commenced. The Goonyella Middle (GM) seam was adequately pre-drained. But, as it turns out, in the absence of other pre-drainage, methane management at LW 104 was wholly reliant on post-drainage and ventilation.
- 4.5 The chapter also considers the implications, for LW 104, of high gas emissions, its rate of production, absence of pre-drainage of surrounding seams, and the performance of its post-drainage.
- 4.6 It emerges that the emission capture rate of the post-drainage system was not sufficient to deal with the gas emissions from all sources at the rate of production pursued by the mine. In that environment, the mine was susceptible to methane exceedances.

²⁴⁹ AGM.002.001.1112, .1158: *GRO-10684-SOP-Second Workings*.

²⁵⁰ WRA.001.001.0001, .0007.

²⁵¹ Part I of the Report, Chapter 2 (Methane in coal mines).

²⁵² Part I of the Report, Chapter 2 (Methane in coal mines).

4.7 This analysis will provide context to consideration of the high potential incidents (HPIs) and the serious accident that occurred on LW 104.

The stratigraphy at LW 104

4.8 At LW 104, the GM seam was being mined at a depth of 390 metres. There are significant coal seams above and below the GM seam, including (in ascending order above the GM seam) the P, QA and QB, and Fairhill (FH) seams. The Goonyella Middle Lower (GML) seam is situated immediately below the GM seam.

4.9 The stratigraphy at LW 104 is depicted in the diagram below, from Dr Williams' report:²⁵³

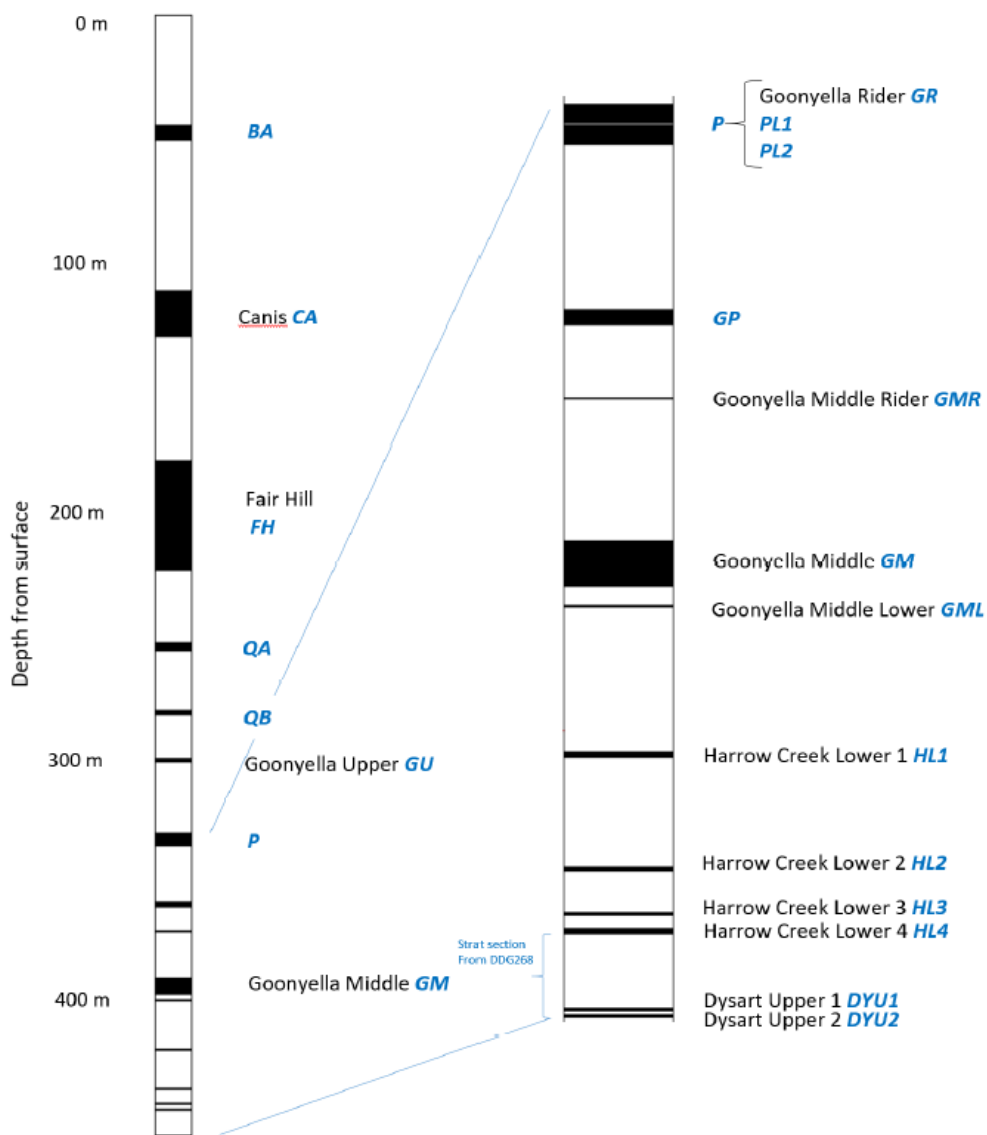


Figure 27: Stratigraphy at LW 104

²⁵³ WRA.001.001.0001, .0009.

Pre-drainage for LW 104

GM seam pre-drainage

- 4.10 A feature of the mining environment at Grosvenor is that there was partial pre-drainage of the P and GM seams by Arrow Energy (Arrow)²⁵⁴ for a number of years prior to mining. This was for Arrow's commercial purposes and without regard to the requirements of mining.²⁵⁵ The nature and extent of this commercial exploitation was reviewed by Dr Williams in his report. He described that:²⁵⁶

The company was extracting coal seam gas for utilisation and it took place over a period of 10~15 years ahead of mining. The surface to in-seam (SIS) wells employed were mostly of chevron design...with usually two SIS laterals intersecting a vertical production well. The chevron pattern results in variable lateral well spacing with resulting non uniform gas extraction.

...

The level and lack of uniform pre-drainage as required by coal mining necessitated supplementary underground in-seam (UIS) pre-drainage, gas extraction.

- 4.11 Supplementary pre-drainage of the GM seam was undertaken by Grosvenor from underground in-seam (UIS) boreholes drilled from 38 cut-through (c/t) maingate 103. They were online from August 2018 to November 2019 and provided drainage for development of LW 104, and subsequently for production.²⁵⁷ This effected a reduction in gas content to around 2 m³/t, which was the objective.²⁵⁸
- 4.12 The result was that a high level of pre-drainage of the GM seam had been achieved prior to mining LW 104.²⁵⁹

P seam pre-drainage by Arrow Energy

- 4.13 It is clear that the P seam was in close enough proximity to the GM seam to be a contributor to gas emissions at LW 104.
- 4.14 As for pre-drainage of the P seam by Arrow, Dr Williams reviewed gas content tests for borehole DDG 295, situated within the mined area of LW 104. He noted that a partial reduction of the virgin gas content of the P seam had been achieved:²⁶⁰

²⁵⁴ Arrow is a petroleum and gas producer.

²⁵⁵ TRA.500.020.0001, .0005, lines 37–44.

²⁵⁶ WRA.001.001.0001, .0010–.0011.

²⁵⁷ WRA.001.001.0001, .0014.

²⁵⁸ TRA.500.020.0001, .0007, lines 18–28.

²⁵⁹ WRA.001.001.0001, .0025.

²⁶⁰ WRA.001.001.0001, .0025. 'Qm' refers to the total measured gas content of coal, generally reported in m³/t.

The P seam tests (actually GR, PL1 and PL2 seams) showed partial predrainage achieved by the P seam Arrow wells (~28% of gas drained to Qm of 7.4 m³/t from virgin ~10.4 m³/t). This is in good agreement with modelled residuals from Arrow wells (~8 m³/t).

- 4.15 Grosvenor recognised that pre-drainage of the P seam by Arrow had not been uniform. Its goaf drainage risk assessment, conducted on 15 January 2020, noted that '[a] wide range of residual gas contents in the P seam have been measured around the face start line of LW 104'.²⁶¹ The following diagram was included by way of illustration of the varied residual gas content.²⁶²

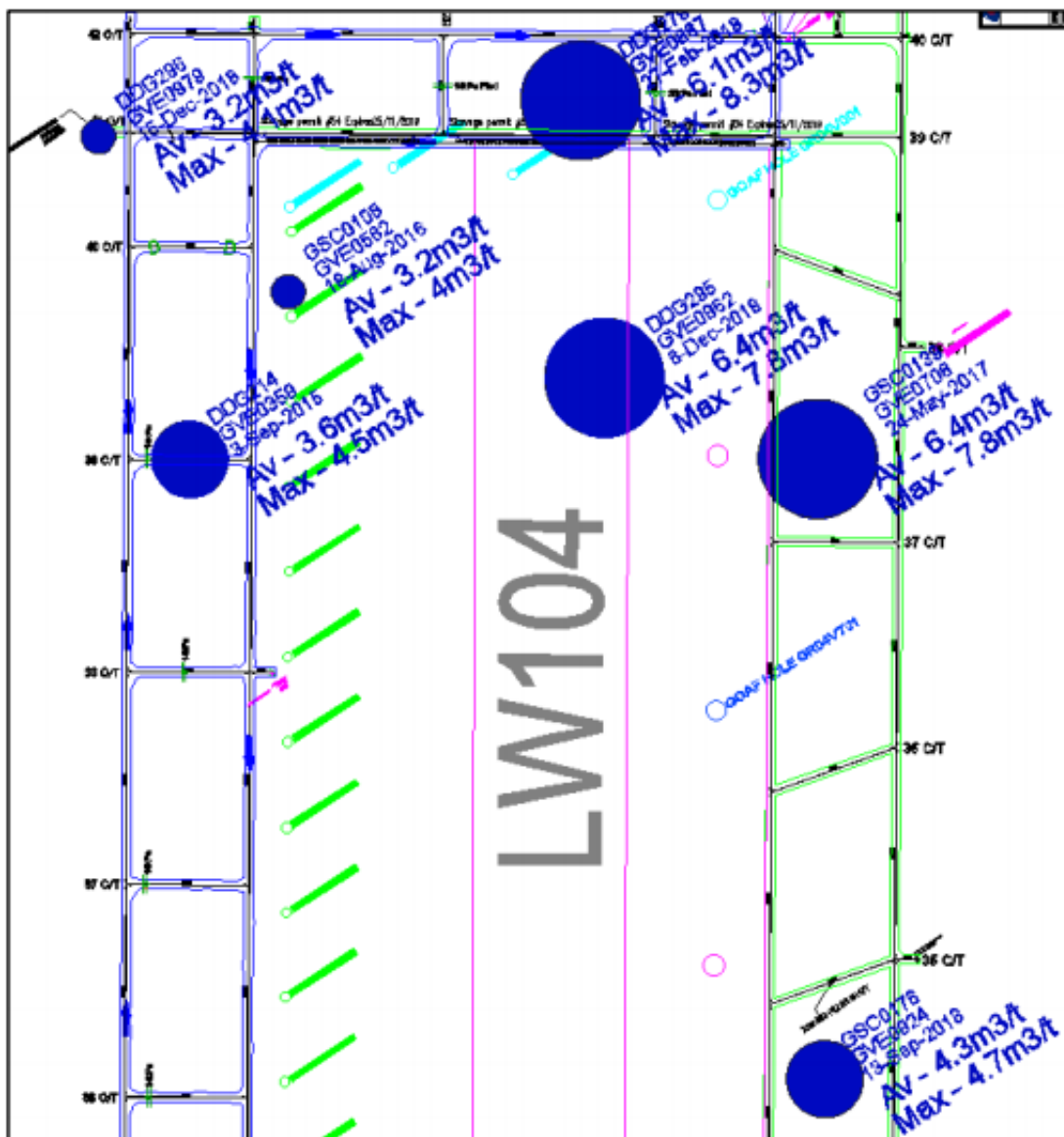


Figure 28: LW 104 inbye showing 'P' seam gas content by date.
Note older results show lower gas content.

²⁶¹ AGM.002.001.0937, .0994: GRO-10699-RA-LW104 Goaf Drainage.

²⁶² AGM.002.001.0937, .0994: GRO-10699-RA-LW104 Goaf Drainage.

Moreby report 2010

- 4.16 Prior to commencement of mining in 2016, Grosvenor had received a number of reports giving predictions of longwall methane emissions.
- 4.17 Mr Andrew Self prepared a report in 2020 which considered the utility of such predictions.²⁶³ He observed that '[p]rediction of gas make is notoriously difficult', and that '[g]as emission predictions early in a project are normally based on sparse data, limited by the number of gas samples taken from bore-holes prior to mine development'. Mr Self commented further that '[a]n accuracy tolerance of $\pm 50\%$ is not unusual in the author's experience at an early stage in the project'.²⁶⁴ He said that predictions are 'indicative at best without calibration data from actual, measured gas emission rates'.²⁶⁵
- 4.18 There are various models in existence to aid in the predictive exercise, but all are flawed.²⁶⁶ One such model is the Flügge model of gas emissions.²⁶⁷ It involves an attempt to predict, in diagrammatic form, the extent of gas emissions from seams above and below the working seam.
- 4.19 In his evidence, Dr Williams described the Flügge model as 'very, very coarse', noting that it did not take 'into account too much from the local geology'.²⁶⁸ He elaborated in his addendum report:²⁶⁹

The Flügge method of assessing longwall gas emission is one of a suite of European empirical methods developed in the 1950's to 1970's. It is based upon mining conditions and volumes very different from those experienced in Australia (refer description and critique in Qu, Balusu, Wilkins and Moreby 2019 – ACARP project report C25065). It defines the degree of emission from seams above and below the working seam using a geometry based on empirical conditions in German coal mines with adjustment for the intensity of gas drainage. It takes no account of gas desorption pressure or gas saturation.

...

All these models involve a high degree of uncertainty requiring calibration against actual mining conditions.

- 4.20 Dr Roy Moreby gave Grosvenor a predictive model of gas emissions in a report from 2010.²⁷⁰ He used the Flügge model for the exercise.

²⁶³ SAN.001.001.0001.

²⁶⁴ SAN.001.001.0001, .0011.

²⁶⁵ SAN.001.001.0001, .0012.

²⁶⁶ SAN.001.001.0001, .0012.

²⁶⁷ Flügge, G., *Die Anwendung der Trogtheorie auf den Raum der Zusatzaus-gasung* (1971) Glückauf-Forschungshefte volume 32: pages 122–129.

²⁶⁸ TRA.500.020.0001, .0053, lines 18–19.

²⁶⁹ WRA.001.002.0001, .0005–.0006.

²⁷⁰ RSH.002.401.0001.

The boundaries of that model are depicted between the red and black lines in Figure 29 below.²⁷¹ The model indicates minimal contribution of gas from the FH seam, giving rise to an issue to be discussed in a subsequent section. The model predicts a much more substantial contribution of gas from the P seam.

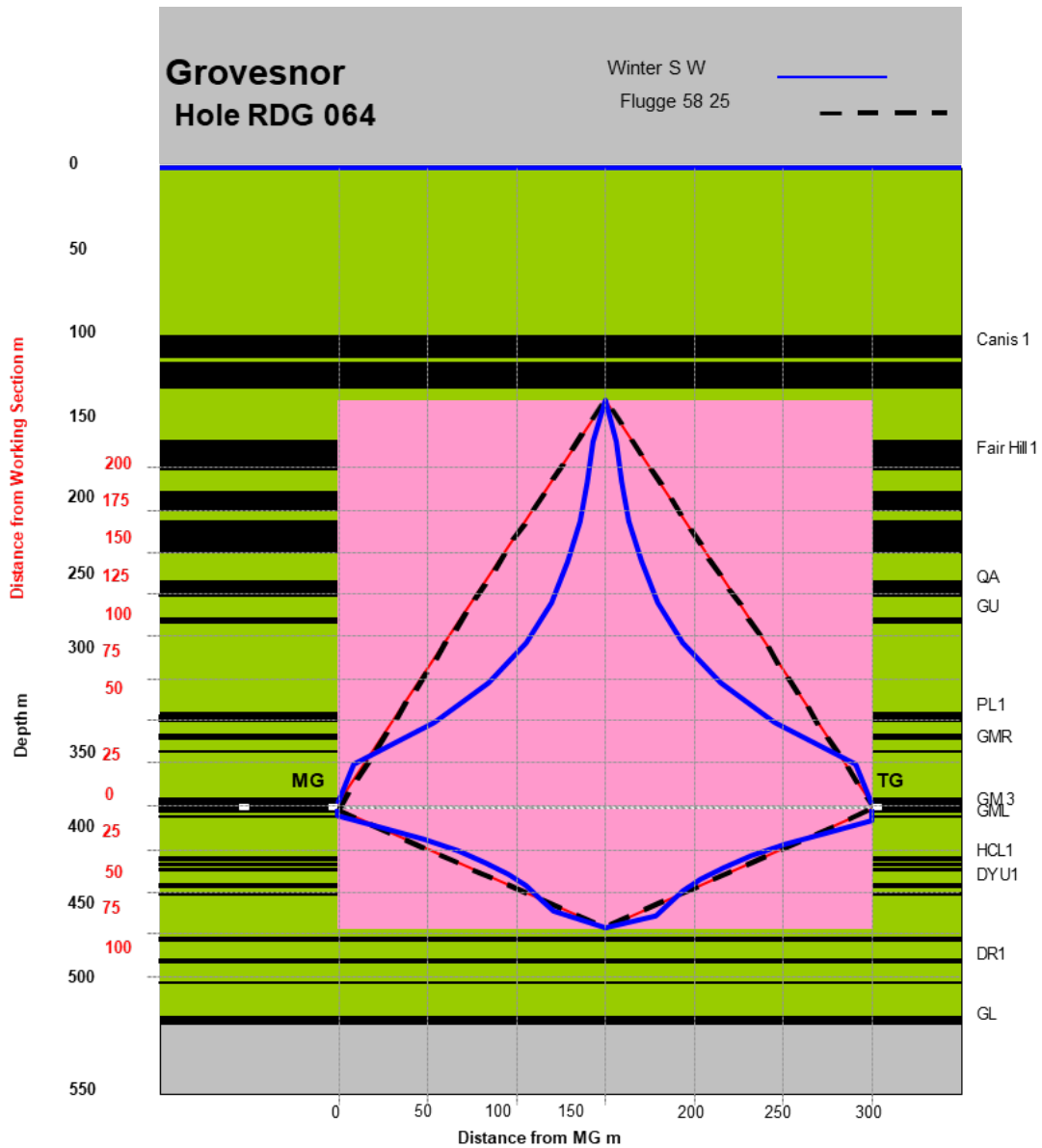


Figure 29: Flügge model of gas emissions.
In this Figure, the P seam is referred to as 'PL1'.

²⁷¹ RSH.002.401.0001, .0028.

- 4.21 In that report, Dr Moreby attempted to quantify the potential specific gas emission (SGE) rates with and without the P seam. He presented the following table, ascribing the P seam’s contribution to total SGE at around 43%:²⁷²

Table 3.3 Potential SGE Rates With and Without P Seam

	Total Potential Release m3/m2	P Seam Potential Release m3/m2	With P seam SGE m3/t	Without P seam SGE m3/t
Roof	74.5	36.5	12.8	6.6
Floor	9.3	0	1.6	1.6
Total	83.8		14.4	8.2

Figure 30: Dr Moreby – Potential SGE rates with and without the P seam

- 4.22 As will be seen later, actual SGE for LW 104 reached around 25 m³/t,²⁷³ indicating that the predicted SGE was underestimated. However, the model certainly identified that the P seam would be a significant contributor to overall gas emissions.
- 4.23 Dr Moreby commented on the expected results of the Arrow Energy pre-drainage and the consequent need for additional underground pre-drainage of the GM and P seams in ‘deeper inbye regimes’. At a depth of 390 metres, the inbye end of LW 104 qualifies as a deeper inbye regime. Dr Moreby said:²⁷⁴

...for the purposes of planning ventilation requirements it is understood that holes with lead times of 3 to 4 years will achieve a gas left target of 4 to 5m³/t in outbye areas of the GM and P seam...However, it is reported that lower permeability in deeper inbye regimes will significantly reduce pre drainage effectiveness and provision will have to be made for additional underground pre drainage and or reservoir stimulation.

- 4.24 A further recommendation was made concerning additional goaf gas capture, namely that:²⁷⁵

...[a]t longwall start up...[a]dditional goaf capture capacity could be provided by directional holes drilled into the P seam from the maingate or tailgate above the goaf.

²⁷² RSH.002.401.0001, .0030–.0031.

²⁷³ SAN.001.001.0001, .0014.

²⁷⁴ RSH.002.401.0001, .0025.

²⁷⁵ RSH.002.401.0001, .0011.

Geogas report 2011

- 4.25 Another predictive gas emission model was provided to Grosvenor by Geogas in 2011.²⁷⁶ It, too, contained predictions of SGE that were markedly lower than what transpired in practice. However, so far as pre-drainage was concerned, the report contained the following recommendations:²⁷⁷

Gas content at the time of mining has been calculated to be between 3 and 7 m³/t...in the P seam and from 2 to 10 m³/t in the GM seam...indicating [sic] the need to implement a predrainage program for outburst mitigation ahead of mining in the GM seam, in addition to the current Arrow predrainage program.

...

Consider additional predrainage of the P seam in some areas and to a lesser extent the QB and GU seams.

Proportion of gas emissions from P seam

- 4.26 In his 2020 report, Dr Williams reviewed gas content testing from boreholes situated within mined areas of LW 101 and LW 103.²⁷⁸ This was to assess the degree to which it could be determined that gas had emitted from seams both above and below the GM seam. From that calculation of the degree of emission, he estimated the proportion by which each of those seams could be expected to contribute gas emissions to LW 104.
- 4.27 He estimated the proportion of gas emitted by the P seam at 27% of overall emissions, less than Dr Moreby's original estimate of 43%, but still significant.²⁷⁹ Accordingly, he considered that 'P seam drainage should be a high priority consideration',²⁸⁰ notwithstanding that it was 'relatively difficult' logistically.²⁸¹

Attempted pre-drainage of the P seam for LW 104

- 4.28 In his evidence, Dr Williams referred to the preferable method of pre-drainage of the P seam, by surface to in-seam (SIS) holes drilled long in advance of production. He said:²⁸²

Pre-drainage takes time. Of all the targets outside the Goonyella Middle seam, it's the P seam that's got the lowest density and a reasonable thickness, so it's the only seam there that's really a pre-drainage target. But it is banded, it is a difficult seam to drill in. So, you know, I think they could do the job okay longwalls ahead.

²⁷⁶ RSH.002.394.0001.

²⁷⁷ RSH.002.394.0001, .0016; .0078.

²⁷⁸ WRA.001.001.0001, .0030; .0047–.0048.

²⁷⁹ WRA.001.001.0001, .0049.

²⁸⁰ WRA.001.002.0001, .0004.

²⁸¹ WRA.001.001.0001, .0008.

²⁸² TRA.500.020.0001, .0052, lines 6–19.

I mean, you could drill surface to in-seam holes - not 310mm diameter, but like what Arrow did, about 96mm diameter - line the holes, put them to a vertical riser for production of gas, and do that years in advance and get it down that way. So that would work. Otherwise, you have to do it by underground in-seam drilling, and, you know, there are some problems potentially with that.

- 4.29 It seems that pre-drainage of the P seam by UIS drilling was attempted by the mine. The secondary extraction risk assessment for LW 104, conducted in December 2019, made reference to an earlier attempt to undertake P seam pre-drainage, which was unsuccessful, and apparently abandoned. It stated:²⁸³

Pre-drainage of the P-Seam over LW104 has been conducted from SIS Boreholes drilled from Arrow. UIS drilling of the P-Seam was attempted from MG104 22c/t that resulted in 837m of drill string being stuck in the P-Seam inbye of MG104 22c/t.

- 4.30 There is no evidence of any further plan or attempt to pre-drain the P seam for the purpose of LW 104.
- 4.31 The mine was aware that a failure to conduct pre-drainage of the P seam beyond that conducted by Arrow would result in increased gas hazards at LW 104. Reference was made in the previous chapter to the attendance at the mine by Inspectors Brownett and Nugent on 15 October 2019. The Mine Record Entry (MRE) records that they met with several senior officers of the mine and were given a briefing about current operational matters. The inspectors were told that:²⁸⁴

Gas emission hazards are expected in LW104 due to gas management treatment had not been developed and implemented at time of development. Risked [sic] based controls will be pro-actively applied for effective gas management when mining defined zones to ensure an acceptable level of risk achieved.

- 4.32 Giving evidence concerning this MRE, Regional Inspector of Mines (RIOM) Mr Stephen Smith said:²⁸⁵

...they've indicated to the two inspectors, that their methane drainage, their pre-drainage, was not going to be sufficient for them to produce without taking great care.

- 4.33 The secondary extraction risk assessment noted that '[g]as content from previous cores taken from 2017 onwards indicates that the P-Seam gas content varies from 4-6m³/t at the commencement of the longwall block'. It further stated that '[t]here will be increased goaf emissions until LW 104 meets the install roadway of LW 103 as there will be gas desorbing from 3 sides, instead of 2'.²⁸⁶

²⁸³ AGM.002.001.1000, .1063: GRO-10671-RA-LW104 Secondary Extraction.

²⁸⁴ RSH.002.145.0001.

²⁸⁵ TRA.500.014.0001, .0071, lines 30–33.

²⁸⁶ AGM.002.001.1000, .1065: GRO-10671-RA-LW104 Secondary Extraction.

- 4.34 That statement was accompanied by the following diagram. The pink shaded area, depicted as being susceptible to P seam desorption, includes the portion of LW 104 mined between 9 March and 6 May 2020:²⁸⁷

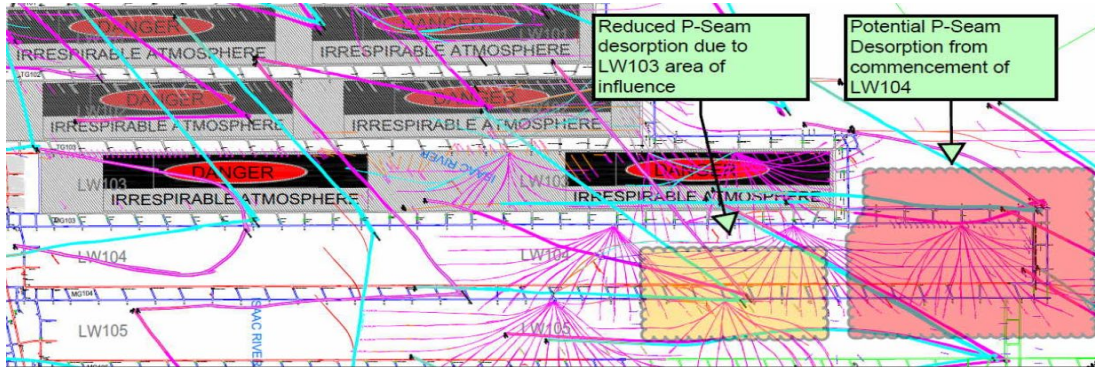


Figure 31: P seam area of influence

- 4.35 Mr Self noted in his report that ‘other mines extracting the GMS do not pre-drain the P seam’.²⁸⁸ However, management of the critical controls of gas drainage and ventilation must necessarily be highly mine specific. Moreover, Grosvenor must have known that pre-drainage of the P seam was desirable in the interests of gas management, or it would not have been attempted. It is also relevant that pre-drainage is usually more reliable than post-drainage in that capture of the gas is more assured.²⁸⁹
- 4.36 Anglo submitted, citing Mr Self’s evidence, that neither pre-drainage of unworked seams nor increased intensity of post-drainage would change the fact that the goaf would contain a large volume of methane.²⁹⁰ Anglo’s contention fails to recognise that the purpose of the pre-drainage of the P seam was to reduce gas make, rather than to eliminate methane from the goaf.

Goonyella Middle Lower seam

- 4.37 The GML seam lies immediately below the GM seam, and has an approximate gas reservoir size (GRS) of $4 \text{ m}^3/\text{m}^2$.²⁹¹ At the inbye end of LW 104 the interburden between the two seams ranged between 0.5–2 metres.²⁹² No pre-drainage of the GML seam was planned or conducted. Dr Williams observed in his evidence that ‘the Goonyella Middle Lower [seam] hasn’t been pre-drained, mainly because it is an exceedingly difficult proposition to pre-drain it’, being only ‘about 30cm thick’.²⁹³

²⁸⁷ AGM.002.001.1000, .1065: *GRO-10671-RA-LW104 Secondary Extraction*.

²⁸⁸ SAN.001.001.0001, .0026.

²⁸⁹ SAN.001.002.0001, .0066.

²⁹⁰ Submission received from Anglo on 21 May 2021 in response to draft chapters, paragraph 131.

²⁹¹ WRA.001.001.0001, .0049.

²⁹² AGM.002.001.1112, .1123: *GRO-10684-SOP-LW104 Second Workings*.

²⁹³ TRA.500.020.0001, .0005, lines 8–9; lines 16–18.

- 4.38 However, it was anticipated that the GML seam would contribute gas emissions to the working seam. The secondary extraction risk assessment noted:²⁹⁴

No pre drainage of the GML seam has been conducted for LW104 and is expected to release gas readily due to the GML reservoir size combined with proximity to the working seam up to approximately CH4000-2000 (MG104 20-36c/t).

- 4.39 Whilst there is evidence that it was not practicable to drain the GML seam, its proximity to the GM seam, and the knowledge that it would 'readily' emit gas would have been relevant to whether other pre-drainage was undertaken, and to gas management overall. That is particularly so given the mine's history of floor heave events causing gas exceedances, which it attributed to gas migrating from the lower seam.²⁹⁵
- 4.40 The issue of floor gas emissions had been recognised during extraction of LW 103. This was previously noted in Chapter 3, where there is a description of an Enablon action plan, including a task requiring 'investigation of under cross block drilling to relief [sic] zones of floor blowers'.²⁹⁶
- 4.41 Coal mine worker, Mr Wayne Sellars, gave anecdotal evidence concerning persistent 'bubbling' of gas from the GML seam through the floor of LW 104. He had this exchange with Counsel Assisting:²⁹⁷

Q. During the life of longwall 104, do you recall instances of methane essentially coming up through the floor of the longwall?

A. Yes.

Q. Do you recall whether that was something that happened all the way through from 9 March onwards or did it start to happen towards 6 May?

A. It had been there for a while, actually, yes. I can't recall if it was right at the very start, but, yes, we had methane coming through the floor, bubbling through the floor, for quite some time, yes.

Q. When you say "bubbling through the floor", are you talking literally that there were bubbles?

A. Yes, because there was water on the longwall floor, through hollows and stuff like that - it would be bubbling up through the water, yes.

²⁹⁴ AGM.002.001.1000, .1063: *GRO-10671-RA-LW104 Secondary Extraction*.

²⁹⁵ This is discussed in paragraphs 2.35 to 2.39 of Chapter 2.

²⁹⁶ AGM.003.001.0342.

²⁹⁷ TRA.500.024.0001, .0049, lines 21–38.

Summary of pre-drainage undertaken for LW 104

4.42 The GM seam was extensively pre-drained. Pre-drainage of the GM seam reduced its *in situ* gas content to approximately 2 m³/t, which was the objective. However, there was no pre-drainage of the seams above the target seam.

Notably, the P seam, which was anticipated to account for a significant proportion of the emissions in LW 104, was not pre-drained. Below the target seam, the GML seam was not pre-drained.

4.43 As a consequence of the failure to pre-drain the P seam, and the apparent inability to pre-drain the GML seam, the post-drainage systems would be required to manage the anticipated emissions from both seams.

Post-drainage planning

P seam laterals

4.44 Having opted not to pursue pre-drainage of the P seam, Grosvenor's strategy for dealing with anticipated gas emissions to LW 104 from that seam rested in large part on a program of drilling two 'lateral goaf holes' in the mid-panel.

4.45 Their purpose, namely to serve as a form of post-drainage once mining commenced, was described in the goaf drainage risk assessment:²⁹⁸

The use of lateral goaf holes to reduce the gas pressure in the freshly caved P seam at the leading edge of the goaf helps reduce gas that would otherwise migrate onto the longwall.

This method of drainage will assist in achieving the high-volume strategy adopted in response to the high SGE values. The laterals will be drilled to intersect face start line vertical goaf holes. The intent is to provide mitigation for well blockage and to allow dewatering before the longwall starts.

4.46 The intent was that these goaf holes would 'mitigate for the increase [sic] gas production of the LW 104 block'.²⁹⁹ It is noteworthy in light of subsequent experience once mining commenced, that the mine was anticipating, at least to some degree, 'high SGE values' and increased gas production on LW 104.

²⁹⁸ AGM.002.001.0937, .0994: *GRO-10699-RA-LW104 Goaf Drainage*.

²⁹⁹ AGM.002.001.0937, .0975: *GRO-10699-RA-LW104 Goaf Drainage*.

- 4.47 Following a spate of HPIs at LW 103 during July 2019, consideration was given to the means by which gas emissions could be better managed in future longwalls, including LW 104. On 11 July 2019, Mr Dieter Haage, Head of Technical, Anglo American Metallurgical Coal Pty Ltd (AAMC), forwarded an email to the AAMC of Head Underground Operations, Mr Glen Britton, and the Grosvenor Site Senior Executive, Mr Trent Griffiths, on the subject 'Grosvenor Gas Plan'. It contained a number of proposals which, later that day, Mr Griffiths approved for inclusion as part of an 'Action Plan...to cover all of these dot points / commitments...'.³⁰⁰
- 4.48 It included the following proposals, the third point of which referred to a plan for three P seam lateral holes for LW 104:

Dealing with elevated SGE's

1. Increased Tailgate Goaf Gas holes with infill holes to bring spacing down from current 50m to 25m. (Commencing August and continuing through 2019 – 2020.) Casper Badenhorst
2. Reduce spacing of Maingate holes from current 300m to 150m, commencing outbye of river bed undermining, Q4 2019. (Casper Badenhorst)
3. Prepare plan and provide budget for 3 X 12" lateral goaf drainage holes in the P seam for LW104 and beyond, drill in 2019 Q4 (New idea, partially successful previously, will be refined for 104. (Russel Packham)

Figure 32: Extract of email of 11 July 2019

³⁰⁰ AGM.005.002.0434.

4.49 By the time of the goaf drainage risk assessment, conducted in January 2020, this had been reduced to two lateral wells. The location of the two proposed P seam laterals is depicted in the following diagram from the goaf drainage risk assessment:³⁰¹

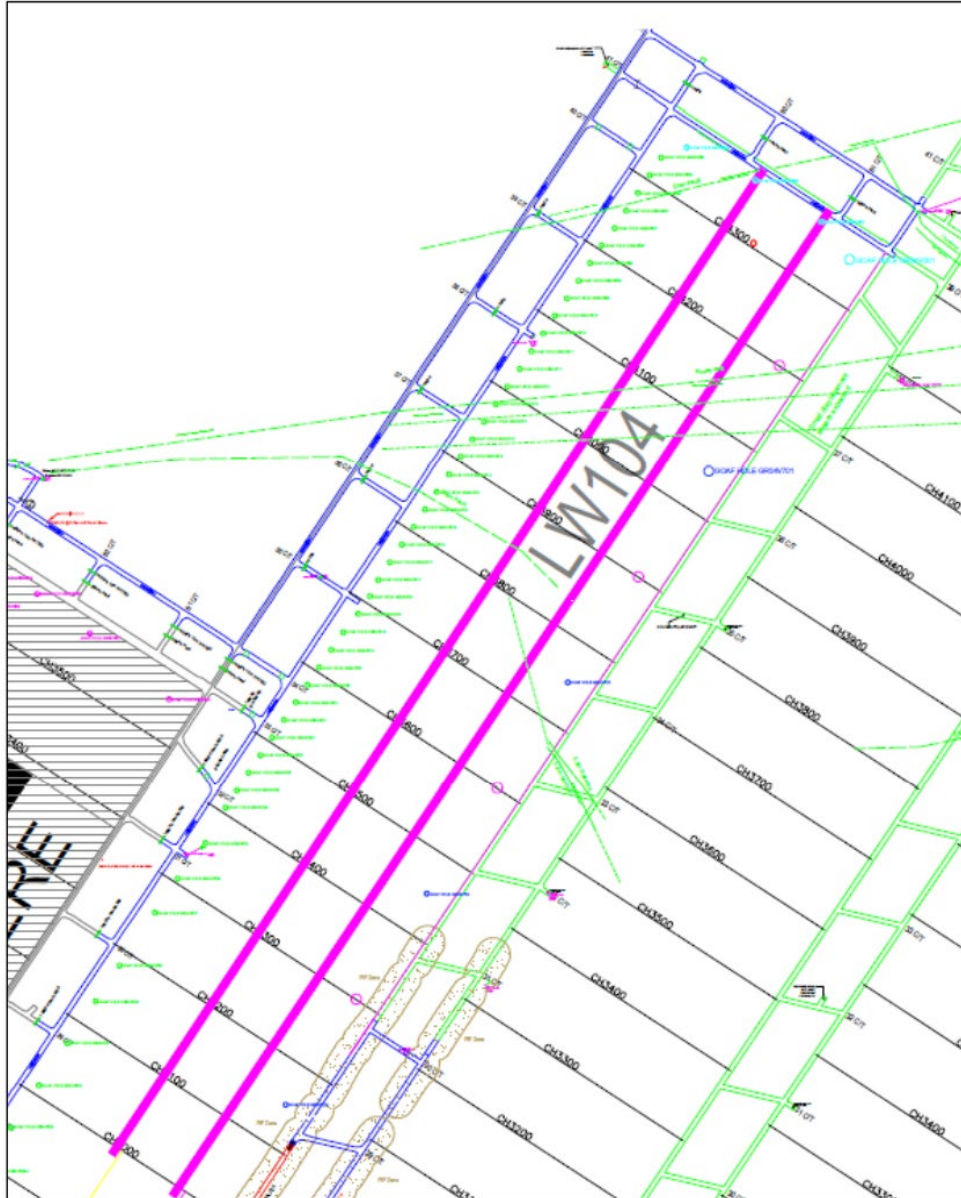


Figure 33: Location of proposed LW 104 mid-panel laterals, shown in purple

4.50 The use of lateral wells was based upon the experience of a well of that type, numbered GRO3L026, on LW 103. The nature and performance of that well was reviewed by Dr Williams in his 2020 report. GRO3L026 was an SIS well 311 mm in diameter, drilled to the P seam, with an in-seam length of 1,347 metres. Dr Williams noted that by virtue of its design it was, amongst other issues, prone to blockage.

³⁰¹ AGM.002.001.0937, .0995: GRO-10699-RA-LW104 Goaf Drainage.

Being blind-ended, it also precluded gas pre-drainage.³⁰² He elaborated further in his evidence:³⁰³

But I think these horizontal holes in goafs are pretty much hit and miss. You could be lucky and get one that flies and a whole lot more don't fly so well. A large-diameter hole is - I think it is probably problematic getting the return velocities up, when you are drilling it, to get all the muck out of the hole, and especially when you go and do branches of floor touches, so you can easily get bogged and things go wrong.

- 4.51 GRO3L026 did indeed become blocked,³⁰⁴ and, as depicted in the following graph prepared by Dr Williams, produced no gas for the first five months of operation on LW 103, before finally coming online:³⁰⁵

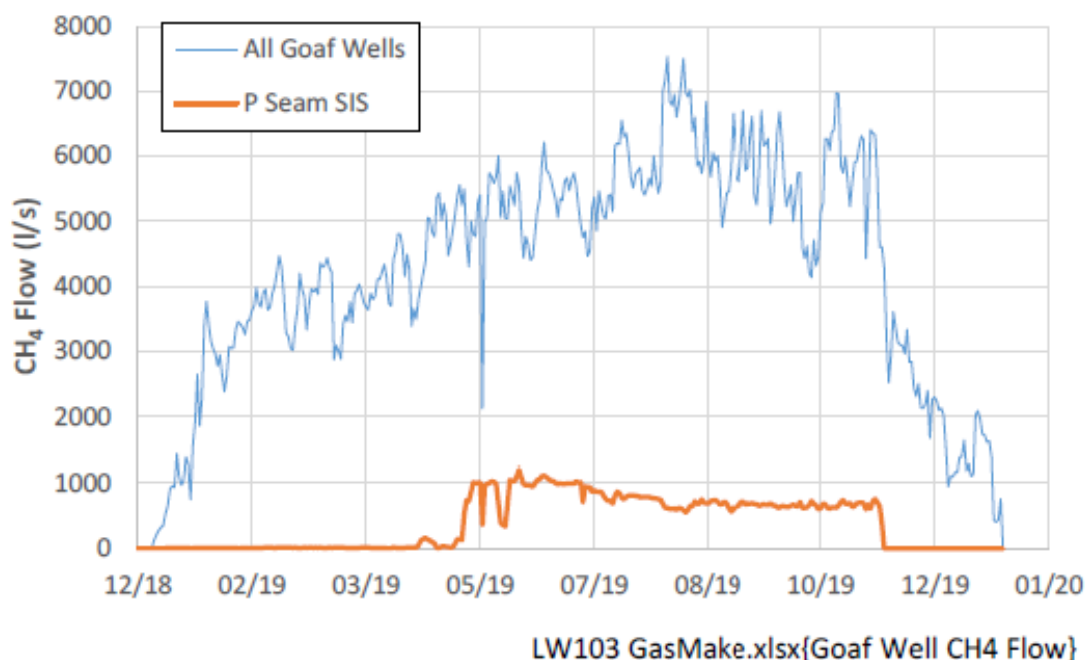


Figure 34: P Seam SIS Well Production

- 4.52 In the joint Learning From Incidents (LFI) report for the first seven HPIs at LW 104, between 18 and 23 March 2020, a timeline was included as Appendix 11. It contains the entries depicted in Figure 35 below, indicating that the drilling of the first P seam lateral for LW 104, GRO4L003, ran overtime.

³⁰² WRA.001.001.0001, .0038.

³⁰³ TRA.500.020.0001, .0035, lines 6–13.

³⁰⁴ AGM.002.001.0937, .0994: GRO-10699-RA-LW104 Goaf Drainage.

³⁰⁵ WRA.001.001.0001, .0039.

Consequently, drilling of the second well, GRO4L004, was abandoned as it did not fit the anticipated time frame for commencement of production.³⁰⁶

Dec 2019- Feb 2020		GR04L003 P Seam Lateral (MG side of LW104 block) drilling experienced difficulty in the Fooey Fault area. The hole completion ran over timeframe by +2 months.
Feb 2020		GR04L004 abandoned due to available time prior to LW104 start up by the Underground Mine Manager (verbal meeting).

Figure 35: Extract from joint LFI report

- 4.53 Submissions to the Board by Anglo acknowledged, with respect to the first lateral well (GRO4L003), that although drilling took place, (as Figure 35 above indicates), the hole was never completed.³⁰⁷ Thus, mining commenced without any strategy for limiting emissions from the P seam to the LW 104 goaf. Consequently, it was necessary that those emissions be dealt with by post-drainage goaf wells, and the ventilation system.
- 4.54 There appears to have been no reassessment of risk or change management process engaged in, despite the abandonment of the P seam lateral strategy, which had been a material component of the overall gas management strategy in the goaf drainage risk assessment.
- 4.55 The mine's secondary extraction SOP and risk assessment were notified to the Coal Mines Inspectorate (the Inspectorate) on 6 March 2020 (three days before commencement of mining), as required by section 320 of the *Coal Mining Safety and Health Regulation 2017* (Qld). It is concerning that both documents represented that the P seam lateral strategy would be implemented, although this was no longer the case.³⁰⁸ Nor was the Inspectorate told that there had been no re-evaluation of risk as a consequence.
- 4.56 The notice referred to in the preceding paragraph was given under cover of a letter of 6 March 2020 from Mr Wouter Niehaus, Underground Mine Manager. It said:³⁰⁹
- I can confirm that the risk assessment has addressed the hazards adequately and that there was no significant change as defined in Section 320 that impacts the mining method or operating procedures.*
- 4.57 Notwithstanding the terms of the letter, neither the secondary extraction risk assessment nor the subsequent goaf drainage risk assessment had assessed the hazard of spontaneous combustion, in the context of a goaf drainage strategy that had by then been developed, to double the number of tailgate goaf wells by reducing the spacing between them to 25 metres.

³⁰⁶ AAMC.001.003.0030, .0048.

³⁰⁷ AGM.999.013.0001, .0020; .0024–.0025; .0029.

³⁰⁸ AGM.002.001.1112, .1159: *GRO-10684-SOP-LW104 Second Workings*; AGM.002.001.1000, .1062: *GRO-10671-RA-LW104 Secondary Extraction*.

³⁰⁹ RSH.002.040.0001, .0168.

Issue of the Fairhill seam

- 4.58 As was seen earlier, the Flügge model produced by Dr Moreby in 2010 gave minimal significance to the potential for gas emissions to the worked seam from the FH seam. This is consistent with a general rule of thumb that seams more than 150 metres distant from the worked seam are unlikely to contribute to gas emissions. Over the mined area of LW 104, the FH seam ranges in depth from between 180 metres to 225 metres so that at its nearest point it was about 165 metres above the GM seam.³¹⁰
- 4.59 However, the Flügge model takes no account of local geology. Dr Williams advanced the view that the importance of a coal seam as a source of potential gas emissions is determined not only by its proximity to the working seam but in addition:³¹¹
- the magnitude of its GRS; and
 - the gas saturation and desorption pressure of that seam.
- 4.60 The FH seam has a thickness of 45 metres.³¹² As such, it constitutes a massive gas reservoir, approximately three times the size of the gas reservoir of the virgin GM seam.³¹³ The FH seam also exhibits high (near 100%) gas saturation and high desorption pressure. The magnitude of gas desorption pressure is a driving force behind gas emission.³¹⁴
- 4.61 Dr Williams explained his view about the importance of gas desorption pressure in the following exchange with Counsel Assisting:³¹⁵
- Q. ...perhaps it is a rule of thumb that seams more than 150 metres distant from the worked seam are not particularly relevant from a gas emission point of view?
- A. Yes.
- Q. Is that a general rule of thumb? Have I been accurate in describing it as such?
- A. Yes, it's probably general, yes. Yes, I - it's not one I'd subscribe to, but it's generally believed.
- Q. Why do you not subscribe to that?
- A. Well, this is the exact case in point: it's further than that, and it can emit gas. It's a peculiar set of circumstances here at Grosvenor, where not only do we have a high gas desorption pressure in the Fairhill seam, but the gas reservoir size is massive. It's a huge gas reservoir.

³¹⁰ WRA.001.001.0001, .0005; .0048.

³¹¹ WRA.001.001.0001, .0029.

³¹² WRA.001.001.0001, .0005.

³¹³ WRA.001.001.0001, .0029.

³¹⁴ WRA.001.001.0001, .0023.

³¹⁵ TRA.500.020.0001, .0018, line 40–.0019, line 16.

Q. So is the size of the gas reservoir of the Fairhill seam, in conjunction with its high gas saturation and desorption pressure, sufficient to outweigh that general rule of thumb?

A. Yes, it is.

4.62 Dr Williams supported his contention as to the potential significance of desorbing gas from the FH seam by reference to gas content testing from boreholes situated in previously mined LW 101 and LW 103. That testing showed that the FH seam did desorb approximately 19% of its gas in the course of mining those longwalls. If that degree of emission (19%) is applied to LW 104, the FH seam would potentially represent 29% of the total gas emitted from the seams above and below the GM seam.³¹⁶

4.63 Applying that method, Dr Williams presented the following table, indicating the estimated gas emission from all seams:³¹⁷

Seam	Gas Reservoir Size (m3/m2)	Gas Emitted (m3/m2)	Degree of Emission	Seam Basis Proportion of Gas Emitted	Cumulative Proportion of Gas Emitted	Average Distance Above/ Below GM Seam (m)
FH	265	50.6	19%	29%	29%	188.6
QA	34	19.8	58%	12%	41%	135.3
QB	34	28.0	83%	16%	57%	108.4
GU	20	18.2	90%	11%	68%	88.9
GR/P	51 (19)	45.9 (17)	90%	27%	95%	56.6
GMR	2	1.4	90%	1%	95%	19.1
GML	4	4.1	96%	2%	98%	1.8
HL1	5	2.8	54%	2%	99%	22.2
HL2	5	1.1	22%	1%	100%	38.6
HL3/4	25	0.0	0%	0%	100%	46.1
Totals	445(412)	172(143)	39%(35%)			

Figure 36: Estimate of gas emitted per seam based on DDG 295 Gas Reservoir LW 104

4.64 Notwithstanding earlier advice from Dr Moreby concerning the unlikelihood of gas emissions from the FH seam, by July 2019 Grosvenor's management suspected that the FH seam was contributing gas emissions to LW 103. It proposed to undertake testing to determine whether this was so.

³¹⁶ WRA.001.001.0001, .0005; .0049.

³¹⁷ WRA.001.001.0001, .0049.

This appears from point two of the following extract from Mr Haage's email of 11 July 2019, setting out the 'Grosvenor Gas Plan':³¹⁸

The plan as I have it is

Establish where the elevated SGE's are coming from :

1. Review again the gas emissions from Arrow history from the GM and P seam to correlate against the current experience. (Jul / Aug 19 - Russel Packham)
2. Drill and measure subsided potential target seams (P seam, Fairhills Seam) to establish post mining gas content for accurate mining process emissions. Mid August 19. (Exploration)
3. Drill and measure pre-drainage gas content and permeability at 3 positions (Inbye, Mid Panel, Outbye for panels 104, 105, 106). (H2 2019 and H1 2020) (Plan to be finalised by Casper Badenhorst and included in the 2020 BP)

Figure 37: Extract of email of 11 July 2019

- 4.65 In the course of the Venting Trial in August 2019, discussed in a later section, further consideration was given to the question of emissions to the goaf from the FH seam. The *Venting Trial Report* noted that testing indicated that the FH seam had liberated 25% of its gas content, and the mine was unsure if that gas was emitting to the goaf. A commitment was made for 'future work to improve pre-drainage practices'. Amongst its conclusions the report stated:³¹⁹

*A gas compliance borehole drilled into the subsided goaf has indicated that the Fairhill Seams retained 75% of it's [sic] gas content and liberated 25% of it [sic] gas content. Due to the Fairhill Seams being 150m below surface and 150m above the Goonyella Middle Seam, it is unclear whether or not the Fairhill Seams contribute to goaf gas levels. Other than the P-Seam, **there is gas coming into the goaf (and the tailgate) from somewhere, it is not known where. This must be a priority of future work to improve pre-drainage practices and goaf/ventilation strategies.** (Emphasis added).*

- 4.66 On 29 September 2019, Dr Moreby provided Grosvenor with a memorandum containing advice concerning emissions from the FH seam.³²⁰ A comparison was conducted between pre-mining gas content from boreholes DDG 213 and DDG 217, and post-mining gas contents of borehole DDG 321, located at the inbye end of LW 103.
- 4.67 Without reaching a definitive conclusion about emissions from the FH and QA seams to LW 103, Dr Moreby noted the size of the FH gas reservoir and hence its potential to make a significant difference to SGE. He advised as follows:³²¹

The problem here is the large GRS contained in the Fairhill plies meaning that say 10% either way makes a significant difference to SGE. Therefore, having additional drainage capacity for gas management is essential.

- 4.68 Thus, Grosvenor was strongly advised to make provision, in the form of 'additional drainage capacity', for (at least the contingency of) emissions from the FH seam.

³¹⁸ AGM.005.002.0434.

³¹⁹ AGM.012.001.0003, .0020: *Venting Trial Report*.

³²⁰ AGM.015.001.0097.

³²¹ AGM.015.001.0097, .0107. 'Plies' means layers in a coal seam, analogous to the term 'strata' used to describe layers in a section of rock.

Proposal for relaxed strata wells to the FH, QA and QB seams

4.69 The FH seam was not a candidate for pre-drainage due to its limited permeability. However, Dr Williams proposed a form of post-drainage, similar in concept, although different in application, to Grosvenor's intended use of the P seam laterals.³²² The strategy was to intercept gas liberated from the FH, QA and QB seams once mining commenced. The method, described in his report, was to:³²³

...drill a row of relaxed strata wells ahead of mining (eg near panel centre, 50 m apart) with cemented casing to the top of the FH seam and slotted conduit to well bottom at the base of the QB seam.

...

Such wells should impact by significantly reducing gas emitted from sources that provide around half the total gas emission [namely the FH, QA and QB seams].

4.70 Dr Williams elaborated on the strategy, and the rationale behind limiting gas emissions to the goaf, in the following exchange with Counsel Assisting:³²⁴

Q. ...Can you perhaps just elaborate on what you see as being the functionality of this kind of well?

A. I think the whole key to controlling - it is all about controlling the gas when you are mining, and pre-drainage is a fantastic way of doing it. You get rid of it that way.

Q. You're not relying so much on your goaf wells in production?

A. Exactly. Goaf drainage. It's all --

Q. Or your ventilation?

A. Yes. It's all hands to the pump. With relaxed strata wells, you've got the opportunity to get the gas out before it gets into the mine workings...When you mine under the boreholes, they should relax and produce, and produce high-purity gas.

4.71 Accordingly, in evidence to the Board, at least one credible strategy was advanced for capturing gas emissions from the FH, QA and QB seams. Anglo, in written submissions, questioned the viability of this strategy.³²⁵ However, there is no evidence that Grosvenor considered any form of strategy for capturing emissions from these seams. Rather, it put all its faith in the efficacy of its post-drainage goaf wells and ventilation.

³²² TRA.500.020.0001, .0054, line 47-.0055, line 10.

³²³ WRA.001.001.0001, .0007.

³²⁴ TRA.500.020.0001, .0054, lines 7-27.

³²⁵ Submission received from Anglo on 21 May 2021 in response to draft chapters, paragraph 50.

Venting Trial and LW 104 post-drainage strategy

4.72 In the first half of August 2019, Grosvenor carried out an exercise called the ‘Venting Trial’ at LW 103. The object of the trial was described in a subsequent report by the mine:³²⁶

The objective of the trial was to test the proposal that additional gas drainage capacity will improve (reduce) longwall tailgate gas levels. The three main benefits of reduced methane levels in the tailgate are:

- a. Enabling continuous production,*
- b. Preventing HPI’s by maintaining methane levels below 2.5%, and*
- c. Gaining tailgate access with diesel machines during maintenance periods*

4.73 The trial involved substantially increasing the number of goaf wells online. Six existing wells that were deep in the goaf and had been decommissioned were reconnected, and six wells near the face were progressively connected.³²⁷ It was estimated that this would achieve total gas flow of 15,000 l/s, with 8,700 l/s comprising methane. The actual results were more modest. Total flow increased from 7,800 l/s to 10,500 l/s. Nonetheless, the trial was regarded as a success and, as Dr Williams observed, it ‘had a large bearing on the approach adopted to goaf drainage in LW 104, namely – a halving of the TG well spacing’.³²⁸

4.74 The underlying theory behind the close spacing strategy was outlined in the *Venting Trial Report*.³²⁹

Goaf hole spacing during the trial period was 50m. As caving occurs, and connectivity is established to the fractured goaf, the new goaf hole impact tailgate gas levels immediately as the hole is within 30m from the face. As cutting continues and the face retreats from the newly flowing goaf hole, gas levels build up and the impact that hole has on the tailgate diminishes. This phenomenon has been observed many times, even before the trial.

This leads to the conclusion that if goaf holes were spaced closer to each other than 50m, immediate relief will be experienced at a higher frequency as holes come on line in closer succession. This is the basis of the argument for 25m spaced goaf holes.

³²⁶ AGM.012.001.0003, .0005: *Venting Trial Report*.

³²⁷ WRA.001.001.0001, .0040.

³²⁸ WRA.001.001.0001, .0041.

³²⁹ AGM.012.001.0003, .0010: *Venting Trial Report*.

- 4.75 The 25 metre spacing of tailgate goaf holes was a substantial part of the goaf gas management strategy for LW 104 to increase drainage capacity. The following description of the strategy appears in the goaf drainage risk assessment under the heading 'Increased drainage volume':³³⁰

Between the 2nd and 16th of August a trial was conducted to maximise goaf drainage by venting gas. During the trial period longwall production was not interrupted by precautionary gas trips. An increase in goaf gas flow from 7800 sL/s to 10,500 sL/s was achieved with the use of 8 extra goaf wells.

Based on the observations from the trial period, the strategy of increasing total volume drained by operating more goaf holes is valid and will be implemented in LW104. Acknowledging however, that during initial longwall goaf development limited goaf holes are available. To increase the volume that can be drained goaf holes will be:

- 1. TG drilled at close spacing (25m)*
- 2. MG drilled at 150m spacing*
- 3. Twin lateral goaf holes drilled into the P seam*

- 4.76 The goaf drainage risk assessment expressly noted a concern that '...with close spaced goaf holes...gas purity may fall to levels that require borehole to be shut in [sic]'.³³¹ This was a recognition of the risk of increased volumes of oxygen being drawn into the goaf from greater drainage capacity.
- 4.77 Despite that concern being noted, the risk of spontaneous combustion from the strategy adopted was not considered as part of that risk assessment, or at all, prior to the commencement of the operation of LW 104.

³³⁰ AGM.002.001.0937, .0990: *GRO-10699-RA-LW104 Goaf Drainage*. References omitted.

³³¹ AGM.002.001.0937, .0991: *GRO-10699-RA-LW104 Goaf Drainage*.

- 4.78 The goaf drainage risk assessment had the following handwritten notation on it, requiring a separate spontaneous combustion risk assessment (WRAC)³³² to be completed by 31 May 2020, more than two and half months after the commencement of production from the longwall:³³³

□ INCREASED SPONTANEOUS COMBUSTION RISK DUE TO INCREASED GAS DRAINAGE HAS NOT BEEN ASSESSED IN THIS WRAC.
 ↳ ADDITIONAL WRAC REQUIRED TO ASSESS & CONTROL SPONT COMB RISK.
 W. NIEHAUS [REDACTED] NOTE ACTION IN ENABLON FOR GARY NEEDHAM TO COMPLETE BY 31/5/2020 (TASK # 01150023) [REDACTED] 27/2/2020

Figure 38: Handwritten notation on goaf drainage risk assessment

- 4.79 Given that the central strategy of the goaf drainage risk assessment was to ‘maximize drainage volume through use of close spaced (25m) tailgate vertical goaf holes and mid-panel lateral goaf holes’,³³⁴ the Board infers that the reference in the notation above to ‘increased gas drainage’ is a reference specifically to the spacing of the vertical goaf holes. It is also apparent from the notation that the mine was aware of the ‘increased spontaneous combustion risk’, but had no plan to carry out the necessary risk assessment prior to commencing production.
- 4.80 Grosvenor was required by the Board to provide any evidence of a spontaneous combustion risk assessment consequent upon the ‘increased gas drainage’, conducted at any time prior to the date of the serious accident.³³⁵ No evidence was forthcoming, and no explanation was offered. The Board inferred that no such risk assessment was conducted.³³⁶
- 4.81 Although the mine intended to increase gas drainage, there are limits to the efficacy of doing so. That is because, as Mr Self explained in his report, ‘[t]here is a conflict between the management of high gas make and spontaneous combustion’, and:³³⁷

³³² Grosvenor had a practice of calling a risk assessment a ‘WRAC’, the acronym meaning workplace risk assessment and control.

³³³ AGM.002.001.0937, .0953: *GRO-10699-RA-LW104 Goaf Drainage*. The handwritten notation reads: ‘Increased spontaneous combustion risk due to increased gas drainage has not been included in this WRAC. Additional WRAC required to assess and control [spontaneous combustion] risk. W Niehaus (signed). Note Action in Enablon for Gary Needham to complete by 31/5/2020 (Task #01150023) W Niehaus (initialled) 27/2/2020’.

³³⁴ AGM.002.001.0937, .0980: *GRO-10699-RA-LW104 Goaf Drainage*.

³³⁵ BOI.999.002.0001, .0002.

³³⁶ Ultimately, Anglo accepted in its written submission that no specific risk assessment was conducted in relation to the risk of spontaneous combustion as a result of the change to 25 metre spaced goaf wells: Submission received from Anglo on 21 May 2021 in response to draft chapters, paragraph 87.

³³⁷ SAN.001.001.0001, .0038.

[m]anagement of these two major hazards represents a compromise, good practice in mining regarding one of the hazards generally represents bad practice concerning the other.

- 4.82 In his evidence, Mr Self elaborated on the risks associated with close spacing of goaf drainage holes:³³⁸

Post-drainage of goaf gas is not as simple as applying the maximum amount of goaf drainage possible. There are a number of reasons behind that statement. Holes compete. If the hole spacing gets too close together, they compete with each other, so you don't capture more gas.

There's an absolute limit on the amount of gas you will capture. The more holes we put in, the more suction we apply, the more flow there is and therefore the more flow of oxygen, actually air, into the goaf.

A post-drainage system will inevitably draw air into the goaf or gas will enter the ventilation system. Ideally all the gas would go to the post-drainage system. Then all the air would stay on the longwall face. But it's impractical to achieve that. We can't prevent both of these from happening at times.

- 4.83 Hence the importance of conducting the spontaneous combustion risk assessment referred to in the handwritten notation.

- 4.84 The view expressed by RIOM Smith was that mining should not have been undertaken at LW 104 without such a risk assessment. He had this exchange with senior counsel for the Construction, Forestry, Maritime, Mining and Energy Union:³³⁹

Q. Can I just ask you this more directly: should production in longwall 104 have even started in circumstances where increased spontaneous combustion risk due to gas drainage had not been assessed in the risk assessment?

A. No, it should not, in my view.

- 4.85 Mr Self was of the same view as RIOM Smith, as indicated in the following answer:³⁴⁰

Q. Would you embark upon production on a longwall, if you were operating a mine, without doing a risk assessment for spontaneous combustion associated with gas drainage – that is, post-drainage?

A. No.

³³⁸ TRA.500.021.0001, .0068, lines 8–23.

³³⁹ TRA.500.015.0001, .0088, lines 37–42.

³⁴⁰ TRA.500.021.0001, .0046, lines 2–6.

Summary of the mine's post-drainage planning

- 4.86 The planned P seam lateral wells were abandoned prior to the commencement of mining in LW 104. The mine's planned post-drainage strategy was, in effect, limited to its plan to draw goaf gases from more closely-spaced goaf drainage wells than on previous longwalls.
- 4.87 The mine's decisions in respect of its pre-drainage and post-drainage planning had significant consequences for the gas make on LW 104. That issue is considered in the next section.

SGE at LW 104

- 4.88 As already noted, in 2010 Dr Moreby predicted that, without pre-drainage of the P seam, the mine's SGE for LW 104 would be 14.4 m³/t. His most recent update of predicted SGE for LW 104, prior to mining, was given in his memorandum of September 2019.³⁴¹
- 4.89 He offered SGE figures in the range 'Minimum', 'Likely', and 'Potential all'. The 'Likely' figures limited the distance above the GM seam that could contribute gas to 150 metres, and therefore excluded the FH seam. The 'Potential all' figures included the FH seam.
- 4.90 On this footing, the predicted SGE figures for the inbye end of LW 104 (borehole DDG 214) were 5.1 m³/t, 11.4 m³/t and 21.7 m³/t, respectively.³⁴² As will be seen, the 'Potential all' figure of 21.7 m³/t was lower, but nonetheless closer, to actual experience once mining commenced. The 'Potential all' estimate, viewed against an actual SGE of 25.4 m³/t,³⁴³ supports Dr Williams' opinion that the FH, QA and QB seams were significant contributors to gas emissions.
- 4.91 Dr Williams undertook a comparison of gas make, and other data, between LW 103 and LW 104 for the first 390 metres of retreat, being the distance achieved at LW 104 up to the date of the serious accident. His comparison revealed that the mine experienced significantly higher gas make on LW 104 than LW 103. He determined that the average daily gas make on LW 104 was 26.8 m³/t.³⁴⁴
- 4.92 The graph below plots gas make for each longwall over the distance of retreat, on a cumulative basis.³⁴⁵ A substantial increase in gas make for LW 104, over that experienced at LW 103, was clear by the stage of about 100 metres of retreat.³⁴⁶

³⁴¹ AGM.015.001.0097.

³⁴² AGM.015.001.0097, .0117.

³⁴³ RSH.038.002.0001.

³⁴⁴ RSH.038.002.0001.

³⁴⁵ Cumulative gas make is the total gas produced per tonne of coal for a given longwall retreat distance from commencement of production.

³⁴⁶ WRA.001.001.0001, .0043.

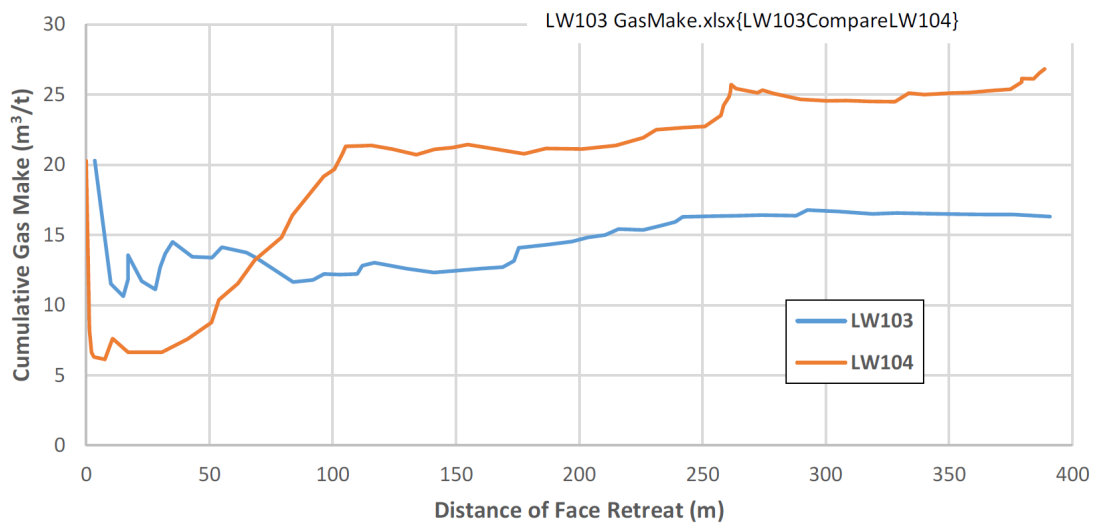


Figure 39: Gas Make for LW 103 and LW 104

4.93 Mr Self was asked to comment on the graph in his evidence. He said that on commencement of retreat some variability was to be expected whilst the strata established a normal caving pattern.³⁴⁷

4.94 After that point, he said:³⁴⁸

...the 103 pattern of gradually increasing specific gas emission with distance is fairly normal. The increase of 104 from very low figures just after face start, up to much higher figures after 100 metres, and then a gradual increase and then a step change is abnormal.

4.95 He said that '[o]bviously longwall 104 was creating more gas than was expected',³⁴⁹ and that an SGE of around 25 m³/t would 'start to raise the alarm bells' for the 'gas and ventilation people'.³⁵⁰ He also said that whilst 25 m³/t was 'not exceptionally high in industry terms, mines which exhibit a higher SGE would typically be producing 3–6 million tonnes per annum'.³⁵¹ Grosvenor's production forecasts targeted 7 million tonnes for 2020.³⁵²

³⁴⁷ TRA.500.021.0001, .0019, lines 32–35.

³⁴⁸ TRA.500.021.0001, .0019, lines 38–43.

³⁴⁹ TRA.500.021.0001, .0020, lines 30–31.

³⁵⁰ TRA.500.021.0001, .0020, lines 9–13.

³⁵¹ SAN.001.001.0001, .0020.

³⁵² AGM.003.001.0063; AGM.003.001.0068; AGM.003.001.0073.

4.96 Dr Williams also set out a range of comparative data for LW 103 and LW 104, in tabular form, for the first 400 metres of retreat. The table is as follows:³⁵³

Area	Mining				Return CH ₄ (m ³ * 10 ⁶)	Goaf Wells			Average Gas Make (m ³ /t)
	Start Date	End Date	Duration (days)	Tonnes Produced		CH ₄ Production (NTP) m ³ * 10 ⁶	Total Number	Period Average CH ₄ Production /Well (NTP) m ³ * 10 ⁶	
LW103	16-Dec-18	05-Feb-19	51	814,966	4.83	8.36	12	0.70	16.2
LW104	09-Mar-20	06-May-20	58	866780	4.20	19.05	20	0.95	26.8

Figure 40: Comparison of data for LW 103 and LW 104

4.97 There are a number of features to note about the comparison:

- a. production overall was comparable as between the two longwalls;³⁵⁴
- b. average gas make for LW 104 was 65% higher, at 26.8 m³/t;³⁵⁵
- c. goaf well production of methane for LW 104 was more than double that of LW 103; and
- d. total goaf wells available for LW 104 was higher, due to the well spacing strategy, but for various reasons some wells were shut in at various times, so that the number online never rose above 12, a comparable figure with LW 103.³⁵⁶

4.98 Finally, it is noted, in connection with the significantly higher gas make of LW 104, that 14 HPis were experienced on that longwall in the first 400 metres of retreat. LW 103 did not experience any HPis over the same distance of retreat.³⁵⁷

³⁵³ WRA.001.001.0001, .0042. 'NTP', in relation to methane (CH₄) production, refers to normal temperature and pressure.

³⁵⁴ In written submissions, Anglo disputed the amount of 814,966 tonnes produced for LW 103 referred to in Figure 40 above, and asserted an amount of 896,786: Submission received from Anglo on 21 May 2021 in response to draft chapters, paragraph 68. Either way, production for that period was comparable as between the two longwalls.

³⁵⁵ WRA.001.001.0001, .0042–.0043. However, if Anglo's asserted figure for LW 103 production is used the increase in average gas make is 75%.

³⁵⁶ TRA.500.020.0001, .0039, lines 14–42; WRA.001.001.0001, .0043.

³⁵⁷ WRA.001.001.0001, .0050.

4.100 The performance of the wells was reviewed in detail by Dr Williams, as set out in the table below:³⁵⁹

Goaf Well	Average CH4%	Average CO ppm	Maximum CO ppm	Duration (days)	Average CH4 Flow (l/s) NTP	Turn off State	Turn Off Contributed to Trough
GR04L001	70.3	22	98	14	472	D,N	L1
GR04L002	77.5	20	93	52	812	C	
GR04M001	89.2	0	5	32	711	C	
GR04M001.5	86.2	1	3	5	374	C	
GR04V001	87.6	0	4	48	742	C	
GR04V002A	71.1	3	14	22	883	A,N	L1
GR04V002A.2	83.7	5	16	11	465	A,N	L1
GR04V003	62.8	48	100	48	513	C,D (T1)	L1
GR04V004	55.5	55	92	23	572	T1	L2
GR04V004.5	60.7	54	128	35	334	D,N (T1)	L3
GR04V005	52.9	43	82	17	449	D,N (T1)	L2
GR04V005.5	45.0	63	103	14	346	T1	L2
GR04V006	42.1	55	97	7	238	T1	L2
GR04V006.5	70.8	41	155	29	318	C (T1)	L2
GR04V007	57.6	62	171	26	397	C,D (T1)	L2
GR04V007.5	41.2	72	98	14	221	T1	L3
GR04V008	46.4	58	95	14	310	T1	
GR04V008.5	51.7	56	83	13	354	C,D (T1,T2)	L3
GR04V009	55.2	49	75	11	455	C T1	
GR04V009.5	53.4	39	65	7	344	C T1	
GR04V010	15.5	13	23	2	0	C T2	

These columns highlighted have above average values

Key for "Turn Off State" Column

N, T1, T2 TARP rating. A "T" in parentheses indicates well is currently rated N but had a T1 or T2 rating earlier in its history

C Flowing on 6/5/20. All normal

D Higher O₂ (>4%) &/or CO (>10 ppm) but not enough to trigger T1

Figure 42: Performance of goaf wells

4.101 It can be seen from the shaded columns that:

- a. average methane concentration and methane flow trended down as the retreat progressed; and
- b. average carbon monoxide showed an increasing trend for the more outbye wells.

³⁵⁹ WRA.001.001.0001, .0044. 'NTP', in relation to the average methane flow, refers to normal temperature and pressure.

4.102 Dr Williams noted that an increase in carbon monoxide generally accompanies an increase in oxygen. He accepted the following summation by Counsel Assisting:³⁶⁰

Q. ...To sum it up, above average CH₄ for the more inbye wells, reducing to a degree, which we can observe, which you would attribute to drawing more oxygen and less methane; is that correct?

A. Yes

4.103 Dr Williams elaborated on his conclusion from the table that the wells were drawing more oxygen as the retreat progressed. He said:³⁶¹

They were just drawing in more air, I think would be the logical thing. It looks like they were having quite a hard time with the TARPs over the last two-thirds of that 400 metres of retreat. It's sort of just a factual sheet, to my way of thinking, that largely sort of speaks to itself... they must have been working really hard to try and contain the gas, and it seems to be getting on top of them, yes.

4.104 In short, in attempting to draw more methane to control the emissions, the result was to draw more oxygen, and some wells were shut in because of active Trigger Action Response Plans.

4.105 The declining efficiency of the goaf wells in extracting methane as the retreat progressed is depicted in the following graph:³⁶²

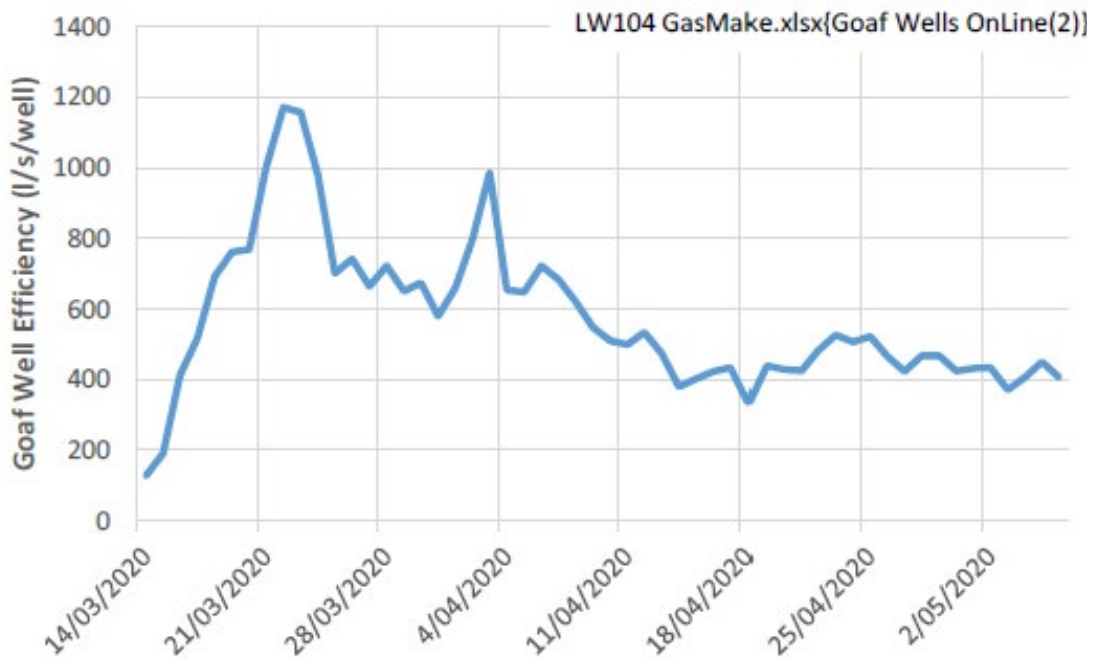


Figure 43: Goaf well efficiency

³⁶⁰ TRA.500.020.0001, .0042, lines 4–8.

³⁶¹ TRA.500.020.0001, .0042, line 41–.0043, line 3.

³⁶² WRA.001.001.0001, .0045.

4.106 An increase in oxygen ingress to the goaf is relevant to spontaneous combustion risk. Mr Self considered the competing objectives of gas management and spontaneous combustion management in the context of the operation of the goaf drainage system. He said in evidence:³⁶³

The objective has to be to remove as much gas as is necessary to allow the longwall to operate at planned production rates and remain compliant with legislation. That's reasonably obvious. We have to run the goaf drainage as hard as we can to achieve production rates but be compliant. If the simplistic strategy of increasing numbers of vertical goaf wells and increasing suction pressure is applied, oxygen increase to the goaf will result in an unacceptable spontaneous combustion risk if goaf well oxygen concentration is not managed.

4.107 This brings into sharper focus the absence of a spontaneous combustion risk assessment in response to the goaf drainage strategy, discussed earlier in the chapter.

4.108 By reference to a series of graphs, Mr Self illustrated the implications for the goaf drainage system of an SGE of 25 m³/t, across a range of rates of production. Anglo has submitted that the SGE figure of 25 m³/t is 'arbitrary'.³⁶⁴ This is incorrect. Dr Williams calculated the SGE for LW 104 as 25.4 m³/t. As discussed earlier,³⁶⁵ he also calculated the average daily gas make as 26.8 m³/t.³⁶⁶ For the purpose of the illustrative graphs that follow, the Board accepts that an SGE of 25 m³/t (rounded down) is a valid denominator.

4.109 Grosvenor's daily production at LW 104 between March and May 2020 naturally fluctuated, but was frequently in the range of 15,000–20,000 tonnes and sometimes more, up to 28,000 tonnes.³⁶⁷ Figure 44, below, shows methane emissions in litres per second at various rates of production.³⁶⁸ The graph illustrates 'peak' and 'mean' figures.

³⁶³ TRA.500.021.0001, .0050, lines 30–41.

³⁶⁴ Submission received from Anglo on 21 May 2021 in response to draft chapters, paragraph 62.

³⁶⁵ See paragraph 4.91.

³⁶⁶ RSH.038.002.0001.

³⁶⁷ AGM.003.001.0063; AGM.003.001.0068; AGM.003.001.0073.

³⁶⁸ SAN.001.001.0001, .0020.

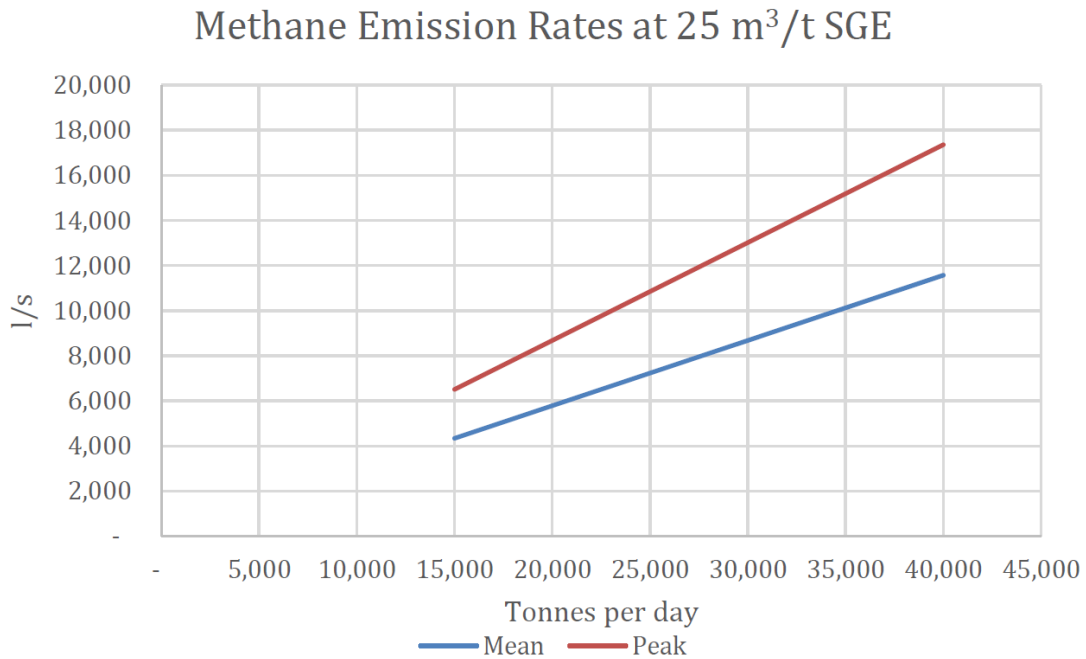


Figure 44: Methane emission rates

4.110 Mr Self made the point that gas emissions should be managed on the basis of peak figures. He gave the following reason:³⁶⁹

Some people would argue that there is only a need to manage the mean gas emission figures. This would be a flawed argument, if gas emission is managed to the mean, around half of the time the system would not be capable of performing to specification and gas exceedances would inevitably result.

4.111 Figure 45 below shows the distribution of the emissions as between ventilation and post-drainage systems.³⁷⁰ The ventilation gas load is assumed at a constant figure of 700 l/s, representing ventilation flow of 70 m³/sec at 1% methane by volume. So, for example, at a production rate of 20,000 tonnes per day, the post-drainage system would be required to capture 8,000 l/s methane.

³⁶⁹ SAN.999.003.0001, .0004

³⁷⁰ SAN.001.001.0001, .0021.

Ventilation and Post Drainage Requirements at 25 m³/t SGE

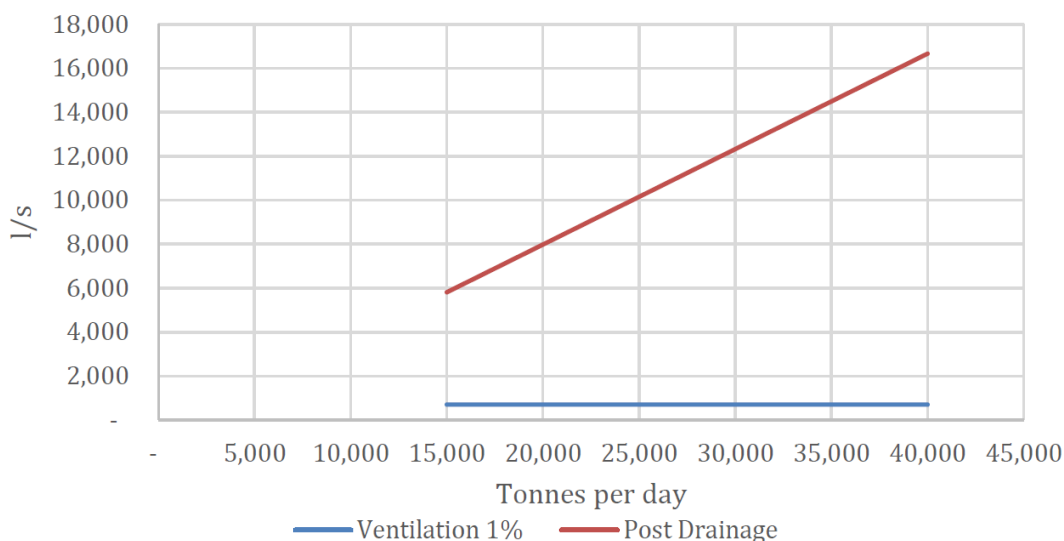


Figure 45: Ventilation and post-drainage requirements

4.112 Post-drainage capture efficiency (PDCE) is a measure of the efficacy of the post-drainage system. Figure 46 below shows the required PDCE, assuming an SGE of 25 m³/t, across different coal production rates.³⁷¹ It can be seen that production in excess of about 16,000 tonnes/day would require a PDCE in excess of 90%.

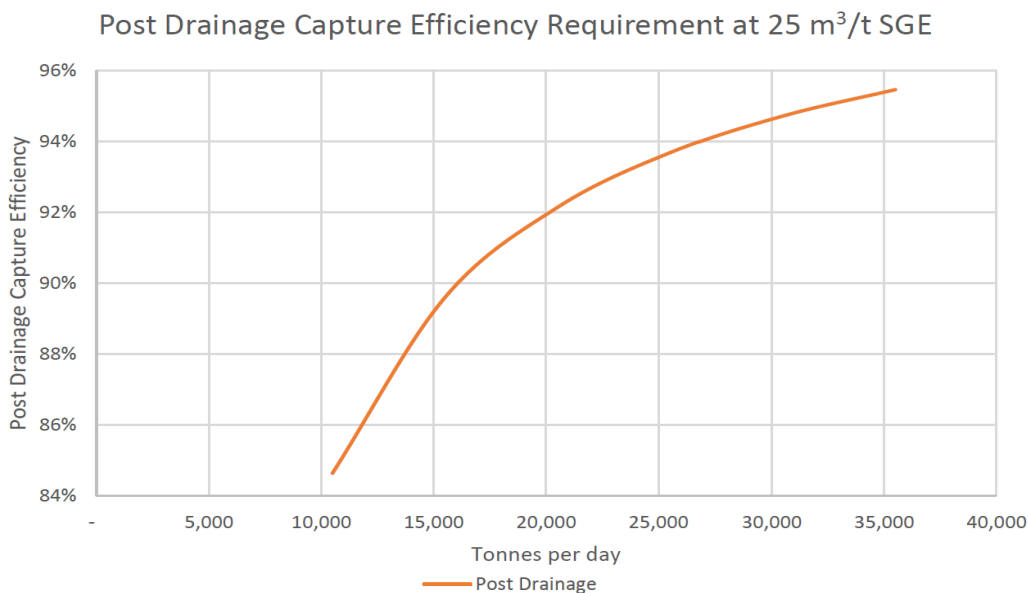


Figure 46: Post-drainage capture efficiency requirements

³⁷¹ SAN.001.001.0001, .0022.

4.113 Mr Self also charted Grosvenor’s actual PDCE for LW 104, as depicted in Figure 47. The PDCE rarely reached 90% and averaged around 83% from 20 March 2020.³⁷² Mr Self said that the figures shown were ‘typical of a post-drainage system in the GMS’.³⁷³

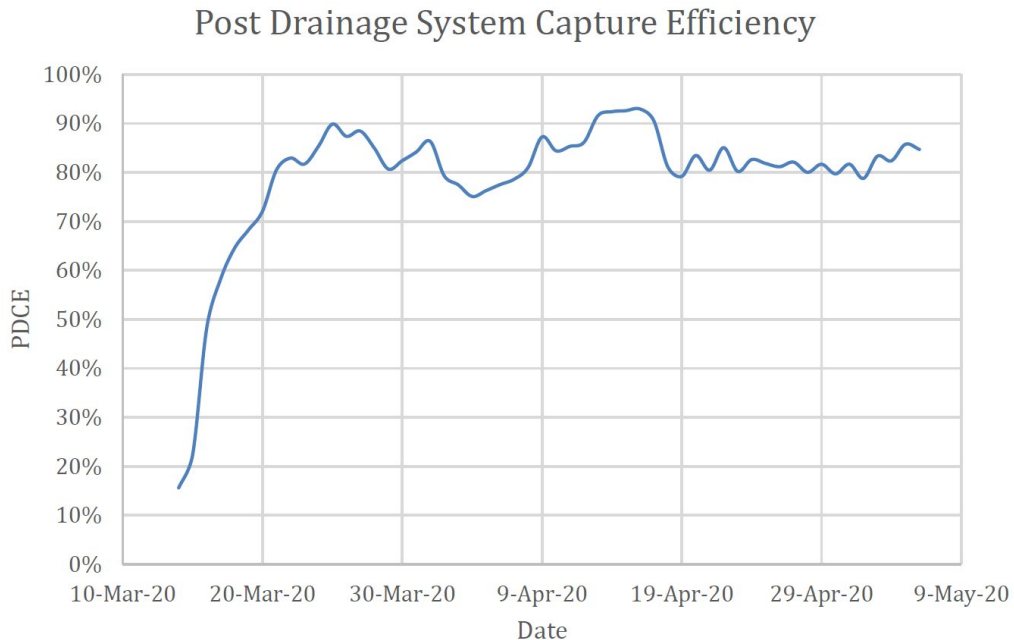


Figure 47: Post-drainage system capture efficiency

4.114 Dr Moreby’s 2010 prediction of SGE was 14.4 m³/t. Mr Self agreed that it would be reasonable for a mine to expect to deal with that level of gas emission through its ventilation and post-drainage.³⁷⁴ However, that early prediction was no more than indicative, and involved a considerable margin of error. As has already been seen, the P seam drainage strategy outlined in the goaf drainage risk assessment had been abandoned prior to production. As to the significance of P seam drainage, Mr Self commented:³⁷⁵

It is clear that at Moreby’s predicted gas emission rates, pre-drainage of the P-Seam would be a marginal requirement. At actual gas emission rates, it would be close to essential.

4.115 When emissions to the workings at LW 104 soon proved to be much greater than the predictions, Grosvenor was caught short, not having sufficient post-drainage capacity for its targeted production.

³⁷² SAN.001.001.0001, .0022.

³⁷³ SAN.001.001.0001, .0028.

³⁷⁴ TRA.500.021.0001, .0009, lines 18–24.

³⁷⁵ SAN.999.003.0001, .0003.

- 4.116 Grosvenor’s PDCE was not sufficiently high to manage the emissions, given the SGE of 25 m³/t, at its rate of production. Mr Self said that very few conventional vertical post-drainage systems would average 90% PDCE.³⁷⁶ This evidence indicates that Grosvenor should have reduced its level of production, once it understood the SGE to be significantly greater than had been modelled by Dr Moreby, so as to ensure that emissions could be captured in accordance with its PDCE. In particular, it can be seen from Figure 47 above that Grosvenor’s PDCE (at average 83%) was not high enough to manage gas emissions at a production rate of 15,000 tonnes daily, a rate which was regularly exceeded.
- 4.117 The graph above at Figure 46 illustrates that the mine’s actual PDCE would allow production of 10,000 tonnes daily, or 70,000 tonnes weekly, given the SGE of 25 m³/t.³⁷⁷
- 4.118 However, as can be seen from the following table, the mine planned for, and achieved, production in excess of this in most of the weeks that LW 104 was in production:³⁷⁸

WEEK (2020)	PRODUCTION IN TONNES			
	PLANNED WEEKLY	PLANNED DAILY (average)	ACTUAL WEEKLY	ACTUAL DAILY (average)
2-8 March	41,128.55	5,876	0	0
9-15 March	57,570.76	8,224	48,400	6914
16-22 March	116,750.57	16,679	147,819	21,117
23-29 March	104,953.80	14,993	90,826	12,975
30 March-5 April	103,623.49	14,803	126,820	18,117
6-12 April	98,883.56	14,126	130,866	18,695
13-19 April	103,673.48	14,810	51,690	7,384
20-26 April	107,902.12	15,414	158,151	22,593
27 April-3 May	109,103.06	15,586	105,343	15,049
4-9 May	109,069.87	15,581	14,683	7,342

Figure 48: LW 104 production

- 4.119 Mr Self was asked whether there was a connection between the deficiency in PDCE required, and the HPIs. He had the following exchange with Counsel Assisting:³⁷⁹

Q. Is there any connection, in your view, between the recurrence of those incidents and the figures that we've been speaking about in terms of how much gas was being generated at 104?

³⁷⁶ TRA.500.021.0001, .0016, lines 32–38.

³⁷⁷ SAN.999.003.0001, .0003.

³⁷⁸ AGM.003.001.0063, .0067; AGM.003.001.0068, .0072; AGM.003.001.0073, .0077. Table prepared by the Board of Inquiry. Actual weekly production figures include the survey adjustment. Note that in the week of 4–9 May the serious accident occurred on 6 May and data are only available for 2 days of production.

³⁷⁹ TRA.500.021.0001, .0020, line 43–.0021, line 6.

A. I think so. The system would be designed for a certain SGE. When that SGE didn't eventuate, and it was much higher, then the post-drainage capture efficiency required to keep the tailgate gas concentration down to acceptable levels would increase. The post-drainage efficiency being achieved I don't think was high enough to achieve that.

4.120 At the least, high gas emission rates, absence of pre-drainage or other form of diversion of gas from surrounding seams, and a goaf drainage system not achieving the necessary PDCE for the rate of production, made LW 104 susceptible to methane exceedances from the range of causes the Board has seen in the course of the Inquiry, for example, goaf falls, equipment failure, poor mining practice in managing ventilation control devices, and barometric pressure changes.

Decision to undertake bi-directional mining

4.121 The timeline in the LFI report (Appendix 11 of that report) for the first spate of HPIs at LW 104 records a decision made at an unspecified date in March 2020, but presumably before commencement of mining on 9 March, to change 'LW 104 planned Uni-Di operation to Bi-Di operation for increased production profile':³⁸⁰

March 2020	Issues at MNM prompted change in LW014 planned Uni-Di operation to Bi-Di operation for increased production profile.
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Figure 49: Timeline extract

4.122 Mr Self explained in his evidence that bi-di cutting is more productive, but increases methane emissions. He said:³⁸¹

In uni-directional cutting the shearer takes a proportion of the coal seam each time it passes across the face and on the repeat run it takes out the floor, the bench left behind, which means it has to do two runs up and down the face to get one shear of coal off. In bi-di cutting, the whole seam is taken each pass and it is therefore more productive and it would therefore create more gas.

4.123 The inference from the timeline entry above is that some unstated issue to do with production at Moranbah North mine prompted a change to a more productive cutting method at LW 104, notwithstanding that increased gas emissions would result. The decision was made with awareness of the issues to do with P seam drainage and the gas hazards anticipated to be encountered from the commencement of mining of LW 104.

³⁸⁰ AAMC.001.003.0030, .0048. The reference to MNM is likely 'Moranbah North Mine'.

³⁸¹ TRA.500.021.0001, .0015, lines 30–43.

Findings

Finding 30

The Board makes the following findings in relation to planning for gas management on longwall 104 (LW 104):

- a. The Goonyella Middle (GM) seam was adequately pre-drained before mining commenced;
- b. No pre-drainage of the Goonyella Middle Lower (GML) seam was undertaken;
- c. The P seam had been partly drained by Arrow Energy prior to mining, but Grosvenor's advisors recommended further pre-drainage of the P seam;
- d. Grosvenor attempted pre-drainage of the P seam for LW 104. This was unsuccessful and was abandoned;
- e. By September 2019, the mine was aware of the potential for gas emissions to the LW 104 goaf from the Fairhill (FH) and QA seams, and had been advised to increase gas drainage capacity to provide for it;
- f. The Venting Trial resulted in close spacing (25 metres) of tailgate goaf wells becoming a central component of the gas management strategy for LW 104;
- g. In lieu of pre-drainage of the P seam, Grosvenor proposed utilising surface to in-seam (SIS) lateral wells as a form of post-drainage, once mining commenced. These were intended to intercept P seam gas before entering the goaf. This was another central feature of gas management strategy for LW 104;
- h. The original proposal in the Grosvenor gas plan was for three lateral wells to the P seam. This was reduced to two by the time of the goaf drainage risk assessment;
- i. The P seam lateral well strategy was abandoned when the first attempt to drill a lateral well failed, and drilling of the second well did not fit the timetable for commencement of production on LW 104;
- j. Grosvenor was aware that increased emissions would occur in the early stages of retreat on LW 104 through the absence of pre-drainage of the P seam, and for other reasons;
- k. In the event, an important part of the gas management strategy decided upon was abandoned. Gas drainage management became fundamentally reliant on the effectiveness of the strategy of close spacing of the tailgate goaf wells, and on the operation of the goaf wells as a whole;

- l. A concern about the prospect of the close spacing of the tailgate goaf wells having implications for increased oxygen in the goaf was noted in the goaf drainage risk assessment but, to the knowledge of mine management, no specific spontaneous combustion risk assessment for the strategy was conducted prior to commencement of, or during, mining of LW 104;
- m. Mining on LW 104 should not have commenced without that spontaneous combustion risk assessment being conducted;
- n. Just prior to commencement of mining, a decision was made to use bi-directional mining instead of uni-directional, to increase production. That choice would have resulted in an increase in gas emissions;
- o. The mine's secondary extraction standard operating procedure (SOP) and risk assessment were notified to the Inspectorate on 6 March 2020 (three days before commencement of mining). Both documents represented that the P seam lateral strategy would be implemented, although by that date this was no longer the case;
- p. Further, the Inspectorate was not told that there had been no re-evaluation of risk as a consequence of the P seam lateral drainage strategy being abandoned; and
- q. Although there was no obligation to do so, the Inspectorate was not advised at any time that no risk assessment for spontaneous combustion associated with increased goaf drainage at LW 104 had been conducted, nor that none would be conducted until the end of May 2020, well after production commenced.

Finding 31

Gas emissions at LW 104 were substantially greater than at LW 103 over the first 400 metres of retreat, and in excess of predictions.

Finding 32

Specific gas emission (SGE) at LW 104 was around 25 m³/t, and greater than anticipated.

Finding 33

In the absence of pre-drainage, or other effective strategy to divert gas from surrounding seams, management of gas emissions was wholly reliant on post-drainage and ventilation.

Finding 34

The actual daily production at LW 104 between March and May 2020 fluctuated. It was frequently in the range of 15,000–20,000 tonnes, and sometimes more, up to 28,000 tonnes.

Finding 35

Post-drainage capture efficiency (PDCE) of methane was not high enough to efficiently capture emissions produced at the rate of production pursued.

Finding 36

The PDCE achieved allowed production at the rate of around 10,000 tonnes daily for an SGE of 25 m³/t.

Finding 37

High gas emission rates, absence of pre-drainage or other form of diversion of gas from surrounding seams, and a goaf drainage system not achieving the necessary PDCE for the rate of production, made LW 104 susceptible to methane exceedances.

Recommendations

Recommendation 1

In light of the Board's finding that mining operations were repeatedly conducted in a manner whereby the gas emissions being generated by the rate of production were in excess of the capacity of the mine's gas drainage system, Grosvenor mine management:

- a. audits and reviews the effectiveness and implementation of the principal hazard management plans for gas management and methane drainage, to ensure that, in future, the risk to persons from coal mining operations is at an acceptable level;
- b. reviews the effectiveness of the mine's operational practices and management systems, to ensure that, in future, production rates are adjusted to match a realistic PDCE and the actual peak specific gas emissions; and
- c. carries out detailed gas reservoir analysis to identify opportunities for gas pre-drainage, or other means of capture of gas before entering longwall workings, and specifically that this analysis include the FH, QA and QB seams.

Recommendation 2

Prior to the commencement of each longwall panel, coal mines arrange a review, to be validated by a third party independent engineering study:

- a. to ensure that adequate gas pre-drainage has been implemented, taking into account a margin for error in any predictive modelling; and
- b. to ensure that adequate post-drainage capabilities are in place, taking into account a margin for error in any predictive modelling.

Recommendation 3

In light of the evidence that gas emission modelling is inherently flawed, with a high margin of error, coal mines, at the time of undertaking second workings risk assessments:

- a. Critically assess and scrutinise any gas emission modelling for an upcoming longwall panel. The assessment should include a review of the model's predictive accuracy for previous longwalls;

- b. Take steps to satisfy themselves that sufficient pre-drainage has in fact been undertaken to the extent reasonably necessary to reduce gas emissions to a safe level;
- c. Ensure post-drainage systems are designed:
 - i. with sufficient redundancy to cope with peak gas emissions, including a factor of safety in drainage capacity, and allowing for system failures; and
 - ii. in such a way that the risk of spontaneous combustion is not increased by oxygen ingress to the goaf;
- d. Ensure ventilation systems are designed in such a way as to ensure they work in combination with the post-drainage system to dilute predicted peak gas emissions to levels that achieve an acceptable level of risk.

Chapter 5 – 14 HPIs at Grosvenor Longwall 104 in 2020

- 5.1 Longwall 104 (LW 104) commenced production on 9 March 2020. The first methane exceedance high potential incident (HPI) occurred nine days later, on 18 March 2020. It was the fourteenth methane exceedance HPI at Grosvenor mine (Grosvenor) since 1 July 2019.
- 5.2 Between 18 March and 6 May 2020, there were 14 methane (CH₄) exceedance HPIs on LW 104. This section considers the circumstances of those 14 methane exceedance HPIs. The summaries that follow are derived from the mine’s own investigation reports.

HPI # 14 – 18 March 2020

- 5.3 On 18 March 2020, mining operations proceeded normally for most of the day. The hazard and incident report form (HIRF) recorded that the inbye sensor was stable at 2.12% as the shearer was cutting into the tailgate (TG) until, at 9:33pm, the reading on the inbye sensor spiked to 2.42% and the shearer stopped at shield #140. The methane reading on the inbye sensor peaked at 2.56% before quickly coming down. At 10:00pm, the outbye sensor reached a peak of 2.3%.³⁸²
- 5.4 The actual and potential consequence of the incident was assessed on the HIRF as follows.³⁸³

Refer to attached Grosvenor Risk Matrix for below:					
Actual Consequence: Not Applicable for Hazards	Insignificant (first aid case, damage 0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1- 1.0% annual revenue)	High (permanent disability/ fatality, Anglo HPI)	Major (numerous permanent disabilities/fatalities, Anglo HPI)
Potential Consequence:	Insignificant (first aid case, damage 0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1- 1.0% annual revenue)	High (permanent disability/ fatality, Anglo HPI)	Major (numerous permanent disabilities/fatalities, Anglo HPI)
Has the hazard, defect or incident been effectively controlled on shift?				YES <input checked="" type="checkbox"/>	NO <input type="checkbox"/>

Figure 50: HIRF Risk Matrix for HPI on 18 March 2020

- 5.5 The notation ‘DNRM HPI’ was made on the top of the form.³⁸⁴
- 5.6 The incident was reported by the Underground Mine Manager, Mr Wouter Niehaus, to Inspector Malcolm Brownnett at 6:00am the following day, 19 March 2020, when Inspector Brownnett was attending the mine for a planned inspection.³⁸⁵ The incident was reported to Industry Safety and Health Representative (ISHR) Mr Stephen Woods at 5:02pm.³⁸⁶

Inspector Brownnett was informed that the cause of the HPI was that the ventilation had scoured the goaf and pulled some of the goaf gases out from behind the shields while the shearer was in the tailgate area.³⁸⁷

³⁸² AAMC.001.003.0030, .0035; .0053–.0054.

³⁸³ AAMC.001.003.0030, .0053.

³⁸⁴ AAMC.001.003.0030, .0053.

³⁸⁵ AAMC.001.009.0288; TRA.500.014.0001, .0076, lines 8–29.

³⁸⁶ AAMC.001.009.0288.

³⁸⁷ AAMC.001.009.0288; TRA.500.014.0001, .0076, lines 35–42.

5.7 The Form 1A indicated that the inbye sensor had registered a peak of 2.56% and the methane concentration exceeded 2.5% for 120 seconds. The outbye sensor did not record an exceedance but it did record a peak of 2.3% at 10:00pm. The shield #149 sensor had not registered an exceedance, and its peak reading at the relevant time was 0.97%.³⁸⁸

HPI # 15 – 19 March 2020

5.8 The next methane exceedance occurred the following morning, 19 March 2020.

5.9 The HIRF recorded that, at 6:00am, the shearer was stopped at shield #115 because the methane concentration had earlier exceeded 1.9%. When the gas level did not decrease, a decision was made to start maintenance with the shearer in that position. During double-chocking of the face from shields #125 to #139, the inbye sensor recorded a reading of 2.57% at 6:43am, with a peak reading of 3.01% at 6:51am. The methane concentration recorded at that sensor remained above 2.5% until 7:52am.³⁸⁹

5.10 The actual and potential consequence of the incident was assessed on the HIRF as follows:³⁹⁰

Refer to attached Grosvenor Risk Matrix for below:					
Actual Consequence: Not Applicable for Hazards	Insignificant (lost acc case, damage +0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1- 1.0% annual revenue)	High (permanent disability/ fatality, Anglo HPI)	Major (numerous permanent disabilities/fatality, Anglo HPI)
Potential Consequence: (lost acc case, damage +0.01% annual revenue etc)	Insignificant (lost acc case, damage +0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1- 1.0% annual revenue)	High (permanent disability/ fatality, Anglo HPI)	Major (numerous permanent disabilities/fatality, Anglo HPI)
Has the hazard, defect or incident been effectively controlled on shift?				YES <input checked="" type="checkbox"/>	NO <input type="checkbox"/>

Figure 51: HIRF Risk Matrix for HPI on 19 March 2020

5.11 The notation 'DNRM HPI' was made on the top of the form.³⁹¹

5.12 Inspector Brownett was notified about the incident during his inspection.³⁹² ISHR Woods was notified at 5:02pm.³⁹³

5.13 The Form 1A confirmed the matters set out in the HIRF. It included an additional detail that, at the time of the event, the shearer had been on stop for 175 minutes. It indicated that the inbye sensor had peaked at 3.01% at 6:50am and had remained above 2.5% for 43 minutes.

The outbye sensor had peaked at 2.5% at 7:22am but had not recorded an exceedance. The shield #149 sensor had not recorded an exceedance, and, at the relevant time, its peak reading was 0.94%.³⁹⁴

³⁸⁸ AAMC.001.009.0288, .0288-.0289.

³⁸⁹ AAMC.001.003.0030, .0049; .0055.

³⁹⁰ AAMC.001.003.0030, .0055.

³⁹¹ AAMC.001.003.0030, .0055.

³⁹² TRA.500.014.0001, .0076, lines 8-33.

³⁹³ AAMC.001.009.0290.

³⁹⁴ AAMC.001.009.0290, .0292.

5.14 The Form 1A also recorded that goaf skid GMS11 on goaf drainage hole GRO4V002A had been experiencing filter blockages with fine materials prior to the exceedance. The blockage had restricted the hole flow and contributed to the gas exceedance.³⁹⁵ It was noted that, '[g]oing forward a dual skid will be set up on hole GRO4V002A to allow cleaning of the filters without compromising goaf drainage'.³⁹⁶

HPI # 16, # 17 & # 18 – 20 March 2020

5.15 There were three exceedances the next day, 20 March 2020.

HPI # 16 – 20 March 2020 at 2:02am (incident one of three)

5.16 At 1:52am, the shearer was stopped at shield #108 to allow further cleaning of the flame arrestor on goaf skid GMS11 attached to goaf drainage hole GRO4V002A, due to low flow. While the shearer was stopped, the inbye sensor recorded a reading of 2.51% at 2:02am and a peak reading of 2.86% at 2:32am.³⁹⁷

5.17 The actual and potential consequence of the incident was assessed on the HIRF as follows.³⁹⁸

Refer to attached Grosvenor Risk Matrix for below:					
Actual Consequence: Not Applicable for Hazards	Insignificant <small>(Best case case, damage <0.01% annual revenue etc)</small>	Minor <small>(medical treatment, damage 0.01-0.1% annual revenue)</small>	Moderate <small>(lost time injury, damage 0.1-1.0% annual revenue)</small>	High <small>(permanent disability/ fatality, Anglo HPI)</small>	Major <small>(numerous permanent disabilities/ fatalities, Anglo HPI)</small>
Potential Consequence:	Insignificant <small>(Best case case, damage <0.01% annual revenue etc)</small>	Minor <small>(medical treatment, damage 0.01-0.1% annual revenue)</small>	Moderate <small>(lost time injury, damage 0.1-1.0% annual revenue)</small>	High <small>(permanent disability/ fatality, Anglo HPI)</small>	Major <small>(numerous permanent disabilities/ fatalities, Anglo HPI)</small>
Has the hazard, defect or incident been effectively controlled on shift?				YES <input checked="" type="checkbox"/>	NO <input type="checkbox"/>

Figure 52: HIRF Risk Matrix for HPIs on 20 March 2020 (1 of 3)

5.18 The notation 'DNRM HPI' was made on the top of the form.³⁹⁹

5.19 The incident was reported by Mr Niehaus to Inspector Paul Brown at 6:45am and ISHR Woods at 6:56am.⁴⁰⁰

5.20 The Form 1A confirmed the matters set out in the HIRF. It indicated that the inbye sensor had peaked at 2.84% at 2:30am and remained above 2.5% for 26 minutes. The outbye sensor peaked at 2.57% at 2:54am and remained above 2.5% for 11 minutes. The shield #149 sensor had not recorded an exceedance.⁴⁰¹

³⁹⁵ AAMC.001.009.0290, .0292.

³⁹⁶ AAMC.001.009.0290, .0292.

³⁹⁷ AAMC.001.003.0030, .0057.

³⁹⁸ AAMC.001.003.0030, .0057.

³⁹⁹ AAMC.001.003.0030, .0057.

⁴⁰⁰ AAMC.001.009.0294.

⁴⁰¹ AAMC.001.009.0294, .0295.

5.21 As with HPI # 15, the Form 1A attributed the cause of the exceedance to a blockage on the goaf skid on goaf drainage hole GRO4V002A. It was again noted that, '[g]oing forward, a dual skid will be set up on the hole to allow cleaning of the filters without compromising goaf drainage'.⁴⁰²

HPI # 17 – 20 March 2020 at 3:28am (incident two of three)

5.22 The next exceedance occurred approximately one and a half hours later. At 3:25am, the shearer started cutting again after the gas concentration dropped to 1.86%. However, a few minutes later, at 3:28am, the inbye sensor recorded a further exceedance of 2.55%.⁴⁰³

5.23 The potential and actual consequence of the incident was assessed on the HIRF as follows:⁴⁰⁴

Refer to attached Grosvenor Risk Matrix for below:					
Actual Consequence: Not Applicable for Hazards	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1- 1.0% annual revenue)	High (permanent disability/ fatality, Anglo IPR)	Major (lifelong permanent disability/fatality, Anglo IPR)
Potential Consequence:	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1- 1.0% annual revenue)	High (permanent disability/ fatality, Anglo IPR)	Major (lifelong permanent disability/fatality, Anglo IPR)
Has the hazard, defect or incident been effectively controlled on shift?				YES <input checked="" type="checkbox"/>	NO <input type="checkbox"/>

Figure 53: HIRF Risk Matrix for HPI on 20 March 2020 (2 of 3)

5.24 The notation 'DNRM HPI' was made on the top of the form.⁴⁰⁵

5.25 The incident was reported by Mr Niehaus to Inspector Brown at 6:45am and to ISHR Woods at 6:56am; the same time that notification about the earlier exceedance was made.⁴⁰⁶

5.26 The Form 1A confirmed the matters set out in the HIRF. It indicated that the inbye sensor peaked at 2.55% at 3:34am and the exceedance lasted one minute. The outbye sensor peaked at 2.1% at 3:59am but did not record an exceedance. The shield #149 sensor had also not recorded an exceedance. At the relevant time, the peak reading on that sensor was 0.85%.⁴⁰⁷

5.27 As with HPIs # 15 and # 16, the cause of the exceedance was attributed to the blockage of the goaf skid on goaf hole GRO4V002A.⁴⁰⁸

⁴⁰² AAMC.001.009.0294, .0295.

⁴⁰³ AAMC.001.003.0030, .0059.

⁴⁰⁴ AAMC.001.003.0030, .0059.

⁴⁰⁵ AAMC.001.003.0030, .0059.

⁴⁰⁶ AAMC.001.009.0297.

⁴⁰⁷ AAMC.001.009.0297.

⁴⁰⁸ AAMC.001.009.0297, .0298.

HPI # 18 – 20 March 2020 at 2:40pm (incident three of three)

- 5.28 The next methane exceedance occurred at approximately 2:40pm that day. However, the HIRF for that methane exceedance recorded that there had been multiple methane stoppages between the start of the 9:30am shift and the time of that exceedance, and that there was a ‘high CH₄ environment’ that day.⁴⁰⁹
- 5.29 The HIRF recorded that, at 2:20pm, the shearer was parked at shield #103 because of high methane levels in the tailgate. At 2:40pm, the shearer was still at that location when the methane concentration exceeded 2.5% on the inbye sensor.⁴¹⁰
- 5.30 As can be seen, a notation on the HIRF by the Explosion Risk Zone (ERZ) controller on shift attributed the cause of the incident to a failure of goaf well GRO4V002A and an inadequate methane drainage system.⁴¹¹

Equipment:	1440	CH ₄ IN T/G >2.5%
- FAILURE @ GOAF WELL	1440	SECURED FACE.
- INADEQUATE CH ₄ DRAINAGE SYSTEM.		

Figure 54: HIRF for HPI on 20 March 2020 (3 of 3)

- 5.31 The potential and actual consequence of the incident was assessed on the HIRF as follows:⁴¹²

Refer to attached Grosvenor Risk Matrix for below:					
Actual Consequence: Not Applicable for Hazards	Insignificant (first and case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/ fatality, Anglo HPI)	Major (numerous permanent disabilities/fatalities, Anglo HPI)
Potential Consequence:	Insignificant (first and case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/ fatality, Anglo HPI)	Major (numerous permanent disabilities/fatalities, Anglo HPI)
Has the hazard, defect or incident been effectively controlled on shift?				YES <input checked="" type="checkbox"/>	NO <input type="checkbox"/>

Figure 55: HIRF Risk Matrix for HPI on 20 March 2020 (3 of 3)

- 5.32 The notation ‘DNRM HPI’ was made on the top of the form.⁴¹³
- 5.33 The incident was reported by Mr Niehaus to Regional Inspector of Mines (RIOM) Mr Stephen Smith at 4:51pm that day and to ISHR Woods at 4:56pm.⁴¹⁴
- 5.34 The Form 1A recorded that, at 2:17pm, the shearer was cutting towards the maingate when it stopped as a result of methane concentrations reaching 2.1% on the inbye sensor. The gas levels continued to rise and, at 2:36pm, reached 2.5% on the inbye sensor.

⁴⁰⁹ AAMC.001.003.0030, .0062.

⁴¹⁰ AAMC.001.003.0030, .0061–.0062.

⁴¹¹ AAMC.001.003.0030, .0062.

⁴¹² AAMC.001.003.0030, .0061.

⁴¹³ AAMC.001.003.0030, .0061.

⁴¹⁴ AAMC.001.009.0300.

The methane concentration on the inbye sensor peaked at 3.55% at 3:03pm and remained above 2.5% for 58 minutes. The outbye sensor peaked at 3.1% at 3:53pm and remained above 2.5% for 57 minutes. The shield #149 sensor did not record an exceedance. Its peak reading during the relevant time was 0.99%.⁴¹⁵

- 5.35 The Form 1A attributed the cause of the incident to a further difficulty with the goaf skid on goaf hole GRO4V002A. It recorded that, at the time of the incident, goaf drainage hole GRO4V002A had shut down unexpectedly due to a carbon dioxide (CO₂) cylinder losing pressure and closing the emergency shut-off valve.⁴¹⁶
- 5.36 RIOM Smith gave evidence that, at the time he received the verbal notification of this HPI, he was aware that it was the fifth methane exceedance at the mine in a little over 48 hours. He was not particularly concerned about the exceedances because they were all attributable to the failure of a single goaf skid and the mine had indicated that it planned to install a second skid in the future, so that maintenance work could be carried out without compromising goaf drainage capacity. He said:⁴¹⁷

The failure of the goaf sled arrangements to adequately remove gas from the goaf explained for me why it was reporting to the tailgate. Their solution of adding the second sled, in my mind, would adequately address that, provided it had the same capacity, and so in terms of actions that the mine could take, that seemed appropriate to me.

HPI # 19 – 22 March 2020

- 5.37 The next methane exceedance occurred two days later. This exceedance also related to a difficulty with the goaf drainage plant.
- 5.38 At 9:47am, the shearer was parked at shield #115 because methane in the tailgate exceeded 1.25%. At 10:23am, the inbye sensor detected an exceedance of 2.5%. The HIRF did not record the duration of the exceedance.⁴¹⁸
- 5.39 The actual and potential consequence of the incident was assessed on the HIRF as follows:⁴¹⁹

Refer to attached Grosvenor Risk Matrix for below:					
Actual Consequence: Not Applicable for Hazards	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical attention, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/fatality, Anglo HPI)	Major (numerous permanent disabilities/fatalities, Anglo HPI)
Potential Consequence:	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical attention, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/fatality, Anglo HPI)	Major (numerous permanent disabilities/fatalities, Anglo HPI)
Has the hazard, defect or incident been effectively controlled on shift?				YES <input checked="" type="checkbox"/>	NO <input type="checkbox"/>

Figure 56: HIRF Risk Matrix for HPI on 22 March 2020

⁴¹⁵ AAMC.001.009.0300, .0300, .0302.
⁴¹⁶ AAMC.001.009.0300, .0300; .0302.
⁴¹⁷ TRA.500.014.0001, .0083, lines 36–46.
⁴¹⁸ AAMC.001.003.0030, .0063–.0064.
⁴¹⁹ AAMC.001.003.0030, .0063.

- 5.40 The notation 'DNRM HPI' was made on the top of the form.⁴²⁰
- 5.41 The incident was reported by Mr Niehaus to RIOM Smith at 6:15pm and ISHR Woods at 6:21pm that evening.⁴²¹
- 5.42 The Form 1A recorded that, at 9:15am, the shearer was cutting into the tailgate when it stopped at shield #115 due to '6 hr max CH₄ rise of 1.25%'. At 10:24am, an exceedance of 2.54% occurred on the inbye sensor. The exceedance lasted for three minutes. The outbye sensor recorded an exceedance of 2.54% at 10:50am which lasted for six minutes. The shield #149 sensor did not record an exceedance. The peak reading on that sensor at the relevant time was 1.08%.⁴²²
- 5.43 The Form 1A noted that an electrician was carrying out a manual oxygen calibration on the 'goaf plant', resulting in the vacuum pumps tripping, causing the gas to start rising.⁴²³
- 5.44 It was noted that, 'going forward a [sic] extra pump (capable of 800+ l/s) external to existing arrangement set up to assist with unexpected outages'.⁴²⁴
- 5.45 RIOM Smith gave evidence that, when he was informed about this incident, he concluded that it was a result of human error. He did not deploy anyone to the mine to follow up on the incident in light of the mine's indication that it was putting a second sled in place to try to avoid the exceedances in the future.⁴²⁵

HPI # 20 – 23 March 2020

- 5.46 The next methane exceedance occurred less than 24 hours later.
- 5.47 At 5:31am on 23 March 2020, the shearer was pulled up at shield #70 due to elevated tailgate gas. At 6:33am, a methane exceedance was recorded on the outbye sensor. At 6:56am, the methane concentration on that sensor peaked at 2.55%.⁴²⁶
- 5.48 The actual and potential consequence of the incident was assessed on the HIRF as follows:⁴²⁷

Refer to attached Grosvenor Risk Matrix for below:					
Actual Consequence: Not Applicable for Hazards	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/ fatality, Arglo HPI)	Major (serious permanent disability/ fatality, Arglo HPI)
Potential Consequence:	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/ fatality, Arglo HPI)	Major (serious permanent disability/ fatality, Arglo HPI)
Has the hazard, defect or incident been effectively controlled on shift?				YES <input checked="" type="checkbox"/>	NO <input type="checkbox"/>

Figure 57: HIRF Risk Matrix for HPI on 23 March 2020

⁴²⁰ AAMC.001.003.0030, .0063.

⁴²¹ AAMC.001.009.0304.

⁴²² AAMC.001.009.0304, .0304–.0305.

⁴²³ AAMC.001.009.0304, .0305.

⁴²⁴ AAMC.001.009.0304, .0305.

⁴²⁵ TRA.500.014.0001, .0085, lines 23–28.

⁴²⁶ AAMC.001.003.0030, .0065–.0066.

⁴²⁷ AAMC.001.003.0030, .0065.

- 5.49 The notation 'DNRM HPI' was made on the top of the form.⁴²⁸
- 5.50 The incident was reported by Mr Niehaus to RIOM Smith at 2:47pm and to ISHR Woods at 2:51pm the same day.⁴²⁹
- 5.51 The Form 1A provided that the outbye sensor peaked at 2.55% at 7:00am and remained over 2.5% for 95 minutes. There was no exceedance on either the inbye sensor or the shield #149 sensor.⁴³⁰
- 5.52 The Form 1A attributed the cause of the incident to a restriction in the detonation arrestor on goaf hole GRO4V001 resulting in a reduction in its drainage capacity from 1400 l/s to 1100 l/s. The reduction in vacuum resulted in methane reporting to the tailgate roadway.⁴³¹
- 5.53 RIOM Smith gave evidence that he considered that this incident was also linked to the issues the mine was having with the goaf sleds. However, as the goaf hole had continued to drain gas from the goaf, he thought that the mine 'hadn't convinced themselves that they actually knew the complete reason for the exceedance'.⁴³²
- 5.54 RIOM Smith noted that the exceedance was detected on the outbye sensor and not on either of the inbye or shield #149 sensors. He concluded:⁴³³
- That the methane was either reporting to the outbye sensor, possibly from leakage through the seals between 104 and 103, or potentially exiting the 104 goaf into what they call C heading and circumventing – being able to pass down a roadway with no sensor in it before rejoining the roadway inbye of the outbye sensor.*
- 5.55 However, he did not ask any questions of the mine about that at the time or take any action in respect to the methane exceedances that had occurred to that date.⁴³⁴

The LFI report for HPIs # 14 – # 20

- 5.56 A single Learning From Incidents (LFI) report dated 3 April 2020 dealt with the seven HPIs that occurred between 18 and 23 March 2020.⁴³⁵
- 5.57 The LFI report concluded that:⁴³⁶
- a. In respect of HPI # 14, there was 'no substantial evidence' found to correlate the exceedance. Rather, the data suggested that a high goaf gas concentration had been scoured by the shearer upon entering the tailgate;

⁴²⁸ AAMC.001.003.0030, .0065.

⁴²⁹ AAMC.001.009.0307.

⁴³⁰ AAMC.001.009.0307, .0307–.0308.

⁴³¹ AAMC.001.009.0307, .0307.

⁴³² TRA.500.014.0001, .0086, lines 5–13.

⁴³³ TRA.500.014.0001, .0087, lines 1–26.

⁴³⁴ TRA.500.014.0001, .0087, lines 28–34.

⁴³⁵ AAMC.001.003.0030.

⁴³⁶ AAMC.001.003.0030, .0045.

- b. HPIs # 15 to # 19 were a result of failures in the goaf gas drainage network; and
- c. HPI # 20 was a result of a failure of the ventilation network which resulted in high purity gas from the goaf entering the ventilation of C heading via 40 cut-through.

There was no mention in the LFI report of the reduced gas flow on goaf drainage hole GRO4V001.

- 5.58 Further, the report provided that a ‘failure of the Citect alarm generation to seamgas personnel impacted the reaction time to any issue’. The report made reference to the fact that goaf hole GRO4V002A had been ‘intended as a P seam vertical well for pre-drainage’. It provided:⁴³⁷

Hole GR04V002A was intended as a P seam vertical well for pre drainage, its location allowed capture of very high gas flow at high purity most likely from the P seam. This hole was not cased as a normal goaf hole which allowed impurities to enter the goaf hole and block the flame arrestor. The faceline start of LW104 is in close proximity to the GDP and following improvements to the poly pipe spine network higher than normal well head suction pressure was available to each goaf hole. The hole also intersects a 1.2m fault plane potentially creating a conduit for multiple coal seam gas collection

- 5.59 The mine did not consider that any critical controls had failed.⁴³⁸ This was a finding which was repeated in respect of each LFI process for the methane exceedance HPIs on LW 104.
- 5.60 As can be seen from the event factors listed below, the most substantial causal factor was found to be the incomplete P seam drainage and lateral hole drilling:⁴³⁹

Individual Factors	Nil
Workplace Factors	P seam gas drainage not completed to proposed strategy to allow LW104 unconstrained production from gas delays. Lateral hole drilling experiencing numerous delays when drilling through fault planes.
Organisational Factors	Citect alarm system faulted with no alarm of the failure to a server. IMT process has no formal document to underpin the system of action allocation and acknowledgement.

Figure 58: LFI Event Factors for HPIs between 18 and 23 March 2020

⁴³⁷ AAMC.001.003.0030, .0045. ‘GDP’ means either gas drainage plant or goaf drainage plant.

⁴³⁸ AAMC.001.003.0030, .0045.

⁴³⁹ AAMC.001.003.0030, .0045.

- 5.61 References to the mine’s awareness of the significance of the failure to drain the P seam were repeated throughout the report. The failure to drain the P seam was identified as a relevant factor in the ‘Control Analysis’, which concluded that:⁴⁴⁰
- a. the goaf skid flame arrestor was blocked causing loss of suction on goaf holes;
 - b. the CITECT alarming system was inoperable;
 - c. the P seam lateral gas drainage holes had failed; and
 - d. there was an absence of a defined Incident Management Team (IMT) process.
- 5.62 The ‘Why Tree Analysis’ considered the issue of the P seam drainage in further detail. It was noted that the mine was experiencing ‘greater than predicted goaf gas’ and concluded that an underlying cause of the methane exceedances was a failure by the mine to understand the timing and importance of the P seam drainage:⁴⁴¹

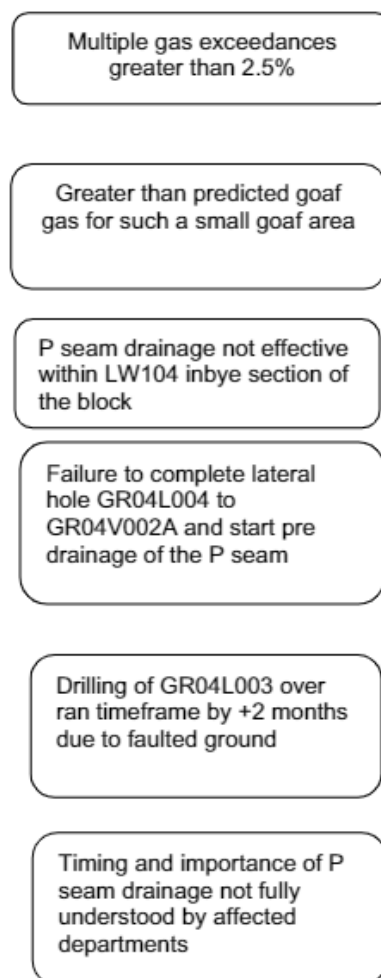


Figure 59: Why Tree Analysis on LFI for HPIs between 18 and 23 March 2020

- 5.63 Notwithstanding the mine’s awareness that there were significant deficiencies in its P seam drainage for LW 104 and that it was experiencing ‘greater than predicted goaf

⁴⁴⁰ AAMC.001.003.0030, .0051.

⁴⁴¹ AAMC.001.003.0030, .0052.

gas', the LFI report did not contain any planned actions to address the issue of greater than expected gas make for LW 104. The preventative actions were:⁴⁴²

Task Description	Hierarchy of Control	Task Assignee	Due Date	Task ID
P seam drainage strategy for each LW block to design & complete prior to LW production phase.	Engineering	G Needham	01/06/2020	TS.01303982
Investigate Citect alarm & messaging system failure and implement controls to prevent a re-occurrence.	Engineering	I Bailey	20/05/2020	TS.01303983
Document the IMT process currently used onsite for acknowledgement of action allocation & understanding.	Administration	W Niehaus	01/06/2020	TS.01303984
Investigate modifications to the goaf skid flame arrestor to allow the current fleet to be maintained whilst remaining in service.	Engineering	C Englebrecht	01/06/2020	TS.01303985
Ventilation network for LW tailgates to assess for risk of failure when using dual return roadways.	Engineering	H Heame	30/06/2020	TS.01303986
Amend the gas drainage TARP to add guidance for high flow goaf hole maintenance practices.	Administration	C Englebrecht	30/04/2020	TS.01303987

Figure 60: LFI Preventative Actions / Recommendations for HPIs between 18 and 23 March 2020

- 5.64 The completed LFI report was signed off on various dates between 3 and 20 April 2020.⁴⁴³ Mr Niehaus, Mr Gary Needham, Seamgas Manager, Ms Kate Bachmann, Safety Health Environment Manager, Mr Trent Griffiths, Site Senior Executive, and Mr Glen Britton, Anglo American Metallurgical Coal (AAMC) Head of Underground Operations, were among those who signed off on it.⁴⁴⁴
- 5.65 The next HPI occurred on 4 April 2020, which was the day after Mr Needham signed off on the report, but before any of Mr Niehaus, Ms Bachmann, Mr Griffiths, or Mr Britton had done so.

The Form 5As provided to the Inspectorate on 15 April 2020

- 5.66 The mine provided the Inspectorate with the Form 5As for HPI # 14 to # 20 on 15 April 2020.

⁴⁴² AAMC.001.003.0030, .0046.

⁴⁴³ AAMC.001.003.0030, .0047.

⁴⁴⁴ AAMC.001.003.0030, .0047.

- 5.67 The Form 5A for HPI # 14 indicated that there was ‘no substantial evidence’ to explain the exceedance, but it was thought that the shearer had ‘scoured’ goaf gases as it left the tailgate.⁴⁴⁵
- 5.68 The Form 5As for HPIs # 15 to # 20 identified that an underlying cause of each of those HPIs was that the P seam drainage had not been completed to the proposed strategy to allow production in LW 104 to proceed unconstrained by gas delays.⁴⁴⁶
- 5.69 The preventative actions set out in the LFI report were included as a single paragraph in the Form 5As.
- 5.70 RIOM Smith gave evidence that he was not aware whether anyone in the Inspectorate has undertaken a collective review of the Form 5As to determine if the mine had undertaken an appropriate analysis of the March HPIs.⁴⁴⁷ He acknowledged that ‘[i]t’s certainly an activity we should do’.⁴⁴⁸
- 5.71 RIOM Smith gave evidence that the Inspectorate was already aware, before it received these Form 5As, that because the mine ‘knew they had not done enough with regard to managing the gas load on the longwall’,⁴⁴⁹ it would need to use ‘operational controls’ to ensure that methane concentrations were kept below the statutory levels.⁴⁵⁰
- 5.72 In response to a question about whether, given the Inspectorate had been notified of 10 HPIs by 15 April 2020, the mine appeared to have its methane management issues under control, RIOM Smith said, ‘they weren’t under control, but the reasons they were not under control were explained’.⁴⁵¹ Each of the HPIs was ‘operationally controllable relatively easily’ and was ‘not a highly technical thing to manage’.⁴⁵²
- 5.73 Accordingly, RIOM Smith said, the Inspectorate did not need to take any further action in relation to the HPIs, as the mine had clearly identified the cause of the HPIs and how they intended to solve them, and had communicated that information to the Inspectorate.⁴⁵³

Findings – HPIs # 14 – # 20

Finding 38

It is likely that the immediate cause of high potential incident (HPI) # 14 was the shearer scouring goaf gases as it entered the tailgate.

⁴⁴⁵ AAMC.001.009.0388, .0390.

⁴⁴⁶ AAMC.001.009.0392, .0394; AAMC.001.009.0404, .0406; AAMC.001.009.0408, .0410; AAMC.001.009.0412, .0414; AAMC.001.009.0396, .0398; AAMC.001.009.0400, .0402.

⁴⁴⁷ TRA.500.014.0001, .0105, lines 26–31.

⁴⁴⁸ TRA.500.014.0001, .0105, lines 33–34.

⁴⁴⁹ TRA.500.015.0001, .0093, lines 30–31.

⁴⁵⁰ TRA.500.014.0001, .0100, lines 22–31.

⁴⁵¹ TRA.500.014.0001, .0101, lines 19–22.

⁴⁵² TRA.500.014.0001, .0101, lines 33–36.

⁴⁵³ TRA.500.014.0001, .0102, lines 8–13.

Finding 39

The immediate cause of HPIs # 15 – # 17 was a blockage in goaf drainage hole GRO4V002A which meant the goaf drainage plant was not able to sufficiently drain goaf gases for a period of time.

Finding 40

The immediate cause of HPI # 18 was a temporary shutdown of goaf drainage hole GRO4V002A which meant the goaf drainage plant was not able to sufficiently drain goaf gases for a period of time.

Finding 41

The immediate cause of HPI # 19 was a trip on goaf drainage hole GRO4V002A which meant the goaf drainage plant was not able to sufficiently drain goaf gases for a period of time.

Finding 42

It is likely that the immediate cause of HPI # 20 was reduced gas flow on goaf drainage hole GRO4V001.

Finding 43

Systemic causes were:

- a. the failure to undertake an adequate pre-drainage regime prior to commencing production; and
- b. greater than predicted gas emissions.

HPI # 21 – 4 April 2020

5.74 At 1:05am on 4 April 2020, the shearer lost power when methane exceeded 2% on the shield #149 sensor. The area was described on the HIRF as being a 'high CH₄' environment. Brattice was erected and butcher's flaps were adjusted. At 2:22am, there was a methane exceedance while those activities were being carried out. It was found that the goaf stream was being flushed intermittently out between shields #146 and #147.⁴⁵⁴

⁴⁵⁴ AAMC.001.003.0002, .0010–.0011.

5.75 The HIRF recorded that the potential and actual consequence of the HPI was considered to be ‘minor’:⁴⁵⁵

Refer to attached Grosvenor Risk Matrix for below:					
Actual Consequence: Not Applicable for Hazards	Insignificant (No air case, damage <0.01% annual revenue etc)	Minor (No air case, damage 0.01-0.1% annual revenue)	Moderate (No time injury, damage 0.1-1.0% annual revenue)	High (Personnel disability, fatality, injury HPI)	Major (Personnel permanent disability/fatality, injury HPI)
Potential Consequence:	Insignificant (No air case, damage <0.01% annual revenue etc)	Minor (No air case, damage 0.01-0.1% annual revenue)	Moderate (No time injury, damage 0.1-1.0% annual revenue)	High (Personnel disability, fatality, injury HPI)	Major (Personnel permanent disability/fatality, injury HPI)
Has the hazard, defect or incident been effectively controlled on shift?				YES <input checked="" type="checkbox"/>	NO <input type="checkbox"/>

Figure 61: HIRF Risk Matrix for HPI on 4 April 2020

- 5.76 The notation ‘DNRM HPI’ was made on the top of the form.⁴⁵⁶
- 5.77 The incident was reported by Mr Niehaus to Inspector Matt Kennedy at 3:28pm and to ISHR Woods at 3:29pm the same day.⁴⁵⁷
- 5.78 The Form 1A recorded that, prior to the incident, the shearer was cutting towards the maingate and was stopped at shield #126 when the shield #149 sensor recorded a methane concentration of 2%. The shield #149 sensor peaked at 2.97% at 2:22am and remained above 2.5% for two minutes. Neither the inbye sensor nor the outbye sensor recorded an exceedance. The Deputy positioned hurdles to minimise the goaf stream passing over the shields in the area due to the cavity.⁴⁵⁸
- 5.79 RIOM Smith gave evidence that the Inspectorate did not take any action on this occasion. He decided none was necessary because it was the first exceedance that had been detected on the shield #149 sensor, and the exceedance had not also been detected on either the inbye or outbye sensor.⁴⁵⁹ He considered there was a ‘high likelihood’ that what was being detected was not the general body of the airway and that there was a ‘possibility’ that it was a layer of methane.⁴⁶⁰
- 5.80 Although there had been eight methane exceedance HPIs on LW 104 by this time, RIOM Smith considered that the first five HPIs were related to the goaf sleds and that the mine had ‘initiated a resolution to that’ by adding another goaf sled. As a result, he thought it would be ‘highly unlikely’ to see any further exceedances caused by that same mechanism.⁴⁶¹ He thought that the mine had been able to provide satisfactory explanations for each of the HPIs that had occurred to that date.⁴⁶²

⁴⁵⁵ AAMC.001.003.0002, .0010.

⁴⁵⁶ AAMC.001.003.0002, .0010.

⁴⁵⁷ AAMC.001.009.0310.

⁴⁵⁸ AAMC.001.009.0310, .0310; .0312.

⁴⁵⁹ TRA.500.014.0001, .0089, lines 12–35.

⁴⁶⁰ TRA.500.014.0001, .0089, lines 44–47.

⁴⁶¹ TRA.500.014.0001, .0090, lines 19–28.

⁴⁶² TRA.500.014.0001, .0090, lines 42–47.

The LFI report for HPI # 21

- 5.81 The incident was investigated as a stand-alone LFI process. The LFI report was dated 20 April 2020.⁴⁶³
- 5.82 The LFI report recorded that, at 1:05am, power to the shearer was tripped when the shield #149 sensor reached 2% methane. The methane concentration fell below 2% at 2:09am and the shearer started again. It was identified that there was a cavity above shields #146 to #148, so the shearer was moved to shield #127. At 2:22am, the goaf stream flushed over the tailgate drive resulting in a peak methane reading of 2.97% at the shield #149 sensor.⁴⁶⁴
- 5.83 The report noted that, although the mine plan provided for a sensor at shield #149, the design of the ventilation system did not include a device to prevent flushing in that area. Accordingly, after the 2% methane reading tripped the shearer, brattice was erected to prevent such an occurrence. It was while that brattice was being erected that a plug of methane was pushed over the sensor, resulting in the reading of 2.97%. The mine noted that the inbye sensor only reached 2.01% for a short time during this event.⁴⁶⁵
- 5.84 The report noted that there were multiple floor blowers across the face at shields #45, #90–#100 and #115–#125. There was a five-metre cavity at shields #145–#148.⁴⁶⁶
- 5.85 The mine did not consider that any critical controls had failed.⁴⁶⁷
- 5.86 Consistently with the finding in the LFI report for HPIs # 14 to # 20 that the mine was experiencing greater than predicted goaf gases, this LFI report also noted that gas make was greater than expected and in excess of the system’s capacity.⁴⁶⁸

Individual Factors	Nil individual factors identified
Workplace Factors	Inadequate ventilation control measures around tg drive area
Organisational Factors	Gas make (SGE) greater than expected in excess of system capacity

Figure 62: LFI Event Factors for HPI on 4 April 2020

⁴⁶³ AAMC.001.003.0002.

⁴⁶⁴ AAMC.001.003.0002, .0005.

⁴⁶⁵ AAMC.001.003.0002, .0005.

⁴⁶⁶ AAMC.001.003.0002, .0014.

⁴⁶⁷ AAMC.001.003.0002, .0005.

⁴⁶⁸ AAMC.001.003.0002, .0005.

5.87 The Control Analysis identified the following failures:⁴⁶⁹

Unwanted Event: Methane in excess of 2.5%				
Hazard: Elevated Methane				
Absent of Failed control and support systems	How did they perform?	Why did they fail or were absent?	Outcome of failed or absent controls and support systems.	Site critical control Yes or No?
Ventilation arrangements for TG drive area	Failed	Ventilation arrangement not adequate to dilute a change in goaf stream	Increase in CH4 make around TG drive area due to goaf stream flushing over drive due to cavity present	No
Longwall Ventilation Set Up Work Order	Absent	New sensor installation location	Brattice and venturis were not installed	No

Figure 63: LFI Control Analysis for HPI on 4 April 2020

5.88 The preventative measures included undertaking a review of the positioning of the shield #149 sensor, and changes to the ventilation arrangements and frictional ignition work order. As can be seen, it did not include any actions with respect to goaf drainage:⁴⁷⁰

Task Description	Hierarchy of Control	Task Assignee	Due Date	Task ID
Review the long term sustainability of the S.243A sensor under roof support #149 in consultation with DNMRE	Administration	Trent Griffiths	30/6/20	TS.01313722
Conduct trial of alternate Ventilation configurations in TG area and report to LW team upon completion	Administration	Hayden Heame	15/5/20	TS.01313723
Update GRO-4801-STD-Longwall Standard Area Management System based on Report from trial Ventilation arrangements from Vent and Gas Super	Administration	Josh Lancaster	15/6/20	TS.01313724
Review and update the frictional ignition work order to include the inspection of the brattice and venturis located with TG drive area	Administration	Josh Lancaster	08/05/20	TS.01313725

Figure 64: LFI Preventative Actions / Recommendations for HPI on 4 April 2020

⁴⁶⁹ AAMC.001.003.0002, .0009.

⁴⁷⁰ AAMC.001.003.0002, .0006.

5.89 The LFI report was completed and signed off on by the department superintendent on 5 May 2020, after several more HPIs had occurred and the day before the serious accident. It was also signed off on by Ms Bachmann, Mr Niehaus and Mr Griffiths on that day. Mr Britton signed off on it on 12 May 2020.⁴⁷¹

The Form 5A for HPI # 21

5.90 The Form 5A was lodged with the Inspectorate on 5 May 2020.⁴⁷² It identified the causes of the incident as gas make in excess of system capacity, and that there was 'no Longwall Ventilation Set Up Work Order for the new sensor installation location'⁴⁷³. The proposed preventative actions were the same as those listed in the LFI report.⁴⁷⁴

Findings – HPI # 21

Finding 44

The immediate cause of HPI # 21 was the flushing of the goaf stream over the tailgate drive.

Finding 45

The systemic cause was that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.

HPI # 22 – 6 April 2020

5.91 The next methane exceedance occurred two days later, on 6 April 2020.

5.92 At 11:10pm on 6 April 2020, the shearer stopped before there was an exceedance recorded at the outbye sensor at 11:30pm.⁴⁷⁵ The ERZ controller noted that a stopping had fallen over in the tailgate C heading at 38–39 cut-through.⁴⁷⁶

5.93 The potential and actual consequence of the incident was assessed on the HIRF as follows:⁴⁷⁷

Refer to attached Grosvenor Risk Matrix for below:					
Actual Consequence: Not Applicable for Hazards	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/fatality, Anglo HPI)	Major (numerous permanent disabilities/fatalities, Anglo HPI)
Potential Consequence:	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/fatality, Anglo HPI)	Major (numerous permanent disabilities/fatalities, Anglo HPI)
Has the hazard, defect or incident been effectively controlled on shift?				YES <input checked="" type="checkbox"/>	NO <input type="checkbox"/>

Figure 65: HIRF Risk Matrix for HPI on 6 April 2020

5.94 The notation 'DNRM HPI' was made on the top of the form.⁴⁷⁸

⁴⁷¹ AAMC.001.003.0002, .0007.

⁴⁷² AAMC.001.009.0424

⁴⁷³ AAMC.001.009.0424, .0426.

⁴⁷⁴ AAMC.001.009.0424, .0426.

⁴⁷⁵ AAMC.001.003.0016, .0028.

⁴⁷⁶ AAMC.001.003.0016, .0028.

⁴⁷⁷ AAMC.001.003.0016, .0028.

⁴⁷⁸ AAMC.001.003.0016, .0028.

- 5.95 The incident was reported by Mr Niehaus to Inspector Keith Brennan at 4:36pm and to ISHR Woods at 4:39pm the next day.⁴⁷⁹
- 5.96 The Form 1A provided that the shearer was cutting towards the tailgate when it stopped at approximately 11:09pm because the methane concentration exceeded 1.8% at the inbye sensor. At 11:31pm, 22 minutes after the shearer stopped, the outbye sensor reached 2.5%. The methane concentration recorded on the outbye sensor peaked at 2.56% at 11:37pm. It is not clear if the exceedance lasted 6 or 12 minutes.⁴⁸⁰
- 5.97 The Form 1A noted that the ERZ controller found the brattice stoppings inbye of 38 cut-through were bleeding ventilation and methane via C heading. He fixed the issue. There had also been floor blowers at the start of the shift from mid-face to the tailgate which resulted in the ERZ controller detecting methane readings of approximately 1% methane on his portable gas detector.⁴⁸¹
- 5.98 The Form 1A also noted that the goaf drainage plant was operating at maximum capacity at the time.⁴⁸²
- 5.99 The Inspectorate did not take any further action in respect of that HPI.⁴⁸³

HPI # 23 – 7 April 2020

- 5.100 There was a further methane exceedance the next day, 7 April 2020.
- 5.101 At 2:20pm, the shearer stopped at shield #15 when it was cutting towards the tailgate because methane was detected at 2.01%. The outbye sensor subsequently recorded a seven minute exceedance.⁴⁸⁴ As a result of the incident, an IMT was formed. The ERZ controller tightened up brattice at the C heading at 38-39 cut-through.⁴⁸⁵
- 5.102 The potential and actual consequence for the incident was assessed as follows:⁴⁸⁶

Refer to attached Grosvenor Risk Matrix for below:					
Actual Consequence: Not Applicable for Hazards	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/fatality, Anglo HPI)	
Potential Consequence:	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/fatality, Anglo HPI)	
Has the hazard, defect or incident been effectively controlled on shift?				YES <input checked="" type="checkbox"/>	NO <input type="checkbox"/>

Figure 66: HIRF Risk Matrix for HPI on 7 April 2020

⁴⁷⁹ AAMC.001.009.0319.
⁴⁸⁰ AAMC.001.009.0319, .0319–.0321.
⁴⁸¹ AAMC.001.009.0319, .0321.
⁴⁸² AAMC.001.009.0319, .0321.
⁴⁸³ TRA.500.014.0001, .0094, lines 12–17.
⁴⁸⁴ AAMC.001.003.0016, .0029.
⁴⁸⁵ AAMC.001.003.0016, .0029.
⁴⁸⁶ AAMC.001.003.0016, .0029.

- 5.103 The notation 'DNRM HPI' was made on top of the form.⁴⁸⁷
- 5.104 The incident was reported (along with HPI # 22) by Mr Niehaus to Inspector Brennan at 4:36pm and to ISHR Woods at 4:39pm the same day.⁴⁸⁸
- 5.105 The Form 1A provided that, at 2:21pm, the shearer was cutting into the tailgate when it stopped at shield #115 for approximately twenty minutes. A gas exceedance occurred at the outbye sensor as a result of additional 'methane make' in the inbye C heading roadway. The outbye sensor recorded a peak of 2.52% at 2:21pm, with the concentration remaining above 2.5% for approximately six minutes. Neither the inbye sensor nor the shield #149 sensor recorded an exceedance.⁴⁸⁹
- 5.106 The Inspectorate did not take any further action in respect of that HPI.⁴⁹⁰

The LFI report for HPIs # 22 – # 23

- 5.107 HPIs # 22 and # 23 were investigated as part of one LFI process. The LFI report was dated 1 May 2020.⁴⁹¹
- 5.108 The mine did not consider that any critical controls had failed.⁴⁹²
- 5.109 The mine concluded that the HPIs resulted from failed ventilation controls adjacent to the goaf which allowed goaf gases to travel down C heading through the brattice ventilation control device (VCD) to the outbye sensor. This is illustrated in the following diagram.⁴⁹³

⁴⁸⁷ AAMC.001.003.0016, .0029.

⁴⁸⁸ AAMC.001.009.0315.

⁴⁸⁹ AAMC.001.009.0315, .0315–.0317.

⁴⁹⁰ TRA.500.014.0001, .0094, lines 12–17.

⁴⁹¹ AAMC.001.003.0016.

⁴⁹² AAMC.001.003.0016, .0022.

⁴⁹³ AAMC.001.003.0016, .0021.

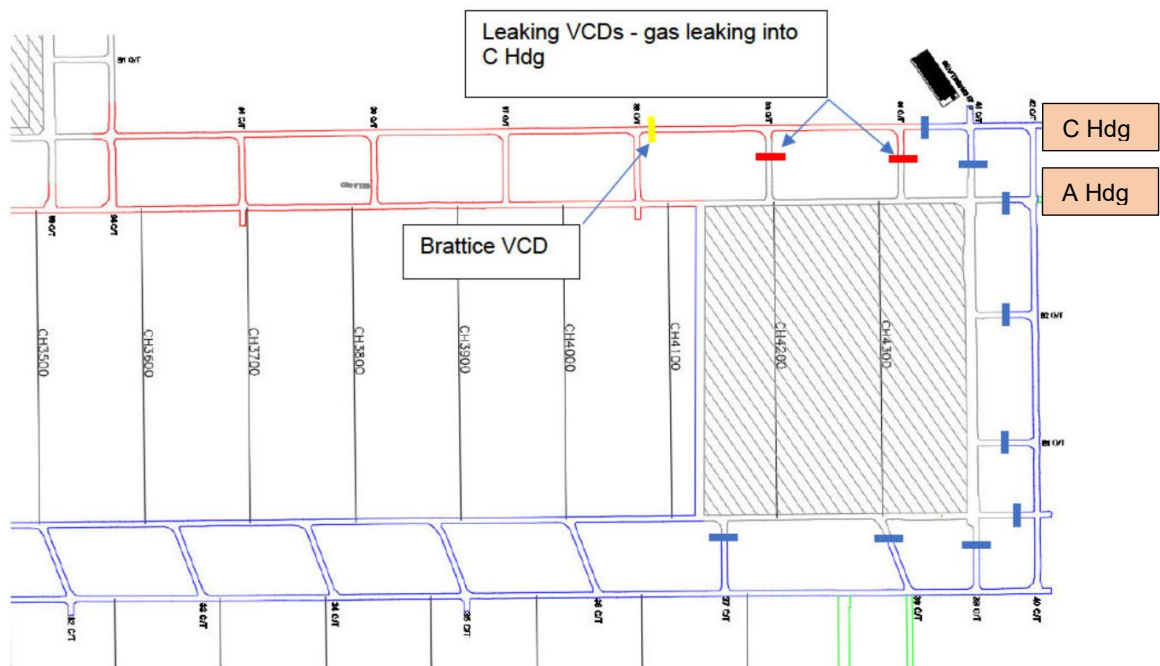


Figure 67: Leaking ventilation control devices

- 5.110 A construction of a rated seal at the site of the brattice VCD would have limited goaf gases bleeding into the C heading through the leaking VCDs.
- 5.111 As can be seen, the cause of the exceedances was attributed to less than adequate ventilation control devices and 'less than adequate methane pre-drainage/recovery/dilution':⁴⁹⁴

Individual Factors	Nil individual factors identified
Workplace Factors	Less than adequate Ventilation Control Devices to prevent goaf gasses entering C Hdg.
Organisational Factors	Less than adequate methane pre-drainage / recovery / dilution.

Figure 68: LFI Event Factors for HPIs on 6 and 7 April 2020

- 5.112 This appears to recognise that the mine's inadequate pre-drainage, or methane recovery, has resulted in higher contributions of gas into the ventilation stream, causing the exceedances on these two occasions. The reference in the LFI report to the leaking of goaf gases into the C heading does not explain the cause of the exceedances, but only the fact that they were detected on the outbye sensor, and not the inbye sensor.

⁴⁹⁴ AAMC.001.003.0016, .0022.

5.113 The findings and conclusions focused on the damaged ventilation control devices which allowed the goaf gases to bleed into the C heading roadway, and the fact that, in combination with the leaking ventilation control devices, the shearer was able to cut to the condition gate at shield #115, despite the gate having a set level of 1.8%. They provided:⁴⁹⁵

- *The VCDs within the cut-throughs are considered damaged...and are allowing the ventilation to pass through the goaf and allow gasses to bleed out into the C Hdg Roadway; and*
- *In combination with the leaking VCDs the shearer was able to cut to the condition gate at #115 before the shearer was stopped. This gate has a set level of 1.8% and when the shearer reached this gate it was at approx. 2%.*

5.114 Both of the mine’s preventative actions and recommendations were responsive to those matters. As can be seen, neither of the actions otherwise dealt with the lack of pre-drainage or the greater than expected gas make for LW 104:⁴⁹⁶

Task Description	Hierarchy of Control	Task Assignee	Due Date	Task ID
Additional Shearer gate to be installed at Shield#90	Engineering	Mathew Gleeson	9/4/20 (Completed)	TS.01313727
Upgrade and install in front of LW the VCDs in the TG (ensure the permits and vent changes are updated)	Engineering	Hayden Hearne	8/5/20 (Completed)	TS.01313728

Figure 69: LFI Preventative Actions / Recommendations for HPIs on 6 and 7 April 2020

Form 5As for HPIs # 22 and # 23

5.115 The Form 5As for HPIs # 22 and # 23 were lodged with the Inspectorate on 5 May 2020.⁴⁹⁷ They reflected, in summary form, the matters in the LFI report.

Findings – HPIs # 22 & # 23

Finding 46

It is likely that the immediate cause of HPIs # 22 and # 23 is that ineffective or damaged ventilation control devices allowed goaf gases to leak into C heading.

Finding 47

The systemic cause was that the gas emissions being generated by the mine’s rate of production were in excess of the capacity of the mine’s gas drainage system.

⁴⁹⁵ AAMC.001.003.0016, .0022.

⁴⁹⁶ AAMC.001.003.0016, .0023.

⁴⁹⁷ AAMC.001.009.0416; AAMC.001.009.0420.

HPIs # 24 – # 27 – 21 April 2020

HPI # 24 – 21 April 2020 at 12:58am (incident one of four)

- 5.116 The next methane exceedance HPI occurred on 21 April 2020. At 12:54am, the shearer stopped at shield #117. A few minutes later, at 12:58am, the shield #149 sensor recorded a methane concentration of 2.52%. The methane level recorded on that sensor peaked at 3.08% at 1:02am.⁴⁹⁸
- 5.117 The ERZ controller observed that the goaf stream appeared to be coming from shields #147 and #148 straight over the shield #149 sensor. He set up brattice in front of the shield legs at shields #145 to #149.⁴⁹⁹ He re-established the venturi and removed some butcher’s flaps. The shearer then continued to cut from shield #117 to #135 before the shield #149 sensor recorded an exceedance of 2.5% again.⁵⁰⁰
- 5.118 The potential and actual consequence of the incident was assessed on the HIRF as follows:⁵⁰¹

Refer to attached Grosvenor Risk Matrix for below:

Actual Consequence: Not Applicable for Hazards	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/fatality, Angio >4PI)	Major (numerous permanent disabilities/fatalities, Angio HPI)
Potential Consequence:	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/fatality, Angio HPI)	Major (numerous permanent disabilities/fatalities, Angio HPI)
Has the hazard, defect or incident been effectively controlled on shift?				YES <input type="checkbox"/>	NO <input type="checkbox"/>

Figure 70: HIRF Risk Matrix for HPI on 21 April 2020 (1 of 4)

- 5.119 The notation ‘DNRME HPI’ was made on the top of the form.
- 5.120 The incident was reported by Mr Niehaus to Inspector Brennan at 1:04pm and to ISHR Woods at 2:47pm on the same day.⁵⁰²
- 5.121 The Form 1A stated that the incident occurred at 12:55am, at which time the shearer was cutting towards the tailgate. At that time, the shield #149 sensor detected a methane exceedance which tripped the armoured face conveyor (AFC) and shearer when the shearer was at shield #118. The exceedance recorded on the shield #149 sensor peaked at 3.08% at 1:04am, and the methane concentration remained above 2.5% for nine minutes. Neither the inbye nor the outbye sensor recorded an exceedance.⁵⁰³

⁴⁹⁸ AAMC.001.009.0568, .0584.

⁴⁹⁹ AAMC.001.009.0568, .0584.

⁵⁰⁰ AAMC.001.009.0568, .0585.

⁵⁰¹ AAMC.001.009.0568, .0584.

⁵⁰² AAMC.001.009.0327.

⁵⁰³ AAMC.001.009.0327, .0327–.0328.

HPI # 25 – 21 April 2020 at 1:58am (incident two of four)

5.122 The next exceedance occurred about an hour later. At 1:58am, the shield #149 sensor recorded a reading of 2.64%.⁵⁰⁴

5.123 The actual and potential consequence of the incident were assessed as follows.⁵⁰⁵

Refer to attached Grosvenor Risk Matrix for below:					
Actual Consequence: Not Applicable for Hazards	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/fatality, Anglo HPI)	Major (numerous permanent disabilities/fatalities, Anglo HPI)
Potential Consequence:	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1% annual revenue)	High (permanent disability/fatality, Anglo HPI)	Major (numerous permanent disabilities/fatalities, Anglo HPI)
Has the hazard, defect or incident been effectively controlled on shift?				YES <input type="checkbox"/>	NO <input type="checkbox"/>

Figure 71: HIRF Risk Matrix for HPI on 21 April 2020 (2 of 4)

5.124 The HIRF did not have the notation ‘DNRM HPI’ on the front of it, but the incident was reported to the Coal Mines Inspectorate (the Inspectorate). Mr Niehaus verbally informed Inspector Brennan and ISHR Woods about this incident at the same time that he informed them of the earlier HPI.⁵⁰⁶

5.125 The Form 1A stated that, at 1:53am, the shearer recommenced cutting. At 1:54am, the shield #149 sensor detected an exceedance and stopped the shearer at shield #134. The exceedance peaked at 2.55% at that time and remained over 2.5% for less than one minute.⁵⁰⁷

HPI # 26 – 21 April 2020 at 1:06pm (incident three of four)

5.126 About 12 hours later, at 1:06pm, the longwall was mining through a cavity when there was another exceedance.

Whilst that exceedance was the subject of a later Form 1A, the HIRF noted there were another two events described as ‘HPI >2.5%’ – at 2:25pm and 4:50pm – which were not reported as HPIs, although it is not clear why they were not:⁵⁰⁸

⁵⁰⁴ AAMC.001.009.0568, .0578; .0590–.0591.

⁵⁰⁵ AAMC.001.009.0568, .0590.

⁵⁰⁶ AAMC.001.009.0325.

⁵⁰⁷ AAMC.001.009.0325, .0325–.0326.

⁵⁰⁸ AAMC.001.009.0568, .0586–.0587.

Peoples Behaviours:	Timeline	
	0930	SOS
	1200	TIFC
		CUT 1 SHEAR.
Environment:	1305	HPI >2.5%
* HIGH CH ₄		CUT 2 SHEAR.
* MINING THROUGH CAVITY:	1425	HPI >2.5%
		CUT 3 SHEAR.
Equipment:	1650	HPI >2.5%
* CH ₄ SENSOR IN POOR POSITION.		
Procedures:		
* SENSOR POSITIONING & ADEQUACY		

Figure 72: HIRF for HPI on 21 April 2020 (3 of 4)

- 5.127 The HIRF recorded that when the shearer left the tailgate, methane flushed from between the shields through the crushed roof. As a result, the brattice and venturis were adjusted, and an adjustment was made to the cut sequence when entering and leaving the tailgate.⁵⁰⁹
- 5.128 The actual and potential consequence of the incident was assessed as follows:⁵¹⁰

Refer to attached Grosvenor Risk Matrix for below:					
Actual Consequence: Not Applicable for Hazards	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/fatality, Anglo HPI)	Major (numerous permanent disabilities/fatalities, Anglo HPI)
Potential Consequence:	Insignificant (first aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/fatality, Anglo HPI)	Major (numerous permanent disabilities/fatalities, Anglo HPI)
Has the hazard, defect or incident been effectively controlled on shift?				YES <input checked="" type="checkbox"/>	NO <input type="checkbox"/>

Figure 73: HIRF Risk Matrix for HPI on 21 April 2020 (3 of 4)

- 5.129 The notation 'DNRM HPI' was made on the top of the form.⁵¹¹
- 5.130 The incident was reported by Mr Niehaus to Inspector Brennan at 3:15pm and to ISHR Woods at 2:47pm that day.⁵¹²
- 5.131 The Form 1A provided that, at 1:05pm, the shearer stopped at shield #141 when a gas exceedance tripped the AFC and shearer. The exceedance peaked at 2.66% and lasted less than one minute. Neither the inbye nor outbye sensor recorded an exceedance.⁵¹³ No reference was made to the other two methane exceedances recorded on the relevant HIRF.

⁵⁰⁹ AAMC.001.009.0568, .0586.

⁵¹⁰ AAMC.001.009.0568, .0586.

⁵¹¹ AAMC.001.009.0568, .0586.

⁵¹² AAMC.001.009.0323.

⁵¹³ AAMC.001.009.0323, .0323-.0324.

HPI # 27 – 21 April 2020 at 11:06pm (incident four of four)

- 5.132 The final methane exceedance of the day occurred several hours later.
- 5.133 At 10:30pm, the hose from the venturi was used to attend to an issue with the AFC. When shearing recommenced, the venturi hose was not reconnected. At 11:06pm, there was a gas exceedance recorded on the shield #149 sensor. It peaked at 5.16% at 11:08pm.⁵¹⁴
- 5.134 As a result of the incident, new brattice was run between shields #144 and #149 and the venturi was reinstalled. An additional venturi was set up at shield #145 to blow along the brattice line.⁵¹⁵
- 5.135 Despite the methane level being in the explosive range, the potential consequence was initially assessed as ‘moderate’ and subsequently downgraded to ‘minor’, as can be seen in the HIRF extract below:⁵¹⁶

Refer to attached Grosvenor Risk Matrix for below:

Actual Consequence: Not Applicable for Hazards	Insignificant (best aid case, damage <0.01% annual revenue)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/fatality, Anglo HPI)	Major (injuries permanent disabilities/fatality, Anglo HPI)
Potential Consequence:	Insignificant (best aid case, damage <0.01% annual revenue etc)	Minor (medical treatment, damage 0.01-0.1% annual revenue)	Moderate (lost time injury, damage 0.1-1.0% annual revenue)	High (permanent disability/fatality, Anglo HPI)	Major (injuries permanent disabilities/fatality, Anglo HPI)
Has the hazard, defect or incident been effectively controlled on shift?				YES <input checked="" type="checkbox"/>	NO <input type="checkbox"/>

Figure 74: HIRF Risk Matrix for HPI on 21 April 2020 (4 of 4)

- 5.136 The notation ‘DNRM HPI’ was made on the top of the form.⁵¹⁷
- 5.137 The incident was reported by Mr Niehaus to Inspector Brennan at 4:41pm and to ISHR Woods at 4:53pm the next day, 22 April 2020.⁵¹⁸
- 5.138 The Form 1A stated that, at 11:06pm, the shearer was stopped at shield #144 when a gas exceedance at the shield #149 sensor tripped the AFC and the shearer. The exceedance peaked at 5.04% at 11:11pm. The methane concentration was above 2.5% for 10 minutes.⁵¹⁹
- 5.139 RIOM Smith gave evidence that an exceedance where the methane concentration was above 5% sets off ‘alarms’ for the Inspectorate. It appears that, on this occasion, any alarm the Inspectorate might otherwise have had was tempered by the fact the exceedance was only detected on the shield #149 sensor. This caused RIOM Smith to consider the sensor was detecting the goaf stream.⁵²⁰

⁵¹⁴ AAMC.001.009.0568, .0588.

⁵¹⁵ AAMC.001.009.0568, .0588.

⁵¹⁶ AAMC.001.009.0568, .0588.

⁵¹⁷ AAMC.001.009.0568, .0588.

⁵¹⁸ AAMC.001.009.0329.

⁵¹⁹ AAMC.001.009.0329, .0329–.0330.

⁵²⁰ TRA.500.014.0001, .0110, line 12–.0111, line 13.

He was satisfied that the immediate cause of all four exceedances was the ventilation in or around the shield #149 sensor.⁵²¹

- 5.140 It is concerning that an exceedance over 5% is explained away as layering, when the *Coal Mining Safety and Health Regulation 2017* (Qld) (the Regulation)⁵²² specifically requires that the mine’s ventilation system must provide for minimising layering of noxious and flammable gases, including methane, within acceptable limits.
- 5.141 Whilst Inspector Brennan discussed the exceedances with Mr Niehaus, neither RIOM Smith nor anyone else at the Inspectorate took any action in respect of these exceedances at the time. RIOM Smith gave evidence that, as he was already planning to attend the mine for an inspection ‘in the next few weeks’ he planned to talk to the mine about these exceedances at that time.⁵²³

The LFI report for HPIs # 24 – # 27

- 5.142 The four HPIs from 21 April 2020 were dealt with as part of one LFI process. That report was dated 19 May 2020.⁵²⁴
- 5.143 In addition to the four HPIs (and the additional two exceedances at 2:25pm and 4:50pm on 21 April 2020), the LFI report considered two further events which had occurred on 22 and 23 April 2020, respectively. Those events involved methane exceedances above 2.5% which were not reported as HPIs. It is not known why they were not.
- 5.144 After considering the four HPIs, and the four additional methane exceedances, the mine concluded, in the LFI report, that none of the critical controls had failed.⁵²⁵
- 5.145 As can be seen from the extract below, the mine considered that some of the relevant factors related to the mine’s ventilation controls, but also that the gas make was greater than expected, in excess of the system.⁵²⁶

Individual Factors	Venturis within TG area had been altered
Workplace Factors	Inadequate ventilation control measures around tg drive area
Organisational Factors	Gas make (SGE) greater than expected in excess of system capacity

Figure 75: LFI Event Factors for HPIs on 21 April 2020

⁵²¹ TRA.500.014.0001, .0113, lines 21–25.

⁵²² Section 344(1)(a).

⁵²³ TRA.500.014.0001, .0111, lines 35–45.

⁵²⁴ AAMC.001.009.0568.

⁵²⁵ AAMC.001.009.0568, .0575.

⁵²⁶ AAMC.001.009.0568, .0575.

5.146 Notwithstanding the identification of the issue of greater than expected gas make, the findings and conclusions focussed solely on the ventilation issue. The findings and conclusions were:⁵²⁷

- *The VCDs within the TG drive area were not effective to dilute goaf gases when the location of the goaf stream moves with production and TG conditions. The goaf stream moved across from the tailgate roadway and through the shields because of cavities / crushed roof above the tailgate shields as the shearer existed the tailgate; and*
- *VCDs and venturi unit have been altered so that other tasks can be undertaken resulting in LTA dilution of goaf gasses [sic].*

5.147 Similarly, the Preventative Actions and Recommendations related only to the ventilation control and did not address goaf drainage. They were:⁵²⁸

Task Description	Hierarchy of Control	Task Assignee	Due Date	Task ID
Conduct trial of alternate Ventilation configurations in TG area and report to LW team upon completion	Administration	Hayden Hearne	11/08/2020	TS.01313723 AP.00782219
Update GRO-4801-STD-Longwall Standard Area Management System based on Report from trial Ventilation arrangements from Vent and Gas Super	Administration	Josh Lancaster	15/06/2020	TS.01313724 AP.00782219
Insert T-piece on air line supplying venturi at TG end of LW and tag (Do not use unless directed by ERZ Controller)	Administration	Josh Lancaster	30/8/2020	TS.01334148 AP.00786507

Figure 76: LFI Preventative Actions / Recommendations for HPIs on 21 April 2020

5.148 The LFI report was signed off on by Mr Hayden Hearne, Ventilation and Gas Superintendent, Mr Logan Mohr, Technical Services Manager, Ms Bachmann, Mr Niehaus, Mr Griffiths and Mr Britton on 8 June 2020, approximately a month after the serious accident.⁵²⁹

5.149 Inspector Smith was not aware of the additional methane exceedances which were not reported to the Inspectorate as HPIs, but which were referred to in the LFI report, until he prepared his statement for the hearings.⁵³⁰ He gave evidence that, if he had been aware of them on 21 April 2020, he would have telephoned the mine to find out why they were not notified as HPIs and may have brought his inspection, planned for 13 or 14 May 2020, forward to the next day.⁵³¹

⁵²⁷ AAMC.001.009.0568, .0576.

⁵²⁸ AAMC.001.009.0568, .0576.

⁵²⁹ AAMC.001.009.0568, .0577.

⁵³⁰ TRA.500.015.0001, .0012, line 8–.0013, line 29.

⁵³¹ TRA.500.015.0001, .0013, line 31–.0014, line 17.

5.150 The Form 5As for HPIs # 24 to # 27 were provided to the Inspectorate on 22 May 2020. They reflected, in summary form, the matters in the LFI report.⁵³²

Findings - # 24 - # 27

Finding 48

The immediate causes of HPIs # 24 to # 27 were tailgate ventilation arrangements which failed to direct methane away from the shield #149 sensor.

Finding 49

The systemic cause was that the gas emissions being generated by the mine's rate of production were in excess of the capacity of the mine's gas drainage system.

The shield #149 sensor issue

- 5.151 The sensor was placed on the canopy of shield #149, as the mine's choice of location, purportedly in compliance with section 243A of the Regulation.
- 5.152 RIOM Smith issued a Directive on 9 April 2020 that the sensor was non-compliant in that location. A dispute between Grosvenor and the Inspectorate arose following the issuing of the Directive and continued until after the serious accident. Nevertheless, the sensor was left in place by the mine.
- 5.153 The mine's documents demonstrate that, by 4 April 2020, some of the ERZ controllers had begun to question the location of the shield #149 sensor. The HIRF for the exceedance on 4 April 2020 contained the following notation:⁵³³

Action Description	By Whom	Action Due (date)	Enablon ID #
ACCESS POSITIONING OF SENSOR ESPECIALLY WITH CAVITY/POOR STRATA IN T/G	HAYDON HEARNE	24-4-20	TS-01302132 TS-01302107 TS-01302108
Conduct LFI	J.Lancaster		TS-01302109
Is a Banner Alert required to be issued? Yes <input checked="" type="checkbox"/> No <input checked="" type="checkbox"/> If yes, which Banner Alert: Green <input type="checkbox"/> Orange <input type="checkbox"/> Red <input checked="" type="checkbox"/>	M. Gleeson J. Lancaster	08/04/20	TS-01302106

Figure 77: HIRF additional actions to prevent reoccurrence for HPI on 4 April 2020

⁵³² AAMC.001.009.0428; AAMC.001.009.0432; AAMC.001.009.0436; AAMC.001.009.0440.

⁵³³ AAMC.001.003.0002, .0011.

5.154 The issue of the location of the shield #149 sensor was again raised, multiple times, on 21 and 22 April 2020. The HIRF for HPI #24 contained the following entry:⁵³⁴

Additional Actions to prevent recurrence: (ERZ Controller/ Supervisor to complete)

Action Description	By Whom	Action Due (date)	Enablon ID #
Remove #149 Sensor	J. Aogstin	29/4/20	
LFI ACTIONS (MANDATORY)	H. HEARNE		AP.00781409
Is a Banner Alert required to be issued? Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>	H. HEARNE		
If yes, which Banner Alert: Green <input type="checkbox"/> Orange <input type="checkbox"/> Red <input checked="" type="checkbox"/>			

Figure 78: HIRF additional actions to prevent recurrence for HPI on 21 April 2020 (1 of 4)

5.155 The HIRF for HPI #26 contained the following entry:⁵³⁵

Action Description	By Whom	Action Due (date)	Enablon ID #
RETHINK POSITION OR ADEQUACY OF CH₄ SENSOR ON #149.	HAYD		
NO PRACTICAL WHEN MINING THROUGH CAVITIES IN T/G AREA.	LOGAN MOHR	30-4-20	
LFI	H. HEARNE		AP.00781409
Is a Banner Alert required to be issued? Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>	H. HEARNE	27/4/20	
If yes, which Banner Alert: Green <input type="checkbox"/> Orange <input type="checkbox"/> Red <input checked="" type="checkbox"/>			

Figure 79: HIRF additional actions to prevent recurrence for HPI on 21 April 2020 (3 of 4)

5.156 The HIRF for the exceedance (not reported as an HPI) on 22 April 2020 contained the following entry:⁵³⁶

Additional Actions to prevent recurrence: (ERZ Controller/ Supervisor to complete)

Action Description	By Whom	Action Due (date)	Enablon ID #
Remove Sensor	W. NICHOLS	5/4/20	
LFI - capture in LFI	H. HEARNE		AP.00781409

Figure 80: HIRF for unreported HPI on 22 April 2020

5.157 However, it is noted that, of the 14 methane exceedances, only those that occurred on 4 April 2020 and 21 April 2020 were exceedances recorded on the shield #149 sensor.

⁵³⁴ AAMC.001.009.0568, .0585.

⁵³⁵ AAMC.001.009.0568, .0587.

⁵³⁶ AAMC.001.009.0568, .0596.

- 5.158 The remainder of the exceedances on 18 March, 19 March, 20 March, 22 March, 23 March, 6 April, and 7 April 2020 were not recorded on the shield #149 sensor. In fact, they were recorded on either the inbye or the outbye sensors or both, but not the shield #149 sensor.
- 5.159 Given that the shield #149 sensor did detect exceedances on 4 April 2020 and 21 April 2020, it was, of course, appropriate that the sensor remain in place, whether required by section 243A of the Regulation or not. It is difficult to see how the mine would satisfy its obligation to ensure that risk was at an acceptable level if it removed a sensor that was detecting methane exceedances. It is noted that section 344 of the Regulation prohibits an unacceptable layering and accumulation of methane at each working place on the longwall, which would include the canopy of the shield closest to the tailgate.

Association between production and the HPIs

- 5.160 Given the levels of SGE being experienced and the inadequacy of the mine's gas drainage at LW 104, it is instructive to compare the production rates of LW 104 with the dates on which the HPIs occurred:⁵³⁷

WEEK (2020)	PRODUCTION IN TONNES				HPIs
	PLANNED WEEKLY	PLANNED DAILY (average)	ACTUAL WEEKLY	ACTUAL DAILY (average)	
2-8 March	41,128.55	5,876	0	0	0
9-15 March	57,570.76	8,224	48,400	6,914	0
16-22 March	116,750.57	16,679	147,819	21,117	6
23-29 March	104,953.80	14,993	90,826	12,975	1
30 March-5 April	103,623.49	14,803	126,820	18,117	1
6-12 April	98,883.56	14,126	130,866	18,695	2
13-19 April	103,673.48	14,810	51,690	7,384	0
20-26 April	107,902.12	15,414	158,151	22,593	4
27 April-3 May	109,103.06	15,586	105,343	15,049	0
4-9 May	109,069.87	15,581	14,683	7,342	0

Figure 81: LW 104 production

- 5.161 A significant number of the HPIs occurred in the three weeks of highest production. The sequence was:
- The first six HPIs occurred between 18 and 22 March and the seventh occurred at 6:33am on 23 March 2020. In the week of 16 to 22 March, 147,819 tonnes of coal were produced;
 - One HPI occurred on 4 April 2020. Production for the week of 30 March to 5 April was 126,820 tonnes;

⁵³⁷ Table prepared by the Board of Inquiry. Actual weekly production figures include the survey adjustment. Note that in the week of 4–9 May the serious accident occurred on 6 May and data are only available for 2 days of production.

- Two HPIs occurred in the week of 6 to 12 April 2020, in which 130,866 tonnes of coal were produced;
- The remaining four HPIs (and four unreported methane exceedances) all occurred between 21 and 23 April 2020. Production for the week of 20 to 26 April was 158,151 tonnes.

5.162 This is depicted in the following graph:⁵³⁸

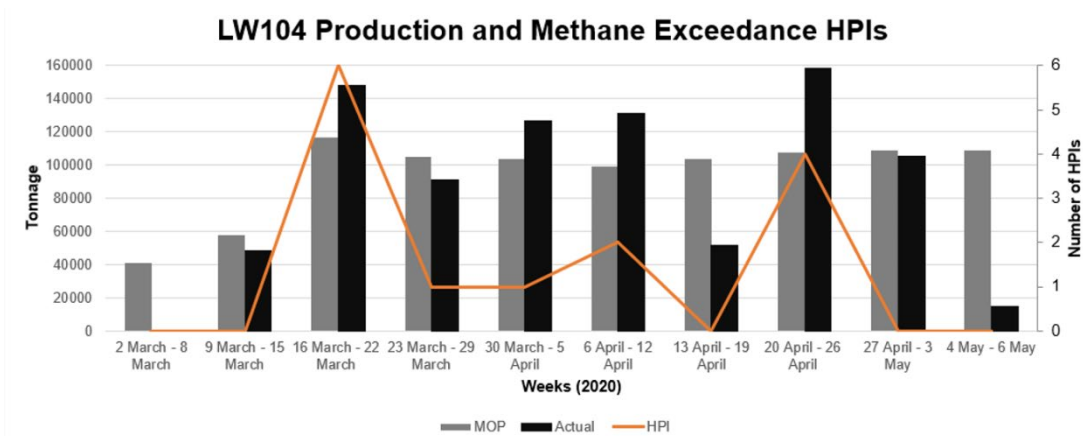


Figure 82: LW 104 production and methane exceedance HPIs

5.163 In each of these weeks, the actual production figure significantly exceeded the mine’s ‘budget target’ of 100,000 tonnes per week,⁵³⁹ in one case by more than 50%.

5.164 Each of the HPIs that occurred on LW 104 took place on days of production substantially in excess of 10,000 tonnes, with the exception of that which occurred on 19 March 2020. However, that HPI was preceded by several days on which production was significantly in excess of that figure. The relationship between the HPIs and the daily level of production is as follows:⁵⁴⁰

HPI number (#)	DATE	PRODUCTION IN TONNES
14	18 March 2020	16,735
15	19 March 2020	8,370*
16, 17 & 18	20 March 2020	17,969
19	22 March 2020	21,578
20	23 March 2020	17,392
21	4 April 2020	28,711
22 & 23	6 April 2020	27,173
24 to 27	21 April 2020	22,511

Figure 83: LW 104 production and HPIs

* The production figures for the preceding three days were 16,735, 16,999 and 19,897 tonnes.

5.165 The above review demonstrates that there is a strong correlation between the mine’s production rates and the occurrence of the HPIs.

⁵³⁸ Graph prepared by the Board of Inquiry.

⁵³⁹ As discussed in paragraph 5.170 and 5.171 below.

⁵⁴⁰ These daily production figures do not include the weekly survey adjustment.

5.166 In his evidence, Mr Tyler Mitchelson, Chief Executive of AAMC, referred more than once to the relationship between production rate and safety. He referred to a conscious decision that had been made, prior to commencement of mining of LW 104, to reduce its budgeted production. He said:⁵⁴¹

Based on the geological data we had, we knew we had gas challenges in 103, and again when we were entering the panel, we knew we were going to have those as well. We had mitigation strategies around gas drainage, again going from 50 to 25. We had gas skids that were going to be on order, but they weren't going to be there until the June time frame. So we consciously made a decision - Grosvenor, in this same section in the previous panel, did probably about 135,000 tonnes a week. We consciously made a decision to drop them to a budget target of 100,000 tonnes a week. What we didn't want is the mine to be pushing themselves over and above the capacity, either for strata management and/or gas management. So it was a decision we made to derate the production levels and the expectations to manage the safety.

5.167 Mr Mitchelson's understanding that about 135,000 tonnes per week was produced 'in the same section in the previous panel' (LW 103), is mistaken. By reference to the table in Dr Williams' report (reproduced in Chapter 4, Figure 42), one can see that for that section, over the period of 51 days, 814,966 tonnes were produced at LW 103. This is an actual average weekly production rate of about 112,000 tonnes.

5.168 However, in a submission to the Board, Anglo states that Dr Williams' figures are incorrect and that, for the relevant period, 896,786 tonnes in total were produced. Over 51 days, the average amounts to 123,088 per week. It was submitted that this figure is consistent with Mr Mitchelson's estimate of 135,000 tonnes per week.⁵⁴²

5.169 As can be seen from Figure 81, for LW 104, if the 'ramp up' week is included, the average production budget from first coal onwards was 101,278 tonnes per week, but from 16 March 2020 onwards the average was 106,744. This equates to a reduction from the production rate on LW 103 of about 16,000 tonnes per week.

5.170 According to Mr Mitchelson's evidence, the production budget for LW 104 was lowered to ensure that the mine could operate at a level consistent with its gas drainage capability. Viewed in this way, it should not have been regarded as an average weekly production target which could be exceeded if it was possible to do so, but, consistently with Mr Mitchelson's evidence, a limit intended to ensure that the capacity of the gas drainage system would not be exceeded.

⁵⁴¹ TRA.500.009.0001, .0106, line 47–.0107, line 16.

⁵⁴² Submission received from Anglo on 21 May 2021 in response to draft chapters, paragraph 69.

- 5.171 Anglo's submission also stated that '[t]he 100,000 tonnes per week that Mr Mitchelson referenced was a budget, not a mandated cap on production'. That observation cannot be gainsaid. The table (Figure 81) reflects that in four of the 8.3 weeks of production, the budgeted production of about 100,000 tonnes was greatly exceeded: 147,819, 126,820, 130,866 and 158,151.
- 5.172 Whilst it is accepted that the average weekly production rate is ordinarily regarded as the appropriate measure of the mine's production rate, it does not follow that, in the context of safely managing 'gas challenges', one can simply rely upon an average and not address the challenge on a week by week, or day by day, basis. The Board notes that Anglo's own investigation into the HPI on LW 103 that occurred on 2 July 2019 identified that:
- Production from the week prior of 83 shears and 158kt [thousand tonnes] contributed to the methane generated within the goaf and face levels.*
- 5.173 The use of average weekly production rates as a measure to control emissions is fraught, as the capacity of the goaf drainage system can be exceeded on any particular day where high production occurs. In the case of LW 104, notwithstanding the known challenges and the number of methane exceedance HPIs, the mine repeatedly compensated for low production weeks by producing well in excess of 100,000 tonnes in subsequent weeks, thus contributing to difficulties in managing methane.
- 5.174 Mr Mitchelson's evidence above referred to the anticipated arrival at Grosvenor of additional gas skids to enhance drainage capacity. However, this was not due until June 2020. In the meantime, production regularly exceeded weekly budget levels, and it has already been seen that total production was 866,780 tonnes. This was despite the abandonment of the P seam lateral strategy and the emergence of higher than expected gas make issues.
- 5.175 It was known by 3 April 2020 at the latest that the lack of P seam drainage caused or contributed to HPIs experienced between 18 and 23 March. The joint LFI report for those HPIs, dated 3 April, concluded that five of the seven HPIs 'were directly attributed to failures in the goaf drainage network'.⁵⁴³ Specifically, it concluded:⁵⁴⁴
- P seam gas drainage not completed to proposed strategy to allow LW104 unconstrained production from gas delays.*
- 5.176 It must also have been apparent to the senior mine officials and the AAMC Head of Underground Operations, who signed the report, that no measures were proposed to compensate for lack of P seam drainage at LW 104, or otherwise to mitigate the effect of the high gas emissions being experienced at its rate of production. Again, the planned increase in goaf drainage capacity was not due until June 2020. Seven further HPIs and the serious accident occurred in the interim.

⁵⁴³ AAMC.001.003.0030, .0045.

⁵⁴⁴ AAMC.001.003.0030, .0045.

- 5.177 In his evidence, Mr Mitchelson sought to emphasise that safety considerations rated ahead of production performance. He said that ‘driving the safety performance will drag the production performance. A safe mine is always a productive mine’.⁵⁴⁵
- 5.178 Mr Mitchelson had the following exchange with Counsel Assisting, to the effect that production targets should never compromise safety systems:⁵⁴⁶
- Q. You don't adapt your safety system so as to meet production targets?*
- A. No. We never do that.*
- Q. That would just be completely wrong?*
- A. Fundamentally - you know, it's against the core values of the business, it's against my own personal core values.*
- 5.179 In a further exchange with Counsel Assisting, Mr Mitchelson referred to his expectation that senior management would reduce production rates, as a short-term measure, so as not to exceed gas drainage capacity:⁵⁴⁷
- Q. So would not, at the very least, a short-term objective or a short-term solution be to reduce the production rate so as to not exceed the goaf drainage capacity?*
- A. Yes, that's absolutely an option.*
- Q. You would expect, wouldn't you, that senior management would be proposing that explicitly as a response?*
- A. Absolutely...*
- 5.180 Contrary to this evidence from Mr Mitchelson, LW 104 was consistently mined at a production rate that exceeded the capacity of its gas drainage, a critical control for the management of catastrophic risk. Specifically, contrary to Mr Mitchelson’s declared expectation, there was no adjustment to actual production, having regard to the high emissions being experienced, nor any management proposal to reduce the rate of production so as not to exceed goaf drainage capacity.
- 5.181 Anglo submitted that the LW 104 production documents show that over the 10 weeks it was in operation, the total amount budgeted for was 935,661.36 tonnes. The submission continued that ‘this averaged out over the 10 weeks of operation, amounts to 93,566.13 tonnes per week’.⁵⁴⁸
- 5.182 In respect of actual production, Anglo submitted that 866,780 tonnes were ‘produced at the Mine over the 66 days it was in operation’.

⁵⁴⁵ TRA.500.009.0001, .0106, lines 24–26.

⁵⁴⁶ TRA.500.009.0001, .0008, lines 6–12.

⁵⁴⁷ TRA.500.009.0001, .0010, lines 8–16.

⁵⁴⁸ Submission received from Anglo on 21 May 2021 in response to draft chapters, paragraph 68.

The submission stated:⁵⁴⁹

Therefore, the average weekly production rate was about 92,210.6 tonnes, again below the 100,000 tonne budget target set for the Mine, as described by Mr Mitchelson in his evidence. This is considerably lower than the average weekly production rate of about 123,088 tonnes per week for LW103...

- 5.183 Anglo further contended that these figures demonstrated that it had reduced production to meet the particular circumstances in which the mine was operating.
- 5.184 The figure of 66 days relied upon by Anglo includes the first week of 'operation' when no coal was produced.
- 5.185 First coal was not until 9 March 2020, meaning that the period of production was actually 58 days, or eight weeks and two days. Furthermore, the first week of production was a typical 'ramp up', with only 48,400 tonnes produced. If that first week of 'ramp up' is included, the average weekly production was 104,611 tonnes. After 16 March, however, the average weekly production increased to 112,326 tonnes.
- 5.186 Accordingly, the Board does not accept Anglo's contentions that the budgeted and actual production for LW 104 was below 100,000 per week, nor that Anglo reduced its rate of production to meet the high gas make being experienced at LW 104.
- 5.187 Anglo's submission contended that:⁵⁵⁰

...a conclusion that production rates ought to have been reduced to avoid HPIs is inaccurate, unwarranted and is not supported by the evidence.

Such a submission is at odds with Mr Mitchelson's evidence about the need to reduce production on LW 104 so as to avoid exceeding gas drainage capacity.⁵⁵¹ It is also irreconcilable with the mine's own repeated findings that what was required to avoid gas exceedance HPIs was 'increased goaf drainage capacity...to meet productivity targets'. It is implicit in those findings that without an increase in goaf drainage capacity, productivity targets should be revised downwards.

- 5.188 Producing coal at a rate that consistently exceeds the capacity of the critical control of gas drainage subjects coal mine workers to an unacceptable level of risk. It follows that coal mine workers on LW 104 were, at least from 16 March 2020,⁵⁵² repeatedly subject to an unacceptable level of risk.

⁵⁴⁹ Submission received from Anglo on 21 May 2021 in response to draft chapters, paragraph 71.

⁵⁵⁰ Submission received from Anglo on 21 May 2021 in response to draft chapters, paragraph 65.

⁵⁵¹ See paragraph 5.166.

⁵⁵² Table in Figure 81.

The Inspectorate's responses

5.189 The Inspectorate was not informed about material circumstances concerning the conditions of mining to be undertaken at LW 104, including that:

- a. the P seam lateral drainage strategy was no longer going to be implemented as had been represented in the mine's secondary extraction standard operating procedure (SOP)⁵⁵³ and risk assessment⁵⁵⁴ which had been provided to the Inspectorate on 6 March 2020 (three days before commencement of mining);
- b. there had been no re-evaluation of risk as a consequence of the P seam lateral drainage strategy being abandoned;
- c. a risk assessment for spontaneous combustion associated with increased goaf drainage at LW 104 had not been conducted, nor that none would be conducted until the end of May 2020, well after production commenced; and
- d. the mine had failed to report all gas exceedances to the Inspectorate (as revealed by the mine's investigation reports).

5.190 Any assessment of the Inspectorate's responses to the HPIs should therefore be on the basis that the Inspectorate did not have complete information about the conditions under which mining operations were being conducted. However, even allowing for that, the Board's view is that the Inspectorate did not give LW 104 the attention it warranted.

5.191 In his statement, RIOM Smith expressed confidence in Grosvenor's capability to manage methane. He said that:⁵⁵⁵

While there had been issues with exceedances prior to July and in July 2019 on longwall 103, the interaction between the Inspectorate and the mine, and the history of HPIs from July 2019 onwards indicates to me that the mine's actions in managing these issues was generally effective. As a result, the Inspectorate had no reason to believe, prior to the startup of longwall 104 that the mine did not have the ability to take appropriate action to manage methane on the subsequent longwall. Such actions could include:

- (a) Production activities such as reducing the cutting rate, producing in uni-di, or modifying monitor set points that slow or stop the shearer;*
- (b) Increasing post-drainage capacity;*
- (c) Increasing the efficiency of the ventilation.*

⁵⁵³ AGM.002.001.1112, .1160: GRO-10684-SOP-Second Workings.

⁵⁵⁴ AGM.002.001.1000, .1062: GRO-10671-RA-LW104 Secondary Extraction.

⁵⁵⁵ SST.002.001.0001, .0003.

- 5.192 In his oral evidence, RIOM Smith said that there was an awareness that Grosvenor would have to 'put in place rigorous operational controls to manage how they produced the coal so that they didn't end up with gas exceedances'. He went on to reiterate that Grosvenor had 'demonstrated... that they had the capability to manage the face'.⁵⁵⁶
- 5.193 In the Board's view, it cannot be accepted that Grosvenor had demonstrated its capability to adequately manage methane. On the contrary, a review of Grosvenor's history shows that the mine had experienced continuing difficulty, if not inability, to manage methane to avoid HPIs. This was so on successive longwalls. There had been an inordinate number of HPIs on LW 102 and LW 103, related specifically to methane management.
- 5.194 The Inspectorate should have identified Grosvenor as a problem mine that was deserving of particular and greater attention. Given Grosvenor's track record on previous longwalls, the Inspectorate ought to have been concerned about its capability to successfully manage methane levels during the production on LW 104. With the commencement of production at LW 104, it would have been timely, even without the occurrence of any HPIs, to have slated Grosvenor for an in-depth inspection and assessment of its gas drainage systems and strategies. However, the Inspectorate had engaged in a number of interactions with Grosvenor during LW 103, in the lead up to LW 104 commencing, and during the course of LW 104 production.
- 5.195 Inspector Brownett did visit Grosvenor and conduct an inspection on 19 March 2020. As the Mine Record Entry shows, this was a general inspection. There was a discussion about the first two HPIs and methane management issues, but the inspection did not assess gas drainage systems and strategies.⁵⁵⁷ An electrical inspection took place on 15 April 2020.⁵⁵⁸ RIOM Smith was scheduled to visit Grosvenor, Grasstree, and Moranbah North on 13 and 14 May 2020. However, he acknowledged in evidence that this was 'more in relation to the 243A sensor and the directives that I'd issued to three mines at that time'.⁵⁵⁹
- 5.196 On LW 102, the Inspectorate attended the mine within a month of commencement of production specifically to review methane exceedances that had occurred. A further three days was spent at the mine in March 2018, in detailed discussion of methane management. This level of attention by the Inspectorate was not evident with respect to LW 104.
- 5.197 It will also be recalled that at the meeting between the Inspectorate and the mine on 15 October 2019, inspectors were informed that gas emission hazards were expected in LW 104 because of problems with pre-drainage.⁵⁶⁰

⁵⁵⁶ TRA.500.014.0001, .0100, line 47–.0101, line 8.

⁵⁵⁷ RSH.002.163.0001.

⁵⁵⁸ RSH.002.164.0001.

⁵⁵⁹ TRA.001.014.0001, .0111, lines 40–42.

⁵⁶⁰ RSH.002.145.0001.

- 5.198 Soon after commencement of production from LW 104, the Inspectorate's confidence in Grosvenor's capability was revealed to have been misplaced. HPIs came in quick succession from 18 March 2020.
- 5.199 As described in detail earlier in this chapter, the exceedances were notified by the mine to various inspectors, as required. The notifications were followed by the Form 1As and 5As. Whilst it is true that the immediate causes of the HPIs were unremarkable, it does not seem to have occurred to any of the inspectors, despite the mine's history, that the HPIs were, or might have been, symptomatic of a greater underlying cause related to methane management.
- 5.200 On 15 April 2020, a number of Form 5As were provided to the Inspectorate in relation to the early HPIs. In them, Grosvenor did not explicitly advise that the P seam had not been drained at all. Instead, it said, rather opaquely:⁵⁶¹

P seam gas drainage not completed to proposed strategy to allow LW104 unconstrained production from gas delays.

- 5.201 Additionally, the proposed solution specified in the Form 5As was expressed in somewhat cryptic terms:⁵⁶²

P seam drainage strategy for each LW block to design & complete prior to LW production phase.

- 5.202 Nonetheless, this was enough information to have conveyed that there was more to the HPIs than their immediate cause, and that gas drainage issues were proving to be a contributor.
- 5.203 It appears that the Form 5As may not have been collectively reviewed. RIOM Smith had this exchange with Counsel Assisting:⁵⁶³

Q. ...My question was whether you know whether you or anybody else, on or after 15 April, reviewed these form 5As to see if the inspectorate was satisfied that the mine had undertaken an appropriate analysis of its March HPIs?

A. Not that I'm aware of, no. I didn't.

Q. Should the inspectorate have done that activity?

A. It's certainly an activity we should do, yes.

- 5.204 If each HPI were viewed only for its immediate cause, it would be understandable that the Inspectorate felt no need to investigate further, or otherwise intervene. However, the mine's history was such that a more proactive approach was called for. In particular, the failure to attend and engage with the mine in depth concerning its methane management, similar to its response with respect to LW 102, represented a lost opportunity to have discovered:

⁵⁶¹ AAMC.001.009.0412, .0414.

⁵⁶² AAMC.001.009.0412, .0414.

⁵⁶³ TRA.500.014.0001, .0105, lines 26–31.

- a. that the mine was engaging in poor practice, in that it was producing at a rate beyond the capacity of its gas drainage system;
- b. that the mine's preventative actions for the HPIs did not address this scenario; and
- c. that no spontaneous combustion risk assessment for the increased goaf drainage strategy had been undertaken.

General findings for LW 104 HPIs

Finding 50

The Learning From Incidents process resulted in a robust assessment of each incident, and a frank acknowledgement of the contributing factors, but there was a significant deficiency, in that the mine incorrectly concluded that the gas drainage system was not a critical control.

Finding 51

The mine experienced high gas emissions at longwall 104 (LW 104). These were a consequence of the specific gas emission (which was around 25 m³/t), and the mine's rate of production.

Finding 52

The mine's gas drainage system was inadequate to manage the high gas emissions.

Finding 53

The drop in production rate to 100,000 tonnes/week to manage gas emissions, referred to by Mr Mitchelson in evidence, was a budget, not a cap on production.

Finding 54

The mine did not limit its production to 100,000 tonnes/week.

Finding 55

The mine ought to have capped the rate of production at 10,000 tonnes/day, or 70,000 tonnes/week, to ensure the gas emissions could be managed by the gas drainage system.

Finding 56

Each of the HPIs that occurred on LW 104 took place on days of production substantially in excess of 10,000 tonnes, with the exception of that which occurred on 19 March 2020. However, that HPI was preceded by several days on which production was significantly in excess of that figure. That level of production contributed to the HPIs.

Finding 57

The mine should have reduced its level of production, once it understood the gas make to be significantly greater than had been predicted, so as to ensure that emissions could be captured by its gas drainage system. This is especially so after 3 April 2020, when the investigation in relation to the first seven HPIs was concluded.

Finding 58

Coal mine workers were repeatedly subject to an unacceptable level of risk at LW 104 through mining operations being conducted in a manner that exceeded the capacity of its gas drainage, a critical control for the management of methane.

Finding 59

Regional Inspector of Mines Mr Stephen Smith said, on behalf of the Inspectorate, that:⁵⁶⁴

While there had been issues with exceedances prior to July and in July 2019 on longwall 103, the interaction between the Inspectorate and the mine, and the history of HPIs from July 2019 onwards indicates to me that the mine's actions in managing these issues was generally effective. As a result, the Inspectorate had no reason to believe, prior to the startup of longwall 104 that the mine did not have the ability to take appropriate action to manage methane on the subsequent longwall.

In light of the mine's continual problems with gas management since 2016, the multiple methane exceedance HPIs on LW 103, and the mine's repeated acknowledgement that these exceedances stemmed from the continual underlying problems (identified above), such an appraisal of Grosvenor's capabilities with respect to methane management was inappropriate.

Finding 60

Grosvenor's history on previous longwalls was such as to require close attention by the Inspectorate to the mine's gas management systems and practices at LW 104. This did not occur, with the result that there was a lost opportunity to discover that the mine's production rate exceeded the capacity of its goaf drainage system. The Inspectorate should have been more proactive.

General recommendations arising from HPIs on LW 103 and LW 104

Recommendation 4

Coal mines regularly assess production rates and adjust them as necessary to ensure they do not result in gas emissions exceeding the capacity of the gas drainage system.

Recommendation 5

Resources Safety & Health Queensland (RSHQ) reviews its risk profiling and response practices with a view to ensuring that it operates as a proactive regulator.

Recommendation 6

The Board repeats its recommendation made in the Part I Report, Chapter 6, recommendation 19, that:

RSHQ take steps to amend the *Coal Mining Safety and Health Act 1999* (Qld) (the Act) and the *Coal Mining Safety and Health Regulation 2017* (Qld) to require a coal mine to develop a set of critical controls with performance criteria which must be incorporated into Principal Hazard Management Plans, and which require:

⁵⁶⁴ SST.002.001.0001, .0003.

- a. the Site Senior Executive (SSE) to notify the Regulator of a failure of a critical control to meet its performance criteria;
- b. the SSE to monitor the effectiveness of the critical controls, and report the results to the mine operator, on a monthly basis; and
- c. coal mine operators to audit critical controls as part of the audit prescribed by section 41(1)(f) of the Act.

Chapter 6 – Gas Monitoring at Grosvenor mine

Introduction

- 6.1 Gas monitoring is an integral component of gas management. This chapter considers the gas monitoring system in place at Grosvenor mine (Grosvenor) for longwall 104 (LW 104).
- 6.2 This chapter also contains a review of matters relevant to the interpretation of gas monitoring data for indicators of spontaneous combustion, as well as a consideration of the Trigger Action Response Plans (TARPs) relevant to spontaneous combustion at Grosvenor. These matters become relevant later in the report.

The gas monitoring system

- 6.3 Gas is monitored in a variety of ways at Grosvenor. There are real-time sensors that monitor for carbon monoxide (CO), carbon dioxide (CO₂), oxygen (O₂) and methane (CH₄). Some sensors monitor for all four of those gases, whilst others only detect a single gas such as methane or carbon monoxide.⁵⁶⁵
- 6.4 There are also multiple tube bundle monitoring stations. A tube bundle system continuously draws gas samples through tubes from multiple monitoring points throughout a mine. Samples are drawn by vacuum to a central location where they are typically analysed for carbon monoxide, carbon dioxide, oxygen and methane. Disadvantages of tube bundle systems include the cycling of the analyser between each tube, as well as the delay involved in drawing the sample from the monitoring point to the analysis point, which, depending on the distance involved, may be in the order of an hour or more.
- 6.5 These two systems are together incorporated into a software system known as ‘Safegas’ which enables the display of measured gas concentrations and ratios, and can trigger alarms when tolerance values are breached. Ordinarily, data is displayed in the control room, where it can be seen by the control room operator. Alarms also sound in the control room, where they are logged and actioned.
- 6.6 In addition to the real-time and tube bundle systems, Grosvenor used a number of movable goaf skids that were able to be connected to boreholes into the goaf. The bulk of the goaf wells on longwall 104 (LW 104) were sunk into the tailgate at 25 metre intervals in the direction of retreat of the longwall face. These wells were then able to be either brought online or shut in as the longwall retreated. The flow from online wells could be varied or turned off altogether. Each of the goaf skids had a four-gas sensor that monitored carbon monoxide, carbon dioxide, oxygen and methane in real-time.

⁵⁶⁵ Not all sensors are relevant for the purposes of this chapter, for example carbon monoxide sensors in the belt road and methane sensors on various items of longwall equipment.

As will be explained, those sensors were connected to the mine's SCADA system, known as CITECT,⁵⁶⁶ and not to Safegas. One goaf skid, installed on goaf well GRO4V010, which was the closest well to the face at the time of the serious accident, had not yet been connected to CITECT. Its data was collected manually at twice daily intervals.

- 6.7 As well as these gas monitoring sensors, the mine had air velocity monitoring sensors in strategic locations that enabled it to determine the volume of air moving through a particular roadway.
- 6.8 Lastly, bag samples were periodically taken at various locations throughout the mine, and also from the tube bundle system and goaf skids. As the name implies, a bag sample is a manual gas collection technique that involves collecting a sample of atmosphere into a special purpose bag either by physically going to the sample location or by taking the sample from the tube bundle system. Those samples are then analysed using a gas chromatograph, which can detect a much larger suite of gases than the four-gas sensors. Gas chromatography is further explained in Chapter 8, which deals with the interpretation of gas monitoring data.

The locations of relevant gas and velocity sensors

Real-time sensors connected to Safegas

- 6.9 At the relevant time, a single real-time four-gas sensor identified as GM002-07-34-37 was situated in the LW 104 tailgate at 3–4 cut-through (c/t). As will be explained, it was co-located with a velocity sensor (RT #37) and a tube bundle (TB #26). For March 2020, this was the only relevant real-time sensor in the longwall return for the detection of indicators of spontaneous combustion.⁵⁶⁷

⁵⁶⁶ CITECT is a system for gathering data and controlling various mining processes. It is a form of Supervisory Control and Data Acquisition (SCADA) software.

⁵⁶⁷ AGM.003.001.0451.

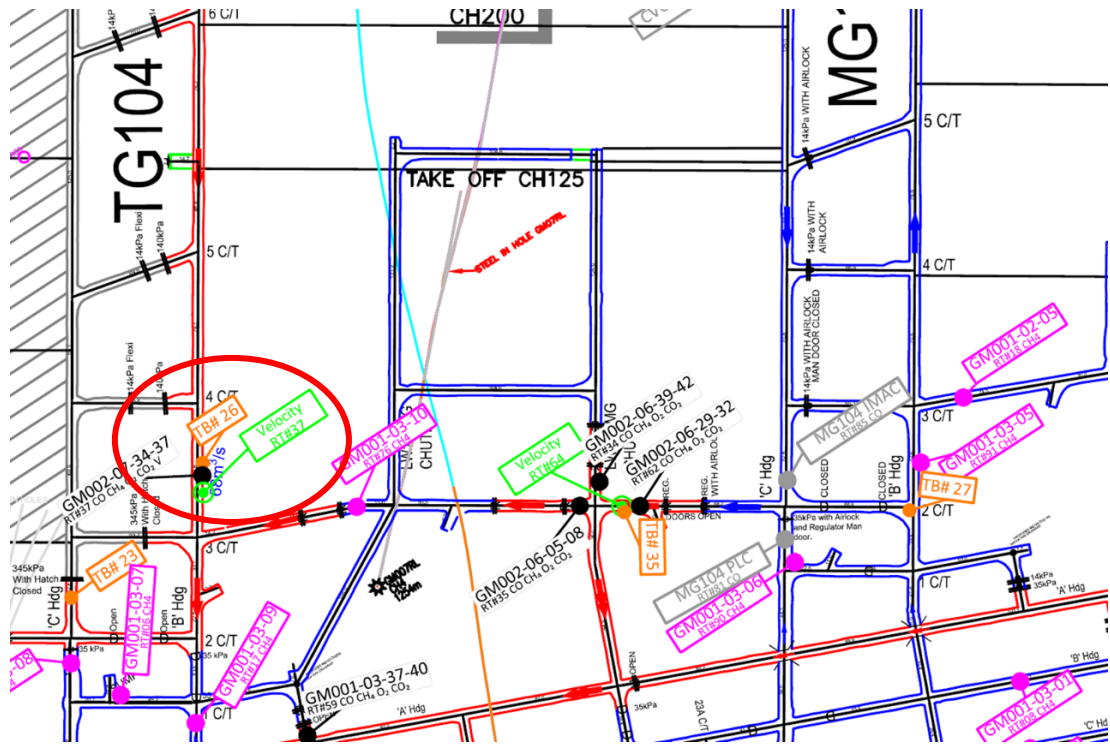


Figure 84: Extract from ventilation plan showing the gas (GM002-07-34-37 and TB #26) and velocity (RT #37) sensors in the location known as 3-4 c/t, TG 104

6.10 By April 2020, a methane sensor (GM002-07-5) had been installed in the tailgate 400 metres outbye of the face. As can be seen, it was co-located with TB #22, to which reference will be made below.⁵⁶⁸

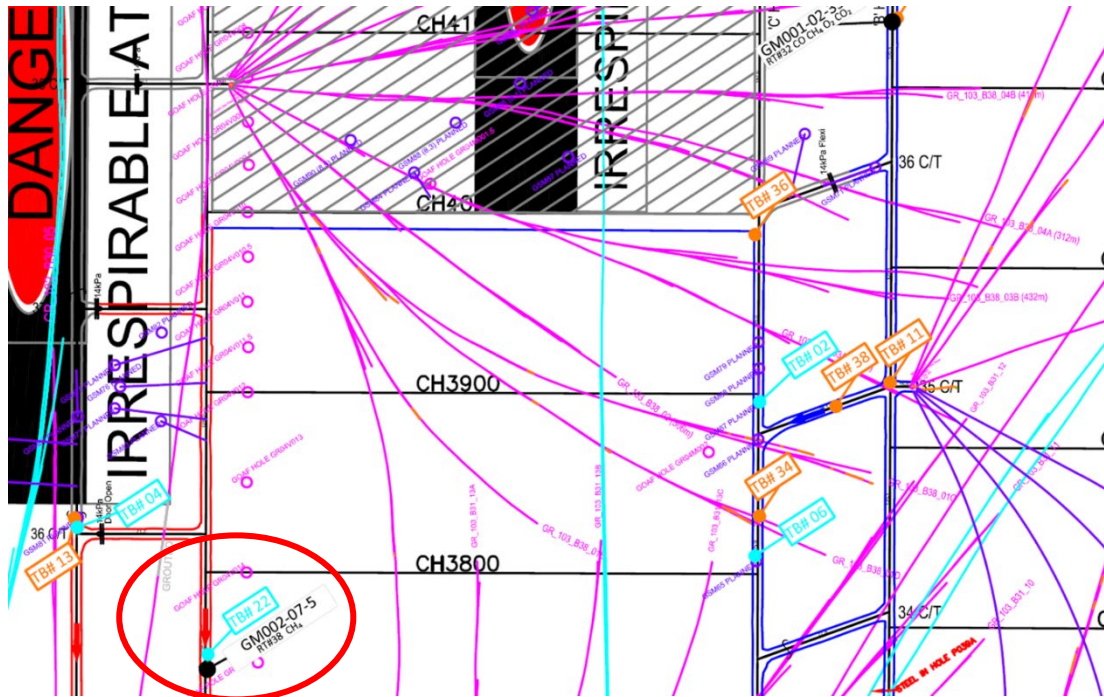


Figure 85: Extract from ventilation plan from June 2020 showing the 400 metre CH₄ sensor (GM002-07-5) and TB #22.
Face position is depicted as it was on 6 May 2020.

Tube bundle sensors

6.11 The relevant tube bundle monitoring stations varied according to the period under consideration. For March 2020, the tube bundle locations of interest were:⁵⁶⁹

- a. TB #26, 3–4 cut-through, tailgate 104 (shown in Figure 84, above);
- b. TB #37, #38–#39 cut-through, B heading, maingate 104 (inbye of the longwall);
- c. TB #38, LW 104 B1 cut-through seal (inbye of the longwall at the rear of the goaf); and
- d. TB #39, #40–#41 cut-through C heading seal, tailgate 104 (inbye of the longwall).

⁵⁶⁸ AGM.003.001.0451.

⁵⁶⁹ WMA.001.002.0001, .0039.

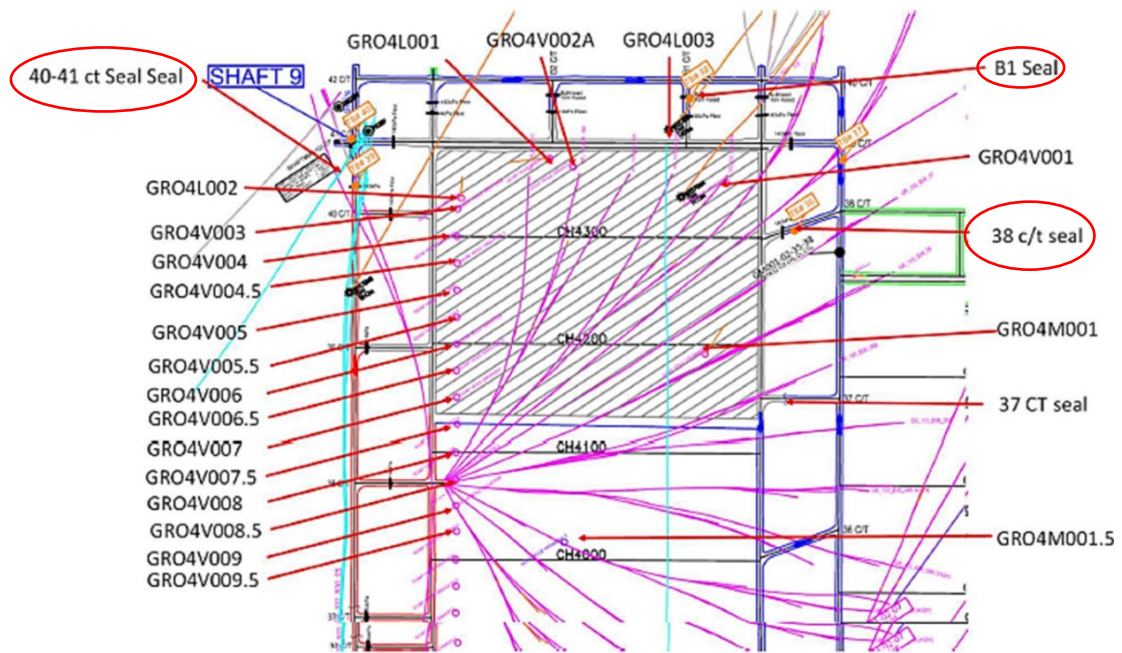


Figure 86: Extract from ventilation plan dated 15 April 2020, marked up to show the location of tube bundle locations (and goaf wells). Note that the face position shown is inbye of the actual position on 6 May 2020.

6.12 For April and May 2020, the relevant tube bundle locations were:

- a. TB #26, #38 and #39, described above;
- b. TB #22, tailgate 104, 400 metre B heading (co-located with the 400 metre methane sensor), depicted above in Figure 86; and
- c. TB #36, #38 cut-through seal, maingate 104 (inbye of the longwall).

6.13 A closer view of the rear of the goaf shows the indicative locations of TB #36, #38 and #40:⁵⁷⁰

⁵⁷⁰ AGM.011.001.2518. The actual tube bundle sampling points would be on the goaf side of the goaf seals.

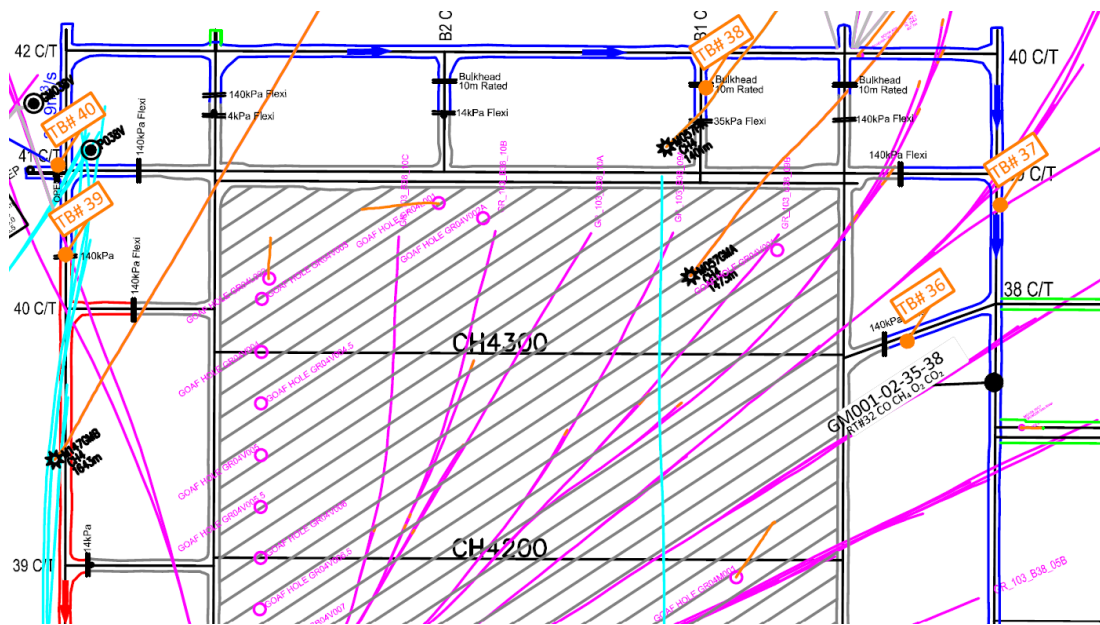


Figure 87: Extract of ventilation plan dated 15 April 2020 showing inbye tube bundle locations

6.14 A feature of the ventilation system design for LW 104 is the inclusion in the longwall of a section of C heading, along which goaf gases, leaking through inbye stoppings or entering through an open cut-through, could travel outbye and bypass the 400 metre sensor and TB #22 before re-joining B heading at 34 cut-through. The second workings standard operating procedure (SOP) for LW 104 proposed that a tube bundle be located in 34 cut-through to capture data from gases in C heading, however it was not installed. This resulted in key data not being available.⁵⁷¹

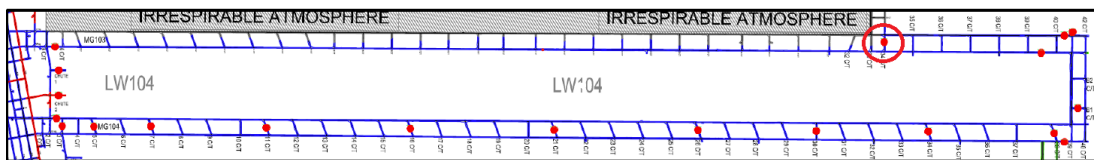


Figure 88: Extract from LW 104 second workings SOP showing planned tube bundle locations including 34 c/t (circled)

Goaf skids

6.15 Goaf wells enable the goaf atmosphere to be drawn to the surface. Mobile goaf skids essentially consist of a variable speed drive that creates suction, as well as communications and monitoring equipment, and safety devices. As the name implies, a skid can be moved from one goaf well to another. At Grosvenor, the goaf skids monitored the extracted gas for carbon monoxide, carbon dioxide, oxygen and methane at five minute intervals.

⁵⁷¹ WMA.002.002.0001, .0028; AGM.002.001.0019, .0070: GRO-10684-SOP-LW104 Second Workings.

The goaf skids were not connected to the mine's Safegas system but, except for the skid on well GRO4V010, sent data to CITECT. GRO4V010, being the most recently commissioned well, had monitoring data manually collected twice daily.⁵⁷²

- 6.16 As a result of the experience with LW 103, where the goaf wells were drilled at 50 metre intervals, a decision was made at LW 104 to drill goaf wells at 25 metre intervals.⁵⁷³ Most of the goaf wells were sunk vertically into the tailgate side of the longwall block, although there were others in the longwall installation roadway and some in the centre and maingate side.

Bag samples

- 6.17 Whilst the methods set out above monitored for the presence of the four gases, carbon monoxide, carbon dioxide, methane and oxygen, manually collected bag samples were regularly analysed in a gas chromatograph (GC), which enables the detection of a much larger suite of gases. Bag samples were regularly taken from some of the tube bundle sampling points, the goaf skids, the longwall seals, and the goaf stream in the tailgate.⁵⁷⁴ However, as will be seen, hazardous conditions in the tailgate precluded the taking of some goaf stream samples in the days leading up to the serious accident on 6 May 2020.⁵⁷⁵
- 6.18 An extract from the mine's ventilation plan below at Figure 89 shows the location of significant bag sample locations:⁵⁷⁶

⁵⁷² WMA.001.002.0001, .0039–.0041.

⁵⁷³ AGM.002.001.0019, .0066: *GRO-10684-SOP-LW104 Second Workings*.

⁵⁷⁴ MSE.001.001.0001, .0013; TRA.500.019.0001, .0010, lines 31–37.

⁵⁷⁵ AGM.003.002.5749, .5751; AGM.003.002.5803, .5805.

⁵⁷⁶ MSE.001.001.0001, .0013.

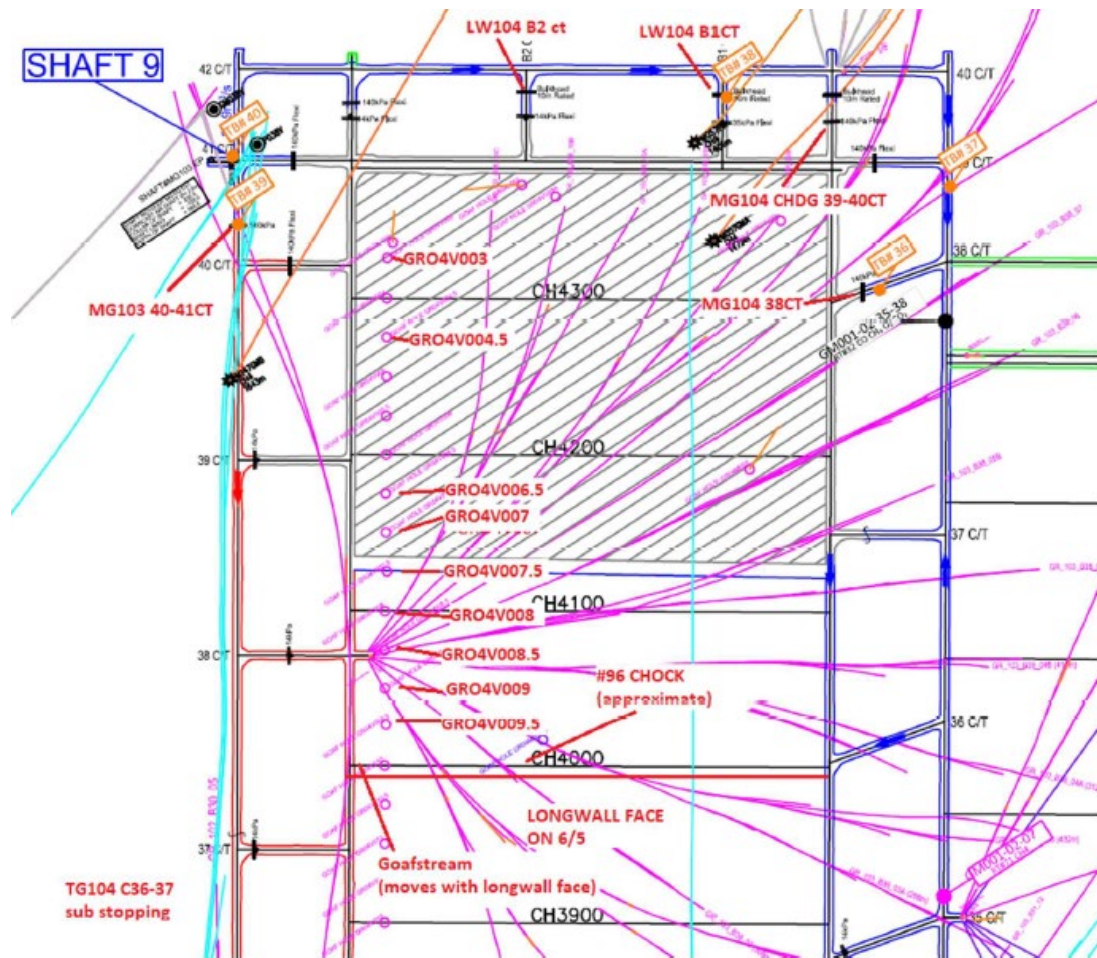


Figure 89: Extract from ventilation plan dated 15 April 2020, showing the location of significant bag sample locations and most, but not all, of the goaf drainage wells. Note that the face position shown is inbye of the actual position on 6 May 2020.

6.19 Bag samples from the goaf skids were mandated in the event that certain TARP triggers were reached.⁵⁷⁷ Having said that, bag samples were not always taken as required by TARP conditions.

Interpretation of gas monitoring data for indicators of spontaneous combustion

6.20 Spontaneous combustion can occur when coal is exposed to oxygen. The process of oxidation generates heat and liberates certain gases, including carbon monoxide and ethylene. If the oxidation process continues and there is insufficient cooling by way of ventilation, the coal can self-heat to the point of ignition.

⁵⁷⁷ AGM.002.001.0778: GRO-1430-TARP-Goaf and UIS Gas Drainage Management; AGM.002.001.0737: GRO-750-TARP-General Body Contaminant; AGM.002.001.0755: GRO-6953-TARP-Active Goaf Spontaneous Combustion.

6.21 Spontaneous combustion describes a process. Not all spontaneous combustion activity will lead to the point at which unchecked heating of the coal can take place. Low level heating of coal may never reach the point of thermal runaway.

Recent testing at Grosvenor suggests that the thermal runaway point of Grosvenor's coal is 100°C.⁵⁷⁸ This suggests that, if the coal at Grosvenor is heated to 100°C it is highly likely that the heating will run away to a point at which the coal is capable of ignition.

6.22 Methane is capable of auto-ignition at 540°C.⁵⁷⁹ Thus, a high temperature spontaneous combustion event, in the presence of an explosive mixture of methane in air, can lead to an explosion. Methane is explosive when it is present in air at concentrations of between 5% and 15%.⁵⁸⁰ It is not explosive when oxygen concentrations are less than 12%.⁵⁸¹

6.23 Spontaneous combustion of coal from the Goonyella Middle seam is documented as having occurred at the underground mines North Goonyella and Moranbah North.⁵⁸²

6.24 The heating of coal progressively results in the production of particular gases at certain temperatures. The sequence of gas production and the temperatures at which they are produced are coal-specific. However, they generally commence with carbon dioxide, followed by carbon monoxide, methane, hydrogen, ethane, and ethylene and then by higher hydrocarbons. Laboratory testing is used to determine a particular coal's gas evolution characteristics with increasing temperature. Figure 90 below illustrates an example of the gas evolution against temperature for a coal sample from the United Kingdom:⁵⁸³

⁵⁷⁸ BBA.001.001.0001, .0002.

⁵⁷⁹ JMU.001.001.0001, .0005.

⁵⁸⁰ JMU.001.001.0001, .0005.

⁵⁸¹ SAN.001.001.0001, .0006. TRA.500.021.0001, .0004, lines 12–17.

⁵⁸² WMA.001.002.0001, .0105.

⁵⁸³ Chamberlain, E. *et al.*, *The ambient temperature oxidation of coal in relation to the early detection of spontaneous heating* (1970) *The Mining Engineer* volume 130: pages 1–16.

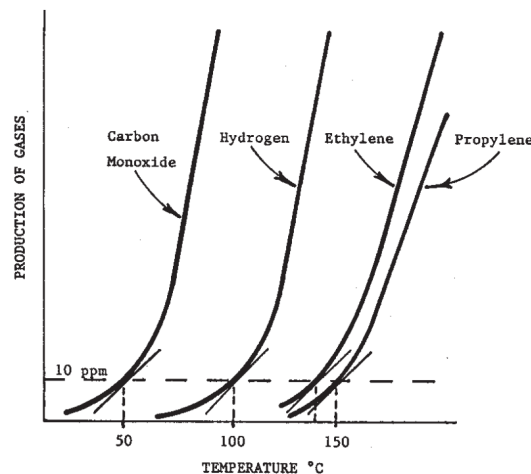


Figure 90: Gas evolution against temperature

- 6.25 Monitoring for carbon dioxide is of limited use in the early detection of spontaneous combustion because it is a natural component in air and can be a seam gas. Carbon monoxide can be an indicator of the heating of coal, but it is produced at low temperatures from normal oxidation, and therefore it is not necessarily an indication of the existence of a problem. What is more important is the amount of carbon monoxide being produced, and also the trend of carbon monoxide concentration levels.
- 6.26 Hydrogen can be used as an indicator of spontaneous combustion. However, it can also be produced by the reaction of acidic water and galvanised pipes left in the goaf.⁵⁸⁴ Caution should be exercised in the use of hydrogen as an early-stage indicator of spontaneous combustion.
- 6.27 Ethylene is a good indicator of an advanced heating because it is not a seam gas and is not generated until temperatures reach around 100°C.⁵⁸⁵ Gas evolution testing undertaken for Grosvenor showed that its coal commenced liberating ethylene at about 90°C.⁵⁸⁶
- 6.28 Merely measuring the concentration of gas to determine whether spontaneous combustion could be imminent is problematic, because:⁵⁸⁷
- a. dilution with other gas streams, including mine ventilation air, reduces the concentration, either below the limit of detection or in a way that leads to an underestimation of the severity of the problem;
 - b. some gases are emitted by other sources such as vehicles or the coal seam itself; and

⁵⁸⁴ WMA.003.016.0001, .0172.

⁵⁸⁵ TRA.500.021.0001, .0049, lines 33–35.

⁵⁸⁶ AGM.014.001.0250, .0271.

⁵⁸⁷ Cliff, D., Brady, D. & Watkinson, M., *The Green Book – Spontaneous Combustion in Australian Coal Mines* (SIMTARS, 2018), page 183; WMA.003.004.0001, .0185.

- c. the concentration of a particular gas does not enable an assessment of whether what is happening is widespread low level heating, or a small but intense event.

6.29 It is therefore standard practice to not only monitor for the concentrations of the four gases, carbon monoxide, carbon dioxide, oxygen and methane, but also to consider a variety of ratios of these gas concentrations. Ratios can be used to indicate the intensity of a heating. Dilution effects can be overcome by calculating the volume of gas being produced over a certain time interval. In these ways the problems of dilution from other gas sources can be eliminated, and the actual intensity of a heating can be discerned.⁵⁸⁸ Some of these ratios are explained below. In addition, gas chromatography can detect even small concentrations of the higher hydrocarbon gases (such as ethylene) that are the harbingers of spontaneous combustion.

Graham's Ratio

6.30 Graham's Ratio measures the intensity of the oxidation of the coal by dividing the amount of carbon monoxide by the amount of oxygen depleted by the oxidation process.⁵⁸⁹ In its simplest form, it assumes that the initial state of the air has the same ratio of oxygen to nitrogen plus argon as fresh air (i.e., 20.95% to 78.08% + 0.93%, which equates to 0.265) and contains no carbon monoxide. Nitrogen and argon are not produced or consumed by any activity or chemical process taking place in the mine and should therefore be constant, with the result that the final value for nitrogen and argon should therefore reflect the equivalent amount of oxygen that was originally present. The ratio is expressed thus:⁵⁹⁰

$$GR = \frac{100 \times CO_f}{0.265 \times N_{2f} - O_{2f}}$$

Where: *f* denotes final concentrations expressed as percentages

6.31 This calculation can be performed by using the theoretical percentage of nitrogen and argon, as stated above, or by using the measured percentage of nitrogen and argon from the GC. The second approach is called the 'long form' Graham's Ratio and allows for calibration and accuracy measurements associated with that specific GC.⁵⁹¹

⁵⁸⁸ Cliff, D., Brady, D. & Watkinson, M., *The Green Book – Spontaneous Combustion in Australian Coal Mines* (SIMTARS, 2018), pages 183–184; WMA.003.004.0001, .0185–.0186.

⁵⁸⁹ TRA.500.018.0001, .0016, lines 28–33; Cliff, D., Brady, D. & Watkinson, M., *The Green Book – Spontaneous Combustion in Australian Coal Mines* (SIMTARS, 2018), page 189; WMA.003.004.0001, .0191.

⁵⁹⁰ Cliff, D., Brady, D. & Watkinson, M., *The Green Book – Spontaneous Combustion in Australian Coal Mines* (SIMTARS, 2018), pages 189–190; WMA.003.004.0001, .0191–.0192.

⁵⁹¹ TRA.500.019.0001, .0023, lines 4–23.

This is done by using actual measures of nitrogen and argon, rather than the theoretical values, with the result that any measurement errors in the concentration of oxygen are compensated for by the same measurement errors in the concentration of nitrogen and argon.⁵⁹²

- 6.32 Laboratory testing shows that Graham’s Ratio increases with temperature up to about 400°C. Whilst each mine should set its own trigger points, generally accepted action levels are.⁵⁹³

<0.4	Normal
0.4 - 1.0	Investigate
>1.0	Heating
>2.0	Serious heating/fire

- 6.33 Graham’s Ratio indicates the intensity of the heating, but not the extent. One kilogram of coal at a particular temperature will lead to the same Graham’s Ratio as one tonne at the same temperature.⁵⁹⁴

- 6.34 The point at which the measurements are made is also significant. A sampling point in a roadway, such as that at 3–4 cut-through, tailgate 104 is ‘unlikely to be of any practical value...as the heating products will be swamped with fresh air until it is a major heating, thus making Graham’s ratio that of fresh air. The large volumes of air used to ventilate mines mean that the initial changes in CO and CO₂ are within the noise levels of the detection systems’.⁵⁹⁵ Graham’s Ratio is a much more useful measure of coal oxidation when the samples are taken in the goaf stream itself.

- 6.35 The use of nitrogen for goaf inertisation will invalidate Graham’s Ratio calculations, as the higher levels of nitrogen will lead to an assumption that the oxygen deficiency is greater than it is in fact, resulting in a misleadingly lower calculation.⁵⁹⁶

Carbon monoxide make

- 6.36 Carbon monoxide make (often called CO Make) involves the calculation of the amount of carbon monoxide flowing past a monitoring point and is usually expressed in litres/minute.⁵⁹⁷ What is required is the carbon monoxide concentration and the volume of airflow. The formula is:

$$CO\ Make\ (l/min) = CO\ (ppm) \times AIRFLOW\ (m^3/sec) \times 0.06$$

⁵⁹² TRA.500.019.0001, .0023, line 15–.0024, line 7.

⁵⁹³ Cliff, D., Brady, D. & Watkinson, M., *The Green Book – Spontaneous Combustion in Australian Coal Mines* (SIMTARS, 2018), page 190; WMA.003.004.0001, .0192.

⁵⁹⁴ Ibid. page 191; WMA.003.004.0001, .0193.

⁵⁹⁵ Cliff, D. et al., *Better Indicators of Spontaneous Combustion* (2000) Project No. C5031 Report, Australian Coal Association Research Program, page 9; WMA.003.001.0001, .0011.

⁵⁹⁶ Cliff, D., Brady, D. & Watkinson, M., *The Green Book – Spontaneous Combustion in Australian Coal Mines* (SIMTARS, 2018), page 203; WMA.003.004.0001, .0205.

⁵⁹⁷ Ibid. page 184; WMA.003.004.0001, .0186.

6.37 This measurement does not vary according to the amount of ventilation, and so dilution is not a factor.⁵⁹⁸

6.38 CO Make has its limitations, as described by Cliff *et al.* in the following passage:⁵⁹⁹

Similar to absolute concentrations, the CO make for a section of a mine is dependent not only on the temperature of the coal, but the amount of coal reacting to produce carbon monoxide. If for whatever reason, extra coal is left in the goaf, an increase in CO make may result without any increase in oxidation intensity. Use of ratios capable of determining intensity should be used as a check in these cases.

6.39 In practice, CO Make trigger levels should be mine-specific due to variations in coal characteristics.⁶⁰⁰

Carbon monoxide/Carbon dioxide Ratio

6.40 This ratio, known as the CO/CO₂ Ratio, is based upon the changes that occur in the ratio of carbon monoxide to carbon dioxide produced as coal temperature increases. It is defined as:⁶⁰¹

$$CO/CO_2 = \frac{CO_f - CO_i}{CO_{2f} - CO_{2i}}$$

With *i* and *f* representing initial and final conditions respectively

6.41 Whilst each mine should develop its own trigger points, typical values for Bowen Basin coal are:⁶⁰²

<0.02	normal
<0.05	temperature of coal <60°C
<0.10	temperature of coal <80°C
<0.15	temperature of coal <100°C
<0.35	temperature of coal <150°C

6.42 Grosvenor replicated these values and temperatures in its Principal Hazard Management Plant (PHMP) for gas management.⁶⁰³

⁵⁹⁸ Cliff, D., Brady, D. & Watkinson, M., *The Green Book – Spontaneous Combustion in Australian Coal Mines* (SIMTARS, 2018), page 184; WMA.003.004.0001 .0186.

⁵⁹⁹ Ibid. page 185; WMA.003.004.0001, .0187.

⁶⁰⁰ Ibid.; WMA.003.004.0001, .0187.

⁶⁰¹ Ibid. page 192; WMA.003.004.0001, .0194.

⁶⁰² Cliff, D., Brady, D. & Watkinson, M., *The Green Book – Spontaneous Combustion in Australian Coal Mines* (SIMTARS, 2018), page 192; WMA.003.004.0001, .0194.

⁶⁰³ AGM.002.001.0251, .0274: *GRO-14-PHMP-Gas Management*.

- 6.43 Unlike Graham's Ratio, the CO/CO₂ Ratio is unaffected by excess nitrogen,⁶⁰⁴ but dilution from seam gas containing carbon dioxide will have an impact.⁶⁰⁵
- 6.44 The CO/CO₂ Ratio will also become invalid if carbon dioxide comes from any other source, such as diesel emissions. The ratio also becomes inaccurate if the carbon dioxide levels are low.⁶⁰⁶

Methane-free calculations

- 6.45 Interpretation of the results of analyses can be impaired by fluctuating levels of other gases. This is of particular concern when considering data from goaf wells, where methane is ordinarily the predominant gas. Fluctuating levels of methane that dilute key spontaneous combustion indicators such as carbon monoxide have the potential to obscure trends. These dilution effects can be unmasked by calculating the amount of carbon monoxide after removing the methane from the equation.⁶⁰⁷ Although Safegas can be configured to automatically undertake this calculation, it was not done at Grosvenor.
- 6.46 Ratios, such as Graham's and CO/CO₂, are unaffected by dilution from other gases – unless the ratio calculation involves the same diluting gas.⁶⁰⁸
- 6.47 As will be seen, methane-free recalculations undertaken using monitoring data from Grosvenor are of significant assistance in determining what was occurring in the LW 104 goaf in the days and weeks leading up to the events of 6 May 2020.

Trigger Action Response Plans (TARPs)

Overview

- 6.48 A Trigger Action Response Plan is a common tool that specifies actions that are to be taken in the event that conditions deviate from normal. The deviation is identified by reference to a set of defined trigger points that require particular things to be done in response. For example, the detection of ethylene in the longwall return at a concentration between 1 and 3 ppm required (amongst other things) four hourly bag samples to be taken from the tailgate general body ventilation station.⁶⁰⁹
- 6.49 At Grosvenor, there were separate TARP parameters for spontaneous combustion in the active goaf to be measured at the following locations:
- a. the longwall return;

⁶⁰⁴ Cliff, D., Brady, D. & Watkinson, M., *The Green Book – Spontaneous Combustion in Australian Coal Mines* (SIMTARS, 2018), page 205; WMA.003.004.0001, .0207.

⁶⁰⁵ Ibid. page 192; WMA.003.004.0001, .0194.

⁶⁰⁶ WMA.003.016.0001, .0225.

⁶⁰⁷ TRA.500.019.0001, .0035, line 47–.0036, line 20.

⁶⁰⁸ MSE.001.001.0001, .0011.

⁶⁰⁹ AGM.002.001.0814: *GRO-6953-TARP-Active Goaf Spontaneous Combustion*.

- b. active goaf seals; and
- c. goaf wells.

6.50 The following is an extract from the active goaf spontaneous combustion TARP showing the trigger points for each of the three locations:⁶¹⁰

NORMAL	LEVEL 1 TRIGGER	LEVEL 2 TRIGGER	LEVEL 3 TRIGGER
<ul style="list-style-type: none"> • CO Make less than 42l/min AND • Graham's Ratio less than 0.3 AND • CO/CO₂ less than 0.2 <i>(*Refer to clarifying information at end of document)</i> 	<ul style="list-style-type: none"> • CO Make equal or greater than 42l/min and less than 53 l/min OR • Graham's Ratio equal or greater than 0.3 and less than 0.5 OR • CO/CO₂ equal or greater than 0.2 	<ul style="list-style-type: none"> • CO Make equal or greater than 53 l/min and less than 93 l/min OR • Graham's Ratio equal or greater than 0.5 and less than 1 OR • Ethylene equal or greater than 1ppm and less than 3ppm and CO Make equal or greater than 42 l/min and less than 53 l/min OR • Sweating, smell, heat or haze (confirmed by ERZ Controller) 	<ul style="list-style-type: none"> • CO Make equal or greater than 93 l/min and Graham's Ratio equal or greater than 1 OR • Ethylene equal or greater than 3ppm and CO Make equal or greater than 53 l/min OR • Smoke (coming from goaf)

Figure 91: Spontaneous combustion in active goaf TARP trigger points for the longwall return as of 5 May 2020

<ul style="list-style-type: none"> • CO less than 130ppm AND • No Ethylene AND • Graham's Ratio less than 0.3 	<ul style="list-style-type: none"> • CO equal or greater than 130ppm and less than 200ppm OR • Ethylene detected and less than 1ppm OR • Graham's Ratio equal or greater than 0.3 and less than 0.5 	<ul style="list-style-type: none"> • CO equal or greater than 200ppm and less than 800ppm OR • Ethylene equal or greater than 1ppm and less than 3ppm OR • Graham's Ratio equal or greater than 0.5 and less than 1 OR • Sweating, smell, heat or haze (confirmed by ERZ Controller) 	<ul style="list-style-type: none"> • CO equal or greater than 800ppm OR • Ethylene equal or greater than 3ppm and CO equal or greater than 200ppm OR • Graham's Ratio equal or greater than 1 and CO equal or greater than 200ppm
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Figure 92: Spontaneous combustion in active goaf TARP trigger points for the active goaf seals as of 5 May 2020

NORMAL	LEVEL 1 TRIGGER	LEVEL 2 TRIGGER	LEVEL 3 TRIGGER
<ul style="list-style-type: none"> O₂ (Oxygen) less than 8% AND CH₄ (Methane) greater than 45% CO (Carbon Monoxide) less than 100ppm Differential pressure across detonation arrestor less than 8kPa 	<ul style="list-style-type: none"> O₂ 8% - 11% AND CH₄ 30% - 45% OR CO 100ppm - 200ppm OR Differential pressure 8kPa - 12kPa across detonation arrestor 	<ul style="list-style-type: none"> O₂ > 11% AND CH₄ < 30% OR CO 200 - 800ppm AND H₂ 10ppm - 25ppm OR Differential pressure > 12kPa across detonation arrestor OR Failing to comply with these TARP monitoring requirements and inspections 	<ul style="list-style-type: none"> CO > 800ppm AND H₂ > 25ppm

Figure 93: TARP trigger points for the goaf wells

Problems with the TARPs

6.51 It is noted that the CO/CO₂ Ratio trigger point of 0.2 in Figure 92 above appears to be incorrectly set at a level that is an order of magnitude higher than it should be (i.e., 0.02). A calculated ratio of 0.2 would generally indicate a coal temperature of over 100°C, which would scarcely be 'normal'.

⁶¹⁰ AGM.002.001.0814 (longwall return and active goaf seals): *GRO-6953-TARP-Active Goaf Spontaneous Combustion*; AGM.002.001.0427 (goaf wells): *GRO-1430-TARP-Goaf and UIS Gas Drainage Management*.

Testing of coal from borehole GSC0004 by CB3 Mining Services Pty Ltd in 2014,⁶¹¹ reviewed by Mr Darren Brady in 2015,⁶¹² showed that at a CO/CO₂ Ratio of 0.2, the coal temperature was almost 120°C.

- 6.52 Similarly, the mine's own PHMP for gas management specified that a CO/CO₂ Ratio of greater than 0.15 equated to a coal temperature in excess of 100°C, whilst a figure greater than 0.35 meant a temperature in excess of 150°C.⁶¹³ This means that a figure of 0.2 must indicate a temperature somewhere between 100°C and 150°C.
- 6.53 It is uncontroversial that the 8 June 2020 ignition at Grosvenor was a spontaneous combustion event.⁶¹⁴ It is important to note that the CO/CO₂ Ratio of 0.2 was not exceeded even prior to or during that ignition of 8 June, whilst 0.02 was exceeded from about 4 June:⁶¹⁵

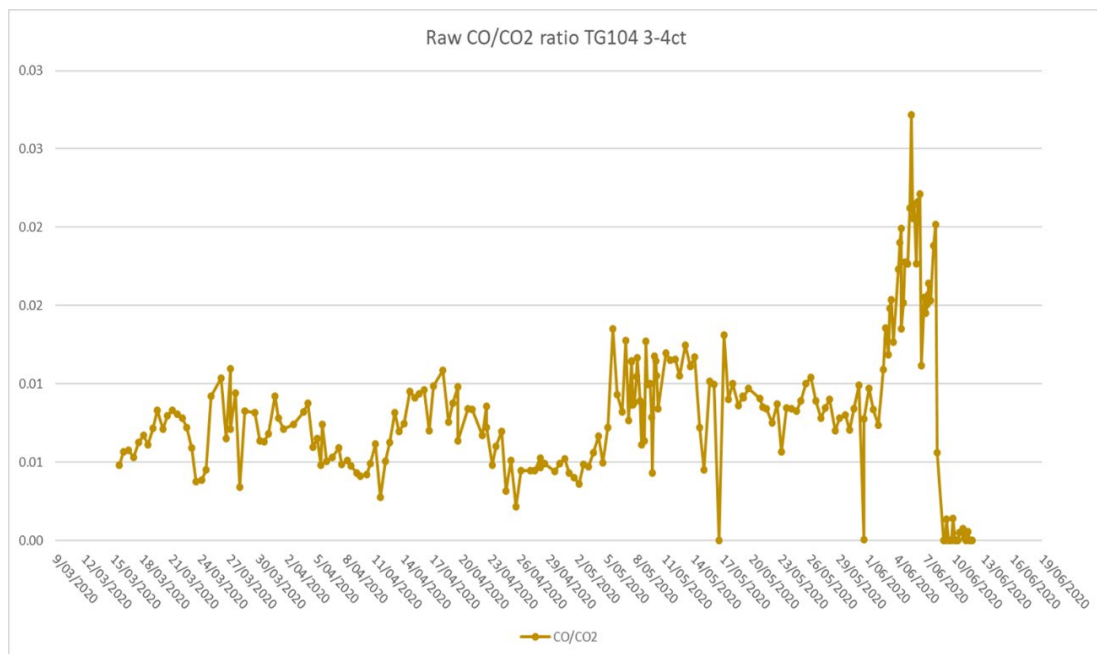


Figure 94: CO/CO₂ Ratio, TG 104 3–4 c/t, from 15 March to 11 June 2020

- 6.54 It is also noted that the active goaf spontaneous combustion TARP triggers for the longwall return include 'AND' statements. These are undesirable. For example, the Level 3 evacuation trigger is specified as being 'Ethylene equal to or greater than 3 ppm and CO Make equal to or greater than 53 l/min'.⁶¹⁶

⁶¹¹ WMA.003.020.0001, .0021.

⁶¹² AGM.014.001.0250, .0271.

⁶¹³ AGM.002.001.0251, .0274: *GRO-14-PHMP-Gas Management*.

⁶¹⁴ RSH.027.005.0001, .0004.

⁶¹⁵ MSE.001.001.0001, .0023.

⁶¹⁶ AGM.002.001.0814: *GRO-6953-TARP-Active Goaf Spontaneous Combustion*.

As Mr Self said in evidence, that would mean that if CO Make was 52 l/min, then even a very high ethylene value would still not result in evacuation.⁶¹⁷ In Mr Self's opinion, TARP triggers should be 'stand-alone'.⁶¹⁸

6.55 The same criticism can be made of the active goaf seal trigger points in that TARP, which also contain an 'AND' statement for 'Ethylene equal or greater than 3 ppm AND CO equal or greater than 200 ppm'.⁶¹⁹

6.56 Another difficulty with the way ethylene is treated in the active goaf spontaneous combustion TARP for the longwall return is that the trigger level of 3 ppm is too high. Mr Sean Muller had the following exchange with Counsel Assisting:⁶²⁰

Q. So if you're monitoring for ethylene - we know that there was a monitoring point at 3-4 cut-through here that was about 4 kilometres from the face. Is there much point monitoring for ethylene at that point?

A. Well, obviously if there is ethylene at that point, that's a big concern, so it should be picked up and identified.

6.57 Detection of up to 3 ppm ethylene in the longwall return hardly seems appropriate for a 'Level 2' trigger as, given the potential for dilution, the presence of any measurable concentration of ethylene at this point is likely to indicate an advanced heating is underway.

6.58 It is noted that the goaf and underground in-seam (UIS) gas drainage TARP does not include any trigger levels based solely on levels of oxygen in goaf wells.⁶²¹ As will be seen, there were occasions when samples from those wells were found to have concerning levels of oxygen, particularly in the period immediately preceding the ignition on 6 May 2020.⁶²²

6.59 A Workplace Risk Assessment and Control (WRAC) process for LW 104 goaf drainage was conducted on 15 January 2020 and signed off on 27 February 2020.⁶²³ As discussed in Chapter 4, it specifically did not address the risk of spontaneous combustion due to increased gas drainage.

6.60 The LW 104 secondary extraction WRAC gave specific attention to the control of spontaneous combustion as a result of oxygen ingress to the goaf. For example, the risk assessment specified how to manage increased bleeder pressure across the goaf and the ingress of oxygen through UIS holes that were open through the maingate pillar.⁶²⁴

⁶¹⁷ TRA.500.021.0001, .0062, lines 6–15.

⁶¹⁸ TRA.500.021.0001, .0062, lines 14–15.

⁶¹⁹ AGM.002.001.0814: *GRO-6953-TARP-Active Goaf Spontaneous Combustion*.

⁶²⁰ TRA.500.019.0001, .0012, line 43–.0013, line 2.

⁶²¹ AGM.002.001.0427: *GRO-1430-TARP-Goaf and UIS Gas Drainage Management*.

⁶²² TRA.500.018.0001, .0032, lines 3–47.

⁶²³ AGM.002.001.0937: *GRO-10699-RA-LW104 Goaf Drainage*.

⁶²⁴ AGM.002.001.1000, .1020: *GRO-10671-RA-LW104 Secondary Extraction*.

However, the risk that surface goaf wells posed in terms of drawing fresh air into the goaf was not addressed. It appears that the goaf drainage WRAC was regarded as a separate project. To the extent that the WRAC was to address the risk of spontaneous combustion posed by increased goaf drainage, it did not.⁶²⁵

6.61 Spontaneous combustion TARPs are derived from consideration of the performance of previous longwall goafs and their associated spontaneous combustion parameters, in combination with the results of laboratory testing to determine gas evolution curves and self-heating characteristics for that specific coal. There are some potential issues with this method of determining TARPs and this was illustrated in evidence provided by Mr Self:⁶²⁶

Q. Which leads me on to the next two questions. I know one of the approaches is to use historical performance of previous longwalls to give information on what's considered normal for the emissions from the goaf.

A. That is slightly flawed, yes.

Q. The question I ask is: does that give you any feeling for a factor of safety between what's normal and what could be a heating?

A. No, and that's a problem.

Q. One aspect is relying on history.

A. Yes.

Q. The second question is relying on laboratory results: is there a potential that the laboratory results can understate particularly the propensity for spontaneous combustion?

A. Absolutely. There is a big difference between a laboratory experiment and a coal mine, as you well know.

Q. So this highlights two potential issues in setting TARPs?

A. Agree.

Q. And you could underestimate –

A. Agree.

Q. -- your TARP's level of intensity of the heating?

A. Yes.

⁶²⁵ AGM.002.001.0937: GRO-10699-RA-LW104 Goaf Drainage.

⁶²⁶ TRA.500.021.0001, .0096, lines 10–39.

The Serinus TARP review: 5 January 2020

Grosvenor active goaf spontaneous combustion TARP

6.62 In January 2020, Serinus provided a preliminary report on a review of spontaneous combustion TARP triggers to Grosvenor management.⁶²⁷ The report recommended, relevantly, changes to the TARPs in use for the active goaf and goaf drainage wells.⁶²⁸ The report also recommended the adoption of a TARP specifically for goaf stream samples.⁶²⁹

6.63 Figure 95 lists the Serinus recommended parameters to be incorporated into the spontaneous combustion TARPs at various locations:⁶³⁰

Applicable TARP	Sample Location	Parameter
Active Goaf	Longwall Return	CO Make
		Graham's Ratio
		Carbon Monoxide to Carbon Dioxide Ratio
	Active Goaf Seal	Carbon Monoxide
		Graham's Ratio
		Ethylene
	Goaf Stream	Carbon Monoxide
		Graham's Ratio
		Ethylene
	Goaf Drainage Holes*	Carbon Monoxide
		Ethylene
	Longwall Retreat	Retreat Rate

Figure 95: Recommended parameters and locations for TARPs

6.64 The Serinus recommendations appear not to have been adopted, or at least not adopted in full, by Grosvenor mine management at the time of the serious accident on 6 May 2020.

6.65 Serinus recommended that a TARP for goaf stream samples be adopted based on the indices of carbon monoxide, Graham's Ratio and the detection of ethylene.⁶³¹ No such TARP was developed and adopted by Grosvenor mine management, although there was a program of taking goaf stream bag samples twice per day.

6.66 It also recommended a TARP based on the rate of longwall retreat, recognising the elevated risk of spontaneous combustion associated with slow retreat rates.⁶³² No such TARP was developed and adopted by Grosvenor mine management.

⁶²⁷ AGM.011.001.1889.

⁶²⁸ AGM.011.001.1889, .1897.

⁶²⁹ AGM.011.001.1889, .1897.

⁶³⁰ AGM.011.001.1889, .1911.

⁶³¹ AGM.011.001.1889, .1976.

⁶³² AGM.011.001.1889, .1915.

- 6.67 Serinus further recommended a new TARP for the monitoring of goaf wells. The Serinus TARP suggested that carbon monoxide and ethylene should be adopted as appropriate parameters.⁶³³ However, the Serinus recommendation does not appear to recognise the need to calculate methane-free carbon monoxide levels in the goaf wells.
- 6.68 Grosvenor mine management had not adopted any of the Serinus goaf well TARP recommendations at the time of the serious accident.
- 6.69 On 1 May 2020, Grosvenor management made some changes to the longwall return active goaf TARP.⁶³⁴ It is not known if the changes adopted by Grosvenor management were influenced by the Serinus report, but there are some significant differences between the two documents.
- 6.70 Figure 96 represents the recommendations made by Serinus for the active goaf spontaneous combustion TARP – longwall return.⁶³⁵

Location	Normal	Level 1 Response	Level 2 Response	Level 3 Response
Longwall Return	CO Make < 40l/min AND Graham's Ratio < 0.3 AND CO/CO ₂ < 0.1	40l/min ≤ CO Make < 50l/min OR 0.3 ≤ Graham's Ratio < 0.5 OR CO/CO ₂ ≥ 0.1 OR Longwall Retreat less than #	50l/min ≤ CO Make < 150l/min OR 0.5 ≤ Graham's Ratio < 1.2 OR Sweating, smell or haze (confirmed by ERZ Controller)	CO Make ≥ 150l/min OR Graham's Ratio ≥ 1.2 OR Smoke (coming from goaf)

Figure 96: Serinus Recommendation – active goaf spontaneous combustion TARP - longwall return

- 6.71 Figure 92 above, is an extract showing the trigger levels for the longwall return location in the Grosvenor active goaf spontaneous combustion TARP that was revised on 1 May 2020.
- 6.72 The most significant difference between the Serinus recommendation and the Grosvenor TARP is the inclusion of ethylene as both a 'Level 2' and 'Level 3' trigger in the Grosvenor TARP.
- 6.73 Serinus recommended the adoption of a CO/CO₂ 'Level 1' trigger of 0.1. As previously discussed, a CO/CO₂ Ratio of 0.1 for a typical Bowen Basin coal is indicative of a temperature of 80 °C or more.⁶³⁶ Although the recommended ratio is half of the Grosvenor TARP ratio, it still appears to be too high a value to adopt as a 'Level 1' trigger.⁶³⁷

⁶³³ AGM.011.001.1889, .1910–.1911.

⁶³⁴ AGM.002.001.0463: *GRO-6953-TARP-Active Goaf Spontaneous Combustion*.

⁶³⁵ AGM.011.001.1889, .1898.

⁶³⁶ See paragraph 6.41.

⁶³⁷ Cliff, D., Brady, D. & Watkinson, M., *The Green Book – Spontaneous Combustion in Australian Coal Mines* (SIMTARS, 2018), page 192; WMA.003.004.0001, .0194.

- 6.74 It is also noted that Serinus had recommended the use of Graham's Ratio and CO/CO₂ Ratio as appropriate indicator parameters in the longwall return.⁶³⁸ This contradicts the advice previously referenced that 'the large volumes of air used to ventilate mines means the initial changes in CO and CO₂ are within the noise levels of the detection systems'.⁶³⁹
- 6.75 Neither the Serinus recommendation nor the Grosvenor longwall return spontaneous combustion TARP accounts for the carbon monoxide being drawn up the goaf wells.
- Mr Martin Watkinson suggested that the CO Make in the goaf wells should be added to the CO Make measured in the longwall return to understand what the total CO Make is for the active goaf.⁶⁴⁰
- 6.76 At the time of the serious accident, no goaf stream TARP had been adopted by Grosvenor mine management. The Board's view is that neither the Serinus recommended longwall return spontaneous combustion TARP, nor the Grosvenor longwall return spontaneous combustion TARP, would have necessarily given early warning of a small but intense heating within the LW 104 goaf.
- 6.77 The next chapter considers the events of 1–6 May 2020. Chapter 8 reviews the evidence of the occurrence of a small but intense heating in the goaf during that period.

⁶³⁸ AGM.011.001.1889, .1911.

⁶³⁹ See paragraph 6.34. See also Cliff., D. *et al.*, *Better Indicators of Spontaneous Combustion* (2000) Project No. C5031 Report, Australian Coal Association Research Program, page 9; WMA.003.001.0001, .0011.

⁶⁴⁰ TRA.500.018.0001, .0026, lines 26–32.

Findings

Finding 61

There should have been, but was not, a Trigger Action Response Plan (TARP) for the goaf stream.

Finding 62

The existing goaf well TARP did not contain a requirement for regular bag samples to be taken under 'Normal' TARP conditions.

Finding 63

The TARPs in place for spontaneous combustion in the active goaf and the goaf wells, as at 6 May 2020, were unlikely to provide a timely warning of a small but intense heating in the goaf. Products of such a heating are likely to report to the goaf stream and/or the goaf wells.

Recommendations

Recommendation 7

Grosvenor develop a set of TARP triggers for spontaneous combustion in the active goaf with respect to the goaf stream.

Recommendation 8

Grosvenor review the TARPs for goaf wells and include a requirement for the taking of regular bag samples under 'Normal' TARP conditions.

Recommendation 9

Coal mines include the carbon monoxide (CO) reporting to the goaf wells with that measured in the longwall return when calculating the total CO Make for the active goaf.

Recommendation 10

Resources Safety & Health Queensland takes steps, through the consultative process provided by the Coal Mining Safety and Health Advisory Committee, to ensure that a Recognised standard based on best practice is developed for the monitoring and control of spontaneous combustion in underground coal mines.

Chapter 7 – The serious accident

Introduction

- 7.1 This chapter reviews the events at Grosvenor mine (Grosvenor) from 1 May to 6 May 2020. At that time, longwall 104 (LW 104) was progressing through unstable strata, and gas emissions were causing elevated methane levels in the tailgate (TG). Both issues resulted in production delays and stoppages. There was heightened concern amongst mine management about their effect.
- 7.2 The chapter also reviews the workers' descriptions, and the other evidence, of the serious accident that occurred shortly before 3:00pm on 6 May 2020.

Gas management

- 7.3 From late April 2020, elevated methane levels in the tailgate were causing persistent delays in mining. These delays are listed in the following table.⁶⁴¹

Date	TG Chainage	Gas delays in hours and minutes
25 April 2020	4051.2	9 hours 30 minutes
26 April 2020	4045.5	0 hours 0 minutes
27 April 2020	4039.3	10 hours 1 minute
28 April 2020	4028.7	17 hours 40 minutes
29 April 2020	4020.7	10 hours 52 minutes
30 April 2020	4012.6	10 hours 17 minutes
1 May 2020	4004.3	5 hours 55 minutes
2 May 2020	3999.8	0 hours 27 minutes
3 May 2020	3999.8	0 hours 0 minutes
4 May 2020	3994.9	1 hour 1 minute

Figure 97: Gas delays at LW 104

- 7.4 The delays identified in this table are only those related to elevated methane in the days leading up to 6 May 2020. There were other production stoppages and delays relating to strata control measures and equipment maintenance.⁶⁴²

⁶⁴¹ Table prepared by the Board of Inquiry, using data from the document *LW104 GasMake*: RSH.038.002.0001, .0004.

⁶⁴² AGM.006.001.0042, .0059.

7.5 In response, Incident Management Teams (IMTs) were formed on two occasions, as indicated in the following extracts from a timeline prepared by Grosvenor:⁶⁴³

28/04/2020	07:30	Gas IMT formed following continual stoppages and delays from periods of elevated methane in the tailgate. 220 minutes slow down and 172 minutes of stoppages last 24 hours. 9 new actions raised.
02/05/2020	14:30	Gas IMT formed following continual stoppages and delays from periods of elevated methane in the tailgate. 24 minutes slow down and 303 minutes of stoppages last 24 hours. 6 new actions raised.

Figure 98: Extracts from timeline showing formation of Incident Management Teams

7.6 In the period 1 to 3 May 2020, emails exchanged between Mr Griffiths and senior mine leadership indicated a high level of concern over gas emissions, and proposed a short-term solution to increase gas drainage capacity.

7.7 The emails indicate that:

- the view was held that gas emissions at LW 104 had reached a critical point, and were regarded as ‘almost to the point of bordering on being unmanageable’;
- a question was raised, but not pursued, as to whether there should be a strategic reduction in mining; and
- the Site Senior Executive (SSE) viewed the priority as being to ‘keep cutting’ in order to negotiate through the difficult strata conditions being experienced in the tailgate, and immediate action on increased goaf drainage was required to achieve this.

7.8 Before discussing these emails, there are two matters referred to in them which it would be helpful to explain.

7.9 The *Coal Mining Safety and Health Regulation 2017* (Qld) (the Regulation) was amended in January 2020, with the amendment relevant to this discussion becoming effective in February 2020.⁶⁴⁴ A new section was inserted into the Regulation and required that ‘at least one automatic methane detector be located in the return airway within 400m of the intersection with the longwall face’, and that the detector must, relevantly, ‘trip the electricity supply to the armoured face conveyor and the longwall shearer cutters when the general body concentration of methane detected in the return air exceeds 2%’.⁶⁴⁵

⁶⁴³ AGM.006.001.0042, .0059.

⁶⁴⁴ *Coal Mining Safety and Health (Methane Monitoring and Ventilation Systems) Amendment Regulation 2019* (Qld), sections 10 and 393(b).

⁶⁴⁵ Regulation, sections 243A(2) and (3)(b).

- 7.10 A Directive was issued to Grosvenor on 9 April 2020 on the basis that the mine's methane monitoring system did not comply with this requirement.⁶⁴⁶ Grosvenor had a sensor at the required location, however it was not configured to trip power to the armoured face conveyor (AFC) and shearer. Rather, a sensor located in the canopy of shield #149 was so configured. Following the Directive, the sensor in the tailgate roadway, described by Grosvenor as the 'Inbye CH₄ Sensor', was re-configured to trip power to the AFC and shearer at a methane concentration of 2%.⁶⁴⁷
- 7.11 Further, the prospect of increasing goaf drainage as an option, to manage difficulties in progressing the longwall as a fault system known as the 'Foey fault' intersected the tailgate end of the face, had been considered since at least 17 April 2020.
- 7.12 On that date, Mr Wouter Niehaus, Underground Mine Manager sent an email to the Coal Mines Inspectorate (the Inspectorate)⁶⁴⁸ describing anticipated issues when that fault reached the tailgate. The purpose of the email was to seek 'approval' from the Inspectorate to 'operate the AFC and shearer to clear...material [from roof falls] when the TG roadway is above 2%'.⁶⁴⁹ In the email, Mr Niehaus described that Grosvenor had used that method to clear such material on LW 103 and 'correct' the resulting ventilation blockages. However, the alternative option of increased goaf drainage on LW 104, to 'establish <2% in the TG roadway', was mentioned in a list of options that, according to Mr Niehaus, '...pose increased risks to people and to the mine'.
- 7.13 The concern about increased goaf drainage was specified: 'This will increase the Spontaneous Combustion risk for the operation'.⁶⁵⁰ The Inspectorate's reply confirmed that it could not grant an exemption permitting a breach of the Regulation, and that the risks associated with the fault were a 'known potential hazard', which it was the mine's responsibility to manage.

Emails of 1 May 2020

- 7.14 Mr Griffiths sent an email at 8:00am on 1 May 2020 to senior mine staff, including Mr Gary Needham (Seamgas Manager), and Mr David Johnson (Commercial Manager), on the subject 'Increased Goaf Drainage'. With respect to the progress of the arrival of additional gas drainage equipment, he said:⁶⁵¹

The blowers and additional skids are tracking well and I'm confident come July/August we will have a 17,000l/s capacity system - this is not far away.

⁶⁴⁶ RSH.002.032.0001.

⁶⁴⁷ SST.002.001.0001, .0032.

⁶⁴⁸ The Coal Mines Inspectorate is a division of Resources Safety & Health Queensland (RSHQ), the Regulator of the coal mining industry. At the time, the Regulator was the Department of Natural Resources, Mines and Energy (DNRME) and the Inspectorate was a division of that department. That department had formerly been titled DNRM, the Department of Natural Resources and Mines.

⁶⁴⁹ RSH.002.041.0001.

⁶⁵⁰ RSH.002.041.0001, .0002.

⁶⁵¹ AGM.012.001.0151.

- 7.15 Mr Griffiths went on to identify the problem of gas emissions that presented in the meantime, exacerbated by delays encountered in mining through Fooey fault:⁶⁵²

Unfortunately despite a rather small LW104 goaf (and goaf gas reservoir), the methane levels in the TG are almost to the point of bordering on being unmanageable - causing huge issues (with the new Directive enforced of 2.0% trip AFC and shearer) with constant delays which is starting to concern me particularly as this fault system moves closer to the TG roadway - and in turn, increasing risk profile...(Emphasis added).

- 7.16 He raised a short-term proposal to increase total gas flow extractions by 3,000 l/s, by venting the gas into the atmosphere, which had the potential to attract penalties for greenhouse gas emissions. He said:⁶⁵³

Right now we'd ideally like to see the background methane levels in the TG roadway reduce by 0.5%, which is around 70m³/s of ventilation would equate to around 350l/s of methane.

Based on the 1 to 5 ratio we saw in LW103 (particularly from the Venting Trial - see attached report), this would equate to around an additional 1,750l/s of methane to be extracted from the goaf gas reservoir.

At an average purity of around 60%, this would require around 3,000l/s of total gas flow above current extraction levels. So from 8,000l/s to 11,000l/s.

Majority of this additional 3,000l/s (of say 1,750l/s of methane) would require to be on venturi (until such time obviously as the next flowmeters [sic] are installed in the coming months).

Some rough calculations show even with this additional 1,750l/s on venturi for 5-6 weeks show we would still come under our tonnes CO₂e threshold by end of June by around 30,000 to 40,000 (as we are currently running at around 28,000t per month). (Emphasis added).

- 7.17 Mr Johnson forwarded the email to Mr Needham at 8:40am that morning, adding his comments, and copying in Mr Griffiths. In his email, Mr Johnson raised, belatedly, and for the first time (on the evidence available to the Board), the question whether there should be a strategic lowering of the rate of production. He said:⁶⁵⁴

Gary:

Overlaying Trent's concerns is the risk that we are heading towards a situation where our business becomes stock-bound as well given the 300kt of product stocks we've already got without Moranbah North having yet turned a drum.

⁶⁵² AGM.012.001.0151.

⁶⁵³ AGM.012.001.0151, .0151-.0152.

⁶⁵⁴ AGM.012.001.0151. 'Stock-bound' refers to the situation where there is no storage space left for the coal being produced.

So, the question is, do we fundamentally need to change the way we operate this longwall? For example, might we better off just cutting 12 hours solid on night shift, then stop and aggressively draw gas for 12 hours on day shifts? Or, do we agree to just retreat 10 shears, then stop and aggressively draw? This longwall has demonstrated it can cut well, so perhaps its our time management that needs to be revisited. (Emphasis added).

- 7.18 It seems plain that Mr Johnson raised the question whether production should be reduced in light of a current stockpile of 300 kt, noting the risk of becoming stock-bound, and that Moranbah North was not producing at this stage.
- 7.19 Mr Griffiths' email reply at 8:46am commenced by saying 'Excellent question. We are in a really interesting position...'. However, it seems that no further consideration was to be given to the question raised by Mr Johnson before mid-June 2020.⁶⁵⁵

Email of 2 May 2020

- 7.20 The next day Mr Griffiths sent another email, at 12:53pm, to the Grosvenor senior leadership team. The email flagged a polyurethane resin (PUR) injection campaign to consolidate the face and roof whilst mining through the Fooey fault.
- 7.21 On the issue of gas emissions, Mr Griffiths gave an instruction for an immediate increase in goaf drainage 'to allow us to keep cutting'. The email said:⁶⁵⁶

*We need to move on the increased goaf drainage "venting" process immediately. For one reason or another (combination of the Directive on the 2.0% AFC and shearer trip and a **BUCKET** load of gas in a rather small goaf) we are losing the war and are at risk of losing this LW as the fault approaches the TG end of the face.* (Emphasis in original).

I've given direction this morning that we need to act with urgency immediately on increasing the goaf drainage extraction to lower the TG methane levels to allow us to keep cutting - this is an absolute must. (Emphasis added).

We have more than enough capable people on the minesite this weekend to coordinate this through an IMT and risk management (JSEA) approach (UM, VO, Vent Co-ordinator, Gas Drainage Co-ordinator, Seamgas Supervisor, LW Mining Co-ordinator just to name a few).

Logan has spoken to Johnno (VO) and he will work with the weekend team to get this process completed so the Seamgas Team can get as many additional Venturi skids online as quickly as possible.

⁶⁵⁵ AGM.012.001.0151.

⁶⁵⁶ AGM.012.001.0071.

Ideally I'd like to see an additional 4-5 venturis on in the next 24 hours increasing the total goaf gas flow by around 3,000l/s (at say 60% methane would be around 1,800l/s) and lower the TG background methane levels by around 0.5% but that might be a tough ask.

Either way, we need to do what we can to ensure we don't lose control of this LW during these next 60 or so metres of retreat. We've worked too hard to lose control now.

Emails of 3 May 2020

7.22 On 3 May 2020, in response to receiving the minutes of the IMT meeting the previous day,⁶⁵⁷ Mr Griffiths sought clarification on the progress of '...setting up and turning on more goaf Venturis to increase total LW104 capacity'. The aim was to reduce the tailgate general body methane levels to 'allow the LW to safely get through the rest of this fault system over the next 60 metres retreat or so'.⁶⁵⁸

7.23 Mr Mark Johnston, the Ventilation Officer, responded at 4:04pm explaining steps that were being taken. These included that more holes had been put on venturi 'to get more suction and flow for the other holes on VPS'. He reported that there was '...9% O₂ 150m back into the TG goaf' and that an effort was being made to lower the overall oxygen levels to address this issue. He said that the goaf wells were '...going as hard as they can and the only wells [that are being] turned off are the ones that go into TARP'.⁶⁵⁹

7.24 In an email forty minutes later, Mr Johnston stated:⁶⁶⁰

I have been keeping a close eye on the Goaf holes as the amount of O₂ we are seeing and the increase of CO on holes as they move back into the goaf is something we really need to watch so we don't create other problems.

7.25 At least one of the potential 'other problems' to which he refers must have been spontaneous combustion in the goaf. The concern expressed was justified, as some of the goaf wells were drawing between about 5% and 11% oxygen.⁶⁶¹

⁶⁵⁷ See paragraph 7.5.

⁶⁵⁸ AGM.013.002.0173, .0175. 'Goaf Venturis', also known as 'ejector skids' are mobile gas extraction plants that utilise a compressed air stream to create a vacuum on the goaf well head. All associated pipework, flame arrestors and control systems are incorporated onto a movable sled or skid. The gas is either free vented (released to the atmosphere) or flared (burned).

⁶⁵⁹ AGM.013.002.0173. 'Going into TARP', in this context, likely refers to the levels of oxygen being drawn from the well increasing to the point where the TARP trigger level required that the well be shut in.

⁶⁶⁰ AGM.013.002.0173.

⁶⁶¹ AGM.013.002.0173, .0175. For a detailed examination of the goaf well data, see Chapter 8.

- 7.26 Although an urgent increase in goaf drainage capacity was being arranged, there appears to have been no suggestion by anyone of bringing forward the completion of the yet to be undertaken spontaneous combustion risk assessment for increased goaf drainage, slated for completion by 31 May 2020.⁶⁶²
- 7.27 The Inspectorate was not aware of these emails. Regional Inspector of Mines Mr Stephen Smith gave evidence that if he had known the SSE ‘was expressing that the methane levels at the tailgate were on the brink of unmanageable’, it ‘may have stimulated a suggestion that they stop mining until they figure out how to manage them’.⁶⁶³

Strata issues

- 7.28 The issues with unstable strata exacerbated delays in the lead up to the serious accident, and contributed to spontaneous combustion risk. Most of 2 and 3 May 2020 were taken up dealing with these issues, particularly the Fooley fault, which was then present at the tailgate end of the longwall, and a number of roof cavities.
- 7.29 The Fooley fault ran diagonally across LW 104 from maingate (MG) to tailgate as depicted in the diagram below. It can be seen that the fault was present at the tailgate end of the face at the time of the serious accident.⁶⁶⁴

⁶⁶² AGM.002.001.0937, .0953: *GRO-10699-RA-LW104 Goaf Drainage*. This is discussed further in chapter 4, paragraph 4.76.

⁶⁶³ TRA.500.015.0001, .0102, lines 16–27.

⁶⁶⁴ TRO.001.001.0001, .0019.

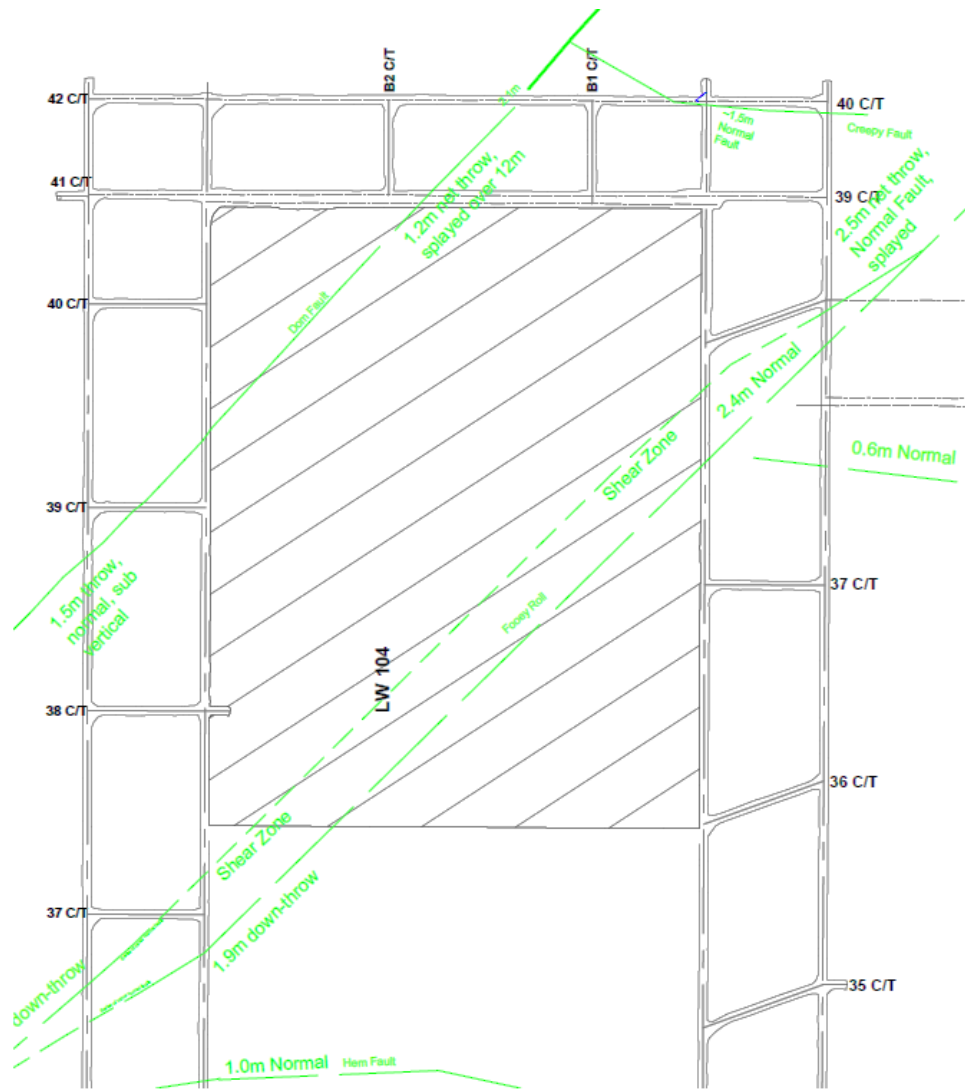


Figure 99: Mapped faults at LW 104 inbye

7.30 The extent of its presence was described in Grosvenor’s Learning From Incidents (LFI) report concerning the serious accident, as follows:⁶⁶⁵

This fault was found to have a variable displacement, with some areas found to have a displacement closer to 4m, creating a full face of stone. The first splay of the Foosy fault was intersected at maingate chainage 4283m on 23rd March 2020, and mining had progressed through this fault up until the day of the incident.

7.31 It was not a single fault, but rather, as Dr Rob Thomas said in evidence, ‘a fault zone with lots of smaller faults and shears in that zone’.⁶⁶⁶

⁶⁶⁵ AGM.006.001.0042, .0047. The LFI report was submitted to the Inspectorate to satisfy the requirement in section 201 of the *Coal Mining Safety and Health Act 1999* (Qld) (the Act). For this reason, it will be referred to throughout this chapter as the ‘section 201 report’.

⁶⁶⁶ TRA.500.017.0001, .0043, lines 13–15.

- 7.32 The face was inspected and mapped by the Grosvenor mine geologist on the morning of 2 May 2020. Anglo's section 201 report for the serious accident summarised the prevailing conditions as follows:⁶⁶⁷

Conditions on the face had been reportedly deteriorating during the previous nightshift, and the Longwall Strata TARP was escalated to Code Red during the inspection. It was observed that there was a 3m cavity from #128 to #132 roof support, delamination occurring from #108 to #128 roof support, and a 2.5m cavity over roof supports #147 to #149. The Tip To Face (TTF) was observed to mostly be tight with the sprags knuckled to the face, however it was extending up to 1.5m in parts. The goaf in the tailgate roadway was identified as being flushed into the rear of #149 roof support with no other signs of heavy loading visible in the roadway. The Foey fault was present on the face at #108 roof support, with some localized deformation occurring around this structure.

- 7.33 Mr Griffiths' concern about strata issues was expressed in his email on 2 May 2020 at 12:53pm. He said:⁶⁶⁸

Unfortunately we [sic] losing control of the fault on the face from 93 roof support to 132 roof support.

The constant "stop - start" lack of momentum last 48 hours has really impacted us and now we are at the cross roads.

At this point in time we are looking at injecting PUR into the face in this area to help create some stability before [sic] get moving again. We are aiming to have this injection work done by around 10am tomorrow.

- 7.34 The Strata Management Review Team met at 2:30pm that day. It noted that there was delamination through a large area above shields #97 to #132, and a further cavity above shields #147 to #149.⁶⁶⁹ A consolidation plan was developed, involving the pumping of PUR above shields #97 to #132 and cavity fill above shields #112 to #116.⁶⁷⁰

- 7.35 The balance of 2 May 2020 was spent making preparations for the pumping of the PUR and void fill.⁶⁷¹

- 7.36 As will be explained in Chapter 9, the process of pumping PUR involves the coal or strata being injected with a two-component resin which expands and hardens, providing support. A discussion of the use of PUR at Grosvenor is contained in that chapter. It is sufficient to note here that it undergoes an exothermic, or heat-producing, reaction while curing, and there is evidence that the oxidation of adjacent coal can be accelerated by this reaction.

⁶⁶⁷ AGM.006.001.0042, .0067. 'Delamination' refers to the strata being fractured into layers.

⁶⁶⁸ AGM.012.001.0071.

⁶⁶⁹ RSH.019.001.0001.

⁶⁷⁰ RSH.019.001.0001, .0003.

⁶⁷¹ AGM.003.001.1259; AGM.003.001.1269.

- 7.37 There was no production on LW 104 on 3 May 2020. Most of the day was taken up with the pumping of PUR.⁶⁷² In total 5,664 litres, or 6.3 tonnes, of PUR were pumped into an area approximately 70 metres wide and 3.9 metres deep.⁶⁷³
- 7.38 Production resumed at 12:10am on 4 May, but little progress was made until about 7:00am. Reasons for the delay recorded by the Deputy included cavity management and ‘throwing rock – buried Bretby #107-111’.⁶⁷⁴

Delays for equipment maintenance

- 7.39 Delays on the longwall continued throughout 4 May 2020. The Production Report for the night shift on that day refers to electrical faults on the shearer and the need to clear the AFC. It also noted ‘stone TG side of shearer’, thermal overloads, broken chain alarms and rock jammed under the shearer.⁶⁷⁵ Further short delays occurred due to the shearer drums being stopped by the shearer methane sensor recording over 1.25% and, later, the inbye sensor recording over 2% methane.⁶⁷⁶
- 7.40 The shearer was idle from about 11:00pm on 4 May 2020 until 3:00am on 6 May.⁶⁷⁷ This was due to repairs being carried out to the AFC, which had suffered chain and flight bar damage.⁶⁷⁸
- 7.41 In fact, the longwall only retreated about 9–11 metres between the time of injection of the PUR on 3 May 2020 and the serious accident on 6 May.⁶⁷⁹ The 28-hour stoppage and the short distance of retreat meant much of the PUR would have been situated above the shields for most of this time, and would have prevented any coal affected by PUR that had fallen behind the shields, from being buried deeper in the goaf.

⁶⁷² AGM.003.001.1274; AGM.003.001.1283; AGM.011.001.2243.

⁶⁷³ See Chapter 9, paragraph 9.82.

⁶⁷⁴ AGM.003.001.1283. The ‘Bretby’ is a cable protection device designed to protect and support the shearer electrical cable and hoses as the shearer moves from end to end.

⁶⁷⁵ AGM.003.001.1298, .1299.

⁶⁷⁶ AGM.003.001.1298, .1299. While these levels do not exceed the 2.5% methane concentration that constitutes a ‘high potential incident’ under the Act, the Regulation requires that the power is tripped at lower levels, to reduce the risk of an ignition being caused by the operating machinery.

⁶⁷⁷ RSH.034.002.0001: the *Grosvenor Shearer Position, PRS Leg Pressure (Bar) & Yield Events*, an electronic log of the shearer’s movements.

⁶⁷⁸ AGM.006.001.0042, .0060–.0061.

⁶⁷⁹ RSH.034.002.0001: *Grosvenor Shearer Position, PRS Leg Pressure (Bar) & Yield Events*.

The day of the serious accident

7.42 Production recommenced at approximately 3:00am on 6 May 2020 when the issues with the AFC were resolved.⁶⁸⁰

Strata conditions

7.43 On 6 May 2020, strata conditions on the longwall were unremarkable until about shield #91. There was a 1.2 metre high cavity above shields #91 to #95. The Fooley fault was located at shield #109. There was a second, 1.4 metre high cavity between shields #135 and #143. A third cavity above shields #144 and #149 was estimated to be at least five metres high.⁶⁸¹

7.44 The longwall strata control TARP was in 'Level 2' as a result of the strata conditions.⁶⁸²

7.45 As a result of the 'Level 2' trigger, the Explosion Risk Zone (ERZ) controller was required to develop an action plan, increase the frequency of inspections and monitoring, and liaise with the Undermanager to mobilise ground consolidation personnel. The Undermanager and Longwall Superintendent were also required to take action.⁶⁸³ As will become apparent, those actions formed part of the day's activities.

The morning's events

7.46 When production resumed at approximately 3:00am, the shearer was located at about shield #118. The night crew drove the shearer from that position into the tailgate and then commenced a run from the tailgate to the maingate.⁶⁸⁴

7.47 The bullgang crew arrived underground to take over from the night shift crew sometime before 7:00am.⁶⁸⁵

7.48 Mr Sam Priest was the bullgang Deputy.⁶⁸⁶ Mr Jamie Dowd was the shearer driver and Mr Aaron Charchalis was the chock operator.⁶⁸⁷ Other workers on that crew included Mr Rowan Sweeney, Mr John Oliver, Mr Mace Kingston, Mr Grant French, Mr Dylan Hutton and Mr Aaron Christiansen.⁶⁸⁸

7.49 Mr Dowd and Mr Charchalis went to the longwall face, arriving at about 7:00am. Mr Dowd had a discussion with the night shift shearer driver. He was informed that the night shift crew had started cutting at about 3:00am. The night shift shearer driver had inspected the drums, picks and sprays and they were in good condition.

⁶⁸⁰ AGM.006.001.0042, .0061.

⁶⁸¹ AGM.006.001.0042, .0067.

⁶⁸² AGM.006.001.0042, .0067.

⁶⁸³ AGM.002.001.0810, .0812–.0813: *GRO-5883-TARP-Longwall Strata Control*.

⁶⁸⁴ RSH.034.002.0001; TRA.500.016.0001, .0024, lines 18–23.

⁶⁸⁵ AGM.003.001.1303; BOI.039.002.0001, .0029.

⁶⁸⁶ AGM.003.001.1303.

⁶⁸⁷ BOI.039.002.0001, .0029–.0030.

⁶⁸⁸ AGM.003.001.1303.

In terms of the tailgate conditions, the night shift shearer driver said that the tips were down on shields #146 and #147 and that Mr Dowd would have issues getting the drums under them next time they cut into the tailgate.⁶⁸⁹

- 7.50 When Mr Dowd and Mr Charchalis took over cutting, the shearer was at about shield #92 or #93 and was heading towards the maingate. Their plan was to do the maingate push and then head back towards the tailgate, slowing down at the fault between about shield #110 and #124 so that they could support the roof as needed.⁶⁹⁰
- 7.51 Between 7:00am and 8:00am, they did two runs into the maingate, as planned. On the first run, they broke a rack bar pin at shield #10 and stopped while fitters attended and replaced it. After the second run into the maingate, they drove back towards the tailgate.⁶⁹¹
- 7.52 When they got to the fault, they slowed the shearer to about four metres a minute. When they got to about shield #135, they stopped the shearer and walked into the tailgate. They noticed the shields were double chocked from about shield #140 and that the tips were down. When the shearer got to the double-chocked shields, Mr Charchalis started manually advancing the shields.⁶⁹²
- 7.53 They stopped the shearer again at about shield #144 and had a discussion with Mr Priest and Mr Mick Burgess, the Longwall Coordinator, about how to proceed. They moved the shield #145 flipper and emptied the cavity of rocks. The shearer advanced one shield.⁶⁹³
- 7.54 They then tried to do the same thing with shield #146, but there was a ‘hell of a lot of stone’ above shield #146 and ‘big rocks’ came down. Mr Dowd started the lump breaker and managed to cut up a few rocks before more rocks came down.⁶⁹⁴
- 7.55 One of the falling rocks struck the lump breaker shear shaft. Around 10:15am, the broken shear shaft was replaced.⁶⁹⁵

Arrival of the afternoon shift crew

- 7.56 The Deputy on the afternoon shift was Mr Adam Maggs.⁶⁹⁶ His crew consisted of the five injured coal mine workers, as well as Mr Beau Lacy, Mr Josh Sloan, Mr Matt Gunn, Mr Jackson Hayes, Mr Tommy Barry and Mr Josh Underdown.⁶⁹⁷
- 7.57 At the start of his shift, Mr Maggs was briefed on the conditions of the day.⁶⁹⁸

⁶⁸⁹ BOI.039.002.0001, .0030.

⁶⁹⁰ BOI.039.002.0001, .0030.

⁶⁹¹ BOI.039.002.0001, .0030.; TRA.500.016.0001, .0024, lines 22–29.

⁶⁹² BOI.039.002.0001, .0030.

⁶⁹³ BOI.039.002.0001, .0030.

⁶⁹⁴ BOI.039.002.0001, .0031.

⁶⁹⁵ AGM.006.001.0042, .0062.

⁶⁹⁶ TRA.510.003.0001, .0010, line 4; line 27.

⁶⁹⁷ TRA.510.003.0001, .0012, lines 11–15.

⁶⁹⁸ TRA.510.003.0001, .0011, lines 6–7.

- 7.58 At about 10:00am, he and his crew arrived underground and he briefed them. He spoke to his crew about the location of the fault, the cavity above the shields between shields #144 and #149 and the fact that the tips were down on shields #145 and #146. He then went through the plan for the shift. He described that briefing process as follows:⁶⁹⁹

So the plan was – you know, what I'd been told from upstairs was we weren't in a position to pump at the time, due to the – you know, the cavity was only in a level 2. It was only over five chocks. There was no tip to face. It was all tight. There was no need to pump. We couldn't pump while we had those tips down, anyway. Pulling up for 24 hours, you know, losing the tailgate – they were considerations. So our thought process was to go through to 149, open it up and get those 145 and 146 up in the air.

So I spoke about that. They boys were clear on that. They agreed on that. They were happy with that. They actually had no questions. I just mentioned to them again about, you know, keeping the face tight, cavity management, what we do every day with tight – if we need to double-chock, we'll double-chock. If we need to pull up, we'll pull up. We'll check gases and different things like that.

- 7.59 After the briefing, Mr Maggs walked the belt road to the face and the other workers travelled by drift runner.⁷⁰⁰

- 7.60 On arrival at the face, Mr Maggs recalled that the goaf was 'tight to behind the shields'.⁷⁰¹ As he walked along the face, he checked the gas readings along the rear walkway and recalled that 'the most [he] could find in CH₄ was about 1.2 to 1.3' mid-face, and 0.9 in the maingate.⁷⁰²

- 7.61 He said there had been a bit more gas than usual in recent times because of the fault. He went on to say:⁷⁰³

You know, we had it higher. General body that day was – I was struggling to get 0.5 across the face in general body.

The most I could find in CO in the rear walkway was three parts that day, three to four parts. The face looked pretty good. We were down to 90 chock until we hit that – you know, the throwdown fault. It was good. It was standing up. There was no dramas.

We had a big roll, seam roll, around that fault, which we'd been managing well. That fault was at around 110 to 112 that last day. We probably had anything from about a 2.8 to 3 metre throwdown around that area. That's probably where I was getting the highest general body, that 0.6.

⁶⁹⁹ TRA.510.003.0001, .0013, lines 3–21.

⁷⁰⁰ TRA.510.003.0001, .0014, lines 8–12.

⁷⁰¹ TRA.510.003.0001, .0016, lines 4–15.

⁷⁰² TRA.510.003.0001, .0017, lines 2 –4.

⁷⁰³ TRA.510.003.0001, .0017, lines 17–31.

7.62 Mr Maggs met up with the bullgang crew at about shield #130. The workers from his own crew were already there.⁷⁰⁴

7.63 Mr Dowd reported to him that the bullgang crew was trying to get the shearer past shields #145 and #146. They were working on the lump breaker shear shaft at the time.⁷⁰⁵

7.64 Mr Burgess and Mr Priest were both at the tailgate end of the face when Mr Maggs arrived. Mr Maggs noticed 'a lot of spoil' in the area. He said:⁷⁰⁶

I talked to Mick then. I told him about – I'd spoken to the under-manager upstairs about the plan we were going to come up and his thoughts on pumping and what we were going to do. He agreed still we weren't going to pump due to those 145 and 146 chocks being down. He said, you know, the same thing I spoke about earlier with that roadway in the tailgate. If it stood for too long, we're a chance of losing that roadway with ventilation and different things like that. And if we pumped, it's not going to help those 145 and 146 chocks. They could get a little bit more pressure on them and weight on them and come down a bit more.

So we agreed on what we were going to do there, that we were going to try and get in there, manage that cavity, get into the tailgate, come back out and get those 145 and 146 chocks up and reassess it then.

7.65 He said that, after doing a changeover with Mr Priest:⁷⁰⁷

I then proceeded into the tailgate, the tailgate drive area. I did my usual checks there, so I looked at the cavity. Tip to face was good, and it was tight. It was high, but it was tight. 145, 146 was down. Venturi was running. Venturi was earthed. Butchers doors were up. Checked the rear walkways. The most I could get in there was 0.8, 0.9 in the rear walkways.

7.66 He checked the tailgate drive and rear walkways for layering, but did not find any. He noticed the standing support in the tailgate had some 'mushrooming' which indicated it had some weight on it. The butcher's doors and Sherwood curtain were in place. The tailgate roadway was standing, and the goaf was tight.⁷⁰⁸

7.67 Having completed his inspection of the area, Mr Maggs had a further discussion with Mr Burgess. Mr Maggs told Mr Burgess he was happy with the plan to try to get the shearer into the tailgate. He then relayed that plan to his crew.⁷⁰⁹

⁷⁰⁴ TRA.510.003.0001, .0019, lines 11–27.

⁷⁰⁵ TRA.510.003.0001, .0019, lines 38–40.

⁷⁰⁶ TRA.510.003.0001, .0020, lines 4–15.

⁷⁰⁷ TRA.510.003.0001, .0021, lines 2–9.

⁷⁰⁸ TRA.510.003.0001, .0021, lines 18–42.

⁷⁰⁹ TRA.510.003.0001, .0023, lines 7–13.

The afternoon shift crew's activities

7.68 Mr Maggs said that once the afternoon crew took over from the bullgang crew, they were 'stop/start, stop/start'. The shearer was located at about shield #143 or #144 and 'the rocks just kept coming in'. The size of the rocks varied from 'big, very big, to sand'. Mr Maggs described the slow progress as 'just continually that slow process of cavity management'.⁷¹⁰

7.69 Mr Maggs and the Undermanager, Mr Neal Bryan, were both present while the workers 'persevered' with trying to drive the shearer from its position at shield #143 or #144 towards the tailgate.⁷¹¹

7.70 He said there was no pressure on the shields between #144 and #148.⁷¹² He said:⁷¹³

You could hear your rubble and your rocks coming from high. And the other thing I noticed, when we say – we had no tip to face. This rock was coming straight down. If you visualise it and that, it wasn't rolling. It wasn't rolling off the front of the chocks or anything like that. It was falling straight.

7.71 In terms of dealing with that falling rock, he said:⁷¹⁴

You know, we chomped away. It would come in bounds. It would choke off and we'd sort of have to chop that big rock up and sort of get past it. We pursued with that for probably two, two and a half hours. That got to around that 12.30 mark and we did another lump breaker shaft, and we didn't seem to be going too far without that lump breaker. It was getting caught up underneath that and building up, and you were getting that - the budgie feeder, if you know what I mean, with that.

7.72 At about 1:00pm, Mr Maggs and Mr Bryan discussed the option of putting DSI Underground (DSI)⁷¹⁵ on standby to put '200 cubes of Carbofill' in the cavity. A decision was made for the DSI crew to go to 35 cut-through to prepare, and for some rock props to be brought to the face.⁷¹⁶

7.73 Mr Maggs contacted Mr Burgess, who approved that plan.⁷¹⁷ Mr Maggs then sent everyone but three of the injured coal mine workers to crib. He said:⁷¹⁸

The boys left. There was only four of us down there, and things went to plan after that. Wayne went straight in. It was – lump breaker going. We got in, into that 149, back out.

⁷¹⁰ TRA.510.003.0001, .0023, lines 30–35.

⁷¹¹ TRA.510.003.0001, .0024, lines 20–22.

⁷¹² TRA.510.003.0001, .0024, lines 14–15.

⁷¹³ TRA.510.003.0001, .0024, lines 33–38.

⁷¹⁴ TRA.510.003.0001, .0025, lines 18–26.

⁷¹⁵ DSI Underground is a trading name of Dywidag-Systems International Pty Limited, a contractor supplying ground support products at Grosvenor.

⁷¹⁶ TRA.510.003.0001, .0026, line 4–.0028, line 3.

⁷¹⁷ TRA.510.003.0001, .0026, lines 34–35.

⁷¹⁸ TRA.510.003.0001, .0028, lines 17–33. 'Reverse snake' refers to the area where the AFC is pushed forward to allow the shearer to cut into the face to commence the next shear.

Nothing was above the chocks. It had come down, and we got back and we parked it up at 120, that 120 area, 115 area, the turn-around area where the snake was. Nealo and I just looked at each other and, you know, it was good.

The boys went in then and pushed the tailgate, got that 145 up, got that 146 up. Everything was tight. Everything was up. That was around that – about quarter past 2 to 2.30 time. We thought we had another – we had to come back in again, we thought, for our second thing – second cut in, but the boys then realised that we had our reverse snake there, it was in, and I also noticed that, too.

- 7.74 Mr Maggs observed that the coal beam between the cut height and the roof height had started to ‘unstitch a little bit’ between shields #115 or #120 and #140. He instructed the workers to move the shearer out and double-chock between shields #120 and #140 before heading to the maingate.⁷¹⁹
- 7.75 Mr Maggs recalls that he and Mr Lacy then went to the maingate so that he could call Mr Burgess to let him know that the plan was to do another shear and reassess the situation on the face when they got back to the tailgate.⁷²⁰
- 7.76 Mr Maggs arranged for the crib change to occur at that time. It was during the changeover that the serious accident occurred.⁷²¹

Descriptions of the serious accident

- 7.77 One of the injured coal mine workers, Mr Wayne Sellars, gave evidence at the public hearings. The remaining four injured workers have provided accounts of their experience of the serious accident but have requested to remain anonymous. The Board respects their request for privacy and, accordingly, they are identified by number only.
- 7.78 The serious accident occurred at about 2:57pm. The shearer was stationary. As a result of the crib change, there were five men at the face when the accident occurred. It was an unfortunate coincidence that as many as five workers were present. Mr Maggs said:⁷²²

So, you know, I’ve never usually got five down around that shearer at that time. I know this is unfortunate to say, but, you know, 10 minutes a day these five boys are there changing over that shearer, and this is when the incident occurred.

- 7.79 Three of the workers were in the area of shields #131 to #133 at the time. According to the mine’s face monitoring system, Mr Sellars was at shield #133, Injured Coal Mine Worker 2 was at shield #132 and Injured Coal Mine Worker 3 was at shield #131.⁷²³

⁷¹⁹ TRA.510.003.0001, .0028, line 43–.0029, line 17.

⁷²⁰ TRA.510.003.0001, .0029, lines 33–38.

⁷²¹ TRA.510.003.0001, .0029, lines 19–25.

⁷²² TRA.510.003.0001, .0029, lines 21–25.

⁷²³ AGM.003.001.2174_2.

However, according to the men's recollection, Injured Coal Mine Worker 2 was located closest to the tailgate, and Mr Sellars and Injured Coal Mine Worker 3 were slightly closer to the maingate than him.⁷²⁴

- 7.80 Injured Coal Mine Worker 4 was located near shield #120. Injured Coal Mine Worker 5 was located near shield #100. There were other workers located towards, and at, the maingate.⁷²⁵ In its LFI report for the serious accident, the mine represented the locations of the workers as follows:⁷²⁶

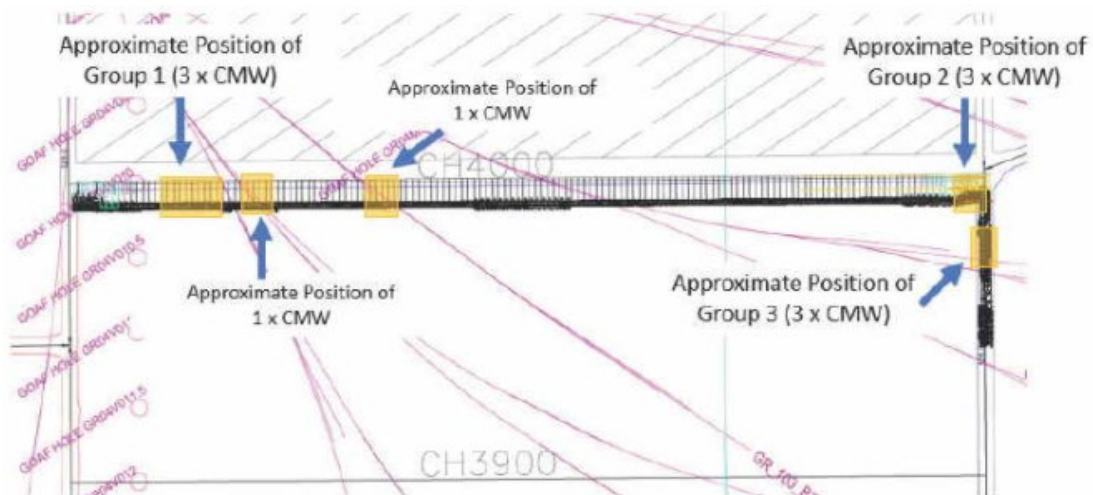


Figure 100: Approximate locations of the workers on the longwall face and at the maingate at the time of the serious accident

- 7.81 Other workers at the maingate end of the longwall, and even much farther away, also provided accounts to mine personnel of their experiences of what occurred shortly after the incident. Some participated in interviews with the Inspectorate. Their accounts are set out below.

Mr Wayne Sellars

- 7.82 Mr Sellars was one of the workers on the longwall face at the time of the serious accident. He gave evidence at the public hearings, including about his experience of the serious accident.
- 7.83 Mr Sellars recalled that the shearer was stationary at the time of the serious accident. Not long before the serious accident, the workers had pulled the shearer up at about shield #125, which was the 'turnaround point'. He described the turnaround point as the point at which 'you could push, advance your chocks, and then the second pass into the tailgate, you could go back in, and then the next pass would keep going out to the maingate'.⁷²⁷

⁷²⁴ SWA.001.001.0001, .0005.

⁷²⁵ AGM.003.001.2174_2.

⁷²⁶ AGM.006.001.0042, .0064.

⁷²⁷ TRA.500.024.0001, .0060, lines 29–46.

- 7.84 The first sign he had that something was wrong was when the first pressure wave came through.⁷²⁸ There was no warning; it ‘took [them] by surprise’.⁷²⁹
- 7.85 When asked what the first pressure wave felt like, he said:⁷³⁰
- Standing in a cyclone. A huge – yes, just a huge pressure wave that went through.*
- 7.86 He described the pressure wave as coming from the direction of the tailgate. He managed to hang on to the shield he was standing next to when it hit. The first pressure wave lasted for ‘a few seconds, a couple of seconds’. He did not recall there being any noise associated with the first pressure wave.⁷³¹
- 7.87 When the first pressure wave ended, the air was still. The ventilation was stopped. He recalled the power was tripped at that point. He turned to Injured Coal Mine Worker 3 and said, ‘They’re not going to like this. There’s another HPI’.⁷³²
- 7.88 He said, ‘[t]he next thing that happened was a second pressure wave, which ignited’.⁷³³ He thought that the second pressure wave occurred about ten seconds after the first.⁷³⁴ He saw a blue flame and the experience was ‘like standing in a blowtorch, for a split second’.⁷³⁵ At the time of the second pressure wave, he heard a noise ‘like two stones being cracked together’.⁷³⁶
- 7.89 From that point, he was on fire and does not recall anything more about the second pressure wave.⁷³⁷
- 7.90 He did recall that, initially, he could not find his self-rescuer, so he held his breath. When he took a breath, he yelled, ‘go, go, go’ and started walking out. At some point on the walk towards the maingate, he recalled being met by his Deputy, Mr Maggs.⁷³⁸
- 7.91 He said, ‘I take my hat off to Adam for coming in’. He recalled Mr Maggs tried to ‘pat [him] out’.⁷³⁹
- 7.92 Mr Sellars said that, once the injured workers reached the maingate, they were put in a vehicle and transported out of the mine. Once they were out of the mine, they were taken to the nurse’s station and treated by first responders before being put in an ambulance and transported to Moranbah Hospital.⁷⁴⁰

⁷²⁸ TRA.500.024.0001, .0061, lines 22–25.

⁷²⁹ TRA.500.024.0001, .0061, line 37.

⁷³⁰ TRA.500.024.0001, .0061, lines 29–30.

⁷³¹ TRA.500.024.0001, .0062, lines 14–37.

⁷³² TRA.500.024.0001, .0062, line 41–.0063, line 1.

⁷³³ TRA.500.024.0001, .0063, lines 22–23.

⁷³⁴ TRA.500.024.0001, .0066, lines 39–42.

⁷³⁵ TRA.500.024.0001, .0063, lines 29–30.

⁷³⁶ TRA.500.024.0001, .0063, lines 41–43.

⁷³⁷ TRA.500.024.0001, .0064, lines 3–5.

⁷³⁸ TRA.500.024.0001, .0064, lines 14–28.

⁷³⁹ TRA.500.024.0001, .0064, lines 30–37.

⁷⁴⁰ TRA.500.024.0001, .0064, line 47–.0065, line 25.

Injured Coal Mine Worker 2

- 7.93 Injured Coal Mine Worker 2 is the worker whom Mr Sellars recalled being closest to the tailgate. He has limited recollection of the incident.
- 7.94 He heard a noise like a goaf fall in the tailgate roadway or behind the tailgate chocks. He also recalled there was a ventilation change which caused pressure on his ears and he heard a noise like ‘garden sprinklers starting’.⁷⁴¹ He said the change of pressure ‘wasn’t normal for where we were and what we were doing’.⁷⁴²
- 7.95 He did not recall a second pressure change. He did, however, recall there was also a flame which wasn’t in existence for very long.⁷⁴³ He recalled being on fire and the fire going out before he fell down unconscious.⁷⁴⁴

Injured Coal Mine Worker 3

- 7.96 Injured Coal Mine Worker 3 is the worker to whom Mr Sellars recalled speaking after the first pressure wave.
- 7.97 He recalled talking to Mr Sellars just prior to the serious accident. He heard ‘a little pop’ and then Mr Sellars turned to him and said, ‘that doesn’t sound good’. He said there was a rock fall that sounded like it was above them or in the tailgate area. It was followed by wind that ‘knocked us completely over’.⁷⁴⁵ He described the intensity of the wind as ‘huge’ and much bigger than the blasts of air he had previously experienced during goaf falls. He thought it came from the direction of the tailgate.⁷⁴⁶
- 7.98 The power went off and it was dark and dusty. He was ‘scrambling in the dirt’ on the ground, trying to locate his light, when ‘the heat and the blast’ came. There was a flame associated with that heat and blast.⁷⁴⁷
- 7.99 He did not notice any suck-back between the first and second events.⁷⁴⁸

Injured Coal Mine Worker 4

- 7.100 Injured Coal Mine Worker 4 described a sudden, strong change in ventilation towards the maingate. He said that within seconds he was engulfed in flames and there was fire and dust everywhere. The first wave of fire ceased when the ventilation changed direction. There was then another change of direction of the ventilation and a second wave of fire which was just as intense as the first.⁷⁴⁹

⁷⁴¹ BOI.039.002.0001.

⁷⁴² BOI.039.002.0001, .0002.

⁷⁴³ BOI.039.002.0001, .0003.

⁷⁴⁴ BOI.039.002.0001.

⁷⁴⁵ BOI.039.002.0001, .0010.

⁷⁴⁶ BOI.039.002.0001, .0011; .0014.

⁷⁴⁷ BOI.039.002.0001, .0010.

⁷⁴⁸ BOI.039.002.0001, .0013.

⁷⁴⁹ BOI.039.002.0001, .0014.

Injured Coal Mine Worker 5

7.101 Injured Coal Mine Worker 5 gave a statement to a colleague at Moranbah Hospital on the night of the serious accident. In it, he reported that he was walking along the face towards the maingate when he felt a burst of air, like a pressure burst, from the tailgate. He was knocked to the ground and felt a second pressure burst from the same direction. He reported seeing a yellow flame when he was on the ground.⁷⁵⁰

7.102 Subsequently, in an interview with the Inspectorate, he said:⁷⁵¹

Just after 3:00ish there was a thick heavy surge of air pressure travelled from the tailgate, to the tailgate to the maingate. It made a whistling noise and it was dusty. I turned to start to walk to the direction of the tailgate to go and help them and then the second pressure surge blew towards me. I saw a wave of ash of some sort for a split second and then the right side of my face, the back of my head, my neck and my upper arm started to burn. I was doing all these movements to try and put it out, then I remember screaming.

7.103 He later clarified some matters in a statement given to the Board of Inquiry. He said he was watching the shearer's position from the mimic on front of the shield he was standing on when the incident occurred. He said the power switched off at the time of the first pressure wave.⁷⁵² He said that he had never experienced a wind blast with that amount of pressure before.⁷⁵³

7.104 He further added in the statement provided to the Board that when a second pressure wave blew towards him, he heard a cracking or popping sound and then saw an orange wave.⁷⁵⁴ The flame was one chock away from him when he saw it.⁷⁵⁵

The accounts of the workers located close to the maingate

7.105 There were two workers located on the longwall face, but much closer to the maingate. Both of them felt the effects of the serious accident, but neither saw a flame.

7.106 Mr Kingston was at shield #6 when the incident occurred. In a statement provided to the Board of Inquiry, he said:⁷⁵⁶

...I then walked back to the maingate area, and was at around 5 chock. I had been standing there for around two minutes before I felt a pressure bump which seemed like a standard type of GOAF fall wind blast. It changed the direction of ventilation considerably for around three to five seconds and then the ventilation reversed the other way and returned to normal.

...

⁷⁵⁰ AGM.005.001.0333.

⁷⁵¹ BOI.039.002.0001, .0015.

⁷⁵² BOI.039.002.0001, .0016. The mimic is the control pad for a shield's functions.

⁷⁵³ BOI.039.002.0001, .0016.

⁷⁵⁴ BOI.039.002.0001, .0016.

⁷⁵⁵ BOI.039.002.0001, .0016.

⁷⁵⁶ KIM.001.001.0001, .0005.

I recall looking at the [CITECT] screen about a minute before the first pressure bump happened and noticed that that the shearer drum was turned off...

- 7.107 The wind blast popped his ears, but he did not notice any type of noise, like a blast or a bang, feel any heat, associated with the first pressure event. He said:⁷⁵⁷

The power stayed on after the first pressure bump, and the lights were on and there was still power to the face.

I think I also said to nearby workers words to the effect of:

“That’s going to drop the power.”

- 7.108 Mr Kingston further recalled that the second pressure bump was greater than the first, and occurred around 15 seconds later:⁷⁵⁸

Around 15 seconds after the first pressure bump, I felt another one and the power dropped out and the whole area was completely consumed in coal dust. The dust meant that I could not see anything in front of me for around five to ten seconds. The second pressure bump was a lot bigger than the first one and it happened within seconds of the ventilation turning back on after the first one. It popped my ears again and I heard a noise that sounded like a heap of rock or something colliding in the distance. I did not feel any heat, but I did feel very overwhelmed and disorientated and because I had coal in my eyes I had to keep them closed.

- 7.109 Mr Aaron Christensen was at shield #5. In his written statement to the mine, he said he felt a small bump followed by a big bump.⁷⁵⁹

- 7.110 A call to the shearer operator was made on the Direct Access Communication (DAC) system. In response, someone said ‘We need help’.⁷⁶⁰

- 7.111 Both Mr Kingston and Mr Christensen went onto the longwall to render assistance to the injured workers.⁷⁶¹

The accounts of the workers at the maingate

- 7.112 There were five workers at the maingate at the time of the incident.

- 7.113 Mr Maggs was at the Distribution Control Board (DCB), about to call Mr Burgess, when he felt the first pressure wave. He said, ‘...it was an event. It was a huge event. It was something I’d never felt before’.⁷⁶² The ventilation reversed straightaway and ‘visibility was zero’. Ten to fifteen seconds later there was a second pressure wave.

⁷⁵⁷ KIM.001.001.0001, .0005.

⁷⁵⁸ KIM.001.001.0001, .0006.

⁷⁵⁹ BOI.039.002.0001, .0016.

⁷⁶⁰ KIM.001.001.0001, .0006; AGM.005.001.0342.

⁷⁶¹ KIM.001.001.0001, .0007–.0008; AGM.005.001.0342, .0342–.0343.

⁷⁶² TRA.510.003.0001, .0032, lines 6–18; .0033, lines 27–28.

He said:⁷⁶³

And the second one, it was just a lot more violent, a lot bigger. We're talking six, seven times, eight times, a lot of pressure and shock.

7.114 He recalled that the power went out with the second pressure wave.⁷⁶⁴

7.115 Mr Maggs ran onto the longwall face to retrieve and assist workers as they came off the longwall face. He assisted in getting the workers transported to the surface.⁷⁶⁵ During the evacuation, Mr Maggs discovered there were tags remaining on the tag board belonging to persons who were not underground.⁷⁶⁶ This had the serious consequence of delaying evacuation, when it was not known whether another explosion was imminent, whilst Mr Maggs verified the location of the coal mine workers to ensure nobody was left behind.

7.116 Mr Lacy was on the platform where the DCB was located. He recalled that he 'felt a progressive pressure differential to the point of causing ear pain'. He described the incident as follows:⁷⁶⁷

Within a matter of seconds there was a sudden complete loss of power to the longwall and Maingate which left the only available lighting to be that of individual miner's cap lamps.

Whilst standing up and looking back towards the Maingate corner I recall hearing an extremely loud rush of howling air and feeling of very strong air flow coming in from outbye which I can only describe as being like standing in a strong wind tunnel.

To the best of my recollection the air blast which was a terrifying experience lasted for around 3 to 5 seconds.

The air blast was immediately followed by a massive pressure wave. I was still facing the Maingate corner and recall being hit with a wave of force and dust although I can't recall a sound. Its force blew me off my feet onto the floor of the main gate platform and over the top of Jackson Hayes. Visibility was basically nil due to the thickness of dust. My altair 5X gas detector was alarming. I grabbed it from my hip and observed that it was reading 12% oxygen and approximately 0.25 to 0.5% carbon dioxide and shortly after it started to alarm with methane also but I cannot recall the value. I recall having difficulty breathing and quickly realised that ventilation had reversed and gas from the goaf was now in the workings.

⁷⁶³ TRA.510.003.0001, .0033, lines 42–44.

⁷⁶⁴ TRA.510.003.0001, .0034, line 10.

⁷⁶⁵ AGM.005.001.0369, .0370.

⁷⁶⁶ TRA.510.003.001, .0040, line 19–.0042, line 43.

⁷⁶⁷ BOI.039.002.0001, .0019.

- 7.117 Mr Hayes was also at the computer in the maingate. In his interview with the Inspectorate, he described the first pressure bump as being like a goaf fall.⁷⁶⁸ He said, '[a]nd then the next pressure wave came over us, all the wind. Myself and Beau were standing next to each other, and I grabbed on to the CME because I was getting blown over'. He said that the second pressure wave 'felt originally like another one, I think, and then it just built and built, and then the dust came'.⁷⁶⁹
- 7.118 Mr John Badke was at the maingate DCB platform. In his written statement to the mine, he described the event as a 'severe wind blast'.⁷⁷⁰
- 7.119 Mr Thomas Barry, who was at the maingate carport area, described two ventilation reversals in his written statement to the mine, the second being larger than the first.⁷⁷¹
- 7.120 Each of Mr Lacy, Mr Hayes, Mr Badke and Mr Barry went onto the longwall to assist the injured workers.⁷⁷²

The accounts of the workers at maingate 36 cut-through

- 7.121 The workers at maingate 36 cut-through described three pressure changes. The Board notes that the descriptions of three pressure waves, by workers some distance from the longwall face and who were located in cut-throughs, is at odds with the descriptions of two pressure waves experienced by those closer to the face. One explanation may be that the workers were farther from the face, and there were multiple pathways by which the overpressure event reached them.
- 7.122 Mr Mick Smith, a Mastermyne supervisor, was assisting with jack-picking the inbye side of the rib at 36 cut-through at the time of the incident. His group had completed spraying a flexible seal at that location.⁷⁷³ In his written statement to the mine, he described hearing a flexi stopping flex outwards with pressure, followed by a suck-back. He said there was a further outward push with more force followed by a suck-back. It happened a third time, with less force.⁷⁷⁴
- 7.123 In his interview, he likened the sound associated with the three waves as like 'a hundred machine doors getting shut and then a thousand and then like 10'. They all occurred within ten to twenty seconds. He further described the incident as follows:⁷⁷⁵

...I heard what was, I believe was just a roof fall in the goaf and then the flexi's hopping, it sort of just sucked back in more than I ever thought they could and then she went bang again and that's when I said to the boys we're getting the hell out of here...

⁷⁶⁸ BOI.039.002.0001, .0020.

⁷⁶⁹ BOI.039.002.0001, .0020. 'CME' is the control and monitoring enclosure, a flame proof box containing the electronics used to control the longwall.

⁷⁷⁰ AGM.005.001.0377.

⁷⁷¹ AGM.005.001.0419.

⁷⁷² BOI.039.002.0001, .0017; AGM.005.001.0455.

⁷⁷³ BOI.039.002.0001, .0021.

⁷⁷⁴ AGM.005.001.0375.

⁷⁷⁵ BOI.039.002.0001, .0021.

7.124 Mr Todd Bell, a second Mastermyne worker, similarly recalled hearing and seeing movement of the flexi stopping. The first push and suck-back was followed by a second which had a lot more force. The third occurred with less force than the first.⁷⁷⁶

He said:⁷⁷⁷

We were doing a seal prep inbye of the last open and were jack picking and chain sawing the in-bye rib for the seal when we heard and felt a roof fall.

... then we see the flexi seal suck in and there was a massive bang and the pressure pushed the flexi back towards us. The pressure was that much it moved us that we then said to each other its time to get out of here

7.125 Mr Sean Farquhar, a third Mastermyne worker, was driving a loader at the time of the incident. He recalled the work group was preparing a seal for installation by keying out the ribs and jack-picking when he felt what he thought was a really big roof fall. He said that 10 to 15 seconds later, a second event 'rocked the place a bit more' such that it 'actually felt like the cut-through was caving in'.⁷⁷⁸ Four to five seconds later there was a third event. He said the second event was a bit softer than the third event which was 'like a big thud' which you could feel 'through everything'.⁷⁷⁹

7.126 Mr Simon Poulter, the final Mastermyne worker at the cut-through, described the incident in his statement to the mine: '...the flexi stopping sucked in and out 3 times (unsure if 2 or 3)'.⁷⁸⁰

The accounts of the workers at maingate 34 cut-through

7.127 The bullgang workers had just finished standing up cans at 34 cut-through when the incident occurred.⁷⁸¹

7.128 In his statement to the mine, Mr Dowd described that he heard three pops.⁷⁸² In his interview with inspectors, he said he felt a 'massive pain' in his jaw and ears which lasted for about two seconds. Three or four seconds later, he felt the same thing, although it was worse. At that time, the brattice bag that was separating the cut-through from the belt road 'flapped and blew'. He then heard a 'massive big loud bang...like a truck hitting the rib'.⁷⁸³

7.129 In his statement to the mine, Mr Charchalis described three pressure bumps.⁷⁸⁴ In his interview with the Inspectorate, he said he felt a very small pressure event in his ears, followed by two big ones which really hurt his ears.

⁷⁷⁶ AGM.005.001.0413.

⁷⁷⁷ BOI.039.002.0001, .0025.

⁷⁷⁸ BOI.039.002.0001, .0025.

⁷⁷⁹ BOI.039.002.0001, .0028.

⁷⁸⁰ AGM.005.001.0381.

⁷⁸¹ BOI.039.002.0001, .0031. 'Cans' are steel tubes filled with concrete that are used as a roof support.

⁷⁸² AGM.005.001.0449.

⁷⁸³ BOI.039.002.0001, .0031.

⁷⁸⁴ AGM.005.001.0431.

The brattice stopping on the maingate roadway side ‘just went bang, bang and then [he was] pretty sure it went bang again’. He did not feel anything other than the pressure in his ears, and he did not hear anything other than the sound of the brattice banging.⁷⁸⁵

7.130 In his statement to the mine, Mr Sweeney described a couple of pressure bumps which blew the stopping bag at 34 cut-through.⁷⁸⁶ In his interview, he said he felt the first bump in his ears, followed by a second, larger one ‘which was quite painful’. There was then a ‘big push of air against the ventilation’ which pushed a brattice wing over and pushed pogoos off the roof. There was then a plume of dust. He did not feel a third bump. When asked, he said that the incident felt ‘very similar’ to a goaf fall he had previously experienced while on the longwall.⁷⁸⁷

7.131 The fourth member of the group, Mr Anthony Ellem, said in his statement to the mine that he thought there was a goaf fall, but did not otherwise describe the sensations associated with the incident.⁷⁸⁸

The accounts of the workers in the crib room at maingate 33 cut-through

7.132 Mr Priest, the bullgang ERZ controller, was in the crib room at the time of the incident. In his statement to the mine, he described feeling two significant pressure waves close together.⁷⁸⁹ In his interview, he clarified that he did not hear anything, or feel a ‘shockwave’. He said there was ‘just that feeling of that pressure in your ears’. He said the two incidents occurred approximately 10 or 15 seconds apart, with the second one being ‘slightly more intense’ than the first. He said there was no stone dust dislodged from the roof.⁷⁹⁰

7.133 Mr French, a bullgang electrician, was talking to Mr Priest at the time of the incident. He described having felt two pressure bumps, after which the power dropped.⁷⁹¹ In his interview with the Inspectorate, he described the first pressure bump as being like a goaf fall at the start of a longwall block ‘when you get those initial first pressure bumps’. The second pressure event, he said, ‘felt like probably five times worse than any, any pressure bump I’ve had before’.⁷⁹²

7.134 Mr Underdown was also in the crib room at the time. He also felt two pressure bumps. When a truck with four injured people came past, he started walking inbye.⁷⁹³

⁷⁸⁵ BOI.039.002.0001, .0033.

⁷⁸⁶ AGM.005.001.0425.

⁷⁸⁷ BOI.039.002.0001, .0032.

⁷⁸⁸ AGM.005.001.0351.

⁷⁸⁹ AGM.005.001.0345.

⁷⁹⁰ BOI.039.002.0001, .0033.

⁷⁹¹ AGM.005.001.0437.

⁷⁹² BOI.039.002.0001, .0035.

⁷⁹³ AGM.005.001.0348.

7.135 Mr Andy Ryan, an electrician working over-time with the bullgang crew on the day shift, was in the crib room at the time. In his statement, he said he felt a big bump or pressure wave that shook the brattice wing in the crib room.⁷⁹⁴

7.136 Mr Gunn felt two pressure bumps.⁷⁹⁵

7.137 Mr Hutton felt a small pressure bump followed by a larger bump.⁷⁹⁶

The account of the worker at the 17 cut-through tripper substation

7.138 Mr Stephen Woodrow was at the 17 cut-through tripper substation, over two kilometres outbye of the longwall face. At approximately 2:55pm, he heard what sounded like someone coming through the double doors from the belt side. He saw what he described as a 'puff of stonedust', but no-one came through. At approximately 3:04pm, the power dropped, and he was told to go to the surface.⁷⁹⁷

The account of the worker at maingate 6 cut-through

7.139 Mr Jason Ditchburn was at the maingate 6 cut-through, approximately 3.5 kilometres outbye of the longwall face. He felt two pressure waves which caused his ears to pop. The power went out after the second pressure wave.⁷⁹⁸

The workers' injuries

7.140 Each of the five workers closest to the tailgate end of the longwall face sustained burn injuries as a result of the serious accident.

7.141 Mr Sellars suffered burns to 70% of his body. He lost his right ear and requires an ear reconstruction. He has had skin grafts to his legs, back, hands, arms, shoulders, face, and head.⁷⁹⁹

7.142 From Moranbah Hospital, he was transferred to the Royal Brisbane and Women's Hospital. He spent three weeks in the intensive care unit of the Royal Brisbane and Women's Hospital before being transferred to the burns unit for about six weeks. He was later re-admitted because of blood clots to his lungs.⁸⁰⁰

7.143 To date, he has had ten surgeries and he expects to have a further three surgeries this year.⁸⁰¹

⁷⁹⁴ AGM.005.001.0387.

⁷⁹⁵ AGM.005.001.0393.

⁷⁹⁶ AGM.005.001.0443.

⁷⁹⁷ AGM.005.001.0357.

⁷⁹⁸ AGM.005.001.0407.

⁷⁹⁹ TRA.500.024.0001, .0066, lines 23–30.

⁸⁰⁰ TRA.500.024.0001, .0065, line 23–.0066, line 12.

⁸⁰¹ TRA.500.024.0001, .0066, lines 14–21.

7.144 The Board has received material, on a confidential basis, which establishes that the other injured coal mine workers suffered burn injuries to varying degrees, and were admitted to hospital as in-patients for treatment for their injuries.⁸⁰²

Other data related to the serious accident

7.145 Other data from the mine assist with an understanding of what occurred during the events described by the workers.

The timing of the serious accident

7.146 The camera footage is of low quality and difficult to interpret. The Bretby camera appears to have recorded the maingate brattice wing being sucked or pushed into the goaf at 2:57:26pm and again at 2:57:37pm. This data would suggest the pressure waves from the tailgate occurred at those times (and 11 seconds apart from each other).⁸⁰³ However, the timing may be less than precise, in that the timestamps of different electronic systems differ by a number of seconds. For example, CITECT data recorded the power tripping on the longwall face at 2:57:43pm, while the Joy system and the Bretby camera recorded the power tripping on the longwall face at 2:57:49pm, some six seconds later.⁸⁰⁴

The number of pressure waves

7.147 As can be seen from the review of the recollections of workers, the weight of evidence discloses that there were two pressure waves separated by an interval of 10 to 15 seconds. Each occurred without warning.

7.148 In the Board's view, there is independent evidence, in the form of measurements of fan pressures, supporting the view of the majority of workers that there were two pressure waves separated in time.

7.149 Data were provided by Grosvenor recording ventilation fan pressure at two locations, Shaft No. 9 and Shaft No. 6, covering the time of the accident. Shaft No. 9 is located near the start line of LW 104 on the tailgate side and is fitted with bulk air cooling (BAC) infrastructure to provide cool air to the longwall face. The driver of the air through the BAC is the mine ventilation system and the negative pressure created by the main fans at Shaft No. 6.⁸⁰⁵

7.150 Shaft No. 9 is also fitted with an exhausting fan, although it had been turned off since the commencement of LW 104 production.⁸⁰⁶

⁸⁰² The Act, section 16, describes a serious accident as an accident at a coal mine that causes the death of a person, or that causes a person to be admitted to a hospital as an in-patient for treatment for the injury.

⁸⁰³ AGM.003.001.2140.

⁸⁰⁴ AGM.003.001.2140.

⁸⁰⁵ AGM.999.020.0001; BOI.999.019.0001.

⁸⁰⁶ AGM.999.020.0001; BOI.999.019.0001.

- 7.151 The Shaft No. 6 installation is a triple-fan performing an exhaust function.⁸⁰⁷ It is located at the mains headings in 11 cut-through, approximately 4.5 kilometres from the longwall tailgate, along the return, at the time of the serious accident.
- 7.152 The arrangements at both Shaft No. 6 and Shaft No. 9 result in a negative pressure difference between the outside atmosphere and that within the shaft, although the value is expressed as a positive figure.
- 7.153 The telemetric data are represented graphically in the following diagram:⁸⁰⁸

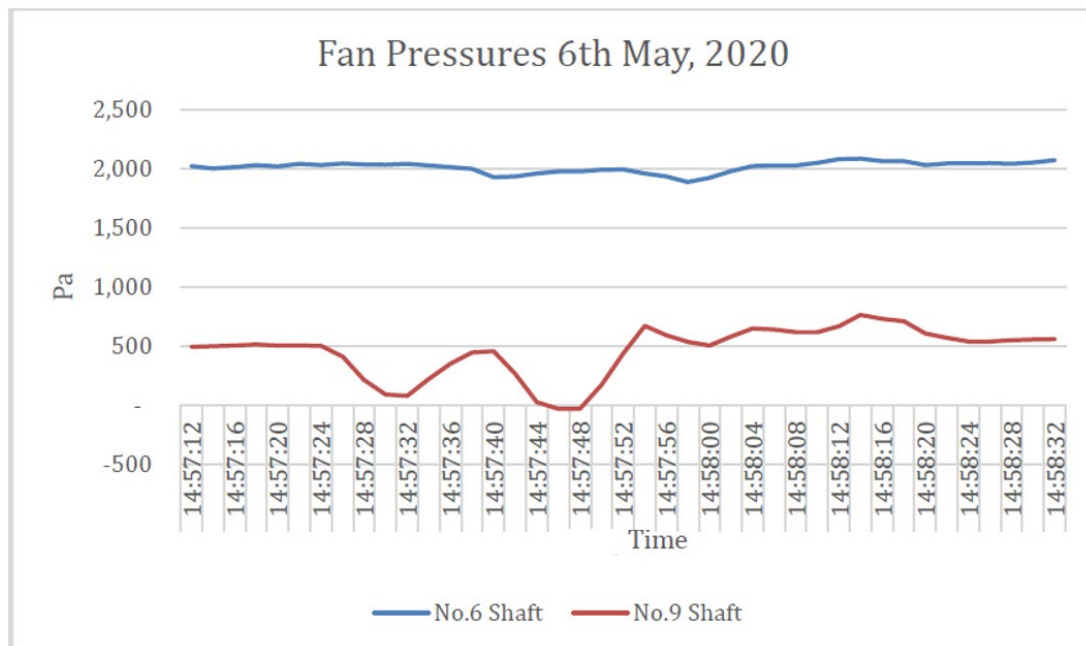


Figure 101: Telemetric data

- 7.154 The data record two variations of pressure at Shaft No. 9, at approximately 2:57:30pm and 2:57:46pm. The graph exhibits a similar characteristic pattern for Shafts No. 6 and No. 9 although the variations are more pronounced in the data for Shaft No. 9 as it is located closer to the face where the overpressure events occurred.
- 7.155 The pressure values show two significant drops and recoveries, about 16 seconds apart, followed by a smaller and fluctuating pressure elevation above normal operating pressure for approximately 30 seconds. This is consistent with two overpressure events arriving at each shaft followed by a smaller negative draw back effect.

Methane detections at the time of the serious accident

- 7.156 Fixed gas sensors were in operation at six locations on LW 104 on the day of the serious accident. Their location, and a description of their functionality, is depicted in the following schematic.⁸⁰⁹

⁸⁰⁷ SAN.999.001.0001, .0002.

⁸⁰⁸ SAN.001.001.0001, .0043.

⁸⁰⁹ AGM.002.001.0075, .0077.

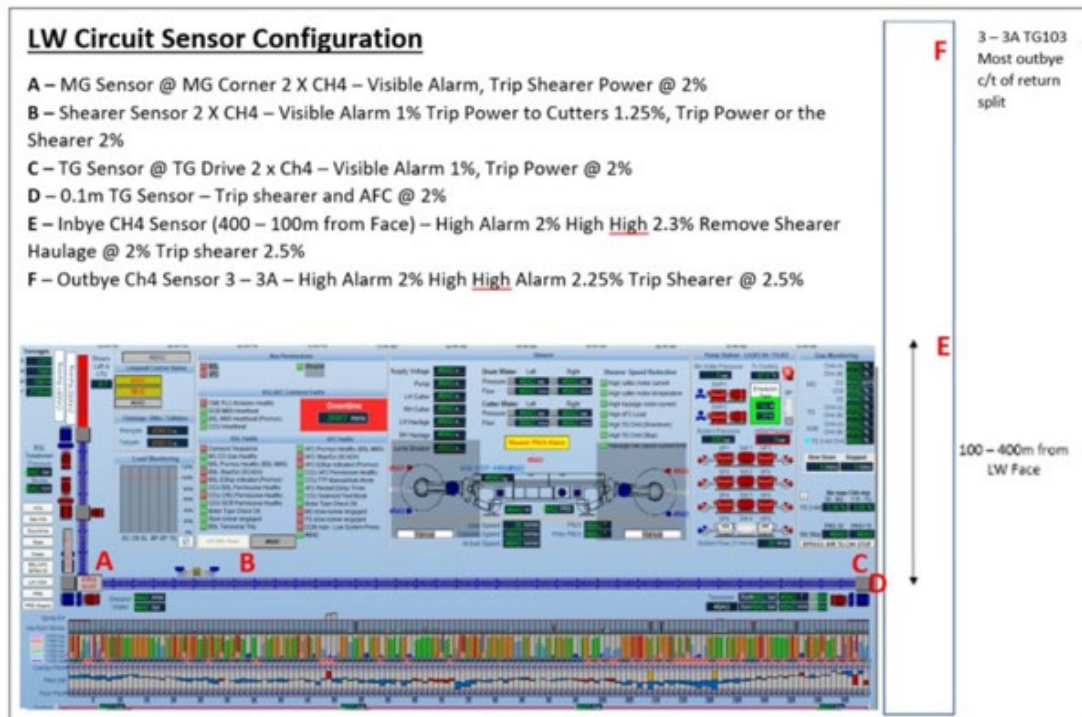


Figure 102: Fixed methane gas sensor configuration for LW 104 on 6 May 2020

7.157 None of the sensors recorded a methane exceedance on 6 May 2020 prior to the serious accident. As can be seen from the following graph, the methane readings at all sensors had been less than 1% between 2:10pm and the time of the serious accident:⁸¹⁰

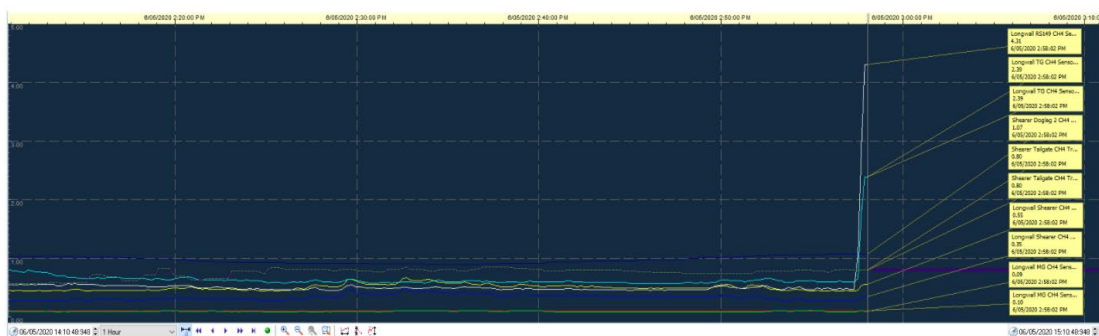


Figure 103: Methane gas levels at fixed sensor locations for 2:10pm–3:10pm, 6 May 2020

7.158 During the incident, only the sensors on the tailgate drive (Location C) and the #149 shield (Location D) recorded increases in methane concentrations. Increases in methane were detected at 2:57:25pm at the #149 shield sensor and 2:57:29pm at the tailgate drive sensor. At 2:57:41pm both sensors detected a sudden increase in methane.⁸¹¹ These can be seen in the graph above.

⁸¹⁰ AGM.002.001.0075, .0084.

⁸¹¹ AGM.002.001.0075, .0084.

- 7.159 The 400 metre sensor (Location E) and the outbye sensor (Location F) did not show appreciable increase in methane.⁸¹²
- 7.160 Power to the face was tripped by the tailgate drive sensor at 2:57:43pm, when the methane concentration at that sensor reached 2%. The peak reading at that sensor did not rise above 2.5%. The #149 shield sensor reached a peak reading of 4.31%, at which point it was likely to have been poisoned.⁸¹³
- 7.161 There is a degree of imprecision involved in using sensor data to attempt to identify the point in time at which the explosion on the face occurred. The sensor on the #149 shield was subsequently tested by SIMTARS and found to have a *t90* value of approximately 15 seconds.⁸¹⁴ The *t90* value is the response time of the detector to achieve 90% of its final value when presented with a step change in concentration. Therefore, a high concentration of gas could be present at a sensor for a number of seconds before it is detected by the sensor.
- 7.162 However, the very rapid increases in the sensor readings at a time proximate to the serious accident at least confirm that the incident was sudden and discrete, rather than one involving an accumulation of gas over a more extended period.
- 7.163 The fact that there was not a gradual accumulation of methane on the longwall face throughout the day is supported by Mr Maggs' evidence that, on numerous occasions, he took gas readings in the tailgate that day and did not detect any high readings.⁸¹⁵ His statutory inspections were recorded in his report as follows:⁸¹⁶

Gas Inspections															Comments	
Inspection	Location	Time	O ₂ (%)	NO ₂ (ppm)	H ₂ S (ppm)	CO (ppm)	CH ₄ (%)	CO ₂ (%)	Wet Bulb (°C)	Dry Bulb (°C)	Velocity (m/s)	Effective Temp (°C)	Area (m ²)	Quantity (m ³ /s)		CO Make (ppm)
First	Longwall Production / C-- / 33-34	6/05/2020 10:55 AM	20.6	0	0	1	0.15	0.08	23	27	1.4	23.06	19.3	27.02	1.6212	
First	Longwall Production / FL_Face Line-- / 35--	6/05/2020 12:55 PM	20.6	0	0	4	0.45	0.08	23	25	4.7	18.61	14.4	67.68	16.2432	Three inspections of tailgate sensor 0.48%ch4. 1st 0.38% ch4 2nd0.62ch4 3rdAll at 149# sensor
First	Longwall Production / B-- / 33-34	6/05/2020 2:10 PM	20.6	0	0	1	0.15	0.06	23	24	2.1	20.02	19.4	40.74	2.4444	Traval rd

Figure 104: Gas inspections recorded on shift statutory report for 6 May 2020

⁸¹² AGM.002.001.0075, .0082–.0083.

⁸¹³ AGM.002.001.0075, .0084; SAN.001.001.0001, .0041.

⁸¹⁴ HAA.001.001.0001, .0023.

⁸¹⁵ TRA.510.003.0001, .0014, lines 23–25 and 40–41; .0017, lines 3–21; .0021, lines 3–19; .0022, lines 25–26; .0023, lines 2–3; .0025, lines 45–47; .0026, lines 1 and 47; .0027, lines 2–3.

⁸¹⁶ AGM.003.002.5803.

Findings

Finding 64

The serious accident comprised two consecutive pressure waves, which proceeded from the tailgate end of the longwall and were separated by about 15 seconds.

Finding 65

No coal mine workers observed a flame front associated with the first pressure wave.

Finding 66

A flame front which burned the five coal mine workers closest to the tailgate end of the longwall face accompanied the second pressure wave.

Finding 67

The five coal mine workers were admitted to hospital as in-patients for treatment for the injuries they sustained as a result of the second pressure wave. Indeed, all five coal mine workers were seriously injured.

Recommendation

Recommendation 11

Coal mines provide all workers who go underground with personal proximity devices that allow location tracking, and are active, for the entire time the workers are underground.

Chapter 8 – The nature and cause of the serious accident: the first pressure wave

Introduction

- 8.1 The Terms of Reference require the Board to determine the nature and cause of the serious accident.
- 8.2 The previous chapter concluded that the serious accident involved two consecutive pressure waves originating from the tailgate end of the longwall, separated by an interval of about 15 seconds.
- 8.3 This chapter assesses the evidence as to the likely cause of the first pressure wave.
- 8.4 It will be seen that the evidence supports a finding that the first pressure wave was likely caused by a methane explosion in the goaf. The likelihood is that this event resulted in an explosible atmosphere of gas being present on the longwall face some seconds later when the second pressure wave was initiated. The source of ignition that triggered the second pressure wave is addressed in the next chapter.

Possible explanations for the first pressure wave

- 8.5 The pressure wave was of considerable force, well beyond the scale of the typical goaf fall that may be experienced from time to time.⁸¹⁷
- 8.6 The Board does not consider that the first pressure wave could have been caused by a gas outburst from the underlying seam. The Goonyella Middle Lower seam, within the extracted area of longwall 104 (LW 104), is located approximately 1.8 metres below the Goonyella Middle (GM) seam and is approximately 30 cm thick, with an estimated gas reservoir of 4m³/m².⁸¹⁸ This volume of gas appears too small to create an outburst that would result in a pressure wave of the magnitude experienced by the coal mine workers on 6 May 2020.
- 8.7 In the circumstances, the first pressure wave could only have been a result of:⁸¹⁹
 - a. a strata collapse; or
 - b. a methane explosion.

⁸¹⁷ BOI.039.002.0001, .0007, .0016,

⁸¹⁸ WRA.001.001.0001, .0049.

⁸¹⁹ TRA.500.025.0001, .0018, lines 26–41.

- 8.8 A description of what is involved in wind blast caused by strata collapse was given by Fowler and Sharma, the authors of an Australian Coal Association Research Program study in 2000, called the *Dynamics of Wind Blasts in Underground Coal Mines*:⁸²⁰

In some underground coal mines where the roof comprises strong and massive rock, the roof strata do not cave regularly as extraction progresses but ‘hang up’, leading to extensive areas of unsupported roof. These areas can collapse, suddenly and often without warning, compressing the air beneath and forcing it out of the goaf through surrounding openings giving rise to a phenomenon known as wind blast. The force of the wind can, and sometimes does, cause injury to mine personnel, disruption to the ventilation system and damage to plant and equipment. It may also increase the hazard of explosion if methane in explosive concentrations is expelled from the goaf and mixed with raised coal dust.

- 8.9 A description of a pressure wave associated with a methane ignition was documented in the New South Wales (NSW) Government investigation report of a fire and explosion on Longwall No. 1 Tailgate at the Blakefield South Mine on 5 January 2011:⁸²¹

Then there was a massive windblast. Huge. It blew totally against natural ventilation of the mine. Air comes in the maingate, across the face, out the tailgate. It blew outbye, across the face and back up the belt. Never quite blew us over, but if you didn’t brace yourself it would have,” the deputy said. “It was rather large. Very unexpected. Within seconds of the blow was the big suck back. The suck back was stronger than the blow.

- 8.10 It is apparent from these descriptions that both events are capable of causing the kind of pressure wave (or wind blast) experienced by the workers at Grosvenor.

Possible cause one: strata collapse in the goaf

- 8.11 To shed light on the possibility of the phenomenon of wind blast from strata collapse being associated with the serious accident, a consultant geotechnical engineer, Dr Rob Thomas was engaged, to:⁸²²

...review the geotechnical environment and the prevailing ground conditions on the lead up to the methane ignition event which occurred on LW 104’s face in Grosvenor Mine on the 6th May 2020 and if deemed relevant, [to] provide comment on the geotechnical factors deemed likely to be associated with the ignition event.

⁸²⁰ Fowler, J., & Sharma, P., *Dynamics of Wind Blasts in Underground Coal Mines* (2000) Project No. C6030 Report, Australian Coal Association Research Program, page 1; RSH.002.233.0001, .0008.

⁸²¹ NSW Government Trade and Investment, *Investigation Report: Fire and Explosion on Longwall No. 1 Tailgate at the Blakefield South Mine 5 January 2011*, NSW Government, (Report, May 2012), <https://www.resourcesandgeoscience.nsw.gov.au/__data/assets/pdf_file/0010/457354/Blakefield-South-Investigation-report-060213.pdf>, page 6.

⁸²² TRO.001.001.0001, .0003.

- 8.12 Dr Thomas prepared two written reports based largely upon documents and data obtained by the Inspectorate from Grosvenor. He also gave oral evidence at the Inquiry's hearings.
- 8.13 Dr Thomas advanced a hypothesis that one or both of the pressure waves were explicable by strata collapse. It should be noted at the outset that there is no direct evidence of a major strata collapse in the goaf. Since the goaf is inaccessible it would not be possible to support the hypothesis directly. Dr Thomas did, however, undertake a task of assessment of whether geotechnical conditions existing at the incident site were such as to make the pressure wave explicable, if not likely, by reference to strata failure.
- 8.14 Dr Thomas acknowledged that his expertise did not extend to assessing whether either pressure wave could have been the consequence of an explosion.⁸²³ Accordingly, he was not asked to consider that issue.
- 8.15 For the purpose of his task, Dr Thomas had regard to the content of the *MDG 1003: Windblast Guideline* (the Guideline) issued by the NSW Department of Primary Industries in November 2007.⁸²⁴ The Board accepts that the Guideline is a useful reference point.
- 8.16 The Guideline was issued in response to investigation of a number of serious incidents due to wind blast in NSW coal mines. The relative prevalence of the phenomenon in the Newcastle Coalfield, and the applicable geology, were described by Sharma in his doctoral thesis, written prior to the issue of the Guideline:⁸²⁵

Longwall mining under massive conglomerate roof in the Newcastle Coalfield of New South Wales, Australia, has resulted in wind blasts of sufficient intensity to raise serious concerns regarding the safety of mine personnel, disruption to the ventilation system and potential expulsion of methane from the goaf. Coal mines in the Newcastle Coalfield which have experienced significant wind blasts include Wallarah, Myuna, and Cooranbong Collieries (Fowler, 1997), Endeavour Colliery and, more recently, Newstan and Moonee Collieries. At Endeavour Colliery, a significant wind blast associated with a major goaf fall preceded an explosion (Anderson, 1997)...

⁸²³ TRA.500.017.0001, .0063, lines 26–34.

⁸²⁴ NSW Department of Primary Industries, Mine Safety Operations Division, *MDG 1003: Windblast Guideline*, NSW Government (Technical Guideline, November 2007) <https://resourcesandgeoscience.nsw.gov.au/__data/assets/pdf_file/0020/419510/MDG-1003-Windblast-guide.pdf>; BOI.031.001.0001.

⁸²⁵ Sharma, P., *Dynamics of Wind Blasts in Underground Coal Mines*, University of New South Wales, (Ph.D Thesis, May 2001) <<http://unsworks.unsw.edu.au/fapi/datastream/unsworks:43627/SOURCE01?view=true>>, page 8.

The high incidence of wind blasts in the Newcastle Coalfield of New South Wales is due to the particular geology of the coalfield, a dominant feature of which is the presence of massive, strong conglomerate beds whose basal sections often lie in close proximity to the coal seams.

8.17 The Guideline proceeds on the basis of the following definition of wind blast:⁸²⁶

“Windblast” - windblast is an event, resulting in sudden, mass air movement, that:-

- 1. has the potential to cause injury to persons and/or*
- 2. has the potential to cause damage to the mine and mining equipment and/or*
- 3. has the potential to seriously disrupt ventilation*

In almost all circumstances the “event” initiating mass air movement is a collapse of strata in a goaf area.

8.18 Grosvenor also defined wind blast in similar terms in its hazard management plan for LW 104 first goaf:⁸²⁷

A Windblast is an event, resulted [sic] in mass air movement that causes injury and/or seriously disrupts ventilation. In almost all circumstances, the “events” that initiated mass air movement are collapse of strata in a goaf.

8.19 The Guideline specifies an air velocity of 20 m/sec as a threshold value, being the velocity at which an unprepared person might be knocked from their feet by force of the blast. Some of the coal mine workers’ accounts include reference to a force of wind which did, or could have, knocked a person from their feet.

8.20 Fowler and Sharma noted the potential for wind blast to expel an explosive concentration of gas onto the face:⁸²⁸

It is of particular concern that methane in explosive concentrations may be expelled from the goaf into the working place as a consequence of wind blast. At Moura No.4 Mine in Queensland, twelve miners were killed in 1986 in an explosion that was considered to have been preceded by a wind blast. The 1995 explosion at Endeavour Colliery in NSW, described in detail in Coal Mining Inspectorate and Engineering Branch (1996) and in outline in Fowler and Torabi (1997), is also believed to have involved just such an occurrence.

...

⁸²⁶ NSW Department of Primary Industries, Mine Safety Operations Division, *MDG 1003: Windblast Guideline*, NSW Government (Technical Guideline, November 2007)

<https://resourcesandgeoscience.nsw.gov.au/__data/assets/pdf_file/0020/419510/MDG-1003-Windblast-guide.pdf>, page 2; BOI.031.001.0001, .0004.

⁸²⁷ RSH.001.049.0001, .0003: *GRO-10685-HMP-LW104 First Goaf*.

⁸²⁸ Fowler, J. & Sharma, P., *Dynamics of Wind Blasts in Underground Coal Mines* (2000) Project No. C6030 Report, Australian Coal Association Research Program, page 4; RSH.002.233.0001, .0011.

Mining under strong, massive roof, such as some sandstones and conglomerates, increases the risk...

8.21 The Guideline also describes the potential for wind blast to cause an explosion:⁸²⁹

The most severe consequence of windblast is a gas and/or coal dust explosion. For such an explosion to develop, fuel and an ignition source are needed, both of which can be provided by a windblast.

Ignition sources may be either man made or natural, the later [sic] being out of positive control. In particular, the incendive nature of roof strata is critical to the risk of explosion from windblast. With respect to man made sources the presence of electrical apparatus in the working place might be classified as that with the highest probability of producing ignition energy. It must be remembered that the best electrical protection now in use may be bypassed due to damage suffered during a windblast. In the event of a wind blast, pressure transducers commonly used to disconnect power may not operate quickly enough to eliminate an ignition source (although they are still useful to control secondary hazards).

Mechanism

8.22 The Guideline gives the following description of the mechanism of wind blast:⁸³⁰

When a massive bed exists above the immediate coal or shale roof line but within the expected caving height of the face, then in the goaf an air gap can develop between the top of the weak immediate roof rubble pile and the upper massive member. Subsequent failure of the massive member will cause sheets of stone to fall into the air gap thus creating a windblast...

8.23 In his report, Dr Thomas identified the key geotechnical features associated with wind blast as:⁸³¹

- (iii) thick and competent rock types in the near-seam overburden that have the potential to span and fail en masse some distance into the goaf and*
- (iv) a limited thickness of interburden between the extraction horizon and the base of the spanning unit, such that a pathway exists for the goaf gases to displace into the mine workings...*

⁸²⁹ NSW Department of Primary Industries, Mine Safety Operations Division, *MDG 1003: Windblast Guideline*, NSW Government (Technical Guideline, November 2007) <https://resourcesandgeoscience.nsw.gov.au/__data/assets/pdf_file/0020/419510/MDG-1003-Windblast-guide.pdf>, page 3; BOI.031.001.0001, .0005.

⁸³⁰ NSW Department of Primary Industries, Mine Safety Operations Division, *MDG 1003: Windblast Guideline*, NSW Government (Technical Guideline, November 2007) <https://resourcesandgeoscience.nsw.gov.au/__data/assets/pdf_file/0020/419510/MDG-1003-Windblast-guide.pdf>, page 5; BOI.031.001.0001, .0007.

⁸³¹ TRO.001.001.0001, .0007.

- 8.24 The 'pathway' referred to in the second feature would require 'the presence of an air gap between the goaf material and the base of the spanning unit, such that the overlying unit is able to detach and in effect, freefall onto the goafed material below'.⁸³²
- 8.25 Dr Thomas provided the following schematic illustrations of the mechanics of a caving-induced wind blast:⁸³³

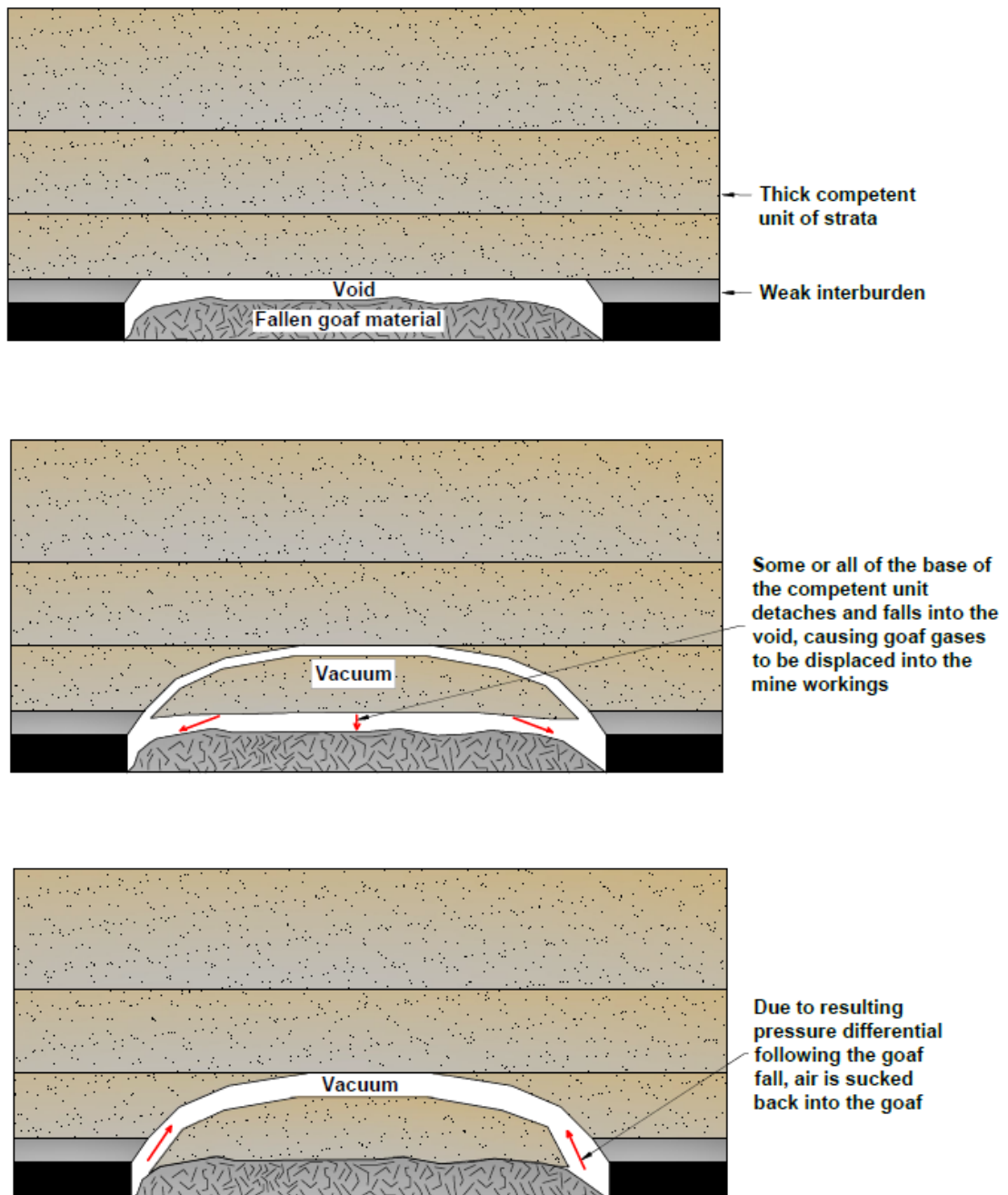


Figure 105: Schematic illustrations of caving-induced wind blast

⁸³² TRO.001.001.0001, .0008.

⁸³³ TRO.001.001.0001, .0021.

8.26 He also gave the following explanation in his evidence:⁸³⁴

Now, in that case, as you can imagine, what that behaves like is like a bellows. That material, when it falls into the void between itself and the goaf pile, compresses and therefore expels the air away from itself, and by virtue of the path of least resistance most of that air, unfortunately, will go on to the longwall face where people are working.

Factors affecting size of the wind blast

8.27 Dr Thomas referred in his evidence to the size of the wind blast being related to the size of the goaf fall. He went on to identify other factors relevant to the magnitude of the event:⁸³⁵

A. ...there are other factors that affect the magnitude of a wind blast. As an off-the-cuff statement, it's fair to say that the bigger the event, the bigger the goaf fall, but there are other factors that can affect the magnitude of an air blast: the way the material falls, does it fall as a planar piston; the number of vents, number of areas where the expelling air can vent itself. There's probably more.

Q. Is the size of the void above the goaf material relevant?

A. I would imagine so, yes. The distance it has to fall, that would be a significant player.

8.28 Fowler and Sharma referred to the following factors as amongst those affecting the magnitude of a wind blast:⁸³⁶

Geological factors which affect the way in which the roof falls. The geological structure of the roof strata and the mechanical properties of both the rock fabric and of the discontinuities (in particular, their strength properties) are, a priori, significant in this regard.

Geometrical factors such as the thickness of the falling roof element and the distance through which it falls, together with both its plan area and the total plan area of the standing goaf.

Massive rock types

8.29 As to what constitutes a thick and competent rock type, having potential to be associated with wind blast, Dr Thomas noted that the Guideline specifies massive units in excess of 10 metres in thickness. This was qualified in the Guideline by the statement that 'irregular windblast events can also occur when thinner beds exist'.⁸³⁷

⁸³⁴ TRA.500.017.0001, .0013, lines 17–23.

⁸³⁵ TRA.500.017.0001, .0019, lines 2–16.

⁸³⁶ Fowler, J. & Sharma, P., *Dynamics of Wind Blasts in Underground Coal Mines* (2000) Project No. C6030 Report, Australian Coal Association Research Program, section 6, page 3; RSH.002.233.0001, .0086.

⁸³⁷ TRO.001.001.0001, .0008.

8.30 Three channels of sandstone exist above the GM seam, namely (in ascending order), the MR, MP and PP channels. They are depicted in the diagram below:⁸³⁸

(i) Location of Sandstone Channels above the GM Seam

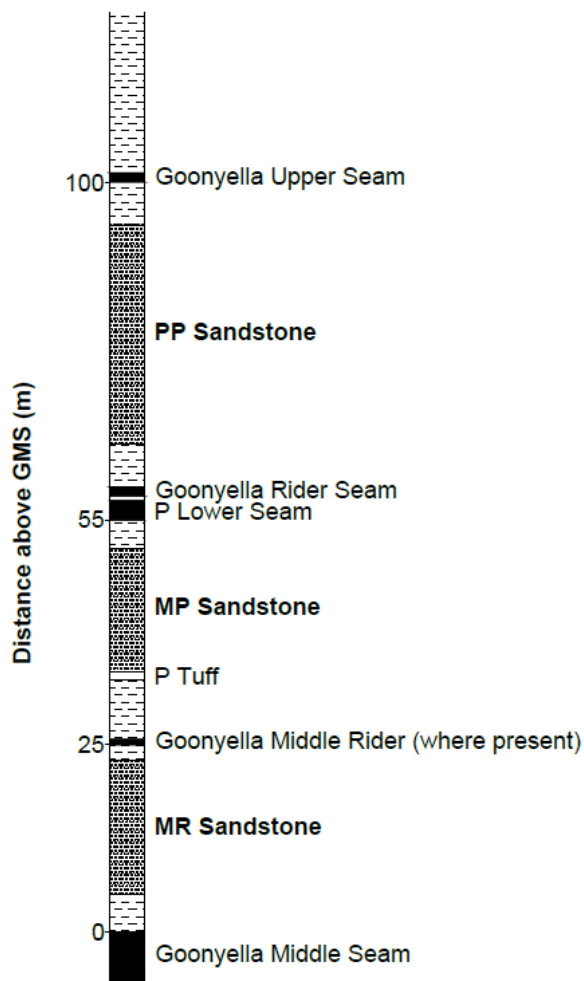


Figure 106: Channels of sandstone above GM seam

8.31 It should be noted that this is a generalised diagram of the stratigraphic sequence above the GM seam. As discussed later, the MR sandstone unit is not always present above LW 104, and where it is present, it varies in thickness and height above the GM seam.

8.32 To make an assessment of the presence or absence of thick competent units of sandstone in the near-seam interburden in the vicinity of the serious accident site, Dr Thomas reviewed Grosvenor’s geophysical sonic logs, sonic-derived unconfined compressive strength data, and chip logs.

⁸³⁸ TRO.001.001.0001, .0018.

- 8.33 The geophysical sonic trace is produced by sending a geophysical tool down a borehole to record data reflecting the strength of the rock mass. The stronger the rock, the higher the sonic velocity. It is possible to estimate the unconfined compressive strength from the sonic trace data.⁸³⁹
- 8.34 Chip logs are a record of a geologist's visual assessment of rock types returned as chips or cuttings from the process of drilling a borehole.⁸⁴⁰ The record by itself is not necessarily reliable, but can be useful in conjunction with data from another source.
- 8.35 To determine the presence of a massive unit, Dr Thomas proceeded on the basis that:⁸⁴¹
- ...a unit was determined as being massive, if it portrayed a near vertical sonic trace and did not therefore show any pronounced and consistent changes in rock mass strength that could otherwise indicate a change in rock type and/or a more bedded rock type.*
- 8.36 On the basis of 'consistent sandstone chips in the geological logs and near vertical sonic traces',⁸⁴² Dr Thomas assessed the MP sandstone as 'a thick and competent unit which would be expected to retain some spanning ability and so behave as a cantilever when located in the goaf'.⁸⁴³
- 8.37 The assessment is illustrated in Figure 107 below.⁸⁴⁴ It juxtaposes sonic logs and chip logs for boreholes RDG 208 and RDG 139R, which are located outbye of the serious accident site. The juxtaposition of the two sources of data enable each to cross reference the other. A similar exercise was conducted for boreholes RDG 206, and RDG 209, both located just inbye of the serious accident site.⁸⁴⁵

⁸³⁹ TRA.500.017.0001, .0030, line 39–.0031, line 4.

⁸⁴⁰ TRA.500.017.0001, .0029, lines 15–30.

⁸⁴¹ TRO.001.001.0001, .0008.

⁸⁴² TRA.500.017.0001, .0031, lines 42–43.

⁸⁴³ TRO.001.001.0001, .0009.

⁸⁴⁴ TRO.001.001.0001, .0017.

⁸⁴⁵ TRO.001.001.0001, .0031.

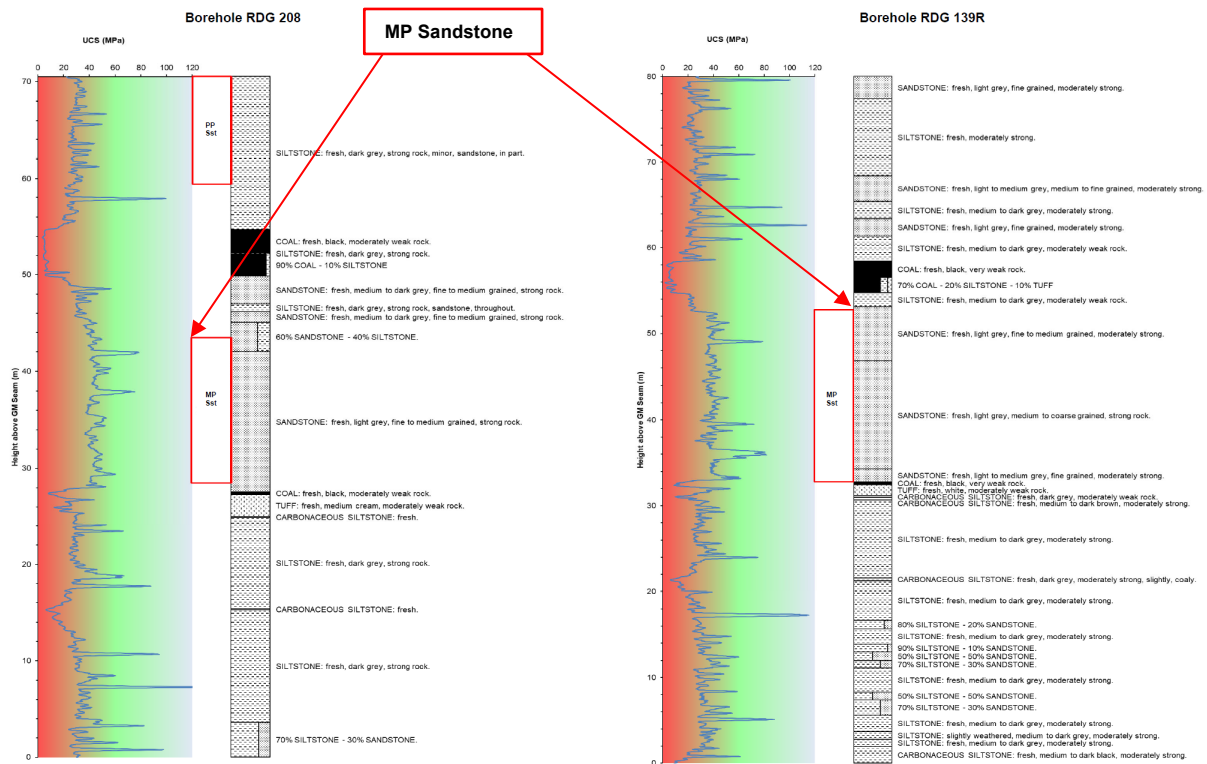


Figure 107: Sonic Logs for Boreholes RDG 208 and RDG 139R

8.38 Specifically, Dr Thomas’ assessment was that ‘[t]he MP Sandstone is...between 15 and 22m thick, and is located 32 to 35m above the GM seam at the ignition site’.⁸⁴⁶ Its unconfined compressive strength was assessed at between 40 to 50 MPa,⁸⁴⁷ putting it into the ‘moderately strong’ category of rock.⁸⁴⁸

Faults

8.39 An additional feature of significance is that the LW 104 face profile was mapped by the Grosvenor mine geologist on 4 May 2020, when the tailgate chainage was 3,998 metres (about 8 metres from the tailgate chainage at the time of the accident). Of note is that a reverse fault of 400 mm was mapped at the tailgate end, sub-parallel to the face, and dipping into it.

⁸⁴⁶ TRO.001.001.0001, .0008.

⁸⁴⁷ TRA.500.017.0001, .0041, lines 11–15.

⁸⁴⁸ TRO.001.001.0001, .0005.

The geologist's map, with an additional arrow pointing to the reverse fault, is depicted below:⁸⁴⁹

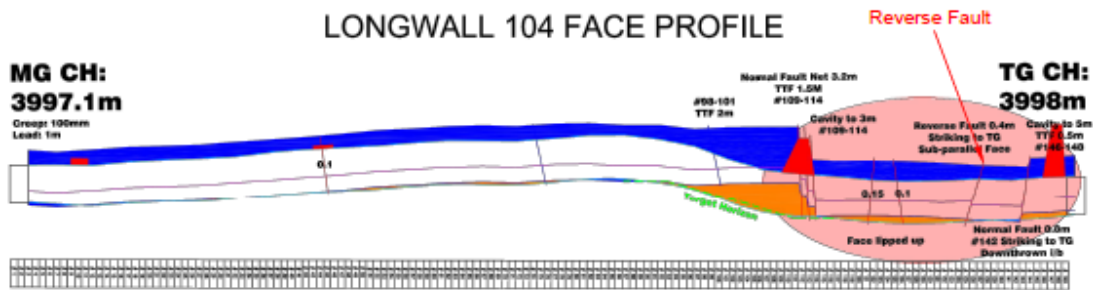


Figure 108: Face profile at TG CH: 3998m

8.40 The significance attributed to the reverse fault by Dr Thomas is that it:⁸⁵⁰

...would have not only severely weakened the cantilever, but also increased the cantilever's tendency to fail in a sudden manner – note: a)...the reverse fault was not only mapped at a sub-parallel and therefore unfavourable angle to the longwall face, but was also located in the tailgate end of the face (i.e., in the area where the ignition occurred) and more critically, dipped into the face, thereby further increasing the potential for sudden block detachment once the fault was located inbye of the supporting influence of the longwall shields...

8.41 The potential significance of a reverse fault is illustrated in the diagram below.⁸⁵¹

Fault Dips Unfavourably into Face

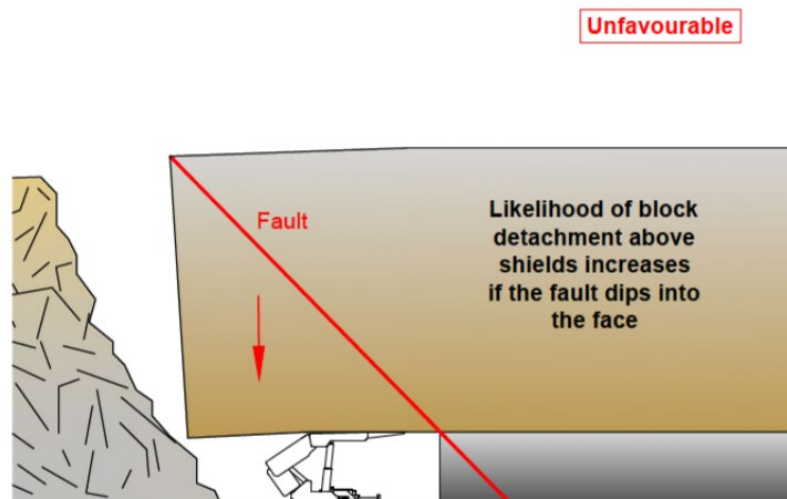


Figure 109: Reverse fault

⁸⁴⁹ TRO.001.001.0001, .0028.

⁸⁵⁰ TRO.001.001.0001, .0009.

⁸⁵¹ TRO.001.001.0001, .0028.

8.42 Other faults, including the Foey fault, were also mapped. Dr Thomas' conclusion about the significance of these faults is that:⁸⁵²

(i) the fault(s) would have provided a distinct plane of weakness for the cantilever to fail along and (ii) the pre-existence of a weak discontinuity, would have aided the sudden detachment of the overlying strata and the associated sudden expulsion of the goaf gases into the mine workings.

8.43 One assumption involved in attributing substantial significance to the reverse fault is that it extended upwards for a sufficient distance to have been operative in the failure of the MP sandstone i.e., approximately 50 metres.

Air gap, bulking factors and the issue of height

8.44 The Guideline identified a number of geological and mining conditions 'known to be associated with wind blast'. Two such conditions are described as follows:⁸⁵³

- *Goaf areas having immediate roof consisting of thick, massive strata, such as conglomerate or sandstone.*
- *Goaf areas having thick, massive beds above the immediate coal or shale roof but lying within the expected height of caving.*

8.45 Thus, the Guideline associates the occurrence of wind blast with the existence of massive strata above the immediate roof, and within the expected height of caving.

8.46 The Guideline includes the following further guidance as to the likelihood of wind blast, based on the height of the massive unit above the roof:⁸⁵⁴

*Experience has shown that the thickness of the septum between the face roof line and the lowest portion of the massive bed is important in reducing windblast effects. It is believed that **if the thickness of the readily caving immediate roof is twice the thickness of the coal section being mined, as a minimum, then the risk of windblast from the upper massive beds reduces considerably. It appears that the fallen immediate roof acts as a dampener on the windblast.*** (Emphasis added).

⁸⁵² TRO.001.001.0001, .0011.

⁸⁵³ NSW Department of Primary Industries, Mine Safety Operations Division, *MDG 1003: Windblast Guideline*, NSW Government (Technical Guideline, November 2007) <https://resourcesandgeoscience.nsw.gov.au/__data/assets/pdf_file/0020/419510/MDG-1003-Windblast-guide.pdf>, page 4; BOI.031.001.0001, .0006.

⁸⁵⁴ NSW Department of Primary Industries, Mine Safety Operations Division, *MDG 1003: Windblast Guideline*, NSW Government (Technical Guideline, November 2007) <https://resourcesandgeoscience.nsw.gov.au/__data/assets/pdf_file/0020/419510/MDG-1003-Windblast-guide.pdf>, page 5; BOI.031.001.0001, .0007.

8.47 Sharma also identified a similar ratio in his thesis, some years prior to the Guideline:⁸⁵⁵

Where there is no interburden between the working horizon and the overlying massive strata or where the thickness of interburden is less than about twice the extracted seam height, wind blast have occurred in narrow longwall panels. However, where a greater thickness of friable interburden is encountered, it significantly modifies the caving characteristics of the massive strata, tending to obviate wind blast (Simpson, Hebblewhite & Fowler, 1997).

8.48 The scenario hypothesised by Dr Thomas involves the massive unit of MP sandstone being a minimum of 32 metres above the roof line, so that the interburden lying between the roof and the massive unit is at least seven times the thickness of the coal section being mined (namely, 4.2 metres). This scenario represents a substantial departure from the terms of the Guideline, and the research into the wind blast phenomenon that preceded it.

8.49 When referred to this in evidence, Dr Thomas expressed the view that the ‘rule’ was ‘actually based on a limited experience in the Newcastle coal field in New South Wales’.⁸⁵⁶ He continued:⁸⁵⁷

Like a lot of things in geotechnical engineering, it's not quite as simple as that. Basically all you need is an air gap which would – and a competent unit that can span instantaneously and then fall into that air gap. That air gap could be several metres high up above the goaf, above the floor. We don't really know.

8.50 It can be seen that Dr Thomas emphasised the importance of identifying the existence of an air gap, rather than focussing on the ratio of immediate interburden to the thickness of the coal section mined.

8.51 One difficulty that the Board sees is that, all things being equal, the higher in the strata that the massive unit is situated, the lesser the likelihood of an air gap, or at least an air gap of sufficient size to have caused the magnitude of wind blast experienced on the face at LW 104. This is due to the operation of bulking factors.

8.52 The significance of bulking factors is that when the overlying material above the roof line collapses without the supporting influence of the shields, it can be expected to ‘bulk up’ i.e., to expand in volume compared with intact rock.

⁸⁵⁵ Sharma, P., *Dynamics of Wind Blasts in Underground Coal Mines*, University of New South Wales, (Ph.D Thesis, May 2001)
<<http://unsworks.unsw.edu.au/fapi/datastream/unsworks:43627/SOURCE01?view=true>>, pages 19–20.

⁸⁵⁶ TRA.500.017.0001, .0020, lines 15–16.

⁸⁵⁷ TRA.500.017.0001, .0020, lines 24–30.

Dr Thomas included details of the expected ratio of expansion in his report:⁸⁵⁸

...as a general rule, Bulking Factors (which relate to the volumetric ratio of expansion of intact to failed rock in a goaf) range between 1.1 and 1.3 for weak, mudstone and siltstone rock types and 1.5 for more competent sandstone rock types...

8.53 The relevance of the height of the spanning unit was acknowledged in Dr Thomas' evidence, where he said:⁸⁵⁹

...in the context of windblast, the higher up that unit is, the lower the likelihood you're going to get a windblast, because there's a concept that is mentioned in this report called bulking, the bulking factor.

...

When rock fractures, it volumetrically expands, so it's just a simple ratio of one over the other. The higher up that spanning unit is, the greater the likelihood that that bulked-up failed material below it is going to fill that void and you won't have an air gap.

8.54 In the course of his report, Dr Thomas estimated a bulking factor in the lowest range, 1.1 to 1.15, from an analysis of the strata in borehole RDG 209, located close to the accident site. In support of that range, Dr Thomas assessed that:⁸⁶⁰

...compared to the first 400m of retreat in LWs 101 to 103, the interburden between the GM Seam and the base of the MP Sandstone is dominated by more silty strata, which upon failure, would be expected to bulk up to a lesser degree in the goaf.

8.55 The void created by the activity of mining is 4.2 metres thick. At a bulking factor of 1.1, and a height of 32 metres to the MP sandstone, the interburden would cave to a height of 35.2 metres (i.e., 32 metres x 1.1), potentially leaving an air gap of 1.0 metre. However, at a bulking factor of 1.15, the caved interburden would reach a thickness of 36.8 metres, more than filling the void created by mining the seam.

8.56 It would also appear to be relevant that the MR sandstone was present in the stratigraphy at borehole RDG 209 (see the circled area in Figure 110 below),⁸⁶¹ although not as a massive unit. That being so, it may well be that a bulking factor greater than 1.1 to 1.15 would be warranted, thereby reducing, or eliminating, the prospect of an air gap.

⁸⁵⁸ TRO.001.001.0001, .0010.

⁸⁵⁹ TRA.500.017.0001, .0021, lines 33–36; lines 41–46.

⁸⁶⁰ TRO.001.001.0001, .0010.

⁸⁶¹ TRO.001.001.0001, .0031.

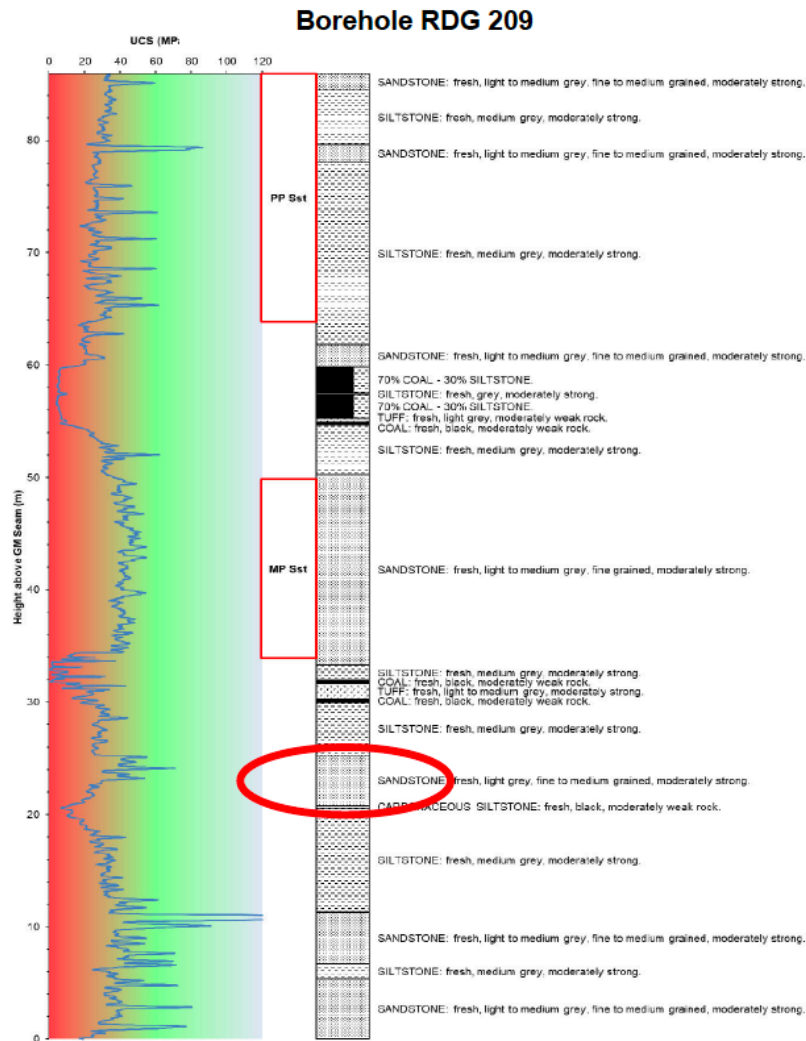


Figure 110: Sonic log for Borehole RDG 209

8.57 One specific scenario that was advanced related to the presence of the MR sandstone in the stratigraphy of boreholes RDG 206 and RDG 209.⁸⁶² Although not present as a massive unit, it was suggested by Dr Thomas that the MR sandstone ‘could also have spanned some distance into the goaf; thereby further reducing the amount of bulked up material present in the goaf’.⁸⁶³ The MR sandstone does not satisfy any of the spanning criteria referred to in the Guideline, so that the scenario cannot be accepted as a likely one. It also appears contradictory to recognise the presence of the MR sandstone, but at the same time to apply the lowest bulking ratio for the interburden between the roof and the MP sandstone.

⁸⁶² See Figure 17 at TRO.001.001.0001, .0031.

⁸⁶³ TRO.001.001.0001, .0010.

Relevance of cavities

- 8.58 There were a number of 2–5 metre cavities mapped at the tailgate end of the longwall between chainage 4,005 metres and 3,990 metres.⁸⁶⁴
- 8.59 The void to be filled by the mining of the seam would be increased by the height and surface area of the cavities, where they existed.⁸⁶⁵
- 8.60 It is accepted that this consideration could contribute to the existence of an air gap, in the location of the cavities. However, the total surface area and volume of the void referable to cavities may not be significant in terms of creating a wind blast. Further, the spanning unit would need to be unsupported over a sufficiently wide area for it to fail. It is unknown, and unknowable, what that area would be, or what height of air gap would be required to produce the force of air experienced by the workers on the face, which was some 30 metres below.

The shields' leg pressure

- 8.61 Data related to the leg pressure on the shields is kept on mine's data gathering and process control system, CITECT. The CITECT leg pressure data for the day of the serious accident show that the pressures on the shields were relatively stable, with varying levels of pressure recorded at different shields, until the time of the serious accident.⁸⁶⁶
- 8.62 The CITECT data show that at a time proximate to the serious accident, the tailgate shields were all recording reduced leg pressures, indicating there was no competent roof above the shields.⁸⁶⁷ This is supported by the workers' observations of the cavity in the area at that time.
- 8.63 At approximately 2:57:25pm, the leg pressures for shields #139 to #149 increased by between 10 and 30 bar, consistent with a load being placed on those shields. This was most likely the result of a rock fall from the cavity. These pressure increases are depicted in the following graph:⁸⁶⁸

⁸⁶⁴ RSH.022.004.0001, .0005.

⁸⁶⁵ TRA.500.017.0001, .0053, lines 3–34.

⁸⁶⁶ AGM.006.001.0042, .0070.

⁸⁶⁷ AGM.006.001.0042, .0070.

⁸⁶⁸ AGM.006.001.0042, .0070.

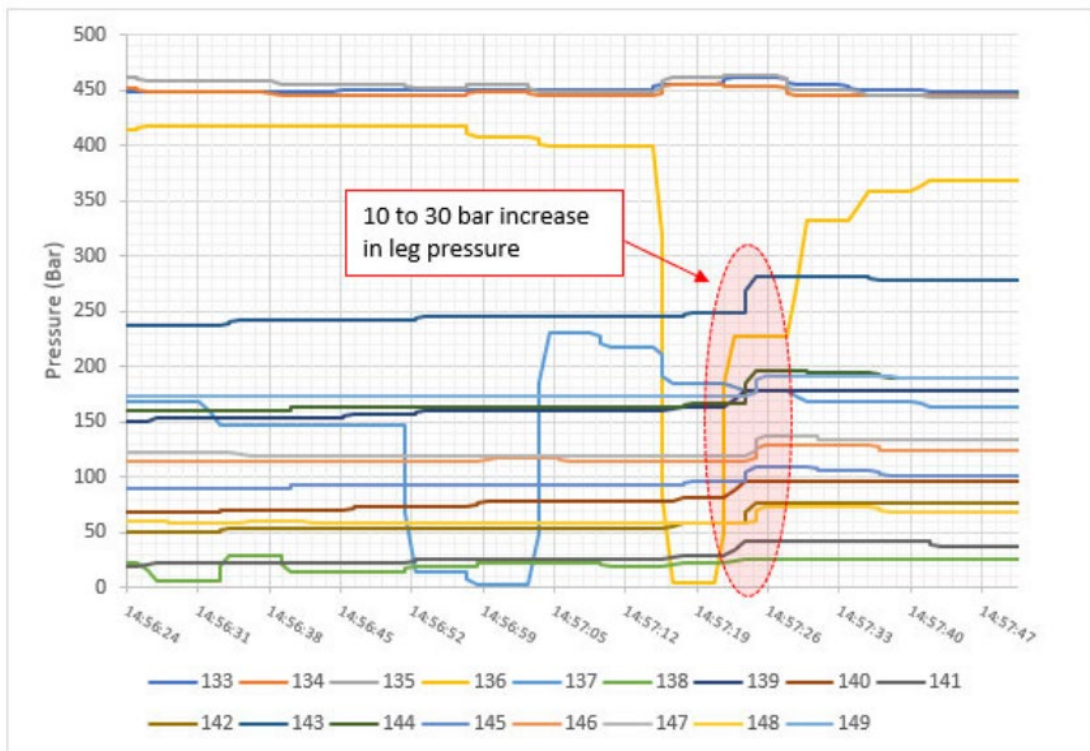


Figure 111: Leg pressure data for the tailgate shields (2:56:24pm–2:57:47pm)

- 8.64 Dr Thomas used the 10–30 bar increase in leg pressure on those shields to support the wind blast hypothesis. He said in his report that the ‘increase in leg pressure...is consistent with the sudden failure of a sizeable overlying roof unit’.⁸⁶⁹
- 8.65 On the Board’s assumption that the shield set pressure of 450 bar roughly corresponds with the rated shield capacity of 1,750 tonnes, an estimate of the increased load on the shields can be calculated by expressing the increase in leg pressure as a percentage of the set pressure and then multiplying by the shield capacity. This calculation indicates that a 10 bar increase in leg pressure is equivalent to 39 tonnes of additional load on the shield and a 30 bar increase in leg pressure is equivalent to 116 tonnes of additional load on the shield.⁸⁷⁰
- 8.66 This increased load is indicative of a strata fall to some degree, and the timing suggests an association with the incident. However, the increased load is not particularly significant, and is not considered to offer material support to a hypothesis of major strata collapse.

No history of wind blast at the GM seam

- 8.67 Dr Thomas acknowledged that wind blast events are rare.⁸⁷¹

⁸⁶⁹ TRO.001.001.0001, .0009.

⁸⁷⁰ The Board’s calculation is supported by confidential information received from the manufacturer.

⁸⁷¹ TRA.500.017.0001, .0014, lines 29–31.

8.68 The Board considers it relevant to the likelihood of wind blast that, unlike in NSW, where a number of events resulted in the issue of the Guideline, the phenomenon is not prevalent in Queensland. In particular, there is no precedent for it in the history of mining the GM seam. Dr Thomas had this exchange with Mr Andrew Clough in the course of his evidence:⁸⁷²

Q. I was curious whether or not you had heard of or had any involvement with a goaf fall of this magnitude previously, as has been reported?

A. In the Goonyella Middle seam?

Q. Yes.

A. Not to my knowledge. I can't think of anything like that, no.

8.69 The Warden's Inquiry into the Moura No. 4 incident accepted that wind blast was associated with the explosion. It appears from the Inquiry's report not to have been contentious that a strata failure wind blast occurred, and that the focus was on identifying the ignition source. As a result, the report does not contain any detailed consideration of the geological and geotechnical features behind the event, which might have been useful to compare with the present incident. The seam being worked at Moura No. 4 was the Moura C seam, with a different overlying stratigraphy than that above the GM seam. The report does note that the strata immediately above the C seam consisted mainly of approximately 60 metres of massive bands of sandstone.⁸⁷³

8.70 The absence of precedent is further reason for caution in assessing whether such an event was involved in the serious accident.

Gas sensor data

8.71 It has already been noted that the effect of a major collapse of strata in the goaf is to compress the atmosphere beneath and force it from the goaf through surrounding openings.

8.72 It was discussed in the previous chapter that prior to the serious accident, the fixed gas sensors in place at LW 104 and in the tailgate return recorded methane levels as stable, and generally less than 1%. During the serious accident only the tailgate drive sensor and the shield #149 sensor recorded substantial increases in the concentration of methane.

⁸⁷² TRA.500.017.0001, .0068, lines 29–36.

⁸⁷³ Mining Warden's Inquiry, *Report On An Accident at Moura No. 4 Underground Mine on Wednesday, 16th July, 1986*, Queensland Government (Report, June 1987)

<<https://www.publications.qld.gov.au/dataset/685e8b8b-7113-4693-af73-a2143526f077/resource/2c4d43e7-5448-44b9-b1c8-b11d2a534c41/download/moura4.pdf>>, page 5.

- 8.73 Given the indiscriminate expulsion of goaf gases onto the longwall face consequent upon a wind blast from strata failure, the Board considers it unlikely that only two sensors would respond to a such an event, and particularly that no increased level of methane would be experienced at either the inbye or outbye sensors in the tailgate return.
- 8.74 It is instructive to compare this limited sensor response with what occurred in several of the high potential incidents on LW 103 and LW 104, where relatively minor goaf or rock falls resulted in concentrations of methane in excess of 2.5% at both the inbye and outbye sensors.
- 8.75 The absence of an increase in methane being detected on either the inbye or the outbye sensors in the tailgate roadway, tends to contradict the notion of large volumes of goaf gas being expelled onto the face by a wind blast from strata failure. On the other hand, as will be seen later in this chapter, the absence of an increase in methane being detected on either the inbye or outbye sensors is explicable on the basis that the pressure wave resulted from an explosion in the goaf.

Possible cause two: methane explosion in the goaf

- 8.76 The alternative explanation for the first pressure wave is that there was a methane explosion in the goaf which caused a pressure wave to propagate through the tailgate onto the longwall face.
- 8.77 Mr James Munday, fire and explosion scene investigator, explained that an explosion results from an ignition of methane. A flame front forms immediately around the ignition source and expands outwards through the surrounding gas-air mixture for as long as there is fuel available to it. A pressure wave is formed, which moves ahead of the flame front. In an enclosed space, the pressure wave produces physical effects such as moving or displacing objects. The amount of gas being burned, the geometry and the venting will all impact the magnitude of the pressure wave. The effect of his evidence was that the magnitude of the first pressure wave was consistent with it having been caused by a methane explosion in the goaf.
- 8.78 A methane ignition will only occur when two conditions are met. Firstly, methane must be present in air within the explosive range. Secondly, there must be an ignition source. What follows is a consideration of the question whether both conditions existed, such that a methane explosion in the goaf explains the first pressure wave.
- 8.79 The chapter includes consideration of the gas monitoring data for LW 104 which have been examined in detail by SIMTARS experts, Mr Martin Watkinson and Mr Sean Muller. It emerges from that consideration that there are indicators that a spontaneous combustion event occurred in the goaf, which support a conclusion that a methane explosion was the likely cause of the first pressure wave.

8.80 Mr Watkinson’s evidence set out his review of the data ‘almost as the mine would have seen it’.⁸⁷⁴ By contrast, Mr Muller’s analysis involved a reprocessing of data that was available to the mine only in raw form. Not all of the indicators of spontaneous combustion identified in this section would have been apparent to the mine prior to the serious accident.

The presence of an explosible mix of methane

8.81 The Coward Triangle, developed in the early part of the last century, identifies the required concentrations of methane and oxygen for the methane to be explosive. It is shown below:⁸⁷⁵

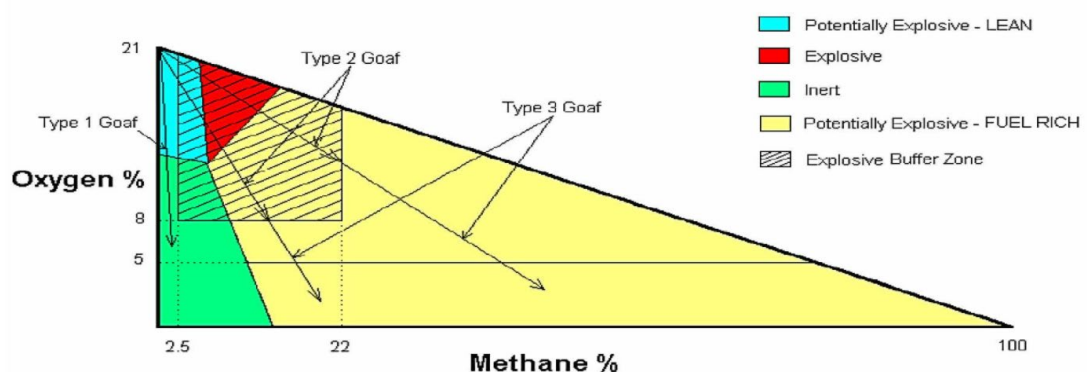


Figure 112: Coward Triangle

8.82 As can be seen from the above triangle, methane is explosive when it is present in air in concentrations of between approximately 5% and 15%. An explosive mixture is possible at oxygen concentrations as low as 12%.

8.83 The explosive range can be affected by factors such as temperature and pressure, but not at the temperatures and pressures that would have existed on the longwall at the time of the serious accident.⁸⁷⁶

8.84 Methane is, of course, always going to be present in the goaf. Testing of the working seam and the P seam undertaken at Grosvenor prior to the commencement of any production confirmed that the gas composition of the two seams was predominantly methane, ranging from 97% to 100%.⁸⁷⁷

8.85 When a longwall retreats, depending on the percentage of the seam extracted, coal from the roof and floor of the target seam may be left behind in the goaf and continue to release methane.⁸⁷⁸ In addition, and as discussed in Chapter 4, methane from surrounding coal seams may migrate to the goaf.

⁸⁷⁴ TRA.500.018.0001, .0066, lines 9–12.

⁸⁷⁵ SAN.001.002.0001, .0002; TRA.500.021.0003, line 42–.0004, line 27.

⁸⁷⁶ TRA.500.025.0001, .0004, line 28–.0005, line 4.

⁸⁷⁷ AGM.002.001.0818, .0829: *GRO-1435-PLAN-Grosvenor Mine Overview Plan*.

⁸⁷⁸ This is the practice in mines working the GM seam.

- 8.86 Prior to the ignition on 6 May 2020, the ten active goaf drainage holes were producing varying concentrations of methane, showing that methane was not present in a uniform concentration throughout the goaf.⁸⁷⁹
- 8.87 Mr Andrew Self explained that the concentration of methane in a goaf is highest deeper in the goaf, reducing in the area closer to the longwall face. At the same time, there is a very low concentration of oxygen deeper in the goaf, increasing towards the longwall face. Somewhere between these two zones is a third zone, called the ‘gas fringe’, in which there will be an explosible mix of methane and oxygen.⁸⁸⁰
- 8.88 Without multiple boreholes measuring gas concentrations close to the longwall face, it is not possible to determine the width of the gas fringe, but Mr Self explained that its general location is depicted by the curved blue line in the area behind the shields in the following diagram:⁸⁸¹

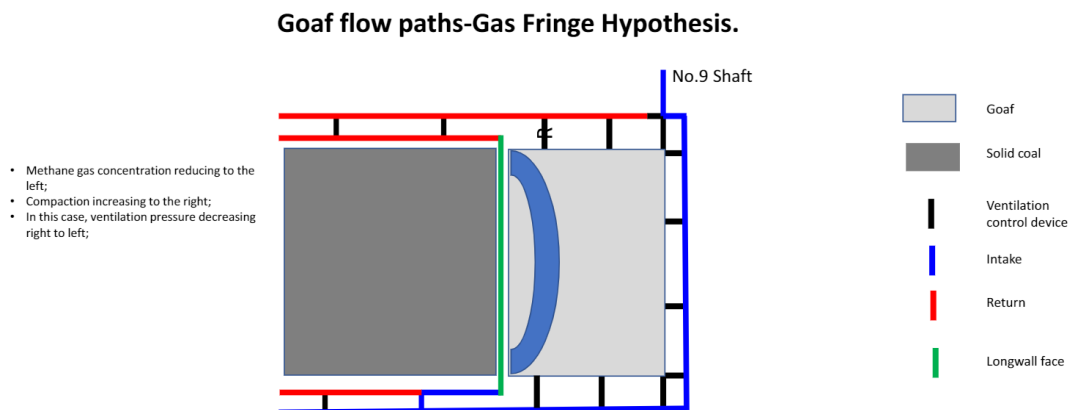


Figure 113: Mr Self’s explanation of the location of the ‘gas fringe’ behind the shields in the goaf

- 8.89 Mr Self considered that, in a gassy mine, it is inevitable that there will be an explosible mixture of methane and oxygen in the goaf ‘most of the time’.⁸⁸²
- 8.90 It is not possible to pinpoint the precise location, or locations, where an explosible mix of methane and oxygen existed shortly before the first pressure wave occurred. There were not enough boreholes measuring gas concentrations in the goaf to determine the limits of the gas fringe at that time. However, there are some indicators in the goaf gas monitoring data that do exist.
- 8.91 At 2:55am on 6 May 2020, gas drawn up GRO4V010 was explosible: methane was present at 14% and oxygen was present at 17%. GRO4V010 was located approximately five metres behind the shields in the goaf.⁸⁸³

⁸⁷⁹ AGM.013.001.0018.

⁸⁸⁰ SAN.001.002.0001, .0036; TRA.500.021.0001, .0030, lines 6–37.

⁸⁸¹ SAN.001.002.0001, .0036; TRA.500.021.0001, .0030, lines 37–42.

⁸⁸² TRA.500.021.0001, .0031, lines 10–13; .0035, line 4. Grosvenor is a gassy mine.

⁸⁸³ AGM.006.001.0042, .0072.

8.92 As can be seen from the following diagram, GRO4V010 was the well closest to the longwall face on 6 May 2020:⁸⁸⁴

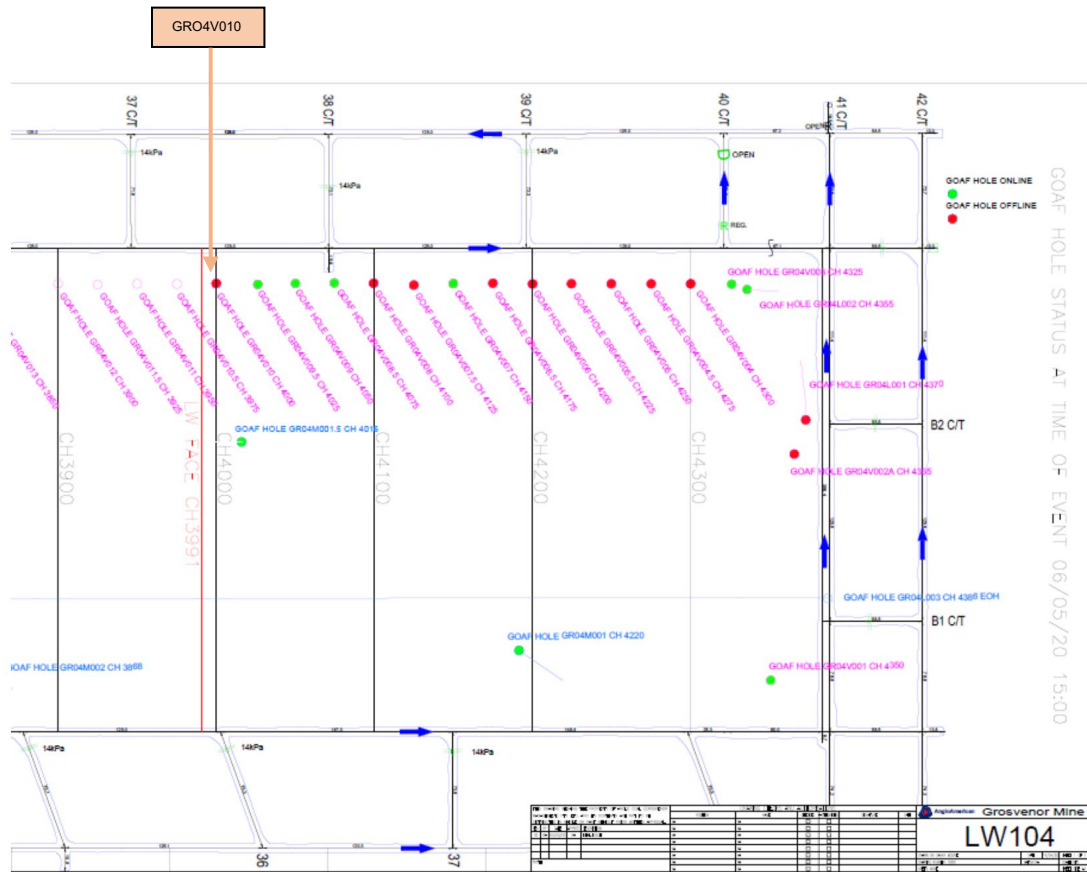


Figure 114: Diagram showing location of goaf hole GRO4V010 on 6 May 2020.
The face position is marked by the red line.

8.93 GRO4V010 was turned off shortly after the sample was taken, so there is no further data available to show whether the gas in that area continued to be in the explosive range in the lead up to the serious accident.⁸⁸⁵ However, it is noted that the explosive mix of methane and oxygen in that sample is consistent with Mr Self’s hypothesis as to the approximate location of the gas fringe. It may well be that an explosive mixture of methane and oxygen persisted in that location between 2:55am and the time of the serious accident.

8.94 There were other indicators that methane may have been present in the explosive range as far back as approximately 30 metres behind the shields in the tailgate area that day.

⁸⁸⁴ AGM.006.001.0042, .0052.

⁸⁸⁵ AGM.006.001.0042, .0061.

As part of his analysis of the CITECT gas data from the goaf well boreholes, Mr Watkinson produced the following graph showing the gas composition from goaf well GRO4V009.5 on 6 May 2020:⁸⁸⁶

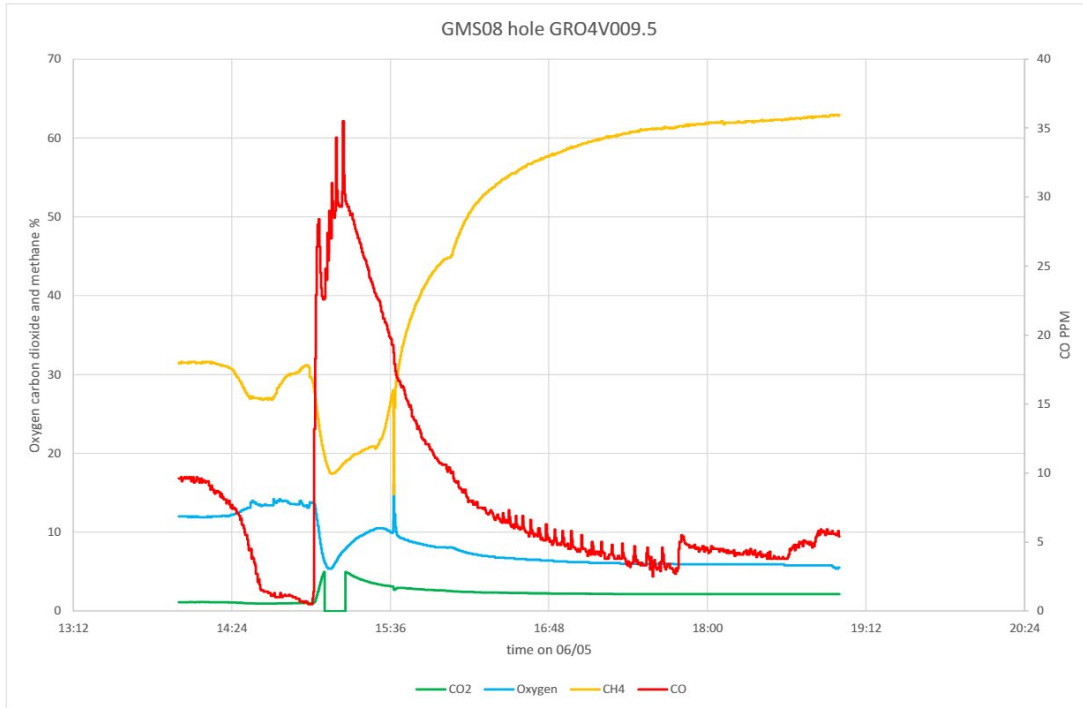


Figure 115: Gas levels detected at goaf hole GRO4V009.5 on 6 May 2020

- 8.95 As can be seen from the graph, methane being drawn from GRO4V009.5 prior to the serious accident fluctuated between about 26% and 32%, and the oxygen concentration rose to approximately 14%.
- 8.96 While the methane concentration in the gas drawn up the well exceeded the upper explosive limit of 15%, it must be borne in mind that goaf well GRO4V009.5 terminated 20 metres above the GM seam.⁸⁸⁷ As methane is a buoyant gas, the methane concentration lower in the goaf is likely to have been less than that which was drawn up the well. It may be that there was an explosive mix of methane under, or near, goaf well GRO4V009.5 on 6 May 2020.
- 8.97 Mr Muller also observed that GRO4V009.5, which was active from 1 May 2020, typically had methane concentrations of between 30% and 60% and oxygen concentrations of between 5% and 10% in the lead up to 6 May 2020. He observed a 'significant decrease in methane and increase in oxygen' immediately prior to the serious accident.⁸⁸⁸

⁸⁸⁶ WMA.001.002.0001, .0063.

⁸⁸⁷ WRA.001.001.0001, .0046.

⁸⁸⁸ RSH.037.003.0001, .0056.

8.98 The graph depicting his observations is set out below:⁸⁸⁹

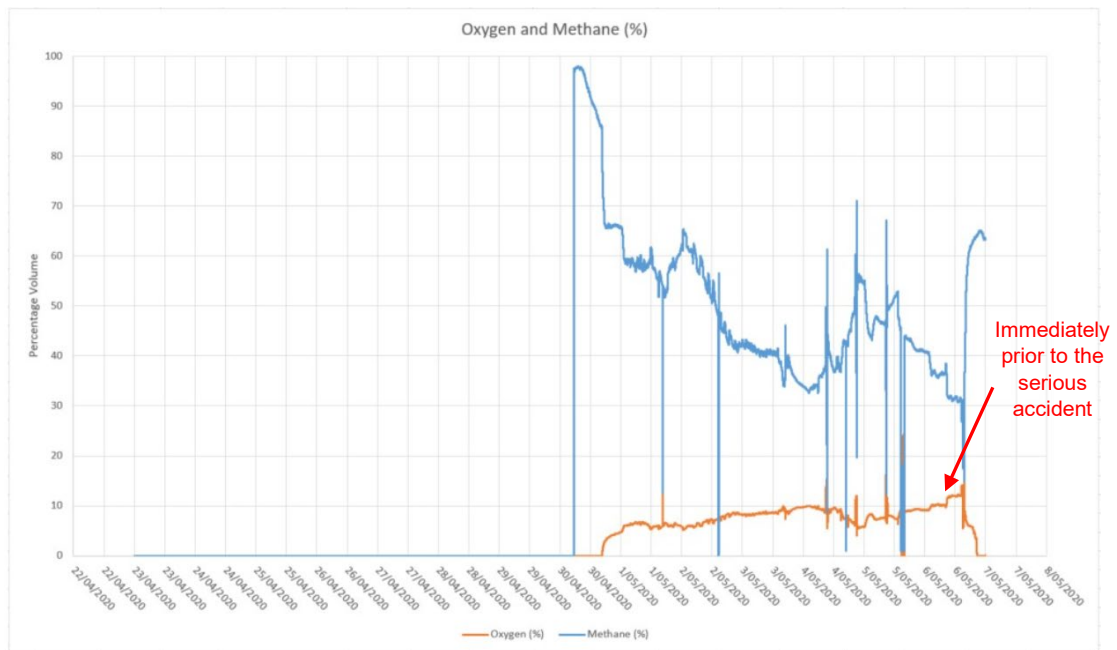


Figure 116: Methane and oxygen at GRO4V009.5

- 8.99 On the evidence available to it, the Board is unable to determine the precise location or limits of the area in which the explosible mix was situated immediately prior to the first pressure wave. However, on the basis of the gas sample taken from GRO4V010 on the morning of 6 May 2020, and the analysis done by Mr Watkinson and Mr Muller of the data from GRO4V009.5, the Board considers it is likely that the gas fringe in the goaf extended up to 30 metres behind the shields at the time of the first pressure wave.
- 8.100 As will be seen later in this chapter, goaf seals provided points of oxygen ingress, which may well mean there were other places in the goaf that had an explosible mixture of oxygen and methane, immediately prior to the serious accident on 6 May 2020.

Ignition source

- 8.101 An explosible mixture of methane will only result in an explosion if there is an ignition source. The potential ignition sources in the goaf are limited to lightning, frictional ignition from strata failure and spontaneous combustion. This section considers the evidence that spontaneous combustion was the ignition source.
- 8.102 There was no lightning in the area around Grosvenor mine proximate to the time of the serious accident. There were rocks falling from cavities above the tailgate shields throughout the day of the serious accident, and very close to the time of the first pressure wave.

⁸⁸⁹ RSH.037.003.0001, .0057.

However, whilst friction generated from rock on rock contact can be an ignition source, the low incendive characteristics of the strata above the GM seam make frictional ignition implausible in this case. Both lightning and frictional ignition as potential ignition sources are discussed further in the next chapter.

- 8.103 This chapter moves on to consider the evidence, including that of a number of relevant experts, which points to a spontaneous combustion event which resulted in a methane explosion in the goaf.
- 8.104 In addition to identifying the area of the goaf in which there is likely to be an explosible mix of methane and oxygen, Mr Self explained that the gas fringe, being relatively high in oxygen and relatively low in methane, is significant because it is an area where oxidation can take place.⁸⁹⁰ He explained that the area depicted by the red blocks in the following diagram is a ‘critical zone’ which has ‘the potential to generate a spontaneous combustion event’:⁸⁹¹

Goaf flow paths-critical zones.

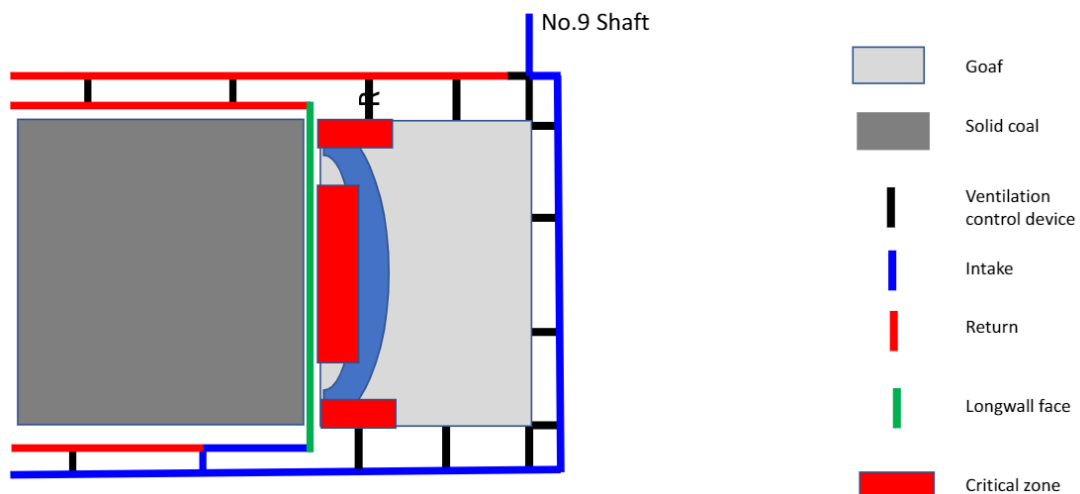


Figure 117: Mr Self’s explanation of the location of a ‘critical zone’ for spontaneous combustion

- 8.105 Mr Self’s diagram suggests a regulator was present in the tailgate inbye cut-through (c/t) connected to the goaf. This arrangement would allow a ventilation flow through the goaf to this cut-through. There is some question whether there was in fact a regulator at this location, or merely a stopping.⁸⁹² However, if it was a stopping, there is evidence that it was leaking, allowing a ventilation flow through this area.⁸⁹³

⁸⁹⁰ TRA.500.021.0001, .0030, line 44–.0031, line 2.

⁸⁹¹ SAN.001.002.0001, .0037; TRA.500.021.0031, lines 15–34.

⁸⁹² TRA.500.021.0001, .0081, lines 8–14.

⁸⁹³ AAMC.001.003.0016, .0022.

- 8.106 Mr Self explained that the combination of the ingress of oxygen from the maingate and along the back of the shields (depicted by the curved blue line), along with the fractured coal along the goaf edge, create 'ideal conditions' for spontaneous combustion activity.⁸⁹⁴
- 8.107 The image below is a view from the tailgate roadway looking back into the goaf taken after the serious accident. There is a pile of coal in the foreground and shield #149 is visible on the right hand side of the image. It can be seen that the roof is still standing some distance back into the goaf. The long tendon supports installed in the roof are clearly visible and appear to be installed at approximately 2 metre intervals.⁸⁹⁵ The number of visible tendons in the roof indicate that the tailgate roadway is standing for at least 10 metres behind shield #149. This open area provides a low resistance path for oxygen to migrate back through the goaf towards the goaf drainage holes, and through the damaged stoppings into the C heading.



Figure 118: View into the goaf from the tailgate roadway after the serious accident

Indicators of spontaneous combustion as the ignition source

- 8.108 This section considers gas monitoring data for LW 104. In the Board's view, whilst the data do not definitively reveal evidence of a large-scale spontaneous combustion event in the LW 104 goaf during the period from March to 6 May 2020, they do indicate that a heating event or events occurred. These events may have been small in size, but nonetheless of sufficient intensity to provide a source of ignition.

⁸⁹⁴ SAN.001.002.0001, .0037.

⁸⁹⁵ 'Tendon supports' are long strand cables that are either grouted or resin encapsulated into the roof. They are used to supplement the standard roof bolt pattern in areas of a mine that require a higher level of ground support.

As will be explained, the principal reasons for those conclusions are:

- a. high levels of oxygen in the goaf at goaf seals and in goaf wells, particularly those wells that were closer to the face, which are undesirable because oxygen is a prerequisite for spontaneous combustion;
- b. repeated detections of traces of ethylene, which is generated in GM seam coal at temperatures above 90°C;
- c. elevated levels of carbon monoxide at goaf seals and goaf wells; and
- d. subtle upward trends in Graham's and CO/CO₂ Ratios.

8.109 Grosvenor's gas data for the period March to May 2020 were analysed by Mr Watkinson and Mr Muller.

8.110 Mr Watkinson examined the real-time, tube bundle, and goaf skid data for signs of spontaneous combustion over the period from March until 8 June 2020.⁸⁹⁶ He also compared data from similar sources for LW 103.

8.111 Although Mr Watkinson reviewed the gas chromatograph (GC) data, the detailed analysis of it was undertaken by Mr Muller. Mr Watkinson's analysis is therefore confined to the data concerning carbon monoxide, carbon dioxide, oxygen, and methane. As will be seen, Mr Watkinson found some, although limited, evidence of spontaneous combustion activity.

8.112 Mr Muller undertook an analysis of GC data of bag samples taken from locations that included tube bundles, the goaf stream in the tailgate, the longwall face and goaf wells. His analyses, using the additional data provided by gas chromatography, as well as a more granular examination of real-time data, do demonstrate tolerably clear evidence of accelerated oxidation.

Real-time data

March 2020

8.113 The only real-time sensor in operation during March measuring the four gases, carbon monoxide, carbon dioxide, methane, and oxygen, in the LW 104 tailgate was that located in 3–4 cut-through. Carbon monoxide make (CO Make) was not being calculated during this period. Carbon monoxide concentrations and Graham's Ratio show an increase, however this is consistent with what would be expected in the early stages of a longwall before the goaf was properly formed.

April 2020

8.114 CO Make was calculated during this period, however none of the data show any signs of abnormal activity.

⁸⁹⁶ A methane ignition occurred at Grosvenor on 8 June 2020.

May 2020

- 8.115 The carbon monoxide data do not show any abnormal trends, apart from a substantial spike associated with the explosion of 6 May 2020. Two other spikes in carbon monoxide are explicable by reason of the operation of diesel machinery in the tailgate at the relevant times. The Graham's Ratio values are similarly unremarkable, with spikes explained on the same basis.
- 8.116 It is not surprising that no evidence of a heating was detected in the real-time data at 3–4 cut-through. The large volumes of air in the longwall return would have diluted any early indicators of spontaneous combustion to within the 'noise levels' of the real-time sensors.⁸⁹⁷

Tube bundle data

- 8.117 The location of the tube bundle sampling points was presented in Chapter 6.

March 2020

- 8.118 The data for March 2020 show limited evidence of spontaneous combustion. Carbon monoxide levels at 3–4 cut-through were normal. Similarly, CO Make, which was being calculated in Safegas for the same location, did not show any abnormal or increasing trends. Graham's Ratio was not being calculated for this location, but Mr Watkinson performed the calculations himself. None of the calculated Graham's Ratio figures exceeded the trigger value of 0.3, specified in the relevant Trigger Action Response Plan (TARP), that would change the TARP condition from 'Normal' to 'Level 1'.
- 8.119 The data for the longwall seals show a rising level of carbon monoxide in the 40–41 cut-through C heading seal, and the calculated Graham's Ratio for the same location exceeded the 'Level 1' TARP trigger of 0.3. This was an early indicator of spontaneous combustion activity.

April and May 2020

3–4 cut-through

- 8.120 For April and May 2020, the raw carbon monoxide figures for the 3–4 cut-through, tailgate 104 and 400 metre tailgate tubes (TB #22 & #26) show no increasing trend. The 400 metre tube was not commissioned until 14 April, however thereafter its data largely correspond with that from the 3–4 cut-through tube, almost 4 kilometres outbye.
- 8.121 Figure 119 illustrates the CO Make as measured at 3–4 cut-through, tailgate 104 and the 400 metre tube bundle point.⁸⁹⁸ The CO Make figures from 3–4 cut-through, tailgate 104 show that the 'Level 1' TARP trigger value of 42 l/min was exceeded on several occasions between the end of March and 6 May 2020.

⁸⁹⁷ Cliff., D. *et al.*, *Better Indicators of Spontaneous Combustion* (2000) Project No. C5031 Report, Australian Coal Association Research Program, page 9; WMA.003.001.0001, .0011.

⁸⁹⁸ WMA.001.002.0001, .0028.

8.122 The CO/CO₂ Ratios did not exceed the 'Level 1' TARP trigger of 0.2 at any stage. However, it has already been noted that this trigger value should likely have been 0.02, in which case a 'Level 1' TARP should have been triggered on multiple occasions. It should also be noted that goaf gas analysis shows that the seam gas at LW 104 includes carbon dioxide; the significance being that the CO/CO₂ Ratio will underestimate the intensity of a heating when carbon dioxide is also present as a seam gas.

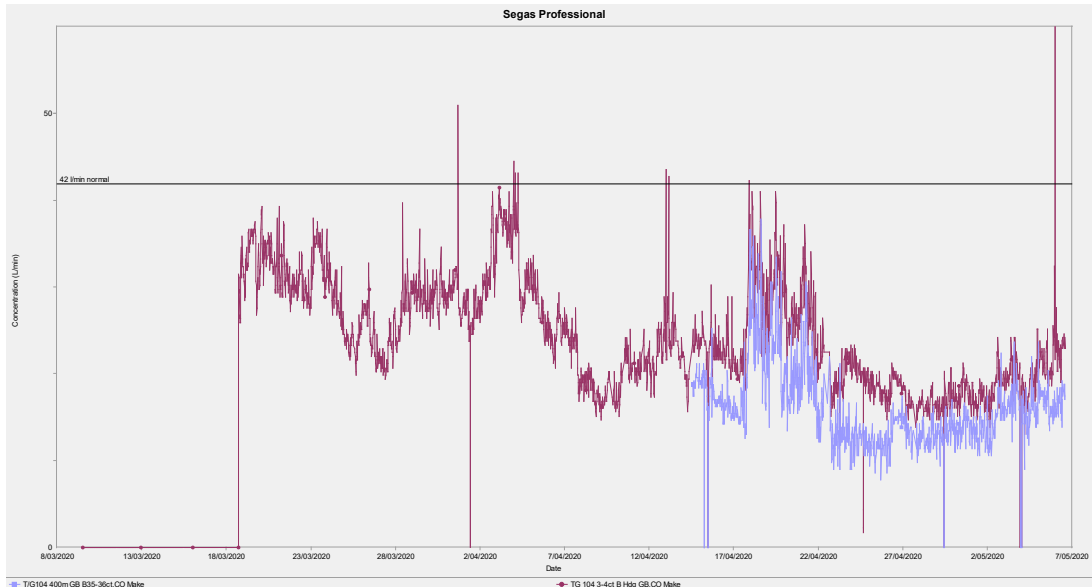


Figure 119: CO Make for TG 104 for 9 March to 6 May 2020

8.123 Although the Graham's Ratio 'Level 1' TARP trigger was exceeded on 4 May (0.43) as illustrated in Figure 120, and then met on 6 May (0.3), there was no obvious increasing trend in the tailgate data.⁸⁹⁹ As noted earlier, the measurement of Graham's Ratio at 3–4 cut-through, tailgate 104, is potentially of no practical value due to the large volumes of ventilation air diluting the changes in carbon monoxide to within the noise levels of the detection systems.⁹⁰⁰

⁸⁹⁹ WMA.001.002.0001, .0029.

⁹⁰⁰ Cliff., D. *et al.*, *Better Indicators of Spontaneous Combustion* (2000) Project No. C5031 Report, Australian Coal Association Research Program, page 9; WMA.003.001.0001, .0011.

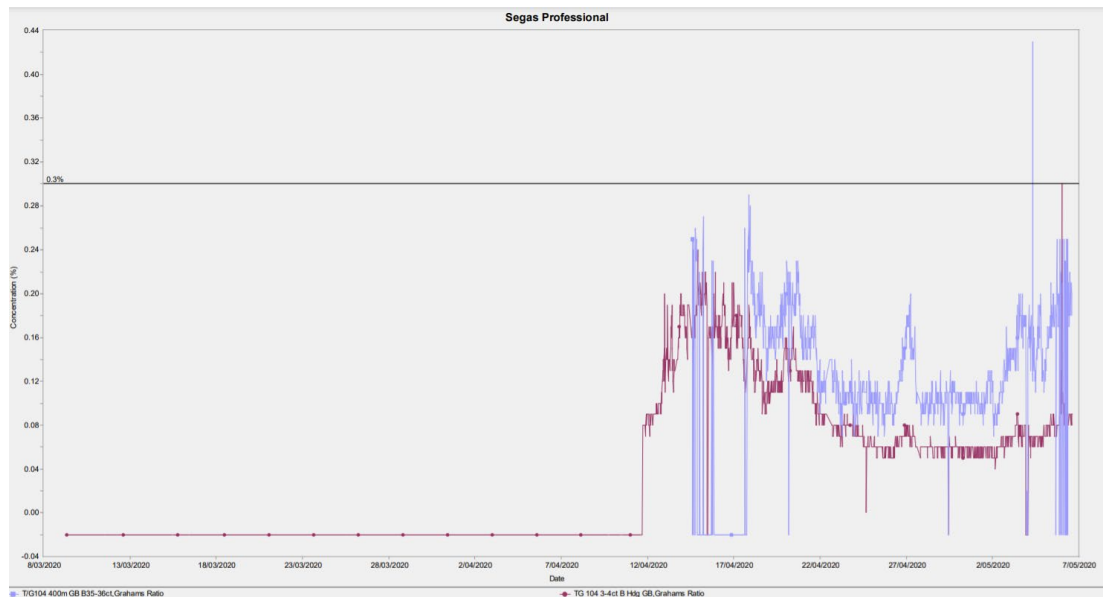


Figure 120: Graham's Ratio for tubes #22 and #26 LW 104 for 8 March to 7 May 2020

Goaf seals

- 8.124 Tube bundle sampling was carried out at the 40–42 tailgate cut-through seal, B1 cut-through seal and the 38 cut-through maingate seal.
- 8.125 The data for the goaf seals are significant because of the high levels of oxygen and elevated carbon monoxide that were detected.
- 8.126 There were two separate periods in early and late April 2020 when carbon monoxide concentrations were trending upwards. The levels in these periods reached the respective 'Level 1' and 'Level 2' TARP triggers of 130 ppm and 200 ppm.
- 8.127 As can be seen in Figure 121 below, analysis of samples taken at each of the three longwall seals revealed the presence of carbon monoxide.⁹⁰¹ The concentration of carbon monoxide at the B1 cut-through seal was relatively low, however those at 38 cut-through and 40–41 cut-through were elevated.

⁹⁰¹ WMA.001.002.0001, .0030.

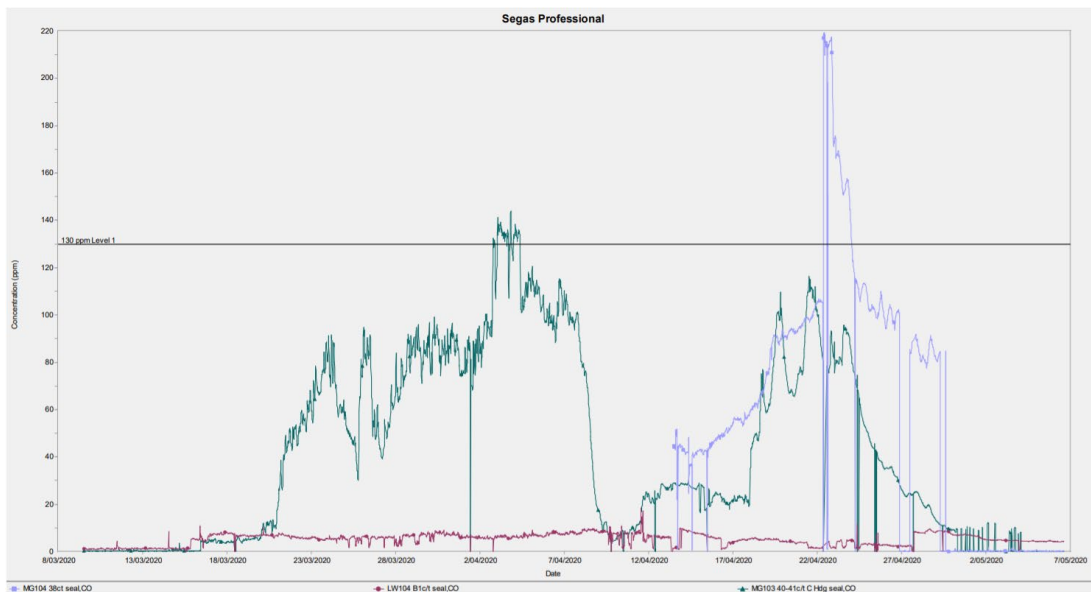


Figure 121: LW 104 seals CO concentrations for 9 March to 6 May 2020 showing 'Level 2' TARP (38 c/t in blue; B1 in red; 40-41 in green)

8.128 The oxygen concentrations at the three longwall seals that were being monitored varied, but were consistent with fresh air for substantial periods, particularly at the 40–41 cut-through, tailgate 104 seal in the days leading up to 6 May 2020.⁹⁰² The proximity of the 40–41 cut-through seal to the No. 9 downcast shaft would be expected to result in a high pressure differential across the seal, which would make this area especially prone to oxygen ingress.⁹⁰³

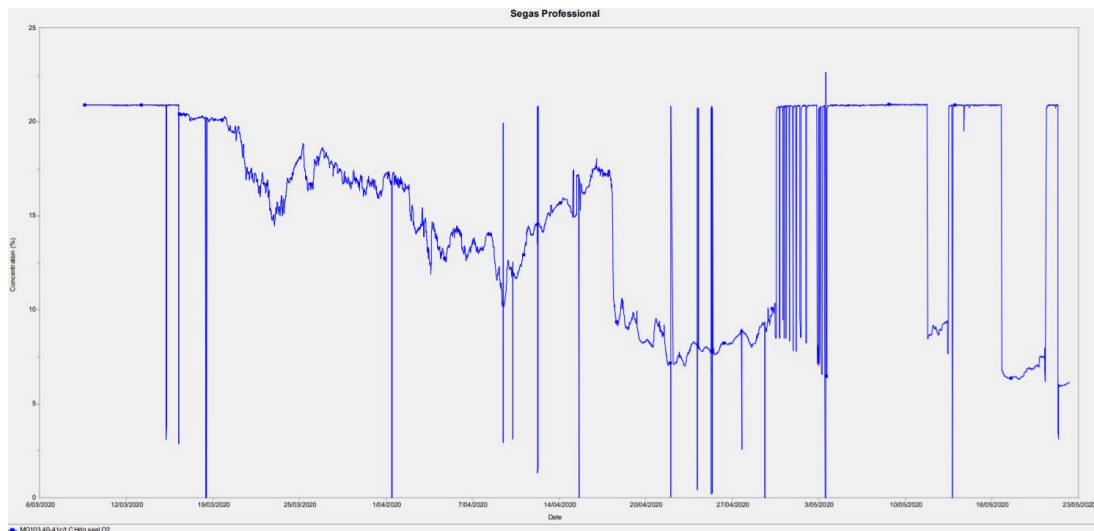


Figure 122: Oxygen concentrations at 40–41 c/t, TG 104 seal tube for 9 March to 6 May 2020

⁹⁰² WMA.001.002.0001, .0032.

⁹⁰³ TRA.500.021.0001, .0021, line 45–.0022, line 37. The Board understands that there was no forcing fan on the downcast shaft, however the fact that it was an intake shaft would lead to the pressure differential referred to by Mr Self.

8.129 Tube bundle monitoring point TB #38 located in B1 cut-through at the rear of the goaf also had high oxygen concentrations for extended periods. The drop in oxygen in late April appears to be the consequence of nitrogen inertisation, which was commenced around 22 April 2020:⁹⁰⁴

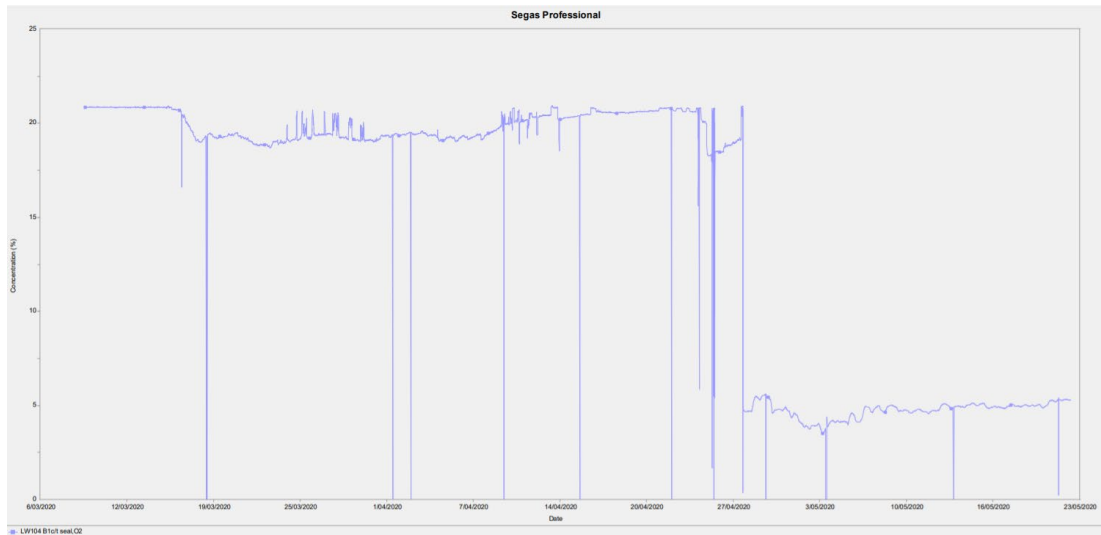


Figure 123: Oxygen readings from B1 c/t tube seal from 8 March to 22 May 2020

8.130 Similarly, high concentrations of oxygen were detected at TB #36, located in 38 cut-through. It appears that inertisation effects were apparent from 22 April 2020:⁹⁰⁵

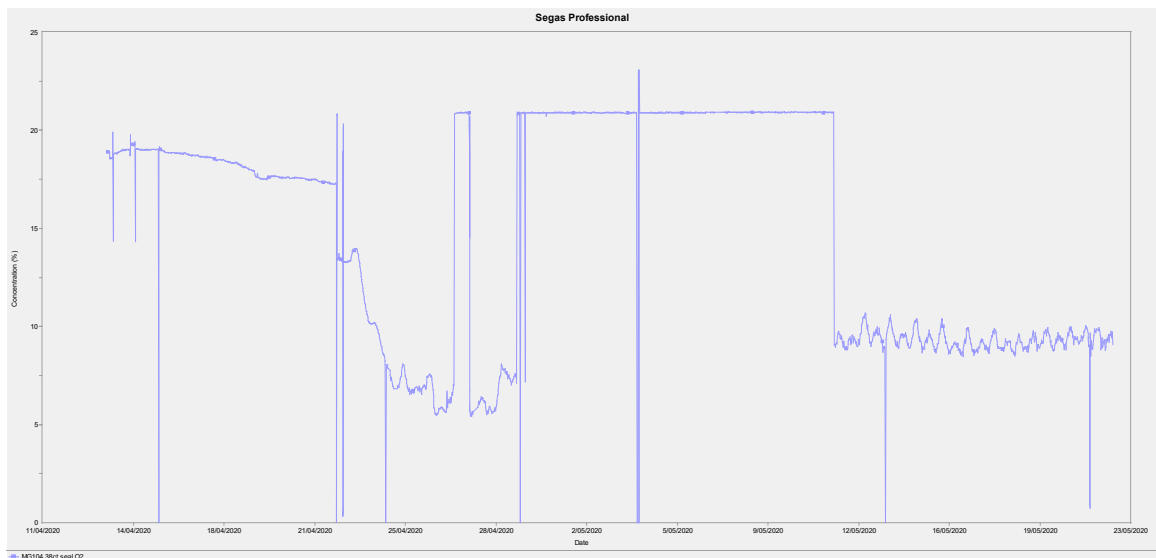


Figure 124: Oxygen readings from 38 c/t tube seal from 6 March to 22 May 2020

8.131 These concentrations of oxygen are concerning, and suggest that the seals were leaking, permitting the ingress of oxygen to the goaf.

⁹⁰⁴ WMA.001.002.0001, .0032.

⁹⁰⁵ WMA.001.002.0001, .0030–.0031.

Nitrogen inertisation was intermittent, resulting in periodic reductions in oxygen at the sampling locations. Although leaking sample tubes will also indicate high levels of oxygen, in this case the presence of carbon monoxide leads to the conclusion that these were valid samples from the goaf.

8.132 The Graham's Ratio values for all of the seals, as illustrated below in Figure 125, show that the 40–41 cut-through seal was in 'Level 1' TARP from 21 March to 3 April 2020, as was the 38 cut-through, maingate 104 seal from 13 to 23 April.⁹⁰⁶ Mr Watkinson's opinion was that these figures, coupled with the raw carbon monoxide concentrations depicted in Figure 121, are a 'clear indication of the onset of spontaneous combustion activity'.⁹⁰⁷

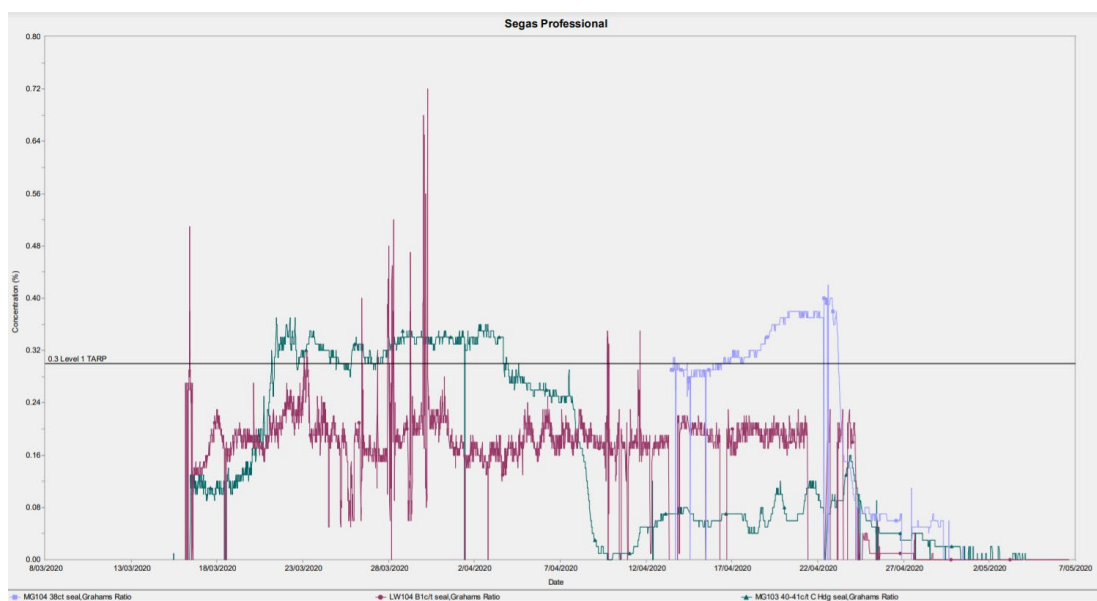


Figure 125: LW 104 seals Graham's Ratio from 9 March to 6 May 2020
(38 c/t in blue; B1 in red; 40-41 in green)

Goaf drainage data

8.133 As will be explained below, the real-time data from the goaf drainage wells show that several wells, particularly those closer to the longwall face, were drawing concerningly high levels of oxygen with an attendant risk of spontaneous combustion.

⁹⁰⁶ WMA.001.002.0001, .0033.

⁹⁰⁷ WMA.001.002.0001, .0033.

8.134 The goaf drainage wells, which are located at 25 metre intervals, are depicted in the following diagram:⁹⁰⁸



Figure 126: Goaf wells on LW 104 - the stars denote those wells that were active at the time of the serious accident on 6 May 2020

- 8.135 For the period prior to 6 May 2020, the raw real-time data from the goaf wells considered by Mr Watkinson do not clearly suggest spontaneous combustion activity.
- 8.136 However, Mr Muller’s analysis of GC data and closer examination of real-time data from these locations, for the same period, paints a different picture. On Mr Muller’s analysis, there is reason to conclude that the excessive levels of oxygen being drawn into the goaf caused a heating to develop, with the products of that process reporting to the goaf wells.

⁹⁰⁸ WRA.001.001.0001, .0045.

6 May 2020

- 8.137 Data from the active goaf wells at between 2:00am and 3:00am on 6 May 2020 show that, of the 11 wells, two were in 'Level 1' TARP condition for high oxygen.⁹⁰⁹ One, GRO4V010, which penetrated the goaf closest to the then position of the longwall face, was in 'Level 2'. As already noted, analysis of the sample taken from GRO4V010 at 2:55am showed that an explosive mixture was being drawn from that well, with methane at 14% and oxygen at 17%.⁹¹⁰ This resulted in that well being shut in; it was not turned on again prior to the serious accident.⁹¹¹
- 8.138 Immediately prior to the event at 2:57pm, goaf well GRO4V009.5 (approximately 30 metres behind the shields), was drawing a concerning mixture of oxygen and methane, at about 14% and 26% respectively, meaning it ought to have been in 'Level 2' TARP conditions:⁹¹²

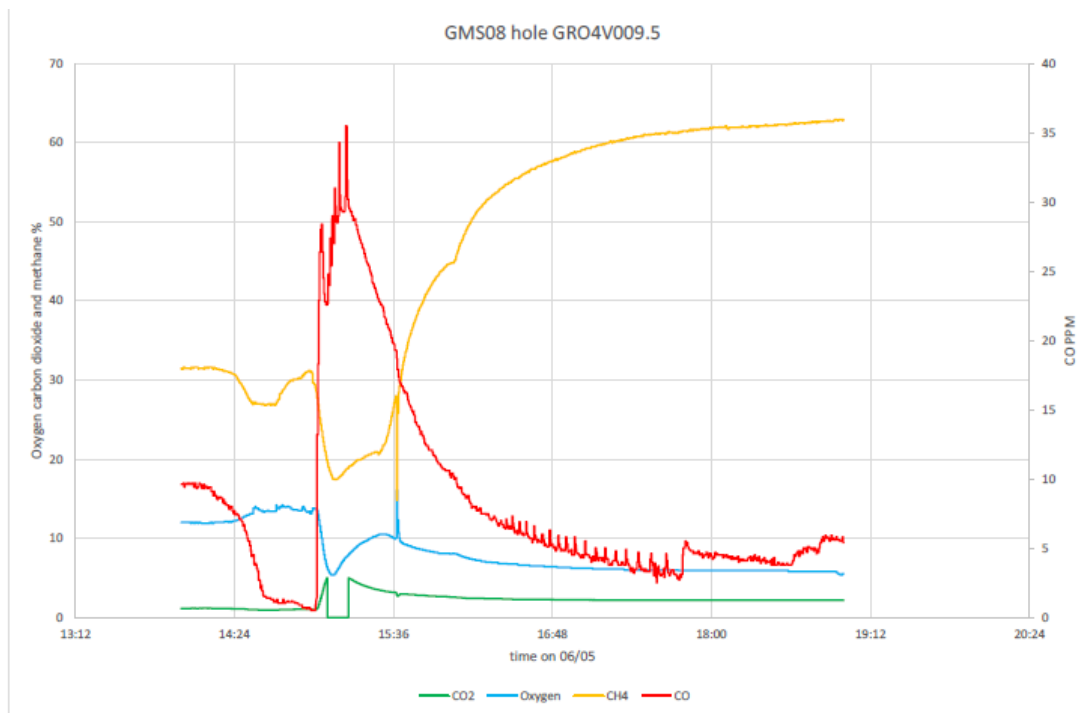


Figure 127: CO₂, O₂, CH₄ & CO concentrations at goaf well GRO4V009.5 on 6 May 2020

⁹⁰⁹ AGM.013.001.0018.

⁹¹⁰ AGM.006.001.0042, .0072.

⁹¹¹ AGM.006.001.0042, .0061; .0067; .0072.

⁹¹² WMA.001.002.0001, .0063.

8.139 At the same time, goaf well GRO4V009 (approximately another 25 metres farther back in the goaf), showed a steady rise in oxygen up to 10% prior to the ignition at 2:57pm:⁹¹³

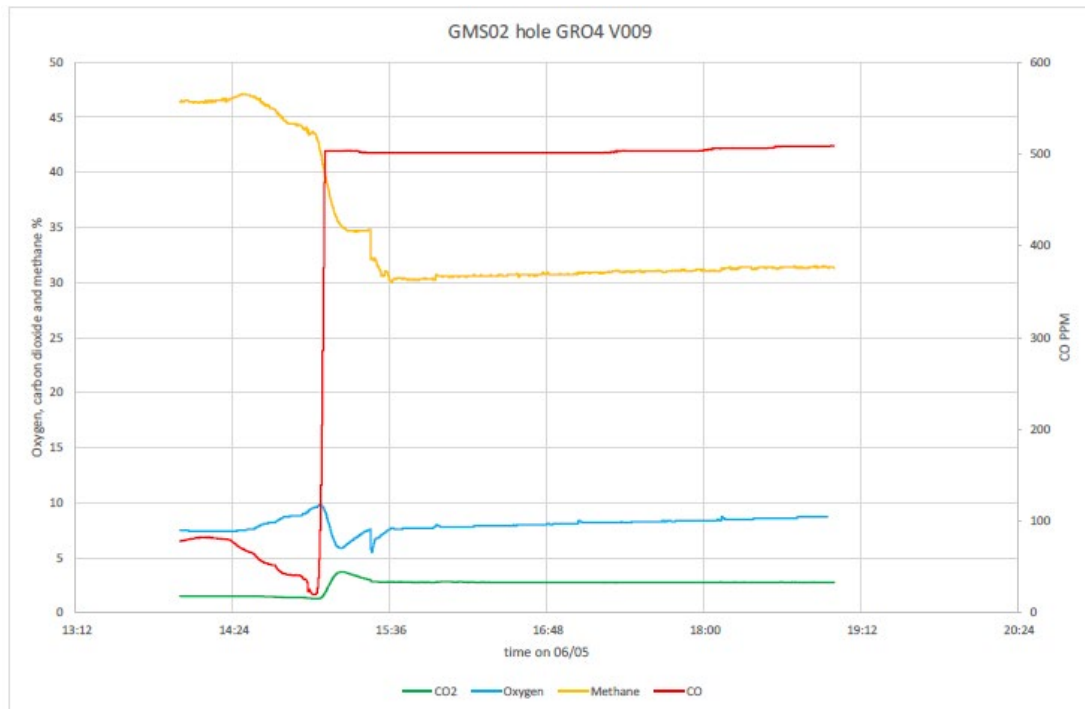


Figure 128: CO₂, O₂, CH₄ & CO (4-gas) concentrations at goaf well GRO4V009 on 6 May 2020

8.140 It follows from what is shown in these graphs that undesirable concentrations of oxygen were present in the goaf at least as far back as approximately 50 metres behind the tailgate shields.

8.141 According to Mr Self, where a 'simplistic strategy of increasing numbers of vertical goaf wells and increasing suction pressure is applied, oxygen increase to the goaf will result in an unacceptable spontaneous combustion risk if goaf well oxygen concentration is not managed'.⁹¹⁴ In his view, the objective should be to manage goaf wells so that the amount of oxygen being drawn into them remains below 5%.⁹¹⁵

⁹¹³ WMA.001.002.0001, .0064.

⁹¹⁴ TRA.500.021.0001, .0050, lines 37–41.

⁹¹⁵ TRA.500.021.0001, .0050, line 47–.0051, line 13.

8.142 Other authoritative sources support that figure of 5%.⁹¹⁶

Data trends over the period 2 to 6 May 2020

8.143 The presence of troubling levels of oxygen in the goaf was not confined to 6 May 2020. The data also show the presence of oxygen at locations both deeper in the goaf and closer to the face over the preceding days.⁹¹⁷ These concentrations of oxygen are consistent with leaking goaf seals and/or high rates of goaf well extraction that drew fresh ventilation air into the goaf.

8.144 Goaf well GRO4V006.5 was drawing oxygen at a concentration that reached up to 9%.⁹¹⁸

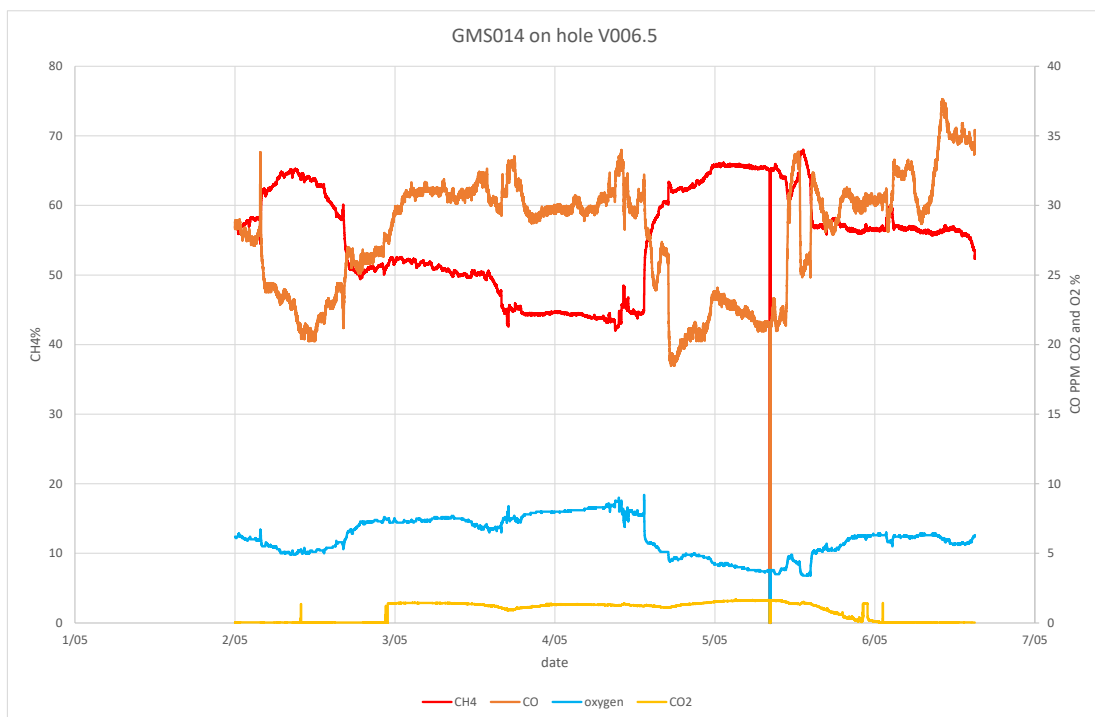


Figure 129: 4-gas data from GRO4V006.5 from 2 May 2020 to 3:00pm on 6 May 2020

⁹¹⁶ Ren, T. & Balusu, R., *The use of CFD modelling as a tool for solving mining health and safety problems* (2010), in Aziz, N. & Kininmonth, R. (eds.), *Proceedings of the 2010 Underground Coal Operators' Conference*, Mining Engineering, University of Wollongong <<https://ro.uow.edu.au/coal/319>>, page 342; Highton, W., *The case against bleeder entries and the reasons for a safer and more efficient alternative* (1980), 2nd International Mine Ventilation Congress, pages 437–447; NSW Industry & Investment, Mine Safety Operations Branch, *MDG 1006: Spontaneous Combustion Management – Technical Reference*, NSW Government (Technical Guideline, May 2011) <https://www.resourcesregulator.nsw.gov.au/__data/assets/pdf_file/0006/419514/MDG-1006-TR-spontaneous-combustion-management.pdf>.

⁹¹⁷ AGM.013.001.0018.

⁹¹⁸ WMA.002.002.0001, .0013.

8.145 At goaf well GRO4V008.5, for the same period, oxygen concentrations were consistently at about 8%, save for a brief excursion to about 20%:⁹¹⁹

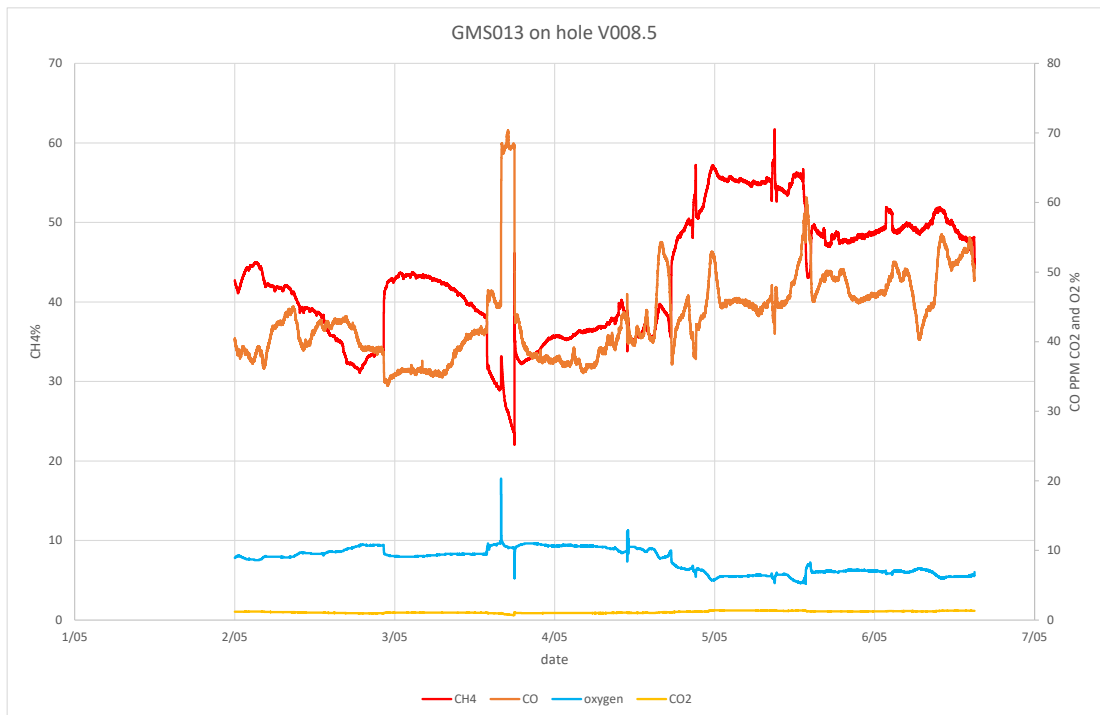


Figure 130: 4-gas data from GRO4V008.5 from 2 May 2020 to 3:00pm on 6 May 2020

⁹¹⁹ WMA.002.002.0001, .0014.

8.146 At goaf well GRO4V009, the trend was similar:⁹²⁰

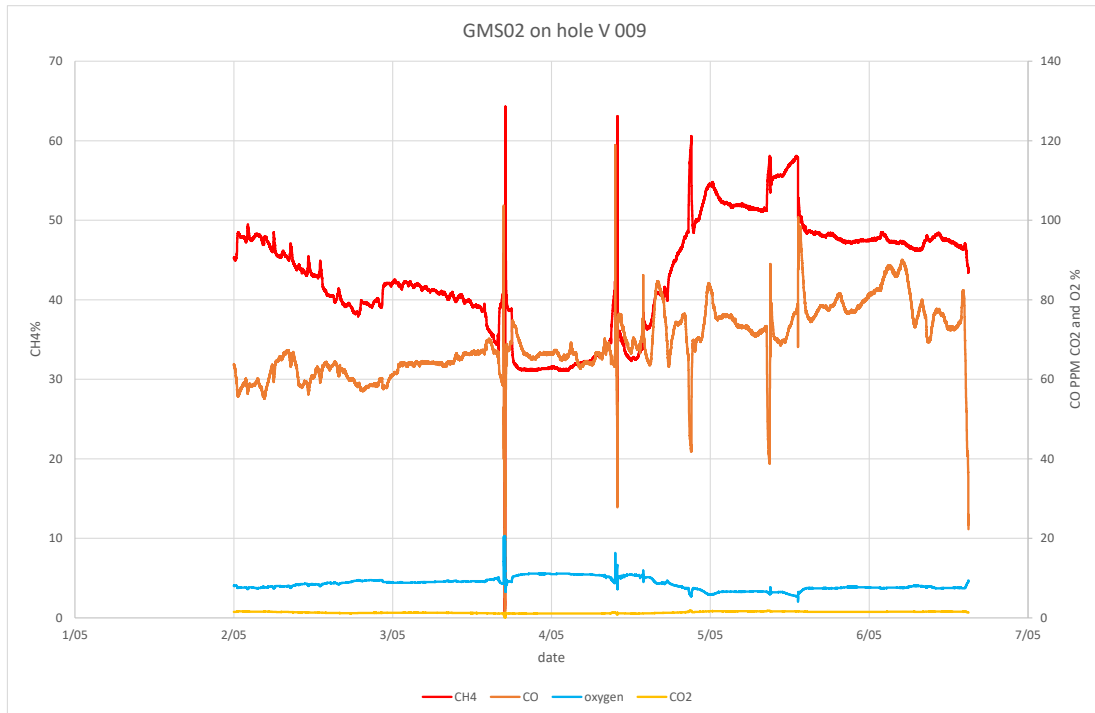


Figure 131: 4-gas data from GRO4V009 from 2 May 2020 to 3:00pm on 6 May 2020

8.147 Goaf well GRO4V009.5 showed increasing concentrations of oxygen and falling levels of methane in the days leading to the explosion. The final sudden rise in oxygen and fall in methane could be related to shutting in the adjacent goaf well GRO4V010 at 3:00am on 6 May 2020:⁹²¹

⁹²⁰ WMA.002.002.0001, .0014.

⁹²¹ WMA.002.002.0001, .0015.

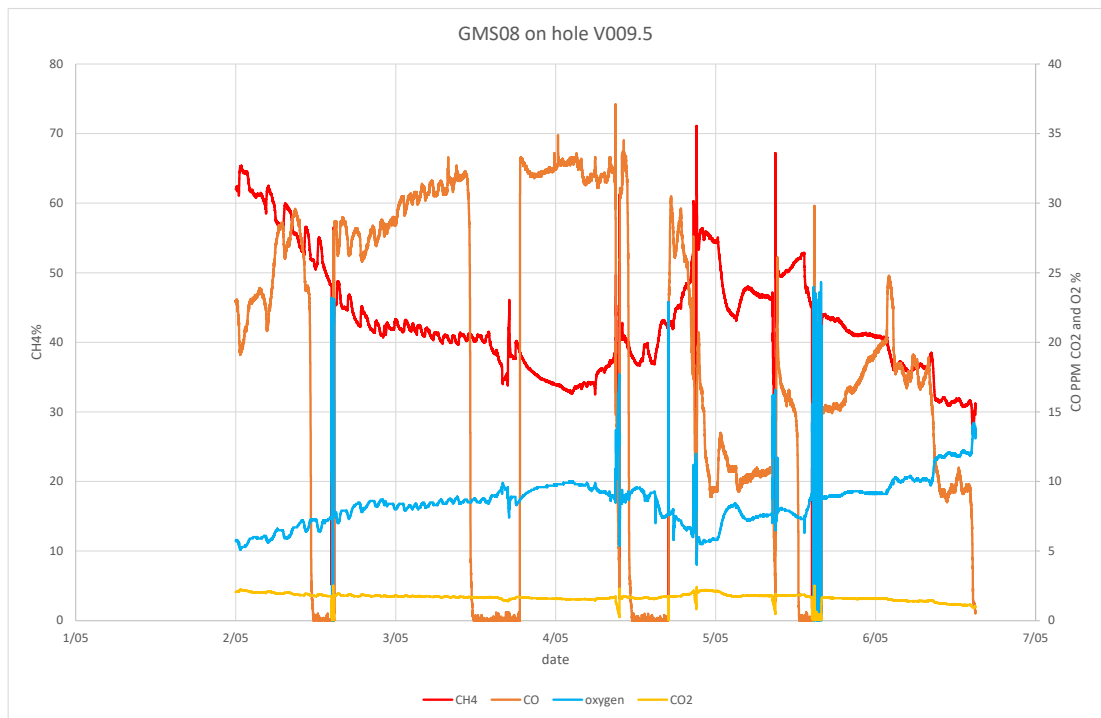


Figure 132: 4-gas data from GRO4V009.5 from 2 May 2020 to 3:00pm on 6 May 2020

8.148 As mentioned earlier, data recorded early on 6 May 2020 from GRO4V010 place an explosive mixture in close proximity to the face.⁹²²

Gas chromatograph data

8.149 The analyses of the bag samples with the gas chromatograph (GC) reveal further information around carbon monoxide concentrations, Graham's Ratio and CO/CO₂ Ratio, as well as the detection of ethylene and higher hydrocarbon gases.

8.150 Grosvenor regularly used an on-site gas chromatograph to undertake analysis of gas from bag samples taken from various locations, including the tube bundles, goaf stream and goaf wells. Figure 133 below describes significant bag sample locations.⁹²³ Mr Muller undertook a review of the GC data.

⁹²² AGM.006.001.0042, .0072.

⁹²³ MSE.001.001.0001, .0013.

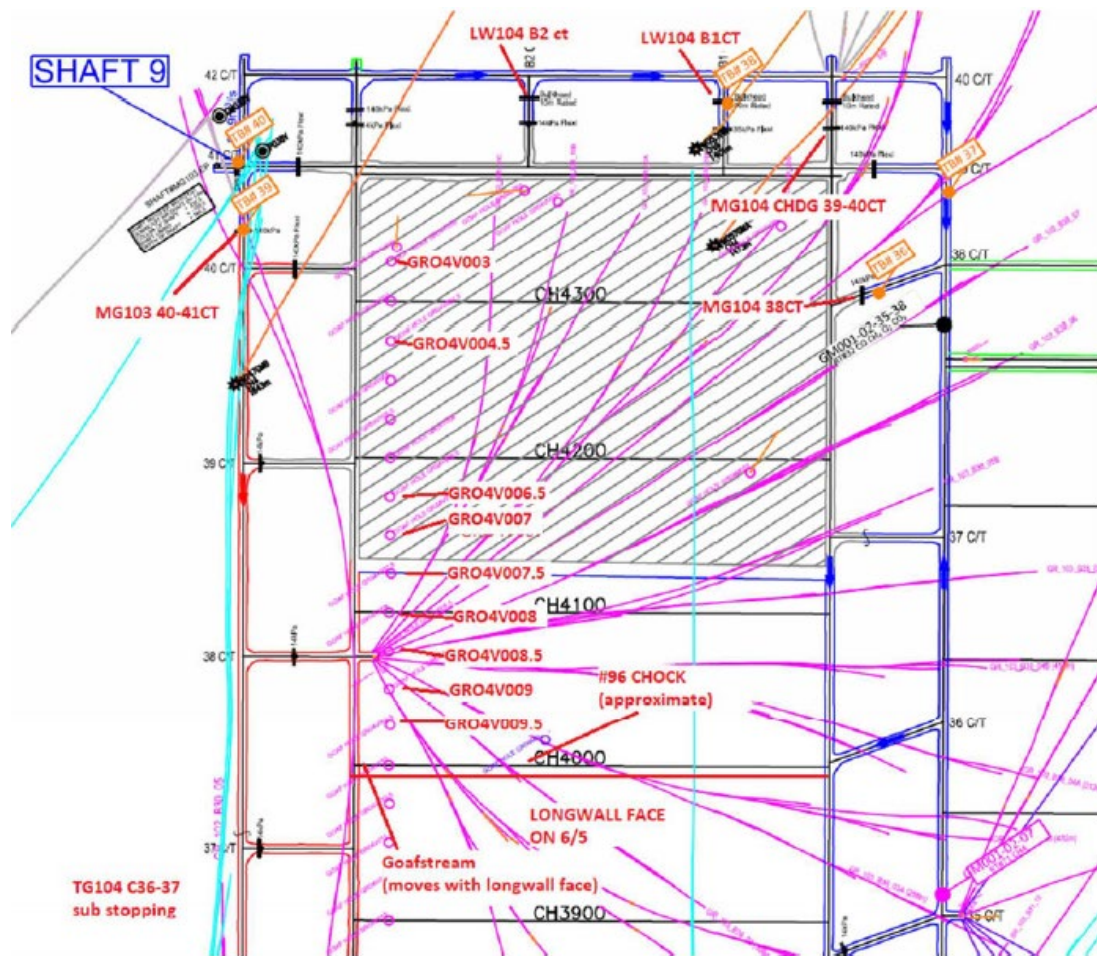


Figure 133: Significant bag sample locations (marked in red)

8.151 A GC is a device that separates and analyses compounds by passing them through a column coated with a substance that causes each of the compounds to elute at a different time (known as retention time), enabling their detection and measurement. The data are generally presented as a graph showing detector response on the vertical axis, whilst retention time is shown on the horizontal (as illustrated in Figure 134 below).⁹²⁴ The area under a peak is used to calculate the concentration of a particular analyte in the original sample.

⁹²⁴ MSE.001.001.0001, .0018.

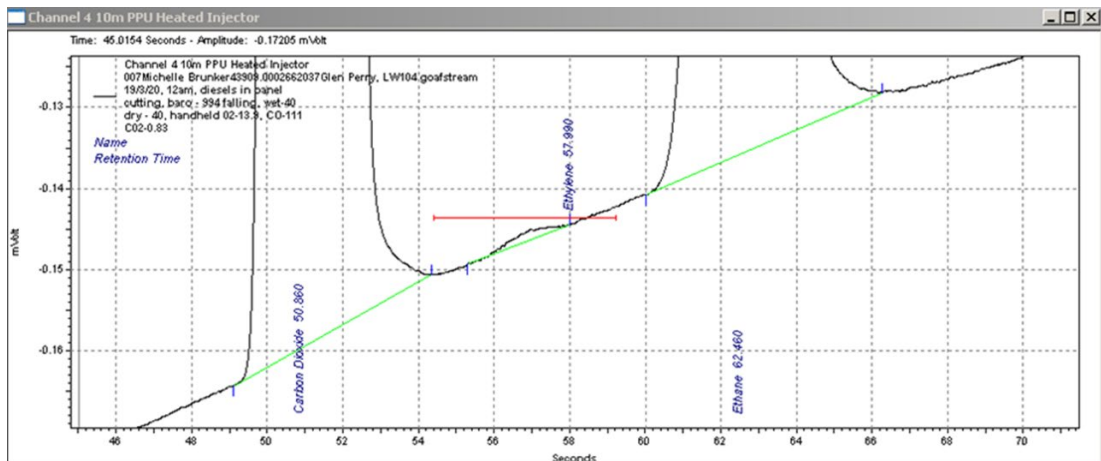


Figure 134: Zoomed-in GC trace from LW 104 goaf stream sample taken 19 March 2020, showing a trace amount of ethylene. CO₂ and ethane were automatically detected.

- 8.152 A GC can detect very small quantities of a wide spectrum of gases, including the four gases detected by the fixed sensors and tube bundles, but also others, including ethylene, which, as noted earlier, is liberated from coal once it has reached a temperature of around 90°C.⁹²⁵ Ethylene is not a seam gas, and not ordinarily present in the mine atmosphere. Its presence is therefore a tell-tale sign of a heating.⁹²⁶
- 8.153 The GC at Grosvenor was configured to automatically detect relevant gases, but at low levels the automatic function did not always result in a detection for a particular analyte, such as ethylene. Identification of the presence of trace amounts of an analyte in the absence of automatic detection was dependent upon the ability of the operator to look closely at the GC trace.⁹²⁷
- 8.154 Trace amounts of ethylene (less than 1 ppm) were regularly detected in samples analysed by the GC at Grosvenor.⁹²⁸ Many of those detections went unnoticed by the GC operator. Whilst Mr Muller accepted that the limit of reporting at SIMTARS for ethylene was 20 ppm, he did not agree with suggestions that sub-1 ppm indications of ethylene on GC traces were not valid, in the sense that ethylene might not in fact be present. Rather, his view was that detections at that level might not accurately reflect the true amount of ethylene present in the sample.⁹²⁹ In any event, the evidence revealed that on some occasions the GC operator at Grosvenor did identify and note sub-1 ppm detections of ethylene.⁹³⁰

⁹²⁵ AGM.014.001.0250, .0271.

⁹²⁶ Cliff, D., Brady, D. & Watkinson, M., *The Green Book – Spontaneous Combustion in Australian Coal Mines* (SIMTARS, 2018), page 183; WMA.003.004.0001, .0185.

⁹²⁷ MSE.001.001.0001, .0018,–.0017.

⁹²⁸ MSE.001.001.0001, .0014.

⁹²⁹ TRA.500.019.0001, .0064, line 5–.0066, line 6.

⁹³⁰ For example, on 3 and 7 April 2020: MSE.001.001.0001, .0014.

8.155 It was also suggested to Mr Muller that the presence of ethylene could be explained by the use of green timber⁹³¹ or an out-of-tune diesel motor in the mine.⁹³² Whilst he agreed that these were possible sources, there was no evidence before the Board suggesting that either of these alternative explanations was applicable to LW 104. In the circumstances, they are most unlikely.⁹³³

LW 104 Goaf Stream

8.156 The GC analyses of the bag samples taken from the goaf stream reveal increasing Graham's Ratio and CO/CO₂ Ratio prior to the serious accident.

8.157 Grosvenor's spontaneous combustion TARP for the active goaf did not have trigger points specific to the goaf stream, rather the zones of interest were the longwall return and the goaf seals.⁹³⁴

8.158 The taking of bag samples from the goaf stream is not a straightforward task, even in ideal conditions. It requires an experienced Deputy to identify the warm goaf stream (usually with an extended hand), confirm that with a hand-held methanometer, and then take the sample, ensuring that what is obtained is the actual goaf stream, undiluted by ventilation air.⁹³⁵

8.159 Shiftly, or twice daily, bag samples were ordinarily taken from the goaf stream. Probably because of the unsafe conditions in the tailgate, a number of samples were not taken in that location between 4 and 6 May 2020. Whilst the failure to take those samples is understandable, it meant that potential evidence of increasing oxidation during that period may have been missed.

8.160 Ethylene was regularly detected at low levels in goaf stream bag samples,⁹³⁶ although its presence frequently went unrecognised by the Grosvenor GC operators, presumably due to the very small peaks which can be difficult for operators to identify.⁹³⁷ It was not present in the samples taken on 3 and 4 May 2020. It may have been present in goaf wells GRO4V009 and GRO4V009.5, but bag samples from those wells were not taken on those dates.

8.161 Mr Muller calculated the 'long-form' Graham's Ratio using the actual measured oxygen/nitrogen ratio from room air. Although the data are patchy because of the missed samples, they reveal an increasing trend from 2 May up to the event on 6 May 2020.⁹³⁸

⁹³¹ TRA.500.019.0001, .0063, line 23–.0064, line 3.

⁹³² TRA.500.019.0001, .0068, lines 10–38.

⁹³³ TRA.500.021.0001, .0064, lines 29–41.

⁹³⁴ AGM.002.001.0463: *GRO-6953-TARP-Active Goaf Spontaneous Combustion*.

⁹³⁵ TRA.500.021.0001, .0032, lines 13–37.

⁹³⁶ Including on 19, 20 & 23 March 2020 and 15, 17, 19 & 21 April 2020: MSE.001.001.0001, .0014–.0016.

⁹³⁷ MSE.001.001.0001, .0018.

⁹³⁸ MSE.001.001.0001, .0063.

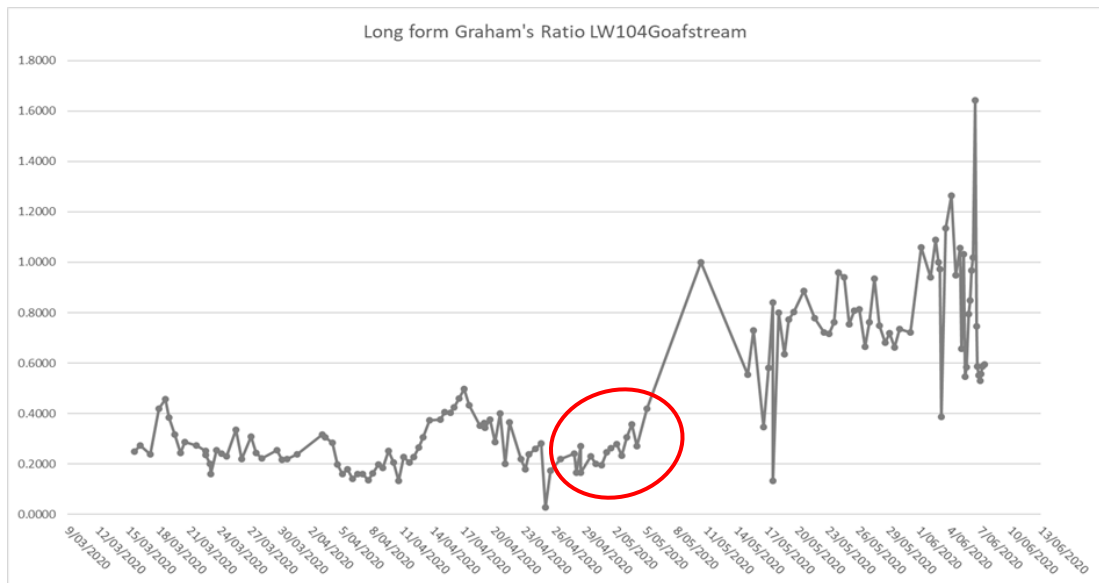


Figure 135: LW 104 goaf stream long-form Graham's Ratio measured using initial O_2/N_2 Ratio from room air

General body tailgate 104, 3–4 cut-through

8.162 This monitoring point is located in the tailgate roadway, but about four kilometres from the face. That distance, coupled with the masking effect of dilution from ventilation air, means that subtle trends were likely to go undetected. No ethylene was detected in this location. The carbon monoxide data show an increase from 5 May 2020 until the methane ignition on 8 June.⁹³⁹

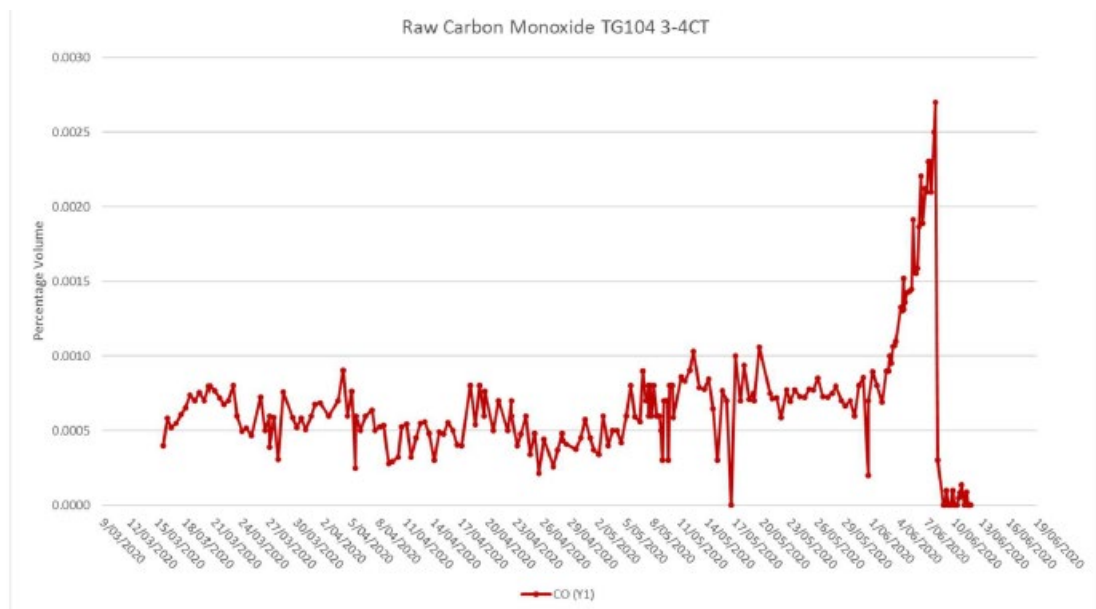


Figure 136: TG 104, 3–4 c/t Raw CO

⁹³⁹ MSE.001.001.0001, .0022.

8.163 Mr Muller also undertook what he called ‘reprocessing’ of the tube bundle data for this monitoring point. To do this he performed the calculation by removing the dilution effect of carbon dioxide emitted from the coal seam. When this is done, subtle indications of a heating appear in the CO/CO₂ Ratio. In particular, Mr Muller considered that the elevated CO/CO₂ Ratio immediately prior to the event of 6 May 2020 showed similarities to that detected up to early June 2020, before the ignition on 8 June.⁹⁴⁰

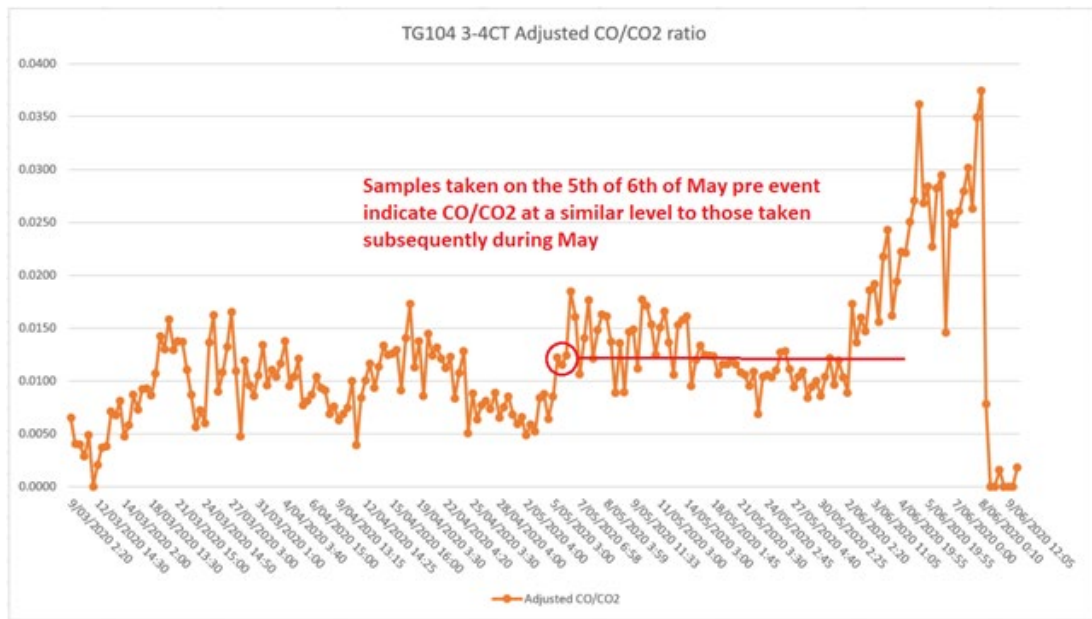


Figure 137: Adjusted CO/CO₂ Ratio for TG 104, 3–4 c/t

⁹⁴⁰ RSH.037.003.0001, .0062.

8.164 A more granular view of the data shows a steady rise in the CO/CO₂ Ratio immediately prior to 6 May 2020:⁹⁴¹

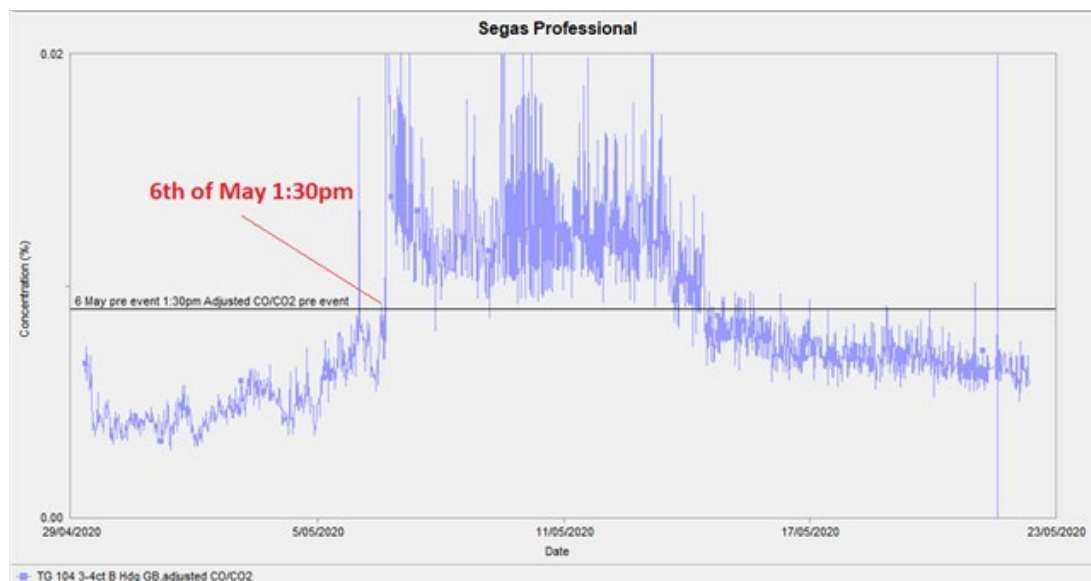


Figure 138: Adjusted CO/CO₂ Ratio at TG 104, 3–4 c/t

Tailgate 104 C heading, 40–41 cut-through

8.165 This goaf seal is located on the tailgate side of the goaf, inbye of the longwall.

8.166 Small ethylene peaks were observed by Mr Muller in the data from 3, 4 and 7 April 2020. Of these, the Grosvenor GC operator observed only those peaks on 3 and 7 April 2020.⁹⁴²

8.167 Whilst Graham’s Ratio was initially as high as 0.4, it declined to unremarkable levels.

Maingate 104, 38 cut-through goaf seal

8.168 This goaf seal is located on the maingate side of the goaf, inbye of the longwall. Ethylene was detected by the Grosvenor GC operator in four bag samples taken from this seal on 22 April 2020. Mr Muller’s review identified the presence of ethylene in a further four bag samples taken on 23 April.⁹⁴³

Goaf wells

8.169 In addition to the tailgate goaf wells in LW 104, there was a well sunk on the maingate side (GRO4M001), and another about two-thirds of the way along the longwall towards the maingate, at about the point of shield #100 at the time of the serious accident (GRO4M001.5).⁹⁴⁴

⁹⁴¹ RSH.037.003.0001, .0062.

⁹⁴² MSE.001.001.0001, .0014.

⁹⁴³ MSE.001.001.0001, .0014.

⁹⁴⁴ See Figure 41, in Chapter 4.

- 8.170 Bag samples taken from the skids on the goaf wells and analysed through the Grosvenor GC revealed that at times the goaf skid real-time sensors were inaccurate. The GC analyses enabled the recalibration by Mr Muller of some of the real-time goaf well data. The recalibrated data demonstrates rises in the methane-free carbon monoxide concentration just prior to the serious accident.
- 8.171 The GC analyses of the bag samples taken from the goaf wells also regularly indicated traces of ethylene.
- 8.172 From samples taken from goaf wells prior to 6 May 2020, Mr Muller identified traces of ethylene below 1 ppm at several of the goaf wells, particularly those closer to the face. This is shown in the following table.⁹⁴⁵ These traces were not identified by the mine's GC operator.

Goaf Well	Date	Time	Ethylene (ppm)
GRO4V003	11 April	2:40am	0.13
	23 April	3:30pm	0.17
GRO4V004.5	2 April	4:05am	0.2
	11 April	3:18pm	0.1
	23 April	3:40pm	0.12
GRO4V007.5	23 April	4:10pm	0.1
	27 April	9:39am	0.14
GRO4V008	2 May	3:10am	0.05
GRO4V008.5	2 May	3:20am	0.11

Figure 139: Ethylene table

- 8.173 Unsurprisingly, there were also GC detections of ethylene at wells GRO4V006.5, GRO4V009 and GRO4V009.5 after the explosion on 6 May 2020.
- 8.174 Bag samples were not taken from GRO4V009 or GRO4V009.5 during the week leading up to the serious accident.⁹⁴⁶
- 8.175 Well GRO4V007 (about 150 metres behind the face on 6 May 2020) showed increased levels of carbon monoxide in mid-April 2020, and also between 4 May and the ignition on 6 May. This was evident from both the raw data and methane-free calculations.⁹⁴⁷

⁹⁴⁵ MSE.001.001.0001, .0014–.0017.

⁹⁴⁶ MSE.001.001.0001, .0008.

⁹⁴⁷ RSH.037.003.0001, .0045. The relevance of the increase in carbon monoxide in mid-April 2020 is discussed in Chapter 9.

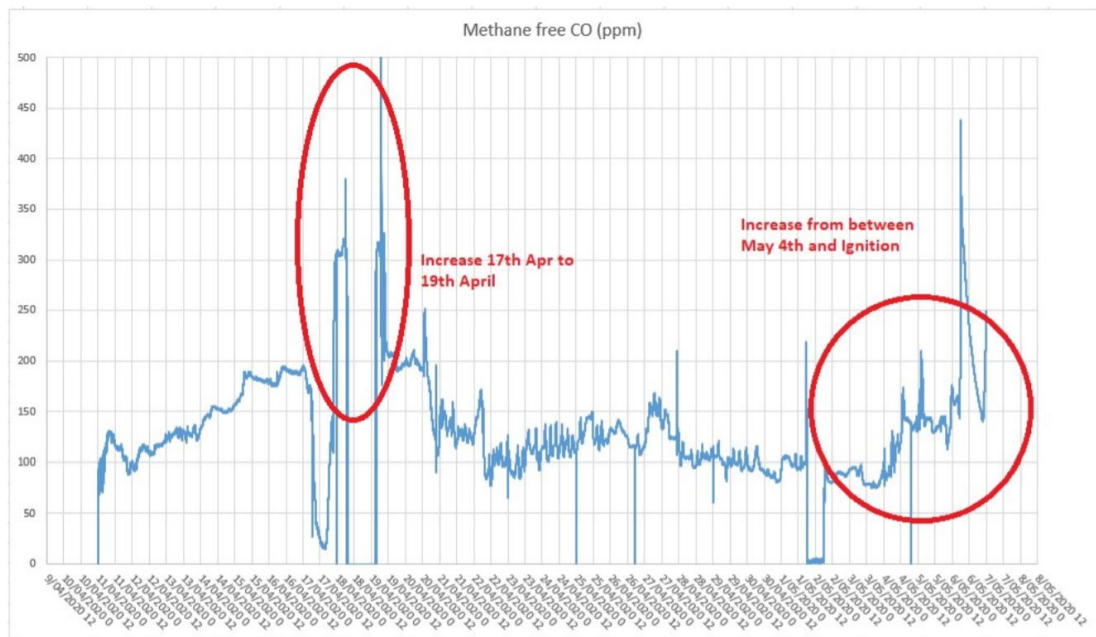


Figure 140: Methane-free CO GRO4V007 from 11 April to 7 May 2020

- 8.176 The increases in carbon monoxide were matched by concurrent increases in Graham's Ratio.⁹⁴⁸
- 8.177 A GC-corrected methane-free carbon monoxide calculation, performed on the real-time data from hole GRO4V008, shows an increase in carbon monoxide commencing on 5 May 2020:⁹⁴⁹

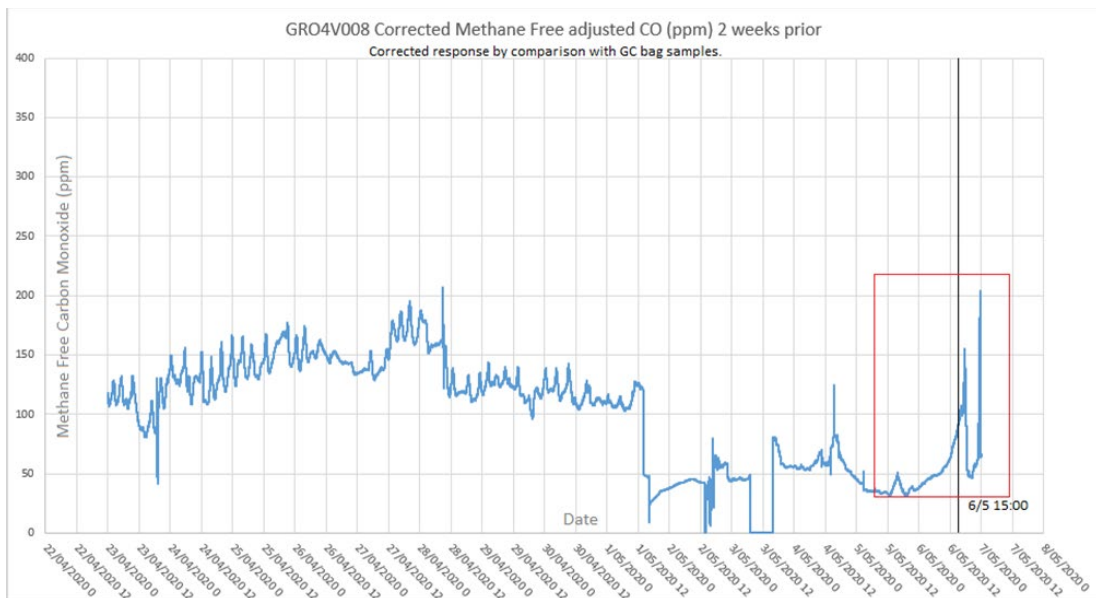


Figure 141: Methane-free CO real-time data, corrected by comparison with GC bag samples GRO4V008, from 23 April to 7 May 2020

⁹⁴⁸ MSE.001.001.0001, .0076.

⁹⁴⁹ RSH.032.002.0001, .0013.

8.178 The carbon monoxide increase is able to be clearly seen when displayed on a graph showing the 48 hours prior to the event:⁹⁵⁰



Figure 142: Carbon monoxide real-time data corrected by comparison with GC bag samples GRO4V008, 48 hours prior to the ignition on 6 May 2020

8.179 A methane-free carbon monoxide calculation for well GRO4V008.5, taken from the real-time data and corrected by comparison with GC data, shows an increase in carbon monoxide that commenced on 4 May 2020:⁹⁵¹

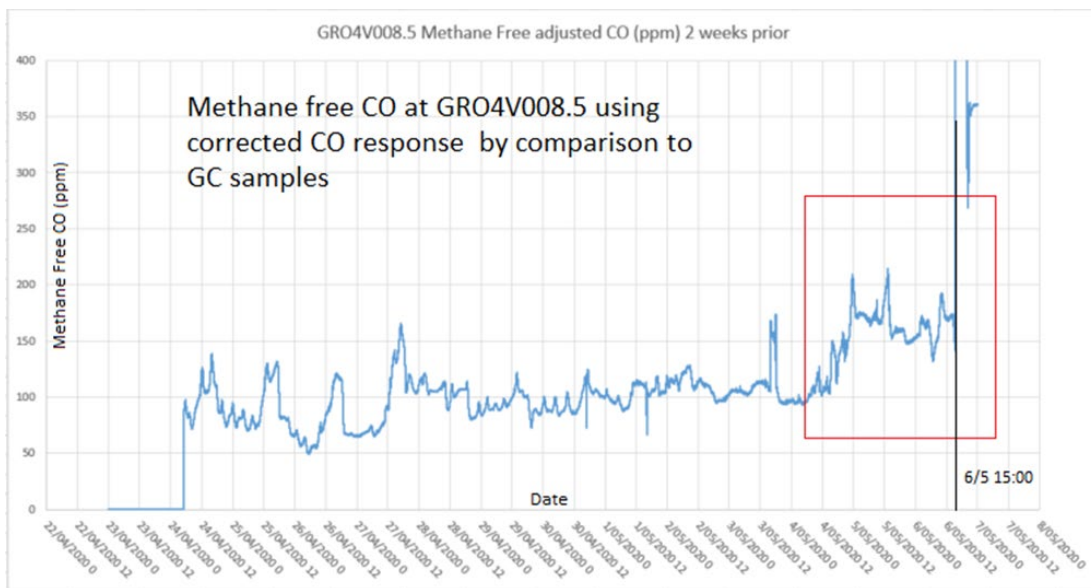


Figure 143: Methane-free CO adjusted for GC at GRO4V008.5

⁹⁵⁰ MSE.001.001.0001, .0079.

⁹⁵¹ RSH.032.002.0001, .0014.

8.180 A methane-free carbon monoxide calculation from well GRO4V009 (about 50 metres behind the shields on 6 May 2020), also reveals an increase commencing on 4 May:⁹⁵²

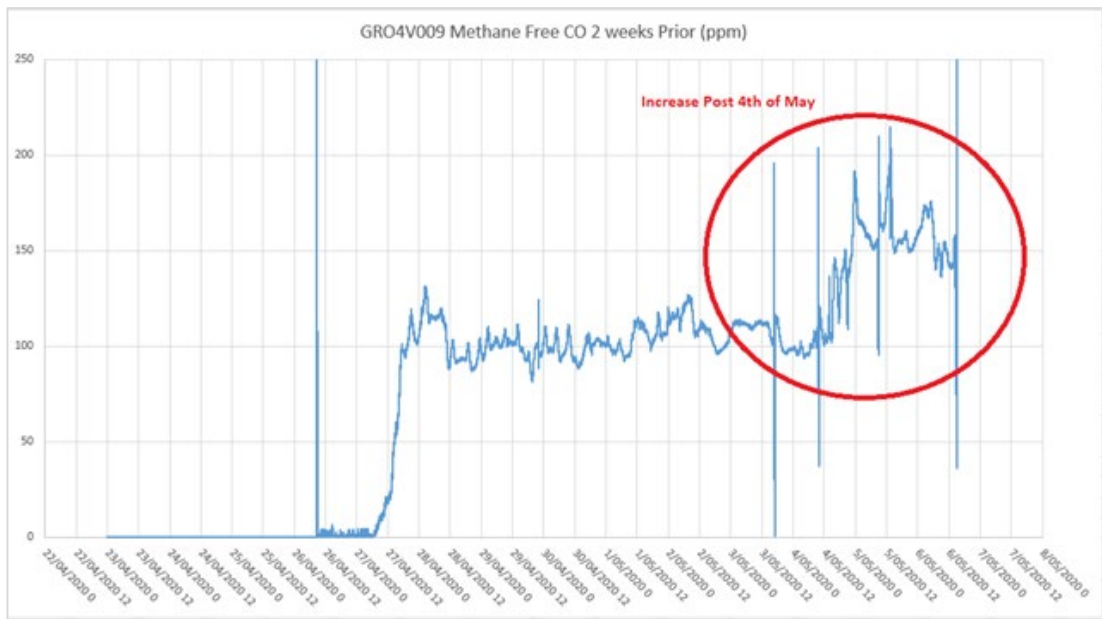


Figure 144: Methane-free CO at GRO4V009, 26 April–7 May 2020

Evidence of methane ignition in the goaf

8.181 The picture at GRO4V009.5 prior to the event shows oxygen concentrations increasing to around 14% prior to the ignition.⁹⁵³

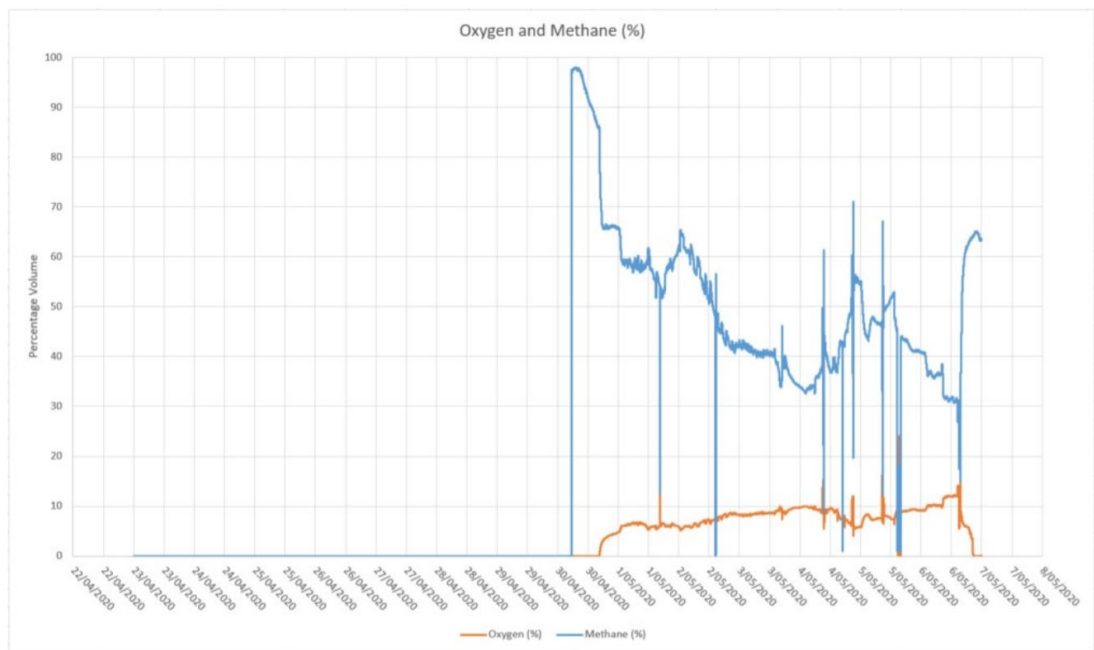


Figure 145: Methane and Oxygen at GRO4V009.5, 30 April to 7 May 2020

⁹⁵² RSH.037.003.0001, .0056.

⁹⁵³ RSH.037.003.0001, .0057.

- 8.182 Quite incidentally, a bag sample was taken from well GRO4V009 at 3:05pm on 6 May 2020, about eight minutes after the ignition. The GC analysis revealed carbon monoxide in excess of 1,000 ppm, as well as other products of combustion such as ethylene and acetylene.
- 8.183 The gas data from GRO4V009.5 were rather different from that from GRO4V009, in that they show a substantially lower amount of carbon monoxide (approximately 30 ppm)⁹⁵⁴ and off-scale concentrations of carbon dioxide.⁹⁵⁵ This is consistent with gas products associated with an efficient combustion of methane at well GRO4V009.5.
- 8.184 The gas data from GRO4V009 show high concentrations of carbon monoxide, which is indicative of a less efficient (fuel rich) combustion. The bag sample results from this well include ethylene and acetylene, consistent with the combustion of coal dust.
- 8.185 As previously explained, there was an explosive mixture measured at GRO4V010 early in the morning on 6 May 2020. This demonstrates the presence of an explosive mixture in the vicinity of goaf well GRO4V009.5.
- 8.186 The picture presented by the data from goaf wells GRO4V009 and GRO4V009.5 clearly shows the combustion of methane at a point that was at least 30 to 55 metres behind the longwall shields.
- 8.187 Observing all of the goaf well data, it is clear that there was a widespread change in the composition of the atmosphere within the goaf, on the tailgate side, following the serious accident. This evidence demonstrates that there was an ignition of methane within the goaf but, by itself, does not identify whether it was associated with the first or second pressure wave.

Discussion

- 8.188 An issue arises about the validity of the test results for ethylene. In submissions filed on its behalf, Anglo contended that the results should be disregarded because they were below SIMTARS' own limits of detection and reporting for that analyte, which are respectively 1 ppm and 20 ppm.⁹⁵⁶
- 8.189 However, Mr Muller's evidence was that the identification of ethylene below the limit of detection did not mean that ethylene was not present. Rather, he said, it meant that quantification of the amount of ethylene became difficult at such low levels. He went on to say that the GC at Grosvenor had been 'validated to the same specifications as all of our GCs in terms of the limit of detection at 1 ppm'.⁹⁵⁷
- 8.190 He also said that 20 ppm was a figure that was 'far in excess of what the capability is of the instrument'.⁹⁵⁸

⁹⁵⁴ MSE.001.001.0001, .0045–.0046.

⁹⁵⁵ AGM.006.001.0042, .0074.

⁹⁵⁶ AGM.999.013.0001, .0004.

⁹⁵⁷ TRA.500.019.0001, .0007, line 16–.0008, line 45.

⁹⁵⁸ TRA.500.019.0001, .0065, lines 7–8.

- 8.191 In its submission, Anglo asserted that ‘no weight could conceivably be given to the propositions that...these were in fact detections of sub ppm amounts of ethylene’⁹⁵⁹ and that ‘to place any weight on so-called ethylene spikes at a sub-ppm level in those circumstances would be unfair and dangerous’.⁹⁶⁰
- 8.192 The Board notes, however, that not only did the Grosvenor GC operator actually detect and record the presence of sub-1 ppm amounts of ethylene on 3, 6, 7 and 22 April 2020, as well as after the ignition on 6 May,⁹⁶¹ but the Grosvenor active goaf spontaneous combustion TARP specifically sets the ‘Level 1’ trigger for goaf seals as being ‘Ethylene detected and less than 1ppm’.⁹⁶²
- 8.193 Anglo’s position as to the utility of detections of trace amounts of ethylene is inconsistent with the mine’s own TARP triggers and cannot be accepted.
- 8.194 There is no plausible explanation for the small amounts of ethylene other than it being emitted by coal at an elevated temperature. A conclusion that there was a heating, or more than one heating event, is supported by the evidence showing periodic increases in carbon monoxide at goaf seals and in the goaf wells.
- 8.195 The overall picture provided by the gas data is of at least one, and potentially more than one, heating events in the LW 104 goaf. These events may well have been small in size, which explains why the mine’s gas monitoring methods did not detect large scale changes in the atmosphere. The changes in some parameters were subtle, however others are quite pronounced. In particular, the carbon monoxide data for wells GRO4M001.5, GRO4V007, GRO4V008, and GRO4V009 show step-change increases in the lead up to the ignition.
- 8.196 The goaf stream samples did not show clear signs of a heating in the days immediately preceding the ignition. However, several of the goaf stream samples are absent as dangerous roof conditions in the tailgate prevented them from being taken. Moreover, it would be possible for gas indicators of spontaneous combustion to be drawn into the goaf wells and not report to the goaf stream.
- 8.197 In the Board’s view, the cumulative effect of the evidence of repeated detections of indicators of spontaneous combustion renders it likely that coal self-heating was occurring in the LW 104 goaf. Whilst not all of those indicators were present simultaneously, the following table sets them out:

⁹⁵⁹ AGM.999.013.0001, .0004.

⁹⁶⁰ AGM.999.013.0001, .0046.

⁹⁶¹ MSE.001.001.0001, .0014–.0017.

⁹⁶² AGM.002.001.0814: *GRO-6953-TARP-Active Goaf Spontaneous Combustion*.

Location	Ethylene	Elevated CO	O ₂ > 5% (goaf wells only)	Elevated O ₂ (goaf seals only)	Elevated GR	Elevated CO/CO ₂ Ratio
3-4 c/t		●			●	●
38 c/t	●	●		●●	●	
B1 c/t				●●	●	
40-41 c/t	●	●●		●●●	●●	
Goaf Stream	●●				●	●
GRO4V010			●			
GRO4V009.5			●			
GRO4V009		●	●			
GRO4V008.5	●	●	●			
GRO4V008	●●	●				
GRO4V007.5	●					
GRO4V007		●●				
GRO4V006.5		●	●		●	
GRO4V004.5	●					
GRO4V003	●					
GRO4M001.5		●				

Figure 146: Detections of indicators of spontaneous combustion on LW 104 between March 2020 and 6 May 2020 (March in grey, April in green, May in red)

8.198 The Board’s conclusion about the occurrence of a heating is consistent with mine management’s own concerns about the potential consequences of oxygen ingress into the goaf from increased goaf drainage, as well as the failure to undertake a risk assessment for spontaneous combustion.

Relative likelihood that the first pressure wave was a result of strata fall or methane ignition

8.199 There is no direct evidence that the first pressure wave was a result of a strata collapse in the goaf. In light of the estimated height of the spanning unit, at least 32 metres above the roof line, and the associated effect of bulking factors, the Board considers it is unlikely that a strata collapse caused the first pressure wave.

8.200 The lack of precedent for such an event in the long history of mining the GM seam also militates against this cause.

- 8.201 Given the expulsion of goaf gases onto the longwall face that would result from a wind blast from a strata failure, the Board considers it unlikely that an increased concentration of methane would be detected only at the tailgate drive and the #149 shield sensors, and not at the inbye or outbye sensors in the tailgate return.
- 8.202 On the other hand, the detection of methane by those two sensors on the longwall face (but not by the inbye or outbye sensors in the tailgate return) can be explained by a methane ignition in the goaf.
- 8.203 Mr Munday gave evidence that the absence of a flame front associated with the first pressure wave did not necessarily mean that the first pressure wave resulted from a strata collapse rather than a methane explosion. He explained that if a methane explosion occurred sufficiently far back in the goaf, the available methane in the area of ignition could be consumed such that the flame front did not continue beyond the goaf. Alternatively, any flame front could become so dissipated through the fractured rock that it was not visible to workers on the longwall.⁹⁶³ However, the pressure wave will continue beyond the point at which the flame front has ceased because the combustion products will continue to expand and generate pressure on the air.⁹⁶⁴
- 8.204 Accordingly, a methane ignition in the goaf, with combustion of the available methane at a point prior to the inbye sensor in the tailgate return, would explain why methane was only detected on the sensors which were located close to the goaf, but not those more distant from it.
- 8.205 An examination of the data from the real-time sensor at 3–4 cut-through LW 104 tailgate return airway on the afternoon of 6 May 2020 shows no appreciable increase in methane. Methane concentrations remain virtually unchanged from around 1.08% at 2:57pm before slowly climbing to 1.34% around 3:40pm. However, there is a steady rise in carbon dioxide over this same time period with a three-fold increase from 0.14% up to 0.42%. Carbon monoxide also climbs from 6 ppm at 2:57pm to over 20 ppm by 3:20pm, after which time the sensor appears to be reading carbon monoxide in error. At the same time, GRO4V009.5 was reading carbon dioxide concentrations 'off scale', i.e., in excess of 5%. This evidence does not support the hypothesis of a wind blast from strata failure. That mechanism would necessarily involve the expulsion of large volumes of goaf gas, particularly methane, into the longwall face area and longwall return. However, the evidence does suggest that the 3–4 cut-through LW 104 tailgate return airway sensor detected products of combustion associated with a methane ignition.
- 8.206 The absence of significant methane readings on the inbye or outbye sensors is explicable by the behaviour of methane explosions, as explained by Mr Munday.

⁹⁶³ TRA.500.025.0001, .0019, lines 15-25.

⁹⁶⁴ TRA.500.025.0001, .0023, lines 29-33.

A methane explosion in the goaf would not necessarily result in elevated methane readings on those sensors, as a strata collapse would be expected to, because a methane explosion necessarily involves the combustion, rather than the displacement, of methane.

- 8.207 The gas data reviewed in this chapter supports the conclusion that there was a heating in the goaf in the lead up to 6 May 2020.
- 8.208 In the circumstances, the Board considers that the probable cause of the first pressure wave was an explosion in the goaf caused by spontaneous combustion.

Findings

Finding 68

The probable cause of the first pressure wave was a methane explosion in the goaf, initiated by spontaneous combustion.

Finding 69

The combination of circumstances which supports this conclusion are:

- a. The magnitude of the pressure wave permits of only two explanations: a methane explosion or strata fall in the goaf;
- b. For the reasons expressed above, a strata fall in the goaf is an unlikely explanation;
- c. There was an explosible mixture of methane and air in the goaf on 6 May 2020, potentially as far back as 30 metres behind the tailgate shields;
- d. Throughout much of the operation of longwall 104, and in particular in the period leading up to 6 May 2020, undesirably high concentrations of oxygen were present in the goaf;
- e. There were increases in carbon monoxide concentrations, Graham's Ratio and CO/CO₂ Ratio, as well as traces of ethylene and higher hydrocarbon gases in the goaf, in the lead up to 6 May 2020. This is evidence of a heating in the goaf having reached at least 100°C, the point beyond which thermal runaway to a temperature sufficient to ignite an explosible mixture of methane and air is possible;
- f. The combination of the explosible mixture of methane and air, and a heating beyond the point of thermal runaway, can result in a methane explosion;
- g. The reporting of products of combustion to many of the goaf wells indicates that, at the time of the serious accident, there was an explosion of methane in the goaf; and
- h. After the serious accident, methane was detected on the shield #149 sensor but not on the two sensors in the tailgate roadway. If a strata fall of the magnitude required to produce the first pressure wave occurred, methane would have been expelled into the tailgate roadway. That methane was not detected at those sensors is consistent with the mechanism of a methane explosion being the cause of the first pressure wave.

Recommendation

Recommendation 12

Coal mines implement a management practice for oxygen concentrations at goaf drainage wells to be maintained at no greater than 5%, and less if necessary, depending on site-specific conditions.

Chapter 9 – The nature and cause of the serious accident: the second pressure wave

Introduction

- 9.1 The workers' descriptions of the serious accident consistently associated the second pressure event with the flame front that caused their injuries.⁹⁶⁵ Those descriptions clearly point to a methane explosion at, or propagating onto, the longwall face. Mr Munday also gave evidence that the second pressure wave and associate flame front had all the characteristics of a methane deflagration.⁹⁶⁶
- 9.2 That being so, it is self-evident that an explosible mixture of methane was present at the point of ignition. The real issue is determining the ignition source for the explosion that caused the pressure wave.
- 9.3 This chapter considers that issue. As will become apparent, the Board considers that the probable ignition source for the methane deflagration on the longwall face was the PUR-initiated heating of coal to thermal runaway, which ignited an explosible atmosphere behind the longwall in the vicinity of shield #111, resulting in a flame propagating onto the longwall face.

The origin of the ignition and direction of travel of the flame front

- 9.4 Mr Murray Nystrom, a fire and explosion scene investigator, was engaged to conduct an explosion scene investigation at Grosvenor mine (Grosvenor).⁹⁶⁷
- 9.5 On 8 May 2020, he attended at the mine and examined a number of items of clothing and personal equipment which belonged to the injured coal mine workers.⁹⁶⁸
- 9.6 He observed that the clothing and other pieces of personal equipment, such as belts, were singed or otherwise partially combusted.⁹⁶⁹ The degree of fire damage suggested that the items were not exposed to 'a prolonged level of fire growth'.⁹⁷⁰ The extent of fire damage was not consistent across all of the items. The items with less damage than others were either exposed to 'a lower temperature or less time or a combination of both'.⁹⁷¹
- 9.7 As a result of these examinations, he concluded that there was a momentary flame front which passed along the longwall face and that the temperature of the flame front would have been between 200°C and several hundred degrees Celsius.⁹⁷²

⁹⁶⁵ BOI.039.002.0001, .0001–.0015.

⁹⁶⁶ TRA.500.025.0001, .0021, line 43–.0022, line 7.

⁹⁶⁷ TRA.500.016.0001, .0041, lines 25–30.

⁹⁶⁸ TRA.500.016.0001, .0041, lines 32–41.

⁹⁶⁹ TRA.500.016.0001, .0043, line 32.

⁹⁷⁰ TRA.500.016.0001, .0044, lines 4–7.

⁹⁷¹ TRA.500.016.0001, .0045, lines 26–29.

⁹⁷² TRA.500.016.0001, .0042, lines 19–29.

- 9.8 On 10 May 2020, Mr Nystrom attended the longwall face and conducted an examination of the scene.⁹⁷³
- 9.9 From the maingate, he did not observe any obvious fire damage until shield #100.⁹⁷⁴ Between shield #100 and shield #110, the observable burn patterns were consistent with a direction of travel of the flame front from the tailgate end of the longwall.⁹⁷⁵ There was an evident increase in fire damage intensity from shield #100 to shield #110.
- 9.10 The fire damage he observed at shield #111 appeared consistent with the flame front originating at that shield.⁹⁷⁶
- 9.11 Between shield #111 and the tailgate, the burn patterns were consistent with the direction of travel of the flame front being from the maingate end of the longwall.⁹⁷⁷
- 9.12 Ultimately, he concluded that the flame front which passed along the longwall face probably originated from, or entered the longwall face at, or in the vicinity of, shield #111.⁹⁷⁸ From there, the flame front travelled in two directions – towards the maingate and towards the tailgate.
- 9.13 As outlined above, there was generally an increase in fire damage intensity between shields #100 and #110. There was also generally a decrease away from shield #111 and towards the tailgate. Despite these overall burn patterns, Mr Nystrom also observed there were localised areas of more intense damage at certain places, including in the vicinity of shield #133.⁹⁷⁹
- 9.14 The Board notes that this is consistent with the significant burn injuries suffered by Mr Wayne Sellars and Injured Coal Mine Workers 2 and 3, all of whom were located at or near shield #133 at the time of the serious accident.
- 9.15 Mr Nystrom gave evidence that localised pockets of fire intensity is a feature he has seen in many of the investigations he has undertaken.⁹⁸⁰ They can result from more intense concentrations of the flammable mixture in the atmosphere at that location, turbulence at that location, or an increase in the actual amount of gas in that area.⁹⁸¹ The presence of areas of localised intense damage were not inconsistent with his conclusion that it is likely the flame front originated at or near shield #111.⁹⁸²

⁹⁷³ TRA.500.016.0001, .0041, lines 43–47.

⁹⁷⁴ TRA.500.016.0001, .0047, line 45–.0048, line 2.

⁹⁷⁵ TRA.500.016.0001, .0048, line 24–.0051, line 16.

⁹⁷⁶ TRA.500.016.0001, .0051, lines 1–32.

⁹⁷⁷ TRA.500.016.0001, .0051, line 34–.0056, line 40.

⁹⁷⁸ TRA.500.016.0001, .0048, lines 4–9.

⁹⁷⁹ TRA.500.016.0001, .0053, lines 17–33.

⁹⁸⁰ TRA.500.016.0001, .0053, lines 43–45.

⁹⁸¹ TRA.500.016.0001, .0053, line 40–.0054, line 9.

⁹⁸² TRA.500.016.0001, .0054, lines 11–15.

- 9.16 Mr Nystrom said that, although he concluded that the flame front originated from the vicinity of shield #111, he was not in a position to say whether the flame front originated within the shield itself or from a position behind that shield in the goaf.⁹⁸³
- 9.17 Mr James Munday, a forensic fire and explosion investigator, was engaged by the Board to provide an opinion on the ignition at Grosvenor. Mr Munday reviewed Mr Nystrom's report of his examination and found it to be 'thorough and well-reasoned'.⁹⁸⁴
- 9.18 The evidence of both Mr Nystrom and Mr Munday was that, beyond shield #100, towards the maingate, there was not enough fuel in the air for the flame front to continue to propagate. The associated pressure wave moving in front of it, though, would have continued for some distance. Mr Munday's evidence was that the pressure wave could have been felt by the workers quite some distance from the longwall, even after the flame front dissipated. This is consistent with the accounts of coal mine workers' located considerable distances from the face.

Possible ignition sources for the methane explosion which caused the second pressure wave

- 9.19 This section considers the potential ignition sources for the methane explosion.

Lightning

- 9.20 It would be theoretically possible for there to be an ignition in the goaf if there was storm activity, particularly lightning, in the area. The mechanism by which a lightning strike could cause an ignition within the mine is through electrical energy being conducted into the underground workings by steel pipes or other conductors joining the surface with the underground workings.
- 9.21 However, data from the Bureau of Meteorology and Weatherzone indicate there was no rain or storm activity near Grosvenor on 6 May 2020.⁹⁸⁵
- 9.22 Accordingly, lightning was not a realistic ignition source.

Frictional ignition from a rock fall

- 9.23 On 6 May 2020, there was a cavity in the tailgate area. Workers reported rocks falling from the cavity throughout the day and shortly before the serious accident. Frictional ignition from rock on rock, or rock on steel, can be an ignition source, but for the reasons that follow the Board considers the possibility of frictional ignition as a result of strata collapse is low.

⁹⁸³ TRA.500.016.0001, .0056, line 42–.0057, line 5.

⁹⁸⁴ JMU.001.001.0001, .0013.

⁹⁸⁵ AGM.008.001.0011; AGM.008.002.0002, .0002–.0009.

- 9.24 Dr Ray Low of the University of Queensland’s materials engineering consultancy, ‘Materials Performance’, was engaged to conduct a literature review into ‘the plausibility of mechanical interactions causing the Grosvenor mine explosion’ (Dr Low’s review).⁹⁸⁶
- 9.25 Dr Low found numerous past instances of ignitions caused by hand tools or coal cutting machinery hitting rock, but that ‘explosions caused by rock on rock interactions from falls in the goaf [were] rare (or [had] been rarely identified)’.⁹⁸⁷ Explosions caused by the phenomenon of rock falls had not been reported in Australia, although there were various reports of it having occurred overseas.⁹⁸⁸
- 9.26 The review identified past experimental studies conducted into the potential for ignition of methane from rock on rock and rock on steel frictional interactions. Those studies indicated the possibility of achieving ignition in specified conditions of sliding or impact friction.⁹⁸⁹ However, in both categories of experiment, the key factor influencing incendivity of such interactions was the rock composition.⁹⁹⁰
- 9.27 Through the work of Ward *et al.* from the University of New South Wales (NSW),⁹⁹¹ a five point ignition categorisation (IGCAT) system for rocks is in place in Australia, and is used as a measure of incendivity. Ward *et al.* explained the classification scale as follows:⁹⁹²

A high ignition category (4–5) from this program indicates a relatively high potential for frictional ignition; a low value (1–2) indicates a significant degree of difficulty in obtaining frictional ignition under the test conditions.

- 9.28 The authors further explained that the classification is based upon the proportion in which several minerals are present.⁹⁹³

Both lithic and quartzose sandstones may display quite high incendivity characteristics, and quartz content from point counting is commonly misleading as an indicator of ignition category. As discussed above, ignition potential appears to be related to the overall proportion of quartz, feldspar and rock fragments as framework grains. The IGCAT value is lower if high proportions of clay matrix are present, and lower still with high proportions of carbonate cementing minerals.

⁹⁸⁶ LOW.001.001.0001.

⁹⁸⁷ LOW.001.001.0001, .0022.

⁹⁸⁸ LOW.001.001.0001, .0026.

⁹⁸⁹ LOW.001.001.0001, .0012–.0021.

⁹⁹⁰ LOW.001.001.0001, .0014; .0021.

⁹⁹¹ See Ward, C., Crouch, A. & Cohen, D., *Identification of potential for methane ignition by rock friction in Australian coal mines* (2001) International Journal of Coal Geology volume 45, pages 91–103.

⁹⁹² *Ibid.* page 96.

⁹⁹³ *Ibid.* page 101.

9.29 Geochempet Services Pty Ltd (Geochempet) operates as a petrographic, geological and geochemical consultancy. As part of the Inspectorate's investigation, drill core samples from two boreholes at Grosvenor mine were supplied to Geochempet for petrographic examination. The object was to determine the incendive sparking potential of the samples in accordance with the methods and classification developed by Ward *et al.*

9.30 Nine samples were tested from borehole DDG 214, and seven from borehole DDG 295. DDG 214 is located adjacent to the mined area of LW 104, while DDG 295 is located within it. The same method was followed for each sample, as described in the following extract from the report relating to the first sample:⁹⁹⁴

A thin section was prepared from the drill core sample to permit detailed mineralogical counting using transmitted polarised light microscopy.

An approximate composition was determined, expressed in volume percent and based on identification and counting of the microscopically observed components at each of 100 widely spaced observation points within the thin section.

The results were then recalculated to yield the necessary parameters;

Quartz + rock fragments + feldspar + pyrite,

Clay matrix cement + mica + clay pellets, and

Carbonate but no organics

for comparison with a triangular classification diagram supplied by C. R. Ward from the University of NSW. Based on the calculated parameters, each sample was then assigned an appropriate IGCAT value (a measure of perceived incendive sparking potential) as designated by zones within Ward's triangular diagram (Fig. 3). Ward's ternary diagram defines five IGCAT zones, with Zone 1 corresponding with the lowest incendive potential and Zone 5 corresponding with the highest potential.

9.31 It was concluded that this sample 'has an IGCAT value that places it within Zone 1 (the lowest frictional ignition risk category)'.⁹⁹⁵

⁹⁹⁴ GEO.001.001.0001, .0003. Sample number DDG214-FI101.

⁹⁹⁵ GEO.001.001.0001, .0003.

9.32 The results of testing of all sixteen samples are set out below in tabulated form:

BOREHOLE DDG 214				
SAMPLE #	DEPTH	Q CONTENT	ZONE	DOCUMENT ID
1	387.04–387.24m	7.8	1	GEO.001.001.0001
2	376.92–377.33m	24.5	1	GEO.001.002.0001
3	364.10–364.37m	12.4	1	GEO.001.003.0001
4	359.00–359.45m	60.6	2	GEO.001.004.0001
5	357.80–358.07m	47.0	1	GEO.001.005.0001
6	355.15–355.57m	72.0	3	GEO.001.006.0001
7	354.12–354.47m	65.0	2	GEO.001.007.0001
8	344.98–345.32m	37.0	1	GEO.001.008.0001
8*	341.62–342.05m	70.0	3	GEO.001.009.0001

* Likely mislabelled as Sample 8 in report, should be Sample 9.

Figure 147: Borehole DDG 214

BOREHOLE DDG 295				
SAMPLE #	DEPTH	Q CONTENT	ZONE	DOCUMENT ID
1	427.35–427.72m	47.0	2	GEO.001.010.0001
2	383.74–384.00m	24.2	1	GEO.001.011.0001
3	379.63–379.80m	39.0	1	GEO.001.012.0001
4	367.97–368.15m	32.0	1	GEO.001.013.0001
5	350.60–350.92m	70.7	3	GEO.001.014.0001
6	345.60–345.95m	46.0	1	GEO.001.015.0001
7	341.27–341.59m	67.0	3	GEO.001.016.0001

Figure 148: Borehole DDG 295

9.33 Longwall 104 (LW 104) was mining the Goonyella Middle (GM) seam at a depth of 390 metres. The seam thickness was approximately 5.7 metres⁹⁹⁶ and was being cut at a height of 4.2 metres. It can be seen from the table for DDG 214 (by reference to samples 1–5) that at a depth of between 357 and 387 metres, the rock was of low incensive quality. This corresponds to a 30 metre interval above the GM seam. Above that, between 341 and 345 metres (samples 6–9) there was a mix of low to mid-range incensive quality rock.

⁹⁹⁶ AGM.002.001.0019, .0030: GRO-10684-SOP-LW104 Second Workings. This was the height at 4,000 metre chainage at LW 104.

- 9.34 It can be seen from the table that for DDG 295 (samples 2–4), at a depth of between 367 and 384 metres, the rock was of low incendive quality. This corresponds to a 20 metre interval above the GM seam. Above that, between 341 and 350 metres (samples 5–7) the rock was a mix of low to mid-range incendive quality.
- 9.35 These results are consistent with the mine’s own testing, also conducted by Geochempet, of the incendivity of samples of rock from a number of different boreholes. The test data, set out below, appear in the mine’s hazard management plan (HMP) for the control of frictional ignition under the heading ‘Grosvenor Mine Incendive Potential’.⁹⁹⁷

Samples have been given an IGCAT classification (1 represents the lowest potential, 5 the highest), identifying their inherent incendive potential:

- *Sample GSC0049A_FP001 at 360.7–361.05m. has an IGCAT value that places it within Zone 1*
- *Sample GSC0049A_FP002 at 361.24-361.44m has an IGCAT value that places it within Zone 1*
- *Sample GSC0049A_FP003 at 361.64-361.84m has an IGCAT value that places it within Zone 2*
- *Sample GSC0052A_FP001 at 374.40-374.69m has an IGCAT value that places it within Zone 1*
- *Sample GSC0052A_FP002 at 374.83-374.95m has an IGCAT value that places it within Zone 1*
- *Sample GSC0052A_FP003 at 375.27-375.39m has an IGCAT value that places it within Zone 2*

- 9.36 SIMTARS was provided with the geological data review from Geochempet services, Dr Low’s review, and other material. It concluded that:⁹⁹⁸

Based on the review of the information provided and other related sources reviewed, the potential for a frictional ignition exists although the probability of such an event occurring is low.

- 9.37 Grosvenor’s own risk assessments and process documents at the time of the accident did not rank frictional ignition from a rock fall as a risk to be managed.

- 9.38 For example, a management plan for the control of frictional ignition, was in place at the mine.⁹⁹⁹ It states that frictional ignition was identified as a Priority Unwanted Event with the potential to cause a fatality. Accordingly, a bowtie analysis had been conducted leading to the development of critical controls.¹⁰⁰⁰

⁹⁹⁷ RSH.001.021.0001, .0004: HMP–Control Frictional Ignition.

⁹⁹⁸ RSH.999.006.0001, .0018.

⁹⁹⁹ RSH.001.021.0001: HMP–Control Frictional Ignition.

¹⁰⁰⁰ RSH.001.021.0001, .0006: HMP–Control Frictional Ignition.

However, the risks identified, and associated controls, were confined to the action of the shearer cutting into rock,¹⁰⁰¹ or metal on metal frictional events.¹⁰⁰² Frictional ignition from a rock fall was not assessed as a risk. Indeed, the Hazard Management Plan defines frictional ignition in the following terms, limited to the action of a metal cutting tool:¹⁰⁰³

Frictional ignitions in development involve a metal cutting tool striking a material with the propensity for frictional sparking, including quartz rich sandstone, pyritic material, intrusive material or metal. The heat produced by the sparking has the potential to ignite a flammable methane atmosphere.

9.39 Consistent with the HMP, a longwall frictional ignition Trigger Action Response Plan (TARP) was in place.¹⁰⁰⁴ Its nominated frictional ignition triggers related to potential metal on metal and rock on metal scenarios, namely:

- a greater than specified height of sandstone in the floor or roof cutting horizon;
- damaged or inoperable picks or sprays in the shearer drum;
- water flow for the shearer cutter drum or lump breaker outside specified limits;
- the operation of race sprays or sprocket sprays on the tailgate drive.

9.40 The mine conducted a ‘First Goaf’ risk assessment relating to initial caving, recognising in it the potential for wind blast arising from initial caving.¹⁰⁰⁵ A variety of risks were identified from the hazard of the ‘[i]nitial Goaf Area behind shields hanging up and suddenly releasing, resulting in a pressure wave’.¹⁰⁰⁶ Frictional ignition from a strata fall was not amongst the identified risks.

9.41 Likewise, the risk assessment for LW 104 secondary extraction¹⁰⁰⁷ does not identify a risk of frictional ignition arising from strata fall.¹⁰⁰⁸

9.42 In August 2020, Grosvenor conducted another risk assessment, the object of which was ‘to consider any available learnings thus far following the gas ignition event that occurred at the mine on 6 May 2020 and the spontaneous combustion event of June 2020’.¹⁰⁰⁹ The assessment rated the risk of rock on rock friction from a roof fall or caving of the goaf as low, having regard to:¹⁰¹⁰

Low incendiary sparking potential of strata - Exploration coring data (cutting horizon) – IGCAT (frictional ignition potential testing).

¹⁰⁰¹ RSH.001.021.0001, .0007: HMP–Control Frictional Ignition.

¹⁰⁰² RSH.001.021.0001, .0017: HMP–Control Frictional Ignition.

¹⁰⁰³ RSH.001.021.0001, .0004: HMP–Control Frictional Ignition.

¹⁰⁰⁴ AGM.002.001.0483: GRO-8515-TARP-Longwall Frictional Ignition.

¹⁰⁰⁵ RSH.001.048.0001: GRO-10672-RA-LW104 First Goaf.

¹⁰⁰⁶ RSH.001.048.0001, .0006–.0007: GRO-10672-RA-LW104 First Goaf.

¹⁰⁰⁷ AGM.002.001.1000: GRO-10671-RA-LW104 Secondary Extraction.

¹⁰⁰⁸ AGM.002.001.1000, .1040–.1041: GRO-10671-RA-LW104 Secondary Extraction.

¹⁰⁰⁹ AGM.011.001.2146: GRO-3600-RA-Explosions.

¹⁰¹⁰ AGM.011.001.2146, .2163: GRO-3600-RA-Explosions.

9.43 Tailgate shield leg pressures, from roof support #139 to #149, showed a sudden increase, in the range of 10 to 30 bar at the time of the serious accident.¹⁰¹¹

This increase in leg pressure is indicative of a fall of ground within the cavity above onto these shields. As with the scenario of rock on rock frictional ignition, the low incensive quality of the overlying strata militates against an ignition from this source.¹⁰¹²

9.44 In summary, on the available evidence, the incensive quality of the strata, for an appreciable distance above the GM seam, is low. There is no history of frictional ignition from a rock fall in the many years of mining the GM seam, and indeed, no proven event of that kind elsewhere in Australia. The mine's own risk assessment, conducted after the accident, rated the risk of explosion from rock on rock friction as low.

9.45 In light of these matters, the Board considers that the possibility of frictional ignition as a result of a strata collapse is low.

Frictional ignition as a result of the shearer picks striking rock

9.46 One possible cause of frictional ignition could be incensive heat generated by the shearer picks striking rock material in the face. However, this possibility can be immediately ruled out because the shearer and cutting drums were stationary at the time of the serious accident. The shearer had been parked at shield #120 at approximately 2:50pm, some seven minutes before the serious accident.¹⁰¹³

Frictional ignition as a result of movement of the shields

9.47 Similarly, the possibility of a frictional ignition as a result of advancing of the shields resulting in rubbing against rock or steel in the roof can be excluded, given that shield #111, and those surrounding it, were not moving at the time of the serious accident and had not been moved for some time. Shield #136, approximately 50 metres away, was the last shield to move prior to the serious accident, and the last function on that shield was 'tip down' and not shield advance.¹⁰¹⁴

9.48 Further, Dr Low's review included the following finding:¹⁰¹⁵

The probability of ignition by steel on rock interactions during the process of double chocking has been deemed negligible due to the low movement velocities well below those required for ignition in the literature.

¹⁰¹¹ AGM.006.001.0042, .0064.

¹⁰¹² See paragraph 9.36 above.

¹⁰¹³ AGM.006.001.0042, .0063.

¹⁰¹⁴ AGM.006.001.0042, .0063.

¹⁰¹⁵ LOW.001.001.0001, .0003.

Mechanical friction

9.49 The armoured face conveyor (AFC) was the only piece of machinery running at the time of the incident. There had also been a recent history of broken flight bars jamming the AFC. These had been replaced and no further damage had been found since production commenced at 3:06am on the morning of 6 May 2020.¹⁰¹⁶

9.50 Dr Low's review found that:¹⁰¹⁷

Rubbing friction of steel on steel will cause ignition of methane-air mixtures only if the friction is sufficient to raise the temperature to a white heat (i.e. greater than 1000°C).

...

The probability of ignition of firedamp at the AFC (which moves at 1.84 m/s) was deemed as negligible due to the low operational velocities which would not be able to create incendive sparks or the white-hot surfaces required for ignition.

9.51 In addition, the fire investigation report and evidence by Mr Nystrom is to the effect that the flame front originated in the vicinity of shield #111, and that the flame travelled from the rear to front walkways.¹⁰¹⁸ This also suggests that the ignition did not originate within the AFC.

Static electricity

9.52 A spark from static electricity can produce enough energy to ignite methane in the explosive range.¹⁰¹⁹

9.53 However, Mr Munday said that a static electrical charge 'will only produce a sufficiently energetic discharge arc if the relative humidity of the surrounding air is below approximately 40%'.¹⁰²⁰

9.54 Mr Munday gave evidence that it was 'highly unlikely' that a static electricity discharge was the ignition source.¹⁰²¹ Mr Munday had reviewed the wet and dry bulb temperature data from the longwall for the day of the serious accident and, from that data, calculated the relative humidity. He determined that the lowest relative humidity that day was 71.1%.¹⁰²²

9.55 He explained:¹⁰²³

Generally speaking, a static electrical discharge will only occur if the relative humidity is below 50%.

¹⁰¹⁶ AGM.006.001.0042, .0061.

¹⁰¹⁷ LOW.001.001.0001, .0002–.0003. 'Firedamp' is another word for methane.

¹⁰¹⁸ NMU.001.001.0001, .0015.

¹⁰¹⁹ JMU.001.001.0001, .0005.

¹⁰²⁰ JMU.001.001.0001, .0014.

¹⁰²¹ TRA.500.025.0001, .0024, lines 8–11.

¹⁰²² TRA.500.025.0001, .0024, lines 11–29.

¹⁰²³ TRA.500.025.0001, .0024, lines 15–17.

- 9.56 On that basis, the relative humidity was too high for any realistic possibility of a static electrical discharge.¹⁰²⁴
- 9.57 Venturis are well known to be a potential source of static electrical discharge. However, the only venturis in operation at the time of the incident were located around shield #90 and in the tailgate drive area.¹⁰²⁵ Moreover, Mr Adam Maggs, the longwall Deputy had inspected at least the venturi in the tailgate drive area and found it to be earthed.¹⁰²⁶ These factors, and Mr Munday's evidence about the significance of the relative humidity on the day of the serious accident, make it unlikely that a static electrical discharge from the venturi was the ignition source.
- 9.58 A further potential source of static electrical discharge is the dust guards between the shields. However, static electricity will only build up on dust guards when they rub against each other, or the shields, when the shields move.¹⁰²⁷ The magnet used to attach the dust guards to the shields acts as a conductive path, which would tend against the build-up of a static charge.¹⁰²⁸ The last shield to have been operated was shield #136. It was operated within the minute before the serious accident. The operation involved sprag extension, shield advance and tip down function.¹⁰²⁹ Shield advance may cause rubbing, however Mr Nystrom's evidence puts the ignition source proximate to shield #111, which is approximately 50 metres from shield #136.
- 9.59 In light of these matters, the Board discounts static electricity as the ignition source.

Electrical ignition

- 9.60 In light of Mr Nystrom's opinion that the fire likely originated at or near shield #111, the electrical equipment from shields #109 to #112 was seized by the Inspectorate on 20 May 2020, for testing. There had been an initial question whether it was possible that the flame front had originated at or near shield #136 or #137. Accordingly, the electrical equipment from shields #135 to #138 was also seized.¹⁰³⁰
- 9.61 The seized equipment included all the local electrical components from those shields – the solenoid banks, LED lights, mimics, tilt sensors and RS20 parts (electrical control system for the shields). The two mains-powered power supply units which supplied power to the seized equipment were also seized, as were the intrinsically safe-powered cables for control of the shields, and the power supply units for all equipment located at shields #99 to #144.¹⁰³¹

¹⁰²⁴ TRA.500.025.0001, .0024, lines 8–35; JMU.999.001.0001.

¹⁰²⁵ TRA.510.003.0001, .0031, lines 4–25; AGM.005.001.0339.

¹⁰²⁶ TRA.510.003.0001, .0021, lines 6–7.

¹⁰²⁷ TRA.500.016.0001, .0033, lines 35–43.

¹⁰²⁸ TRA.500.016.0001, .0033, lines 35–43.

¹⁰²⁹ TRA.500.016.0001, .0026, lines 40–43; AGM.006.001.0042, .0063.

¹⁰³⁰ TRA.500.016.0001, .0027, line 16–.0028, line 8.

¹⁰³¹ TRA.500.016.0001, .0028, line 10–.0029, line 8. 'Intrinsically safe' means equipment designed and constructed so that the amount of electrical energy within the equipment is unable to, in any circumstance, generate sufficient heat or sparks to ignite a flammable gas.

- 9.62 The seized items were subsequently inspected and tested at SIMTARS.¹⁰³²
- 9.63 A report prepared by SIMTARS explained the testing process and outcomes. Each of the seized items was visually examined and functionally tested. Simulation of the operation of the roof support system did not reveal any abnormalities in the equipment. Some of the cables had low insulation resistance, but there were no short or open circuits.¹⁰³³
- 9.64 Overall, the inspection and testing process revealed no evidence that the seized electrical components might have been the cause of the ignition.¹⁰³⁴
- 9.65 Mr Marty Denham, an electrical fire investigator, attended and oversaw the SIMTARS testing process.¹⁰³⁵ He considered the testing processes were appropriate and were apt to find any potential faults with the equipment.¹⁰³⁶ He considered there was no evidence to suggest that an electrical fault in any of the tested items was the ignition source.¹⁰³⁷
- 9.66 Some items were not seized, including the electrical components of the underground communication system and the emergency stop for the hydraulic pumps. Inspector Neville Atkinson, who oversaw the electrical investigation, considered that these items were not likely to be a possible ignition source, because they were located in a low position on the shields and because those components had intrinsically safe circuits, in respect of which there were 'no issues' with their certification.¹⁰³⁸
- 9.67 The shearer and the AFC mains cables were located near shield #111 and were identified as a potential source of ignition if they had failed and created an electric arc.¹⁰³⁹ Inspector Atkinson requested permission to conduct tests on the cables to verify their integrity, but this was denied due to risks associated with the application of the high voltages required for the testing process in an explosion risk zone. Although Inspector Atkinson could not conduct the tests on the cable, he stated in his statutory declaration:¹⁰⁴⁰

As a result of the observations that I made of the site of the incident and the other information obtained during the course of the investigation more generally, I do not believe that the remaining electrical equipment which remains untested presents a significant possibility as being a potential source of ignition.

¹⁰³² TRA.500.016.0001, .0029, lines 43–46.

¹⁰³³ PBI.001.001.0001, .0006; .0038.

¹⁰³⁴ TRA.500.016.0001, .0031, lines 22–26.

¹⁰³⁵ TRA.500.017.0001, .0003, lines 12–36.

¹⁰³⁶ TRA.500.017.0001, .0003, lines 38–46.

¹⁰³⁷ TRA.500.017.0001, .0004, lines 1–28.

¹⁰³⁸ ANE.001.001.0001, .0006; TRA.500.016.0001, .0038, lines 34–41.

¹⁰³⁹ ANE.001.001.0001, .0005.

¹⁰⁴⁰ ANE.001.001.0001, .0006.

9.68 Whilst the possibility of electrical ignition cannot be completely eliminated, extensive testing of the most likely sources of electrical ignition was undertaken in a thorough way. The Board considers it unlikely that electrical equipment was the source of ignition.

Miners' cap lamps and personal devices

9.69 After the incident, the Inspectorate seized the cap lamps and personal gas detectors worn by the injured coal mine workers.¹⁰⁴¹ The personal proximity devices from two other coal mine workers who had been in the LW 104 panel on the day of the serious accident were also seized. These items were inspected and tested at SIMTARS.

9.70 The testing of the cap lamps did not reveal any non-compliances. A short circuit test was performed which showed the protection circuitry to be operational and, in each case, it remained in safe mode.¹⁰⁴²

9.71 The testing of the other devices was unable to create sufficient heat or electric discharge for devices of that kind to have been the ignition source.¹⁰⁴³

9.72 An electrician lost a personal proximity device on the longwall around shield #102 on 30 April 2020.¹⁰⁴⁴ However, it is most unlikely that the lost device was the ignition source as its battery would have been completely discharged by 6 May 2020.¹⁰⁴⁵

9.73 Overall, testing of those items did not reveal any evidence that a cap lamp, personal gas detector or personal proximity device could have been the cause of the ignition.¹⁰⁴⁶

Contraband

9.74 As part of the investigation, Resources Safety & Health Queensland¹⁰⁴⁷ required production of completed forms for contraband searches at the mine.¹⁰⁴⁸ There was no evidence of contraband being found on the investigation inspections. Contraband searches have been conducted as per the mine's procedure. There was no evidence that there was equipment that did not comply with contraband requirements.

¹⁰⁴¹ TRA.500.016.0001, .0029, lines 10–17.

¹⁰⁴² PBI.001.001.0001, .0019.

¹⁰⁴³ PBI.001.001.0001, .0029–.0033.

¹⁰⁴⁴ AGM.006.001.0042, .0059.

¹⁰⁴⁵ PBI.001.001.0001, .0038.

¹⁰⁴⁶ TRA.500.016.0001, .0031, lines 28–36.

¹⁰⁴⁷ The Regulator of the coal mining industry.

¹⁰⁴⁸ RSH.015.029.0001. 'Contraband' is defined in the *Coal Mine Safety and Health Act 1999* (Qld), schedule 3 'Dictionary' as material that by its hazardous nature presents an unacceptable risk if taken underground. Includes items such as smoking products (tobacco, lighters or matches) and devices that could create an open flame, arc or spark: *Coal Mining Safety and Health Regulation 2017* (Qld), section 367.

- 9.75 The investigation into the serious accident did not reveal any suggestion that any of the workers in the vicinity of the ignition point had contraband in their possession. The Board is satisfied that the serious accident was not likely to have been caused by an item of contraband.

Exothermic reaction from the curing of PUR

- 9.76 Polyurethane resin (PUR) is a polymeric substance commonly used for consolidation purposes when encountering problematic face or roof conditions. PUR was injected into the longwall face on 17 April and 3 May 2020.
- 9.77 The process involves the injection of resin consisting of two components into a pre-drilled hole, which enables the resin to flow into the fractured coal or strata. The mixing of the components causes the PUR to expand and harden, but also generates heat as part of an exothermic reaction.
- 9.78 The PUR used at Grosvenor in April and May 2020 was DSI 'Strata Bond HA', distributed by DSI International (DSI).¹⁰⁴⁹ According to the Technical Data Sheet for that product, the maximum reaction temperature when the two products HA 'A' and HA 'B' are mixed at a 1:1 ratio by volume is less than 135°C.¹⁰⁵⁰ A risk assessment report by DSI for the use of the product described a maximum curing temperature during testing of 'between 110°C - 120°C (see Arnsberg permit)', although with the rider that 'this may increase depending on volume'.¹⁰⁵¹ The 'Arnsberg permit' referred to is an approval for use of the product by the Arnsberg Regional Authority, North Rhine-Westphalia, Germany. However, that permit identified a much higher maximum reaction temperature in testing (assuming a 30°C ambient temperature) of 146.53°C.¹⁰⁵² Furthermore, the NSW Mine Safety Technology Centre Test Report for the product reported a mean reaction temperature of 139.7°C.¹⁰⁵³ These matters raise concerns about the product's true maximum curing temperature.
- 9.79 The evidence considered in this section shows that 6.3 tonnes of PUR was injected into the longwall face in the area between shields #97 and #132 on 3 May 2020. By virtue of the longwall retreat between then and 6 May 2020, some or all of that product was likely to be in the goaf, immediately behind the shields, at the time of the serious accident.

¹⁰⁴⁹ DSI International is a trading name of Dywidag-Systems International Pty Limited, a contractor supplying ground support products at Grosvenor.

¹⁰⁵⁰ WMA.003.006.0001.

¹⁰⁵¹ RSH.024.004.0001, .0010.

¹⁰⁵² RSH.024.008.0001, .0002.

¹⁰⁵³ RSH.024.010.0001, .0002.

9.83 A schematic illustration of the location of PUR injections on the face at LW 104 is shown below:¹⁰⁵⁷

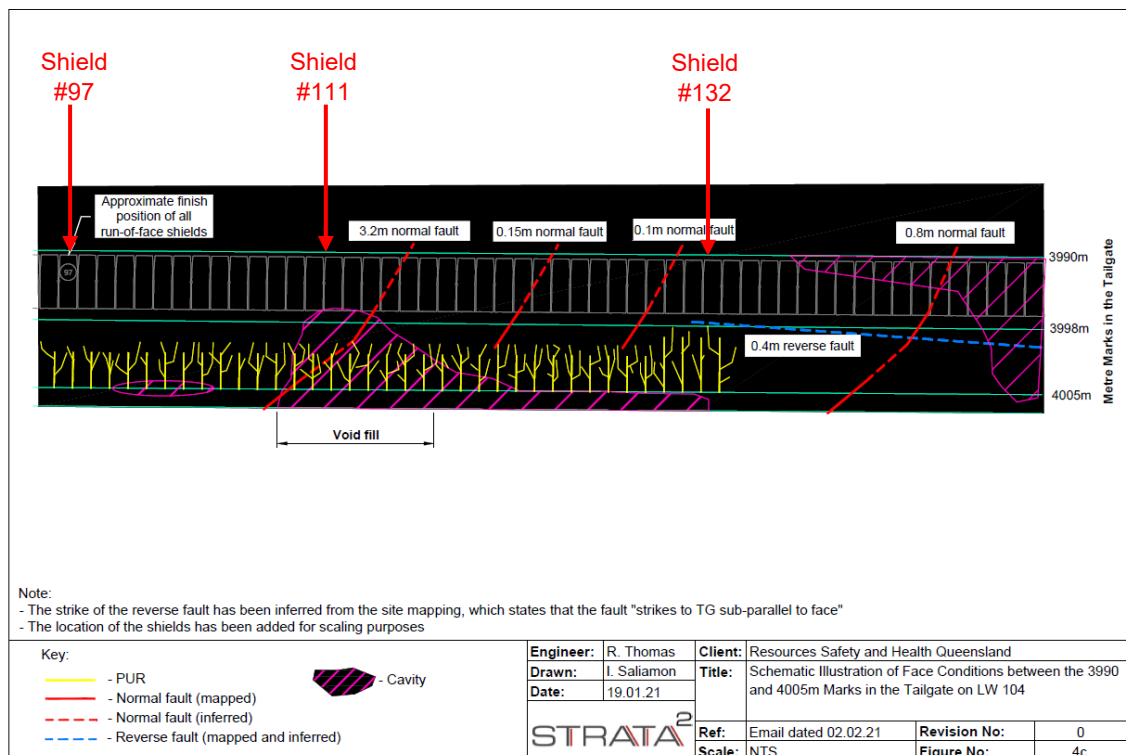


Figure 150: Idealised plan view of PUR injection locations on LW 104 on 3 May 2020

9.84 DSI's risk assessment for the PUR compound in question contains a diagram that assists in understanding the manner in which the product is used, although it should be noted that the image below shows PUR being injected into roof material comprised of rock, whereas at Grosvenor, the roof consisted of a coal beam:¹⁰⁵⁸

¹⁰⁵⁷ RSH.022.004.0001, .0004.

¹⁰⁵⁸ RSH.024.004.0001, .0012.



Figure 151: Example of the use of PUR for longwall face and roof consolidation

The likely location of the PUR on 6 May 2020

- 9.85 The evidence available to the Board conflicts as to the distance retreated between 3 and 6 May 2020. Whilst mapping undertaken by the mine geologist¹⁰⁵⁹ suggests that the distance of retreat was in the order of 15 metres, data from the mine's data-gathering and process control system, CITECT, show that, in that period, only 11 shears were completed. The CITECT data are likely to be more reliable. Given that the maximum width of a shear is approximately 0.85–1 metre,¹⁰⁶⁰ it seems unlikely that the distance of retreat was as far as 15 metres. The Board is satisfied that the longwall actually retreated approximately 9–11 metres between 3 and 6 May 2020.¹⁰⁶¹
- 9.86 The distance from the face to the rear of the longwall shields varies between 6.5 and 8.5 metres, depending on where they are in the operating sequence, as shown in Figure 152 below.¹⁰⁶² This means that by 6 May 2020, all of the PUR injected on 3 May would have been either directly above the rear of the shields, or in the goaf immediately behind them. If the distance of retreat was in the order of 15 metres, all of the PUR would have been in the goaf just behind the shields. In the Board's view, therefore, the difference of four metres is of no moment.

¹⁰⁵⁹ RSH.024.031.0001.

¹⁰⁶⁰ WMA.001.002.0001, .0097; AGM.003.001.0539, .0605.

¹⁰⁶¹ AGM.003.001.0073, .0077. According to production figures, the retreat was 9.2 metres, but that document does not include the two shears on the morning of 6 May. The precise width of each shear is unknown, so this is not inconsistent with an approximation of 9–11 metres.

¹⁰⁶² WMA.001.002.0001, .0097.

The risk of a PUR-initiated spontaneous combustion event

- 9.88 The risk of PUR initiating a spontaneous combustion event was well known to Anglo American plc (Anglo). Between 2014 and 2019, Anglo commissioned several technical reports concerning the spontaneous combustion potential of coal at Grosvenor.
- 9.89 Testing for this purpose is conducted using the adiabatic oxidation method. This method simulates the conditions in which the spontaneous combustion of coal ordinarily occurs, by including the effect of environmental heat and eliminating the loss of reaction heat to the surrounding environment.¹⁰⁶⁴
- 9.90 In 2014, samples of GM seam coal taken from boreholes at a depth of 187 metres (i.e., not from LW 104) were assessed as having 'low intrinsic spontaneous combustion reactivity'. However the author of the report, Dr Beamish, whose speciality is characterising the spontaneous combustion potential of coal, said that:¹⁰⁶⁵

There is one possible situation that could lead to a spontaneous combustion event ...[t]his is when the coal comes into contact with an external heat source, such as a curing compound (for example PUR). Under these circumstances the temperature of the coal may be artificially raised beyond the point where the natural inhibition from moisture and mineral matter in the coal is overcome and thermal runaway prevails. This can be seen from the results of a step-heat test [shown in the figure below] applied to a sample from Grosvenor Mine to obtain the RIT value. Where this situation is likely to be present, vigilant gas monitoring should be adopted to identify the presence of any elevated temperature in the coal using indicator gas trends.

¹⁰⁶⁴ Wang, D. et al., *Test method for the propensity of coal to spontaneous combustion* (2009) Procedia Earth and Planetary Science volume 1: page 20, at 21.

¹⁰⁶⁵ WMA.003.019.0001, .0030.

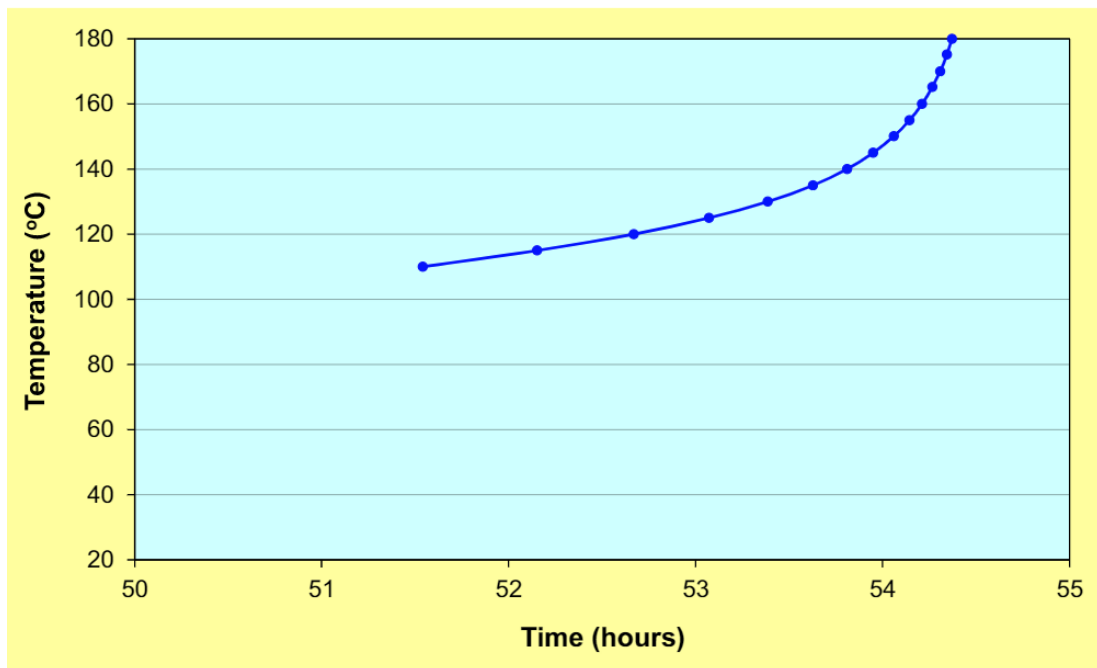


Figure 154: Self heating curve for coal sample from Grosvenor Mine at elevated temperature

- 9.91 In 2019, Anglo arranged for the testing of samples of coal from LW 103 for spontaneous combustion potential. The author of the report (which remains in draft form), Dr Beamish, concluded that:¹⁰⁶⁶

For the samples from 103MG 25CT at a mine ambient temperature of approximately 45°C, incubation to thermal runaway is not possible in any practical timeframe. However, if the coal comes into contact with an external heat source for a period of time, self-heating to thermal runaway is possible.

- 9.92 Dr Beamish went on to observe that:¹⁰⁶⁷

*The result of No Thermal Runaway for each of the samples, **if a loose pile of coal is formed at critical thickness with sufficient continuous air supply and minimal heat dissipation**..., is consistent with the low intrinsic reactivity of each of the samples and the moisture content in the coal that acts as a moderator of coal self-heating. (Emphasis in original).*

It should be noted that the longer the coal is exposed to a cooler temperature, the longer it takes to reach thermal runaway (incubate) due to heat dissipation effects to the surroundings. Conversely, if the coal is exposed to an external heat source, this will reduce the time to reach thermal runaway due to the temperature dependence of the oxidation reaction rate.

¹⁰⁶⁶ WMA.003.017.0001, .0002.

¹⁰⁶⁷ WMA.003.017.0001, .0020; .0029–.0030.

For coals with a low intrinsic reactivity an external heat source can often be the root cause of developing a spontaneous combustion event.

...

There is one possible situation that could lead to a spontaneous combustion event ...This is when the coal comes into contact with an external heat source, such as a curing compound (for example PUR (Cliff, Beamish and Cuddihy, 2009) or other products that produce an exothermic reaction). Under these circumstances the temperature of the coal may be artificially raised and a short incubation period ensues. The effect of an externally induced heating for [one] of the samples is shown [in the figure below]. These results have been obtained by step-heating the coal sample to successively higher temperatures using the oven heaters and then returning the oven to adiabatic mode to monitor the self-heating rate. Where this situation is likely to be present, vigilant gas monitoring should be adopted to identify the presence of any elevated temperature in the coal using indicator gas trends.

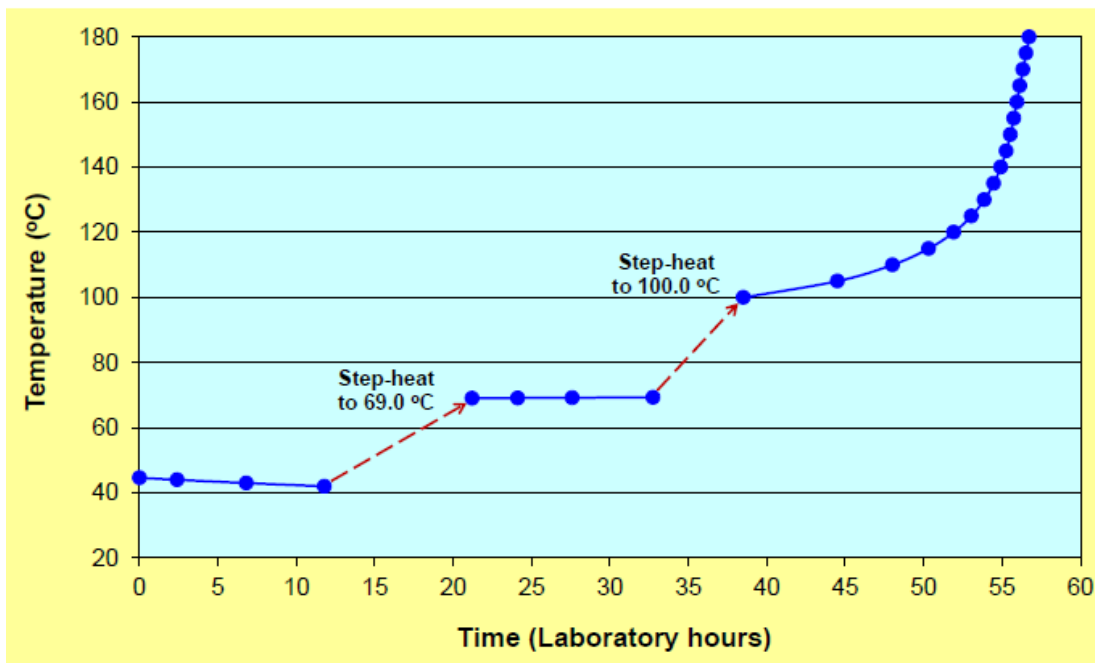


Figure 155: External heat source induced self-heating for a coal sample from the top of the Goonyella Middle seam

9.93 Coal samples from the middle and lower portions of the GM seam responded in a similar way when subjected to 'step-heating'.¹⁰⁶⁸

¹⁰⁶⁸ WMA.003.017.0001, .0030–.0031.

- 9.94 Dr Beamish's draft report referred to a 2009 paper by Cliff *et al.* where the authors summarised the factors that influence the developing of a coal heating. One of those factors was:¹⁰⁶⁹

Amount and nature of coal left in goaf: This relates to a critical pile thickness needed for the coal to insulate itself and prevent heat losses as well as the particle size distribution of the coal which will affect the rate at which the oxidation reaction can take place. (Note again that a substance like PUR is also a very good insulator and when coal is encased in PUR it is effectively placed in an insulated oven and heated to 152°C.)

- 9.95 Elsewhere in the same report, the authors said:¹⁰⁷⁰

The use of polyurethane resin (PUR) and explosives can introduce significant heat and these have contributed to a number of events that have been attributed to spontaneous combustion.

...At North Goonyella, there were three events that can all be traced back to the use of significant amounts of PUR. PUR cures with an exothermal temperature of 152 C. When coal is encapsulated in a block of PUR, it is raised to a temperature of 152C and then both the PUR and coal act as insulators, effectively sealing in the heat. This then leads to an accelerating oxidation rate that is blamed on spontaneous combustion.

- 9.96 The Board does not take the authors to be intending to convey that 'encapsulation' of coal is the only means by which heat transfer from PUR to adjacent coal could occur. Dr Beamish, one of the co-authors, confirmed as much in cross-examination. He was referred to the second of the above passages. He confirmed that '[encapsulation of coal] is of some relevance, but it may not necessarily be the only way that the heat transfer takes place'.

- 9.97 It is likely that the statements quoted above were based upon the results of testing carried out for the purpose of an earlier Australian Coal Industry Research Laboratories (ACIRL) report into the North Goonyella spontaneous combustion event in 1997. Following that event, ACIRL conducted an investigation into the implications for the onset of spontaneous combustion of coal at North Goonyella from the use of PUR and other cementitious grouts. In particular, the investigation considered whether the exothermic characteristics of those products had the capacity to trigger a heating of a coal mass that would not otherwise self-heat.¹⁰⁷¹

¹⁰⁶⁹ Cliff, D., Beamish, B., Cuddihy, P. & Rowlands, D., *Explosion, Fires and Spontaneous Combustion*, in *Australasian Coal Mining Practice* 3rd edition, (The Australasian Institute of Mining and Metallurgy, 2009), page 808: WMA.003.003.0001, .0005.

¹⁰⁷⁰ *Ibid.*, page 810: WMA.003.003.0001, .0006.

¹⁰⁷¹ RSH.035.002.0001, .0004–.0005.

9.98 One of the tests undertaken as part of the investigation involved placing three small lumps of coal into a 30 litre bucket, which was then filled with PUR. Thermocouples were inserted into the lumps of coal, and also into the PUR surrounding the coal. Temperature measurements, of both the coal and PUR, were taken at regular intervals. In each case the PUR heated first, and the coal temperature then quickly matched that of the surrounding PUR.¹⁰⁷² The report went on to say:¹⁰⁷³

Further, temperatures developed in the PUR are much reduced from those seen in...tests in which only PUR was used to form the block. This is because much of the heat released by the PUR reaction is used to heat up the embedded coal.

9.99 This testing demonstrates the ability of PUR to heat adjacent coal. At the PUR/coal proportion used in that test, the mixture attained temperatures of between 40°C and 50°C.

9.100 Further testing was conducted to investigate the temperatures which could be reached at different PUR/coal proportions.

9.101 The report noted that the final temperature rise will depend on the heat of the reaction during curing, the physical properties of the PUR and the coal, and the relative proportions of the PUR and coal.¹⁰⁷⁴ The effect of varying the proportions of PUR and coal are shown in the following graph, where the dotted line represents the PUR/coal modelling:¹⁰⁷⁵

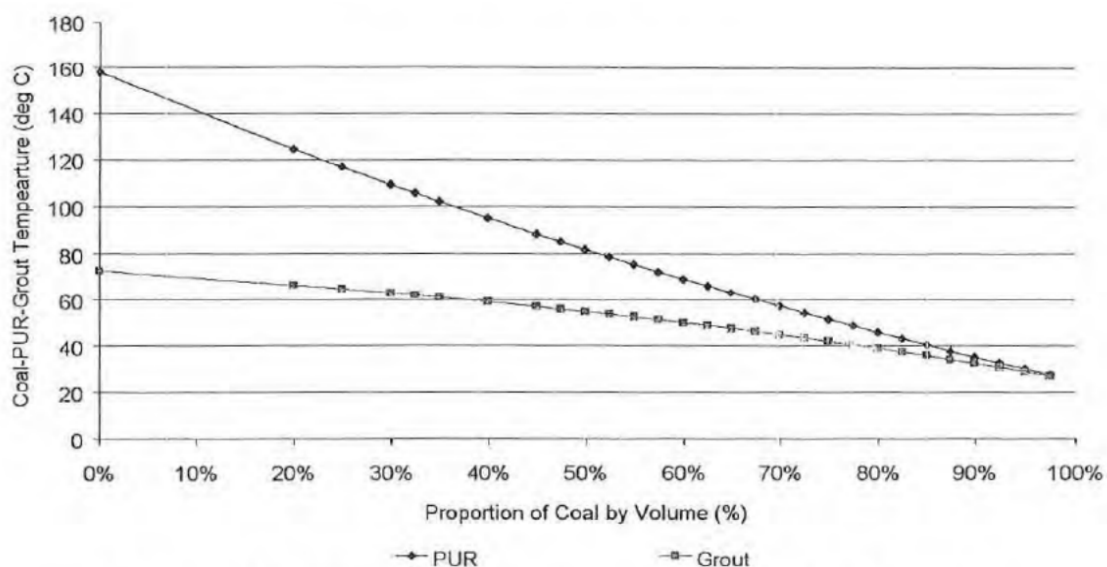


Figure 156: Coal-PUR-Grout Temperatures at Varying Coal Proportions

9.102 The graph shows that when the PUR/coal mix consists of a proportion of approximately 35% or less of coal, the mixture reaches and exceeds 100°C.

¹⁰⁷² RSH.035.002.0001, .0015.

¹⁰⁷³ RSH.035.002.0001, .0015.

¹⁰⁷⁴ RSH.035.002.0001, .0024.

¹⁰⁷⁵ RSH.035.002.0001, .0025.

- 9.103 Accepting that the proportion of PUR to coal is relevant, the other noteworthy point on the question of heating of coal by PUR is that, as Dr Beamish stated, it is only necessary that a very small piece of coal, perhaps of tennis ball size, be heated to the point of thermal runaway i.e., 100°C. A piece as small as that would be capable of initiating a spontaneous combustion event (see paragraph 9.126).
- 9.104 The introduction of large quantities of PUR into fractured coal, as occurred at Grosvenor across an overall distance of 70 metres, enhances the prospect that at some location within the injected area, a small piece of coal would be heated to 100°C and continue self-heating from that point.
- 9.105 The Grosvenor Principal Hazard Management Plan (PHMP) for spontaneous combustion specifically recognised an exothermic reaction from PUR as a potential source of heat.¹⁰⁷⁶ Similarly, the risk of the exothermic reaction from PUR providing an ignition source was recognised in the explosions risk assessment.¹⁰⁷⁷ That risk, however, was assessed as ‘rare’, on the basis that either there were no records of the event occurring or that it was highly unlikely to occur within the next twenty years. Even if it did occur, the maximum reasonable consequence level was assessed as ‘moderate’, with the worst reasonable safety outcome a mere ‘lost time injury’.¹⁰⁷⁸
- 9.106 The risk assessment for explosions identified the chemical energy provided by an exothermic reaction, but only as a potential source of ignition, not as an initiator of spontaneous combustion.¹⁰⁷⁹
- 9.107 The risk analysis for the use of polymeric chemicals for strata control and sealing (issued 17 February 2020) noted the exothermic reaction and asserted that ‘to minimise the potential for fire, fire retardants are added, and restrictions have been placed on the quantity of PUR to inject per hole’.¹⁰⁸⁰ A ‘self-generated fire of resin’ was identified as a risk, which was to be controlled by:¹⁰⁸¹
- a. the use of a fire retardant;
 - b. a volume limit;
 - c. increased Explosion Risk Zone (ERZ) inspections (fire watches) during the setting time— every 30 minutes for four hours—with excess heating addressed by the cessation of pumping and the application of cooling water; and

¹⁰⁷⁶ RSH.005.001.0200, .0211.

¹⁰⁷⁷ AGM.011.001.2146, .2165: *GRO-3600-RA-Explosion Bowtie*.

¹⁰⁷⁸ AGM.011.001.2146, .2157: *GRO-3600-RA-Explosion Bowtie*.

¹⁰⁷⁹ RSH.033.002.0001: *GRO-3600-RA-Explosion Bowtie*.

¹⁰⁸⁰ RSH.024.001.0001: *GRO-1486-RA-Use of Polymeric Chemicals for Strata Consolidation and Sealing*.

¹⁰⁸¹ RSH.024.001.0001, .0014: *GRO-1486-RA-Use of Polymeric Chemicals for Strata Consolidation and Sealing*.

- d. a prohibition on pumping into an area that has been grouted with cementitious product within the previous 24 hours.
- 9.108 Surprisingly, the level of risk of self-generated fire was assessed as being '3L', meaning that 'the unwanted event has never been known to occur; or it is highly unlikely that it will occur within 30 years'. The potential consequence for safety was a 'medical treatment case', and the financial impact was limited to a 'brief disruption to operation'.¹⁰⁸² The risk analysis does not, however, address spontaneous combustion of coal resulting from the application of PUR. Similarly, the HMP for the use of polymeric chemicals refers to the risk of fire in the resin itself, but not to spontaneous combustion. It also specifies the fire watch inspection regime set out above.¹⁰⁸³
- 9.109 There is nothing novel in the proposition that PUR poses a genuine risk of self-ignition when injected in substantial quantities into a void. On 13 December 1986, a fire occurred on the longwall face at West Cliff Mine, situated near Appin, NSW, after PUR was pumped into a roof cavity.¹⁰⁸⁴ After the explosion at Pike River mine in November 2010, PUR that was used to seal the mine portal caught fire, significantly disrupting the sealing process.¹⁰⁸⁵
- 9.110 On 21 November 2007, the Coal Mines Inspectorate issued Safety Bulletin No. 74, entitled, *Isocyanates from 2-pack paints and use of polyurethane resins in mining*.¹⁰⁸⁶ It relevantly said:

2.6 Spontaneous combustion

The official report into the Michael Colliery fire (Scotland 1968) concluded that the polyurethane was ignited by spontaneous combustion. The report suggests that the polyurethane is such a good insulator that it enhances the coal's propensity to spontaneous combustion and should not be used where coal is prone to spontaneous combustion.

Other concerns emerge from the work carried out by the UK HSE following the Daw Mill Colliery incident (England 2006). When mixing both parts in the correct ratio of 1 to 1, with no water or coal contamination, the maximum curing temperature reached was 133°C.

¹⁰⁸² RSH.024.001.0001, .0009: *GRO-1486-RA-Use of Polymeric Chemicals for Strata Consolidation and Sealing*.

¹⁰⁸³ RSH.024.002.0001, .0011: *GRO-5026-HMP-Use of Polymeric Chemicals*.

¹⁰⁸⁴ West Cliff Mine, *Report of an Investigation into the Notification of a Dangerous Occurrence*. <<http://www.mineaccidents.com.au/uploads/westcliff-incident-report-part-a.pdf>>.

¹⁰⁸⁵ Royal Commission on the Pike River Coal Mine Tragedy, *Transcript of Phase Two Hearing* (20 September 2011) <[https://pikeriver.royalcommission.govt.nz/vwluResources/20-September-Final/\\$file/20-September-Final.pdf](https://pikeriver.royalcommission.govt.nz/vwluResources/20-September-Final/$file/20-September-Final.pdf)>, page 2309.

¹⁰⁸⁶ Queensland Mines Inspectorate, *Isocyanates from 2-pack paints and use of polyurethane resins in mining – Mines safety bulletin no. 74 – 21 November 2007 – Version 1*, Queensland Government, (Safety Bulletin, November 2007) <<https://www.rshq.qld.gov.au/safety-notices/mines/isocyanates-from-2-pack-paints-and-use-of-polyurethane-resins-in-mining>>.

When the mixture is contaminated with water, this rose to 170°C. When the mixing ratio was changed from the recommended 1/1 to 4/1 a maximum temperature of 198°C was reached.

There is an established link between the uncontrolled application of polyurethane and fire, and this was demonstrated by the Westcliff Colliery incident (NSW, December 1986). Observations from a number of experienced mining engineers suggest that there is a connection between using polyurethane as a void filler and spontaneous combustion events. Experiences at North Goonyella in 1996 and anecdotal evidence pertaining to incidents at other mines suggest a connection.

2.7 Controls

Wherever polyurethane is used, a risk assessment must be carried out. Suppliers of polyurethane shall demonstrate that a fire retardant has been added.

It is important that the emergency response management system has identified hazards associated with fire involving polyurethane and that there are adequate controls in place for emergency response.

- 9.111 Grosvenor has a standard work instruction that was issued on 16 March 2020 for the application of PUR and urea silicate resin.¹⁰⁸⁷ That instruction specifies that the maximum amount of PUR to be injected is 200 kg or 180 litres, and that injection is to cease in the event of signs of excessive heating. It required the completion of an application report that contains a sign-off by the ERZ controller. That report must detail the location of each hole and the litres injected. At the conclusion of the job, the ERZ controller must be notified that a four hour fire watch is required.¹⁰⁸⁸ Precisely how a fire watch is conducted is not clear. This is an acute problem if production resumes before the expiration of the four hour period, as the mined-through PUR and potentially affected coal will either be above the shields or in the immediate goaf.
- 9.112 The April 2019 version of Recognised standard 16, *The use and control of polymeric chemicals at underground coal mines*,¹⁰⁸⁹ was in force at all relevant times. Whilst it requires an inspection immediately following the injection of PUR 'to ensure no undue heating occurs',¹⁰⁹⁰ it does not explicitly refer to the risk of spontaneous combustion.
- 9.113 At some point during LW 103, a decision was taken to change the supplier of PUR from Minova Australia Pty Ltd (Minova) to DSI. The Minova PUR product that had been used was called 'Bevedol S21 – Bevedan 1F'. The Technical Data Sheet for that product specifies the maximum curing temperature as being 122°C, which was achieved from a starting temperature of 30°C.¹⁰⁹¹

¹⁰⁸⁷ RSH.024.003.0001: *Standard Work Instruction (SWI) Application of Polyurethane Resin (PUR) and Urea Silicate Resin (USR)*.

¹⁰⁸⁸ RSH.024.003.0001, .0009–.0010: *Standard Work Instruction (SWI) Application of Polyurethane Resin (PUR) and Urea Silicate Resin (USR)*.

¹⁰⁸⁹ BOI.019.001.0001.

¹⁰⁹⁰ BOI.019.001.0001, .0014.

¹⁰⁹¹ BOI.020.001.0001; BOI.020.002.0001.

9.114 As part of the change process from Minova to DSI, Grosvenor undertook what it called a ‘polymeric chemical evaluation’ of the respective products, as well as a risk analysis. Despite the opinions set out in Dr Beamish’s reports, which Anglo itself had commissioned, as well as its own PHMPs and risk assessments, neither the evaluation nor the risk analysis addressed the risk of spontaneous combustion initiated by the substituted PUR. Furthermore, the evaluation report did not mention the different curing temperatures of the two products,¹⁰⁹² yet concluded that there was ‘no significance [sic] difference’ between them.¹⁰⁹³

Dr Beamish’s recent experiments

9.115 In March 2021, Dr Beamish undertook further testing of coal from the GM seam and produced a report.¹⁰⁹⁴ The sample used in his testing was taken from the proposed LW 108 at Grosvenor at a depth of about 467 metres. That sample comprised a core of both high and low ash roof coal, with an obvious delineation between the two. Those were then ground so as to provide fine and coarse fractions of each.

9.116 The testing firstly involved calculation of the average self-heating rate, or R_{70} , which is based on the time taken for the coal to self-heat from 40°C to 70°C, expressed as °C/hour. The low ash coal required about 83 hours to self-heat to the required temperature, resulting in an R_{70} of 0.36°C/hour, whereas the high ash coal took about 123 hours, leading to an R_{70} of 0.24°C/hour. The lower figure for the high ash coal is due to the insulating quality of the relatively high amounts of mineral matter.¹⁰⁹⁵

9.117 The Intrinsic Spontaneous Combustion Propensity (ISCP) classification system for Queensland coals has seven ranking levels ranging from ‘low’ to ‘extremely high’. Coal with an R_{70} below 0.5°C/hour falls into the ‘low’ category. Both the high and low ash roof coals therefore have low ISCP.¹⁰⁹⁶

9.118 Considering its low ISCP, the behaviour of GM seam coal is anomalous, in that there have been numerous incidents in underground coal mines in which spontaneous combustion of GM seam coal has been either confirmed, or strongly suspected.¹⁰⁹⁷

9.119 Dr Beamish also conducted incubation testing on the low ash coal whereby it was ‘step-heated’ to 60°C, then 80°C and finally 100°C in order to determine the point at which the coal experienced thermal runaway. These tests were undertaken under conditions of both normal and sluggish ventilation.¹⁰⁹⁸

¹⁰⁹² Although, in specifying 110–120°C the DSI risk assessment substantially understated the curing temperature.

¹⁰⁹³ RSH.024.039.0001, .0004.

¹⁰⁹⁴ BBA.001.001.0001.

¹⁰⁹⁵ BBA.001.001.0001, .0018.

¹⁰⁹⁶ BBA.001.001.0001, .0012.

¹⁰⁹⁷ TRA.500.022.0001, .0004, line 33– .0005, line 1.

¹⁰⁹⁸ ‘Normal’ ventilation is 10⁻⁵ m/s, whilst ‘sluggish’ is 5⁻⁵ m/s; TRA.500.022.0001, .0023, lines 10–18.

9.120 In each ventilation scenario, thermal runaway was achieved relatively quickly after heating to 100°C.¹⁰⁹⁹ Each scenario is respectively depicted in the following two graphs:¹¹⁰⁰

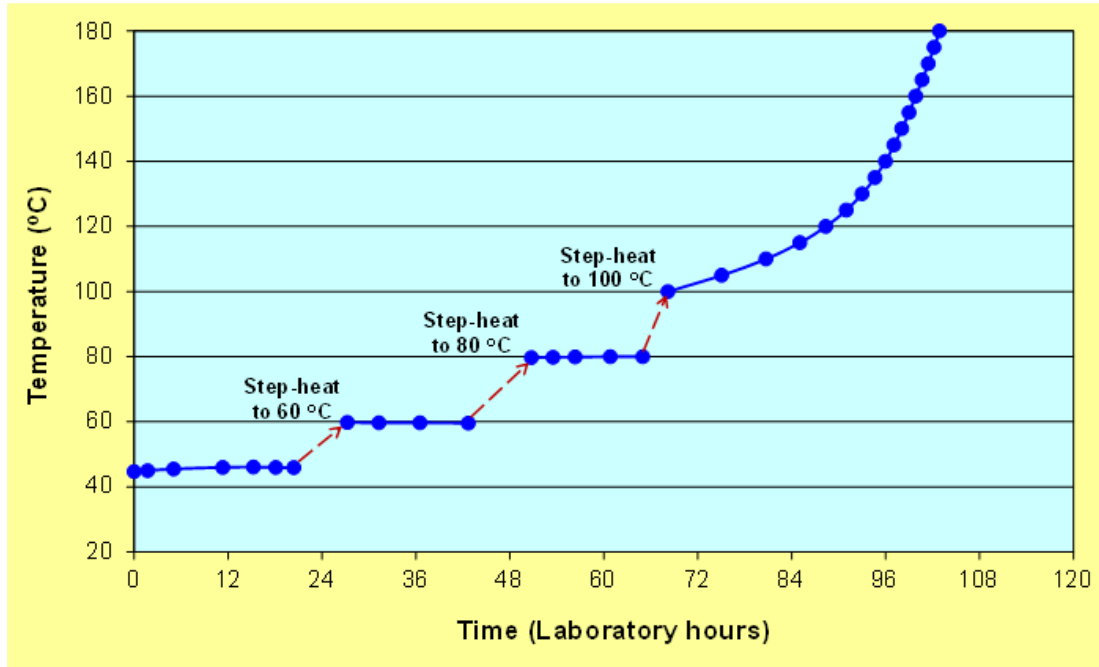


Figure 157: Incubation behaviour of low ash roof coal at mine ambient and elevated temperatures (natural air leakage)

¹⁰⁹⁹ BBA.001.001.0001, .0021.

¹¹⁰⁰ BBA.001.001.0001, .0039; .0040.

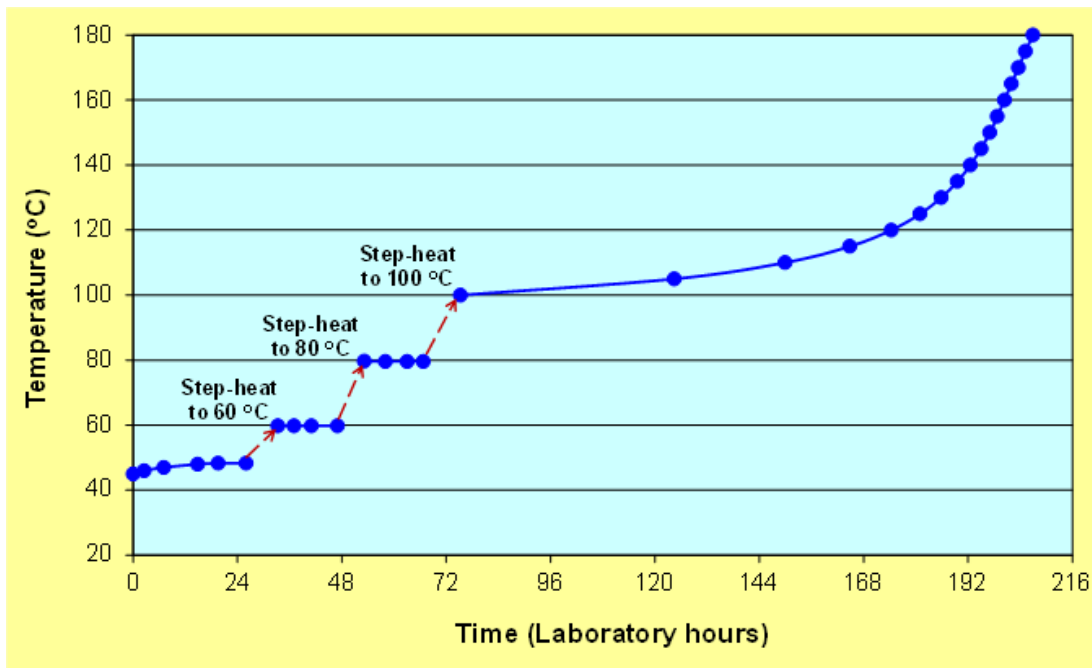


Figure 158: Incubation behaviour of low ash roof coal at mine ambient and elevated temperatures (sluggish ventilation)

9.121 Additionally, Dr Beamish subjected samples of finely ground low ash roof coal to incubation at elevated temperatures of 120°C and 140°C under conditions of both normal and sluggish ventilation.

The time taken to achieve thermal runaway ranged from less than an hour for the 140°C/natural ventilation test, up to about three days when the conditions were 120°C/sluggish ventilation:¹¹⁰¹

¹¹⁰¹ BBA.001.001.0001, .0026.

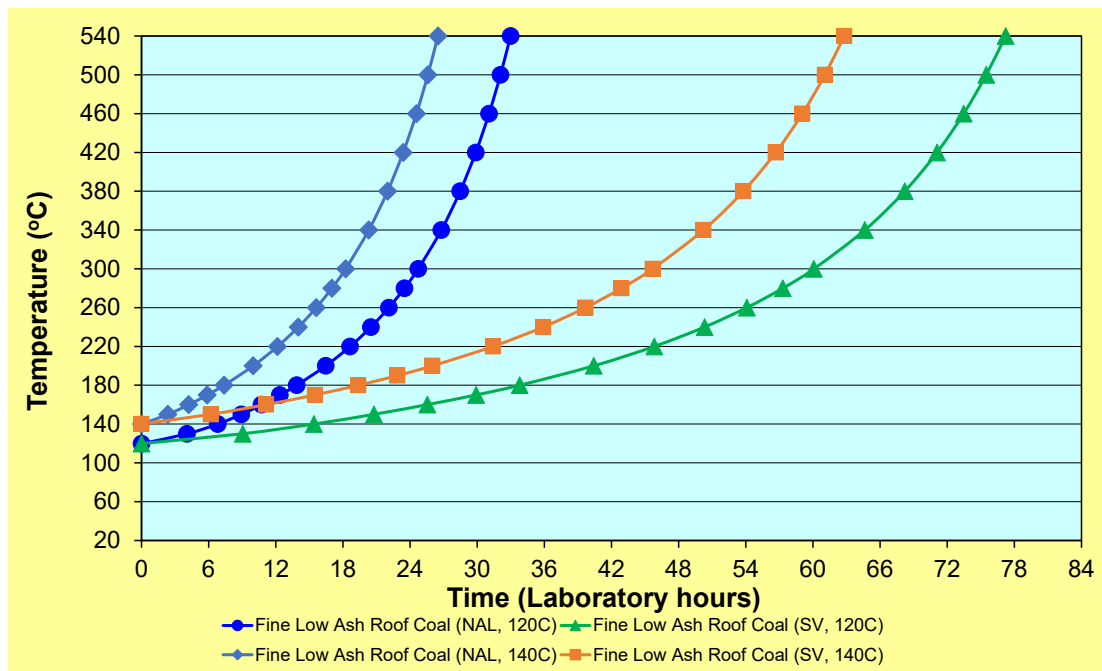


Figure 159: Self-heating behaviour of fine low ash roof coal in response to an elevated temperature external heat source

9.122 Particle size affects the combustion propensity of the coal, in that smaller particles provide a larger overall surface area than coarser particles, allowing greater oxidation. As a result, testing was undertaken of both coarse and fine particles of low ash roof coal, and coarse particles of high ash roof coal,¹¹⁰² at a starting temperature of 140°C, in normal ventilation conditions. The sample with the least combustible propensity was the coarse high ash coal, which nonetheless achieved thermal runaway within 36 hours. However, the other samples achieved thermal runaway more quickly:¹¹⁰³

¹¹⁰² There was insufficient high ash coal available for both fine and coarse testing.

¹¹⁰³ BBA.001.001.0001, .0027.

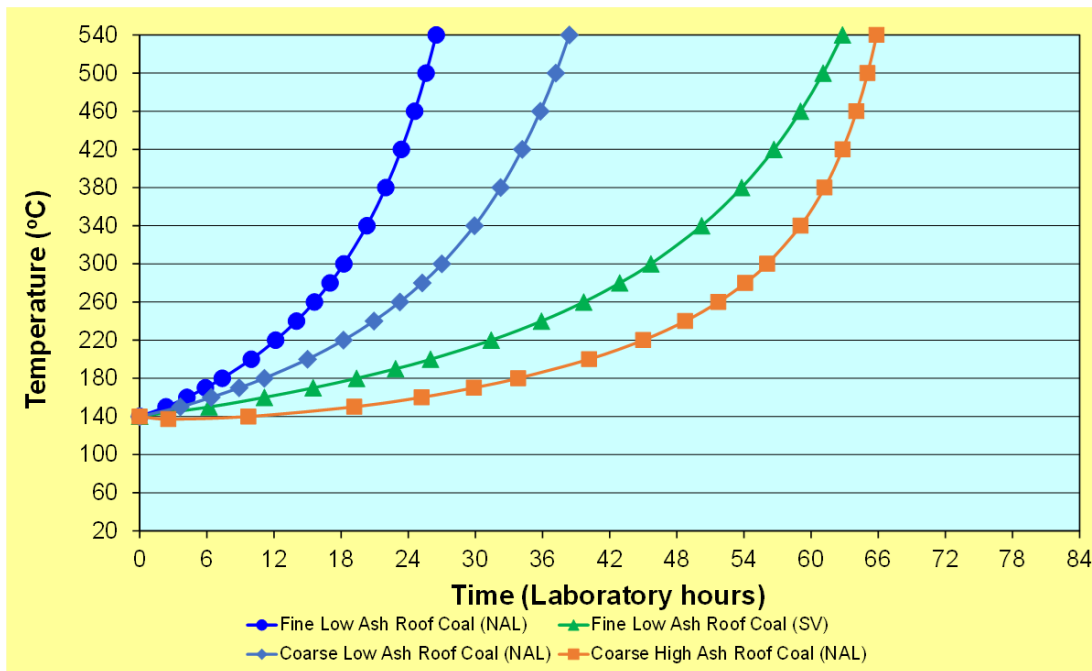


Figure 160: incubation testing at different particle sizes

- 9.123 In all the scenarios the fine low ash roof coal subject to natural air ventilation reached thermal runaway in less than 24 hours.
- 9.124 Dr Beamish gave evidence about the capability of coal heated by PUR to retain its heat. He had this exchange with Counsel Assisting:¹¹⁰⁴

Q. If you assume that a quantity of PUR is injected into the roof at the face and that that is then mined through so that the coal in the roof that had been injected with PUR is then sitting above the shields...

...[and if] we assume that the coal is heated initially by the curing reaction associated with that PUR, would that coal that was in the roof beam above the shields retain that heat?

A. It could retain a significant amount of heat, yes.

Q. Now, it wouldn't be exposed to oxygen necessarily in that situation, would it?

A. It could still be in a slight oxygen environment, which would be enough for it to be able to continue to react.

...

Q. ...if it were to cave into the goaf immediately behind the shields, there might be oxygen there?

A. There would be some oxygen there, at a level that's higher than what it would have previously been exposed to, yes.

¹¹⁰⁴ TRA.500.022.0001, .0031, line 44–.0032, line 26.

- 9.125 Dr Beamish was next asked about the capability of coal, initially heated by PUR, to achieve the temperature of 540°C as depicted in a PowerPoint slide (number 17) that is replicated in Figure 159 above.¹¹⁰⁵
- 9.126 The evidence proceeded:¹¹⁰⁶
- Q. Is it plausible that the sort of effect that we see...described in this slide, slide 17, could occur?*
- A. It is. It's also plausible that it could have reached that sort of temperature before it fell, in that case.*
- Q. So it could be in the roof at that temperature?*
- A. It could also be in the roof at some temperature of that order.*
- Q. Would it necessarily be a large amount of coal that reached that temperature?*
- A. No, no. It could easily be a very small tennis ball or soccer ball sized piece of coal.*
- 9.127 When Dr Beamish was recalled to give evidence on 9 April 2021 he referred to a scenario where a block of coal in the roof above the shields was 'surrounded significantly by material that's going off exothermically'. Dr Beamish said that such material, being heavily insulated, would not 'lose heat in a hurry'. He went on to say that as the longwall retreated, fractures would start to appear in the roof immediately behind the back of the shields, and those fractures would then provide 'availability for air to get to that coal, which is now at an elevated temperature and it can then start to react...a lot faster than what it would have done in the actual, normal mine environment'.¹¹⁰⁷
- 9.128 The evidence went on to consider the reaction timeframe for the coal to reach elevated temperatures, referring to the graph in Figure 160 above.
- 9.129 The following exchange occurred by reference to some commentary Dr Beamish had included in the presentation in respect of Figure 160:¹¹⁰⁸
- Q. [The slide] talks about the implications of this reaction rate. Can you explain what you mean here?*
- A. What we're sort of saying is that you can see that it is only a short time frame involved for those temperatures to get elevated, which is what all those tests actually show. And as I said before, they are done in air, so they are actually as close to real time - they are probably minimum time frames. Clearly at the higher ventilation flow rate, it happens a lot quicker, and that's because of that reaction rate behaviour with the oxygen availability.*

¹¹⁰⁵ BBA.001.003.0001, slide 17.

¹¹⁰⁶ TRA.500.022.0001, .0032, lines 28–41.

¹¹⁰⁷ TRA.500.025.0001, .0032, lines 17–35.

¹¹⁰⁸ TRA.500.022.0001, .0032, line 34–.0033, line 6.

- 9.130 The effect of his evidence was that, in the scenario described in paragraph 9.126 above, the timeframe for the coal to reach 540°C (the auto-ignition temperature of methane) is 1–3 days.¹¹⁰⁹ This evidence supports the proposition that coal heated by the PUR injected on 3 May 2020 could have ignited methane in the goaf on 6 May.
- 9.131 The Board notes that Figures 159 and 160 show the reaction of coal at starting temperatures of 120°C and 140°C, but that a similar effect can be seen at a starting temperature as low as 100°C, as discussed in 9.120 above.
- 9.132 Dr Beamish also gave evidence that even if coal does not achieve thermal runaway, there are various means by which it may nevertheless ‘exacerbate...into flame’.
- 9.133 Dr Beamish gave evidence as to the means by which glowing coal, which was at a temperature of at least 440°C, but not necessarily as high as 540°C, could burst into flame:¹¹¹⁰

The one thing that...people tend to forget is that in that temperature range, the coal could actually be glowing...

...[t]here are a couple of ways that [the glowing coal bursting into flame] could possibly happen. If there were a hot spot like that, sitting in the roof, and it did drop down, even just the movement of the hot spot dropping down through the air would create a velocity effect greater than what it had been exposed to. It's now into a more oxygen-rich environment than it was previously, and that could actually exacerbate it into flame.

If there was an injection of air back into the goaf, if that coal had fallen down and it hadn't quite reached that point, but there was an injection of air from a windblast suck-back effect, then it could also create the same thing. It's like a bellows effect in a blacksmith's furnace.

- 9.134 There is substantial evidence from workers on and near the longwall face that on 6 May 2020 they experienced a suck-back effect following the first pressure wave. Mr Munday gave evidence that, following any methane deflagration, there will inevitably be a suck-back effect.¹¹¹¹ Any PUR-heated coal behind the shields would therefore have been subject to the ‘bellows effect’ as described by Dr Beamish above.
- 9.135 The Board accepts the cogency of Dr Beamish’s work. It also accepts Dr Beamish’s evidence referred to above. The Board is satisfied that heating GM seam coal to 100°C carries with it a serious risk of thermal runaway.

¹¹⁰⁹ BBA.001.003.0001, slide 20.

¹¹¹⁰ TRA.500.022.0001, .0033, lines 8–33.

¹¹¹¹ TRA.500.025.0001, .0029, lines 22–47.

SIMTARS' testing of PUR

- 9.136 With the assistance of DSI, SIMTARS undertook testing of the product Strata Bond HA that had been used at Grosvenor on LW 104. An attempt was made to test the PUR in accordance with the requirements of the NSW regulatory guideline, *Non-metallic materials for use in underground coal mines*.¹¹¹² The test included determining the maximum exothermic reaction temperature, firstly at a room temperature of 21.6°C, and secondly at the mine ambient temperature of 40°C. The guideline imposes a maximum curing temperature of 150°C.
- 9.137 Because of the carcinogenic properties of the PUR, it was necessary that it be mixed in an area outside the test chamber where the ambient temperature was in the low 20's. Further, attempts to heat the test chamber to 40°C were unsuccessful, with the maximum temperature able to be achieved being 36.5°C. Thus, the second experiment was commenced with the PUR at a temperature of about 21°C instead of 40°C, and a room temperature of only 36.5°C.
- 9.138 The first two heating tests involved putting about 200 ml of PUR into three paper cups, each of which had three temperature sensors (or thermocouples). The first test, conducted at a room temperature of 21.6°C, resulted in a maximum temperature of 141.6°C. Corrected for an ambient temperature of 40°C, the maximum was 158°C, meaning that the product failed the test.
- 9.139 The second test involved the same process, however as set out above, the room was heated to 36.5°C. That resulted in a maximum temperature of 140.7°C. Corrected for a 40°C ambient temperature, that equated to 143.8°C, which was notionally a pass, however as seen in the figure below, the low temperature of the PUR at the start of the test caused the temperature at the thermocouples to initially decline before increasing.¹¹¹³ It is therefore not possible to say what the maximum temperature would have been had the test commenced with the room and PUR both at a temperature of 40°C.¹¹¹⁴

¹¹¹² NSW Trade & Investment, Mine Safety Operations Branch, *MDG 3608: Non-metallic materials for use in underground coal mines*, NSW Government (Technical Guideline, August 2012) <https://www.resourcesregulator.nsw.gov.au/__data/assets/pdf_file/0003/444198/MDG-3608-FINAL-120921.pdf>.

¹¹¹³ PBI.999.001.0001, .0026.

¹¹¹⁴ TRA.500.024.0001, .0026, lines 11–43.

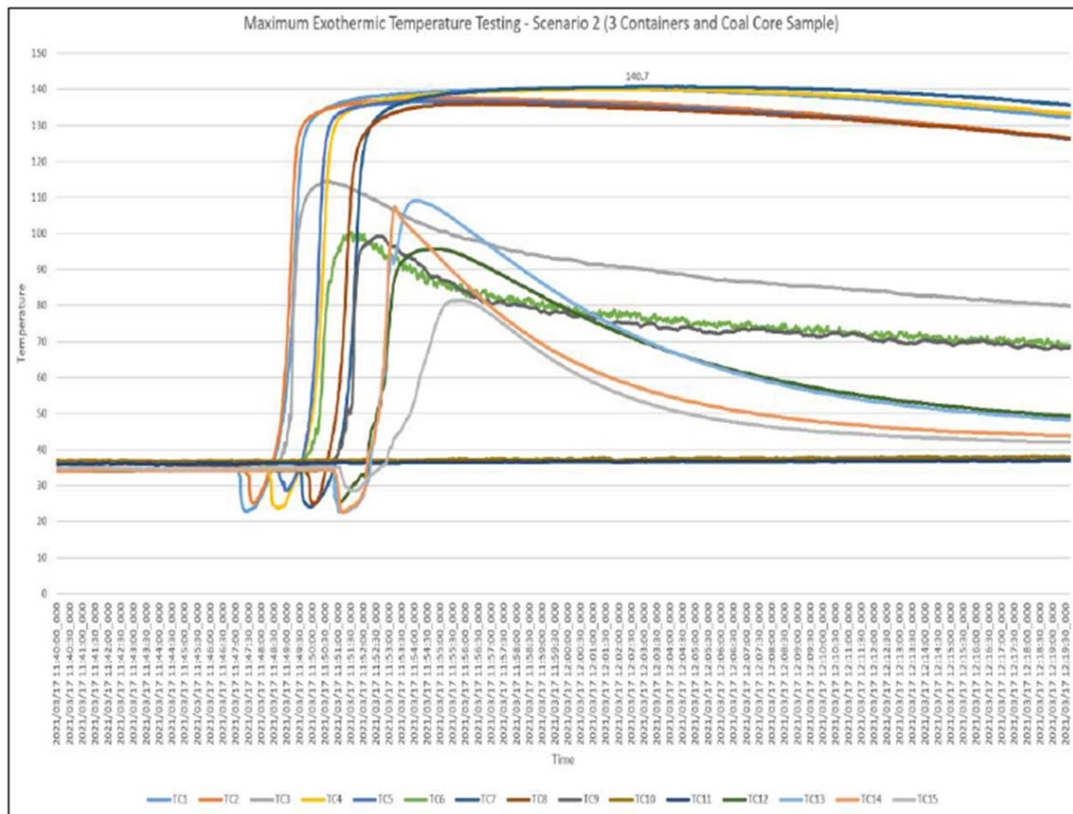


Figure 161: Graph showing the increase in temperature in PUR at a room ambient temperature of 36.5°C

- 9.140 An attempt was then made to test the product by injecting it into the bored-out centre of a cylindrical coal core and measuring temperature both inside and on the outside of the core, however the presence of air in the receiving chamber caused the PUR to expand and overflow over the outside of the core. This rendered the results of the test unreliable.¹¹¹⁵
- 9.141 Lastly, a larger quantity of PUR was placed in an insulated container mixed together with a quantity of broken coal at a room temperature of 36.5°C. The maximum temperature reached during the exothermic reaction was 138.8°C.
- 9.142 Significantly, whilst the smaller samples of PUR in the earlier tests cooled to a temperature of 100°C relatively quickly, the larger quantity in the insulated container required 2 hours and 41 minutes to cool to the same temperature. This was due to the larger mass of PUR.¹¹¹⁶

¹¹¹⁵ TRA.500.024.0001, .0013, line 43–.0016, line 26.

¹¹¹⁶ TRA.500.024.0001, .0013, lines 14–41.

- 9.143 Dr Beamish regarded this as of importance as coal encased in PUR will be heavily insulated. Roof coal injected with PUR could therefore retain a high temperature until the point at which the roof fractures behind the shields, exposing the heated coal to air and causing it to react more quickly than it would in the normal mine environment.¹¹¹⁷
- 9.144 The SIMTARS findings are consistent with Dr Beamish's earlier test results. Nothing in the SIMTARS test results caused Dr Beamish to alter the opinions he expressed in his reports to Anglo, or his evidence given to the Inquiry.¹¹¹⁸

DSI's submissions

- 9.145 DSI initially contended that:¹¹¹⁹
- a. There was insufficient evidence that its product was capable of 'creating an ignition source which could culminate in spontaneous combustion of GM seam coal'; and
 - b. There was no evidence that its product 'created an ignition source which culminated in an event of spontaneous combustion'.
- 9.146 Spontaneous combustion does not require an ignition source. In GM seam coal, it requires an amount of airflow that is sufficient to provide oxygen, but insufficient to enable cooling. The process can be initiated, or accelerated, by the presence of additional heat. The proposition contended for by Dr Beamish, Mr Watkinson and Mr Self was that the PUR could itself trigger spontaneous combustion by supplying the necessary heat. According to Dr Beamish's testing, under the right conditions and once heated to 100°C, GM seam coal will inevitably achieve thermal runaway.
- 9.147 The submissions asserted that the evidence was unreliable because neither Dr Beamish, nor Mr Parmar (who conducted the testing at SIMTARS) had been in the mine and were not familiar with the conditions that applied on the face. That may be so, however the Board is not considering Dr Beamish's evidence in isolation. For example, it was suggested to Dr Beamish that 'significant volumes of water'¹¹²⁰ in the target seam would inhibit the exothermic reaction. However, the evidence discloses that the GM seam had been effectively pre-drained prior to the commencement of extraction. That pre-drainage would have removed much of that water. In any event, Dr Beamish's evidence was that the inherent moisture in that particular rank of coal was between 1% and 3%.¹¹²¹

¹¹¹⁷ TRA.500.025.0001, .0032, lines 3–25.

¹¹¹⁸ TRA.500.025.0001, .0031, lines 13–33.

¹¹¹⁹ DSI.999.001.0001.

¹¹²⁰ TRA.500.022.0001, .0046, line 47–.0047, line 23.

¹¹²¹ TRA.500.022.0001, .0046, line 47–.0047, line 12.

- 9.148 Whilst it is correct to say that Mr Parmar was unfamiliar with the conditions underground, all he was asked to do was to measure the curing temperature of the product in accordance with the relevant NSW regulatory guideline, *Non-metallic materials for use in underground coal mines*.¹¹²² Although Mr Parmar was not able to create the precise conditions required for the test, in that he could not pre-heat the test chamber or the PUR to 40°C, his findings as to the maximum curing temperature (141.6°C, 140.7°C, and 138.8°C)¹¹²³ are comparable to those of the NSW Mine Safety Technology Centre (139.7°C) and the Arnsberg Regional Authority (146.53°C).
- 9.149 DSI also submitted that no indicia of burning coal¹¹²⁴ were detected by coal mine workers. This is of course correct, however the scenario presently under consideration involves a small amount of coal undergoing thermal runaway. The Board notes that those indicia were not reported prior to the explosion on 8 June 2020, either.
- 9.150 DSI's submissions did not address the reality that its product generates temperatures well in excess of 100°C when curing. The risks associated with polymeric products that achieve such temperatures are well-recognised.¹¹²⁵ Its submission that PUR cannot heat coal to the same temperature as that at which the PUR cures overlooks the evidence as to the quantities that were injected into the face and roof. The ability of a large mass of PUR to heat coal will be far greater than if the quantity of PUR is relatively small. In any event, all that is required is for a small quantity of coal to be heated to approximately 100°C, which the evidence establishes is the point of thermal runaway.
- 9.151 DSI's supplementary submissions sought to emphasise that there was no direct evidence, and no justifiable basis on which it could be inferred, that 'the curing process of the PUR, in mine conditions, heated the GM coal to 100°C'. Certainly, it is correct that there is no direct evidence of that process and its effects at LW 104. However, the foregoing discussion establishes the capability of PUR to effect the heating of coal to the necessary degree. The combination of circumstances which make this the likely source of ignition in the present case are set out in the Board's findings at the conclusion of this chapter.

¹¹²² NSW Trade & Investment, Mine Safety Operations Branch, *MDG 3608: Non-metallic materials for use in underground coal mines*, NSW Government (Technical Guideline, August 2012) <https://www.resourcesregulator.nsw.gov.au/__data/assets/pdf_file/0003/444198/MDG-3608-FINAL-120921.pdf>.

¹¹²³ PBI.999.001.0001, .0032; Excluding the coal core test, which failed because air in the core caused the PUR mixture to overflow.

¹¹²⁴ i.e., glowing coal, heat haze, smoke, or odour.

¹¹²⁵ Cliff, D., Beamish, B., Cuddihy, P. & Rowlands, D., *Explosion, Fires and Spontaneous Combustion*, in Kininmonth, R. & Baafi, E. (eds.) *Australasian Coal Mining Practice*, 3rd edition (The Australasian Institute of Mining and Metallurgy, 2009), page 810; WMA.003.003.0001, .0006.

The mine's gas data following the PUR injection campaign on 17 April 2020

9.152 The mine's goaf gas data, which show evidence of heating in various samples taken proximate to the PUR injection campaign on 17 April 2020, is suggestive of a link between the injection of PUR and the heating of coal. This provides some support for the evidence of Dr Beamish and the SIMTARS testing.

9.153 Mr Muller reviewed the data from the bag samples taken from the goaf stream. The following figure, which identifies the goaf stream CO/CO₂ Ratio, reveals spikes between 17 and 20 April 2020:¹¹²⁶

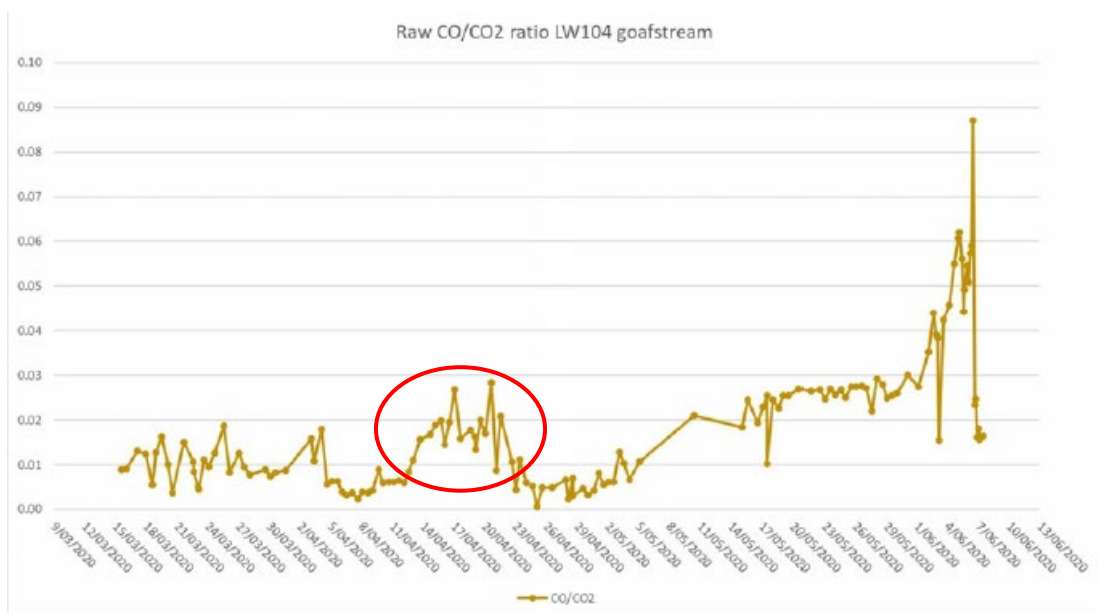


Figure 162: LW 104 Goaf Stream CO/CO₂ Ratio

9.154 The raw carbon monoxide data from the tailgate 104, 3–4 cut-through also show an increase in carbon monoxide in the days after 17 April 2020:¹¹²⁷

¹¹²⁶ MSE.001.001.0001, .0019.

¹¹²⁷ MSE.001.001.0001, .0022.

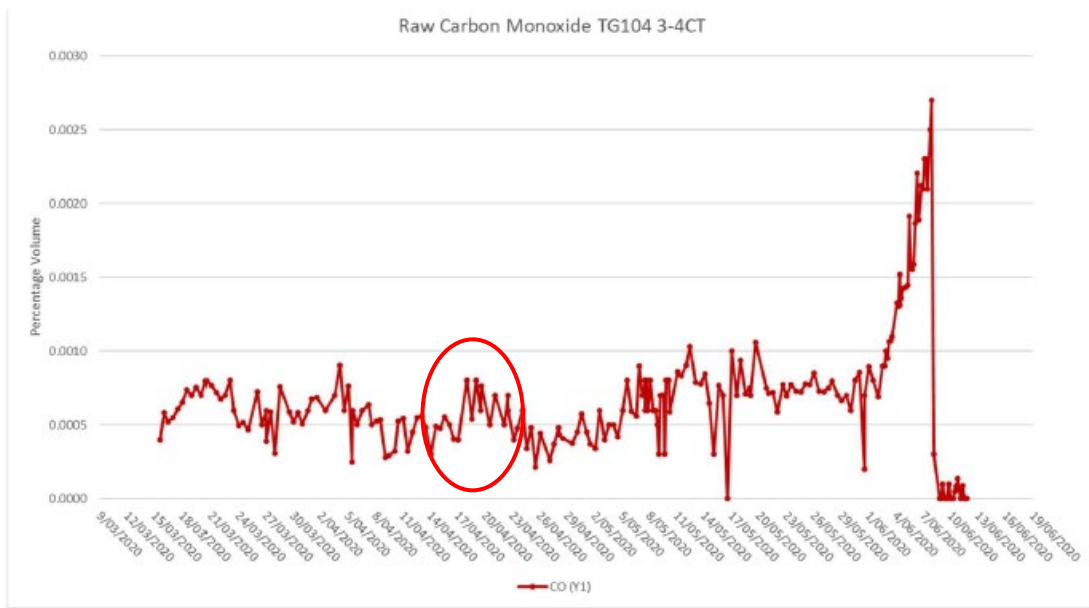


Figure 163: TG 104 3-4 c/t Raw CO

9.155 A substantial spike in carbon monoxide, up to almost 200 ppm, occurred between 17 and 26 April in samples taken from maingate 104 38 cut-through goaf seal:¹¹²⁸

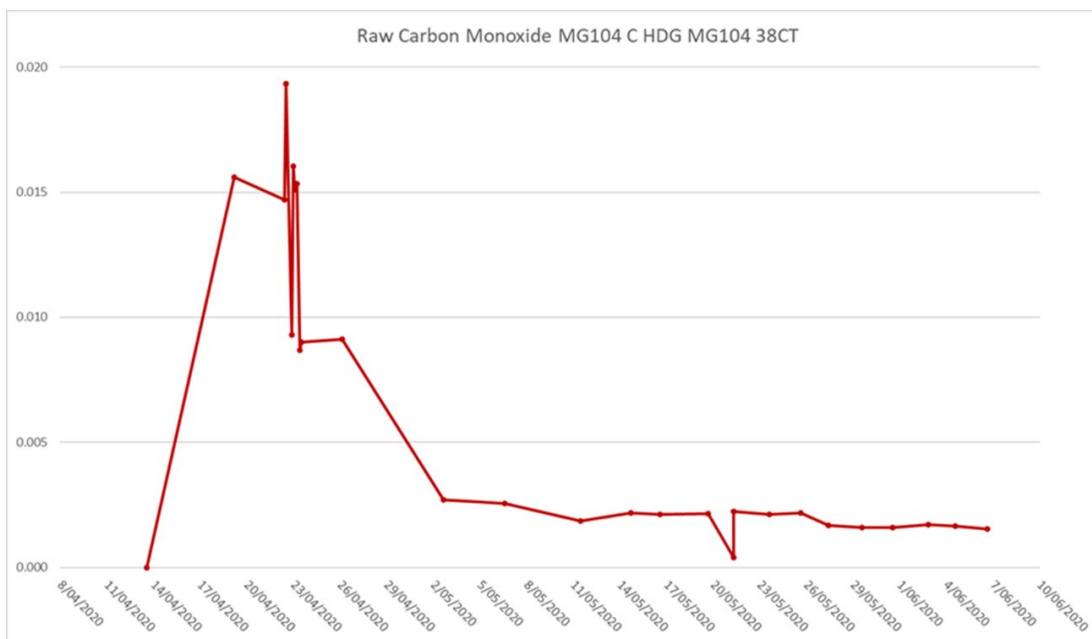


Figure 164: MG 104 38 c/t CO (0.02% = 200 ppm)

9.156 Some of the goaf wells also showed carbon monoxide spikes that coincided with the 17 April PUR campaign. Mr Muller’s methane-free calculation for data taken from goaf well GRO4V006.5 shows such an increase:¹¹²⁹

¹¹²⁸ MSE.001.001.0001, .0029.

¹¹²⁹ RSH.037.003.0001, .0040.

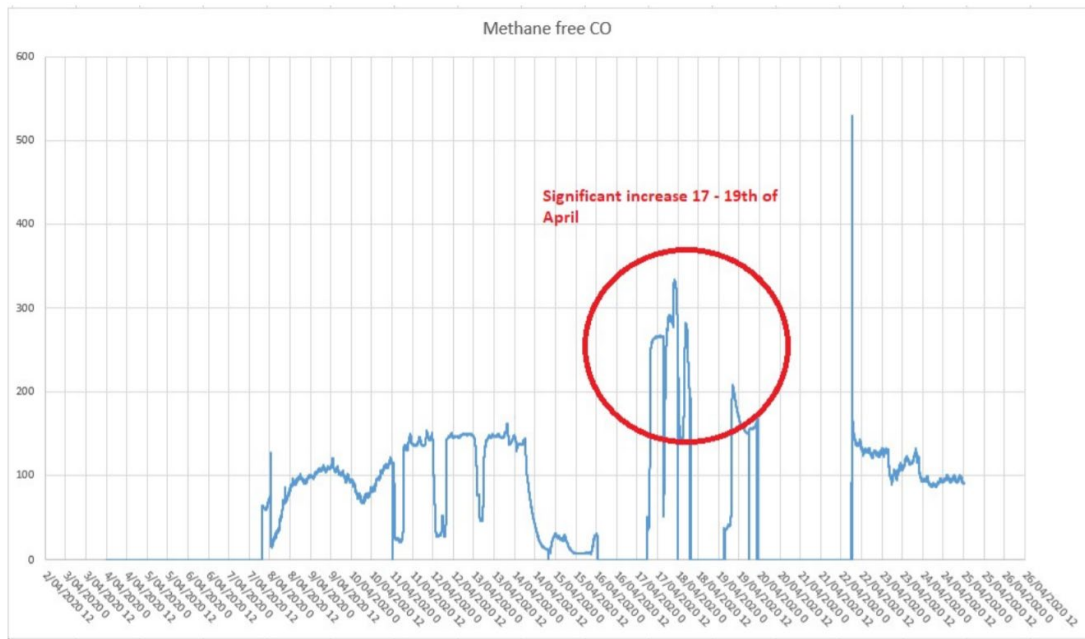


Figure 165: Methane-free CO GRO4V006.5, 8-25 April 2020

9.157 Similarly, Mr Muller’s carbon monoxide methane-free calculation showed spikes in carbon monoxide which coincided with the PUR injection on 17 April 2020:¹¹³⁰

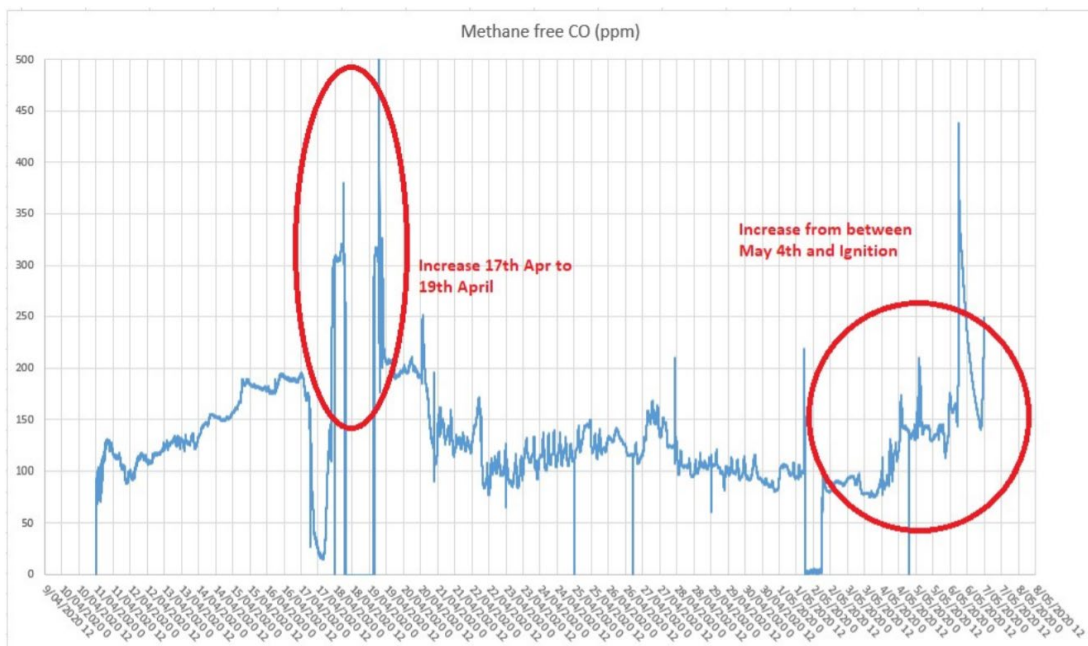


Figure 166: Methane-free CO GRO4V007, from 11 April to 7 May 2020

¹¹³⁰ RSH.037.003.0001, .0045.

The mine's gas data following the PUR injection campaign on 3 May 2020

9.158 Mr Watkinson gave evidence that a small, high-intensity spontaneous combustion event may go undetected.¹¹³¹ He concluded that, as a result of the PUR injected on 3 May 2020, 'a localised spontaneous combustion could have been initiated in the roof coal above the supports'.¹¹³²

9.159 Similarly, in relation to small, high intensity heatings, Dr Beamish said:¹¹³³

They are the hardest type of heating to detect when you have a small defined hotspot, because of the nature of the dilution effects that take place. It depends on where your monitoring points are with respect to where it is, and so it is much more difficult to detect these sorts of things.

9.160 There was in fact some gas data which suggested a heating behind the shields in the goaf, on the morning of 6 May 2020, in the area in which PUR had been injected. As can be seen, goaf drainage well GRO4M001.5 showed a small spike in carbon monoxide on the morning of 6 May 2020:¹¹³⁴

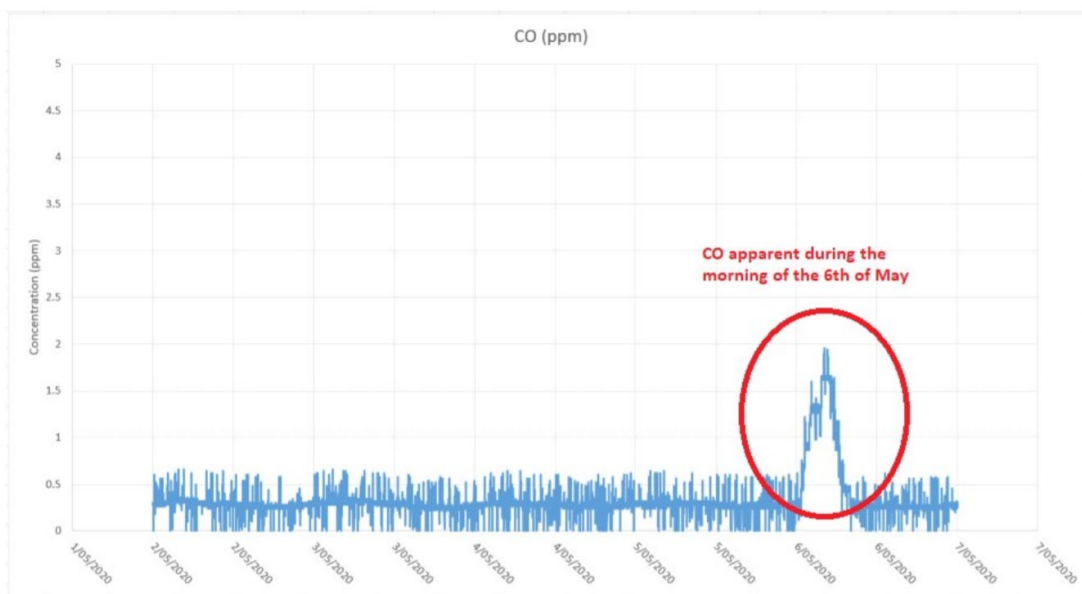


Figure 167: CO at GRO4M001.5 from 2 to 7 May 2020

9.161 Whilst the increase was from less than 0.5 ppm up to about 2 ppm, it occurred after a period of several days where carbon monoxide concentrations were stable at or below about 0.5 ppm. This is significant, for two reasons. Firstly, this well penetrated the goaf in a location that was close to that part of the longwall face and roof that was injected with PUR on 3 May 2020. Secondly, it is also very close to shield #96, at which indicators of an advanced heating were detected after the explosion of 6 May.

¹¹³¹ TRA.500.018.0001, .0047, lines 35–40.

¹¹³² WMA.001.002.0001, .0103.

¹¹³³ TRA.500.022.0001, .0033, lines 41–46.

¹¹³⁴ RSH.037.003.0001, .0013.

The explosion of 8 June 2020

- 9.162 After the events of 6 May 2020, the mine closely monitored the LW 104 goaf for signs of spontaneous combustion. The mine monitoring for spontaneous combustion was supported by daily reviews by an external consultant with expertise in mine atmosphere interpretation.
- 9.163 The first matter of concern was raised on or about 20 May 2020, after a Deputy, using a handheld detector to conduct a survey of the longwall, found elevated temperature and carbon monoxide at shield #96. A report from the external consultant of the same date said that a ‘couple of results’ from the goaf stream were ‘beginning to raise an eyebrow’.¹¹³⁵
- 9.164 As previously noted, the PUR injection in May 2020 occurred between shields #97 and #132. The coal behind shield #96 would have been on the edge of that PUR campaign.
- 9.165 On 25 May, the consultant advised that although they could ‘see no indicators of abnormal oxidation...goafstream CO and related indicators are gradually increasing and vigilance is still required’.¹¹³⁶
- 9.166 Subsequently though, on each of 26, 27, 29 and 31 May, the consultant advised that there were ‘no indications of abnormal oxidation’.¹¹³⁷
- 9.167 On 2 June 2020, a Spontaneous Combustion Management Team (SCMT) was formed due to a combination of an increase in CO Make and the carbon monoxide concentration at shield #96, as well as a Graham’s Ratio over 0.5. On 4 June, a dedicated tube bundle (TB #22) was installed at shield #96.
- 9.168 The situation continued to deteriorate. At a meeting at 8:00am on 6 June 2020 there was a discussion of the predictions of an external expert that the CO Make ‘Level 3’ TARP trigger was likely to be reached at Tube Bundles #22 and #26¹¹³⁸ by midnight that night. The expert further predicted that, if the intensity remained the same, the goaf stream Graham’s Ratio was likely to be over 1.0 by midday that day, and over 2.0 by midnight the next day.¹¹³⁹
- 9.169 The remaining operating goaf wells were shut in at 8:40am, resulting in a methane concentration that exceeded 2.5% at the outbye sensor in tailgate 104 at 12:50pm. At an SCMT meeting at 4:00pm, it was decided to prevent any personnel from entering the mine, other than those who, at the direction of the Incident Management Team, were working on nitrogen injection lines.

¹¹³⁵ RSH.027.005.0001, .0041–.0042.

¹¹³⁶ RSH.027.005.0001, .0047.

¹¹³⁷ RSH.027.005.0001, .0050–.0051.

¹¹³⁸ At shield #96 and tailgate 104 3–4 cut-through, respectively.

¹¹³⁹ Graham’s Ratio is explained in Chapter 6, which also discussed that for typical Bowen Basin coal a Graham’s Ratio >1.0 indicates a heating, and >2.0, a ‘serious heating/fire’.

- 9.170 At a meeting at 7:30am the next day, 7 June 2020, it was noted that the '[c]urrent ventilation strategies...[had] not achieved inertisation of the combustion source...'.¹¹⁴⁰ There was then a discussion about whether to increase the level of inertisation, or to conduct a ventilation change to reduce the longwall face ventilation as much as possible. It was decided to pursue the latter strategy.
- 9.171 Late on the evening of 7 June, after a risk assessment had been conducted, multiple emails with the Chief Inspector of Coal Mines exchanged, a permit to change ventilation prepared and approved, and a job safety analysis completed, the ventilation change proceeded as planned.
- 9.172 By 1:15am on 8 June, all of the underground steps in the ventilation change had been completed and workers returned to the surface. No workers were thereafter permitted underground. The final step in the process was to adjust the 'knife gate' on Shaft No. 9 from the surface.¹¹⁴¹ This was completed at 1:37am.
- 9.173 At 2:45am, there was an ignition of methane on the longwall.
- 9.174 As with the earlier high potential incidents and the serious accident, the mine conducted an investigation and produced a Learning From Incidents (LFI) report. It identified the following factors as contributing to the ignition:¹¹⁴²
- a. the need to preserve the incident scene after 6 May meant that the mine had limited access to potentially damaged ventilation control devices at the tailgate end of the longwall;
 - b. because of strata difficulties, the longwall had been double-chocked in that area, inhibiting the flow of ventilation along the face;
 - c. the longwall had been stationary for an extended period, allowing a continual ventilation pathway into the goaf;
 - d. the ventilation system design involving dual returns down to 34 cut-through and thereafter a single return. That design involved seals at each of cut-throughs 34 to 41 between the two roadways. Those seals were suspected to have been damaged, allowing part of the goaf stream to report to C heading. After 6 May, when ventilation along the face was restricted, the path of least resistance for fresh air was through the goaf, past those damaged seals and into C heading;
 - e. the TARP for spontaneous combustion in the active goaf was deficient in that it did not contemplate response levels for monitoring at the goaf stream or localised heating indicators. For example, no response was required by the TARP for a Graham's Ratio of 0.5 at shield #96 or the goaf stream;

¹¹⁴⁰ RSH.027.005.0001, .0056.

¹¹⁴¹ A 'knife gate' is a type of valve that closes by placing a barrier in the path of a gas or liquid, in this case the ventilation flow into the mine.

¹¹⁴² RSH.027.005.0001, .0062–.0067.

- f. the impacts of nitrogen inertisation appear to have been limited, mainly because the injection system did not provide adequate flow. Further, despite the presence of oxygen behind seals in the active goaf, the TARP contained no triggers that required any action.

9.175 The likely cause of the ignition itself was said to have been:¹¹⁴³

- a. accelerated oxidation (a reference to spontaneous combustion) occurring within the goaf environment;
- b. reversal of pressure driver (maingate becoming the low-pressure side of the face instead of the tailgate), amending airflow pathways and in turn oxygen/methane levels within the goaf environment; and
- c. greater than 5% methane being drawn across the location of the accelerated oxidation event site.

9.176 Significantly, the 'Control Analysis' acknowledged the shortcomings of the mine's ventilation system, as set out in the following extract from the Control Analysis Table:¹¹⁴⁴

Absent OR Failed control and support systems	How did they perform?	Why?	Outcome
Ventilation System	Partially effective. Did not fully manage CH ₄ at TG if post drainage fails	Extent of pre-drainage (reliant on post drainage to be fully effective)	Reliance on high longwall ventilation quantities and pressure to manage TG methane load
			Increased spontaneous combustion risk
Methane pre-drainage	Partially Effective	Underlying and overlying methane bearing seams have significant impact on LW TG methane levels	Reliance on post drainage measures
		Elevated methane levels in TG roadway when post drainage system reduced	Reliance on higher post drainage density (TARP driven) leading to potential to move oxygen and explosion fringe around goaf

Figure 168: Extract from Control Analysis Table

¹¹⁴³ RSH.027.005.0001, .0068.

¹¹⁴⁴ RSH.027.005.0001, .0058–.0059.

9.177 The authors of the LFI report also wrote:¹¹⁴⁵

It is recommended to further identify the pre-drainage opportunities (both underlying and overlying methane bearing coal seams) through detailed gas reservoir analysis to reduce reliance on ventilation quantities and post goaf drainage measures. This in turn will reduce differential pressures across the face and goaf, and in turn spontaneous combustion risk.

9.178 Thus, the mine found that:

- a. coal seams underlying and overlying the seam being mined contributed significantly to specific gas emissions on LW 104;
- b. its failure to sufficiently pre-drain LW 104 led to a reliance on high longwall ventilation quantities and pressure to manage gas emissions, thereby increasing the spontaneous combustion risk;
- c. similarly, the failure to sufficiently pre-drain meant a reliance on higher post-drainage that caused oxygen ingress to the goaf and elevated methane levels in the tailgate when post-drainage was reduced; and
- d. when the mine ventilation changed, an explosible mixture containing methane was drawn across an area where ‘accelerated oxidation’ was occurring.

9.179 In the Board’s view, three of the above four factors identified by the mine as contributing to the ignition on 8 June 2020 were present prior to the serious accident on 6 May. It is arguable that the only difference between the two events was the cause of the ‘ventilation change’, which on 6 May is likely to have been an event in the goaf which resulted in an explosible mixture of methane being moved to, or towards, the longwall and over an area of accelerated oxidation.

9.180 The mine also concluded that there ought to have been a spontaneous combustion TARP for the goaf stream.

9.181 It is noted that neither of the tube bundles in the tailgate, nor those located at goaf seals, detected signs of the heating prior to 2 June 2020; rather, the signs of incipient spontaneous combustion were picked up in the goaf stream and on a specially installed tube bundle at shield #96. Even as late as 31 May, the mine was being advised that there were no signs of abnormal oxidation. This underscores the previously discussed difficulties associated with detecting a small but intense heating against a background of high ventilation flows, and a large amount of oxidising coal within the goaf. It highlights the importance of monitoring in the correct locations¹¹⁴⁶ and with appropriate TARP parameters and trigger points.

¹¹⁴⁵ RSH.027.005.0001, .0068.

¹¹⁴⁶ TRA.500.022.0001, .0033, lines 41–46.

Recognised standard 16

- 9.182 The Recognised standard,¹¹⁴⁷ section 13.1 – polymeric chemicals, only addresses the risks of the products themselves catching fire. It does not address the risk of spontaneous combustion as a result of the products causing coal to heat.
- 9.183 Polymeric chemicals are used extensively throughout underground coal mines in Queensland.
- 9.184 As noted above, if heated to 100°C, GM seam coal can undergo thermal runaway. All known testing of the PUR product used at Grosvenor in the lead up to the serious accident showed that it cured between 138.8°C and 146.53°C.
- 9.185 Depending on the type of coal and the curing temperature of products used, the risk of spontaneous combustion resulting from the application of polymeric chemicals will be an ongoing concern for mines.

Coal dust explosions

- 9.186 Methane explosions can be initiating events for more serious coal dust explosions. The methane explosion at Grosvenor did not initiate such an event. It is appropriate to review the measures that prevented the methane explosion from initiating a coal dust explosion.
- 9.187 The Board examined the most recent results for stone dusting in the LW 104 return immediately preceding the serious accident for compliance with section 301 of the *Coal Mining Safety and Health Regulation 2017* (Qld) (the Regulation).
- 9.188 The application of stone dust to the roof, sides and floor of a roadway is designed to prevent or suppress a coal dust explosion by maintaining the incombustible content of the roadway dust above prescribed levels.¹¹⁴⁸ The Regulation prescribes a minimum of 85% incombustible material for dust in a 200 metre section of panel roadway within 400 metre of a longwall face.¹¹⁴⁹
- 9.189 The last set of sample results before the serious accident provided to the Board for the LW 104 return roadway were taken on 28 April 2020. The table below sets out the results from samples taken in the longwall return roadway between 35 cut-through to 38 cut-through which corresponds to a distance of approximately 300 metres.¹¹⁵⁰

¹¹⁴⁷ Mines Inspectorate, Mine Safety and Health, Department of Natural Resources, Mines and Energy, *Recognised standard 16: The use and control of polymeric chemicals at underground coal mines*, Queensland Government (Recognised Standard under the *Coal Mining Safety and Health Act 1999*, April 2019)

<https://www.resources.qld.gov.au/__data/assets/pdf_file/0005/1445972/recognised-standard-16.pdf>; BOI.019.001.0001.

¹¹⁴⁸ Regulation, section 300.

¹¹⁴⁹ Regulation, section 301.

¹¹⁵⁰ AGM.016.001.0001, .0002.

Laboratory Number	Area/Zone	Location in tailgate 104 B heading	Sampling Date	% Incombustible Material
OM30311/08	03032	37c/t to 38c/t	28/04/2020	91.7
OM30311/07	03031	36c/t to 37c/t	28/04/2020	83.7
OM30311/06	03030	35 c/t to 36c/t	28/04/2020	74.4

Figure 169: Stone dusting results

9.190 The samples taken between 37 and 38 cut-through in the LW 104 return represent the incombustible content within the first 100 metres outbye the face. This is a high level of incombustible content and would be expected to prevent a methane explosion initiating a coal dust explosion.

9.191 The high standard of stone dusting in the LW 104 return, adjacent to the longwall face, was noted by Mr Andrew Self during evidence.¹¹⁵¹

Q. So any of those factors were potentially present at this time when the explosion took place?

A. I don't think the risk of coal dust explosion was high. That tailgate was stone-dusted to a standard which is higher than I've seen.

9.192 The importance of ensuring compliance with the prescribed stone dusting standards cannot be overstated. In the case of the serious accident at Grosvenor, the high levels of incombustible content within the first 100 metres of the LW 104 return, outbye the face, may well have prevented a major coal dust explosion.

¹¹⁵¹ TRA.500.021.0001, .0089, lines 36 – 40.

Findings

Finding 70

The cause of the second pressure wave was a methane deflagration on the longwall face.

Finding 71

The probable ignition source for the methane deflagration on the longwall face was the PUR-initiated heating of coal to thermal runaway, which ignited an explosible atmosphere behind the longwall in the vicinity of shield #111, resulting in a flame propagating onto the longwall face. The combination of circumstances which support this conclusion are:

- a. The polyurethane resin (PUR) 'DSI Strata Bond HA' generates heat while curing, potentially achieving temperatures as high as 146.5°C;
- b. PUR has the capacity to heat adjacent coal;
- c. In certain proportions, a mixture of PUR and Goonyella Middle (GM) seam coal has the potential to reach 100°C as a result of the heat generated from the curing of the PUR;
- d. If heated to 100°C, GM seam coal has the potential to undergo thermal runaway to a temperature sufficient to ignite a mixture of methane and air;
- e. The quantity of coal required to be heated so as to initiate such an ignition may be as small as the size of a tennis ball;
- f. Approximately 5,600 litres of DSI Strata Bond HA was injected into the face from shield #97 to shield #132 on 3 May;
- g. The ignition source was located in the vicinity of the rear of shield #111;
- h. PUR injected into the longwall face and roof on 3 May 2020 had the potential to initiate a heating of adjacent coal;
- i. The heated coal had the potential to reach thermal runaway once exposed to air, either in the roof after the injected area had been mined through, or after it caved into the goaf behind the longwall shields;
- j. The distance of retreat of the longwall over the days that intervened between the injection of PUR on 3 May and the ignition on 6 May 2020 was such that PUR-affected coal was likely to have been in the goaf immediately behind the shields on 6 May;
- k. In normal conditions, that residence time of the coal immediately behind the shields would not be sufficient for the coal to reach thermal runaway without an external heat source;
- l. An increase in carbon monoxide, indicative of coal heating, was detected at goaf well GRO4M001.5, which penetrated the goaf at about shield #100, on the morning of 6 May 2020;

- m. On 20 May 2020, after the serious accident, a heating was detected in the area immediately behind shield #96, proximate to the area of the PUR campaign on 3 May; and
- n. The other potential ignition sources are unlikely.

Finding 72

The mine's risk assessment for the change from Minova PUR to the DSI product did not address spontaneous combustion risk and concluded that there was no significant difference between the two products.

Finding 73

In light of the results of testing by the New South Wales Mine Safety Technology Centre and the Arnsberg Regional Authority, the DSI risk assessment report for its PUR product understated its curing temperature.

Finding 74

Recognised standard 16 does not address the risk of spontaneous combustion resulting from polymeric chemicals heating coal to thermal runaway. It is essential that this risk be addressed in the standard.

Finding 75

The level of stone dust maintained in the first 100 metres of longwall return outbye the face was sufficient to suppress a coal dust explosion and prevent it from propagating to other parts of the mine.

Recommendations

Recommendation 13

Coal mines conduct a thorough risk assessment for the use of polymeric chemicals, especially polyurethane resins, which includes a consideration of the risk of spontaneous combustion of coal being initiated by the product, before introduction and application at site.

Recommendation 14

The industry undertake research into polyurethane resins to determine the extent to which their use poses a risk of initiating spontaneous combustion of coal.

Recommendation 15

Resources Safety & Health Queensland takes steps to ensure that Recognised standard 16 is reviewed through the consultative process provided by the Coal Mining Safety and Health Advisory Committee, and that consideration is given to including a requirement within the standard that Site Senior Executives ensure a risk assessment is conducted in respect of the potential hazard arising from polymeric chemicals heating adjacent coal, resulting in spontaneous combustion.

Chapter 10 – Proactive inertisation of the active goaf, and strategies to limit oxygen ingress

Introduction

- 10.1 Oxygen and methane are typically present in the active goaf to varying degrees. Inertisation involves the displacement of oxygen from the goaf (or any workings) by means of an inert agent. The concept of excluding oxygen from a fire or heating by the introduction of an oxygen-free gas is well known, and ‘has been the principal means of extinguishing or controlling goaf heatings for hundreds of years’.¹¹⁵²
- 10.2 In 1987, the Moura No. 4 Inquiry found that the use of nitrogen as a method of inertisation ‘has been successful overseas as well as in Australia and obviously warrants more attention as a potential method of dealing with...spontaneous heating’.¹¹⁵³
- 10.3 Inertisation has since been widely deployed to lower the risk of potential explosions during longwall panel sealing.
- 10.4 Dr Ting Ren, Associate Professor of Mining Engineering at the University of Wollongong, gave the following description of the nature and object of proactive inertisation of an active goaf:¹¹⁵⁴
- [T]he active goaf inertisation basically refers to the action of creating an inert atmosphere in goaf areas and in underground coal mines by means of injecting inert materials such as inert gas to deplete or reduce oxygen concentrations to a low level that would effectively suppress or contain the onset of active coal oxidation or spontaneous heating or potentially a gas explosion situation.*
- 10.5 Numerous underground coal mine fires and explosions have occurred in goafs in both New South Wales (NSW) and Queensland since underground mining commenced in the 1800s. Many of these events have been associated with the loss of lives, the most recent being the Moura No. 2 explosion in 1994.
- 10.6 The next section describes some further events since the Moura No. 2 explosion. Whilst these more recent events did not result in catastrophic incidents involving loss of life, the potential for this to have happened was very real. The economic loss to the mines in question was also enormous.

¹¹⁵² Cliff, D., Brady, D. & Watkinson, M., *The Green Book – Spontaneous Combustion in Australian Coal Mines* (SIMTARS, 2018), page 238; WMA.003.004.0001, .0240.

¹¹⁵³ Mining Warden’s Inquiry, *Report On An Accident at Moura No. 4 Underground Mine on Wednesday, 16th July, 1986*, Queensland Government (Report, June 1987)
<<https://www.publications.qld.gov.au/dataset/685e8b8b-7113-4693-af73-a2143526f077/resource/2c4d43e7-5448-44b9-b1c8-b11d2a534c41/download/moura4.pdf>>, page 24.

¹¹⁵⁴ TRA.500.023.0001, .0003, lines 39–46.

- 10.7 This history, including what the Board has found as to the cause of the serious accident at the Grosvenor mine (Grosvenor) on 6 May 2020, justifies consideration of the role that proactive inertisation might play in the Queensland coal mining industry to enhance management of the risks of fire and heating events in active goafs, in the interests of safety and health.
- 10.8 As will be explained, there are practical limitations to the efficacy of regimes for gas monitoring for spontaneous combustion, including the element of human error. The deficiencies of spontaneous combustion identification and monitoring systems, identified in evidence to the Board, provide further reason to consider the role of proactive inertisation in conjunction with those systems.
- 10.9 As will appear from this chapter, proactive inertisation is most effective when employed in conjunction with other measures to limit oxygen ingress to the goaf. Dr Ren said in his evidence:¹¹⁵⁵

In addition to the use of inert materials, such as inert gas, this process could involve a combination of other actions, for example, ventilation controls, pressure balancing, seals, injection of other materials, depending, like foams, slurries, things like that, to minimise oxygen ingress into the goaf area.

- 10.10 Dr Rao Balusu, Senior Principal Mining Engineer at CSIRO Energy, and Dr Ren, each responded in writing to a list of questions submitted to them by the Board concerning topics related to proactive inertisation of the active goaf.¹¹⁵⁶ Dr Ren also gave oral evidence at the Board's public hearings. Both experts participated in a major Australian Coal Association Research Program (ACARP) project in 2005¹¹⁵⁷ to do with proactive inertisation of active goafs, and have otherwise published articles related to the subject. A long list of published reference material was also provided by Dr Balusu with his responses to the Board. The discussion in this chapter draws from their evidence, and published material as referenced.

Some past fire or explosion events

- 10.11 The foreword by Mr Mark Stone¹¹⁵⁸ to the SIMTARS publication *Spontaneous Combustion in Australian Coal Mines* commences with the following statement:¹¹⁵⁹

Spontaneous combustion is a major hazard in underground coal mining operations. If not detected early and managed properly, it can lead to death, injury, and productivity loss.

¹¹⁵⁵ TRA.500.023.0001, .0004, lines 1–6.

¹¹⁵⁶ BAL.001.001.0001; RET.001.001.0001.

¹¹⁵⁷ Balusu, R., Ren, T. & Humphries, P., *Proactive Inertisation Strategies and Technology Development* (2005) Project No. C12020 Report, Australian Coal Association Research; BOI.036.001.0001.

¹¹⁵⁸ Mr Stone is the CEO of the Regulator, Resources Safety & Health Queensland.

¹¹⁵⁹ Cliff, D., Brady, D. & Watkinson, M., *The Green Book – Spontaneous Combustion in Australian Coal Mines* (SIMTARS, 2018); WMA.003.004.0001, .0005.

Sadly, spontaneous combustion initiated explosions have been the cause of many mining disasters and significant loss of life throughout centuries of coal mining internationally and in Australia.

10.12 This section lists some of the events that have occurred in the last twenty years where mines, or parts of a mine, have had to be sealed and abandoned due to fire or explosion within the active goaf:

- a. An underground fire broke out in December 2003 at the Southland Colliery in NSW.¹¹⁶⁰ It resulted in the closure of the mine and the complete loss of the longwall equipment that was mining longwall SL4 (LW SL4). The cause of the fire was determined to be a heating event that started in the previous longwall goaf and spread to the active goaf.

The Southland mine was exploiting the Greta seam which varied in thickness from 4.8 metres to 7.0 metres but only the lower 3.5 metres of the seam was extracted. The top of the seam caved into the active longwall goaf.

- b. On 5 January 2011, a low-pressure methane explosion occurred at the NSW Blakefield South Mine somewhere in the tailgate area adjacent to 20 cut-through of LW 1. A methane fire was observed coming from the tailgate goaf shortly after the explosion. The mine personnel were evacuated, and the mine was sealed. The longwall equipment was not recovered. The investigation by the NSW Mine Regulator stated that there were two plausible sources of ignition that could neither be confirmed nor eliminated. These were:¹¹⁶¹

- a surface lightning strike and a subsequent conduction to the underground goaf; and
- a spontaneous combustion event that had remained undetected.

The overlying Whynot, Wambo and Redbank Creek seams caved into the LW 1 goaf during extraction and may have provided a fuel source for a potential spontaneous combustion event.

The investigation report also made note of the levels of oxygen within the goaf due to a ventilation arrangement in place at the time of the explosion. It said:¹¹⁶²

¹¹⁶⁰ Gallagher, R., *Southland heating and mine fire – Part 1*, Australia's Mining Monthly (Online Magazine, February 2004) <<https://www.miningmonthly.com/markets/international-coal-news/1284859/southland-heating>>.

¹¹⁶¹ NSW Trade & Investment, Mine Safety, *Investigation Report: Fire and explosion on Longwall No 1 Tailgate at the Blakefield South Mine 5 January 2011*, NSW Government (Report, May 2012) <https://www.resourcesandgeoscience.nsw.gov.au/__data/assets/pdf_file/0010/457354/Blakefield-South-Investigation-report-060213.pdf>, page 47.

¹¹⁶² NSW Trade & Investment, Mine Safety, *Investigation Report: Fire and explosion on Longwall No 1 Tailgate at the Blakefield South Mine 5 January 2011*, NSW Government (Report, May 2012) <https://www.resourcesandgeoscience.nsw.gov.au/__data/assets/pdf_file/0010/457354/Blakefield-South-Investigation-report-060213.pdf>, page 12.

Leaving the 21 cut-through open has allowed more air to pass across the goaf parallel to the face and behind the chocks. This created a situation of increased oxygen availability that assisted goaf gas burning during the January 2011 incident.

- c. The North Goonyella Mine in Queensland was evacuated on 1 September 2018 due to high methane levels coming from the LW 9N goaf.

Between 2 and 26 September, Peabody Pty Ltd, the operator of the mine, made attempts to manage suspected heating of coal, to enable re-entry to the mine and continue mining operations. Smoke was observed coming from the mine ventilation shaft on 27 September, indicating an advanced underground fire.¹¹⁶³

The North Goonyella mine had a history of spontaneous combustion events with two previous events resulting in the sealing and subsequent loss of the longwall. The LW 5 South panel was sealed in September 1999 with the subsequent loss of all longwall equipment. The LW 7 North panel was sealed in February 2014, also resulting in the loss of the longwall equipment.¹¹⁶⁴

The North Goonyella mine was extracting the Goonyella Middle (GM) seam, leaving approximately 2 metres of coal in the roof. This roof coal caved into the goaf during longwall extraction.

- d. Subsequent to the methane ignition event at Grosvenor on 6 May 2020, an increasing spontaneous combustion trend was observed through gas monitoring of the LW 104 goaf. Grosvenor mine management communicated to the Inspectorate on 8 June that a methane explosion had occurred in LW 104 after completing a ventilation change.¹¹⁶⁵ During July 2020, the LW 104 panel was sealed up. The longwall equipment is lost.

10.13 The economic loss alone justifies a review of how active goafs are managed within the Queensland coal mining industry. Of course, the risk to life makes it an imperative.

10.14 The common factors in each of these events have been a fire or heating in the goaf of the active longwall and the presence of substantial volumes of coal within the caved mass of the goaf. The risk of spontaneous combustion increases significantly during longwall mining where large quantities of broken coal are left behind the shields with exposure to high oxygen levels in the goaf.¹¹⁶⁶

¹¹⁶³ Queensland Mines Inspectorate, Resources Safety & Health Queensland, *Mines Safety Bulletin No. 174: Incident at North Goonyella Coal Mine – Version 1, 28 September 2018*, Queensland Government (Safety Bulletin, September 2018) <<https://www.rshq.qld.gov.au/safety-notices/mines/incident-at-north-goonyella-coal-mine>>.

¹¹⁶⁴ RSH.002.421.0001, .0018; .0020.

¹¹⁶⁵ RSH.003.001.1645.

¹¹⁶⁶ Balusu, R., Ren, T. & Humphries, P., *Proactive Inertisation Strategies and Technology Development* (2005) Project No. C12020 Report, Australian Coal Association Research, page 1; BOI.036.001.0001, .0018.

- 10.15 Mining of the GM seam, as at Grosvenor, involves leaving significant remnant coal in the goaf.

Limitations of spontaneous combustion monitoring

- 10.16 To monitor and manage the underground atmosphere, Queensland coal mines typically utilise a combination of three systems: real-time telemetric sensors, tube bundle analysis and gas chromatography. Monitoring for spontaneous combustion is one purpose for which these systems are used. The well-known reference text, *Spontaneous Combustion in Australian Coal Mines*, maintains that:¹¹⁶⁷

Australian underground coal mines set the benchmark for some of the world's best practices in gas monitoring. The Queensland underground coal mining industry as a whole has arguably the most comprehensive gas monitoring systems in the world.

- 10.17 Without seeking to cast doubt on that general statement, the identification of developing spontaneous combustion, and the management of that 'major hazard', remains problematic. Some day-to-day practical deficiencies in the monitoring and identification of spontaneous combustion, a number of which relate to human error, were referred to by Mr Self in evidence to the Board. They are summarised below:

- a. Gas monitoring systems necessarily cannot give a complete picture of activity in the goaf. Mr Self said:¹¹⁶⁸

Gas monitoring takes place at a limited number of locations. We very rarely monitor in the goaf itself. We can monitor goaf wells, but you only have so many gas monitoring points, and things can happen which - they're not normally missed, but things can accelerate and not be identified at an early stage, which is not where we want to be. We need to be identifying problems at an early stage.

- b. Gas monitoring calibration can be deficient. Mr Self said that it was within his experience that:¹¹⁶⁹

Gas monitoring systems may be unreliable. Over-reliance on a gas monitoring system in that case is a problem. I've seen gas monitoring systems where as many as 50 per cent of the points weren't working.

- c. Ventilation changes have the potential to be very dangerous, exacerbating what might otherwise be a minor event. Mr Self said:¹¹⁷⁰

¹¹⁶⁷ Cliff, D., Brady, D. & Watkinson, M., *The Green Book – Spontaneous Combustion in Australian Coal Mines* (SIMTARS, 2018), page 153; WMA.003.004.0001, .0155.

¹¹⁶⁸ TRA.500.021.0001, .0046, lines 14–21.

¹¹⁶⁹ TRA.500.021.0001, .0046, lines 36–39.

¹¹⁷⁰ TRA.500.021.0001, .0038, lines 31–35; TRA.500.021.0001, .0039, lines 45–46.

Human intervention is a major factor in spontaneous combustion. I think quite often there may be a fairly minor event happening, and as operators we exacerbate the problem, typically by a ventilation change.

...

Ventilation changes are extremely high risk when there's a spontaneous combustion event happening.

- d. Mr Self explained the reason behind that statement:¹¹⁷¹

Ventilation changes have led and continue to lead to explosions. The mechanism is that a reduction in airflow to a spontaneous combustion event by means of, say, putting on seals may lead to an increase in temperature coincident with an increase in flammable gas concentration. So the reduction in airflow quantity at the event has two effects - it can increase the temperature and it can increase the concentration of gas at that location. This is where there's a long history in the UK of explosions occurring on an extraction face.

The Board notes that the spontaneous combustion-initiated methane explosion at Grosvenor on 8 June 2020 occurred less than 45 minutes after a ventilation change that was intended to '[inertise] the combustion source'.¹¹⁷²

- e. There can be inappropriate or selective use of spontaneous combustion indicators. Mr Self said:¹¹⁷³

I've seen situations - most spontaneous combustion events, I'm talking about something serious, because I don't get involved in non-serious events, mostly there's one indicator which begins to perform badly before the others do, and it's not always the same one, and some people have a particular pet indicator, and you can't afford to do that. You've got to look at a spectrum of them.

- f. There is a recurring tendency by operators towards denial of indications of spontaneous combustion. In the following exchange with Counsel Assisting, Mr Self said:¹¹⁷⁴

Q. What do you mean when you say that there can be a tendency to trust the benign indicators and discount adverse ones?

A. This is what I call denial. Operators never want to admit they have a spontaneous combustion event happening. The reason for that is it will mean that you stop production, you evacuate the mine and you have to report to your boss that you've done that.

¹¹⁷¹ TRA.500.021.0001, .0040, lines 17–26.

¹¹⁷² RSH.027.005.0001, .0056–.0057.

¹¹⁷³ TRA.500.021.0001, .0048, lines 12–19.

¹¹⁷⁴ TRA.500.021.0001, .0048, line 43–.0049, line 14.

I've seen it many, many times. It's a real thing. We get adverse indication on one spontaneous combustion indicator. We don't believe that one. We believe the other four that say things are okay. But they may be saying it's okay for a good reason, and the one that's giving the adverse reading may be doing that for a good reason as well.

I've seen people try and find any excuse for having identified a bad indicator.

- 10.18 Trigger Action Response Plans (TARPs) define the actions required by site personnel in response to deviation from what is considered to be normality in mine conditions. Through human error there can be inadequate responses to TARPs. Mr Self gave the following description:¹¹⁷⁵

It's [the response to spontaneous combustion indicators] also TARP driven. When gas monitoring alarms are raised, then that raises a TARP...Which introduces a human element. There have been cases where the person has not used the correct TARP. There may be cases where the person doesn't know what it means or doesn't know how to react or he's very busy and is doing something else because the conveyors have stopped. So as soon as you introduce the human element, you introduce a variability which you can't control.

- 10.19 Apart from the question of responding appropriately to TARPs, a further issue can arise with the appropriateness of the response triggers. The *Spontaneous Combustion in Australian Coal Mines* book points out that defining normality is one thing, but '[w]hat is not so easy to define is the degree of increasing risk, and when the higher levels of a TARP should be invoked'.¹¹⁷⁶
- 10.20 Mr Self's view was that a spontaneous combustion event was the most likely cause of the serious accident, despite the absence of detection of signs by the mine's gas monitoring systems.¹¹⁷⁷ The absence of detection, he said, was a 'major concern'. He elaborated in the following exchange with Counsel Assisting:¹¹⁷⁸

Q. You say the absence of any detection by the traditional indicators beforehand is of major concern. Can you elaborate on that, as to why it's a concern?

A. We monitor for spontaneous combustion. We design systems to minimise the risk of spontaneous combustion. We gas monitor. We analyse data. Based on that data, we take actions such as inertisation.

¹¹⁷⁵ TRA.500.021.0001, .0046, lines 23–34.

¹¹⁷⁶ Cliff, D., Brady, D. & Watkinson, M., *The Green Book – Spontaneous Combustion in Australian Coal Mines* (SMTARS, 2018), page 115; WMA.003.004.0001, .0117.

¹¹⁷⁷ SAN.001.001.0001, .0049.

¹¹⁷⁸ TRA.500.021.0001, .0043, lines 35–46.

If we don't know that a spontaneous combustion event is beginning and even progressing, then we're unable to take action, and one of those actions may be to evacuate people. If we don't know it's there, then we can't take those appropriate actions, whatever they may be.

- 10.21 The nature and extent of gas monitoring at Grosvenor has been considered in detail in Chapters 6 and 8. The Board has found that the probable cause of the first pressure wave was a methane explosion in the goaf, initiated by spontaneous combustion. It has also found that the probable ignition source for the methane deflagration was a PUR-initiated spontaneous combustion. Neither heating was detected by the mine's gas monitoring methods.
- 10.22 Similarly, the mine's monitoring methods failed to give early warning of the developing heating that led to the explosion on 8 June 2020. Even as late as 31 May, relying on the mine's monitoring methods, the mine was advised that there were 'no indications of abnormal oxidation'.¹¹⁷⁹
- 10.23 The fact that those scenarios could develop, despite the use of conventional monitoring systems that did not clearly detect them, is of major concern.
- 10.24 Notwithstanding the sophistication of gas monitoring equipment, these apparent deficiencies raise the question whether management of the hazard of spontaneous combustion, and underground fires, would be assisted by a program of routine and continuous inertisation of the active goaf.

The elements of combustion

- 10.25 Three ingredients are needed for combustion to occur, namely:
- fuel;
 - oxygen; and
 - heat.
- 10.26 All three ingredients may exist within the goaf, in that:
- the fuel can be either methane gas or coal;
 - oxygen will be present in the goaf to some degree due to ingress of air from the ventilation system or through boreholes or other connections to the surface;
 - heat could arise from several sources, including the spontaneous combustion of coal left in the goaf.
- 10.27 Removal of any one of these ingredients will prevent a fire or explosion occurring within the goaf.

¹¹⁷⁹ RSH.027.005.0001, .0050–.0051.

- 10.28 It is not possible to remove the fuel from the goaf, as methane will be released through the fracturing and depressurising of adjacent coal seams both above and below the extracted seam. Furthermore, where selective mining of a thick seam is practised, residual coal from the roof or floor will form part of the caved goaf.
- 10.29 Ignition sources must be identified and managed according to their mechanism. However, the most practical preventative measure against fire and explosion is to ensure that an explosive atmosphere in a mine does not exist in the presence of any potential ignition source. This indicates that removal of oxygen from the goaf is the most practical way to reduce the risk of a fire or explosion from occurring within that location.
- 10.30 Removing oxygen from the goaf and reducing the risk of a fire or explosion can be achieved through:
- a. limiting oxygen ingress to the active goaf, so far as practicable, through proactive inertisation strategies; and
 - b. employing other strategies to reduce oxygen concentrations within the active goaf.
- 10.31 Both aspects are discussed below.

Modelling the extent of oxygen ingress to the active goaf

- 10.32 It is difficult to directly measure the oxygen concentration deep within the goaf due to the area being inaccessible.
- 10.33 Analysis of the typical extent of oxygen ingress to the goaf was a significant part of an ACARP project in 2005.¹¹⁸⁰ The project utilised field studies at two mines and computational fluid dynamics (CFD) to characterise oxygen ingress patterns and concentrations within the goaf.
- 10.34 Figure 170 illustrates the typical goaf gas distribution behind the longwall face, derived from gas monitoring at seven points around the longwall goaf perimeter at one of the mines involved in the study.¹¹⁸¹

¹¹⁸⁰ Balusu, R., Ren, T. & Humphries, P., *Proactive Inertisation Strategies and Technology Development* (2005) Project No. C12020 Report, Australian Coal Association Research; BOI.036.001.0001.

¹¹⁸¹ Ren, T. & Balusu, R., *Proactive goaf inertisation for controlling longwall goaf heatings* (2009) *Procedia Earth and Planetary Science* volume 1: page 309, at 310; BOI.036.002.0001, .0002.

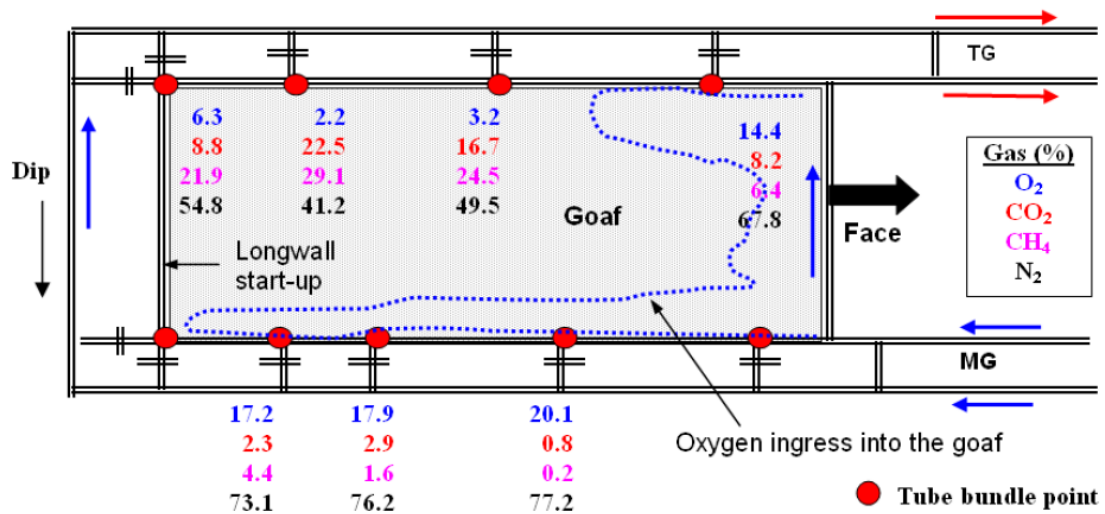


Figure 170: Typical gas distribution in a longwall goaf

- 10.35 The dashed blue line represents where oxygen concentrations are estimated to be around 12%. This forms the boundary between an atmosphere where an explosive methane mixture can form and one where the atmosphere is too oxygen deficient for an explosive mixture to form. The results show high levels of intake air ingress on the maingate side of the panel, with the oxygen concentration at more than 17% up to 400 metres inbye of the longwall face. Oxygen ingress on the tailgate side of the panel was less due to higher goaf gas emissions in the panel.¹¹⁸²
- 10.36 Researchers have used CFD modelling extensively within Australia and overseas to understand the complicated nature of gas flows within the goaf and gain a better understanding of how induced inertisation affects the composition and movement of gases within the goaf. The oxygen distribution within the active goaf, as analysed by CFD modelling, is depicted in Figure 171.¹¹⁸³

¹¹⁸² Balusu, R., Ren, T. & Humphries, P., *Proactive Inertisation Strategies and Technology Development* (2005) Project No. C12020 Report, Australian Coal Association Research, page 7; BOI.036.001.0001, .0024.

¹¹⁸³ Balusu, R., Ren, T. & Humphries, P., *Proactive Inertisation Strategies and Technology Development* (2005) Project No. C12020 Report, Australian Coal Association Research, page iii; BOI.036.001.0001, .0009.

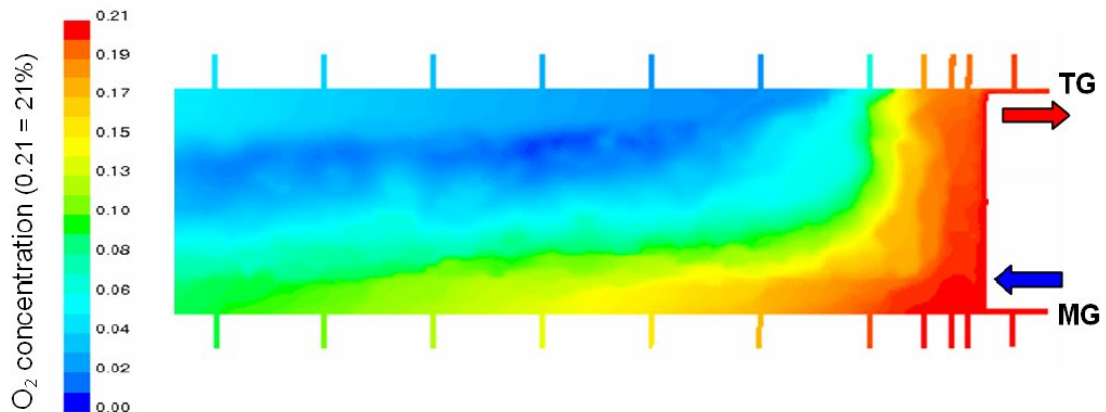


Figure 171: Oxygen distribution in the longwall goaf – a base model result

10.37 It can be seen that the CFD base case model in Figure 171 closely matches the measured oxygen distribution illustrated in Figure 170. These models further show that the major location of oxygen ingress to the active goaf is at the maingate side of the longwall face.

Inertisation strategies

10.38 Significant oxygen ingress to the goaf can lead to spontaneous heatings, particularly during face stoppage or slow face retreat in the panel. This requires the deployment of inertisation strategies based upon a detailed understanding of goaf gas flow patterns and distribution characteristics.¹¹⁸⁴

10.39 The 2005 ACARP study demonstrated that inert gas injection at a location close behind the face line will only have negligible impact on goaf inertisation, as most of the inert gas injected will simply disperse into the main ventilation stream and disappear into the return airflow.¹¹⁸⁵ This is illustrated in Figure 172.¹¹⁸⁶ The model indicates that the most effective injection locations should be at least 200 metres behind the face line on the maingate side.

10.40 The implication of this finding is that it will be difficult to implement effective inertisation during the early stage of goaf formation, and until the longwall face has retreated at least 200 metres from commencement.

¹¹⁸⁴ Balusu, R., Ren, T. & Humphries, P., *Proactive Inertisation Strategies and Technology Development* (2005) Project No. C12020 Report, Australian Coal Association Research, page 5; BOI.036.001.0001, .0022.

¹¹⁸⁵ Ibid. page 33; BOI.036.001.0001, .0050; see also TRA.500.023.0001, .0008, lines 32–39.

¹¹⁸⁶ Ibid. page v; BOI.036.001.0001, .0011.

10.41 Image (c) from Figure 172 illustrates the extent to which oxygen has been displaced from the goaf by the inertisation process. It also indicates that while oxygen ingress and explosive atmospheres cannot be eliminated from the goaf through active inertisation, they can be significantly reduced in area, so as to lower the risk of a heating or explosion occurring.

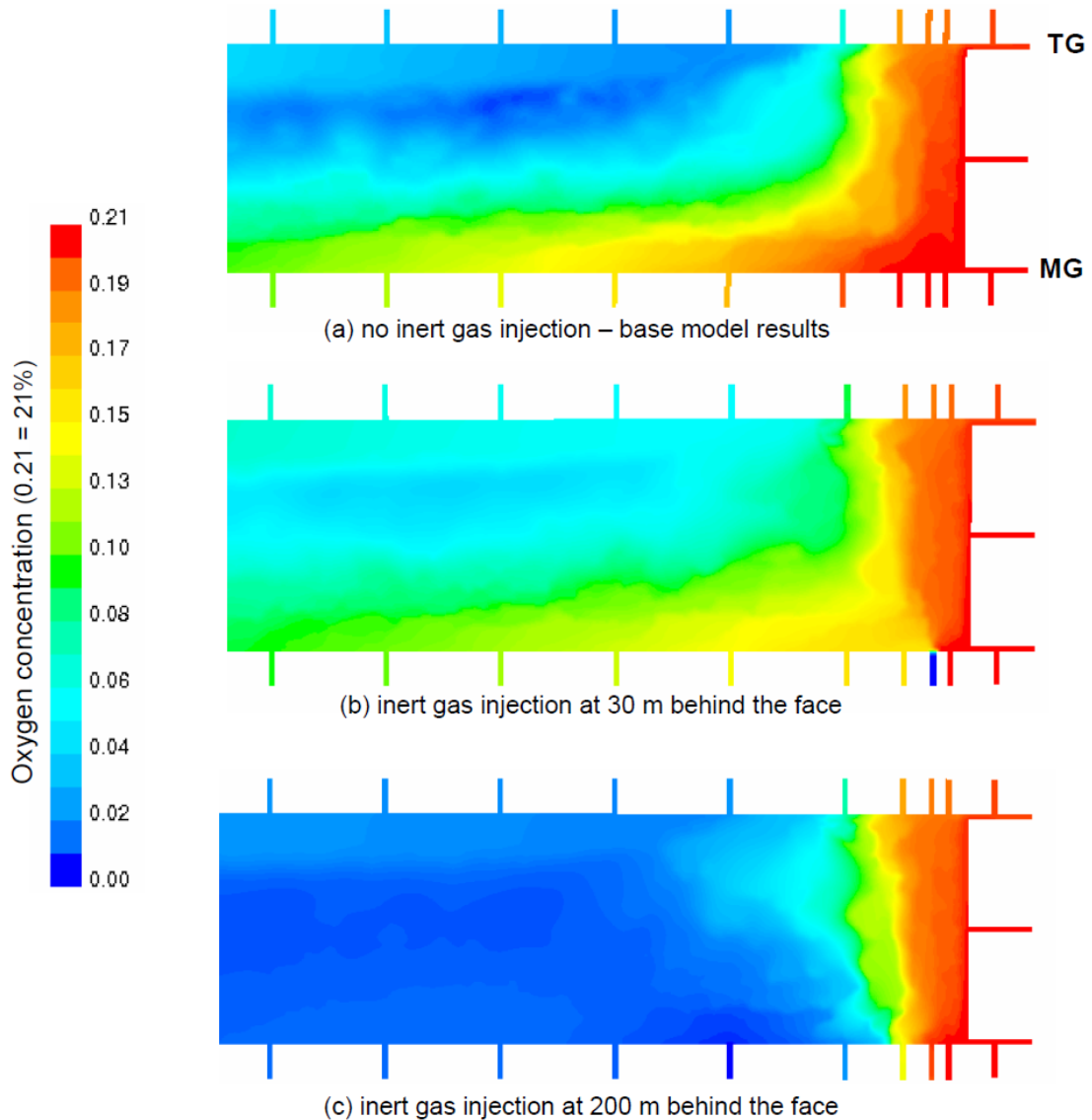


Figure 172: Figure in 2005 ACARP Study: CFD Modelling of Goaf Inertisation

10.42 The 2005 ACARP report recommended guidelines for proactive goaf inertisation, namely:¹¹⁸⁷

- inert gas should be injected into the goaf at 200 to 400 m behind the face, or inbye side of a suspected heating location in the goaf.

¹¹⁸⁷ Balusu, R., Ren, T. & Humphries, P., *Proactive Inertisation Strategies and Technology Development* (2005) Project No. C12020 Report, Australian Coal Association Research, pages ix-x; BOI.036.001.0001, .0015-.0016.

- *inert gas flow rate of around 0.5 m³/s is recommended for most cases¹¹⁸⁸ – this inertisation rate may need to be increased or decreased based on field conditions.*
- *inert gas should be injected on intake side of the goaf in most cases.*
- *inert gas may be injected through goaf holes (preferable, if goaf holes are available) or through cut-throughs on the intake side of the goaf.*
- *inert gas may need to be injected on both sides of the goaf if some heating is suspected on return side of the goaf.*
- *onsite nitrogen generation units or boiler gas are recommended for proactive inertisation into longwall goafs.*
- *inert gas injection to be continued until face resumes normal production in case of prolonged stoppages or until face has retreated for more than 300 to 500 m past the suspected heating location, in case of heatings.*
- *ventilation system in and around the panel also should be designed to minimise oxygen ingress into the longwall goaf for effective inertisation.*

10.43 In his answers to the Board, Dr Balusu nominated the ‘suggested effective and practical strategy’ for inertisation under normal retreat operations, indicating the continued relevance of the above guidelines from 2005. He said:¹¹⁸⁹

- *...injection of inert gas directly into the goaf at strategic deep locations, i.e. at the inbye locations, at high flow rates would be the suggested effective and practical strategy under normal longwall retreat operations. Studies indicated that inert gas should be injected into the deep goaf (at least more than 200m behind the face) at multiple strategic points to minimise oxygen ingress into the active goaf.*
- *...[this practice] would allow the inert gas to fill the goaf and spill out towards the face which assists in minimising oxygen ingress into the goaf. In addition, injection of inert gas deep into the goaf will be more effective and require lower volumetric rates than shallow inert gas injection.*

10.44 Dr Balusu and Dr Ren both emphasised the need for proactive inertisation strategies to be developed according to site conditions. Dr Balusu said in his written answers to the Board:¹¹⁹⁰

...the success or failure of inertisation operations depends entirely on the design and implementation of appropriate inertisation strategies to suit local mining conditions.

¹¹⁸⁸ As indicated in paragraph 10.54, more recent estimates are for flow rates at around 1,500–2,000 l/s.

¹¹⁸⁹ BAL.001.001.0001, .0020.

¹¹⁹⁰ BAL.001.001.0001, .0008.

10.45 Dr Ren elaborated in his evidence:¹¹⁹¹

...I think if we assume that a mine site has the inertisation system available - there are many factors, actually, affecting the design of the inertisation strategy. The first one obviously is ventilation... And also the mining method - your cutting head, for example, you mentioned, you could be leaving coals, roof coals or floor coals.

The other factor is the gas composition.... Obviously with other systems that you're running, gas drainage systems, in particular goaf drainage, you have different goaf hole locations, operating parameters - all these things will impact on the design of an effective inertisation system.

The choice of an inertisation gas

10.46 Nitrogen (N₂) and carbon dioxide (CO₂) are the commonly used gases for induced inertisation, due to their availability and relatively low cost.

10.47 The usual preference is for nitrogen. Dr Ren stated in his written response that:¹¹⁹²

In Australia, nitrogen gas (N₂) is the most commonly used and preferred inert gas for goaf inertisation, mainly due to its availability from a range of generators and ease of delivery on sites. Nitrogen remains the preferred choice for most longwall mines in Australia.

10.48 In his evidence he referred to the reasons for that preference:¹¹⁹³

...in Australia, in most cases, most of the mine sites would prefer to use nitrogen because the system is simple, it offers a continuity of inert gas supply, and there's lots of operational experience there already.

10.49 Nitrogen has the advantage that it can successfully replace air in active goafs, as it has similar density and flow characteristics.¹¹⁹⁴ It also has the advantage that it is non-toxic and, provided enough oxygen is present to sustain life, will not have an adverse health effect should a person be exposed to it.

10.50 Dr Ren indicated that 'the use of CO₂ can achieve better goaf inertisation effect in some suitable mining conditions'.¹¹⁹⁵ Carbon dioxide is denser than air and where the longwall retreat is to a higher elevation, 'CO₂ injection at a lower location (via cut-through seals) behind the face could achieve an improved inertisation effect as compared with N₂ injection'.¹¹⁹⁶

¹¹⁹¹ TRA.500.023.0001, .0013, line 31–.0014, line 6.

¹¹⁹² RET.001.001.0001, .0010.

¹¹⁹³ TRA.500.023.0001, .0012, line 45–.0013, line 1.

¹¹⁹⁴ BAL.001.001.0001, .0020.

¹¹⁹⁵ RET.001.001.0001, .0011.

¹¹⁹⁶ RET.001.001.0001, .0011; see also BAL.001.001.0001, .0016.

- 10.51 However, carbon dioxide has the disadvantage of being a noxious gas in high concentrations. Concentrations of more than 10% carbon dioxide may cause convulsions, coma, and death. Carbon dioxide concentrations of more than 30% lead to loss of consciousness in seconds.¹¹⁹⁷ It is also not as readily available as nitrogen in large commercial volumes.
- 10.52 The hazards associated with an inert gas being pushed onto the working face from a goaf fall should be considered as part of the risk assessment before implementing an induced inertisation strategy.

Infrastructure requirements for inertisation of the active goaf

- 10.53 The minimum nitrogen injection quantity required to maintain an inert atmosphere within the active goaf will depend on site specific factors including goaf gas make, pressure differentials across the goaf seals, face ventilation quantities, goaf well extraction rates and the quality of implemented controls to prevent oxygen ingress to the goaf.
- 10.54 At the time of the 2005 ACARP report, a gas flow rate of 500 l/s was recommended. However, Dr Balusu informed the Board that:¹¹⁹⁸

In the current mining environment with longer panels, high production targets of 5-10 MT per year and high goaf gas drainage requirements, studies indicate that inert gas flow rates of around 1,200 - 1,500 l/s are required for effective inertisation in active longwall goafs, particularly in spontaneous combustion-prone mines or in seams with flat gradients.

- 10.55 On the issue of the required gas flow rate, Dr Ren said in his evidence:¹¹⁹⁹

...We recommended at that time (the 2005 ACARP report) that the inert gas flow should be a minimum of 0.5 cubic metres per second or 500 litres per second, but I think the recent field experience and study indicated that this may be not sufficient, in particular for some longwall panels exceeding 350 metres wide and you're running 2000 metres long. That sort of inert gas rate may need to be increased to a minimum, say, 1.5 [cubic] metres per second, but dependent on the field conditions.

- 10.56 Dr Balusu's opinion is that a total inert gas flow rate capacity of around 1,500–2,000 l/s is recommended for high production longwall mines with high spontaneous combustion risk, or for mines with a previous history of spontaneous combustion incidents.¹²⁰⁰

¹¹⁹⁷ Langford N., *Carbon dioxide poisoning* (2005) Toxicology Reviews volume 24, pages 229–235.

¹¹⁹⁸ BAL.001.001.0001, .0015.

¹¹⁹⁹ TRA.500.023.0001, .0007, lines 37–45.

¹²⁰⁰ BAL.001.001.0001, .0015.

10.57 An on-site nitrogen generation unit would be required to produce the inertising gas. The following description of various options for generating nitrogen on site is based on an article by Lewis and Lebrecht.¹²⁰¹

10.58 Three technologies commonly used to produce industrial nitrogen are:

- Cryogenic air separation;
- Pressure Swing Adsorption (PSA); and
- Membrane systems.

10.59 Figure 173 illustrates typical infrastructure associated with each technology.



Figure 173: Nitrogen generation options: cryogenic air separation, pressure swing adsorption and membrane systems (from left to right)

10.60 Cryogenic air separation involves compressing air and cooling it to remove water vapour, carbon dioxide and other hydrocarbons. The purified air then passes into a vacuum chamber where it is further cooled until it is partially liquified. It then flows into a distillation chamber where gaseous nitrogen is separated from liquid oxygen.

10.61 Moderate sized cryogenic air separation plants typically supply nitrogen at volumes over 2,500 l/s at a purity of 99%. There is a relatively high capital cost and high power cost associated with cryogenic air separation plants.

10.62 PSA plants compress an air stream and pass it through filters to remove entrained air and water. The pressurised purified air is then passed through one of two vessels packed with carbon that adsorb the oxygen and allow the purified nitrogen to pass through. Whilst one vessel is adsorbing oxygen, the other vessel is depressurised to allow the oxygen to desorb from the carbon and vent to atmosphere. Automatic cycling of adsorption and desorption of oxygen between the two vessels enables continuous production of nitrogen.

10.63 A single PSA unit can economically produce nitrogen in quantities between 300 l/s to 2,500 l/s at purities between 95% and 99%.

¹²⁰¹ Lewis, R. & Lebrecht, T., 'Meeting Nitrogen Demand', *American Institute of Chemical Engineers* (Online Magazine, June 2018) <<https://www.aiche.org/resources/publications/cep/2018/june/meeting-nitrogen-demand>>.

- 10.64 Membrane nitrogen systems use multiple membrane modules that each contain thousands of hollow membrane fibres. When compressed air permeates through the fibres, oxygen, water vapour and carbon dioxide are selectively removed, producing a nitrogen rich product stream.
- 10.65 Membrane nitrogen systems typically produce nitrogen in quantities around 300 l/s, at purities ranging between 95% to over 99%. Membrane nitrogen systems, especially the Air Liquide system, tradename FLOXAL, have been widely adopted in Queensland longwall coal mines to inertise goafs as part of the final sealing procedure. These modular systems can produce up to 1,000 l/s nitrogen at purities between 95% and 99.5%.
- 10.66 The foregoing discussion would suggest that PSA plants should be considered as an appropriate technology to adopt when designing a system to inertise the active goaf. Higher nitrogen injection rates will be required so as to simultaneously maintain an inert atmosphere in sealed goafs, maintain positive pressure chambers and inertise the active goaf.
- 10.67 The *Spontaneous Combustion in Australian Coal Mines* book refers to the growing use of PSA units:¹²⁰²

PSA units are available in Australia, and at least 12 installations are operating in processing industries. The rate of installation of modern PSA plants on a world-wide basis is increasing rapidly now that the systems have been proven, and technology improved. Operating costs are low and the only requirement is for a supply of oil-free, dry compressed air.

- 10.68 The book supports the option of one or more PSA plants. It states:¹²⁰³

An attractive supply option for Central Queensland mines would appear to be the use of one or more PSA plants, supplemented by liquid nitrogen and ambient temperature evaporators for use in unusual cases, where very high flow rates are required for relatively short periods.

This arrangement would appear to offer the optimum strategy in terms of minimising capital investment, maximising security of supply, providing an immediately available supply of inert gas and minimising operating costs.

¹²⁰² Cliff, D., Brady, D. & Watkinson, M., *The Green Book – Spontaneous Combustion in Australian Coal Mines* (SIMTARS, 2018), page 246; WMA.003.004.0001, .0248.

¹²⁰³ Ibid. page 247; WMA.003.004.0001, .0249.

Interaction between inertisation and goaf drainage

10.69 Proactive inertisation of the active goaf, concurrent with methane drainage from goaf wells has been practised at overseas mines.¹²⁰⁴ However, there is limited experience of operating both systems concurrently within Australian mines.

10.70 The following commentary was supplied to the Board by Dr Balusu, contending for the use of a 'goaf gas drainage maximisation strategy', in combination with continuous inertisation strategies. He said:¹²⁰⁵

- *It is recommended that the strategy of 'Goaf gas drainage maximisation' should be adopted to minimise methane accumulations in active goafs.*
- *A goaf gas drainage maximisation strategy involves draining all the goaf gas that can be drained from active goafs and adjacent sealed goafs at safe gas concentration levels, even if it appears that this strategy is simply increasing goaf gas drainage rates unnecessarily.*
- *Goaf management strategies should include goaf gas drainage maximisation strategy in combination with appropriate continuous inertisation strategies to reduce the risks of goaf gas rush onto the longwall face and spontaneous combustion in active goafs.*
- *A goaf gas drainage maximisation strategy may involve a combination of gas capture strategies, such as tailgate drainage goaf holes, maingate drainage goaf holes, panel centreline drainage goaf holes, tailgate cut-through goaf hole drainage, deep goaf gas drainage, adjacent sealed goaf gas drainage, goaf gas drainage from a number of goaf holes, and additional vertical and horizontal goaf holes in the start-up area, etc.*

10.71 Dr Balusu also drew attention to the potential benefits of proactive inertisation to the effectiveness of goaf gas drainage through displacement of oxygen, and recommended further research on this issue:¹²⁰⁶

Goaf gas drainage without any proactive inertisation in active goafs generally leads to increased oxygen ingress into the active goafs, depending on gas emissions, gas drainage rates and other mining and operational conditions.

...

¹²⁰⁴ Bessinger S., Abrahamse J., Bahe K., McCluskey G. & Palm T., *Nitrogen inertization at San Juan Coal Company's long-wall operation* (Conference Paper, 2005) Society for Mining, Metallurgy & Exploration (SME) Annual Meeting.

¹²⁰⁵ BAL.001.001.0001, .0022–.0023.

¹²⁰⁶ BAL.001.001.0001, .0020–.0021.

*Preliminary studies were carried out to investigate the effect of current proactive inertisation strategies on goaf gas drainage and longwall return gas levels. These studies indicated that **inert gas injection into deeper locations in the goaf can assist in increasing goaf gas drainages rates through surface goaf gas holes by replacing some O₂ in the goaf holes with N₂.** (Emphasis added).*

...

So far, inertisation research and studies have been focussed only on reducing oxygen ingress into active goafs. Further research is recommended to advance continuous inertisation technologies for active goafs to achieve the twin objectives of increasing goaf gas drainage rates and minimising oxygen ingress. This research may include studies with inert gas injection through surface boreholes as well as through the maingate cut-through seals to assist in minimising oxygen ingress into the gas drainage holes and into active goafs.

- 10.72 Likewise, Dr Ren referred to the potential advantage of inertisation to goaf drainage effectiveness, and to the fact of ongoing research on that question. He said in evidence:¹²⁰⁷

...in particular for very gassy mines, in some way the goaf inertisation could assist the methane drainage process or goaf drainage process by chasing out the oxygen and feeding perhaps part of the inert gas that you injected in to the drainage system, and so therefore it's a win:win situation - you contain the spon com and in the meantime you improve the capture efficiency. I believe that the research is still going, supported by ACARP. I'm looking forward to the outcome from this project as well.

...

...when you're injecting the inert gas, it will take over the space, whatever is going to be occupied either by oxygen or methane. So in that way, if we could increase the inert gas flow, it will be able to take much space that would otherwise be occupied by oxygen and also in a way that it would help maximising the goaf gas capture of goaf gas from the system.

- 10.73 On the other hand, Mr Self cast doubt on the view that proactive inertisation could be used successfully in combination with high capacity goaf drainage systems. He said in his report:¹²⁰⁸

Maintenance of a near inert goaf in the interests of spontaneous combustion risk reduction is practically impossible, particularly where the goaf drainage system extracts high flows of mainly inert gases.

¹²⁰⁷ TRA.500.023.0001, .0024, lines 3–12; lines 23–29.

¹²⁰⁸ SAN.001.001.0001, .0038.

The impact of nitrogen inertisation on spontaneous combustion indicators

10.74 The NSW *Spontaneous Combustion Management – Technical Reference* lists the following indices and ratios as useful indicators of the development of a heating:¹²⁰⁹

- Graham’s Ratio;
- CO Make;
- CO/CO₂ Ratio;
- Trickett’s Ratio;
- Young’s Ratio;
- H₂/CO Ratio; and
- Air free analysis.

10.75 It also states that the most useful indicators for TARPs are:

- Graham’s Ratio, because values steadily increase as the heating progresses and it indicates the intensity or temperature of a heating (but not the size);
- CO/CO₂ Ratio, because it also steadily increases as the heating progresses (although not appropriate for mines with a high CO₂ seam gas composition); and
- CO Make, because it compensates for varying air quantity.

10.76 Graham’s Ratio cannot be used as an indicator for spontaneous combustion once nitrogen is injected into the goaf because the normal ratio between nitrogen and oxygen in fresh air will have been disturbed. This is also true of other ratios that rely on oxygen deficiency such as Trickett’s Ratio and Young’s Ratio.¹²¹⁰

10.77 Whether the adverse effect of nitrogen inertisation on some of the spontaneous combustion indicators outweighs the benefits of proactive inertisation was the subject of some difference of opinion in the evidence to the Board.

¹²⁰⁹ NSW Industry & Investment, Mine Safety Operations Branch, *MDG 1006: Spontaneous Combustion Management – Technical Reference*, NSW Government (Technical Guideline, May 2011) <https://www.resourcesregulator.nsw.gov.au/__data/assets/pdf_file/0006/419514/MDG-1006-TR-spontaneous-combustion-management.pdf>, page 56.

¹²¹⁰ RET.001.001.0001, .0012.

10.78 Mr Self referred to the fact that all of the spontaneous combustion indicators had flaws, and each had different flaws. He said:¹²¹¹

There are probably five key spon com indicators which have got flaws each but have got different flaws. So the flaws that affect one won't affect the other in the same way, and one may pick up spontaneous combustion in certain circumstances and one may pick up in different ones.

10.79 Consequently, he said, it was important to have multiple indicators available to assess for signs of spontaneous combustion.¹²¹²

10.80 Mr Self acknowledged that proactive inert gas injection would mitigate against air ingress to the goaf, but argued that the 'corruption of spon com indicators make this a flawed strategy, in my opinion'. He argued that inertisation be limited to occasions 'when we get into trouble'.¹²¹³

10.81 Dr Ren acknowledged that nitrogen inertisation would disturb Graham's Ratio and Trickett's Ratio. He said in his report:¹²¹⁴

Obviously goaf inertisation will disturb the process of nature formation of goaf atmosphere and induce contamination to some [of] the above indicators, such as Graham's ratio and Trickett's ratio, are not going to work during nitrogen inertisation.

10.82 He referred to the continuing utility of the range of other indicators to assess the progress of a potential heating during goaf inertisation,¹²¹⁵ but also acknowledged the merit of further research on the impact of inertisation on the gas ratios.¹²¹⁶

10.83 In his written answers to the Board on this topic, Dr Balusu said traditional indicators such as CO Make, CO/CO₂ Ratio and ethylene concentration levels would continue to be good spontaneous combustion indicators, subject to the implementation of a continuous goaf gas monitoring system with sufficient tube bundle points installed in appropriate cut-through seals.¹²¹⁷

10.84 In the Board's view, it might also be argued that if oxygen concentrations in the goaf could be reduced to 5% through inertisation, the importance of a tool such as Graham's Ratio might be somewhat diminished.

¹²¹¹ TRA.500.021.0001, .0048, lines 24–28.

¹²¹² SAN.001.001.0001, .0046.

¹²¹³ TRA.500.021.0001, .0068, lines 32–42.

¹²¹⁴ RET.001.001.0001, .0012.

¹²¹⁵ RET.001.001.0001, .0012.

¹²¹⁶ TRA.500.023.0001, .0032, line 46–.0033, line 6.

¹²¹⁷ BAL.001.001.0001, .0019.

Competing views on proactive inertisation

10.85 The book, *Spontaneous Combustion in Australian Coal Mines*, suggests some circumstances in which ‘progressive nitrogen inertisation’ might be practised, including mines that are subject to spontaneous combustion. It states:¹²¹⁸

In Australia, progressive nitrogen inertisation of goafs is not widely practised, but with the wider use of longwall methods it may become necessary if slow retreat rates or major delays occur. It is used in some mines with coals which are subject to spontaneous combustion. It may also be necessary to consider its use during extended stoppages caused by geological or industrial difficulties, or when the face equipment is being salvaged. Although the use of nitrogen is expensive, the alternative cost of the loss of a longwall face due to an uncontrolled heating may be sufficient to justify its use.

10.86 In his written answers to the Board, Dr Balusu expressed support for the wider use of continuous inertisation, as a routine and continuous strategy, including in high production panels. He said that:¹²¹⁹

Proactive inertisation with continuous inert gas injection into the deep goaf is highly recommended as a practical strategy for prevention and control of spontaneous combustion in active longwall goafs.

10.87 Dr Balusu said that it was ‘practicable to implement ... proactive inertisation strategies in current high production longwall panels as a routine and continuous practice’.¹²²⁰

10.88 Notwithstanding his descriptions of deficiencies in monitoring and identification of spontaneous combustion, Mr Self was not in favour of continuous proactive inertisation. In his evidence, he contended that ‘a robust spontaneous combustion management system does not need proactive inertisation’.¹²²¹

10.89 Dr Ren was invited to respond to this argument in his evidence. He said:¹²²²

I would say that a robust spon com management plan should include an active goaf inertisation system in place, because if you run a pit that is liable to spon com, you do all the monitoring, you do all the controls, you try to minimise the risk, but there's always the chance that you could be going through particular locations, you know, slowing down your advance or retreat, you have roof failures and things like that, and that could cause potential risk, and that is the time that the active goaf inertisation should kick in, you know, to contain any potential heating events.

¹²¹⁸ Cliff, D., Brady, D. & Watkinson, M., *The Green Book – Spontaneous Combustion in Australian Coal Mines* (SIMTARS, 2018), page 100; WMA.003.004.0001, .0102.

¹²¹⁹ BAL.001.001.0001, .0010.

¹²²⁰ BAL.001.001.0001, .0009.

¹²²¹ TRA.500.021.0001, .0068, lines 39–42.

¹²²² TRA.500.023.0001, .0022, line 42–.0023, line 10.

So I would say a robust spon com management plan should consider the use of, or at least perhaps an integral part of that system should include a proactive inertisation system. That's my view.

10.90 Dr Ren referred to the use of active inertisation in some mines in NSW and Queensland with high production rates and high gas emissions,¹²²³ but also advocated ongoing study of the process for high production mining at depth in gassy mines. He said in his evidence:¹²²⁴

Because we are operating in a changing mining environment, and we're getting deeper, it's getting gassy, our longwall mines are getting perhaps bigger and highly productive, that actually presents a lot more challenges, for example, ventilation, dealing with gas, and of course spon com. That can, to some extent, change the goaf atmosphere or the goaf gas dynamics, and therefore we will need further studies to better understand exactly what is happening and so that we can do a better job in containing the potential heating or gas events.

10.91 In the following exchange with Mr Andrew Clough, Dr Ren referred to the additional advantage of active inertisation, namely reduction in size of that part of the goaf atmosphere in the explosive range:¹²²⁵

Q. ... I understand that your studies were primarily directed at controlling or preventing the development of spontaneous combustion. However, I wonder if you have any comment on the other effect, which is the impact on the total volume of explosive gas mixture sitting in the goaf, whether or not the proactive inertisation - one of the other potential benefits is it will actually reduce the size of the zones within the goaf that contain an explosive gas mixture?

A. I think that will be the add-on bonus for goaf inertisation. You are injecting inert gas into the atmosphere of the goaf, and that inert gas, if you're using nitrogen, is ready to diffuse and mix with the goaf gas or oxygen. In that manner, if you provide sufficient inert gas in that environment, then you will be able to render the goaf atmosphere out of the explosive range in addition to containing spon com.

Strategies to limit oxygen ingress

Managing air ingress at the longwall maingate

10.92 The usual ventilation practice in Queensland longwall coal mines is for the intake air to enter the longwall face from the maingate conveyor roadway.

¹²²³ TRA.500.023.0001, .0031, line 38–.0032, line 11.

¹²²⁴ TRA.500.023.0001, .0032, lines 26–35.

¹²²⁵ TRA.500.023.0001, .0034, lines 14–29.

The gap between shield #1 on the longwall face and the adjacent maingate coal pillar forms a large opening into the active goaf. The ventilation stream travels directly towards this opening.

- 10.93 A quantity of air entering the goaf at the maingate will travel through the extracted area towards the tailgate. This quantity of air travelling behind the shields introduces oxygen to the goaf. Dr Ren referred to the implications:¹²²⁶

Now, coming back to the maingate corner, if you see most of the longwalls, we run quite high ventilation to the face, so when the ventilation is entering the longwall through the maingate corners, it has very high momentum, so therefore a part of that ventilation will tend to penetrate into the goaf. If that happens, it will compromise to a great extent the inertisation effect. To minimise that sort of impact, we will need to minimise the oxygen ingress from that point by - for example, in most cases, we would have a goaf curtain. I have seen most of the mines will have these things in place.

- 10.94 As indicated by Dr Ren, standard practice in Queensland underground longwall coal mines is to erect a brattice screen in the maingate between shield #1 and the coal rib. The purpose of the screen is to restrict the ventilation from entering the goaf and divert the associated air stream along the longwall face. This is depicted in Figure 174 below.¹²²⁷

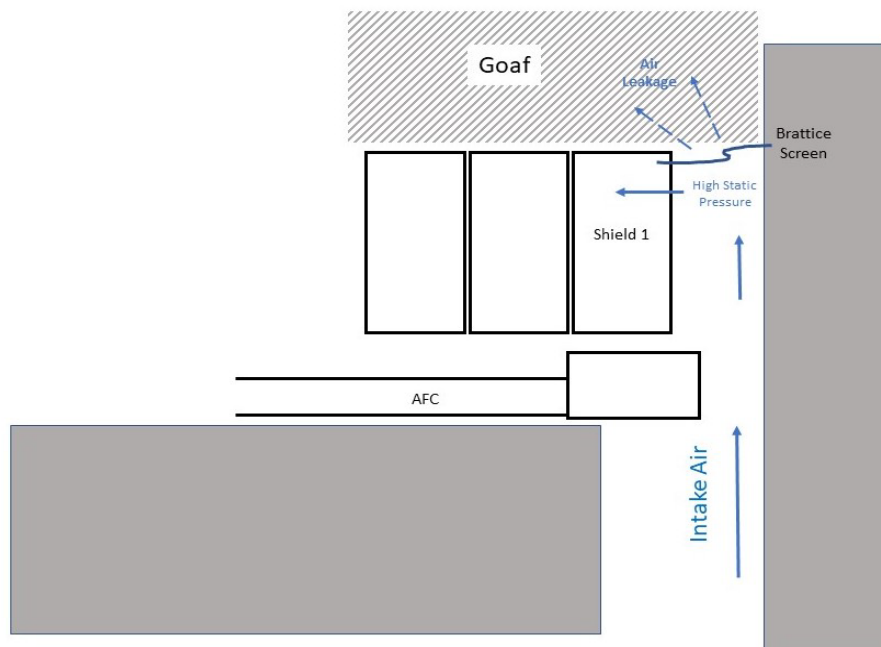


Figure 174: Maingate brattice screen

¹²²⁶ TRA.500.023.0001, .0035, lines 5–15.

¹²²⁷ Schematic prepared by the Board of Inquiry.

- 10.95 Air quantities on Australian longwall faces are typically greater than 50 m³/s. These large ventilation volumes create high static pressures against the brattice screen and increase leakage through the screen.
- 10.96 Dr Ren recommended extending the coverage of the screen to the fourth or fifth shield, in conjunction with other measures:¹²²⁸

Further to that, I would suggest it's not only just a curtain next to the first chock and second chock, maybe extending that a bit further along the longwall face, I would say maybe to the fourth or fifth longwall chocks, to maximise the impact of stopping oxygen or air ingress into that position.

This could be also combined with other techniques, for example, a plug you could drop in or put in through a cut-through just outbye of your injection point. All these things will come together, and that will help you to have the inertisation system work better and more effective.

- 10.97 Use of the brattice screen at the maingate is temporary in nature and must be repeated on an ongoing basis. Each successive advance of shield #1 requires the screen to be adjusted and maintained. Consequently, a high level of diligence is required to ensure the screen is erected and maintained to the highest standard. Even so, it is expected that 2 or 3 m³/s of ventilation will enter the goaf at the maingate and migrate behind the shields towards the tailgate.
- 10.98 The Board proposes that a more permanent engineering arrangement to limit oxygen ingress, depicted in Figure 175, would warrant further investigation:¹²²⁹

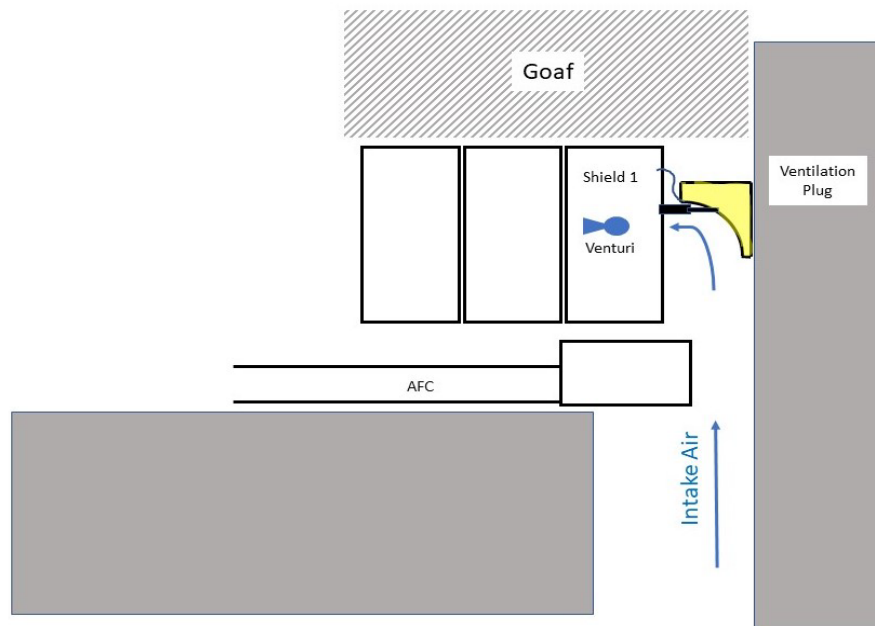


Figure 175: A suggested arrangement to divert ventilation across the longwall face

¹²²⁸ TRA.500.023.0001, .0035, lines 17–29.

¹²²⁹ Schematic prepared by the Board of Inquiry.

- 10.99 A plug, made from a light but strong fire retardant anti-static (FRAS) material, extending from the roof to the floor, could be attached to shield #1. The plug could be pushed across to the maingate rib line using hydraulics as part of the shield advance and set sequence. The plug could then be retracted during the advance cycle of the shield.
- 10.100 Incorporating a transition curve into the plug's design would create a smooth redirection of the ventilation stream onto the face line without creating a high static pressure in the maingate adjacent to the goaf. The redirection of the ventilation could also be assisted by using a venturi at shield #1.
- 10.101 The gap between shield #1 and the plug could be closed with the incorporation of a flexible curtain, as illustrated by the blue freeform line in the Figure above.
- 10.102 During periods of slow longwall retreat, and/or where signs of accelerated oxidation have been detected in the goaf, a more substantial barrier than a brattice screen may be required in the maingate.
- 10.103 Phenolic resin foams have been used at some mines to create a rapid seal where the risk of fire or explosion must be controlled. This includes Pike River mine in New Zealand, North Goonyella mine in Queensland and San Juan mine in the United States.¹²³⁰
- 10.104 A cheaper alternative to phenolic resin foam seals was explored as part of an ACARP project in 2010.¹²³¹ This project utilised commercially available software, field measurements and expert opinion to investigate the performance of foaming agents in controlling the ingress of oxygen into longwall goafs around the face perimeter. The project aimed to develop simple and cost-effective techniques to reduce the airflow in longwall goafs during normal operations and enhance inertisation of the active goaf atmosphere.
- 10.105 The application of the foam involved injecting the product into the caved goaf from a cut-through inbye the longwall face on the maingate. The foam increases the resistance of the goaf against air ingress.
- 10.106 Dr Ren provided the following response to a request for any comment or update on the status of the project:¹²³²

...Key work included the testing of foaming agents and devices in laboratory (surface) and field trials at a QLD underground coal mine. Field tests demonstrated that it was possible to change oxygen ingress depth into goaf area by pumping foams as 'plugs' via cut-throughs behind longwall face...

¹²³⁰ Wilson Mining, *Sealing Underground Heavings and Mine Fires* (Web Page, 2021) <<http://www.wilsonmining.com.au/sealing-underground-heating-and-fires>>.

¹²³¹ Humphries, P., Ren, T. & Yarlagadda S., *Foam Injection Technologies for Goaf Inertisation* (2011) Project No. C15020 Report, Australian Coal Association Research Program.

¹²³² RET.001.001.0001, .0004.

The author is not aware of further development of this technology in Australia since the completion of this project.

Managing the pressure differential across the goaf

10.107 The mine ventilation system creates a pressure differential from the longwall maingate to the tailgate return. The pressure difference from one end of the face to the other can be estimated by the Atkinson equation.

$$\Delta P = R \times Q^2$$

Where: ΔP is the pressure differential between two points;
R is the resistance to the air flow along the pathway between the two points; and
Q is the quantity of air flowing (usually expressed in m³/s)

10.108 An important aspect of this equation is that the pressure difference is very sensitive to the quantity of air flowing. A doubling of the quantity of air flowing along the longwall face will result in a four-fold increase in the pressure differential from maingate to tailgate.

10.109 Longwall faces with high ventilation flows will have high differential pressures between the maingate and tailgate and consequently high-pressure differentials across the goaf. This has the effect of more air being drawn into the goaf from the maingate side of the goaf. Brune and Saki *et al.* describe this phenomenon:¹²³³

As the face ventilation quantity is increased, a higher pressure differential is created between the face and the gob and more air (oxygen) will migrate into the gob through gaps between the shields. Oxygen ingress into the gob will enhance the formation of explosive mixtures. Where the coal has a high propensity for spontaneous combustion, the oxygen ingress may also increase the spon-com potential.

10.110 This is an example of the conflict that can arise between managing gas emissions and spontaneous combustion. High ventilation flows are used to dilute gas emissions, but in turn, increase the risk of spontaneous combustion due to the creation of a high pressure differential across the goaf.

Managing air ingress through perimeter goaf seals

10.111 Another source of oxygen into the active goaf is through the seals that have been built around the goaf perimeter. The purpose of goaf seals is to contain the goaf atmosphere and prevent the ingress of ventilation air.

10.112 Effective seal construction usually involves some pre-excavation into the roof, the floor, and the coal rib at the seal site, so that the seal is built against solid foundations.

¹²³³ Saki, S.A., Brune, J.F. *et al.*, *CFD study of the effect of face ventilation on CH₄ in returns and explosive gas zones in progressively sealed longwall gobs*, (2017) Journal of the Southern African Institute of Mining and Metallurgy volume 117 issue 3: page 261.

10.113 The ground stresses around the active goaf can lead to further fracturing of the rock and coal around the seal. These stresses can also result in cracks forming within the seal itself. It is for this reason that additional standing support is installed at the seal site to limit post construction deformation of the coal and strata. It is also usual to construct the seal from flexible materials where high stresses and strata deformation are expected at the seal site.

10.114 Even the best constructed seals cannot prevent the movement of air in and out of the goaf through fractures in the seal or in the coal and rock that surround the seal.



Figure 176: A seal site with standing support

10.115 The passage of an atmosphere into or out of an active goaf through a seal depends on the atmospheric pressure differential across the seal.

10.116 Where the atmospheric pressure within the goaf is less than the air pressure outside the goaf it is expected that air will migrate around and through the seal into the active goaf. This is referred to as the goaf breathing in.

10.117 Where the atmospheric pressure within the goaf is greater than the atmospheric pressure in the perimeter roadway outside the goaf, it is expected that the goaf atmosphere will leak out through the seals. This is referred to as the goaf breathing out.

10.118 It is important to understand the atmospheric pressure differential across the seals in order to determine where oxygen may ingress to the goaf. The pressure differential across the seal is a combination of the pressures created through the mine ventilation system and through daily barometric fluctuations.

10.119 As is the case at Grosvenor, perimeter roadways are usually ventilated by a shaft or borehole behind the longwall goaf that may act as either an upcast or an intake shaft. The choice of having the shaft as an upcast or an intake has an impact on the ventilation pressure differentials that are created across the seals. Ignoring the influence of barometric pressure, the two different scenarios are illustrated in Figures 177 and 178 below.¹²³⁴

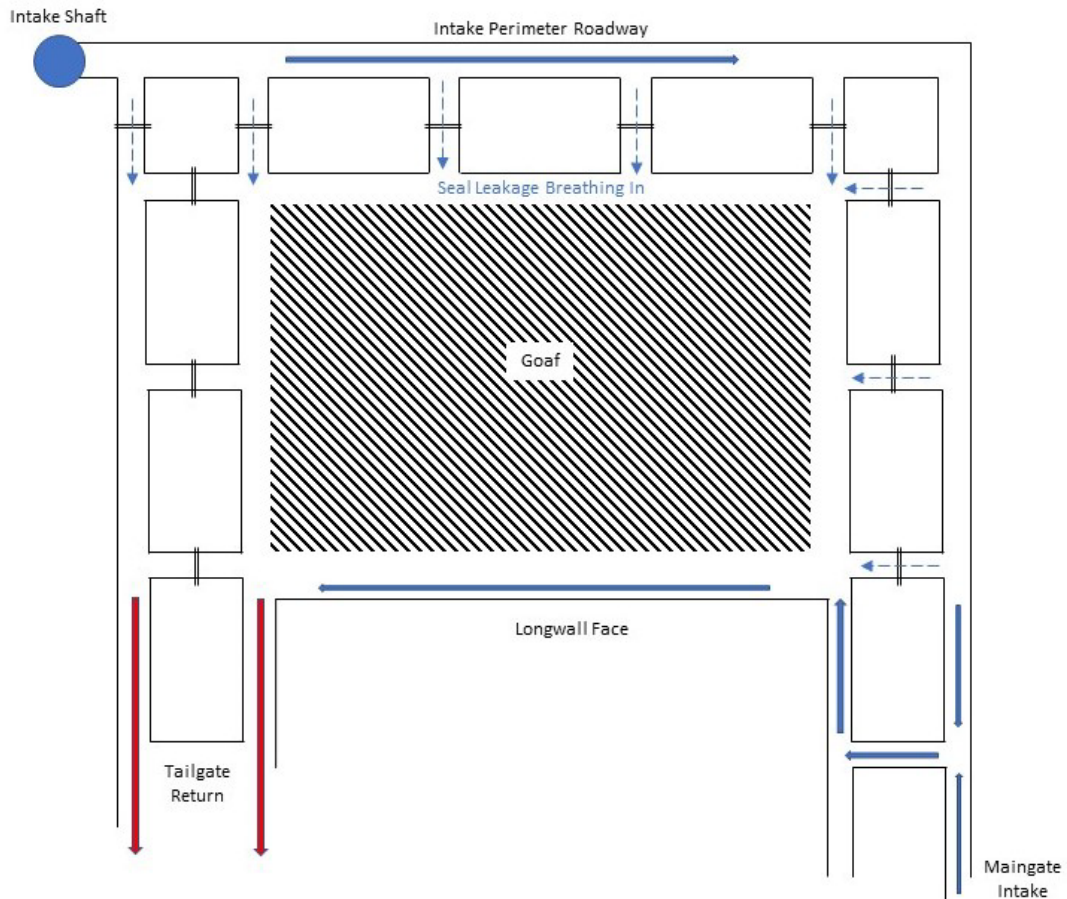


Figure 177: Perimeter Roadway on Intake

10.120 Figure 177 illustrates the seals breathing in due to the pressure in the intake perimeter roadway being higher than the pressure in the goaf. The fact that this occurs was presented in evidence by Mr Self during the Inquiry hearings.¹²³⁵

¹²³⁴ Schematics prepared by the Board of Inquiry.

¹²³⁵ TRA.500.021.0001, .0022, lines 1–37.

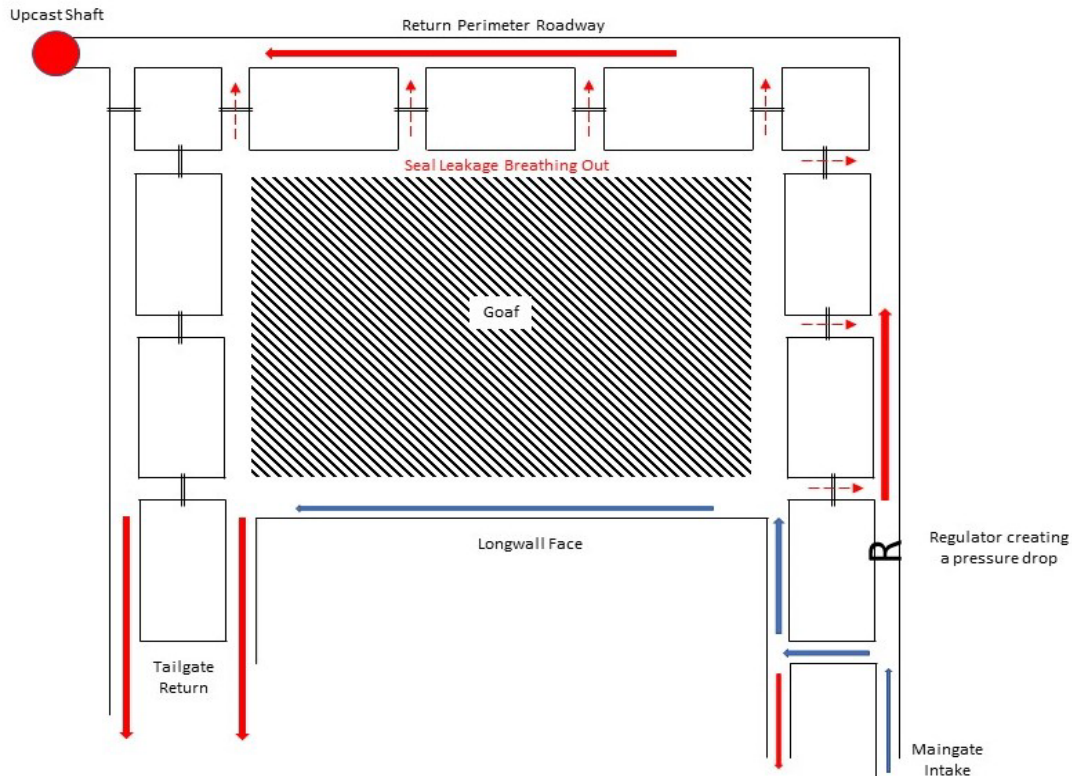


Figure 178: Perimeter roadway on return

10.121 Figure 178 illustrates the seals breathing out due to the lower pressure in the perimeter roadway created by the exhausting fan at the upcast shaft. A regulator has been constructed in the maingate roadway inbye the last open cut-through to create a reduction in ventilation pressure in the perimeter roadway. The migration of goaf gases towards the seals and the breathing out reduces the likelihood of oxygen ingress into the goaf at the seal site.¹²³⁶

10.122 Barometric pressure changes overlay the mine ventilation pressures and can be of a much greater magnitude than the mine ventilation pressures. Low pressure systems associated with passing storms result in an atmospheric barometric pressure lower than the goaf pressure with a consequent breathing out of goaf gases. The gases breathing out of the goaf mainly report into the tailgate roadway but also through the goaf seals.

10.123 Conversely, a high-pressure system, often associated with clear dry weather, may result in air breathing into the goaf.

10.124 Limiting air ingress through the perimeter seals is achieved by constructing seals to a high standard and implementing ventilation arrangements that do not create high pressure differentials across the seals.

¹²³⁶ TRA.500.021.0001, .0022, lines 1–37.

10.125 Ongoing monitoring of seals is necessary to manage the risk of spontaneous combustion and the formation of explosive atmospheres within the goaf. In Queensland, *Recognised standard 09: The Monitoring of Sealed Areas* outlines the minimum standard of monitoring goaf seals to achieve an acceptable level of risk. Some relevant sections of Recognised standard 09 are reproduced below:¹²³⁷

Monitoring of sealed areas should be carried out in order to adequately predict and define the potential for an explosive atmosphere to occur within a sealed area. Sufficient samples should be taken to delineate both the size of any explosive zone and the time that the zone will be within the explosive range.

...

Sealed areas should be monitored for carbon monoxide, carbon dioxide, methane, oxygen, hydrogen, ethane and ethylene on a routine basis.

The design of the sampling regime will be influenced by previous experience at the mine in monitoring of sealed areas and be based on a risk assessment. It must conform to and meet the requirements of the mines Spontaneous Combustion Management Plan and all other relevant Hazard Management Plans and this Recognised Standard.

Pressure differentials across seals and sealed areas are to be minimised with the differential to be understood and appropriate monitoring set. The installation of pressure gauges on each seal may assist in determining pressure differential and leakage.

The barometric pressure should be measured and the monitoring regime designed to take into account the effect of sealed areas breathing.

Pressure balance chambers

10.126 Pressure balance chambers can be used to limit air ingress to the goaf and are an effective control to counter the effects of atmospheric barometric pressure changes. Astar coal mine in NSW makes use of this technique, which is illustrated in Figure 179.¹²³⁸

¹²³⁷ Department of Natural Resources, Mines and Energy, *Recognised standard 09: The Monitoring of Sealed Areas*, Queensland Government (Recognised standard under the *Coal Mining Safety and Health Act 1999*, June 2010)

https://www.rshq.qld.gov.au/data/assets/pdf_file/0018/240372/recognised-standard-09.pdf, pages 3–4.

¹²³⁸ NSW Industry & Investment, Mine Safety Operations Branch, *MDG 1006: Spontaneous Combustion Management – Technical Reference*, NSW Government (Technical Guideline, May 2011) <https://www.resourcesregulator.nsw.gov.au/__data/assets/pdf_file/0006/419514/MDG-1006-TR-spontaneous-combustion-management.pdf>, page 34.

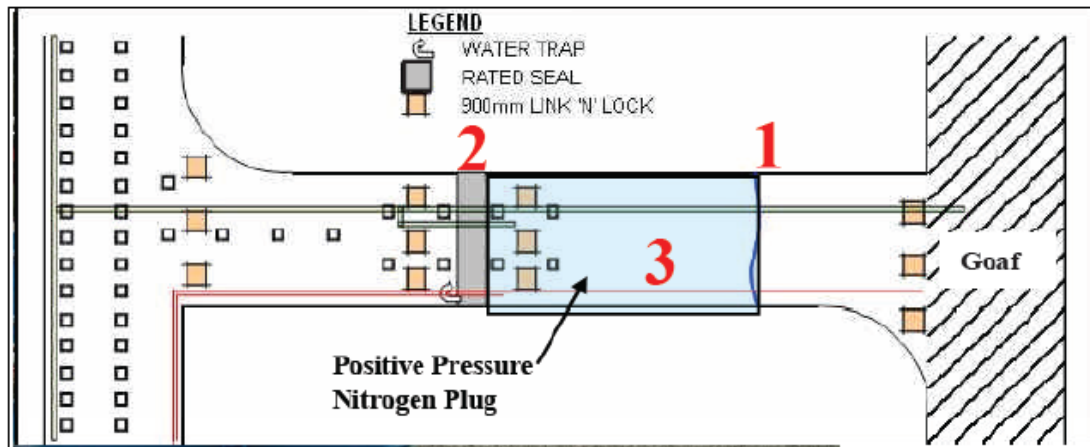


Figure 179: Pressure Balance Chamber as implemented at Austar mine

10.127 The goaf is isolated by constructing two stoppings in each access roadway (annotations 1 and 2 in the Figure above). The area between the two stoppings (annotation 3) is pressured by piping inert gas from a unit located on the surface. The higher pressure within the chamber prevents air ingress through the chamber and to the goaf and prevents goaf gases from leaking into the perimeter roadway.

Managing oxygen ingress through surface to in-seam drill holes, underground in-seam gas holes and open pipes through seals

10.128 Another potential source of oxygen ingress to the active goaf is through any boreholes or open pipes that connect the goaf with the outside atmosphere. It is important to log where all surface drill hole collars are located and ensure that the holes are grouted and capped after their useful life.

10.129 Underground in-seam drilling (UIS) holes should also be identified on mine plans and grouted and sealed after being intersected by development. Open UIS holes that pass into the goaf through the adjacent pillar, floor or roof will provide a conduit for oxygen ingress if not identified and sealed.

10.130 Pipework that passes through goaf seals for water drainage or other purposes should be blanked off or furnished with valves that can be closed and locked.

10.131 Audits and inspections should be conducted to ensure all potential connections to the goaf have been identified and plugged.

Goaf drainage holes

10.132 The purpose and operation of goaf drainage wells has been considered in detail in Chapter 4, including the need to balance methane extraction with the spontaneous combustion risks associated with drawing oxygen into the goaf.

10.133 Goaf wells are typically drilled along the tailgate side of the longwall block in advance of the extraction. The wells are not drilled down into the seam but terminated at some distance above the seam. The wells remain inactive until mining has passed under and the caving of the goaf extends up to the base of the well.

10.134 To aid the extraction of methane from the goaf wells a partial vacuum is often applied to the well at the surface. The application of a vacuum to the goaf well could result in oxygen being drawn through the goaf and into the well. The likelihood of this occurring depends on the rate of vacuum applied to the well and the proximity of the well to a source of air.

10.135 Goaf wells on suction can draw air into the goaf through the caved strata and through fractures in the rock mass.

10.136 Dr Ren and Dr Balusu give the following guidance:¹²³⁹

- *Goaf gas drainage should include a combination of goaf holes near the face and deep goaf holes in the panel in order to improve the overall gas drainage efficiency and to reduce the effects of barometric pressure changes on tailgate gas levels,*
- *The strategy of continuous operation of deep goaf holes at moderate capacity should be implemented. i.e., intermittent operation of deep goaf holes at high capacity may not improve the overall efficiency and may lead to problems,*
- *Ventilation system in the panel should be designed to minimise oxygen ingress into the goaf, including immediate sealing-off all the cut-throughs behind the face, in order to improve overall gas drainage efficiency,*
- *Oxygen concentration at all goaf holes should be continuously monitored and controlled at less than 5% to reduce the risk of spontaneous heating in the longwall goafs,*
- *Goaf gas drainage should be carried out from more goaf holes at optimum capacity. It is preferable that gas drainage is carried out by 3 to 4 holes, rather than 1 to 2 holes, this would reduce oxygen ingress into the goaf.*

¹²³⁹ Ren, T. & Balusu, R., *The use of CFD modelling as a tool for solving mining health and safety problems* (2010), in Aziz, N. & Kininmonth, R. (eds.), *Proceedings of the 2010 Underground Coal Operators' Conference, Mining Engineering, University of Wollongong* <<https://ro.uow.edu.au/coal/319>>, page 342.

Findings

Finding 76

Gas monitoring systems in use in Queensland underground coal mines are of a high standard, but there remain practical deficiencies, including human error, in reliance on gas monitoring to detect developing spontaneous combustion.

Finding 77

The principal benefit of proactive inertisation lies in a significant reduction in the proportion of the goaf which is susceptible to spontaneous combustion or methane ignition. Safety risks and production losses are correspondingly reduced.

Finding 78

Studies have shown that proactive inertisation can be successful in limiting oxygen ingress to the goaf in Australian mines.

Finding 79

The technology exists, for example through the use of membrane systems and Pressure Swing Adsorption units, for suitable quantities of nitrogen to be generated at a mine site.

Finding 80

Some of the traditional indicators of spontaneous combustion, derived from gas monitoring, would be disturbed by nitrogen inertisation. Others would be unaffected. The disturbance of some indicators is not sufficient to outweigh the advantage of minimising the opportunity for spontaneous combustion to develop in the first place.

Finding 81

Inertisation may deliver benefits to the operation of goaf drainage systems, as it leads to the replacement of oxygen in the goaf, allowing the goaf wells to safely run at lower methane purity.

Finding 82

Given there is a history of spontaneous combustion events in the Goonyella Middle (GM) seam, proactive inertisation may well be appropriate for a mine such as Grosvenor mine where significant quantities of remnant coal are left in the goaf. It is no longer sufficient to continue on the same path of substantial reliance on gas monitoring to manage the hazard of spontaneous combustion.

Finding 83

Achieving effective goaf inertisation in the first 200 metres of longwall retreat will be difficult due to the lack of consolidation, which permits oxygen ingress deep into the goaf.

Finding 84

Where proactive inertisation is practised, it should be done in conjunction with strategies to limit the ingress of oxygen to the goaf, such as:

- limiting oxygen ingress at the maingate corner;
- ensuring longwall face ventilation quantities are not excessive;
- appropriate goaf perimeter road ventilation arrangements;
- seal construction and monitoring; and
- pressure balance chambers.

Recommendations

Recommendation 16

Coal mines, in particular those working the GM seam, assess the risk of spontaneous combustion and consider designing and implementing proactive inertisation as a measure to deal with that risk.

Recommendation 17

Coal mines review the ventilation arrangements it has in place around the active goaf, with the view to identifying opportunities to reduce oxygen ingress to the goaf.

Recommendation 18

The industry undertake research, including field studies, into the simultaneous operation of goaf drainage systems and continuous inertisation.

Chapter 11 – Labour hire and contract employment arrangements

Introduction

- 11.1 The five men injured in the serious accident on 6 May 2020 were labour hire workers.
- 11.2 The Terms of Reference require the Board to make recommendations for mine operators, relevant obligation-holders and other relevant parties for improving safety and health practices and procedures for mitigating against the risk of similar incidents occurring in the future, including, where relevant, recommendations directed to the nature of any particular employment arrangements which may be better apt to ensure acceptable risk levels to workers.
- 11.3 This chapter considers the nature and prevalence of labour hire and contract work at Queensland mines and the risks that such employment arrangements pose to safety at mines.¹²⁴⁰
- 11.4 The Board engaged the assistance of Professor Michael Quinlan to aid its understanding of these matters. Professor Quinlan is Emeritus Professor of Industrial Relations at the School of Management at the University of New South Wales (NSW). He undertook a literature review to assist the Board to understand the impact on safety resulting from the use of labour hire workers. That review provided a comprehensive overview of the impacts of the use of labour hire workers in a number of jurisdictions, both in Australia and overseas, and across a range of industries.¹²⁴¹
- 11.5 The first part of this chapter contains a summary of key aspects of his literature review. The following parts of the chapter include evidence specific to the mines the subject of this Inquiry and Professor Quinlan’s observations and suggestions.
- 11.6 Current legislation in Queensland and, indeed, throughout Australia, enables the casualisation of workforces. This casualisation of employment at mines has the potential to diminish the influence of the unions. Certainly, at Grosvenor mine (Grosvenor), where the workforce is predominantly labour hire, it seems that union influence may be limited.¹²⁴²
- 11.7 There are fundamentally different views held in relation to the safety risks associated with labour hire and contract work at mines.

¹²⁴⁰ In this chapter, unless the context suggests otherwise, a reference to safety should be taken to be a reference to safety and health.

¹²⁴¹ BOI.001.004.0001.

¹²⁴² TRA.500.024.0001, .0058, line 26–.0059, line 41; .0071, lines 27–42.

The Construction, Forestry, Maritime, Mining and Energy Union (CFMMEU) argues that the material before the Board demonstrates that the best way for a mine operator to ensure the safety of workers, having regard to employment arrangements, is to directly employ workers on a permanent basis and to minimise labour hire employment so far as reasonably practicable.¹²⁴³ On the other hand, whilst acknowledging in evidence that there is a risk that some labour hire workers perceive that their employment might be jeopardised if they raised safety issues, witnesses on behalf of Anglo American Metallurgical Coal Pty Ltd (AAMC) stated that positive, proactive steps are taken to dispel that perception and to encourage all workers to raise safety concerns.¹²⁴⁴

- 11.8 While there may be different views about the risks, the clear evidence is that labour hire and contract work are currently entrenched in the Queensland coal mining industry. Accordingly, the final part of this chapter provides recommendations to minimise the safety risks associated with labour hire and contract work.

A review of labour hire and contract employment arrangements, and their impacts on safety in the workplace

- 11.9 This section summarises Professor Quinlan’s literature review to provide an overview of labour hire and contract work, as well as the advantages and disadvantages and the safety impacts associated with these employment arrangements.

Labour hire and contract work

- 11.10 Labour hire and contract work are two forms of casual employment, both characterised by their precarious, temporary nature. They can be distinguished from permanent and on-going employment.¹²⁴⁵
- 11.11 Labour hire is often described as a triangular employment arrangement. Under such an arrangement, a labour hire agency supplies a worker to another organisation (host). The labour hire agency is the worker’s employer, while both the labour hire agency and the host have responsibilities to the worker.¹²⁴⁶

¹²⁴³ CMU.013.001.0001, .0043.

¹²⁴⁴ TRA.500.009.0001, .0063, lines 9–39; TRA.500.010.0001, .0023, line 38–.0024, line 39 (Mr Mitchelson); TRA.500.010.0001, .0071, line 39–.0072, line 9 (Mr Jones).

¹²⁴⁵ BOI.001.004.0001, .0004.

¹²⁴⁶ BOI.001.004.0001, .0004.

11.12 The following diagram represents a typical labour hire arrangement:¹²⁴⁷

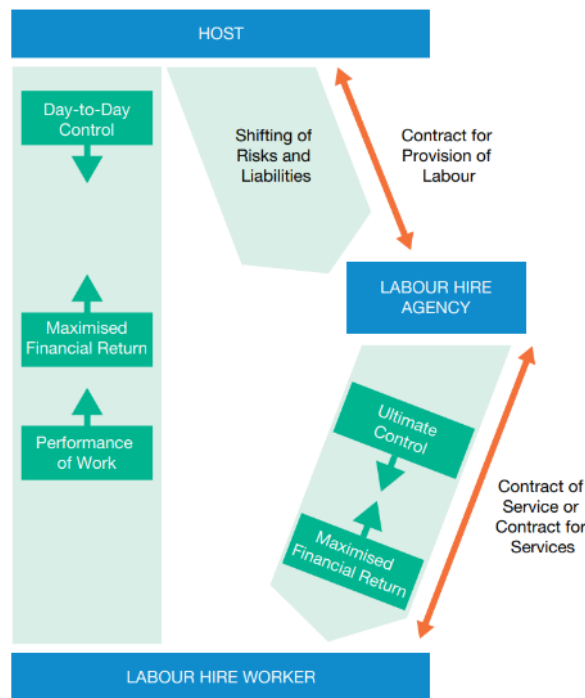


Figure 180: Labour hire arrangement

- 11.13 A key feature of the labour hire arrangement is the split between the contractual and control relationships of the parties. Under a labour hire arrangement, the contractual relationships are between the labour hire agency and the host on the one hand, and the labour hire agency and the worker on the other. Although the worker’s contract is with the labour hire agency, the worker is under the control of the host while performing work at the host’s workplace.¹²⁴⁸
- 11.14 Labour hire workers might perform a series of short-term arrangements amounting to a lengthy period of continuous work, but their employment at the mine remains subject to termination at short, or indeed, very short notice.
- 11.15 Contractors perform work at a mine under a contract with the mine. Contractors might typically perform short-term specialised tasks, such as discrete repair or construction tasks, as well as ongoing specialised tasks, such as strata consolidation. Contractors often supply their own plant and equipment.¹²⁴⁹ Contractors may be substantial organisations, or smaller businesses, or persons who work for themselves under a contract with the mine. All contractors and their workers are vulnerable to termination of contracts and exclusion from future contracts.

¹²⁴⁷ Forsythe, A., *Victorian Inquiry into the Labour Hire Industry and Insecure Work: Final Report* (2016) Industrial Relations Victoria, Department of Economic Development, Jobs, Transport & Resources <<https://s3.ap-southeast-2.amazonaws.com/hdp.au.prod.app.vic-engage.files/3615/5685/9019/IRV-Inquiry-Final-Report-.pdf>>, page 48.

¹²⁴⁸ BOI.001.004.0001, .0016.

¹²⁴⁹ BOI.001.004.0001, .0022.

- 11.16 Contractors' workers are also referred to as contractors. Furthermore, labour hire workers and contractors are often referred to collectively as 'contractors', thereby distinguishing them from workers employed directly and permanently by a mine operator.
- 11.17 The term 'contractor' is not defined in the *Coal Mining Safety and Health Act 1999* (Qld) (the Act). However, the context in which it is used in the Act makes it clear that the term refers only to contractors as described in paragraph 11.15 above. The term 'labour hire worker' is not defined in the Act.
- 11.18 The term 'coal mine worker' is defined in the Act as follows:

coal mine worker means an individual who carries out work at a coal mine and includes the following individuals who carry out work at a coal mine –

- (a) an employee of the coal mine operator;*
- (b) a contractor or employee of a contractor;*
- (c) a service provider or employee of a service provider.*

Labour hire workers fall within the first part of this definition being individuals who carry out work at a coal mine.

- 11.19 As will be seen, the safety risks associated with the use of labour hire workers and contractors at mines arise because of the temporary nature of their engagement. For this reason, it is useful to consider the risks arising from these two employment arrangements together.

The rise of labour hire workers and contractors in the Australian coal mining industry

- 11.20 In the last four decades, there has been a decline in the number of Australian workers employed on a full-time, permanent basis and an increase in workers employed on a casual or temporary basis. There has also been an increase in the use of contractors engaged to do work previously undertaken by the direct employees of an organisation. These changes have occurred, to varying degrees, across all industries.¹²⁵⁰
- 11.21 The Australian coal mining industry has seen a similar increase in the use of labour hire to that which has occurred across the Australian economy generally, although the rise in temporary employment arrangements in the mining industry started a little later than in other industries.¹²⁵¹
- 11.22 Prior to the mechanisation of coal mining in Australia, competition among workers, safety issues, and job insecurity, detracted from union efforts to promote solidarity amongst the workers.

¹²⁵⁰ BOI.001.004.0001, .0004.

¹²⁵¹ BOI.001.004.0001, .0089.

As a result, the unions successfully pushed for measures which included prohibitions on non-permanent employment arrangements, including the employment of part-time and casual workers, and limits on the circumstances in which mine operators could engage contractors.¹²⁵²

11.23 Subsequently, in 1990, industry awards came into effect which did not contain any provisions for temporary or casual employment, whether as a labour hire worker or contractor.¹²⁵³

11.24 However, the protection of permanent employment at Australian mines was weakened from the mid-1990s by a combination of legislative reforms, industry down-sizing and employer challenges to union control, including as a result of enterprise bargaining.¹²⁵⁴

11.25 From the mid-1990s, the growth in labour hire and contractor arrangements at mines has been significant. The use of such arrangements has increasingly been for the performance of core work, rather than the specialist work contractors had previously been engaged to undertake.¹²⁵⁵

The rise of labour hire workers and contractors in Queensland coal mines

11.26 As can be seen from the data referred to below, the Queensland coal mining industry has experienced a similar increase in the number of labour hire workers and contractors to that which has occurred in the Australian coal mining industry generally since the 1990s.

11.27 Research from 2007 into the rise of temporary employment arrangements in Queensland coal mines revealed that, in 1996, direct employment accounted for 94.1% of the overall workforce at open cut mines in the central and northern coalfields in Queensland. Only 5.9% were contractors. By 2002, the proportion of direct employees had fallen to 61.5%, while the proportion of contractors had risen to 39.5%.¹²⁵⁶

11.28 That research concluded that the rapid shift in the proportions of direct employees and contractors at Queensland mines were related to falling coal prices and federal industrial relations legislation changes. These included the introduction of the *Workplace Relations Act 1996* (Cth), which permitted the unfettered use of contractors.¹²⁵⁷

¹²⁵² BOI.001.004.0001, .0005.

¹²⁵³ BOI.001.004.0001, .0005.

¹²⁵⁴ BOI.001.004.0001, .0006.

¹²⁵⁵ BOI.001.004.0001, .0006; .0089.

¹²⁵⁶ BOI.001.004.0001, .0007.

¹²⁵⁷ BOI.001.004.0001, .0007.

11.29 The trend towards the increased use of labour hire workers and contractors at Queensland mines continued. Data from the Commissioner for Mine Safety and Health revealed that, by 2017, there were more contractors than direct employees in Queensland coal mines. In 2016–17, there were 11,648 direct employees and 14,090 contractors in open cut coal mines. In underground coal mines there were 2,564 direct employees and 2,723 contractors.¹²⁵⁸

11.30 Today, the use of labour hire workers and contractors in Queensland mines varies between sites. Some mines still employ predominantly permanent, full-time workers while others are entirely operated by contractors.¹²⁵⁹

The reasons why organisations use labour hire workers and contractors

11.31 The main reasons why host organisations engage labour hire workers and contractors appear to be flexibility and cost savings. The most significant advantage for host organisations is the ability to increase their labour supply during periods of demand without having to increase their employee numbers, and reduce that supply when it is no longer required.¹²⁶⁰

11.32 Other advantages include:¹²⁶¹

- *providing enhanced numerical flexibility to cope with peaks and troughs in demand, staff absences, or to manage specific work (e.g. programmed maintenance)*
- *simplifying recruitment and selection processes and meeting interim or immediate staff needs at short notice*
- *facilitating access to specialist skills from time to time as required*
- *reducing in-house staff and outsourcing non-core business areas, including the management of areas of expertise (e.g. human resources, occupational health and safety)*
- *reducing costs associated with staff overheads and entitlements,*
- *simplifying tax planning, and*
- *outsourcing risk management and administrative burdens associated with regulatory compliance, including unfair dismissal claims and workers' compensation.*

11.33 It would seem that another advantage to organisations is the marginalisation of the union, which serves to limit the risk of increased work stoppages through industrial disputes, reduced productivity and higher labour costs.¹²⁶²

¹²⁵⁸ BOI.001.004.0001, .0008.

¹²⁵⁹ BOI.001.004.0001, .0089.

¹²⁶⁰ BOI.001.004.0001, .0011; .0090.

¹²⁶¹ BOI.001.004.0001, .0012.

¹²⁶² BOI.001.004.0001, .0025.

The reasons why workers engage in labour hire and contract work

11.34 For workers, the advantages of labour hire work include having an agent who scouts for work and tailors work conditions to suit the worker.¹²⁶³ Other advantages include increased independence to determine their own work options, and the ability to have more flexible and varied work.¹²⁶⁴

11.35 A 2008 Australian Bureau of Statistics survey identified that workers engage in labour hire work for a variety of reasons. The nominated reasons and the percentage of the respondents who selected them were:¹²⁶⁵

- a. ease of obtaining work (55.7%);
- b. the fact that it is hassle-free (15.6%);
- c. respondents like short-term work (2.8%);
- d. they are unable to find work in their line of business (7.1%);
- e. labour hire work is a condition of working in the job/industry (9.2%);
- f. a lack of experience prevents them finding a permanent job (2.4%);
- g. it allows them to gain more experience (2.8%);
- h. it affords them flexibility (7.4%); and
- i. other unspecified reasons (17.8%).

11.36 However, there is also evidence that some labour hire workers and contractors engage in such temporary forms of employment because of a lack of options. For example, a 2009 study conducted in the European Union found that more than half of the study participants had ‘involuntary motivations’ for engaging in labour hire work. They would have preferred permanent work, or were using the job as a stepping stone to other work.¹²⁶⁶

11.37 More recently, in 2016, the *Victorian Inquiry into the Labour Hire Industry and Insecure Work* (the Victorian Inquiry) considered the above surveys—as well as submissions from unions, industry groups, non-government organisations and academics—as part of an assessment of workers’ reasons for taking up labour hire work. The Inquiry concluded:¹²⁶⁷

¹²⁶³ BOI.001.004.0001, .0011.

¹²⁶⁴ BOI.001.004.0001, .0012.

¹²⁶⁵ BOI.001.004.0001, .0017.

¹²⁶⁶ BOI.001.004.0001, .0017.

¹²⁶⁷ BOI.001.004.0001, .0018; Forsythe, A., *Victorian Inquiry into the Labour Hire Industry and Insecure Work: Final Report* (2016) Industrial Relations Victoria, Department of Economic

Development, Jobs, Transport & Resources <<https://s3.ap-southeast-2.amazonaws.com/hdp.au.prod.app.vic-engage.files/3615/5685/9019/IRV-Inquiry-Final-Report-.pdf>>, page 82.

While there is evidence that some workers are attracted to the flexibility that labour hire offers and see it as a path to ongoing employment, many workers accept labour hire engagements as the only choice open to them and would prefer permanent positions. There is also considerable financial insecurity attached to many labour hire engagements.

- 11.38 The Victorian Inquiry was not specifically focussed on the mining industry. The Board is not aware of any study conducted on the reasons why Queensland coal mine workers engage in labour hire work, and Professor Quinlan did not reference any such study. In some cases, it may be that workers prefer labour hire work. In other cases, such as at Grosvenor where the bulk of the available production positions are labour hire positions, it seems likely that at least some workers take up labour hire work because direct, permanent employment is not an option.

Disadvantages of labour hire and contract work

- 11.39 Despite the advantages of labour hire and contractor arrangements, there are concerns that, generally, labour hire workers are paid less than direct employees and that contract labour has been used to undermine labour standards and weaken or remove union presence.¹²⁶⁸
- 11.40 Another concern associated with labour hire is that labour hire workers can be used to substitute an existing workforce with a cheaper equivalent which is more likely to be compliant because of the temporary nature of their engagement. The growth of unstable employment conditions may impact negatively on the living standards of a worker and the worker's family, including limiting their ability to access loans and credit or plan for their future. Organisations may be less likely to invest in the training and development of labour hire staff. Labour hire workers are likely to have less of a voice in the workplace.¹²⁶⁹
- 11.41 The Victorian Inquiry considered the effects of labour hire on working conditions, labour standards, and regulatory compliance. While it identified a number of positive experiences for workers, it found that most of the evidence was negative. The negative effects included low or irregular earnings, under-payment, fear of reporting problems, job insecurity, irregular hours, powerlessness to negotiate, abuse, and exploitation.¹²⁷⁰
- 11.42 *Keep it in the regions*, the report of the 2018 federal parliamentary committee, found that, in the Australian mining industry, one of the disadvantages for labour hire workers was that they were often employed on conditions that were significantly different from those of their directly employed colleagues.¹²⁷¹

¹²⁶⁸ BOI.001.004.0001, .0011.

¹²⁶⁹ BOI.001.004.0001, .0012–.0013.

¹²⁷⁰ BOI.001.004.0001, .0019.

¹²⁷¹ BOI.001.004.0001, .0022–.0023.

Safety impacts associated with labour hire and contract work

- 11.43 One of the disadvantages associated with labour hire and contract work, identified above, is its negative impact on safety. The safety impacts associated with labour hire and contract work are explored below.
- 11.44 Going back as far as the 1980s, there is a considerable body of research into the safety and health implications of temporary and insecure work arrangements, including labour hire arrangements. There is a high degree of consistency in the findings that those implications are overwhelmingly negative.¹²⁷²
- 11.45 The research shows that, generally speaking, temporary and insecure work arrangements are associated with a higher incidence of injuries and fatalities, as well as poorer physical and mental health. Workers employed in such arrangements generally have a poorer knowledge of, and poorer access to, regulatory employment rights, and are less willing to raise occupational health and safety concerns.¹²⁷³
- 11.46 In addition, the existence of labour hire arrangements at a workplace presents more complex inter-organisational chains of responsibility. It also increases demands on regulator resources.¹²⁷⁴
- 11.47 Other safety impacts arise from the fact that labour hire workers are, generally speaking, significantly less likely to have access to complaint mechanisms, health services, statutory entitlements to protections and benefits, return to work pathways, and representation.¹²⁷⁵
- 11.48 In terms of the research into the safety impacts associated with labour hire and contract work generally, Professor Quinlan said, by way of summary:¹²⁷⁶

Overall, there has been a high if not remarkable degree of consistency in the findings of the hundreds of articles now published on the health outcomes associated with this array of arrangements or the effects of job-insecurity.

This point has been made repeatedly, including comparisons of contract labour with other types of precarious work (like temporary employment). For example, in a 2015 paper on the use of independent, dependant and employee contractors at the Pike River Coal Mine, Lamare et al stated there 'is also a substantial body of evidence that shows that the effects of insecure work, whether it is through subcontracting or not, are pervasive and overwhelmingly negative'.

¹²⁷² BOI.001.004.0001, .0026–.0027.

¹²⁷³ BOI.001.004.0001, .0028.

¹²⁷⁴ BOI.001.004.0001, .0033.

¹²⁷⁵ BOI.001.004.0001, .0033.

¹²⁷⁶ BOI.001.004.0001, .0027. References omitted.

11.49 There has been only limited research into whether the use of labour hire and contract labour has affected occupational health and safety outcomes in Australian and New Zealand mining.¹²⁷⁷ However, the research that has been undertaken has reached similar findings to that based on general workforce data.¹²⁷⁸ In his literature review, Professor Quinlan said:¹²⁷⁹

In sum, the body of research specifically examining contract labour and safety is small but (even after discounting the weaker studies) relatively consistent in its findings and these match more general research on the subject.

Fear of raising safety concerns because of precarious employment

11.50 One issue considered in a number of the mine safety reviews and inquiries examined by Professor Quinlan is the willingness, or reluctance, of labour hire and contract workers to raise safety concerns.

11.51 A report prepared as part of an independent inquiry into the 2006 Beaconsfield Gold Mine disaster found there was no evidence that the use of contractors at the mine had compromised safety or contributed to the disaster. However, the report did observe that contract workers at the mine:¹²⁸⁰

...stated they felt able to raise OHS issues at toolbox meetings, and most with longer tenure at the mine had although several indicated they felt less free to do this because of a desire not to make themselves too conspicuous or “rock the boat”.

11.52 An earlier 1999 Swedish study found that temporary workers were less likely to raise safety issues than permanent workers and that, when they did, those concerns were less likely to be treated seriously.¹²⁸¹

11.53 An issues paper produced by the Queensland Office of Industrial Relations for the 2016 Inquiry into the Regulation of the Labour Hire Industry noted:¹²⁸²

A good part of the reason for the poorer labour market outcomes for labour hire employees lies in the insecurity of employment.

¹²⁷⁷ BOI.001.004.0001, .0044.

¹²⁷⁸ BOI.001.004.0001, .0048.

¹²⁷⁹ BOI.001.004.0001, .0092–.0093.

¹²⁸⁰ BOI.001.004.0001, .0051; from Quinlan, M., *Report on OHS Management at the Beaconsfield Joint Venture Gold Mine, Tasmania up to and Including the Time of the Rockfall Incident at the 925 Level of the Mine that Occurred at around 9.23 pm, Resulting in the Death of Larry Paul Knight and the Entrapment of Todd Andrew Russell and Brant George Webb* (2009) Expert Report prepared for Greg Melick SC, Independent Investigator appointed by the Tasmanian Government, 30 August 2007, pages 151–152.

¹²⁸¹ BOI.001.004.0001, .0033.

¹²⁸² BOI.001.004.0001, .0035; Office of Industrial Relations, *Regulation of the Labour Hire Industry 2016: Issues Paper*, Queensland Government (Issues Paper, December 2016) <https://www.oir.qld.gov.au/sites/default/files/labour-hire-issues-paper-december-2016.pdf?acsf_files_redirect>, page 8.

This makes workers vulnerable to exploitation but also less likely to speak up about their concerns for fear of losing their job, and, in the case of temporary visa workers from overseas, jeopardising their prospects of staying in the country.

11.54 The Inquiry's subsequent report, issued in June 2016, added that:¹²⁸³

...many mining operators have moved to predominantly labour hire workforces in recent years with the stated aim of reducing overheads and increasing workforce flexibility – especially in major Bowen Basin operations stretching from Biloela to Blackwater and Moranbah.

11.55 The report did not make specific reference to the implications of labour hire on occupational health and safety in the mining industry but made the following observation about the raising of occupational health and safety concerns generally:¹²⁸⁴

The Committee heard that some workers are employed on a labour hire basis for several years in the same role. Due to the casual nature of their employment, many of the workers are afraid to complain about safety issues at work and are afraid to take sick leave for fear of losing their jobs.

11.56 The Victorian Inquiry also reported evidence of labour hire workers holding fears about reporting safety concerns.¹²⁸⁵

11.57 Professor Quinlan said, in relation to his review of the various Australian government inquiries, including the Queensland and Victorian Inquiries referred to above:¹²⁸⁶

Overall, the result of this review of government inquiries, investigations and audits was consistent with the research evidence, and provided some additional insights into the effects of job insecurity/vulnerability on incident reporting and disorganisation associated with contract labour use contributing to serious incidents.

¹²⁸³ BOI.001.004.0001, .0035; Finance and Administration Committee, Parliament of Queensland, Report No. 25, *Inquiry into the practices of the labour hire industry in Queensland* (Parliamentary Report, June 2016)

<<https://www.parliament.qld.gov.au/documents/tableOffice/TabledPapers/2016/5516T1028.pdf>>, page 12.

¹²⁸⁴ BOI.001.004.0001, .0035–.0036; Finance and Administration Committee, Parliament of Queensland, Report No. 25, *Inquiry into the practices of the labour hire industry in Queensland* (Parliamentary Report, June 2016)

<<https://www.parliament.qld.gov.au/documents/tableOffice/TabledPapers/2016/5516T1028.pdf>>, page 17.

¹²⁸⁵ BOI.001.004.0001, .0036.

¹²⁸⁶ BOI.001.004.0001, .0093.

11.58 A Queensland mining and quarrying safety reset was conducted in 2019.¹²⁸⁷ The safety reset included an online survey which received 518 responses from 110 mine sites, and 20 interviews. The four most prevalent themes associated with safety were:¹²⁸⁸

1. *the importance of **leadership** in addressing safety issues and the impact this had on safety culture*
2. *the impact of **workforce** casualisation and the importance of an experienced, well-trained and permanent workforce in improving safety culture*
3. *the need for improved quality of **training** and more frequent training*
4. *the need for clearly defined, standardised and simplified **processes**, policies, and procedures.*

11.59 The safety reset responses included the following concerns:¹²⁸⁹

- a. that safety concerns could not be raised without fear of reprisal;
- b. that there was a focus on production over safety;
- c. a desire for greater enforcement of existing laws and regulations, including more unannounced site inspections and more independent monitoring of mine operations; and
- d. environmental hazards that impact workers health.

11.60 The top-three issues raised by stakeholders and attendees in the telephone interviews were consistent with those from the online survey:

1. Fear of speaking out;
2. Workforce casualisation;
3. Inadequate training.

11.61 The safety reset responses represent the most recently collected attitudes and beliefs of Queensland coal miners. Given the small number of respondents, which represented only around 1% of the workforce, the results must be treated with caution. With this caveat, the responses tended to echo concerns raised in research and elsewhere in this report relating to workforce changes, reporting problems and improved safety management.

¹²⁸⁷ BOI.001.004.0001, .0059; Chemical Storm Pty Ltd trading as Ronan Analytics, *Queensland Safety Reset Survey Analysis and Key Findings Report* (2019), Report prepared for the Queensland Department of Natural Resources, Mines and Energy, page 3: 'An online survey of mine and quarry workers who attended a series of Safety Reset sessions was conducted by the Queensland Department of Natural Resources, Mines and Energy (DNRME). It was conducted over a six-week period ending late August 2019. Survey respondents answered five questions to provide general suggestions on how safety outcomes could be improved in the mining and quarrying industries'.

¹²⁸⁸ BOI.001.004.0001, .0059–.0060.

¹²⁸⁹ BOI.001.004.0001, .0060.

These responses are consistent with Professor Quinlan’s review of formal inquiries and audits which indicated that there is a link between labour hire and contract work and a fear of raising safety concerns.

Production and safety bonuses for coal mine workers

- 11.62 In his report, Professor Quinlan observes that incentive-based payment regimes, including in relation to the contracting arrangements, have been used in the coal mining industry for centuries. He also notes that complaints about their adverse effect on safety are longstanding.¹²⁹⁰
- 11.63 In 2007, the NSW Mine Safety Advisory Council commissioned research into a number of matters, including production and safety bonuses.¹²⁹¹ The resultant report, *Digging Deeper*, noted that research into production bonuses revealed that there are a number of complexities associated with such schemes, including adverse outcomes such as risk taking and under-reporting of incidents.¹²⁹²
- 11.64 *Digging Deeper* noted that there was a belief, held by direct employees and labour hire workers alike, that the reporting of lost time injuries by contractors and labour hire workers would be detrimental to their employment.¹²⁹³ The report noted:¹²⁹⁴

In particular, contractors reported that they are penalised by reduced payments or withdrawal of access to contracting work as a result of reporting incidents or injuries. We were consistently told by contractors that, as a result, they do not report such events, even when they occur. These views were expressed to us on site and in the consultations undertaken by the project with contracting companies. The consistency and strength of these reports demonstrates the impact that such views have on reporting behaviour.

Whether in fact mining companies do actually withdraw access to work or reduce payments as a result of reporting incidents or injuries is to some extent less important than the strongly held belief by all contractors involved in the project that this would be the result of reporting. This belief drives the reported behaviour of under-reporting.

¹²⁹⁰ BOI.001.004.0001, .0098.

¹²⁹¹ BOI.001.004.0001, .0099.

¹²⁹² BOI.001.004.0001, .0099; Shaw Idea, *Digging Deeper: Wran Consultancy Project Vol 1* (Report commissioned by the NSW Mine Safety Advisory Council, November 2007)

<https://resourcesandgeoscience.nsw.gov.au/__data/assets/pdf_file/0008/719657/digging-deeper-report-vol-1.pdf>, page 59; AAMC.001.041.0001, .0087.

¹²⁹³ BOI.001.004.0001, .0106; Shaw Idea, *Digging Deeper: Wran Consultancy Project Vol 1* (Report commissioned by the NSW Mine Safety Advisory Council, November 2007)

<https://resourcesandgeoscience.nsw.gov.au/__data/assets/pdf_file/0008/719657/digging-deeper-report-vol-1.pdf>, page 59; AAMC.001.041.0001, .0087.

¹²⁹⁴ BOI.001.004.0001, .0106; Shaw Idea, *Digging Deeper: Wran Consultancy Project Vol 1* (Report commissioned by the NSW Mine Safety Advisory Council, November 2007)

<https://resourcesandgeoscience.nsw.gov.au/__data/assets/pdf_file/0008/719657/digging-deeper-report-vol-1.pdf>, page 59; AAMC.001.041.0001, .0087.

- 11.65 *Digging Deeper* concluded that production and safety bonus schemes that involved payment in exchange for achieving particular outcome targets have not proven themselves to consistently or reliably improve safety outcomes.¹²⁹⁵ It recommended:¹²⁹⁶

As a result, we recommend that NSW mining enterprises should review their existing safety incentive schemes and shift them from a focus on outcome data to a focus on improvement and contribution...

Given the potential for under-reporting and the other negative effects associated with payment schemes based on outcome measures and the lack of evidence of value from them, we recommend that such schemes should not be used in the industry.

- 11.66 The reference to ‘a focus on outcome data’ in the *Digging Deeper* extract immediately above is a reference to the measurement of lag safety performance indicators. The reference to ‘a focus on improvement and contribution’ is a reference to the measurement of lead safety performance indicators.¹²⁹⁷
- 11.67 A 2014 US study by the Office of Mining in the National Institute of Occupational Safety and Health (NIOSH) into coal mine workers’ reporting of safety incidents noted that some of the reasons commonly given by miners for not reporting incidents included fear of jeopardising rewards that are based on having low injury rates and peer pressure, in the sense of a concern that co-workers would lose a bonus.¹²⁹⁸
- 11.68 In respect of safety bonus schemes, the authors said:¹²⁹⁹

Finally, an important potential negative outcome of injury-based bonus plans is that safety incidents may go unreported, and the organization does not learn about safety problems that are likely to continue to arise unless appropriate countermeasures are taken.

¹²⁹⁵ BOI.001.004.0001, .0107; Shaw Idea, *Digging Deeper: Wran Consultancy Project Vol 1* (Report commissioned by the NSW Mine Safety Advisory Council, November 2007)

<https://resourcesandgeoscience.nsw.gov.au/__data/assets/pdf_file/0008/719657/digging-deeper-report-vol-1.pdf>, page viii; AAMC.001.041.0001, .0014.

¹²⁹⁶ BOI.001.004.0001, .0107–.0108; Shaw Idea, *Digging Deeper: Wran Consultancy Project Vol 1* (Report commissioned by the NSW Mine Safety Advisory Council, November 2007)

<https://resourcesandgeoscience.nsw.gov.au/__data/assets/pdf_file/0008/719657/digging-deeper-report-vol-1.pdf>, page ix; AAMC.001.041.0001, .0015. A guide to undertaking a review of existing safety incentive schemes is provided as Attachment 10 in Volume 2: see Shaw Idea, *Digger Deeper: Wran Consultancy Project Vol 2* (Report commissioned by the NSW Mine Safety Advisory Council, November 2007)

<https://resourcesandgeoscience.nsw.gov.au/__data/assets/pdf_file/0011/719660/digging-deeper-report-vol-2.pdf>; AAMC.001.041.0259.

¹²⁹⁷ Lead and lag indicators were explained and discussed in Part I of the Report, Chapter 6 (Corporate Governance).

¹²⁹⁸ BOI.001.004.0001, .0101.

¹²⁹⁹ BOI.001.004.0001, .0102; Peters, R. & Kosmoski, C., *Why Miners Report (or do not report) Safety-relevant Information* (2014) Engineering and Mining Journal: page 58.

Based on the survey responses from the five mines in this study, the current structure of incentive programs at some mines appears to be deterring individuals from reporting safety incidents. Several programs are reactive and only reduce incentives for behaviors that are detrimental to production (e.g., extended absences, lost-time accidents) rather than also rewarding behaviors that are proactive and positive for safety (e.g., wearing PPE, identifying mistakes and hazardous conditions). It can be argued that utilizing injury rate-based incentive programs may not be encouraging employees to work safer. Instead, such programs may be rewarding employees either for taking risks but being lucky enough not to have accidents, or for not reporting incidents when they do happen.

11.69 In respect of production bonuses, the authors said:¹³⁰⁰

All five of the mines NIOSH assessed were offering bonuses to miners for achieving goals related to the amount of coal mined. Although NIOSH did not ask for, nor were provided with, the actual amounts of these bonuses, comments from several of the miners interviewed suggested that these bonuses were substantial at some mines. It is possible that the practice of offering substantial production-based bonuses can lead miners to take dangerous shortcuts and to perform certain tasks too fast (e.g., driving mobile equipment). Such bonus programs may also cause workers to neglect maintenance and repair of equipment if they think the equipment will keep running long enough to achieve the tonnage required to earn their bonuses.

A strict emphasis on production and the time it takes a miner to do his/her work can simultaneously decrease an emphasis on safety. When miners are focused on production, reporting safety relevant information can take a back seat to output and efficiency. This is because raising safety issues and reporting accidents takes time, and the time it takes to communicate these issues is in direct competition with his or her total compensation. In other words, safety-related communications are necessary to prevent accidents, but the time it takes to do this may be perceived as having negative consequences for production and efficiency, especially when those are the primary metrics used to determine the amount of bonus an employee receives.

11.70 The report concluded that large production bonuses might give workers the impression that production is valued over safety, causing them to work in an unsafe way. Injury-based bonuses could cause workers to fail to report incidents and injuries.¹³⁰¹

¹³⁰⁰ BOI.001.004.0001, .0103; Peters, R. & Kosmoski, C., *Why Miners Report (or do not report) Safety-relevant Information* (2014) Engineering and Mining Journal: page 58.

¹³⁰¹ BOI.001.004.0001, .0113.

Strategies for minimising safety risks associated with labour hire and contract work

11.71 There has been limited research into how organisations can minimise safety risks associated with labour hire and contract work. As a result, there is no clear answer to this question.¹³⁰²

11.72 A Queensland-based, non-mining study that examined stakeholder views on risk-minimisation strategies for labour hire arrangements suggested the following:¹³⁰³

...development of long-term relationships between host and agency (including close and ongoing links between managers of both with a mutual commitment to OHS as a priority); the provision of specialised services (not generalised labour hire); careful selection (physical capacities, knowledge and experience) and induction of agency workers including alignment of practices to meet OHS responsibilities by both agency and host; thorough risk assessment processes by the agency prior to placement and no short-term placements; agency managers being highly receptive to worker concerns about OHS (on a 24-hour basis) and taking these up with the host without fear of retribution measures.

11.73 Professor Quinlan considers that a large and well-constructed study of safety in the Australian coal mining industry, with a particular focus on the impact of labour hire and contract work, would be very valuable.¹³⁰⁴

Evidence specific to the mines the subject of this Inquiry

11.74 The previous section contained a summary of Professor Quinlan’s literature review. This section considers the evidence about the safety impacts of labour hire and contract work at the mines which are the subject of this Inquiry.

Labour hire workers and contractors at Grosvenor, Grasstree, Moranbah North and Oaky North mines

11.75 There are labour hire workers at Grosvenor, Moranbah North, and Grasstree mines.¹³⁰⁵ Generally, more than 50% of the workforce across those sites are contractors or labour hire employees.¹³⁰⁶ Mr Warwick Jones, the head of Human Resources at AAMC, understands that those numbers are ‘not dissimilar’ to many other mining sites in Queensland.¹³⁰⁷

11.76 What follows is a breakdown of the number of direct employees and contractors (including labour hire workers) at Grosvenor, Moranbah North, and Grasstree mines in May 2020 according to a statement given by Mr Jones to the Inquiry.

¹³⁰² BOI.001.004.0001, .0081.

¹³⁰³ BOI.001.004.0001, .0081.

¹³⁰⁴ BOI.001.004.0001, .0093.

¹³⁰⁵ AAMC.001.036.0001, .0005.

¹³⁰⁶ AAMC.001.036.0001, .0005.

¹³⁰⁷ AAMC.001.036.0001, .0005.

- 11.77 At Grosvenor, there were 167 direct employees on site (19% of the workforce). Of those employees, 38 (4% of the workforce) were employed in operator, trades, or Explosion Risk Zone (ERZ) controller roles. There were 697 mining and non-mining contractors on site (81% of the workforce). 76% of the total site workforce were contractors (including labour hire workers) engaged in mining tasks.¹³⁰⁸
- 11.78 At Moranbah North, there were 435 direct employees on site (37% of the workforce). Of those employees, 281 (24% of the workforce) were employed in operator, trades or ERZ controller roles. There were 758 mining and non-mining contractors on site (63% of the workforce). 58% of the total site workforce were contractors (including labour workers) engaged in mining tasks.¹³⁰⁹
- 11.79 At Grasstree, there were 431 direct employees on site (55% of the workforce). Of those employees, 273 (35% of the workforce) were employed in operator, trades, or ERZ controller roles. There were 351 mining and non-mining contractors on site (45% of the workforce). 37% of the total site workforce were contractors (including labour hire employees) engaged in mining tasks.¹³¹⁰
- 11.80 As to Oaky North mine, in December 2019, 65% of the workforce consisted of full-time employees. Approximately 35% of the workforce was comprised of supplementary labour.¹³¹¹ As to actual numbers, there were 450 workers, of whom 290 were direct employees and 160 of whom were contractors.¹³¹²

The nature of the arrangements between the mines and the labour hire agencies

- 11.81 At each of Grosvenor, Moranbah North and Grasstree, One Key is one of the labour hire companies supplying workers to these mines. Various contractors also perform work at the sites.
- 11.82 One Key is a specialist provider of managed workforce services and labour hire which operates in the mining, oil and gas and infrastructure industries, including at underground coal mines.¹³¹³
- 11.83 Mr Ben Lewis is the Regional Director at One Key. He provided a statement to the Inquiry and gave evidence at the first tranche of public hearings about the arrangement between Grosvenor and One Key.
- 11.84 In his statement, Mr Lewis described the labour hire model at Grosvenor as an 'integrated workforce management model', whereby almost the entirety of the production workforce is supplied and managed by One Key. One Key manages the recruitment, engagement, generic induction, rostering, payroll, performance management and discipline, and injury management of the workers.

¹³⁰⁸ AAMC.001.036.0001, .0005–.0006.

¹³⁰⁹ AAMC.001.036.0001, .0005–.0006.

¹³¹⁰ AAMC.001.036.0001, .0005–.0006.

¹³¹¹ OCH.507.002.0001, .0007.

¹³¹² OCH.504.001.0084.

¹³¹³ LBE.001.001.0001, .0002.

Anglo retains responsibility for the supervision and safety of the workers when they are on site. As at May 2020, One Key was supplying 402 workers to Grosvenor.¹³¹⁴

- 11.85 By contrast, One Key’s presence at Moranbah North and Grasstree represents a more traditional model in that One Key provides workers as required, but in much smaller numbers than it provides to Grosvenor. In May 2020, One Key supplied three workers to Moranbah North and 98 workers to Grasstree.¹³¹⁵
- 11.86 One Key did not supply any workers to Oaky North. Oaky North engaged a number of different labour hire agencies for the supply of its labour hire workers.¹³¹⁶

The nature of Anglo’s arrangements with One Key at Grosvenor

- 11.87 In relation to Anglo’s use of labour hire workers and contractors, most evidence in the Board’s first tranche of hearings concerned the labour hire agreements with One Key at Grosvenor.
- 11.88 Anglo entered into a labour hire agreement with One Key on 2 March 2016, which was extended for a further two years in 2019. Pursuant to the agreement, One Key provides Anglo with labour hire workers to fill the operational and trades roles at Grosvenor.¹³¹⁷
- 11.89 Mr Tyler Mitchelson had not yet become the Chief Executive Officer (CEO) of AAMC when the agreement was put in place. However, he said that he understood that the labour hire model implemented by Anglo was designed so that Anglo would have ‘the safest, most productive employees’. He acknowledged that cost was also a consideration.¹³¹⁸
- 11.90 In relation to the reasons for engaging a labour hire model at Grosvenor, Mr Jones said that, at the time Anglo was considering what labour model to use at Grosvenor in 2013–2014, AAMC’s ‘operational excellence group’ conducted a review of the available options. He said:¹³¹⁹

Out of that, they really came back with a conclusion that said the best performance that was being seen at that time, when you tried to normalise for operating conditions and circumstances and equipment and other things that are all different, was a contract model that had labour hire or contractors and an owner/operate [sic] management structure sitting over the top of that, and preferably down to frontline leaders. That was the model that was adopted at that point.

¹³¹⁴ LBE.001.001.0001, .0004–.0005.

¹³¹⁵ LBE.001.001.0001, .0005.

¹³¹⁶ OCH.504.001.1027.

¹³¹⁷ AAMC.001.036.0001, .0004; LBE.001.001.0001, .0003.

¹³¹⁸ TRA.500.009.0001, .0047, line 34–.0048, line 20.

¹³¹⁹ TRA.500.010.0001, .0047, lines 7–15.

- 11.91 Mr Jones said that, according to the operational excellence group’s review of the various options, safety was not a distinguishing factor between the options, and the labour hire model gave the greatest production performance (although he did not identify what it was about the data reviewed that led to the conclusion that a wholly labour hire workforce gave the best performance). He agreed that other benefits of the labour hire model were that Anglo could outsource issues such as payroll, superannuation, and leave entitlements.
- Further, Anglo did not have to pay as much by way of workers’ compensation premiums or concern itself with enterprise bargaining.¹³²⁰
- 11.92 Pursuant to the agreement between Anglo and One Key, the employment obligations largely rest with One Key and the safety obligations rest with Anglo.¹³²¹
- 11.93 One Key provides workers to Grosvenor in accordance with a manning schedule issued by Anglo. The manning schedule is a live document which evolves over time. It sets out the number of roles Anglo requires to be filled at Grosvenor, the qualifications required to be held for those roles, and the estimated duration of the roles.¹³²²
- 11.94 To fill the manning schedule, One Key identifies a pool of prospective employees with the necessary qualifications, skills, and experience. It conducts interviews, validates the information provided by the candidates, and conducts reference checks. At the end of that process, One Key presents a shortlist of recommended candidates to Anglo.¹³²³
- 11.95 At that stage of the process Anglo undertakes its own vetting process to ensure the recommended workers have the desired background and experience and are ‘the sort of coal mine workers, if you like, that we want to have on the site’.¹³²⁴
- 11.96 The contract between Anglo and One Key provides that One Key is required to train its employees in Anglo’s Safety, Health and Environment (SHE) requirements, policies, and procedures, but in practice, that training is done by Anglo. All workers hired to perform work at the site are required to have already completed the generic induction and, at site, are provided with further training and a site induction. That part of the process is the same for direct employees and labour hire workers.¹³²⁵
- 11.97 Anglo monitors the work performance of the One Key workers once they are placed on site.¹³²⁶ As already noted, Anglo is also responsible for the safety of the workers on site. One Key effectively has no say on safety issues at Grosvenor.¹³²⁷

¹³²⁰ TRA.500.010.0001, .0047, line 17–.0048, line 9.

¹³²¹ TRA.500.010.0001, .0048, lines 23–27.

¹³²² TRA.500.013.0001, .0062, line 40–.0063, line 14.

¹³²³ LBE.001.001.0001, .0006–.0007.

¹³²⁴ TRA.500.010.0001, .0044, lines 27–36.

¹³²⁵ TRA.500.010.0001, .0042, line 15–.0043, line 32; .0125, line 5–.0127, line 2.

¹³²⁶ TRA.500.010.0001, .0049–.0050.

¹³²⁷ TRA.500.010.0001, .0062, lines 25–27.

The nature of One Key's employment arrangements with its employees

- 11.98 Mr Jones said ^{that} Anglo is not involved in the employment arrangements between One Key and its employees.¹³²⁸
- 11.99 Mr Lewis explained the nature of One Key's employment arrangements with its employees in a statement which was supplemented by evidence given in the public hearings.
- 11.100 He said that the Enterprise Agreement that applies to the One Key workers at Grosvenor is a greenfield agreement¹³²⁹ between FES Coal Pty Ltd and the CFMMEU dated 13 August 2018. One Key's workers are paid, and receive entitlements, in accordance with that Agreement. Pursuant to the agreement, there are four categories of employment—permanent, part-time, fixed term, and casual employees.¹³³⁰
- 11.101 Mr Lewis said that One Key provides fixed term and casual employees to Grosvenor. He said that One Key's permanent employees are not placed at Anglo because Anglo does not want the additional cost and obligation that comes with hiring a permanent worker.¹³³¹
- 11.102 The fixed term employees are employed pursuant to contracts in which the term of employment is aligned with the length of the contract between One Key and Grosvenor. In mid-2019, the contract between One Key and Grosvenor was extended for two years, with an option to extend for a further year. The workers' fixed term contract periods reflect that time period.¹³³²
- 11.103 Workers on fixed term contracts are paid annual leave, personal or carer's leave, compassionate leave, long service leave, public holiday leave, accident pay, and superannuation.¹³³³
- 11.104 Although the duration of each fixed term contract is aligned with the length of the contract between One Key and Anglo, workers on a fixed term contract are liable to have their contract terminated at any time by the giving of a requisite period of notice. Workers who have been employed by One Key for more than three years must be given three weeks' notice. Workers who have been employed for between one and three years must be given two weeks' notice. Workers who have been employed for less than 12 months are only required to be given one week's notice. If the worker is over 45 years of age, a further one week's notice must be given.¹³³⁴

¹³²⁸ AAMC.001.036.0001, .0004.

¹³²⁹ A 'greenfield agreement' is an enterprise agreement that is made in relation to a new enterprise between a union and an employer before any employees are employed.

¹³³⁰ LBE.001.001.0001, .0002–.0003.

¹³³¹ TRA.500.013.0001, .0067, line 35–.0068, line 1.

¹³³² LBE.001.001.0001, .0003.

¹³³³ TRA.500.013.0001, .0054, lines 4–25.

¹³³⁴ TRA.500.013.0001, .0054, line 27–.0056, line 4.

- 11.105 Workers on casual contracts receive paid long service leave, accident pay and superannuation, but receive no other form of paid entitlements.¹³³⁵
- 11.106 Workers on casual contracts may have their contract terminated on only one hour's notice.¹³³⁶
- 11.107 Over the life of Grosvenor mine, there have been ebbs and flows in the number of workers Anglo has required on site. When the numbers required by Anglo increase, One Key advertises for workers to fill the vacancies on site.¹³³⁷
- 11.108 On the other hand, when the numbers required at Grosvenor decrease, some workers necessarily lose their employment at Grosvenor. Mr Lewis said that it is 'a sensitive situation' when the number of workers Anglo requires on site decreases. One Key tries to find work somewhere else for the workers who are no longer required at Grosvenor, but it is not always possible to do so.¹³³⁸
- 11.109 There have been two significant occasions on which One Key has downsized the numbers of workers at Grosvenor. On one occasion approximately 20 workers lost their jobs. On a second occasion, in 2018, One Key was required to remove about 40 development operators. On both occasions, One Key was given notice of the downsizing event in the order of 'a couple of weeks, perhaps'.¹³³⁹
- 11.110 One Key's workers are aware that, from time to time, Anglo might downsize its workforce and that, when that happens, some One Key workers will lose their jobs. To determine which of the workers will lose their jobs, One Key has regard to the workers' performance reviews and their experience at the mine.¹³⁴⁰
- 11.111 This suggests that those with less favourable performance reviews, and the most recently hired, are the most likely to lose their jobs when downsizing occurs.

Anglo's engagement with labour hire workers at Grosvenor

- 11.112 Mr Jones gave evidence that labour hire workers are fully integrated into Anglo's workforce at Grosvenor. In response to a question about whether the labour hire model operated such that One Key workers attended at the site only for a few days, he said:¹³⁴¹

No, it really doesn't happen that way on any site, but certainly not so on Grosvenor where under the arrangement – that's why I talked before about sort of a collaborative arrangement with One Key. It is recognition that we have a [sic] put in place a contract for services for a three-year period, and that doesn't see people come and go in hourly increments around that.

¹³³⁵ TRA.500.013.0001, .0056, line 37–.0057, line 2.

¹³³⁶ TRA.500.013.0001, .0057, lines 43–46.

¹³³⁷ TRA.500.013.0001, .0064, lines 21–36.

¹³³⁸ TRA.500.013.0001, .0064, line 38–.0065, line 2.

¹³³⁹ TRA.500.013.0001, .0065, line 8–.0066, line 23.

¹³⁴⁰ TRA.500.013.0001, .0065, line 43–.0066, line 11.

¹³⁴¹ TRA.500.010.0001, .0127, lines 32–41.

We would anticipate, short of some major change in the operational circumstance, to continue with the majority of that workforce over the period of that time.

- 11.113 He said that One Key workers tend to be employed at Grosvenor for long periods of time. The average tenure of both permanent employees and One Key workers is 3.7 years. One Key workers at Grosvenor also tend to be experienced workers. On average, they have 8.5 years of experience prior to working at Grosvenor.¹³⁴²
- 11.114 Anglo trains and inducts all workers, including labour hire workers. It assumes responsibility for checking workers' competencies prior to starting at site, and monitors those competencies to ensure that they remain current.¹³⁴³
- 11.115 Anglo issues a 'constant drumbeat' at Grosvenor, asking workers to report hazards and safety issues. It does this in a number of ways, including through toolbox meetings, safety presentations, and initiatives such as the 2018 *How We Rock Up Matters* campaign.¹³⁴⁴
- 11.116 Anglo also has a scheme, called *Your Voice*, through which workers can make an anonymous complaint.¹³⁴⁵ Mr Jones said that ensuring this scheme works correctly requires a balance, because if a worker does not report enough detail, there is nothing to investigate, but too much detail means that confidentiality cannot be maintained. Achieving the balance can be 'quite difficult'.¹³⁴⁶

The process by which Anglo may dismiss a labour hire worker from site

- 11.117 The agreement between Anglo and One Key provides that Anglo's Site Senior Executive (SSE) can require a One Key worker to be removed from site for a number of reasons, including because the SSE is dissatisfied with the worker's conduct.¹³⁴⁷
- 11.118 However, Mr Jones said that that clause is rarely used. In practice, if a concern arises with respect to a One Key worker's performance, Anglo notifies One Key. One Key undertakes a performance management process and, at the conclusion of that process, advises Anglo of the outcome. At the end of the performance management process, Anglo applies its consequence model to One Key's decision-making process to ensure there is consistency between One Key's outcome and the outcome Anglo would have arrived at.¹³⁴⁸

¹³⁴² TRA.500.010.0001, .0131, lines 12–36.

¹³⁴³ TRA.500.010.0001, .0124, line 38–0127, line 2; .0127, line 43–0130, line 36.

¹³⁴⁴ TRA.500.010.0001, .0133, line 30–0134, line 20.

¹³⁴⁵ TRA.500.010.0001, .0071, lines 28–37.

¹³⁴⁶ TRA.500.010.0001, .0072, line 27–0073, line 7.

¹³⁴⁷ TRA.500.010.0001, .0052, lines 36–42.

¹³⁴⁸ TRA.500.010.0001, .0049–0051.

11.119 Mr Jones described the process as follows:¹³⁴⁹

What we would do is, if it's a performance management issue, again, we would rely in this case on One Key's performance management process. At the end of that, if there was some form of discipline, for example, up to and including potentially termination of employment, we would make sure that we've applied our own consequence matrix or our consequence model, as we call it, to their decision-making process just to ensure that there is some consistency in the way that we would treat a coal mine worker versus, if you like, the output of their process.

11.120 Thus, if a worker is to be terminated for misconduct or poor performance, that decision is usually made, in the first instance, by One Key.¹³⁵⁰

11.121 The SSE's discretion to require a worker to be removed from site is exercised rarely, and only after an internal review process. Mr Jones said:¹³⁵¹

... you would very rarely get to a situation where the SSE unilaterally, with no other input from anybody else, has exercised the right [to dismiss a worker from site]...in practice it has gone through multiple reviews or recommendations before it gets there.

11.122 Mr Lewis agreed that this was, in practice, how Anglo American plc (Anglo) companies dealt with discipline issues with respect to One Key workers. Although the One Key employees work under Anglo's direction at Grosvenor, when a disciplinary process needs to be undertaken, Anglo refers the matter to One Key to undertake that process. Mr Lewis said that, generally speaking, Anglo allows One Key to follow its own process and determine the appropriate outcome.¹³⁵²

11.123 Mr Damien Wynn, the SSE at Grasstree, gave evidence that there was an occasion when he required the removal of a Deputy who failed to report a safety incident. That is the only incident Mr Lewis was aware of when an SSE required the removal of a One Key worker from one of its sites.¹³⁵³

11.124 Mr Lewis said that, during the period of inquiry under the Terms of Reference, nine workers had been removed from Grosvenor and six workers from Grasstree. In some cases, the reason for the removal was that the worker was found to be in breach of the safety and health management system. It was not known whether, in those cases, the worker self-reported the safety issue they were involved in, or the incident came to Anglo's attention by some other means.

On another occasion, a worker was dismissed from site for attending work when ill, contrary to the mine's then efforts to avoid coronavirus transmission.¹³⁵⁴

¹³⁴⁹ TRA.500.010.0001, .0050, lines 31–40.

¹³⁵⁰ TRA.500.010.0001, .0052, line 36–.0053, line 11.

¹³⁵¹ TRA.500.010.0001, .0053, line 46–.0054, line 5.

¹³⁵² TRA.500.013.0001, .0083, line 38–.0084, line 35.

¹³⁵³ TRA.500.013.0001, .0090, lines 15–30.

¹³⁵⁴ TRA.500.013.0001, .0081, line 43–.0083, line 36.

Obligation owed by One Key for its employees' safety at Grosvenor

11.125 One Key conducts a site safety audit at Grosvenor on an annual basis. The most recent audit occurred in January 2020 and involved One Key's Health, Safety and Environment (HSE) manager and Grosvenor's safety representative.¹³⁵⁵ The audit documentation indicates that One Key's HSE manager, Ms Rachael Small, confirmed that there was a documented site specific safety and health management plan in place at the mine. The audit documentation did not reveal how thorough the assessment of the safety and health management plan was, and Mr Lewis was not able to say how thorough the assessment was, given he was not at the mine at the time. He stated that the audit process would have taken several hours.¹³⁵⁶

11.126 Despite the fact that it conducts site safety audits at Grosvenor, One Key does not consider that it has any statutory obligations at the mine pursuant to either section 43 or 47 of the Act. One Key provides labour only, and the workers work under the control of Anglo. His evidence was to the effect that, in those circumstances, One Key has no control over the workers on site.¹³⁵⁷

11.127 One Key considers that all the operational risks, including risks arising from methane exceedances, are Anglo's responsibility. If One Key received notice of a series of concerns or events, One Key would 'absolutely' rely on Anglo to respond to those risks and would seek comfort from Anglo that the risks had been managed.¹³⁵⁸

11.128 This situation can be contrasted with One Key's obligations to its employees placed at mines in NSW. Mr Lewis said that, in NSW, One Key has an obligation to its workers deployed at mine sites pursuant to section 19 of the *Work Health and Safety Act 2011* (NSW) (the NSW Act).¹³⁵⁹

11.129 Section 19 of the NSW Act provides, relevantly:

19 Primary duty of care

(1) A person conducting a business or undertaking must ensure, so far as is reasonably practicable, the health and safety of—

(a) workers engaged, or caused to be engaged by the person, and

(b) workers whose activities in carrying out work are influenced or directed by the person,

while the workers are at work in the business or undertaking.

(2) A person conducting a business or undertaking must ensure, so far as is reasonably practicable, that the health and safety of other persons is not put at risk from work carried out as part of the conduct of the business or undertaking.

¹³⁵⁵ LBE.001.001.0001, .0009.

¹³⁵⁶ TRA.500.013.0001, .0070, line 8–.0071, line 47.

¹³⁵⁷ TRA.500.013.0001, .0084, line 37–.0085, line 41.

¹³⁵⁸ TRA.500.013.0001, .0093, lines 24–47.

¹³⁵⁹ TRA.500.013.0001, .0087, lines 21–44.

(3) *Without limiting subsections (1) and (2), a person conducting a business or undertaking must ensure, so far as is reasonably practicable—*

(a) the provision and maintenance of a work environment without risks to health and safety, and

(b) the provision and maintenance of safe plant and structures, and

(c) the provision and maintenance of safe systems of work, and

(d) the safe use, handling, and storage of plant, structures and substances, and

(e) the provision of adequate facilities for the welfare at work of workers in carrying out work for the business or undertaking, including ensuring access to those facilities, and

(f) the provision of any information, training, instruction or supervision that is necessary to protect all persons from risks to their health and safety arising from work carried out as part of the conduct of the business or undertaking, and

(g) that the health of workers and the conditions at the workplace are monitored for the purpose of preventing illness or injury of workers arising from the conduct of the business or undertaking.

11.130 Mr Lewis said that One Key complies with that obligation in NSW by developing its own HSE management plan.¹³⁶⁰

11.131 In fact, section 19 of the NSW Act is in identical terms to section 19 of the comparable Queensland legislation, that is, the *Work Health and Safety Act 2011* (Qld) (the WHS Act). However, unlike the NSW Act, the Queensland legislation does not apply to, *inter alia*, ‘a coal mine to which the *Coal Mining Safety and Health Act 1999* applies’.¹³⁶¹

11.132 Whilst One Key’s position is that it has no obligations under the Act,¹³⁶² Resources Safety & Health Queensland (RSHQ), relying upon sections 43 and 47, as well as section 39 of the Act, argues to the contrary.¹³⁶³ In any event, the Board notes that One Key supports a recommendation which would seek to correct the situation that exists at present whereby labour hire companies do not have the clear and express workplace health and safety obligations such as those found in section 19 of the NSW Act.¹³⁶⁴

¹³⁶⁰ TRA.500.013.0001, .0087, lines 39–42; .0085, lines 30–41.

¹³⁶¹ WHS Act, schedule 1 ‘Application of the Act’, part 2, division 1, clause 2(1)(a).

¹³⁶² TRA.500.013.0001, .0084, lines 37–44.

¹³⁶³ Submission received from RSHQ on 27 October 2020 in response to a draft chapter, paragraphs 19–21.

¹³⁶⁴ OKR.999.001.0001, .0027.

No requirement for Anglo to notify One Key of HPIs at Grosvenor

11.133 Mr Jones gave evidence that, during the period of time the subject of this Inquiry, there was no formal process by which Anglo notified One Key when either an Anglo high potential incident (HPI) or a Department of Natural Resources, Mines and Energy (DNRME) HPI occurred at Grosvenor.¹³⁶⁵

11.134 Rather, he said, notifications of such events would occur directly to the workers themselves, through toolbox talks or other presentations at site.¹³⁶⁶ Further, One Key representatives were expected to become aware of such events through their access to Anglo's Enablon system.¹³⁶⁷

11.135 It appears that Anglo did not report the HPIs that occurred at Grosvenor during the period of inquiry under the Terms of Reference, to One Key. The site safety audit documentation completed by Ms Small did not record Anglo advising One Key that there had been any methane exceedance HPIs in the previous calendar year.¹³⁶⁸ That is so, notwithstanding there had been, by January 2020, 13 methane exceedance HPIs in the previous calendar year.¹³⁶⁹

11.136 In response to questions by counsel for a party to the Board of Inquiry, Mr Lewis accepted that these should have been included in the audit:¹³⁷⁰

Q. So do you know why the audit did not include those details of the gas exceedances?

A. No, I don't. Like I say, I didn't perform that audit. As you say, it's clearly missing some of those incidents.

11.137 Mr Lewis also gave evidence that, while it was difficult to speculate what One Key would have done if it had known about the incidents, he thinks that he personally would have made some enquiries to find out how the risk was going to be managed.¹³⁷¹

11.138 Mr Lewis stated that he was also unaware of the methane exceedances that occurred at Grosvenor during the operation of Longwall 103 in 2019. He said that the only way he would become aware of such incidents would be through asking questions of Anglo at a safety audit or by being notified of them by Anglo at their monthly meetings.¹³⁷²

¹³⁶⁵ TRA.500.010.0001, .0057–.0058.

¹³⁶⁶ TRA.500.010.0001, .0057, lines 25–39.

¹³⁶⁷ TRA.500.010.0001, .0132, lines 23–45.

¹³⁶⁸ OKR.003.017.0001.

¹³⁶⁹ TRA.500.013.0001, .0094, lines 33–45.

¹³⁷⁰ TRA.500.013.0001, .0095, lines 19–22.

¹³⁷¹ TRA.500.013.0001, .0095, lines 24–32.

¹³⁷² TRA.500.013.0001, .0096, lines 5–19.

11.139 One Key is a licensed labour hire entity pursuant to the *Labour Hire Licensing Act 2017* (Qld) (the LHLA). Section 31 of the LHLA imposes a requirement on licensees to report the number of ‘notifiable incidents’¹³⁷³ involving its workers that were notified pursuant to the WHS Act in each reporting period. However, the WHS Act does not apply to coal mines, so there is no requirement on a labour hire agency to report events at a coal mine that result in death, serious injury or illness to its workers, nor those that expose its workers to the risk of such outcomes.¹³⁷⁴

11.140 Mr Lewis gave evidence that, although it was not required by legislation, One Key did in fact make a report about the serious accident at Grosvenor on 6 May 2020 which resulted in injury to workers it supplied to the mine.¹³⁷⁵

Fear of raising safety concerns amongst labour hire workers and contractors

11.141 Mr Lewis gave evidence that he believed the One Key workers were not treated any differently to Anglo’s permanent employees during the period of time the subject of this Inquiry. He considered, from his observations on site and his engagement with Anglo and his workers, that the culture at Grosvenor was that everyone is on ‘one team’.¹³⁷⁶

11.142 Mr Lewis considered that his workers at Grosvenor were very vocal about raising any concerns they had. He conceded, of course, that he could not know how many One Key workers had safety concerns that were not raised.¹³⁷⁷

11.143 Mr Lewis said that he did not believe there was any reason to think that there would have been any reluctance on the part of One Key workers to report safety concerns. However, he accepted that ‘rightly or wrongly, it could be a perception’ among the workers that, if they raised safety concerns at the mine, their job might be in jeopardy during the next downsizing event. He considered, though, that the positive reinforcement the workers received in regard to the importance of raising concerns balanced out that risk.¹³⁷⁸

11.144 Mr Joe Barber, a Site Safety and Health Representative (SSHR) directly employed at Oaky North, gave evidence that he was of the view that contractors believed their jobs ‘are more easily pushed aside’ than those of direct employees.¹³⁷⁹ He believed that they would rather ‘turn a blind eye to things’ than direct employees.¹³⁸⁰

¹³⁷³ Defined in section 35 of the WHS Act to mean the death of a person, or a serious injury or illness of a person, or a ‘dangerous incident’, which itself is defined in section 37 as an incident in relation to a workplace that exposes a worker or any other person to a serious risk to a person’s health or safety.

¹³⁷⁴ WHS Act, schedule 1 ‘Application of Act’, part 2, division 1, clause 2(1)(a).

¹³⁷⁵ TRA.500.013.0001, .0088, lines 10–42.

¹³⁷⁶ TRA.500.013.0001, .0074, lines 23–41.

¹³⁷⁷ TRA.500.013.0001, .0076, line 14–.0077, line 17.

¹³⁷⁸ TRA.500.013.0001, .0078–.0079.

¹³⁷⁹ TRA.500.005.0001, .0051, lines 43–47.

¹³⁸⁰ TRA.500.005.0001, .0051, line 47–.0052, line 2.

11.145 Mr Richard Harris, an ERZ controller and SSHR directly employed at Grasstree, said that in his 15 years as Deputy, from his observations, and from what he had been told, contractors had a perception that they would lose their job if they spoke up about safety issues.¹³⁸¹ Contractors had told him that they were pressured to do their jobs quickly.¹³⁸²

11.146 In Mr Harris' view, a lot of contractors were reluctant to report safety issues. He said:¹³⁸³

Sometimes they report them to me and I will take them to management, and they don't want their name to it...Because of the pressures that the contractors have felt and those issues they have brought to me, I've actually gone to the production or operations manager at the time and spoken to him about it. The next day, he [the production or operations manager] addressed the workforce at the pre-shift meeting and said there will be no reprisals for anyone who speaks up for any safety issues.

11.147 Mr Harris was of the view that the contractors' fears continued to exist notwithstanding such reassurance to workers.¹³⁸⁴

11.148 On behalf of Anglo, Mr Mitchelson and Mr Jones gave evidence that Anglo would not penalise a labour hire employee for raising safety concerns at an Anglo mine. To the contrary, Anglo actively encouraged all workers, including labour hire workers, to raise safety issues.¹³⁸⁵

11.149 However, Mr Mitchelson acknowledged that there was a perception in the industry, including in the Anglo workforce, that labour hire workers might be dismissed for reporting a safety matter.¹³⁸⁶

11.150 In an exchange with Counsel Assisting, Mr Mitchelson said:¹³⁸⁷

Q. I suppose that leads into this issue. There's what you'd describe no doubt as the reality of the safety culture and what might be, at least as far as some work is concerned, the perception. So I take it you would say that no worker would be disciplined or dismissed or demobilised, whatever term you want to use, for reporting a safety matter?

A. No, I wouldn't accept that. Absolutely not.

Q. But do you accept that at least so far as some workers are concerned, there is a perception that they might?

¹³⁸¹ TRA.500.006.0001, .0009.

¹³⁸² TRA.500.006.0001, .0009, line 46–.0010, line 20.

¹³⁸³ TRA.500.006.0001, .0010, lines 26–41.

¹³⁸⁴ TRA.500.006.0001, .0011, lines 21–35.

¹³⁸⁵ TRA.500.009.0001, .0063, lines 9–16; TRA.500.010.0001, .0023, line 38–.0024, line 39 (Mr Mitchelson); TRA.500.010.0001, .0071, line 39–.0072, line 9; .0075, lines 30–40 (Mr Jones).

¹³⁸⁶ TRA.500.009.0001, .0063, lines 18–23.

¹³⁸⁷ TRA.500.009.0001, .0063, lines 9–39. 'ISHRs' refers to Industry Safety and Health Representatives.

A. Yes, and I think this came through - it's a perception of the industry. In discussions with our own workforce, there is that perception, and it's something that we took on from the safety resets last year. Every coal mine company or every mining company had to do them, and it was a great piece of feedback to be able to engage with the workforce directly to understand what were those concerns, and being able to understand if - in that forum, it was a very open discussion and we got a lot of hazards and a lot of feedback as to how we could improve. From that, we've looked at how do we change our internal reporting culture to make it safe and make it comfortable.

We always try to ensure that even through the line structure, if that doesn't work, obviously there's the other ways to go with SSHRs, ISHRs, the inspectorate. We also have our own - the anonymous reporting thing, "Your Voice", that allows people to do that. My preference is always to deal with the issue, so that anybody on that site is comfortable with raising safety issues.

11.151 Mr Jones accepted that there was a risk that labour hire workers would have a perception that their employment might be jeopardised if they raised safety matters.¹³⁸⁸ Anglo actively tried to dispel such a perception through presentations and workforce communication sessions that encouraged workers to raise 'genuinely held safety concerns' and reassured workers that, if they did, 'there will be no fallout as a result of that'.¹³⁸⁹ However, he acknowledged that there remained a risk that some individuals did not feel confident raising safety issues.¹³⁹⁰

11.152 There was the following exchange between counsel representing One Key and Mr Jones:¹³⁹¹

Q. Associated with that is a topic that Mr Hunter asked you about, and others have been asked about, to do with the risk of under-reporting or non-reporting of safety issues and the possible risk that that might occur or would be more likely to occur by labour hire staff than by permanent mine staff. That's the focus of the question. Do you think, from your experience, that there is any basis for concern that that could occur or does occur?

A. I think there is a basis for concern. I think it would be foolish to sit here and say there is not a basis for concern.

But I would also add, in my experience - and it is one of the things that I do actually look for and test and challenge a little bit when I go out, particularly to Grosvenor but not only to Grosvenor, and ask that question - I actually don't

¹³⁸⁸ TRA.500.010.0001, .0071, lines 39–45.

¹³⁸⁹ TRA.500.010.0001, .0071, line 47–.0072, line 9.

¹³⁹⁰ TRA.500.010.0001, .0095, lines 25–28.

¹³⁹¹ TRA.500.010.0001, .0094, line 32–.0095, line 28. 'VFL' or 'Visible Felt Leadership' is a leadership style promoted in Anglo's Safety, Health and Environment (SHE) policy which encourages leaders, managers and supervisors to be available, visible and felt in the workplace: AAMC.001.005.0093, .0102.

have the concern across our sites that it is a material factor in under-reporting or not raising hazards or incidents across our operations.

Q. How have you been able to satisfy yourself that it is not a matter of concern?

A. Because I've been to sites, I've been underground doing our VFLs, I've challenged people about their willingness to speak up, I've sat through some of the safety resets where we particularly address the issue of everybody on site needs to speak up. I've participated in a number of what we call deep dive sessions, where we actually did some small group, you know, what's not working in safety and what do we need to do better, two or three years ago. In a couple of those sessions we had only labour hire, because we wanted to address labour hire issues. When I say "we", it was me and two other people that weren't connected to the sites, and we asked these questions directly to people.

Now, again, the comment can be, well, that's going to be filtered and they know who they are talking to and they are not going to tell you the truth. I get that. All I can say is that we talk to people, we ask them about their level of uncertainty and concern about raising issues, and I didn't come away from that saying that we have a systemic problem. Now, does that mean that there is not a risk that there's not [sic] individuals who don't feel confident raising those issues? I certainly would not say that.

11.153 Mr Jones added that, when it comes to a worker being dismissed from site after raising a concern, there will be other reasons for the dismissal, not the raising of the safety concern. Nonetheless, he acknowledged that the workers on site might not know the full story and consider that a worker has been dismissed for raising a safety concern.¹³⁹²

Production and safety bonuses for One Key labour hire workers at Grosvenor

11.154 The evidence heard in this Inquiry about the issues of production and safety bonuses was confined to evidence about production and safety bonuses for One Key labour hire workers at Grosvenor. The Inquiry did not hear evidence about production and safety bonuses in the industry more generally.

11.155 The evidence came primarily from Mr Jones. Anglo, not One Key, pays bonuses to One Key workers. Mr Jones said that bonuses are considered to be an important part of a worker's pay.

¹³⁹² TRA.500.010.0001, .0097, lines 13–38.

While bonuses are discretionary, in the sense that Anglo is not obliged to pay bonuses, workers expect them. There was this exchange between Counsel Assisting and Mr Jones:¹³⁹³

Q. So that is a completely discretionary exercise undertaken by Anglo? There is no discussion with One Key about it?

A. Correct. I only hesitate with “discretionary” on the basis that if we didn’t pay a bonus in any form, then we would have issues in terms of market competitiveness and relativity. So it is discretionary in terms of its form. In theory it is discretionary as to whether we pay or not, but there is a certain market reality that we also have to understand around it, yes.

11.156 For labour hire workers, the production bonuses are calculated on the basis of metres of advance (for development) or metres of retreat (for longwall).¹³⁹⁴

11.157 Bonuses can be substantial. The variation between the amount of bonus paid to each worker each month can also be substantial. Between July 2019 and April/May 2020, the bonus amount paid to individual workers was between \$1,000 and \$4,000 per month.¹³⁹⁵

11.158 The terms of the bonus are ‘very well known and understood around the mine site’.¹³⁹⁶ There was the following exchange between Counsel Assisting and Mr Jones:¹³⁹⁷

Q. So everyone would know that the faster you advance or retreat, the more you get paid?

A. There is an impact on bonus, absolutely, yes.

11.159 The safety bonus is affected by lost time injuries and medical treatment injuries.¹³⁹⁸ He explained this in the following exchange with Counsel Assisting:¹³⁹⁹

Q. One thing that is not specified in that document, or indeed in any other document that I’ve seen – and correct me if one exists – is the imposition of penalties for safety incidents. Can you explain to us how that works? There is such a thing, isn’t there, as a safety penalty?

A. Yes, there is a modifier. I would rather use the word “modifier”, but I get it.

Q. It reduces the amount payable, doesn’t it?

¹³⁹³ TRA.500.010.0001, .0066, lines 28–37.

¹³⁹⁴ TRA.500.010.0001, .0064, lines 27–33; AGM.003.005.0008.

¹³⁹⁵ TRA.500.010.0001, .0065, lines 19–24.

¹³⁹⁶ TRA.500.010.0001, .0066, lines 45–47.

¹³⁹⁷ TRA.500.010.0001, .0067, lines 2–4.

¹³⁹⁸ A ‘lost time injury’ is a work-related injury resulting in the employee/contractor being unable to attend work or being unable to perform the routine functions of his/her job, on the next calendar day following the day of the injury, whether a scheduled workday or not. A ‘medical treatment injury’, also known as a ‘medical treatment case’ or ‘MTC’, is a work-related injury resulting in treatment of a type that can only be administered by a medical specialist such as a nurse or doctor.

¹³⁹⁹ TRA.500.010.0001, .0067, lines 6–40.

A. Yes.

Q. *The workers would see it as a penalty rather than a modification?*

A. *Yes, okay, I will explain why I say “modifier” in a second. Originally when the Grosvenor bonus was designed, there was a suite of metrics that were included. It was actually quite a complex bonus. This goes to the issue of bonus design and whether it is simple, complex, whatever. They had quite a complex arrangement and there was a series of metrics, safety related and not, that looked at things like panel standards, equipment damage, hazards, things like recordable injuries and so on. That sat there as a sort of guide, if you like, as to what management might take into account, or Anglo might take into account, when it was looking to modify the bonus up or down.*

Over time, that became really quite complex for people to understand and administer, and I think any sort of utility in it was lost.

I think around early 2019 they went back to a much more simple modifier which looked at lost time injuries and medical treatment injuries, and, where that occurred, deducting the bonus for that particular shift where that injury might occur.

11.160 Mr Jones said that the occurrence of an injury would not necessarily result in the application of the ‘modifier’. The incident would be reviewed and the site safety and health manager would make a recommendation to the SSE.¹⁴⁰⁰

11.161 He said that if the deduction is applied, it ‘applies to all coal mine workers who are participating in the bonus scheme’ which ‘would typically be all of the labour hire crew, so approximately 400 [workers]’.¹⁴⁰¹

11.162 Mr Jones stated that all the workers were aware that a reported injury might result in a deduction of the bonus.¹⁴⁰²

11.163 In respect of whether the ‘modifier’ posed a risk to safety practices at the mine, Mr Jones gave the following evidence in an exchange with Counsel Assisting:¹⁴⁰³

Q. *Do you accept that there is a risk that imposing a modifier or a deduction for a safety incident such as [a medical treatment or lost time case] that might discourage its reporting because it is likely to affect the earnings of not just the worker but everyone on shift?*

A. *I accept there is a risk if it is not applied appropriately and if it is not part of a broader system that aligns with ensuring that, you know, all injuries, all incidents, are reported.*

Q. *How do you mitigate against that risk?*

¹⁴⁰⁰ TRA.500.010.0001, .0067, line 42–.0068, line 6.

¹⁴⁰¹ TRA.500.010.0001, .0073, line 39–.0074, line 4.

¹⁴⁰² TRA.500.010.0001, .0070, lines 37–45.

¹⁴⁰³ TRA.500.010.0001, .0070, lines 2–26.

A. *I think, as I say, there are a couple of things. You have to make sure that everything else in your organisation is absolutely aligned and clear about the need to report, the purpose of reporting, and encouraging that.*

I think that's the most significant thing. The second thing is I think you need to make sure that the weighting of this stuff is not too severe. So if you look at the instance that happened here in the deduction that you are talking about, the net effect for an individual over the course of that month was about \$100. So for that month they earned \$3,300 and that was modified down to \$3,200 for that month. So again, I think if the weighting is wrong and you've got one incident having a more than reasonable impact on bonus, then I think that risk increases.

11.164 A little later, the exchange continued:¹⁴⁰⁴

Q. *Do you accept this proposition, that rightly or wrongly some workers, and particularly labour hire workers, may have a perception that if they raise safety matters then they are likely to jeopardise their employment?*

A. *I think it's a risk. I think it's something that we have to constantly be aware of and make sure that that's not the culture that exists across our operations.*

Q. *Does Anglo overtly – and I mean in writing – say to its workers, “You will not be dismissed for legitimately raising a safety issue”?*

A. *In writing, in many, many presentations that are provided and in many workforce verbal communication sessions that are held, it is very much the theme that we need people to raise issues, put their hand up: where they've got genuinely held safety concerns, we need to understand it and there will be no fallout as a result of that.*

Q. *Is it sometimes, though, complicated by the fact that the workforce as a whole benefits from increased production because of the bonus scheme, and that the reporting of safety matters has at least the potential to inhibit production and that, therefore, there is perhaps a culture amongst the workers that discourages them from raising that because of, for example, peer group pressure or a perception that co-workers will not appreciate it if you complain about a safety matter?*

A. *I just don't think it is as binary as that. I don't think it is as black and white. I don't believe that individuals would jeopardise their own sort of safety or that of somebody standing next to them or working alongside them for the sake of a \$100 bonus over the course of a month.*

11.165 The Board notes that a \$100 bonus may well be a considerable sum for some workers. Further, if there were a number of \$100 deductions in a given month, the overall reduction may be significant.

¹⁴⁰⁴ TRA.500.010.0001, .0071, line 39–.0072, line 25.

11.166 The evidence of Mr Wayne Sellars, one of the workers injured in the serious accident, is in contrast to parts of the evidence of Mr Jones.

11.167 Mr Sellars made an association between permanent workforce and union influence, resulting in benefits to permanent workforces at mines, and drawbacks for the predominately labour hire workforce (with limited union influence) at Grosvenor:¹⁴⁰⁵

Q. Can you give us an idea of your perceptions of the benefits and any drawbacks of being employed as a labour hire worker at the mine?

A. As a labour hire worker compared to being a permanent?

Q. That's right.

A. Oh, huge difference between being a permanent and a labour hire, contractor, yes.

Q. When you say "huge difference", when you were at Newlands, were you a permanent employee?

A. Yes.

Q. You were there for five years?

A. Yes.

Q. What are the sorts of differences that you experienced?

A. Union.

Q. Beg your pardon?

A. You've got a union to back you.

11.168 Mr Sellars later clarified that when he referred to there being no union at Grosvenor, he was referring to the absence of a CFMMEU lodge on site.

11.169 Mr Sellars expressed the view that 'contractors are treated differently to permanent workforce', noting that with 'a permanent workforce, you've got more of a voice to speak up'. In particular, Mr Sellars gave the example of bonus schemes breeding bad culture:¹⁴⁰⁶

A. It's just – contractors are treated differently to permanent workforce.

Q. But in what way?

A. Just – a permanent workforce, you've got more of a voice to speak up. Like, bonus schemes and stuff like that. Like, we were punished – if someone injured themselves, we'd lose our bonus on site and stuff like that, and that breeds bad culture. It puts everyone offside, if you can understand what I mean.

...

¹⁴⁰⁵ TRA.500.024.0001, .0058, lines 26–47.

¹⁴⁰⁶ TRA.500.024.0001, .0059, lines 29–41.

11.170 The matters which impact the payment of the safety bonus, namely medical treatment and lost time injury cases, are lag safety performance indicators. Based on Mr Jones' evidence, it does not appear that the bonus structure incorporates a 'focus on improvement and contribution' component, which is a component recommended in the *Digging Deeper* report.¹⁴⁰⁷

Glencore's labour hire arrangements at Oaky North

11.171 As already noted, in December 2019, of the 450 workers at Oaky North, 290 were direct employees and 160 were contractors.

11.172 Much of the evidence about labour hire at the Inquiry was directed to the arrangements in place between Anglo and One Key at Grosvenor. There was limited evidence about labour hire at Oaky North provided by Ms Kylie Ah Wong, General Manager (Health, Safety & Training) for Glencore Coal Assets Australia Pty Limited (GCAA).

11.173 Supplementary labour is used when specialist skill is needed, such as the installation of secondary support or ventilation control devices. When required, supplementary labour is also used on some of the operating crews.¹⁴⁰⁸

11.174 Every worker (whether direct employee or contract worker) is required by GCAA and under legislation to have the generic induction, site induction and familiarisation training. All workers' training and competencies are checked, and training is provided where required.¹⁴⁰⁹

11.175 Training days are scheduled every two months. Such training is designed to deliver specific content that reinforces the maintenance of the workers' safety skills, awareness, and knowledge. Workers are also required to undertake periodic refresher training in each of their competencies. Critical updates are delivered to the workers via toolbox talks and pre-start meetings. The communications may include notifications to oncoming crews of any relevant safety issues.¹⁴¹⁰

11.176 Oaky North has a policy of integrating contract workers with its permanent workforce, including through its 'Career Pathway' scheme which facilitates the progress of workers from contract worker to direct employee. The 'deputy training program' is available to both contractors and direct employees.¹⁴¹¹

¹⁴⁰⁷ Shaw Idea, *Digging Deeper: Wran Consultancy Project Vol 1* (Report commissioned by the NSW Mine Safety Advisory Council, November 2007)

<https://resourcesandgeoscience.nsw.gov.au/__data/assets/pdf_file/0008/719657/digging-deeper-report-vol-1.pdf>, page ix; AAMC.001.041.0001, .0015. Lead and lag indicators, and their significance in the context of safety performance, were explained and discussed in Part I of the Report, Chapter 6 (Corporate Governance).

¹⁴⁰⁸ TRA.500.008.0001, .0035, lines 7–30.

¹⁴⁰⁹ OCH.507.002.0001, .0005.

¹⁴¹⁰ OCH.507.002.0001, .0006.

¹⁴¹¹ OCH.507.002.0001, .0007.

11.177 The Board did not hear any significant evidence about bonuses paid to labour hire workers at Oaky North. Ms Ah Wong said that bonuses for labour hire workers would be arranged by their employer.¹⁴¹²

Professor Quinlan's observations and suggestions

11.178 When he gave evidence, Professor Quinlan said that the sum total of the research all pointed to an elevated risk associated with contract labour.¹⁴¹³

11.179 He said that whilst the research disclosed only some evidence of victimisation of labour hire workers associated with the raising of safety concerns, there was a 'widespread perception' that such a thing might occur which required extra steps to be taken by the mine operator and the labour hire agencies to ensure that workers had a voice when it came to safety concerns. He explained this as follows:¹⁴¹⁴

I mean, victimisation does occur, but I think the perception or fear of that is much broader than in actual incidents. It's almost as if you have to lean over to make sure that there is – those perceptions are broken down. I mean, a very positive relationship, for instance emphasising the importance of raising safety issues and celebrating actions taken to improve safety is part of the thing, and also telling people repeatedly, as I'm sure mine managers do, that they should raise issues. But there needs to be, I think, some effort to combat any perception that raising an issue – even one that may reflect to some degree poorly on the worker themselves, it still needs to be reported...

... [T]here's a need to probably go an extra step to ensure that that fear is allayed... that people feel that not only is reporting safety issues important but that they should do it and there will be no – you know, that the company really wants to – as I said, I'm sure many companies make this point, but I think that message just has to be strengthened.

11.180 He considered that it would be beneficial for there to be more research on the impact of contract labour on safety in Queensland coal mines. He considered that detailed research should be based on interviews with mine workers holding different positions, management and other stakeholders, union representatives, or Industry Safety and Health Representatives (ISHRs).¹⁴¹⁵

11.181 Professor Quinlan suggested that research take the form of a longitudinal study to measure the regulatory knowledge and compliance of workers, their willingness to raise safety issues, positive responses and actions on issues that are raised, and the effectiveness of contractor management regimes generally.¹⁴¹⁶

¹⁴¹² TRA.500.008.0001, .0039, lines 1–14.

¹⁴¹³ TRA.500.011.0001, .0066, lines 8–13.

¹⁴¹⁴ TRA.500.011.0001, .0073, lines 12–38.

¹⁴¹⁵ TRA.500.011.0001, .0065, lines 19–37.

¹⁴¹⁶ TRA.500.011.0001, .0068, lines 7–16.

11.182 He proposed a number of solutions to the problem of reduced worker voice, suggesting:¹⁴¹⁷

...[G]reater efforts within the mines to ensure that worker voice was achieved, but more particularly in strengthening the representative structure, the role of SSHRs and ISHRs in mines in terms of strengthening their voice, particularly in lower unionised mines, because generally the research says that representative structures are more effective than other forms of feedback, if you like, because they enable workers to make complaints anonymously, and also because it's through a representative process, there's less opportunity for retribution or fear of retribution.

I mean, the fear is as important as any actuality that might occur. The representatives also add negotiating skills, so they are able to talk to workers and filter, if you like, the more serious ones out...So, there are a variety of ways in which that process works more effectively.

11.183 Professor Quinlan agreed that steps taken at Grosvenor were effective towards reducing risks associated with labour hire. Examples involved induction of labour hire workers in the same way as permanent employees, integrating them into crews with permanent employees, and requiring them to participate in risk assessments alongside permanent employees.¹⁴¹⁸ He agreed that the fact that Grosvenor's labour hire workforce had the same average tenure at the mine as its permanent workforce was another protective factor. He was 'absolutely' supportive of regular encouragement of hazard reporting at Grosvenor. Overall, he considered that every system in place at Grosvenor to encourage safety reporting is 'good'.¹⁴¹⁹

11.184 Professor Quinlan was supportive of the roles the ISHRs play in safety at mines. He considers that Queensland currently has the best system operating in the world. The best practice model involves the ISHRs having a union connection so that they are seen by the workers as completely independent.¹⁴²⁰

11.185 Professor Quinlan was supportive of the idea of the imposition of a safety and health obligation on labour hire companies at mines. The advantage would be to require both the mine operator and the labour hire agency to indicate their processes, including the extent to which they have taken measures to ensure that workers can report safety issues. He considers that labour hire agencies should have an obligation to report safety matters.

¹⁴¹⁷ TRA.500.011.0001, .0066, lines 21–38.

¹⁴¹⁸ Without any criticism of Professor Quinlan or Grosvenor, the Board notes that, while the steps taken at the mine may well have been effective, the definition of 'coal mine worker' in the Act, schedule 3 'Dictionary', encompasses labour hire workers. It is therefore unremarkable that they were included in such processes as inductions and risk assessments. Further, given the high proportion of labour hire workers at Grosvenor, it is not surprising that they were integrated into crews with permanent employees.

¹⁴¹⁹ TRA.500.011.0001, .0083, line 44–.0085, line 46.

¹⁴²⁰ TRA.500.011.0001, .0090, line 37–.0091, line 30; .0093, lines 2–14.

Such a requirement would increase the labour hire agency's level of knowledge of, and interaction with, the mine operator and would also provide the Inspectorate with a tool to see how well safety was being managed between the mine operator and the labour hire agency.¹⁴²¹

11.186 As to Professor Quinlan's observation that it would be beneficial for there to be greater research on the impact of contract labour on safety in Queensland coal mines, the Board has been informed that the Mining Safety and Health Advisory Committee is currently carrying out an extensive study, over a five year period, on reporting culture. It seems eminently sensible for the Coal Mining Safety and Health Advisory Committee to undertake a similar study in relation to coal mines.

Absence of cogent evidence of reprisal and 'reprisal' under the Act

Absence of cogent evidence of reprisals

11.187 There is a strong body of evidence that vulnerable workers hesitate to complain about safety issues for fear of losing their employment. What is not clear is whether such workers are actually at risk of losing their employment, or whether the fear is borne out of a perception that is not necessarily based in reality.

11.188 Assuming the existence of reprisal conduct, it seems almost impossible to capture cogent evidence of actual reprisals against workers for complaining about safety issues. For this Inquiry to capture such evidence, a worker who claims to have experienced or witnessed reprisal conduct would have to be prepared to come forward, give evidence and be exposed to cross-examination on behalf of the mine. The very process would likely dissuade such a person from coming forward, for fear of future reprisal.

11.189 Nonetheless, the fundamental problem remains that even if the perception of the existence of reprisal conduct is unwarranted, perception is as dangerous as reality and must be vigorously addressed.

Protection from reprisal under the Act

11.190 Contravention of section 275AA(1) of the Act is a reprisal, punishable by a maximum penalty of 1,000 penalty units.

11.191 By section 275AB of the Act, a reprisal is a tort. Anyone found by a court to have suffered detriment as a result of a reprisal is entitled to damages.

11.192 The definition of a reprisal, within section 275AA, largely mirrors section 41 of the *Whistleblowers Protection Act 1994*, now repealed. In turn, the *Public Interest Disclosure Act 2010*, which superseded the *Whistleblowers Protection Act 1994*, has largely picked-up the definition of reprisal in the Act.

¹⁴²¹ TRA.500.011.0001, .0070, line 40–.0072, line 1.

- 11.193 Fundamental to a reprisal under section 275AA is a 'detriment'. Whilst 'detriment' is defined in both pieces of legislation noted in the paragraph above, it is not defined in the Act. It follows that the word should be given its ordinary meaning. In the Board's view, this word's meaning is broad, likely describing all manner of disadvantage, including physical, pecuniary and emotional (including the emotional impact of threats).
- 11.194 Section 275AA of the Act should be a deterrent to reprisal conduct. However, any prosecution under the section necessarily means that the worker/complainant will be identified. For the reasons expressed in paragraph 11.188 above, it is likely that few workers would come forward to make a complaint.
- 11.195 Consequently, to encourage workers to come forward about reprisal conduct and make a complaint, thereby enhancing the deterrent effect of section 275AA, the Inspectorate needs to be receptive to such complaints, undertake prompt and thorough investigations, and provide appropriate feedback to the complainants. This response by the Inspectorate will both reassure workers that such complaints are taken seriously and enhance the prospects of success in a prosecution.

Findings

Finding 85

There is a perception among coal mine workers that a labour hire worker or contractor who raises safety concerns at a mine might jeopardise their ongoing employment at the mine. It has not been possible to assess how widespread that perception might be. However, the existence of a perception, no matter how widespread, creates a risk that safety concerns will not always be raised.

Finding 86

The perception that a labour hire worker or contractor might jeopardise their employment by raising safety concerns at a mine creates a risk that safety concerns will not always be raised.

Finding 87

It is critical to safety at mines that all safety concerns are raised in a timely way.

Finding 88

It is critical that all workers believe that they can raise safety concerns at mines without fear that their employment may be in jeopardy as a result.

Finding 89

Coal mines must be vigilant to address the perception that labour hire workers and contractors might jeopardise their ongoing employment by raising safety concerns.

Finding 90

Production and safety bonuses largely based on lag safety performance indicators are not a reliable means of improving safety outcomes and may in fact lead to under-reporting of safety incidents and injuries.

Finding 91

An extensive study undertaken by the Coal Mining Safety and Health Advisory Committee (CMSHAC) on reporting culture in coal mines would benefit the industry in Queensland.

Finding 92

Neither coal mine operators nor Site Senior Executives (SSEs) presently have an obligation to report the occurrence of high potential incidents (HPIs) involving labour hire workers to the labour hire agency that supplied those workers.

Finding 93

In Queensland, labour hire agencies providing workers to the coal mining industry have no clear and express obligation to ensure that the workplaces into which they send their employees are as safe as reasonably practicable (such as that contained in section 19 of the *Work Health and Safety Act 2011* (NSW) (the NSW Act)), and may be entirely unaware of the occurrence of incidents that pose a risk of significant adverse effects to the safety and health of those employees. Even if a labour hire agency becomes aware of the occurrence of a reportable HPI, it has no obligation to report it to the Regulator.¹⁴²²

Finding 94

The imposition of a safety and health obligation on labour hire agencies which employ coal mine workers, such as that set out in section 19 of the *Work Health and Safety Act 2011* (Qld) (the WHS Act), would make coal mine operators and labour hire agencies mutually responsible for the safety and health of labour hire workers and add a layer of oversight of safe practices. Additionally, a labour hire agency subject to such an obligation would be likely to develop a culture that encouraged its workers to report—to its own management—safety and health incidents and concerns. This may lead to the reporting of HPIs that might otherwise escape the attention of the Regulator.

Finding 95

There is scope to improve the mechanisms for safety issues to be raised by workers. Safety committees similar to those in the WHS Act and the *Mining and Quarrying Safety and Health Act 1999* (MQSHA) are not provided for under the *Coal Mining Safety and Health Act 1999* (Qld) (the Act).

Finding 96

The term ‘detriment’ in sections 275AA and 275AB of the Act is not defined.

Finding 97

Prompt and thorough investigation of reprisal complaints, and the provision of appropriate feedback to complainants, will reassure workers generally that such complaints are taken seriously, and will also enhance the prospects of success in a prosecution.

¹⁴²² Resources Safety & Health Queensland (RSHQ), of which the Coal Mines Inspectorate is a division, is the Regulator of the coal mining industry. Previously, the Regulator was the Department of Natural Resources, Mines and Energy (DNRME), formerly DNRM, the Department of Natural Resources and Mines.

Recommendations

Recommendation 19

Coal mines review their site induction procedures to ensure that all new workers at the mine, including labour hire workers and contractors, are fully informed about the fundamental importance of the reporting of safety concerns, including occupational health hazards, and assured that reprisals will not be taken in response. This will include ensuring that all new workers at the mine are aware of and understand the operation of sections 274, 275, 275AA and 275AB of the Act.

Recommendation 20

RSHQ takes steps, through the consultative process provided by CMSHAC, to include a component in the generic induction for coal mine workers (*Recognised standard 11: Training in Coal Mines*) on the roles of the Industry Safety and Health Representative and Site Safety and Health Representative, so as to promote awareness of the functions of each.

Recommendation 21

Mine operators review their contracts with labour hire agencies and include, where necessary, provision for a documented process by which performance management issues, and grievance issues, in respect of labour hire workers are addressed.

Recommendation 22

The industry reviews its production and safety bonus structures and make any necessary changes to ensure that those structures do not inadvertently discourage the reporting of safety incidents or injuries.

Recommendation 23

Similarly to the SSE's obligations under sections 106(1)(a), (b) and (c) of the Act, RSHQ takes steps to amend the Act to require the SSE at a mine to inform the management of a labour hire agency which has employees at the mine when the following events occur, as soon as practicable after the event comes to the SSE's knowledge:

- a. an injury or illness to an employee of the labour hire agency from coal mining operations that causes an absence from work of the person;
- b. a high potential incident happening at the coal mine;
- c. any proposed changes to the coal mine, or plant or substances used at the coal mine that affect, or may affect, the safety and health of persons at the mine.

Recommendation 24

RSHQ takes steps to amend the Act to require labour hire agencies to notify the Regulator of a serious accident, an HPI of a type prescribed under a regulation, or a death at a coal mine, involving their employees.

Recommendation 25

Without diminishing the burden, or extent, of obligations imposed on others under the Act, RSHQ takes steps to amend the Act to impose a safety and health obligation on labour hire agencies which supply workers to a mine, in similar terms to section 19 of the NSW Act.

Recommendation 26

When submitting a panel of names of individuals experienced in coal mining operations as nominees for membership of CSMHAC under section 79 of the Act, organisations representing coal mine operators should ensure the panel includes representatives of labour hire agencies.

Recommendation 27

Consistently with Part 7 of the MQSHA and Part 5 of the WHS Act, RSHQ takes steps to amend the Act to enable the formation of safety committees upon request by an SSHR or when directed by the Chief Inspector.

Recommendation 28

As part of carrying out its functions under section 76A of the Act, CSMHAC considers including within its 5 year Strategic Plan activities that will facilitate improvements in the reporting culture in Queensland coal mines.

Recommendation 29

RSHQ takes advice, as required, and if necessary, takes steps to amend section 275AA of the Act to clarify the application of the reprisal offence, with a view to strengthening protections for workers. For example, this may involve including a definition of 'detriment'.

Recommendation 30

In relation to reprisal complaints, the Inspectorate undertakes prompt and thorough investigations, and provides appropriate feedback to complainants during the investigation and prosecution process.

Chapter 12 – Industry safety and health representatives

Appointment of ISHRs

- 12.1 Part 8 of the *Coal Mining Safety and Health Act 1999* (Qld) (the Act) provides for the appointment of Industry Safety and Health Representatives (ISHRs) and sets out their functions and powers.
- 12.2 ISHRs are appointed by the Construction, Forestry, Maritime, Mining and Energy Union (CFMMEU)¹⁴²³ pursuant to section 109 of the Act, which provides that the union may, after a ballot of its members, appoint up to three ISHRs.
- 12.3 Appointed ISHRs must be holders of a First or Second Class Certificate of Competency, or a Deputy's Certificate of Competency.¹⁴²⁴ An ISHR's term is for a period of four years,¹⁴²⁵ although ISHRs can be re-elected for consecutive terms.¹⁴²⁶ An appointed ISHR works full-time in that role.¹⁴²⁷ The role is funded by the union.¹⁴²⁸ Despite the links to the union, which could be expected to have an industrial agenda, an ISHR is prohibited from exercising a function or power for a purpose other than a safety and health purpose.¹⁴²⁹

ISHR functions and powers

- 12.4 The ISHR role is additional to, and ideally complementary with, that of the Site Safety and Health Representative (SSHR), a role provided for by Part 7 of the Act.
- 12.5 Section 118(1) of the Act provides for the functions of an ISHR. Its terms make it plain that the role is to be performed as a representative of all coal mine workers. The functions are:
- (a) *to inspect coal mines to assess whether the level of risk to the safety and health of coal mine workers is at an acceptable level;*
 - (b) *to review procedures in place at coal mines to control the risk to safety and health of coal mine workers so that it is at an acceptable level;*
 - (c) *to detect unsafe practices and conditions at coal mines and to take action to ensure the risk to the safety and health of coal mine workers is at an acceptable level;*

¹⁴²³ Act, schedule 3 'Dictionary', definition of 'union'.

¹⁴²⁴ Act, section 109(2); Act, schedule 3 'Dictionary' defines 'certificate of competency' to mean a certificate of competency granted by the board of examiners under the Act.

¹⁴²⁵ Act, section 109(3).

¹⁴²⁶ WST.001.001.0001; HLJ.001.001.0001.

¹⁴²⁷ Act, section 110.

¹⁴²⁸ Act, section 111.

¹⁴²⁹ Act, section 117.

- (d) *to participate in investigations into serious accidents and high potential incidents and other matters related to safety or health at coal mines;*
- (e) *to investigate complaints from coal mine workers regarding safety or health at coal mines;*
- (f) *to help in relation to initiatives to improve safety or health at coal mines.*

12.6 Section 119(1) of the Act provides ISHRs with a number of powers to enable them to perform their functions, namely:

- (a) *to make enquiries about the operations of coal mines relevant to the safety or health of coal mine workers;*
- (b) *to enter any part of a coal mine at any time to carry out the representative's functions, if reasonable notice of the proposed entry is given to the site senior executive or the site senior executive's representative;*
- (c) *to examine any documents relevant to safety and health held by persons with obligations under this Act, if the representative has reason to believe the documents contain information required to assess whether procedures are in place at a coal mine to achieve an acceptable level of risk to coal mine workers;*
- (d) *to copy safety and health management system documents, including principal hazard management plans, standard operating procedures and training records;*
- (e) *to require the person in control or temporarily in control of a coal mine to give the representative reasonable help in the exercise of a power under paragraphs (a) to (d);*
- (f) *to issue a directive under section 167.*

Evidence

12.7 In this Inquiry, the Board heard from two of the three current ISHRs and one retired ISHR about their experience of the role, and issues involved in performing their functions and exercising their powers.

12.8 Mr Jason Hill was elected as an ISHR in about May 2012 and has been re-elected twice since then.¹⁴³⁰ He holds a Deputy's Certificate of Competency.¹⁴³¹ He is based in the union's Rockhampton office.¹⁴³²

¹⁴³⁰ HLJ.001.001.0001.

¹⁴³¹ HLJ.001.001.0001, .0002.

¹⁴³² HLJ.001.001.0001.

- 12.9 Mr Stephen Woods was elected as an ISHR in about July 2012 and has also been re-elected twice since then.¹⁴³³ He also holds a Deputy's Certificate of Competency.¹⁴³⁴ He is based in the union's Mackay office.¹⁴³⁵
- 12.10 Mr Greg Dalliston was elected as a District Union Inspector (the role that became an ISHR in 2001) in 1993.¹⁴³⁶ He held those positions for 25 years until his retirement in 2018.¹⁴³⁷ He obtained a Deputy's Certificate in 1988.¹⁴³⁸ Mr Dalliston also served continuously on the Coal Mining Safety and Health Advisory Committee from its inception in 2000, until his resignation in June 2019.¹⁴³⁹ His knowledge and length of experience are respected in the industry.
- 12.11 The Board was further assisted by a report from Professor Michael Quinlan, Emeritus Professor of Industrial Relations at the School of Management at the University of New South Wales, dealing in part with the role of worker representatives.¹⁴⁴⁰ Professor Quinlan also gave oral evidence at the first tranche of hearings in August 2020.¹⁴⁴¹

Brief history of the ISHR role

- 12.12 It is instructive to briefly consider the history of the role of coal mine workers' representatives before turning to some issues raised in evidence and submissions.
- 12.13 In his report, Professor Quinlan described the following history:¹⁴⁴²

Legislative powers to enable working miners to inspect mines were enacted in the UK in 1872, soon followed by NSW (1876) before spreading to other Australian jurisdictions and other countries like New Zealand, Canada with similar measures introduced in France, Belgium and Germany from the late 19th century onwards. In Queensland campaigning for similar measures began in the 1880s but legislation was not enacted until 1910 when the:

Mines Regulation Act 1910 (1 Geo V 24) empowered miners to elect persons to carry out inspections on their behalf; to view the mine's record book (section 9(4)); to inspect the scene of accidents (section 28(2)); to be notified by the mining warden of any inquiry into fatal accidents at the mine (section 31(2)); as well as to be notified of any special rules and lodge objections to them (sub-sections 51(2), (3) and (5)).

¹⁴³³ WST.001.001.0001.

¹⁴³⁴ WST.001.001.0001, .0002.

¹⁴³⁵ WST.001.001.0001.

¹⁴³⁶ DGR.001.001.0001.

¹⁴³⁷ DGR.001.001.0001.

¹⁴³⁸ DGR.001.001.0001.

¹⁴³⁹ Queensland Government, *Coal Mining Safety and Health Advisory Committee Annual report 2018-2019* (Report, 2019) <https://www.publications.qld.gov.au/dataset/9512a740-755a-4df4-aabf-73627317b303/resource/62e2ce7b-ee5e-465d-9f33-c9619f81ffdc/download/cmshac-annual-report-2018-2019.pdf>, pages 2–3.

¹⁴⁴⁰ BOI.001.004.0001.

¹⁴⁴¹ TRA.500.011.0001, .0062–.0112.

¹⁴⁴² BOI.001.004.0001, .0115. References omitted.

12.14 Limitations of the ‘check-inspector’ system emerged, including ‘the resistance of some mining companies to their activities and their vulnerability of appointees to intimidation/dismissal’.¹⁴⁴³

12.15 Professor Quinlan explained that coalminers unions in Queensland and NSW began to appoint ‘district check inspectors’ who were full-time union officials (and thus were independent of government inspectors and not vulnerable to mine management reprisals) to undertake inspections and assist those in particular mines (especially where union presence was weaker).¹⁴⁴⁴ These positions were given legislative recognition in Queensland in 1938,¹⁴⁴⁵ and have existed since.

12.16 Professor Quinlan also said in evidence:¹⁴⁴⁶

...the ISHRs were developed - and we don't have to go back to how important the coal miners union has been in improving mine safety legislation. I think we can take that as read. But critical to this was dealing with workplaces where there was less effective representation, or check inspectors, as they used to be known, were subject to some intimidation, and so there was a very long push to get ISHRs onto site and inspect those sites, who would not be subject to those same pressures.

12.17 Professor Quinlan said that the miners’ representative components of the Queensland and NSW systems:¹⁴⁴⁷

...were regarded as essential elements of best-practice mine safety legislation in the New Zealand review that followed the Pike River disaster and subsequent Royal Commission, serving as a model for the new mine safety laws adopted [there].

Issue 1 – The appointment model

12.18 A continuing role by ISHRs was supported by parties at the Inquiry, but the appointment model was questioned by some submitters. Submissions were made that:

- there was a ‘disconnect between the functions of the union appointed ISHRs elected by a small proportion of the overall coal mine workers and SSHRs...’;¹⁴⁴⁸
- ‘...ISHR powers are at worst open to abuse for industrial purposes...’;¹⁴⁴⁹
- ‘...ISHRs would be best placed to perform their role as employees of the DNRME...’;¹⁴⁵⁰ and

¹⁴⁴³ BOI.001.004.0001, .0115.

¹⁴⁴⁴ BOI.001.004.0001, .0115–.0116.

¹⁴⁴⁵ BOI.001.004.0001, .0116; see *Coal Mining Act 1925* (Qld), section 70A.

¹⁴⁴⁶ TRA.500.011.0001, .0091, lines 1–9.

¹⁴⁴⁷ BOI.001.004.0001, .0140.

¹⁴⁴⁸ QRC.999.001.0001, .0003.

¹⁴⁴⁹ QRC.999.001.0001, .0003.

¹⁴⁵⁰ OCH.508.001.0480, .0484.

- a Ministerial appointment would reduce the ‘propensity for industrial conflict’ and ‘fosters greater accountability...’.¹⁴⁵¹

Despite those express concerns, the Board of Inquiry did not receive any evidence of abuse of the ISHR function. Nor did the evidence tend to support the submission that Ministerial appointment would be a better appointment model.

- 12.19 The model in NSW, and under the *Mining and Quarrying Safety and Health Act 1999* (Qld) (MQSHA), is for an ISHR to be appointed by the Minister, but on a nomination by the CFMMEU.¹⁴⁵² The Queensland model is more robust in the Board’s view, in that the appointees are democratically elected by members of the union, rather than appointed by direct nomination. Whilst it is true that union membership is declining, the model of ISHRs being appointed following a ballot of union members has a strong history of advancing safety in coal mines, and is not to be lightly interfered with.
- 12.20 Professor Quinlan acknowledged that the decline in union membership was a problem without a simple solution, but was not such, in his view, as to justify a change in representation.¹⁴⁵³
- 12.21 Professor Quinlan also emphasised the value of independence, and of the union’s contribution, describing the Queensland model as:¹⁴⁵⁴

Probably the world's best practice model, and I think in general what it's managed to achieve - and when we did the survey of the five countries, that's how it came out. The advantage of having union connection is that these people are seen as completely independent, and that's critical. And the union has made a significant contribution to this, both in the fact that it pays their salaries and it also does the SSHR training and mentors a lot of the SSHRs.

- 12.22 Mr Dalliston also spoke in support of the historical value of the independence of ‘district union inspectors’ (now ISHRs).¹⁴⁵⁵
- 12.23 Through declining membership, union funding for the function is falling upon a diminishing proportion of coal mine workers, but the CFMMEU made no submission for an alternative, and indeed, resisted any change to the current model.¹⁴⁵⁶

¹⁴⁵¹ OCH.508.001.0480, .0484.

¹⁴⁵² *Work Health and Safety (Mines and Petroleum Sites) Act 2013* (NSW), section 28(2); *Mining and Quarrying Safety and Health Act 1999* (Qld), section 108. The position is called a ‘District Workers’ Representative’ under the MQSHA.

¹⁴⁵³ TRA.500.011.0001, .0093, lines 22–27.

¹⁴⁵⁴ TRA.500.011.0001, .0091, lines 22–30.

¹⁴⁵⁵ TRA.500.013.0001, .0025, line 44–.0026, line 4.

¹⁴⁵⁶ CMU.008.008.0001, .0033–.0036.

Issue 2 – Relationship with SSHRs

- 12.24 Both Mr Hill and Mr Woods placed considerable store in the value of an interactive relationship with the SSHRs. It is not difficult to see why that would be so. The SSHRs are on site and well-positioned to be aware of local safety issues. The ISHRs are in a position to bring to bear not only the independence already spoken about, but potentially greater technical experience and competence. ISHRs are required to hold at least a Deputy's Certificate, whereas SSHRs may be drawn from a wider range of occupations at the mine, with fewer technical competencies.
- 12.25 The union runs an annual training conference for SSHRs, which is an opportunity for ISHRs to network. ISHRs arrange additional training for SSHRs if required.¹⁴⁵⁷
- 12.26 Mr Hill said that SSHRs played a 'vital role' in maintaining safety at mines.¹⁴⁵⁸ They were the 'eyes and ears on the ground' for both the ISHRs and the Inspectorate.¹⁴⁵⁹ In his view, SSHRs were generally very good at inspecting and identifying hazards. They reduced the ISHRs' workload because they were often able to deal with worker complaints at the local level before the issue was 'escalated' to the ISHRs or the Inspectorate.¹⁴⁶⁰
- 12.27 Mr Woods agreed that the relationship between ISHRs and SSHRs is 'extremely important'.¹⁴⁶¹ He said that ISHRs relied heavily on maintaining a 'collaborative relationship' with SSHRs in order to facilitate an ongoing dialogue about safety at individual mines.¹⁴⁶² ISHRs tried to cultivate good relationships with the SSHRs through the union's safety conferences.¹⁴⁶³ He considered that SSHRs should have security of employment so they could not easily be moved on for raising safety issues.¹⁴⁶⁴
- 12.28 Both ISHRs referred to the existence of a good working relationship with SSHRs who were union members, but to having lesser relationships, or none at all, with those who were not.
- 12.29 Mr Hill considered that he had a good relationship with the SSHRs at Oaky North mine and Grasstree mine. Both of those SSHRs were employees and union members.¹⁴⁶⁵ Mr Hill said that in his experience, the SSHRs who communicated most frequently with the ISHRs were union members.¹⁴⁶⁶ SSHRs who were casuals or contractors, and who had a good working relationship with the ISHRs, were in the minority.¹⁴⁶⁷

¹⁴⁵⁷ TRA.500.004.0001, .0070, lines 16–38.

¹⁴⁵⁸ HLJ.001.001.0001, .0005.

¹⁴⁵⁹ HLJ.001.001.0001, .0005.

¹⁴⁶⁰ TRA.500.004.0001, .0067, line 42–.0068, line 9.

¹⁴⁶¹ TRA.500.004.0001, .0006, lines 2–7.

¹⁴⁶² WST.001.001.0001, .0003.

¹⁴⁶³ TRA.500.004.0001, .0006, lines 9–15.

¹⁴⁶⁴ WST.001.001.0001, .0003.

¹⁴⁶⁵ TRA.500.004.0001, .0067, lines 24–34.

¹⁴⁶⁶ HLJ.001.001.0001, .0005; TRA.500.004.0001, .0069, lines 6–13, 28–38.

¹⁴⁶⁷ HLJ.001.001.0001, .0005.

He said it was not ‘overly common’ to be contacted by an SSHR who was not a member.¹⁴⁶⁸ In his view, that was because those SSHRs knew they could be targeted by the Site Senior Executive (SSE) for talking to an ISHR.¹⁴⁶⁹

- 12.30 Mr Woods considered that he had a good relationship with the SSHRs at Moranbah North mine,¹⁴⁷⁰ but he had had no communication at all with the SSHRs at Grosvenor mine (Grosvenor).¹⁴⁷¹
- 12.31 This evidence was consistent with the statement provided by Mr Reece Campbell, an SSHR at Grosvenor between 2018 and 2021, who recalled no more than two attendances by ISHRs at Grosvenor in that period.¹⁴⁷²
- 12.32 This evidence indicated to the Board that the ISHRs needed to be more proactive in cultivating relationships with those SSHRs who were not union members. After all, as discussed above, the value of the ISHR function, historically, has in part been to bring an independent check function to sites that may not be strongly unionised. It would seem to follow that performance of the function would be assisted by cultivation of useful relationships with SSHRs.
- 12.33 Mr Hill referred to a practical problem in that there was no mechanism for ISHRs to be informed of the outcome of elections of SSHRs at a mine,¹⁴⁷³ and there were over 60 mines. The election process involved the returning officer for the election notifying the result to the mine’s SSE and the Chief Inspector of Coal Mines.¹⁴⁷⁴ Mr Dalliston said his experience was that the Inspectorate would not provide information about election results due to privacy concerns, and this made the performance of the ISHR function more difficult.¹⁴⁷⁵ Mr Hill also gave evidence that it was unproductive to ‘chase up every mine’ for details of any change of SSHR.¹⁴⁷⁶ He said it would be helpful if there was a means to update the ISHRs with the names of newly-elected SSHRs at mines.¹⁴⁷⁷
- 12.34 On the face of it, this could simply be achieved by amending the *Coal Mining Safety and Health Regulation 2017* (Qld) to add the ISHRs to the list of persons to be notified by the returning officer of the result of the SSHR election.¹⁴⁷⁸ This would give the ISHRs the opportunity to make themselves known to elected SSHRs and to commence interaction with them, for mutual benefit in the interests of safety overall.

¹⁴⁶⁸ TRA.500.004.0001, .0069, lines 28–31.

¹⁴⁶⁹ HLJ.001.001.0001, .0006.

¹⁴⁷⁰ WST.001.001.0001, .0005.

¹⁴⁷¹ TRA.500.004.0001, .0012, lines 22–24; WST.001.001.0001, .0004.

¹⁴⁷² CRE.001.001.0001, .0007; CRE.001.002.0001.

¹⁴⁷³ TRA.500.004.0001, .0071, lines 30–40.

¹⁴⁷⁴ TRA.500.004.0001, .0071, lines 42–46; Regulation, schedule 1B ‘Site safety and health representative election process’, clause 13(6).

¹⁴⁷⁵ DGR.001.001.0001, 0014.

¹⁴⁷⁶ TRA.500.004.0001, .0071, lines 13–28.

¹⁴⁷⁷ TRA.500.004.0001, .0072, lines 30–41.

¹⁴⁷⁸ Regulation, schedule 1B ‘Site safety and health representative election process’, clause 13(6).

Issue 3 – Alteration of powers

- 12.35 The CFMMEU contended, through the evidence of witnesses and in submissions, for the extension of ISHR powers under the Act. It is one thing to acknowledge, as the Board does, the importance of the ISHR role, both historically and at the present time. Recommending an extension of powers is another. There is a balance to be struck between the right of a mine operator to manage the mine (safely) and the powers to be exercised by workers' representatives. Any alteration to the balance that has existed successfully for many years would need to be treated with caution.
- 12.36 The role of district union inspectors (now ISHRs) has been recognised since 1938, when section 70A was introduced into the *Coal Mining Act 1925* (Qld) (the predecessor Act), which was repealed and replaced by the Act. Under section 70A, district union inspectors were given the same powers as miners' officers (now SSHRs). They were, essentially:
- power to inspect the workings of the mine (upon giving notice);¹⁴⁷⁹
 - power to make a record of any inspection, which was to be added to the mine book (now the mine record), and in the case of 'the existence or apprehended existence of any danger', to forward the report to an inspector;¹⁴⁸⁰ and
 - power to suspend operations in any dangerous place.¹⁴⁸¹
- 12.37 Access to the mine book 'at all reasonable times' was also provided for.¹⁴⁸²
- 12.38 Under the Act, the powers and functions of SSHRs and ISHRs have been separately described in Parts 7 and 8.
- 12.39 Section 119 of the Act preserves the traditional powers of entry to the mine and suspension of operations. The power of entry exists for the exercise of any of the functions under section 118. The power to give a Directive under section 167 (that is, to suspend operations where the ISHR believes risk is not at an acceptable level) is exercisable at an arguably lower threshold than under the predecessor Act, which required operations to be dangerous.
- 12.40 Any relevant documents may be examined under that section, subject only to the belief required by section 119(1)(c). There is an additional power under section 119(1)(e) to require 'reasonable help' from the person in control of the mine, in the exercise of any power. The power of referral of an issue to an inspector is now reflected in section 121 of the Act.

¹⁴⁷⁹ *Coal Mining Act 1925* (Qld), sections 70(1) and (2).

¹⁴⁸⁰ *Coal Mining Act 1925* (Qld), section 70(5).

¹⁴⁸¹ *Coal Mining Act 1925* (Qld), section 70(6).

¹⁴⁸² *Coal Mining Act 1925* (Qld), section 65(4).

12.41 Thus, the same, or similar powers, have been available in support of the role for over 80 years. The CFMMEU has submitted that the role is ‘already very effective...in mine safety’.¹⁴⁸³ In the Board’s view, submissions about enlargement of powers should be viewed in that context.

12.42 Submissions concerning various powers are discussed below.

Inspections – section 118(1)(a)

12.43 ISHRs routinely attend each of the mines and conduct inspections. They keep a register of the inspections that are performed to ensure that each mine is inspected regularly.¹⁴⁸⁴

12.44 Mr Hill said that there are a range of factors that determine when an ISHR attends a mine for an inspection, namely:¹⁴⁸⁵

- a. the frequency of high potential incidents (HPIs) reported to the ISHRs;
- b. complaints from coal mine workers about health and safety matters; and
- c. requests from SSHRs.

12.45 Mr Woods said that the ISHRs have a system whereby they try to attend all mines once a year, and underground coal mines twice a year.¹⁴⁸⁶ He said that he tried to schedule inspections if he had not been to a mine for a while or if he observed things on social media which caused him concern.¹⁴⁸⁷

12.46 The CFMMEU submitted in favour of a power of inspection to be exercised without notice.¹⁴⁸⁸ Evidence from witnesses concerning this did not rise above assertion as to the value of such a power.¹⁴⁸⁹ The Queensland Resources Council submitted, on the other hand, that ‘in the high-risk coal mining industry it is essential that the requirement to provide reasonable notice is retained’.¹⁴⁹⁰ The only reason advanced for that view was so that entry could be ‘undertaken safely’.¹⁴⁹¹

12.47 The Board notes that under the NSW legislation, notice of inspection is required save ‘in the event of an incident or any situation involving a serious risk to the health or safety of a person emanating from an immediate or imminent exposure to a hazard’.¹⁴⁹²

¹⁴⁸³ CMU.008.008.0001, .0036.

¹⁴⁸⁴ HLJ.001.001.0001, .0004. It is noted, however, that this does not appear to be true for Grosvenor.

¹⁴⁸⁵ HLJ.001.001.0001, .0018.

¹⁴⁸⁶ TRA.500.004.0001, .0007, lines 20–22.

¹⁴⁸⁷ WST.001.001.0001, .0014.

¹⁴⁸⁸ CMU.008.008.0001, .0037.

¹⁴⁸⁹ HLJ.001.001.0001, .0019; WST.001.001.0001, .0015.

¹⁴⁹⁰ QRC.999.001.0001, .0003.

¹⁴⁹¹ QRC.999.001.0001, .0003.

¹⁴⁹² *Work Health and Safety (Mines and Petroleum Sites) Act 2013* (NSW), section 29(3)(a)(ii).

- 12.48 Mr Woods gave evidence that if he received a complaint relating to a matter that may cause death or serious injury, he attended the mine straight away, informing the SSE on his way.¹⁴⁹³ This does not suggest any difficulty accessing a mine, or the need for expanded power, such as that in the NSW legislation.
- 12.49 The Board is not persuaded to recommend amending the Act to provide for power of entry without notice.

Examination of documents – section 119(1)(c)

- 12.50 Section 119(1)(c) provides for a power to ‘examine any documents relevant to safety and health...if the representative has reason to believe the documents contain information required to assess whether procedures are in place at a coal mine to achieve an acceptable level of risk to coal mine workers’. The power to examine documents pursuant to section 119(1)(c) is limited to an examination of documents for the purpose of assessing the adequacy of safety procedures at the mine, and may only be exercised where the ISHR has reason to believe the documents contain information required to make that assessment.
- 12.51 Section 119(1)(d) provides for copying of documents, but only in respect of ‘safety and health management system documents’, which seems anomalous. As to this, the CFMMEU submitted:¹⁴⁹⁴

...both Mr Hill and Mr Woods also gave evidence about difficulties in being allowed to copy documents examined under s 119(1)(c) of the CSMH Act. They have the power in s.119(1)(c) to examine, but arguably not copy, relevant documents. They separately have the power in s.119(1)(d) to copy safety and health management system documents, which seems to be a narrower category. Copies of documents falling into the former category are arguably able to be obtained via ss.119(1)(e), (2) and/or (3) but it is not clear.

- 12.52 In the past, when many documents may well have been in hard copy, requiring manual photocopying, there may have been a reason to restrict the burden of copying documents. In the modern digital age, it is difficult to see any continuing rationale for restricting the power to copy documents to those forming part of the safety and health management system, given there may be documents which do not form part of the mine’s safety and health management system, but which an ISHR is nonetheless entitled to examine pursuant to section 119(1)(c) of the Act. An unreasonable request for copying such documents could be resisted under section 119(2) or (3) of the Act.

Directives – section 166

- 12.53 On the basis of existence of the power to issue a Directive under section 167, the CFMMEU argued for the additional power to issue a Directive under section 166.¹⁴⁹⁵

¹⁴⁹³ WST.001.001.0001, .0014.

¹⁴⁹⁴ CMU.008.008.0001, .0038. References omitted.

¹⁴⁹⁵ CMU.008.008.0001, .0037.

The only evidence was by way of the ISHRs' assertion of belief in the utility of such a power.¹⁴⁹⁶

- 12.54 In the Board's view, the existence of the power to suspend operations under section 167 is not a sufficient basis on which to extend the power under section 166 to ISHRs. Section 166 is concerned with a 'Directive to reduce risk'.

An inspector or inspection officer may give a Directive to take preventative action if he or she reasonably believes that 'a risk from coal mining operations may reach an unacceptable level'.

- 12.55 Given the width of operation of section 166, it would be a considerable step to extend the exercise of the power beyond the persons nominated by it. The Board would not recommend that step on the available evidence.
- 12.56 If an ISHR believes a safety and health management system in place at a mine is inadequate or ineffective, the ISHR must advise the SSE and, if the ISHR is not satisfied the SSE is taking the action necessary to make it adequate and effective, the ISHR must inform an inspector.¹⁴⁹⁷ The Board heard evidence of this sort of action by an ISHR resulting in a favourable safety outcome.¹⁴⁹⁸

Participate in investigations – section 118(1)(d)

- 12.57 Mr Woods and Mr Hill each received notifications of some of the methane HPIs which are the subject of inquiry. There was no instance in which the ISHRs conducted an independent investigation beyond receipt of the verbal and written notification (Form 1A). The reasons were, variously and in summary:¹⁴⁹⁹

- physical distance of the ISHRs from the mine;
- work may already have recommenced by the time of the notification (so that there was little purpose in a visit to the mine); and
- either the Inspectorate had determined that work could recommence, or the mine had determined the cause and how to prevent the recurrence, such that further investigation was not required.

- 12.58 However, a mine's HPIs would typically be reviewed by the ISHR prior to carrying out an inspection.¹⁵⁰⁰

¹⁴⁹⁶ HLJ.001.001.0001, .0020; DGR.001.001.0001, .0015.

¹⁴⁹⁷ Act, section 121.

¹⁴⁹⁸ TRA.500.004.0001, .0051, line 45–.0057, line 27.

¹⁴⁹⁹ HLJ.001.001.0001, .0017–.0018; HLJ.001.001.0001, .0021–.0037; WST.001.001.0001, .0030–.0036.

¹⁵⁰⁰ TRA.500.004.0001, .0007, lines 28–40.

- 12.59 In the case of a serious injury or fatality, ISHRs attend at the mine as soon as possible to commence an investigation.¹⁵⁰¹ As an instance, when Mr Woods received the notification of the serious accident on 6 May 2020, he attended the mine that night and for a further eight days thereafter.¹⁵⁰²
- 12.60 A fairly recent Supreme Court ruling¹⁵⁰³ clarified that the ISHR function of participating in investigations¹⁵⁰⁴ did not impliedly confer a power to insist on participation in an inspector's investigation, for example, by attending a witness interview and questioning the witness. The court found that this did not preclude a cooperative arrangement for participation at the discretion of the inspector and 'governed by the proper exercise by the inspector of his or her powers'.¹⁵⁰⁵ The court also observed that '[t]he function of participating in investigations also may be advanced by the exercise by the ISHR of the specific powers conferred upon him or her by s 119'.¹⁵⁰⁶

Other matters

Generic induction

- 12.61 Mr Hill and Mr Woods perceived that there was sometimes a reluctance on the part of workers to speak with them during their inspections and observed that they are contacted more frequently by union members than non-union members.¹⁵⁰⁷ One possibility referred to in evidence is that ISHRs may be perceived by some workers as union representatives rather than industry representatives.¹⁵⁰⁸
- 12.62 Mr Hill noted that the generic induction for coal mine workers (Recognised standard 11)¹⁵⁰⁹ does not include a component on the role of SSHRs and ISHRs.¹⁵¹⁰ Mr Dalliston said that the role of the ISHRs should be well known if a mine inducts its workforce properly.¹⁵¹¹ However, in the Board's view, there would be merit in ensuring that the Recognised standard 11 induction includes an information component on the role of the SSHRs and ISHRs.

¹⁵⁰¹ HLJ.001.001.0001, .0017; TRA.500.004.0001, .0023, lines 27–46.

¹⁵⁰² WST.001.001.0001, .0029–.0030.

¹⁵⁰³ *Woods v Newman, Chief Inspector of Coal Mines* (2020) 3 QR 312; [2020] QSC 10.

¹⁵⁰⁴ Act, section 118(1)(d).

¹⁵⁰⁵ *Woods v Newman, Chief Inspector of Coal Mines* (2020) 3 QR 312; [2020] QSC 10, at [82].

¹⁵⁰⁶ *Woods v Newman, Chief Inspector of Coal Mines* (2020) 3 QR 312; [2020] QSC 10, at [79].

¹⁵⁰⁷ TRA.500.004.0001, .0012, line 33–.0014, line 6; TRA.500.004.0001, .0016, line 37–.0017, line 2.

¹⁵⁰⁸ TRA.500.004.0001, .0014, lines 8–16.

¹⁵⁰⁹ Department of Natural Resources, Mines and Energy, *Recognised standard 11: Training in coal mines*, Queensland Government (Recognised standard under the *Coal Mining Safety and Health Act 1999*, July 2012) <https://www.resources.qld.gov.au/__data/assets/pdf_file/0016/240370/recognised-standard-11.pdf>.

¹⁵¹⁰ TRA.500.004.0001, .0076, lines 19–31.

¹⁵¹¹ DGR.001.001.0001, .0014.

Distribution of Mine Record Entries

- 12.63 The Board heard some evidence from the ISHRs of some deterioration in the relationship with the Inspectorate since sometime in 2019.¹⁵¹² Various matters about this deterioration in the relationship were disputed by Mr Newman.¹⁵¹³ It is only necessary for the Board to note the desirability of mutual respect and reasonable cooperation between parties with overlapping functions under the Act.
- 12.64 One particular matter, however, is worthy of mention. Prior to 17 February 2020, ISHRs were part of a wide email distribution list of Mine Record Entries (MREs). After that date, wider distribution of MREs by that means ceased.¹⁵¹⁴ Two reasons were given:¹⁵¹⁵
- that section 173(3) of the Act did not require distribution other than to the operator and SSE; and
 - that the MRE was a confidential document.
- 12.65 As to the first reason, section 173(3) of the Act does not restrict wider publication, and section 128(d) arguably supports wider distribution to parties who would benefit from the information, having regard to the objects of the Act.
- 12.66 As to the second reason, the MRE is required to be entered on the mine record, so that it is accessible to all coal mine workers. It is posted on a notice board.¹⁵¹⁶ In that way it would be accessible to an ISHR during an inspection. It is difficult to see in what sense an MRE is a confidential document. It certainly has not been treated as such in the past, given the wide distribution list that previously existed.¹⁵¹⁷
- 12.67 Plainly, it would be to the benefit of the ISHRs' function to have a convenient means of being aware of, at least, the results of inspectors' inspections and audits, without potentially having to travel to the mine to undertake an examination of the noticeboard or mine record.

¹⁵¹² HLJ.001.001.0001, .0009; WST.001.001.0001, .0005–.0008.

¹⁵¹³ TRA.500.002.0001, .0007, line 25–.0011, line 16.

¹⁵¹⁴ TRA.500.002.0001, .0019, line 40–.0020, line 10.

¹⁵¹⁵ TRA.500.002.0001, .0020, lines 31–41.

¹⁵¹⁶ TRA.500.002.0001, .0020, lines 43–45.

¹⁵¹⁷ WST.001.001.0001, .0038–.0039.

Findings

Finding 98

Industry Safety and Health Representatives (ISHRs) continue to have an important role in maintaining safety and health at coal mines, based on the historic role of district union inspectors.

Finding 99

The model for appointment of ISHRs under the *Coal Mining Safety and Health Act 1999* (Qld) (the Act) is the best available, in that it provides the opportunity for organised labour to participate democratically in the appointment process. It also guarantees that industry representatives are independent of both government and management at coal mines.

Finding 100

The ISHR function is best carried out where a cooperative arrangement exists between the ISHRs and the Site Safety and Health Representatives (SSHRs).

Finding 101

The relationship between ISHRs and SSHRs is more easily formed when both are union members.

Finding 102

ISHRs should be more proactive in cultivating those relationships with SSHRs who are not union members.

Finding 103

ISHRs would be assisted by a mechanism whereby they are routinely informed of the outcome of SSHR elections at coal mines.

Finding 104

The powers afforded to ISHRs in section 119 of the Act are adequate, save that it appears anomalous that there is no power under section 119(1)(c) to copy all documents that may be examined under that provision.

Finding 105

Awareness of the role of SSHRs and ISHRs would be enhanced by ensuring that the Recognised standard 11 induction includes an information component on the functions of each.

Finding 106

Given the large number of coal mines, ISHRs would be assisted by continuation of the previous practice of email distribution of Mine Record Entries (MREs) from the Inspectorate.¹⁵¹⁸

Recommendations

Recommendation 31

The current model of appointment of ISHRs be retained.

Recommendation 32

Resources Safety & Health Queensland (RSHQ) takes steps to amend the *Coal Mining Safety and Health Regulation 2017* (Qld), schedule 1B 'Site safety and health representative election process', clause 13(6), to require the returning officer for a ballot in respect of the election of an SSHR to give notice of the result of the ballot to the ISHRs.

Recommendation 33

The ISHRs take a more proactive role in cultivating mutually beneficial relationships with SSHRs.

Recommendation 34

RSHQ takes steps to amend section 119(1)(c) of the Act to permit copying of all documents amenable to examination under that provision.

Recommendation 35

RSHQ takes steps, through the consultative process provided by the Coal Mining Safety and Health Advisory Committee, to include a component on the roles of SSHRs and ISHRs in the *Recognised standard 11: Training in coal mines*, so as to promote awareness of the availability of both functions.

Recommendation 36

The Inspectorate reinstates the practice of sending MREs to ISHRs.

¹⁵¹⁸ The Coal Mines Inspectorate is a division of Resources Safety & Health Queensland (RSHQ), the Regulator of the coal mining industry. Previously, the Regulator was the Department of Natural Resources, Mines and Energy (DNRME) and the Inspectorate was a division of that department. That department had formerly been titled DNRM, the Department of Natural Resources and Mines.

Chapter 13 – Site safety and health representatives

13.1 Part 7 of the *Coal Mining Safety and Health Act 1999* (Qld) (the Act) deals with Site Safety and Health Representatives (SSHRs). SSHRs have a number of functions and powers aimed at assessing the level of risk to coal mine workers at a coal mine, and ensuring that risk is at an acceptable level. The role is based upon the traditional check inspector role discussed in Chapter 12 in connection with the Industry Safety and Health Representative (ISHR) function.

SSHR functions and powers

13.2 Section 99(1) of the Act provides that the functions of an SSHR are:

- (a) *to inspect the coal mine to assess whether the level of risk to coal mine workers is at an acceptable level;*
- (b) *to review procedures in place at the coal mine to control the risk to coal mine workers so that it is at an acceptable level;*
- (c) *to detect unsafe practices and conditions at the coal mine and to take action to ensure the risk to coal mine workers is at an acceptable level;*
- (d) *to investigate complaints from coal mine workers at the mine regarding safety or health.*

13.3 Section 99(4) provides that an SSHR who undertakes an inspection must:

- (a) *make a written report on the inspection; and*
- (b) *give a copy of the report to the site senior executive; and*
- (c) *if the inspection indicates the existence or possible existence of danger, immediately –*
 - (i) *notify the site senior executive or the responsible supervisor; and*
 - (ii) *send a copy of the report to an inspector.*

13.4 Further, if an SSHR believes a safety and health management system is inadequate or ineffective, the representative must inform the Site Senior Executive (SSE).¹⁵¹⁹ If the SSHR is not satisfied that the SSE is taking the action necessary to make the safety and health management system adequate and effective, the SSHR must advise an inspector.¹⁵²⁰

13.5 The SSE and supervisors at the mine must give reasonable help to an SSHR in carrying out the SSHR's functions.¹⁵²¹

¹⁵¹⁹ Act, section 99(5).

¹⁵²⁰ Act, section 99(6).

¹⁵²¹ Act, section 99(2).

13.6 Section 100 of the Act provides that an SSHR has the power:

- (a) *to enter any area of the coal mine at any time to carry out the functions of the site safety and health representative, if reasonable notice is given to the site senior executive or the site senior executive's representative;*
- (b) *to examine any documents relevant to safety and health held by the site senior executive under this Act, if the site safety and health representative has reason to believe the documents contain information required to assess whether procedures are in place at the coal mine to achieve an acceptable level of risk to the coal mine workers.*

13.7 If an SSHR reasonably believes a danger exists to the safety or health of coal mine workers because of coal mining operations, the SSHR may, by written report to the SSE, order the suspension of the operations.¹⁵²² Upon receipt of the report, the SSE must stop the operations and ensure they are not restarted until the risk to coal mine workers from operations is at an acceptable level.¹⁵²³

13.8 If the SSHR reasonably believes there is immediate danger to the safety and health of coal mine workers from operations, the SSHR may personally stop the operations or require the supervisor in charge to stop the operations.¹⁵²⁴

13.9 When performing its functions, or exercising its powers, an SSHR must not unnecessarily impede production at the mine.¹⁵²⁵

Background

13.10 The Act provides that coal mine workers at a coal mine may elect up to two of their number to be SSHRs for the mine.¹⁵²⁶ The election process is regulated under Schedule 1B of the *Coal Mining Safety and Health Regulation 2017* (Qld) (the Regulation).

13.11 The required competencies to be an SSHR are set by the Coal Mining Safety and Health Advisory Committee.¹⁵²⁷ They are published on the Queensland Government's Business Queensland website.¹⁵²⁸ They involve completion of the Mine Supervisor training course of three units:

- RIIRIS301D – Apply Risk Management Processes
- RIIWHS301D – Conduct Safety and Health Investigations

¹⁵²² Act, sections 101(1), (2).

¹⁵²³ Act, sections 102 and 103.

¹⁵²⁴ Act, section 101(3).

¹⁵²⁵ Act, section 104.

¹⁵²⁶ Act, section 93.

¹⁵²⁷ Act, section 93(3).

¹⁵²⁸ Queensland Government, *Coal mining competencies*, Queensland Government: Business Queensland (Web Page, 25 March 2021) <<https://www.business.qld.gov.au/industries/mining-energy-water/resources/safety-health/mining/competencies-certificates/coal>>.

- RIICOM301D – Communicate Information.

13.12 Subject to acquiring those competencies, any coal mine worker may become an SSHR upon election.¹⁵²⁹ This broad eligibility is in contrast to the required competency of the ISHRs, who must hold a First or Second Class Certificate of Competency or Deputy's Certificate of Competency.¹⁵³⁰

SSHR functions and powers: some SSHRs' experiences

13.13 The Board heard oral evidence from three SSHRs, from Oaky North and Grasree mines, about the practical performance of the function. The Board also received statements from an SSHR at Grosvenor mine (Grosvenor).

13.14 Mr Joe Barber is a fitter employed by Oaky Creek Coal Pty Ltd at the Oaky North mine (Oaky North).¹⁵³¹ He has worked in that position since 2007 and has nearly 40 years' experience in the mining industry.¹⁵³² Mr Barber was first elected to the SSHR role in 2013 or 2014.¹⁵³³ He was re-elected unopposed on two occasions.¹⁵³⁴ He remained in that role from when he was first elected until he commenced long service leave in mid-2020.¹⁵³⁵

13.15 Mr Richard Harris is employed as an Explosion Risk Zone (ERZ) controller at Grasree mine (Grasree).¹⁵³⁶ He worked there from 2004 to 2012 and then returned in early 2018.¹⁵³⁷ He has approximately four or five years' experience as an SSHR, most recently taking up that role for a second time 12 months ago.¹⁵³⁸

13.16 Mr James Hoare is also an ERZ controller at Grasree.¹⁵³⁹ He has been in the SSHR position since February 2013.¹⁵⁴⁰

13.17 Mr Reece Campbell is employed by FES Coal Pty Ltd, a subsidiary of One Key Holdings Pty Ltd (One Key) at Grosvenor as a miner driver. He has worked at Grosvenor since it was a greenfield site.¹⁵⁴¹ He was elected to the SSHR role in 2018 and remained in that role until January 2021.¹⁵⁴²

¹⁵²⁹ Act, sections 93(1)–(3). References in this section to position titles and timeframes reflect the status of these matters at the time the relevant SSHR gave evidence in the first tranche of public hearings.

¹⁵³⁰ Act, section 109(2).

¹⁵³¹ TRA.500.005.0001, .0033, lines 37–45.

¹⁵³² TRA.500.005.0001, .0035, lines 9–15.

¹⁵³³ TRA.500.005.0001, .0036, lines 2–3.

¹⁵³⁴ TRA.500.005.0001, .0036, lines 11–24.

¹⁵³⁵ BJO.001.001.0001.

¹⁵³⁶ TRA.500.006.0001, .0002, lines 21–27.

¹⁵³⁷ TRA.500.006.0001, .0002, lines 39–42.

¹⁵³⁸ TRA.500.006.0001, .0002, line 44–.0003, line 3.

¹⁵³⁹ TRA.500.006.0001, .0035, lines 2–3; HJI.001.001.0001.

¹⁵⁴⁰ TRA.500.006.0001, .0035, lines 12–14.

¹⁵⁴¹ CRE.001.001.0001.

¹⁵⁴² CRE.001.001.0001, .0002.

Inspections

- 13.18 Mr Barber said that he would conduct inspections if he personally observed problems on site, or if another worker reported a problem to him.¹⁵⁴³ When inspectors or ISHRs attended the mine, he would join them on their inspections.¹⁵⁴⁴ There was not, however, a program in place for inspections to be conducted on a regular basis.¹⁵⁴⁵
- 13.19 Mr Harris said that he tried to do a whole-of-mine inspection every month or so.¹⁵⁴⁶ He would make arrangements with mine management a few days in advance of the inspection.¹⁵⁴⁷ During an inspection, he would engage with coal mine workers about any issues they may have.¹⁵⁴⁸ He said that management did not accompany him on his inspections.¹⁵⁴⁹
- 13.20 Mr Hoare had a similar approach to inspections as Mr Harris in that he tried to regularly set aside a day to travel to all parts of the mine and engage with any work groups he came across.¹⁵⁵⁰ He and Mr Harris tried to conduct those inspections on a month-about basis.¹⁵⁵¹
- 13.21 Mr Campbell said that he and the other SSHR would generally have places of interest that they conducted monthly inspections at, and that if something specific was pointed out to them, they would also attend that location. The monthly inspections would typically take approximately five or six hours. Any issues observed during these inspections which they considered to require corrective tasks were raised at a monthly meeting between the SSHRs and three members of the Senior Leadership Team (SLT).¹⁵⁵²

Review procedures

- 13.22 The SSHRs were involved to varying degrees in reviews of procedural documents which required periodic updating.
- 13.23 Mr Barber said that the review of procedures in place at the mine was done when the 'use-by date' for procedures was reached.¹⁵⁵³ Management would ask an SSHR to assist in that review.¹⁵⁵⁴ He considered that there was a benefit in involving an SSHR in that review process, even if the subject of the procedure under review was not within his work experience.¹⁵⁵⁵

¹⁵⁴³ TRA.500.005.0001, .0044, line 30–.0045, line 14.

¹⁵⁴⁴ TRA.500.005.0001, .0045, lines 16–28.

¹⁵⁴⁵ TRA.500.005.0001, .0045, lines 16–21.

¹⁵⁴⁶ TRA.500.006.0001, .0012, lines 25–36.

¹⁵⁴⁷ TRA.500.006.0001, .0013, lines 13–21.

¹⁵⁴⁸ TRA.500.006.0001, .0013, lines 1–7.

¹⁵⁴⁹ TRA.500.006.0001, .0012, lines 38–46.

¹⁵⁵⁰ TRA.500.006.0001, .0037, lines 40–46.

¹⁵⁵¹ TRA.500.006.0001, .0038, lines 1–3.

¹⁵⁵² CRE.001.001.0001, .0004–.0005.

¹⁵⁵³ TRA.500.005.0001, .0045, lines 37–46.

¹⁵⁵⁴ TRA.500.005.0001, .0046, lines 12–23.

¹⁵⁵⁵ TRA.500.005.0001, .0046, line 36–.0047, line 15.

- 13.24 Mr Harris said that he had ‘done some reviews’, although not a great deal since resuming the SSHR role.¹⁵⁵⁶ He said the Mine Senior Officer (MSO) or department heads determined who would participate in the reviews and that an SSHR was ‘not always’ involved.¹⁵⁵⁷
- 13.25 Mr Hoare said that he participated in reviews of procedures if asked to do so, although it was not a mine requirement that an SSHR was always present.¹⁵⁵⁸
- 13.26 Mr Campbell said it was the mine’s function to review procedural documents, however the SSHRs would be involved in that process. SSHRs would also review documents when someone raised a concern with them.¹⁵⁵⁹

Detect unsafe practices and conditions and take action

- 13.27 Mr Barber said that he detected unsafe practices in the course of walking around the mine site on a daily basis.¹⁵⁶⁰ If he observed workers to be doing something which was unsafe, he would ensure the workers corrected what they were doing.¹⁵⁶¹ It was necessary for him to take such action a ‘[c]ouple of times a week, maybe’.¹⁵⁶² He said that 80% to 90% of the unsafe practices and conditions he observed were ‘trivial’ in nature.¹⁵⁶³ In Mr Barber’s view, many coal mine workers did not understand or care about the Act or the Regulation and ‘sometimes go a bit bull at a gate’ in their approach to their work tasks.¹⁵⁶⁴
- 13.28 Mr Harris also said that 80% to 90% of the matters he dealt with as an SSHR were minor in nature.¹⁵⁶⁵ Most of the issues, such as roadway dust or unacceptable roadway conditions, could be dealt with on the same shift in which the problem was observed.¹⁵⁶⁶ Those sorts of problems came to his attention from his own observations or by reports from workers.¹⁵⁶⁷
- 13.29 Mr Hoare agreed with Mr Harris that 80% to 90% of the safety issues that came to his attention were minor.¹⁵⁶⁸ He would usually become aware of them through reports from workers. He would be informed of more serious issues by the MSO or Mine Manager, Mr Kevin Schiefelbein.¹⁵⁶⁹

¹⁵⁵⁶ TRA.500.006.0001, .0013, lines 37–44.

¹⁵⁵⁷ TRA.500.006.0001, .0014, lines 18–38.

¹⁵⁵⁸ TRA.500.006.0001, .0040, lines 22–25.

¹⁵⁵⁹ CRE.001.001.0001, .0005–.0006.

¹⁵⁶⁰ TRA.500.005.0001, .0047, line 47–.0048, line 12.

¹⁵⁶¹ TRA.500.005.0001, .0048, lines 14–20.

¹⁵⁶² TRA.500.005.0001, .0048, lines 22–26.

¹⁵⁶³ TRA.500.005.0001, .0049, lines 2–5.

¹⁵⁶⁴ TRA.500.005.0001, .0054, lines 19–27.

¹⁵⁶⁵ TRA.500.006.0001, .0006, lines 1–12.

¹⁵⁶⁶ TRA.500.006.0001, .0006, lines 5–7.

¹⁵⁶⁷ TRA.500.006.0001, .0006, lines 14–37.

¹⁵⁶⁸ TRA.500.006.0001, .0037, lines 26–32.

¹⁵⁶⁹ TRA.500.006.0001, .0037, lines 18–24.

13.30 Mr Campbell did not specifically identify the role of the SSHR in detecting unsafe practices and conditions. Rather, he said that, in his experience, ‘coal mine workers generally did not put up with anything that was unacceptable or unsafe’.¹⁵⁷⁰ If anything was unsafe, experienced workers ‘would speak up and things would be corrected’.¹⁵⁷¹ The various levels of supervision, and the high levels of training, of the workers guarded against unsafe practices. Further, detection of unsafe practices that did occur could happen by the Deputy’s inspections.¹⁵⁷²

Investigate complaints from coal mine workers

13.31 Mr Barber said that he received complaints from workers that were alternatively trivial or major.¹⁵⁷³ Complaints came from all categories of workers: employees, contractors and labour hire workers.¹⁵⁷⁴ Sometimes labour hire workers requested that he not name them.¹⁵⁷⁵

13.32 Mr Harris said that he received complaints from coal mine workers ‘quite often’.¹⁵⁷⁶ There were more complaints that came from the permanent workforce than from contractors or labour hire workers.¹⁵⁷⁷

13.33 Mr Hoare said that worker reports were the main means by which he became aware of issues at the mine.¹⁵⁷⁸ His experience was that the majority of the complaints were made by permanent employees. Complaints were only occasionally made by a WorkPac or One Key worker, and very rarely, if ever, by a contractor.¹⁵⁷⁹ Mr Hoare made it clear to the workers that they could notify him of any safety concerns anonymously.¹⁵⁸⁰ Nonetheless, he observed that permanent employees felt comfortable raising safety issues with him while labour hire workers did not.¹⁵⁸¹ He had observed labour hire workers working in unacceptable conditions but who had not raised a concern about those conditions.¹⁵⁸²

13.34 Mr Campbell said that, if a worker made a complaint to him, he would insist they ‘put in a hazard report’.¹⁵⁸³

¹⁵⁷⁰ CRE.001.001.0001, .0006.

¹⁵⁷¹ CRE.001.001.0001, .0006.

¹⁵⁷² CRE.001.001.0001, .0006.

¹⁵⁷³ TRA.500.005.0001, .0049, lines 19–22.

¹⁵⁷⁴ TRA.500.005.0001, .0049, lines 37–40.

¹⁵⁷⁵ TRA.500.005.0001, .0053, lines 15–20.

¹⁵⁷⁶ TRA.500.006.0001, .0016, lines 5–6.

¹⁵⁷⁷ TRA.500.006.0001, .0016, lines 8–13.

¹⁵⁷⁸ TRA.500.006.0001, .0041, lines 10–15.

¹⁵⁷⁹ TRA.500.006.0001, .0041, lines 24–30.

¹⁵⁸⁰ TRA.500.006.0001, .0042, lines 44–47.

¹⁵⁸¹ TRA.500.006.0001, .0042, lines 30–37; TRA.500.006.0001, .0043, lines 2–9.

¹⁵⁸² TRA.500.006.0001, .0043, lines 2–22.

¹⁵⁸³ CRE.001.001.0001, .0006.

He said that while everyone had a responsibility for safety, '[i]t would be fair to say that some workers approach their supervisor directly and pointed out issues and others would just complaint [sic] to themselves that no one was doing anything about things'.¹⁵⁸⁴ Mr Campbell said that he encouraged the reporting of concerns. He could take complaints to the monthly meeting with the SLT representatives in a confidential way. He could also raise 'grave' concerns straight away, but he noted that most complaints made to him were 'minor or third hand information'.¹⁵⁸⁵

Use of powers

- 13.35 Mr Barber said that there had been 'a handful of occasions' during his time as an SSHR when he had had to stop operations pursuant to section 101 of the Act.¹⁵⁸⁶ There were 'countless occasions' when he had informally advised workers to cease unsafe practices.¹⁵⁸⁷
- 13.36 Mr Harris said that he had never had to refer a matter to an inspector, nor had he, in his most recent stint as SSHR, had to stop operations.¹⁵⁸⁸ In the normal course, issues were sorted out with the cooperation of the mine management.¹⁵⁸⁹
- 13.37 Mr Hoare had, on one occasion, sought advice from an inspector but had never had to refer a safety matter to an inspector.¹⁵⁹⁰ He had never suspended the whole of operations, but on one occasion, he had stood down some of the conveyors for 24 hours.¹⁵⁹¹
- 13.38 Mr Campbell said that he stopped work on one occasion, but not pursuant to the power in section 101 of the Act. In his view, 'ordering a suspension under section 101 is a significant power that should be reserved for when someone is in immediate, life threatening danger'.¹⁵⁹² He has never had occasion to stop work in those circumstances.¹⁵⁹³
- 13.39 The sparing use of powers to refer an issue to an inspector or to suspend operations is consistent with the findings of an extensive study of worker representative roles undertaken by Professor Michael Quinlan and others in 2013–14.¹⁵⁹⁴

¹⁵⁸⁴ CRE.001.001.0001, .0006.

¹⁵⁸⁵ CRE.001.001.0001, .0006.

¹⁵⁸⁶ BJO.001.001.0001, .0006.

¹⁵⁸⁷ BJO.001.001.0001, .0006.

¹⁵⁸⁸ TRA.500.006.0001, .0007, lines 3–7.

¹⁵⁸⁹ TRA.500.006.0001, .0007, lines 13–22.

¹⁵⁹⁰ TRA.500.006.0001, .0039, lines 5–19.

¹⁵⁹¹ TRA.500.006.0001, .0039, lines 21–34.

¹⁵⁹² CRE.001.001.0001, .0007.

¹⁵⁹³ CRE.001.001.0001, .0007.

¹⁵⁹⁴ Walters D., Wadsworth E., Johnstone R., & Quinlan M., *A study of the role of workers' representatives in health and safety arrangements in coal mines in Queensland: Final Report*, Cardiff University (Report, January 2014) <<https://orca.cf.ac.uk/87475/1/qldminesafetyreport0314.pdf>>; see BOI.001.004.0001, .0117.

The study found that representatives ‘made careful and selective use’ of powers.¹⁵⁹⁵ However, the study also found that possession of such powers by SSHRs ‘considerably strengthened perception of their own legitimacy’. It found that:¹⁵⁹⁶

Possessing such powers also enhanced their confidence that they would be taken seriously by senior managers in their pursuit of actions that were in the main consultative and cooperative in part because they have the potential to use powers that would seriously inconvenience senior management.

Notifications of high potential incidents

- 13.40 Section 106(1)(b) of the Act requires that the SSE ‘tell’ the SSHR about a high potential incident (HPI). The SSHRs who gave evidence had received notifications of one or more HPIs under inquiry.
- 13.41 Mr Barber said that he received verbal, but not written, notifications of HPIs.¹⁵⁹⁷ He said that he was verbally notified of the gas exceedance that occurred at Oaky North on 6 December 2019, about three hours after the event. By that time, the incident had been resolved and the mine was back in production.¹⁵⁹⁸ He said that neither he nor the other SSHR was told about the mine’s investigation into the incident.¹⁵⁹⁹ Mr Barber said that ‘[m]ines are generally very quick to get to the bottom of what has caused a gas exceedance and then putting in preventative measures to stop it from happening again’.¹⁶⁰⁰
- 13.42 Mr Harris said that he was always advised of HPIs at the mine. He would receive a verbal notification if he was on-site at the time of the incident, or an emailed notification if he was not.¹⁶⁰¹ However, by the time he received notification of them, the incident would be ‘old news’ and would have already been resolved.¹⁶⁰² He had no role to play by the time he heard about the matter.¹⁶⁰³
- 13.43 In Mr Harris’ experience, HPIs ‘are no secret at the mine’.¹⁶⁰⁴ Workers were told about them, and the steps that were taken to prevent their recurrence.¹⁶⁰⁵ However, he said that ‘[t]here have been a couple of occasions in recent times when management have been reluctant to report an incident as an HPI’.¹⁶⁰⁶

¹⁵⁹⁵ BOI.001.004.0001, .0124.

¹⁵⁹⁶ BOI.001.004.0001, .0125.

¹⁵⁹⁷ BJO.001.001.0001, .0008.

¹⁵⁹⁸ BJO.001.001.0001, .0009.

¹⁵⁹⁹ BJO.001.001.0001, .0010.

¹⁶⁰⁰ BJO.001.001.0001, .0009.

¹⁶⁰¹ HRI.001.001.0001, .0009.

¹⁶⁰² HRI.001.001.0001, .0009.

¹⁶⁰³ HRI.001.001.0001, .0009.

¹⁶⁰⁴ HRI.001.001.0001, .0008.

¹⁶⁰⁵ HRI.001.001.0001, .0008.

¹⁶⁰⁶ HRI.001.001.0001, .0004.

On those occasions, Mr Harris had advised management that the workers were aware of the matter and that it would be better to report the incident as an HPI, to put the workers at ease.¹⁶⁰⁷

- 13.44 Mr Hoare said that he was notified about HPIs when they occurred, but that, beyond a discussion with the mine manager or MSO, he had had no occasion to intervene further.¹⁶⁰⁸
- 13.45 Mr Campbell said that he was notified about HPIs orally and by being provided with the Form 1A in relation to the incident. He said that SSHRs were not required to actively respond to those notifications.¹⁶⁰⁹
- 13.46 It is noted that, unlike the ISHRs, the SSHRs do not have an express function of participating in investigations. The required notification would, nonetheless, assist to keep the SSHR abreast of the occurrence of a safety issue.

Relationship with ISHRs

- 13.47 Mr Barber said that he had contact with the ISHRs 'at least monthly'.¹⁶¹⁰ He said that if SSHRs 'need a bit of back up' in discharging their functions, the ISHRs are on call to assist.¹⁶¹¹ Mr Barber said that that arrangement was helpful, because while the SSHRs were 'the link between the workforce and the SSE', SSHRs sometimes required the ISHR to intervene and assist.¹⁶¹²
- 13.48 Mr Harris said that he had a 'very good relationship' with the ISHRs and that he relied on them 'very heavily'.¹⁶¹³ He considered that having a good relationship with the ISHRs was beneficial.¹⁶¹⁴ He said, 'I rely on their experience and their knowledge of the mining industry and the legislation to help me out as well'.¹⁶¹⁵ He rang an ISHR for advice when he was at a loss as to what to do in respect of safety matters at the mine.¹⁶¹⁶ He also involved an ISHR if the mine disputed whether an incident was an HPI or when an employee was disciplined in relation to a safety matter.¹⁶¹⁷
- 13.49 Mr Hoare also said he had a good relationship with the ISHRs and that he would call an ISHR if he had a safety-related question that he could not handle himself, although that did not happen often.¹⁶¹⁸

¹⁶⁰⁷ HRI.001.001.0001, .0004.

¹⁶⁰⁸ TRA.500.006.0001, .0045, line 18–.0046, line 2.

¹⁶⁰⁹ CRE.001.001.0001, .0008.

¹⁶¹⁰ BJO.001.001.0001, .0006.

¹⁶¹¹ TRA.500.005.0001, .0050, lines 32–39.

¹⁶¹² TRA.500.005.0001, .0050, lines 41–47.

¹⁶¹³ HRI.001.001.0001, .0003.

¹⁶¹⁴ TRA.500.006.0001, .0005, lines 37–46.

¹⁶¹⁵ TRA.500.006.0001, .0005, lines 39–41.

¹⁶¹⁶ HRI.001.001.0001, .0003.

¹⁶¹⁷ HRI.001.001.0001, .0004.

¹⁶¹⁸ HJI.001.001.0001, .0003.

- 13.50 Mr Campbell described his relationship with the ISHRs as ‘entirely professional’.¹⁶¹⁹ He said he never had a particular reason to contact an ISHR prior to the serious accident. He said he was not aware of any ISHRs attending Grosvenor mine from the time of his election in 2018 until the serious accident, except for one occasion in October 2018 and another in early 2020.¹⁶²⁰
- 13.51 The evidence of Mr Barber, Mr Harris and Mr Hoare confirmed the Board’s view of the benefits of a complementary working relationship between SSHRs and ISHRs.

Relationship with mine management

- 13.52 The SSHRs spoke favourably of the degree of respect and support afforded to them by senior mine management in the performance of their role. Mr Barber had had less favourable experiences with others at supervisor level.
- 13.53 While Mr Barber considered that he and the SSE had ‘a healthy respect for one another’,¹⁶²¹ he had experienced difficulty with some supervisors over being released from his job as a fitter to perform SSHR duties.¹⁶²² Mr Barber said that sometimes his SSHR tasks were planned in advance, but sometimes urgent matters came up.¹⁶²³ The ‘push back’ from supervisors came from his attendance to unplanned matters.¹⁶²⁴
- 13.54 Mr Harris had not encountered those difficulties. He said that he had generally received a good response from management when he had made recommendations, or identified tasks that needed to be done.¹⁶²⁵ His recommendations were taken seriously and actioned by mine management.¹⁶²⁶ He considered that the mine management respected and valued the SSHR role.¹⁶²⁷
- 13.55 Mr Hoare also had a good relationship with mine management, particularly the mine manager, Mr Schiefelbein.¹⁶²⁸ He had never been turned away from the door of Mr Schiefelbein or Mr Damien Wynn, the SSE at Grasstree, if he needed to deal with them directly.¹⁶²⁹
- 13.56 Mr Hoare said that when he prepared a report from an inspection, the mine took the process seriously and had always actioned the tasks that he requested be done.¹⁶³⁰

¹⁶¹⁹ CRE.001.001.0001, .0007.

¹⁶²⁰ CRE.001.001.0001, .0007; CRE.001.002.0001.

¹⁶²¹ TRA.500.005.0001, .0043, lines 18–22.

¹⁶²² BJO.001.001.0001, .0003–.0004.

¹⁶²³ TRA.500.005.0001, .0043, lines 31–45.

¹⁶²⁴ TRA.500.005.0001, .0043, line 47–.0044, line 6; BJO.001.001.0001, .0003–.0004.

¹⁶²⁵ TRA.500.006.0001, .0021, lines 16–27.

¹⁶²⁶ TRA.500.006.0001, .0022, lines 26–29.

¹⁶²⁷ TRA.500.006.0001, .0022, lines 31–33.

¹⁶²⁸ HJI.001.001.0001, .0003.

¹⁶²⁹ TRA.500.006.0001, .0036, line 43–.0037, line 5.

¹⁶³⁰ TRA.500.006.0001, .0047, line 42–.0048, line 17.

13.57 It was apparent from Mr Campbell's statement that he considered there was a good line of communication between the SSHRs and the SLT representatives at the mine.¹⁶³¹ The monthly safety meetings attended by the SSHRs involved discussion of a wide range of topics and included discussion of the SSHR monthly reports. The meetings were 'very open'.¹⁶³²

Combining the SSHR role with substantive position

13.58 Each of the SSHRs spoke of some of the challenges they encounter in fulfilling their role.

13.59 Mr Barber enjoyed the role and the 'people interaction' that came with it.¹⁶³³ Notwithstanding his own enjoyment of the role, he considered there was a reluctance among workers to nominate for the position because it can be a 'thankless job'.¹⁶³⁴ He gave evidence that that is the case because '[y]ou have to make decisions that sometimes people don't like. You work on both sides of the fence, so to speak'.¹⁶³⁵ Mr Barber said that carrying out the SSHR role sometimes resulted in 'personal attacks' from other workers and immediate supervisors.¹⁶³⁶

13.60 In Mr Barber's view, it was very difficult to carry out the SSHR role on top of his substantive job because of the competing priorities involved.¹⁶³⁷ He considered that the SSHR role should be a full-time one.¹⁶³⁸

13.61 Mr Harris said that it was rare for new people at the mine to nominate for the SSHR role because it was considered to be an arduous role.¹⁶³⁹ He considered the mine was 'very good' at facilitating his SSHR role, although he felt 'a lot of pressure' as a result of having to combine that role with his substantive role.¹⁶⁴⁰ He considered that the SSHR role should be a full-time role at the mine.¹⁶⁴¹

13.62 Mr Hoare considered that the SSHR role took approximately 20% to 30% of his time.¹⁶⁴² He gave evidence that it is sometimes logistically difficult to attend to his SSHR role if the mine was short on ERZ controllers, but he was generally able to attend to incidents when they occurred.¹⁶⁴³

¹⁶³¹ CRE.001.001.0001, .0005.

¹⁶³² CRE.001.001.0001, .0008.

¹⁶³³ TRA.500.005.0001, .0036, lines 36–39.

¹⁶³⁴ TRA.500.005.0001, .0036, line 41–.0037, line 4.

¹⁶³⁵ TRA.500.005.0001, .0037, lines 2–4.

¹⁶³⁶ TRA.500.005.0001, .0037, lines 26–35.

¹⁶³⁷ BJO.001.001.0001, .0003–.0004.

¹⁶³⁸ BJO.001.001.0001, .0015.

¹⁶³⁹ TRA.500.006.0001, .0004, lines 14–21; HRI.001.001.0001, .0002.

¹⁶⁴⁰ HRI.001.001.0001, .0008.

¹⁶⁴¹ HRI.001.001.0001, .0008.

¹⁶⁴² TRA.500.006.0001, .0036, lines 9–11.

¹⁶⁴³ TRA.500.006.0001, .0036, lines 23–31.

13.63 Mr Campbell said that he did not consider there were any difficulties in combining the SSHR role with his substantive job at the mine.¹⁶⁴⁴ However, he did suggest there could be benefit in making the role a full-time position. He said:¹⁶⁴⁵

My own experience has led me to think that to do the SSHR role efficiently and productively, it might well be made into a full-time role. The responsibility to discharge of the obligations [sic] under the Act to expose unsafe work practices and review relevant documentation can involve a review of thousands of documents onsite that are continuously under review and changing, and to be able to get around the site both underground and surface can sometimes be difficult.

Training

13.64 Mr Barber's evidence was that when first nominated for the role, he did not have the necessary competencies. Before being 'signed off by the SSE' as SSHR, he had completed the necessary qualifications.¹⁶⁴⁶ The mine had paid for the training and given him time to complete it.¹⁶⁴⁷

13.65 Mr Barber said that he had not received any further training by the mine for the purpose of fulfilling his SSHR role, but he attended the annual conference run by the Construction, Forestry, Maritime, Mining and Energy Union (CFMMEU).¹⁶⁴⁸ He had received support from the company to attend that training.¹⁶⁴⁹ His view was that it would be desirable if more training were available in areas such as communication skills, report writing, and risk assessment.¹⁶⁵⁰

13.66 When first elected, Mr Harris already held the required qualifications¹⁶⁵¹ and a Deputy's Certificate Of Competency.¹⁶⁵² In his view, the qualifications and experience as a deputy had assisted him to 'see what's going on around the place', and work out if the workers are doing the right thing or not when he performed his inspections.¹⁶⁵³

13.67 Mr Harris said the only further training he had received was attending the yearly workshops facilitated by the CFMMEU. He had always been supported by the mine to attend the workshops.¹⁶⁵⁴

13.68 Mr Hoare had also been supported by the mine to attend the annual CFMMEU conference and mining safety conference.¹⁶⁵⁵

¹⁶⁴⁴ CRE.001.001.0001, .0003.

¹⁶⁴⁵ CRE.001.001.0001, .0004.

¹⁶⁴⁶ TRA.500.005.0001, .0034, line 21–.0035, line 2.

¹⁶⁴⁷ BJO.001.001.0001, .0002.

¹⁶⁴⁸ BJO.001.001.0001, .0002; TRA.500.005.0001, .0040, lines 30–36.

¹⁶⁴⁹ BJO.001.001.0001, .0002.

¹⁶⁵⁰ TRA.500.005.0001, .0041, line 1–.0042, line 3.

¹⁶⁵¹ HRI.001.001.0001, .0002.

¹⁶⁵² TRA.500.006.0001, .0003, lines 10–12.

¹⁶⁵³ TRA.500.006.0001, .0003, lines 32–41.

¹⁶⁵⁴ HRI.001.001.0001, .0002.

¹⁶⁵⁵ HJI.001.001.0001, .0002.

13.69 Mr Campbell held the necessary qualifications for the role when he was elected.¹⁶⁵⁶ He also attended 'external training' which included 'a legislative course requiring familiarity with the Act and Regulations'.¹⁶⁵⁷ He was not a member of the union, and did not attend any union conferences.¹⁶⁵⁸

¹⁶⁵⁶ CRE.001.001.0001, .0003.

¹⁶⁵⁷ CRE.001.001.0001, .0003.

¹⁶⁵⁸ CRE.001.001.0001, .0003.

Findings

Finding 107

Site Safety and Health Representatives (SSHRs) perform an important safety role at mines.

Finding 108

In the main, the SSHR role is, currently, concerned with day-to-day site conditions and practices, rather than higher level safety issues such as catastrophic risk mitigation.

Finding 109

The role is utilised as intended: to identify issues and address safety concerns.

Finding 110

Senior management at coal mines are supportive of the role, which includes facilitating some training and allowing time away from the SSHRs' substantive jobs.

Finding 111

SSHRs consider that it would be preferable for the SSHR role to be a full-time position.

Finding 112

The SSHRs make sparing use of the exercise of powers under the *Coal Mining Safety and Health Act 1999* (Qld) (the Act), although the existence of the powers appears to serve as an incentive for management to achieve outcomes cooperatively.

Finding 113

There are mutual benefits from a complementary working relationship between SSHRs and Industry Safety and Health Representatives (ISHRs).

Finding 114

SSHRs have been notified of high potential incidents as required by section 106(1)(b) of the Act.

Recommendations

Recommendation 37

The Construction, Forestry, Maritime, Mining and Energy Union and management at coal mines encourage coal mine workers to nominate for election as an SSHR.

Recommendation 38

Consistently with Recommendation 35, Resources Safety & Health Queensland takes steps, through the consultative process provided by the Coal Mining Safety and Health Advisory Committee to include information about the importance and nature of the role of SSHRs in the generic induction for coal mine workers, *Recognised standard 11: Training in coal mines*.

Recommendation 39

Coal mines use their work order system to schedule and record the completion of an SSHR inspection to assist with incorporating the inspection activity into the mine's weekly plan, and to demonstrate management support for the SSHR function.

Recommendation 40

Site Senior Executives consider whether it would be advantageous to make the SSHR role at their mine a full-time position.

Glossary of terms

Term	Meaning
Acceptable level of risk	<p>For risk to a person from coal mining operations to be at an acceptable level, the operations must be carried out so that the level of risk from the operations is –</p> <ul style="list-style-type: none"> a) within acceptable limits; and b) as low as reasonably achievable. <p>'Within acceptable limits' and 'low as reasonably achievable' must have regard to –</p> <ul style="list-style-type: none"> a) the likelihood of injury or illness to a person arising out of the risk; and b) the severity of the injury or illness. <p><i>Coal Mining Safety and Health Act 1999</i> (Qld) (the Act), section 29.</p>
Adiabatic oxidation method	<p>Testing method that simulates the conditions in which spontaneous combustion of coal occurs, by including the effect of environmental heat and eliminating the loss of reaction heat to the surrounding environment.</p>
Adsorption	<p>The adhesion of atoms, ions or molecules from a gas, liquid or dissolved solid to a surface. This process creates a film of the adsorbate on the surface of the adsorbent. To be compared with absorption, in which a fluid is dissolved by or permeates a liquid or solid.</p>
Armoured face conveyor (AFC)	<p>An articulated chain conveyor that transports the coal along the longwall face after it has been cut by the coal shearer.</p>
Attendance Notice	<p>A notice, usually in the form of a letter, which is issued by the Chairperson of the Board of Inquiry requiring a person to attend the Inquiry at a stated time and place to give evidence or produce specific documents or things.</p> <p>The Act, section 213(13).</p>
Automatic methane detector / methane sensor	<p>A methane detector that automatically activates a visible alarm and trips the electricity supply when the methane concentration in the atmosphere reaches a particular level.</p>
Banner alert	<p>A term used in Anglo procedures indicating the requirement to communicate feedback on incidents and hazards to the workforce.</p>

Bi-directional cutting (bi-di)	<p>The method of cutting coal where the full height of coal extraction is cut in both directions, forward and reverse.</p> <p>See also Uni-directional cutting below.</p>
Blowers	<p>Mobile gas extraction plants that utilise either a liquid ring pump or a fan to create a vacuum on the goaf well head. All associated pipework, flame arrestors and control systems are incorporated onto a moveable sled or skid. The extracted gas is either free vented or flared.</p>
Bowtie analysis	<p>An analytical method for identifying and reviewing controls intended to prevent or mitigate a specific unwanted event.</p>
Brattice curtain	<p>A temporary ventilation device consisting of a woven anti-static and fire-resistant propylene cloth that is hung from the roof to redirect airflow.</p> <p>Also sometimes referred to as a brattice sail, brattice screen or brattice wing.</p>
Bretby	<p>A cable protection device designed to protect and support the shearer electrical cable and hoses as the shearer moves from end to end.</p>
Butcher's flaps	<p>A temporary ventilation device for redirecting the ventilation flow, consisting of plastic flaps hung from the roof.</p>
Cavities	<p>The holes created in the roof from strata failure.</p>
Caving	<p>The process by which the roof collapses into the goaf on retreat during longwall mining.</p>
Chainage	<p>Used in surveying to refer to a distance measured in metres along an imaginary line, such as the centre line of a road.</p>
CITECT	<p>A system for gathering data and controlling various mining processes. CITECT is the brand name of a SCADA (Supervisory Control and Data Acquisition) software solution.</p>
Control and Monitoring Enclosure (CME)	<p>A flameproof box containing the electronics used to control the longwall.</p>
CO Make	<p>The amount of carbon monoxide emitted from oxidising coal over a defined time period.</p> <p>See Chapter 6, paragraph 6.36.</p>
CO/CO₂ Ratio	<p>Used to estimate the intensity of oxidation of coal.</p> <p>See Chapter 6, paragraph 6.40.</p>

Coal Measures	Coal bearing sequence of rocks.
Coal mine operator	<p>A 'coal mine operator' for a coal mine is—</p> <p>(a) the holder; or</p> <p>(b) if another person has been appointed as the coal mine operator under section 53 and the appointment is notified to the chief inspector under section 49, the other person.</p> <p>The Act, section 21(1).</p>
Contraband	<p>Material that by its hazardous nature presents an unacceptable risk if taken underground.</p> <p>The Act, schedule 3 'Dictionary'.</p> <p>Includes items such as smoking products (tobacco, lighters or matches) and devices that could create an open flame, arc or spark.</p> <p><i>Coal Mining Safety and Health Regulation 2017 (Qld) (the Regulation), section 367.</i></p>
Crib room	A location where coal mine workers eat and a meeting station for the ERZ controllers.
Cut-through (c/t)	A passage cut through the coal which connects two parallel headings.
Direct access communication (DAC)	An underground intercom system.
Deflagration	<p>Combustion reaction in which the flame front is moving through the fuel-air mixture at less than the speed of sound.</p> <p>To be compared with detonation, where the reaction proceeds through the fuel mixture or the fuel-air mixture faster than the speed of sound.</p>
Delamination	The result of strata breaking apart along the pre-existing layers.
Deputy	ERZ controller.
Development	The process of mining roadways (or headings) and reinforcing the roof and sides (walls) of an area in preparation for secondary extraction (extracting the coal).

Directive	<p>A notice issued under the Act by a mines inspector for the purpose of requiring the mine operator to take some form of action. Directives are related to safety and risk management.</p> <p>The Act, part 9, division 5.</p>
Drift	<p>A tunnel made in the rock or ground for access to the mine workings.</p>
Drift runner	<p>Brand name for a flameproof diesel-powered man-riding vehicle carrying up to 12 personnel.</p> <p>Also sometimes colloquially referred to as a 'drifty'.</p>
Drivage	<p>An underground roadway in the process of being developed.</p>
Ejector skids	<p>Mobile gas extraction plants that utilise a compressed air stream to create a vacuum on the goaf well head. All associated pipework, flame arrestors and control systems are incorporated onto a movable sled or skid. The gas is either free vented (released to the atmosphere) or flared (burned).</p> <p>Also known as a Venturi Skid.</p>
Enablon	<p>A brand name for a software system used to manage operational tasks.</p>
Explosion risk zone (ERZ)	<p>Any part of a mine on the return side of a place where a methane level equal to or greater than a level prescribed by regulation is likely to be found.</p> <p>The Act, schedule 3 'Dictionary'.</p>
Firedamp	<p>Another term for methane.</p>
First workings	<p>See Development.</p>
Flameproof	<p>Electrical components contained within a robust protective enclosure that, in the event of the electrical components causing an ignition of flammable gas, contains the ignition within the enclosure.</p>
Floor blowers	<p>Gas emissions released from fractures in the coal seam floor.</p>
Floor heave	<p>The failure and subsequent upward displacement of the seam floor strata due to <i>in situ</i> stress.</p>
Form 1A	<p>A form used within the Queensland coal mining industry to make the first written notification of an incident to the Inspectorate.</p>

<p>Form 5A</p>	<p>A form used in the Queensland coal mining industry to give notice to the Inspectorate of the occurrence of:</p> <ul style="list-style-type: none"> • a high potential incident; or • an incident in which a person suffers an injury— <ul style="list-style-type: none"> - requiring medical treatment; or - that prevents the person carrying out normal duties. <p>The Form 5A must be submitted within one month of the incident.</p> <p>The Regulation, section 16.</p>
<p>Gas chromatography</p>	<p>Analytical technique that separates and analyses compounds by passing them through a column coated with a substance that causes each of the compounds to elute at a different time (known as retention time), enabling their detection and measurement.</p>
<p>Gas drainage plant</p>	<p>Fixed centralised gas extraction unit usually consisting of a number of liquid ring pumps. Individual goaf wells are connected to the gas drainage plant via a gas reticulation pipe network.</p> <p>Also known as Vacuum plant system (VPS).</p>
<p>Gas Make</p>	<p>The amount of gas emitted during mining operations from all sources (including seams above and below the working seam) per tonne of coal mined. In the context of this report, gas make refers to methane.</p>
<p>General body concentration</p>	<p>For gas in an underground mine or part of an underground mine, means the concentration of gas measured at a representative location in the mine or part.</p>
<p>Goaf</p>	<p>That part of a mine from which the coal has been partially or wholly extracted and then abandoned.</p>
<p>Goaf stream</p>	<p>The contaminant rich flow of gasses from the goaf into the return airway.</p>
<p>Goaf venturi</p>	<p>Mobile gas extraction plants that utilise a compressed air stream to create a vacuum on the goaf well head. All associated pipework, flame arrestors and control systems are incorporated onto a movable sled or skid. The gas is either free vented (released to the atmosphere) or flared (burned).</p> <p>Also known as Ejector skids.</p>
<p>Graham's Ratio</p>	<p>Used to estimate the intensity of oxidation of coal.</p> <p>See Chapter 6, paragraph 6.30.</p>

Hazard	<p>A thing or a situation with potential to cause injury or illness to a person.</p> <p>The Act, section 19.</p>
Heading (hdg)	<p>A roadway in a mine.</p>
High potential incident (HPI)	<p>An event, or a series of events, that causes or has the potential to cause a significant adverse effect on the safety or health of a person.</p> <p>The Act, section 17.</p>
Holder	<p>The holder under the <i>Mineral Resources Act 1989</i> of an exploration permit, mineral development licence or mining lease for the coal mine.</p> <p>The Act, schedule 3 'Dictionary'.</p>
Inbye	<p>In a direction away from the surface entry of an underground mine.</p>
Industry (the)	<p>When referring to the Industry, the Board refers to the Queensland coal mining industry, including both underground and open cut mines.</p> <p>Context will disclose that some findings and recommendations in the report will apply only to underground coal mines, but others will apply to coal mines generally.</p>
Industry Safety and Health Representative (ISHR)	<p>A person appointed under section 109(1) to represent coal mine workers on safety and health matters and who performs the functions and exercises the powers of an industry safety and health representative mentioned in part 8, division 2 of the Act.</p> <p>The Act, section 27.</p>
Inertisation	<p>The replacement of the normal atmosphere by an inert (inactive) atmosphere; use of inert gas to prevent the formation of an explosive mixture and to control the risk of spontaneous combustion.</p>
Inspector (of Mines)	<p>A person appointed as an inspector under the Act.</p> <p>The Act, schedule 3 'Dictionary'.</p> <p>The functions of inspectors are set out in section 128 of the Act.</p>
Inspectorate (Coal Mines Inspectorate)	<p>An organisational unit within the Regulator (RSHQ) of the coal mining industry.</p>
Intake air	<p>Fresh air brought to the working face by the ventilation system.</p>

Intake roadway/airway (Intake)	An underground roadway that carries the intake air.
Intrinsically safe	Equipment designed and constructed so that the amount of electrical energy within the equipment is unable to, in any circumstance, generate sufficient heat or sparks to ignite a flammable gas.
Labour hire	The concept of a business outsourcing its recruitment process to a third party who not only undertakes the hiring process, but directly employs the workers who are then deployed to perform work at the 'host' business.
Longwall (LW)	A longwall is a panel (block) of coal. Longwall mining is a form of underground coal mining. The face of the longwall panel is continuously cut mechanically as the panel retreats.
Lost time injury (LTI)	A work-related injury resulting in the employee/contractor being unable to attend work or being unable to perform the routine functions of his/her job, on the next calendar day following the day of the injury, whether a scheduled workday or not.
Maingate (MG)	The intake airway and the conveyor belt road to move coal from the face towards the surface.
Medical treatment injury	A work-related injury resulting in treatment of a type that can only be administered by a medical specialist such as a nurse or doctor. Also known as a Medical Treatment Case (MTC).
Outburst	A violent ejection of seam gas and coal into the workings.
Outbye	In a direction towards the surface entry of an underground mine.
Oxidation	The chemical reaction between a substance and oxygen. In relation to coal, oxidation results in heat generation and accordingly is the driver of spontaneous combustion.
Panel	The working of coal seams in separate panels or districts, e.g., a development panel or a longwall panel.
Personal emergency device (PED)	Ultra-low frequency through-the-earth communication system used for paging. Originally developed to provide a fast and reliable method of informing underground miners of emergency situations.
Personal gas detector (PGD)	A handheld device for measuring the presence of gas (usually methane) in air. Used as part of the mine safety system for gas detection and monitoring.

Personal proximity device (PPD)	A device used for tracking a person's location.
Principal hazard	A hazard at the coal mine with the potential to cause multiple fatalities. The Act, section 20.
[a] Regulator	A ventilation control device used for controlling the volume of air entering a mining district. (To be distinguished from the 'Regulator' of the coal mining industry, RSHQ).
Return air	Air that has ventilated a working face, often contaminated with heat, dust and gases, which travels down the return airway and is then expelled from the mine by the main exhausting fan.
Return roadway/airway (Return)	An underground roadway that carries the return air.
Roadway	An underground passageway developed during the initial mining process and used for transport and ventilation.
Reverse snake	The area where the AFC is pushed forward to allow the shearer to cut into the face to commence the next shear.
Rib	The side wall of a roadway.
Serious accident	An accident at a coal mine that causes – (a) the death of a person; or (b) a person to be admitted to a hospital as an in-patient for treatment for the injury. The Act, section 16.
Secondary support	Rock support installed after the primary support installed during development. Secondary support provides additional rock support over and above the primary support.
Second workings	The process of extracting coal after an underground area has been accessed and developed for this purpose.
Sherwood curtain	A ventilation arrangement consisting of a brattice curtain in the return roadway at the tailgate end of the longwall face. The purpose is to divert some of the ventilation flow towards the goaf stream and divert it away from the tailgate motors.

Self-contained self-rescuer (SCSR)	A respiratory device used by miners for the purpose of escape during mine fires and explosions—it provides the wearer a closed-circuit supply of oxygen for periods of time usually less than one hour.
Shearer	A mining machine for longwall faces that uses rotating cutting drums to ‘shear’ the coal from the face as it progresses along the face.
Shields	Also known as chocks or powered roof supports (PRS). Large hydraulic jacks used to support the roof in longwall mining systems.
Site Safety and Health Representative (SSHR)	A coal mine worker elected under section 93 by coal mine workers at the coal mine to exercise the powers and perform the functions of a site safety and health representative mentioned in part 7, division 2 of the Act. The Act, section 28.
Site Senior Executive (SSE)	The most senior officer employed or otherwise engaged by the coal mine operator, for the coal mine who – (a) is located at or near the coal mine; or (b) has responsibility for the coal mine. The Act, section 25.
Specific gas emission (SGE)	The total quantity of gas emitted by a longwall during mining operations divided by the total tonnes mined, to determine an average emission per tonne.
Spontaneous combustion	The process of self-heating of coal by oxidation. After exposure by mining, coal undergoes a continuous exothermic oxidation reaction when exposed to air. A hazard exists when, in confined areas, the rate of heat accumulation due to oxidation exceeds the rate of cooling by ventilation or environment. The coal can then increase in temperature until combustion takes place leading to the emission of toxic and explosive gases and ultimately with propagation to open fire.
Stock-bound	The situation where there is no storage space left for the coal being produced.
Stopping	A ventilation control device which stops ventilation flow through a roadway or cut-through.
Strata	A naturally occurring layer, or series of layers, of rock.

Stratigraphy	The structure of a particular set of strata.
Tag board	A peg board where underground personnel place a token or tag to indicate their presence in a section of the mine.
Tailgate (TG)	The end of the longwall face adjacent to the return air roadway. The longwall return airway may also be called the tailgate.
Tailgate drives	The electric motors that drive the longwall armoured face conveyor (AFC) at the tailgate end of the face.
Tailgate roadway	The longwall return roadway/airway.
Tendon supports	Long strand cables that are either cemented or glued into the roof. They are used to supplement the standard roof bolt pattern in areas of a mine that require a higher level of ground support.
Thermal runaway	A process where the heat being generated by a chemical reaction exceeds the rate at which the heat is lost resulting in further acceleration of the chemical reaction. Often used in the context of describing spontaneous combustion activity.
Trigger Action Response Plan (TARP)	A hazard management tool that specifies actions that are to be taken in the event that conditions deviate from normal. The deviation is identified by reference to a set of defined trigger points that require particular things to be done in response.
Tube bundle system	A mechanical system for continuously drawing gas samples through tubes from multiple monitoring points located in an underground coal mine. The gas samples are drawn via vacuum pump to the surface and are typically analysed for oxygen, methane, carbon dioxide and carbon monoxide.
Undermanager	Mineworker who is in charge of the mine on a shift basis (i.e., shift supervisor).
Uni-directional cutting (uni-di)	The method of cutting coal where the top portion of the coal extraction height is cut in one direction and the remaining bottom portion is cut when returning in the other direction. See also Bi-directional cutting above.
Vacuum plant system (VPS)	See Gas drainage plant above.
Ventilation control device (VCD)	A structure to control or direct ventilation flow, which includes stoppings, regulators, overcasts, brattices, butcher's flaps, Sherwood curtains, and seals.

Venturi	A device for assisting the flow of a gas or liquid by the use of a secondary stream of air flowing through an arrangement that creates a partial vacuum. These devices can be used to assist the underground ventilation or the flow of goaf gasses in goaf wells.
Wind blast	An event, resulting in sudden, mass air movement, that: <ol style="list-style-type: none">1. has the potential to cause injury to persons; and/or2. has the potential to cause damage to the mine and mining equipment; and/or3. has the potential to seriously disrupt ventilation.

List of acronyms

Acronym	Meaning
AAMC	Anglo American Metallurgical Coal Pty Ltd
AFC	Armoured Face Conveyor
c/t	Cut-through
CEO	Chief Executive Officer
CFD	Computational Fluid Dynamics
CFMMEU	Construction, Forestry, Maritime, Mining and Energy Union
CH₄	Methane
CME	Control and Monitoring Enclosure
CMSHA	<i>Coal Mining Safety and Health Act 1999 (Qld)</i>
CMSHAC	Coal Mining Safety and Health Advisory Committee
CMSHR	<i>Coal Mining Safety and Health Regulation 2017 (Qld)</i>
CO	Carbon monoxide
CO₂	Carbon dioxide
DCB	Distribution control board
DNRME	Department of Natural Resources, Mines and Energy (previously the Department of Natural Resources and Mines or DNRM)
DNRM/DNRME HPI	An HPI, as defined by the legislation, which was reported to the Regulator. DNRME (previously DNRM) was the Regulator for the coal mining industry until 1 July 2020. On 1 July 2020, Resources Safety & Health Queensland (RSHQ) became the Regulator for the industry.
ERZ	Explosion Risk Zone
ERZ controller	Explosion Risk Zone controller
FH seam	Fairhill Seam
GC	Gas Chromatograph
GCAA	Glencore Coal Assets Australia Pty Limited
GML seam	Goonyella Middle Lower Seam
GM seam	Goonyella Middle Seam
GRS	Gas reservoir size
HPI	High Potential Incident
HIRF	Hazard and Incident Report Form
ICAM	Incident Cause Analysis Method

Acronym	Meaning
IGCAT	Ignition Categorisation system (for rocks)
IMT	Incident Management Team
IOM	Inspector of Mines
ISCP	Intrinsic Spontaneous Combustion Propensity
ISHR	Industry Safety and Health Representative
LFI report	Learning From Incidents report (Anglo)
LHLA	<i>Labour Hire Licensing Act 2017</i> (Qld)
LRP	Liquid ring pump
LTA	Less than acceptable
LW	Longwall
MG	Maingate
MRE	Mine Record Entry
MSHAC	Mining Safety and Health Advisory Committee
MSO	Mine Senior Officer
O ₂	Oxygen
PDCE	Post-Drainage Capture Efficiency
PHMP	Principal Hazard Management Plan
PRS	Powered Roof Support
PUR	Polyurethane Resin
RIOM	Regional Inspector of Mines
RSHQ	Resources Safety & Health Queensland
SGE	Specific Gas Emission
SHE	Safety Health and Environment (Anglo)
SIS	Surface to in-seam
SHMS	Safety and Health Management System
SIMTARS	Safety in Mines Testing and Research Station
SLT	Senior Leadership Team
SOP	Standard Operating Procedure
SSE	Site Senior Executive
SSHR	Site Safety and Health Representative
TARP	Trigger Action Response Plan
TG	Tailgate

Acronym	Meaning
UIS	Underground in-seam
UMM	Underground Mine Manager
VCD	Ventilation Control Device
VO	Ventilation Officer
VPS	Vacuum Plant System
WHS	Workplace Health and Safety
WRAC	Workplace Risk Assessment and Control (Anglo)

Appendix 1 – Terms of Reference

On 22 May 2020, the Minister for Natural Resources, Mines and Energy established the Board of Inquiry under section 202(1) of the *Coal Mining Safety and Health Act 1999* (Qld) by gazette notice.¹⁶⁵⁹

The gazette notice specified the membership of the Board and its Terms of Reference.

The Board of Inquiry was initially comprised of retired District Court Judge Terry Martin SC as the Chairperson of the Board, and Professor Andrew Hopkins AO as a Member.

Mr Andrew Clough, former Chief Inspector of Coal Mines and retired mining engineer replaced Professor Hopkins as a Member of the Board on 23 June 2020.

An extraordinary gazette regarding the change in the Board's membership was subsequently published on 23 June 2020.¹⁶⁶⁰

A further extraordinary gazette extending the Board's reporting date from 30 November 2020 to 31 May 2021, was published on 17 September 2020.¹⁶⁶¹

The Board's Terms of Reference are relevantly extracted below.

Terms of Reference of Board of Inquiry

2.1 In accordance with part 12 of the Act, the board is to:

- i. inquire into the incidents described in subparagraphs a. to e.:
 - a. the serious accident that occurred at Grosvenor mine (operated by Anglo Coal (Grosvenor Management) Pty Ltd) on 6 May 2020, which resulted in serious injuries to five coal mine workers;
 - b. the 27 high potential incidents that occurred at Grosvenor mine (operated by Anglo Coal (Grosvenor Management) Pty Ltd) involving exceedances of methane (>2.5%) in and around the longwall on various dates between 1 July 2019 and 5 May 2020;
 - c. the 11 high potential incidents that occurred at Grasstree mine (operated by Anglo Coal (Capcoal Management) Pty Ltd) involving exceedances of methane (>2.5%) in and around the longwall on various dates between 1 July 2019 and 5 May 2020;
 - d. the single high potential incident that occurred at Moranbah North mine (operated by Anglo Coal (Moranbah North Management) Pty Ltd)

¹⁶⁵⁹ *Establishment of a Board of Inquiry Notice (No 01) 2020* in Queensland, *Government Gazette: Extraordinary*, No. 25, 22 May 2020, Volume 384, pages 173–174.

¹⁶⁶⁰ *Amendment of Establishment of a Board of Inquiry Notice (No 01) 2020* in Queensland, *Government Gazette: Extraordinary*, No. 52, 23 June 2020, Volume 384, page 411.

¹⁶⁶¹ *Amendment of Establishment of a Board of Inquiry (No 02) 2020* in Queensland, *Government Gazette: Extraordinary*, No. 11, 17 September 2020, Volume 385, page 45.

involving an exceedance (>2.5%) of methane in and around the longwall between 1 July 2019 and 5 May 2020;

- e. the single high potential incident that occurred at Oaky North mine (operated by Oaky Creek Holdings Pty Limited) involving an exceedance of methane (>2.5%) in and around the longwall between 1 July 2019 and 5 May 2020.

(the incidents)

- ii. determine the nature and cause of the serious accident and, in doing so, make findings of fact about any factors that, in the board's view, contributed materially to the cause of the serious accident;
 - iii. assess and determine whether the operational practices and management systems in existence at each of the mines or at corporate levels above them at the time the incidents occurred were adequate and effective to achieve compliance with the relevant safety laws and standards;
 - iv. make recommendations for mine operators, relevant obligation-holders and other relevant parties for improving safety and health practices and procedures for mitigating against the risk of similar incidents occurring in the future, including, where relevant, recommendations directed to the nature of any particular employment arrangements which may be better apt to ensure acceptable risk levels to workers;
 - v. make any other recommendations that the board considers appropriate having regard to its findings;
 - vi. provide the Minister with an interim report, by 31 August 2020;
 - vii. provide the Minister with a report, suitable for publication, about its findings and recommendations, by 30 November 2020.
- 2.2 Subject to section 215 of the Act, the board is to conduct its inquiry and deal with any evidence it may receive in such a way as to minimise the likelihood of prejudicing any contemporaneous investigations or any current or future proceedings, including investigations and proceedings for offences under the Act.
- 2.3 The board is to conduct its inquiry and deal with any evidence it may receive in such a way as to minimise, so far as possible, a person's exposure to reprisal of the kind mentioned in section 275AA of the Act, where the person is giving evidence to the board and has identified that they fear reprisal as a result of giving evidence to the board, including conducting private hearings where considered appropriate and as permitted by s 208 of the Act.
- 2.4 The board may, if it considers it appropriate, provide the Minister with a separate report to that mentioned in 2.1(vi) or 2.1(vii), about any matters it considers are not suitable for publication, because publication might reasonably prejudice other investigations or

proceedings, or if for other reasons the board considers the contents of the separate report should not be made public pursuant to section 203 of the Act.

- 2.5 However, if the board provides the Minister with a separate report under 2.4, any report provided under 2.1(vi) or 2.1(vii) must contain a statement that the board has provided the Minister with a separate report and the reasons for providing a separate report.
- 2.6 The board may hold hearings at times and in places, and in a manner, it considers appropriate, including holding hearings by way of audio or visual link.
- 2.7 The board may inspect or conduct a viewing of a place as reasonably necessary to inform its proceedings.
- 2.8 The board may, where it considers it appropriate, collaborate and share information with any investigative authorities in order to assist any investigations into the incidents.
- 2.9 Nothing in these terms of reference shall be taken to limit the board's powers and functions under part 12 of the Act.

Appendix 2 – Board of Inquiry team and subject matter experts

Board of Inquiry team

Board Members	
Terry Martin SC	Chairperson and Board Member
Andrew Clough	Board Member (from 23 June 2020)
Professor Andrew Hopkins AO	Board Member (until 18 June 2020)

Operations Team	
Amanda Ford	Executive Director (from 26 November 2020)
Suzanne Stone	Executive Director (until 11 October 2020)
Rachel Scalongne	Director (A/Executive Director from 12 October 2020 to 30 November 2020)
Letitia Farrell	Executive Manager
Megan Lutz	Communication and Engagement Officer (from 20 October 2020)
Kirsten Crook	Communication and Engagement Officer (until 18 October 2020)
Monique Newman	Project Officer
Tina Kloiber	Records Officer (until 31 July 2020)

Legal Team	
Jeffrey Hunter QC	Senior Counsel Assisting
Glen Rice QC	Senior Counsel Assisting
Ruth O’Gorman	Counsel Assisting
Renaë Kirk	Special Counsel
Isabelle MacNicol	Lawyer (from 20 January 2021)
Genevieve Feely	Lawyer (from 19 January 2021)
Laura Dawson	Lawyer (until 22 January 2021)

Subject Matter Experts

A number of subject matter experts were engaged to provide advice and assistance to the Board during the course of the Inquiry, including:

Subject Matter Experts	Expertise
Mr Andrew Clough (until 22 June 2020)	Mining and geotechnical engineering
Professor Michael Quinlan	Industrial relations, and occupational health and safety
Mr Mark Parcell	Legislative compliance and mine safety
Mr John Weissman	Underground gas management
Professor Jim Joy	Risk management
Dr Rao Balusu	Mining engineering research, with a focus on spontaneous combustion, gas drainage and inertisation
Dr Ting Ren	Mining engineering research, with a focus on spontaneous combustion, gas drainage and inertisation
Mr James Munday	Explosion and fire investigation
Dr Rick Brake	Mine ventilation

Appendix 3 – Experts’ qualifications and experience

This appendix summarises the qualifications and experience of each professional expert who is mentioned in this report. These experts gave evidence during the Inquiry’s public hearings, except for Dr Rao Balusu who provided a written response to questions that were submitted to him by the Board.

Mr Murray Nystrom

Mr Murray Nystrom is the director of Australian Forensic Pty Ltd, a position he has held for thirty years. He has worked as a forensic fire investigator for over forty years, including when previously employed by the Queensland Police Service.

Over the course of his career, he has examined more than 6,000 fire scenes to determine the origin and cause of fires. He is a member of several professional associations, both in Australia and internationally, including as a Fellow of the Australian Institute of Professional Investigators, a member of the Queensland Association of Fire Investigators and a member of the International Association of Arson Investigators. He holds a Bachelor of Applied Science (Chemistry) from the Queensland Institute of Technology and a Graduate Certificate in Fire Investigations from Charles Sturt University.¹⁶⁶²

Mr Nystrom carried out an explosion scene examination at Grosvenor mine (Grosvenor) and prepared a report to assist with the investigation into the origin and cause of the serious accident.¹⁶⁶³

Mr Marty Denham

Mr Marty Denham is a principal fire investigator and electrical safety consultant, and the managing director at QEC Global. He is also a director at SAA Approvals Pty Ltd, an accredited certifier of electrical equipment. Mr Denham has over 36 years’ experience in the electrical safety industry and has investigated a wide range of electrical accidents, shocks, faults and fires. He holds diplomas in electrical engineering and fire scene examination and was a certified electrical inspector with the former Department of Mines and Energy.

Mr Denham oversaw the examination and testing, by SIMTARS, of the electrical equipment collected from the fire scene at Grosvenor, to assist investigations into the cause of the fire.¹⁶⁶⁴

Dr Rob Thomas

Dr Rob Thomas is a principal geotechnical engineer and director at Strata2 Pty Ltd. Dr Thomas has over 30 years’ experience in the underground coal mining industry with particular experience in the fields of roadway support systems, mine design and longwall geomechanics.

¹⁶⁶² RSH.019.001.0227.

¹⁶⁶³ NMU.001.001.0001, .0002.

¹⁶⁶⁴ DEN.001.001.0001, .0003.

Dr Thomas holds a Bachelor of Science (Geology) from Liverpool University, and a PhD in Rock Mechanics from Nottingham University.¹⁶⁶⁵

Dr Thomas provided a report about the geotechnical environment and the prevailing ground conditions in the lead up to the serious accident at Grosvenor, and the potential impact of the strata conditions on the mechanism of the serious accident.¹⁶⁶⁶

Mr Martin Watkinson

Mr Martin Watkinson is a mining engineer employed by the Safety in Mines Testing and Research Station (SIMTARS). In that role, Mr Watkinson provides technical advice on ventilation, spontaneous combustion and emergency response to the Queensland mining industry and the Mines Inspectorate, including assisting with investigations into serious accidents and incidents.¹⁶⁶⁷

In addition to his role with SIMTARS, Mr Watkinson has considerable experience working in underground coal mines, primarily as a mining engineer but also in management roles.

Mr Watkinson analysed the real-time and tube bundle data from LW 104 for signs of spontaneous combustion activity, and prepared a report of his findings.¹⁶⁶⁸

Mr Sean Muller

Mr Sean Muller is a Senior Analytical Chemist at SIMTARS. In that role, he conducts quantitative analysis of a range of gases. Mr Muller has over 10 years' experience in the underground coal mining industry as an analytical chemist specialising in the analysis of underground atmospheres and spontaneous combustion indicators.¹⁶⁶⁹

Mr Muller reviewed the gas chromatographic data from the LW 104 panel and surface gas wells for evidence of spontaneous combustion indicators, and prepared a report of his findings.¹⁶⁷⁰

Dr Ray Williams

Dr Ray Williams is a geologist and geotechnical engineer with over 48 years' experience in the coal mining industry. Dr Williams primarily worked in coal seam gas-related work, including gas drainage, and modelling of gas emission and production. Dr Williams founded GeoGAS in 1990, a gas consultancy and laboratory services company. He holds a Bachelor in Geology and a PhD in Geology from the University of Newcastle.

¹⁶⁶⁵ RSH.019.001.0185.

¹⁶⁶⁶ TRO.001.001.0001, .0003.

¹⁶⁶⁷ RSH.019.001.0574.

¹⁶⁶⁸ WMA.001.001.0001, .0008.

¹⁶⁶⁹ RSH.019.001.0615.

¹⁶⁷⁰ MSE.001.001.0001, .0010.

Dr Williams provided a report that included an independent review and assessment of gas reservoirs, gas drainage and gas emissions on LW 103 and LW 104.¹⁶⁷¹

Mr Andrew Self

Mr Andrew Self is a mining consultant with over 43 years in the mining industry. He is the director of Australian Coal Mining Consultants Pty Ltd and holds a Bachelor of Science from the University of Nottingham, with a focus on rock mechanics, mine design, surveying, ventilation, mechanical engineering, electrical and electronic engineering, geology and geophysics.

Mr Self provided a report examining how methane gas, ventilation, and spontaneous combustion management systems operated at Grosvenor mine.

Dr B. Basil Beamish

Dr B. Basil Beamish is a mining engineer and the managing director of B3 Mining Services Pty Ltd, a consultancy company that provides testing to the mining industry for quantifying the spontaneous combustion propensity of coal and other materials. Dr Beamish holds a Bachelor of Science, a Masters of Science in Mining Engineering from the University of New South Wales and a PhD in Mining Engineering from the University of Auckland.¹⁶⁷²

Dr Beamish provided a report on the potential for spontaneous combustion and polymeric chemical-induced combustion for Goonyella Middle seam coal.¹⁶⁷³

Dr Ting Ren

Dr Ting Ren is an Associate Professor of Mining Engineering at the School of Civil, Mining and Environmental Engineering at the University of Wollongong. He previously worked at the CSIRO as a research scientist, senior research engineer and a ventilation engineer. Prior to this, he was a mining engineer and senior research fellow in the United Kingdom. He is the co-editor of the International Journal of Mining Science and Technology. He holds a Masters Degree and a PhD in Mining Engineering.¹⁶⁷⁴ His work spans many areas of underground coal mining, including inertisation.

Dr Ren provided the Board with responses to questions on continuous inertisation of active goafs.

¹⁶⁷¹ WRA.001.001.0001, .0005.

¹⁶⁷² TRA.500.022.0001, .0002, lines 27–30.

¹⁶⁷³ BBA.001.001.0001, .0007.

¹⁶⁷⁴ TRA.500.023.0001, .0002–.0003.

Dr Rao Balusu

Dr Rao Balusu is a mining engineer with more than 34 years' experience in different aspects of mining engineering and coal mine management. He has a PhD in Mining Engineering from the University of Wollongong. He has worked on, or led, research projects on such topics as mine gas control, longwall geomechanics, spontaneous combustion, goaf gas flow mechanics, and inertisation. Currently, he is employed by CSIRO as a Mining Research Team Leader.

Dr Balusu provided a written response to questions from the Board relating to management of gas and oxygen in goafs.¹⁶⁷⁵

Mr Bipin Parmar

Mr Bipin Parmar is a Principal Engineer at SIMTARS within the Training, Testing and Certification Centre. He has previously worked as a consultant engineer and testing engineer. He is a recognised Technical Assessor by the National Associations of Testing Authorities and as Assessor of the International Electrotechnical Commission Systems for Certification to Standards Relating to Equipment for Use in Explosive Atmospheres. Mr Parmar holds a high national diploma in Electrical & Electronics Engineering from North East London Polytechnic and a Bachelor of Engineering & Computing from the Queensland University of Technology.¹⁶⁷⁶

Mr Parmar prepared a report detailing the inspection, assessment and testing of electrical equipment taken from Grosvenor mine after the serious accident. He also prepared a report detailing his testing of polyurethane material supplied by DSI Underground.

Mr James Munday

Mr James Munday is a senior investigator with Fire Forensics Pty Ltd. He is a consultant forensic scientist specialising in the investigation of fires and explosions. He has worked in the profession for over 40 years, including previously as a senior court reporting officer for the United Kingdom (UK) Home Office Forensic Science Service and as a forensic scientist for the Metropolitan Police Forensic Science Laboratory in the UK.

Mr Munday is a member of a number of relevant professional associations, both in Australia and internationally, including the Australia & New Zealand Forensic Science Society, the Institution of Fire Engineers and the International Association of Arson Investigators and is a Fellow of the Chartered Society of Forensic Sciences. He holds an Associate Degree equivalent in Chemistry from the University of Dundee and post-graduate qualifications in fire investigation.¹⁶⁷⁷

Mr Munday provided a report within his expertise in relation to the Board's inquiry into the nature and cause of the serious accident.

¹⁶⁷⁵ BAL.001.001.0001.

¹⁶⁷⁶ PBI.999.001.0001, .0035--.0037.

¹⁶⁷⁷ JMU.001.001.0001, .0016--.0021.

Professor Michael Quinlan

Professor Michael Quinlan is an Emeritus Professor at the University of New South Wales. From 1994 to 2018, he was a Professor of Industrial Relations at the University of New South Wales and, before that, a full-time academic at Griffith University in Brisbane.

During his career, Professor Quinlan's major field of research and teaching was occupational health and safety (OHS) especially in the areas of changing work organisation, risk management and regulation.

Professor Quinlan undertook a literature and information review on a number of matters pertaining to mine safety and employment arrangements, including OHS risks associated with the use of labour hire arrangements.¹⁶⁷⁸ Professor Quinlan prepared a written statement and gave evidence at the Inquiry's first tranche of public hearings.¹⁶⁷⁹

¹⁶⁷⁸ BOI.001.004.0001; BOI.001.005.0001.

¹⁶⁷⁹ QMI.001.001.0002.

Appendix 4 – Leave to Appear

The parties identified in the table below were given leave to appear at the public hearings by virtue of having received a notice from the Chairperson pursuant to either section 207 or section 213 of the *Coal Mining Safety and Health Act 1999* (Qld) over the course of the Inquiry.

Organisation	Counsel	Solicitors
Resources Safety & Health Queensland	Deborah Holliday QC Liam Dollar Rachael Taylor	RSHQ Corporate
Anglo American <ul style="list-style-type: none"> • Anglo American Metallurgical Coal Pty Ltd • Anglo Coal (Capcoal Management) Pty Ltd • Anglo Coal (Moranbah North Management) Pty Ltd • Anglo Coal (Grosvenor Management) Pty Ltd 	Saul Holt SC April Freeman Angus Scott Benjamin Dighton	Ashurst Australia
Oaky Creek Holdings Pty Ltd	Damian Clothier QC John Bremhorst	Allens
One Key Resources Pty Ltd	Peter Roney QC	DLA Piper Australia
Construction, Forestry, Maritime, Mining and Energy Union (CFMMEU)	Steven Crawshaw SC	CFMMEU Legal
Injured Coal Mine Worker – Wayne Sellars	Charles Wilson	GC Law
Injured Coal Mine Workers – Redacted Redacted	Claire Grant	Rees R & Sydney Jones
Injured Coal Mine Worker – Redacted	Jeremy Trost	Kartelo Law
Injured Coal Mine Worker – Redacted		Hall Payne Lawyers

QUEENSLAND COAL MINING
BOARD OF INQUIRY

Various other coal mine workers	Andrew O'Brien	McGinness & Associates Lawyers
Industry and Site Safety and Health Representatives	Steven Crawshaw SC	Hall Payne Lawyers
Dywidag-Systems International Pty Limited t/a DSI Underground	Paul Telford	Cantle Carmichael Legal
Komatsu Mining Corporation Group		Clyde & Co
Queensland Resources Council		Mills Oakley Lawyers In-House Representative

Appendix 5 – Conduct of the Inquiry

Procedure

Pursuant to section 206 of the *Coal Mining Safety and Health Act 1999* (Qld) (the Act), the Board established procedures for the efficient and effective operation of the Inquiry.

The following Practice Guidelines were published on the Board's website outlining the procedures to be followed for the Inquiry:

- Practice Guideline No. 1, issued on 15 June 2020 and amended on 30 June and 9 November 2020, covered leave to appear, communicating with the Board, public hearings, witness statements, and confidentiality requests (**Appendix 6**).
- Practice Guideline No. 2, issued on 17 July 2020 and further amended on 3 February 2021, covered public hearings, witnesses, witness statements and evidentiary material, and procedural matters (**Appendix 6**).

A Document Management Protocol was also published with Practice Guideline No. 1, outlining the Board's intention to receive all materials electronically. The Protocol explained how material was required to be collected, digitised and provided to the Board (**Appendix 6**).

Evidence Collection and Management

In the course of the Inquiry, the Board has sought to inform itself on all aspects of the Terms of Reference in various ways, including by:

- relying on its powers under the Act to seek information and documents from organisations and individuals (**Appendix 7**);
- conducting interviews and conferences with various persons of interest, including the Chief Inspector of Coal Mines, other inspectors from the Inspectorate, professional experts, and some of the injured coal mine workers (**Appendix 8**);
- engaging experts to provide assistance and advice directly to the Board (identified in Chapter 1 of this report);
- calling for information from the general public;
- visiting the surface facilities and installations at Grosvenor, and the longwall and development area at Moranbah North mine. Other Inquiry team members visited the longwall at Oaky North mine;
- conducting two tranches of public hearings in August 2020 and March/April 2021.

Since the commencement of the Inquiry on 22 May 2020, the Board has received and considered approximately 11,500 documents, with over 2,000 documents tendered as exhibits during the public hearings.

Hearings

The Board conducted two tranches of public hearings in Brisbane spanning 25 sitting days over a period of eight weeks.

The first tranche of hearings were held over three weeks, from 4 August to 21 August 2021, during which time the Board heard evidence from 28 witnesses. The second tranche of hearings were held over five weeks, from 9 March to 9 April 2021, with the Board hearing from 12 witnesses.

The persons who gave oral evidence at the Inquiry's first tranche of hearings were listed in Appendix 8 of Part 1 of the Report. A list of the witnesses who gave evidence at the second tranche of hearings are identified in **Appendix 9** of this part of the report.

The hearings were conducted in the Brisbane Magistrates Court and were available to be viewed via livestream, with access available through the Board's website.

The first tranche of hearings focussed on the high potential incidents (HPIs) at Moranbah North, Grasstree and Oaky mines, the role of the Inspectorate, Industry and Site Safety and Health Representatives and the union, and how the management structure and employment arrangements of mining companies may impact on mine safety.

The second tranche of public hearings focussed on the 27 HPIs and the serious accident at Grosvenor, the response of the Inspectorate to the mine's HPIs, and expert evidence in relation to making coal mines safer by introducing the practice of active goaf inertisation.

During week four of the second tranche, the Queensland Government imposed a three-day lockdown for the Greater Brisbane area due to a COVID-19 outbreak. Hearings were adjourned and witnesses rescheduled to the final week of hearings, which took place on 7 and 9 April 2021.

The public hearings of the Inquiry concluded on 9 April 2021.

Natural Justice

As required by section 206(1)(a) of the Act, the Board observed natural justice in conducting the Inquiry. Parties with leave to appear (**Appendix 4**) were given the opportunity to make submissions to the Board at the conclusion of the first and second tranche of public hearings in relation to the evidence that was presented at the hearings.

In the preparation of Part I of the Report, the Board provided the parties with an opportunity to respond to relevant extracts of the report before the Board formed any final opinions or made any final decisions or recommendations.

The same process has been followed in relation to this part of the report, with the Board circulating relevant draft extracts, including the Board's provisional views, findings and recommendations, and inviting the parties to respond by providing written submissions. All submissions received were considered by the Board in finalising Part II of the report.

Engagement and Communication with Stakeholders and the Public

This was a public inquiry in accordance with section 208 of the Act.

Shortly after the establishment of the Board of Inquiry in May 2020, a website was launched to disseminate information to interested stakeholders. The website was updated regularly to ensure reliable and current information was readily available.

The website has received more than 207,400 hits from over 22,000 unique viewers since it was launched.

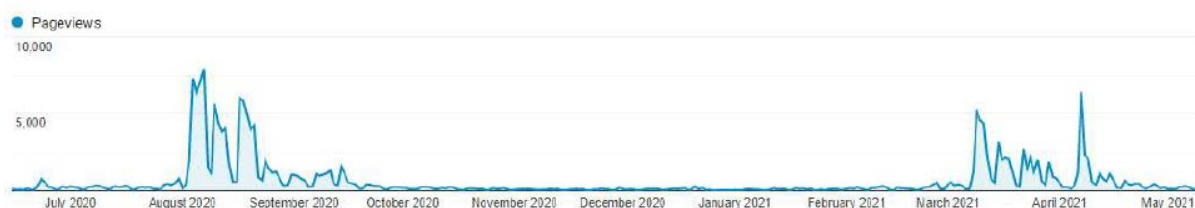


Figure 181: Number of website page views from July 2020 to May 2021

The Board provided a 'Register Your Interest' option on the website to allow stakeholders to register to receive ongoing information and indicate interest in the public hearings. More than 430 stakeholders registered over the course of the Inquiry. Email updates were regularly distributed, providing consistent, timely and relevant information to stakeholders.

Recordings of the public hearings, transcripts and exhibits have also been published on the Board's website.

Media Engagement

Targeted engagement was established with national, local and regional media. Media Guidelines to assist journalists were published on the Board's [website](#). Since the start of the Inquiry, more than 400 continuous media engagement touchpoints have occurred, including the proactive provision of media releases/statements and articles, and responses to requests and general enquiries.

Advertising

As outlined in Part I of the Report, opportunities to provide information to the Board, relevant to the Terms of Reference, were advertised in The Australian and The Courier Mail newspapers. Radio advertising occurred for two weeks through Triple M Mackay and Airlie Beach, and 4RFM Moranbah.

Following the first tranche of hearings, additional radio advertisements specifically called for public information about safety culture, gas management and ventilation practices in underground coal mines. Placements of advertisements were aligned with mining shift patterns in local and mining source communities and surrounding communities.

Livestreaming

A livestream of the public hearings was available from the Board's website enabling access from any internet-enabled device. More than 12,400 unique viewers from 17 countries watched the live stream during the first tranche of hearings, while over 10,000 unique viewers from 12 countries viewed the second tranche of hearings.



Figure 182: Location of viewers of the public hearings for Tranche 2

Public Submissions

The Board actively called for information from the general public and interested persons during the Inquiry.

The majority of submissions provided information relevant to the Board's Terms of Reference and the issues under consideration by the Board.

Part I of the Report identified the public submissions received up until 30 November 2020. Public submissions received by the Board from 1 December 2020 are listed in **Appendix 8** of this part of the report.

Records Management

By section 210 of the Act, the Board must keep a record of its proceedings.

The records of the Inquiry comprise both physical and electronic records. All records have been managed in accordance with the following legislation and policies:

- *Public Records Act 2002* (Qld);
- Commissions of Inquiry Retention and Disposal Schedule;
- General Retention and Disposal Schedule (GRDS); and
- Records Governance Policy.

Publication and Confidentiality

Over the course of the Inquiry, various parties made claims of confidentiality or applications that certain material not be published on the Board's website. A number of these claims and applications were accepted. In most cases, the remainder of the document nonetheless contained relevant material that ought to be disclosed in the public interest. As a result, some of the documents on the Board's website have been redacted, though only to the extent necessary to remove information that the Board has accepted should not be published. Where redactions were not practical, publishable excerpts of documents have been compiled in a separate document, and that document is provided on the website.

All documents have had personal information redacted in order to appropriately protect the privacy of individuals.

Custodianship

Upon cessation of the Inquiry, the Inquiry's records will be transferred to Resources Safety & Health Queensland as the custodian of the Inquiry's records in accordance with the *Public Records Act 2002* (Qld).

Applications to access the Inquiry's records should be made in writing to Resources Safety & Health Queensland, addressed to Right to Information Services, GPO Box 2454, Brisbane, QLD 4001.

Appendix 6 – Practice Guidelines and Protocols

Practice Guideline No.1

Providing information, seeking leave to appear, conduct of public hearings, communicating with the Board, witness statements and confidentiality requests.

Part A. Providing information to assist the inquiry

1. The Board of Inquiry (“the Board”) invites any person with information relevant to the inquiry’s Terms of Reference (available [here](#)) to submit that material to the Board by 26 June 2020.
2. The material is to be provided, in writing, by email or post.
3. If the material is to be emailed, it can be sent to the Executive Director at info@coalminesinquiry.qld.gov.au.
4. If the material is to be posted, it can be sent to:
Executive Director
Queensland Coal Mining Board of Inquiry
GPO 1321
Brisbane QLD 4001

Part B. Leave to appear at public hearings

5. The Board will hold public hearings as part of the inquiry. This part deals with applications for leave to appear at public hearings.
6. By applying for leave to appear at public hearings, a person is asking permission to present evidence or ask questions of a witness, or present arguments/submissions about the evidence. If a person is granted leave to appear at public hearings, that person must comply with all terms of Practice Guideline No.1, including any amended terms.
7. “Leave to appear” is not to be confused with attending public hearings of the Inquiry as an observer. Subject to social distancing obligations, any person is permitted to attend and observe the public hearings.

People who do not need to seek leave to appear at public hearings

8. A person given notice by the Chairperson of the Board (“the Chairperson”) pursuant to section 207 of the *Coal Mining Safety and Health Act 1999* (“the Act”) does not need to seek leave to appear.
9. A person given an attendance notice by the Chairperson pursuant to section 213 of the Act does not need to seek leave to appear whilst giving evidence in compliance with the attendance notice.

10. A person giving evidence at the public hearings in compliance with an attendance notice may be represented by a lawyer or agent.

People who do need to seek leave to appear at public hearings

11. A person who has not received a notice pursuant to section 207 of the Act or an attendance notice pursuant to section 213 of the Act but who wants to appear at public hearings will require the leave of the Chairperson to do so.
12. A person who is given leave to appear at the public hearings may be represented by a lawyer or agent.

How to apply for leave to appear at public hearings

13. A person seeking leave to appear at public hearings should send a brief written application by email to the Executive Director at board@coalminesinquiry.qld.gov.au as soon as possible, but no later than 4.00PM 3 July 2020.
14. The application for leave to appear should identify:
 - (a) the name of the person wanting leave to appear and an email address and contact telephone number for that person;
 - (b) the parts of the Terms of Reference in which the person is interested or in respect of which their interests may be materially affected by the inquiry and the grounds on which those interests exist or may be materially affected;
 - (c) the parts of the Terms of Reference in which the person has particular knowledge or expertise enabling that person to assist the inquiry, together with the sources of that knowledge and the extent of that expertise;
 - (d) the subject matter of any submissions the person proposes to make.
15. Leave to appear may be determined on the basis of the material contained in the application. In such cases, the person seeking leave to appear will receive written notification that their application has been granted or refused.
16. In some cases, the Chairperson may require further information about why the application for leave to appear should be granted. In such cases, the person seeking leave to appear will receive written notification that further written information is required or that the application will be heard and considered at the commencement of the public hearings, or at some other specified time.
17. Nothing in this Guideline prevents a person from seeking leave to appear at any time after the public hearings have commenced. If a person wants to seek leave to appear after the public hearings have commenced, the person should contact the Executive Director on 0475 985 817 to arrange for their application to be received and considered.

Leave to appear may be subject to conditions

18. Leave to appear may, in the Chairperson's discretion, be limited by conditions including conditions that:
 - (a) the evidence sought to be adduced or tendered by the person must be in the form of a witness statement provided to Counsel Assisting the inquiry in advance of the public hearings; and
 - (b) examination of any witness or witnesses, or the making of submissions, be restricted to a particular topic or topics.
19. Any leave to appear may be varied or withdrawn or made subject to additional conditions at any time in the discretion of the Chairperson.

Part C. Conduct of Public Hearings

20. The Board may direct that certain hearings, or parts of a particular hearing, be held in private. In all other cases, the hearings will be open to the public and live-streamed via the Board's website.

Initial public hearing

21. The Board will convene an initial public hearing in due course:
 - (a) the Chairperson and Counsel Assisting will make general introductory remarks concerning the nature and scope of the inquiry;
 - (b) applications for leave to appear at public hearings which have not already been determined will be heard and considered; and
 - (c) information about the conduct of the inquiry, including likely public hearing dates, will be provided.

Public hearings generally

22. The procedure to be followed at the public hearings will be subject to the direction of the Chairperson.
23. Generally, and subject to the Chairperson's discretion:
 - (a) all witnesses giving evidence at the public hearings will be called and examined by counsel assisting the inquiry. A witness' examination-in-chief will usually involve the tendering of a statement provided by the witness to counsel assisting in advance of the hearing. In some cases, the witness' examination-in-chief may be taken orally;
 - (b) the order of further examination of each witness will usually be:
 - i. examination by the parties given leave to appear;
 - ii. examination by the lawyer or agent (if any) representing the witness; and

iii. re-examination by Counsel Assisting.

24. The Chairperson may limit the issues about which a witness may be examined and limit the time available for examination by any person.
25. At the completion of the examination of a witness, the witness shall, unless excused from further attendance, be taken to have been stood down only and to be subject to recall at the direction of the Chairperson.

Part D. Communicating with the Board

26. The Board will provide general notice of procedural matters via the Board's website.
27. Any person communicating with the Board should do so initially by email to the Executive Director at board@coalminesinquiry.qld.gov.au.
28. Unless otherwise specified by the Board, submission of any electronic documents (including witness statements and their exhibits, submissions, and all other information) to the Board is to be in accordance with the Document Management Protocol published on the Board's website.
29. Where possible, all written material submitted to the Board should be in fully text-searchable, multi-page PDF/A format.
30. [Paragraph number not used]
31. If any person is unable to provide their written material to the Board in that way, alternative arrangements can be made by telephoning the Executive Director on 0475 985 817.

Part E. Witness statements

32. Where possible, any person who gives evidence at a public hearing should first provide a witness statement to Counsel Assisting the inquiry.
33. Where possible, witness statements should be in the form of an affidavit or statutory declaration.
34. Witness statements:
 - (a) should clearly and concisely set out the relevant evidence the witness can give;
 - (b) must contain only statements of factual matters within the direct knowledge of the witness, unless (c) or (d) apply;
 - (c) may contain statements of factual matters of which the witness has been informed, or believes, if the source of the information or the basis for the belief is clearly identified in the witness statement;
 - (d) may contain statements of opinion, provided the witness possesses specialised knowledge in a field relevant to the inquiry and attaches a copy of his or her curriculum vitae to the statement;

- (e) must have exhibited to them (by attachment or accompanying presentation) all documents or true copies of documents relating to the evidence given by the witness which are in the witness's possession or control, or describe as precisely as possible any such documents which are not in the witness's possession or control and, in that case, state where the witness believes the documents to be located;
- (f) must present those exhibits in a way that will facilitate the Board's efficient and expeditious reference to them, and in particular –
 - i. where possible, in electronic form, by providing them in fully text searchable, multi-page PDF/A format;
 - ii. alternatively, with respect to hard copies, by placing a letter, number or other identifying mark on each exhibit and numbering the pages.

35. [Paragraph number not used]

36. Following receipt of a witness's primary statement, the Board may request the witness to:

- (a) attend an interview with Counsel Assisting the inquiry to discuss the statement; and/or
- (b) **[Paragraph number not used]**
- (c) provide a supplementary statement.

37. If the person attends an interview with Counsel Assisting, the person may be represented by a lawyer or agent.

Part F. Publication and confidentiality

38. Subject to the Chairperson's determination of any application for confidentiality, all information, witness statements (including attachments), documents or submissions provided to the Board may be published on the Board's website or otherwise made publicly available.

39. Any person who provides a witness statement or any other information to the Board, and who wishes to apply for confidentiality or non-publication orders in relation to the fact of the material being provided or in relation to the whole or any part of the material should:

- (a) if it is considered necessary to make any such order *before* providing any material, contact the Executive Director by email at board@coalminesinquiry.qld.gov.au to discuss arrangements; or
- (b) provide the material to the Board under cover of a written notice stating:
 - i. the part of the information or material in respect of which confidentiality is sought;

- ii. whether confidentiality is sought in respect of the world at large or subject to acceptance of publication to some person or categories of persons; and
- iii. the grounds on which such confidentiality is asserted to be necessary and appropriate despite the public nature of the inquiry.

40. [Paragraph number not used]

41. Where confidentiality is applied for in relation to material provided to the Board, either:
- (a) the Chairperson shall decide the application on the papers and notify the person or their nominated representative accordingly. If confidentiality is refused, the material or information in question will nevertheless be kept confidential for seven days from notification of the decision; or
 - (b) the Board shall notify the person or their nominated representative that they will be required to appear before the Chairperson on a date to be advised for further consideration of the application. The material or information in question will be kept confidential until (and in accordance with) the Chairperson's decision following that appearance.
42. Nothing in this Guideline should be taken as limiting the Chairperson's powers, whether at the request of any person or on his own initiative, to treat any material or information as confidential and to take any steps appropriate for the preservation of that confidentiality.

TERRY MARTIN SC

Chairperson and Board Member

9 November 2020

Practice Guideline No.2

Public Hearings – practical matters and witness arrangements

Public Hearings

1. The conduct of public hearings will comply at all times with restrictions and guidelines published by the Commonwealth and Queensland State Government with respect to the management of the COVID-19 pandemic, including with respect to:
 - (a) Restrictions on travel;
 - (b) Social distancing requirements.
2. The Board will hold public hearings in Brisbane and may hold public hearings in other locations, subject to practical considerations including compliance with COVID-19 restrictions and guidelines.
3. Subject to any orders the Chairperson may make and paragraph 1. above, and in addition to Part C. of Practice Guideline No. 1:
 - (a) All public hearings will be available for viewing by live stream accessible on the Board's website www.coalminesinquiry.qld.gov.au;
 - (b) Members of the public may attend public hearings in person and view the hearings from designated seating, observing social distancing; and
 - (c) Where interest is raised, the Board may arrange viewing facilities at other locations for members of the public to view the live stream of the hearings.

First Public Hearing

4. The first public hearing of the Board will commence on 4 August 2020 at Court 17, Brisbane Magistrates Court, Level 4, 363 George Street, Brisbane, Queensland.
5. By 5:00pm on 27 July 2020, Counsel Assisting will provide all parties or their legal representatives with a document setting out the key issues on which the Board intends to focus during the initial hearing.
6. The Chairperson will make opening remarks.
7. Senior Counsel Assisting the Board will make opening submissions.

Witnesses, witness statements and evidentiary material

8. Subject to any orders the Chairperson may make prohibiting publication of any document or information provided to the Board, and in addition to Part E. of Practice Guideline No. 1, while public hearings are on foot:
 - (a) Where possible, the Board will publish regularly to the parties and/or on its website a list of the witnesses to be called to give oral evidence and the proposed dates and times of their evidence;

- (b) The published list of witnesses will be updated regularly (and remains, therefore, subject to change);
- (c) If a witness statement has not already been made available to the parties, the Board will, where possible, make the witness statement available to the persons with leave to appear at least 2 business days before the witness is called;
- (d) Where possible, 4 business days before a witness is called, the Board will give the witness or his or her legal representative notice of the Board's area of interest and a list of the documents to which the witness may be taken (other than those attached to or referred to in the witness's statement) and provide all other parties with an interest in such issues or documents with copies of the notice and the list;
- (e) At least 4 business days before the witness is to be called to give evidence, any person with leave to appear who wishes to cross-examine the witness must give notice to the Executive Director by email to board@coalminesinquiry.qld.gov.au specifying -
 - i. The name of the witness proposed to be cross-examined;
 - ii. A considered estimate of the time which will be required for the cross-examination;
 - iii. In relation to expert witnesses, the topics and parts of the experts' reports which will be the subject of cross-examination, including the propositions and suggestions to be put to the experts, sufficiently to enable the experts to properly address all questions.
- (f) If the person giving a notice of proposed cross-examination anticipates showing the witness any document -
 - i. If the document has already been provided to the Board, it must be identified in the notice;
 - ii. If the document is not already available on the Board's website (whether as an attachment to a witness statement or otherwise), a copy of it must be provided with the notice, where possible, in accordance with the [Document Management Protocol](#). If that is not possible, the document must be provided in one of the following electronic formats:
 - 1. Text for plain text records;
 - 2. Fully text searchable PDF/A or PDF for formatted document type records;
 - 3. TIFF for images such as plans;
 - 4. JPEG 2000 or JPEG for photos;

5. MPEG4 for videos.
 - (g) Any person with leave to appear who wishes to have evidence adduced from a witness other than a witness proposed to be called by Counsel Assisting must give notice to the Executive Director by email to board@coalminesinquiry.qld.gov.au accompanied by a witness statement from the witness.
9. Generally, and subject to the Chairperson's discretion:
 - (a) All witnesses giving evidence at the public hearings will be called and examined by Counsel Assisting the Inquiry. The examination-in-chief of a witness will usually involve the tendering of a statement provided by the witness to Counsel Assisting in advance of the hearing. In some cases, the examination-in-chief may be taken orally;
 - (b) The order of further examination of each witness will usually be:
 - i. Examination by the parties given leave to appear;
 - ii. Examination by the lawyer or agent (if any) representing the witness; and
 - iii. Re-examination by Counsel Assisting.
10. The Chairperson may limit the issues about which a witness may be examined and limit the time available for examination by any person.
11. At the completion of the examination of a witness, the witness shall, unless excused from further attendance, be taken to have been stood down only and to be subject to recall at the direction of the Chairperson.
12. Nothing in this Guideline prevents a person seeking leave from the Chairperson to cross-examine a witness at any time during the Inquiry if something occurs during the Inquiry which leads that person to believe that his or her interests may be adversely affected.

Procedural matters

13. Any person with leave to appear who wishes to raise a procedural matter must give notice to the Executive Director by email to board@coalminesinquiry.qld.gov.au identifying the matter, stating the outcome sought, and summarising the submissions to be advanced in support of that outcome.

TERRY MARTIN SC

Chairperson and Board Member

3 February 2021

Document Management Protocol

Purpose of this Protocol

- 1.1 This Protocol sets out the means and format in which electronic documents are to be produced to the Queensland Coal Mining Board of Inquiry (the Board).
- 1.2 To facilitate the expeditious conduct of the Inquiry, the Board intends, as much as possible, to receive, manage and consider, materials in electronic form.
- 1.3 The Protocol should be read in conjunction with Practice Guideline No. 1, which is available on the Board's website at www.coalminesinquiry.qld.gov.au.
- 1.4 Where the Board thinks it appropriate, this Protocol may be varied, changed or replaced at any time.
- 1.5 Pursuant to this Protocol, a person is expected not to convert electronic documents to hard copy for the purposes of providing documents to the Board. Unless otherwise agreed with the Board, a person is expected to convert hard copy documents to electronic form for the purposes of production to the Board in accordance with this Protocol.
- 1.6 The Protocol applies to:
 - (a) all witness statements (including exhibits to witness statements); and
 - (b) unless otherwise specified by the Board, all other information, relevant documents and submissions referred to in Practice Guideline No. 1.

General Principles

Identification of documents

- 2.1 Document identifiers (Document IDs) and page numbers will be unique to each page and will be the primary means by which documents will be referenced.
- 2.2 A person will identify documents for the purpose of production using unique Document ID. A Document ID will be in the following format:

PPP.BBB.FFF.NNNN

Where:

Level	Description
PPP	The producing party code is a three alpha code unique to each producing. The Board will liaise with producing parties and advise the producing party code to be used by each party.
BBB	The box number identifies a specific physical archive box or email mailbox or any other physical or virtual container. The box number is padded with zeros to consistently result in a 3 digit structure.

FFF	The folder number identifies a unique folder number allocated by each party in its own document collection. The folder number is padded with zeros to consistently result in a 3 digit structure.
NNNN	This refers to each individual page of each document. The page number is padded with zeros to consistently result in a 4 digit structure.

An example of the Document ID structure is XYZ.001.001.0001 where:

XYZ	Party Code
001	Unique box number allocated by person
001	Unique folder or container number allocated by person
0001	Sequential page or document number

Note: If a different number is required, please contact the Board to discuss.

- 2.3 It is understood and accepted that Document IDs may not be consecutive as a result of the removal of irrelevant documents during review. Host and attachment documents must, however, be identified and be given consecutive Document IDs.
- 2.4 A document filename is to be adopted according to its corresponding Document ID upon electronic production.

Document Management

Document metadata

- 3.1 Wherever possible, a person is to rely on the automatically identified metadata of electronic documents. Automatically identified metadata should be used when:
- (a) searching for documents;
 - (b) itemising documents in a list;
 - (c) producing documents in accordance with the Production Specification at Schedule 1 of this Protocol.
- 3.2 A person should take reasonable steps to ensure that all appropriate document metadata is not modified or corrupted during collection and preparation of electronic documents for review and production.
- 3.3 The Board accepts that complete document metadata may not be available for all electronic documents. A person should attempt to provide complete metadata where practicable.

De-duplication of documents

- 4.1 A person must take reasonable steps to ensure that duplicate documents are removed from the exchanged material (de-duplication).
- 4.2 Duplication will be considered at a document group level. That is, all documents within a group comprising a host document and its attachments, will be treated as a duplicate only if the entire group of documents is duplicated elsewhere.

Exclusion of unusable file types

- 5.1 Files with no user-generated content, such as system files and executable files, are to be excluded from the disclosure process (to the extent possible).
- 5.2 Temporary internet files and cookies are to be excluded from the disclosure process.

Document Production

Production of documents to the Board

- 6.1 All documents will:
 - (a) be accompanied by an excel spreadsheet as detailed at Schedule 1;
 - (b) be provided in electronic format in accordance with paragraphs 7, 8 and 9;
 - (c) include all requested metadata and files responsive to the production or tranche in their entirety.

Document format and naming

- 7.1 All documents will be provided as fully text-searchable images as multi-page PDF/A files.
- 7.2 Electronic documents that do not lend themselves to conversion to PDF (for example, complex spreadsheets or databases) may be provided to the Board as native electronic documents or in another form as agreed by the producing party and the Board.
- 7.3 Each file provided by a producing party to the Board will be stored in the folder structure that matches the Document ID structure. Further information is contained in Schedule 2 to this Protocol.
- 7.4 A unique page number label in the format described in paragraph 2.2 will be electronically stamped on the top right hand corner of each page of every document. Such page numbering can be readily achieved using commercial off the shelf products such as Adobe Acrobat Professional or Nitro PDF, however, any similar method will suffice.
- 7.5 The page number assigned to the first page of a document will be the Document ID for that document.

Format for witness statements and submissions

- 8.1 To enable hyperlinking to exhibits referred to within witness statements or submissions:
- (a) witness statements and submissions should be provided as both –
 - i. Microsoft Word documents; and
 - ii. fully text-searchable images as multi-page PDF/A files;
 - (b) where a document is referred to in a submission or witness statement, the reference must be to the Document ID for the document; and
 - (c) each reference to an exhibit's Document ID should be made enclosed in double square brackets, for example [[ABC.001.001.0345]].

Completeness of documents

- 9.1 Where documents are produced, all parts of the document should be produced. For example, for an email chain the final instance of that chain, showing all parts of that chain, is to be produced along with every attachment.

Production media

- 10.1 Documents and accompanying metadata should be provided to the Board on a solid state universal serial bus storage (USB stick) or a portable hard drive or read-only optical media (e.g. CD-ROM, DVD-ROM), and delivered to the Board at Level 23, 50 Ann St, Brisbane.

Data security

- 11.1 Producing parties will take reasonable steps to ensure that the data is useable and is not infected by malicious software.
- 11.2 If data is found to be corrupted, infected by malicious software or is otherwise unusable, the producing party will, within 2 working days of receipt of a written request from the Board, provide a copy of the data that is not corrupted, infected by malicious software or otherwise unusable (as the case may be).

Schedule 1 – Production specification

Excel index

- 1.1 All documents to be produced will be itemised in an excel index containing the following information for each document, where available:
- (a) Document ID (see paragraph 2.2 of the Protocol);
 - (b) host Document ID (see below “Document hosts and attachment relationships”);
 - (c) document date;

- (d) document type (see tab “DocType List” in the sample spreadsheet referred to in paragraph 1.2 of this Schedule);
- (e) document title;
- (f) author;
- (g) author organisation;
- (h) recipient;
- (i) recipient organisation;
- (j) confidential – yes/no/part and, if partly confidential, identifying the relevant part (refer to Practice Guideline No. 1 at paragraph 29(b)(i));
- (k) confidential – scope (refer to Practice Guideline No. 1 at paragraph 29(b)(ii));
- (l) confidential – grounds (refer to Practice Guideline No. 1 at paragraph 29(b)(iii)).

1.2 A sample spreadsheet is available from the Board’s website www.coalminesinquiry.qld.gov.au.

Document hosts and attachment relationships

- 1.3 Every document that is attached to another document will be called an attached document.
- 1.4 Attached documents will have the Document ID of their host document in the metadata field called ‘Host Document ID’.
- 1.5 Host documents and attached documents are jointly referred to as a ‘Document Group’.
- 1.6 In a Document Group, the host document will be immediately followed by each attached document in the order of their Document IDs.
- 1.7 Annexures, attachments and schedules to an agreement, report, legal document or minutes of a meeting may be described as separate attached documents associated with the relevant host document.

Schedule 2 – Folder structure and naming of files

- 2.1 This schedule specifies how electronic documents and images are to be located and named for the purposes of production to the Board.
- 2.2 The folder containing all documents will be named either ‘\Documents\’ or ‘\Images\’.
- 2.3 Documents produced as searchable images will be named ‘Document ID.pdf’. Only the final full stop between the Document ID and the file extension will be used (e.g. ‘ABC0010020312.pdf’).
- 2.4 Documents produced as native electronic documents will be named ‘DocumentID.xxx(x)’ where ‘xxx(x)’ is the original default file extension typically

assigned to source native electronic files of that type (for example, 'ABC0010020312.docx').

- 2.5 Folders containing documents will be structured in accordance with the Document ID hierarchy. For example, the document produced as a searchable image called 'ABC0010020312.pdf' would be located in the folder called 'Documents\ABC\001\002\'. That document will appear in the directory listing as 'Documents\ABC\001\002\ABC0010020312.pdf'. Where this same document has been produced as a Word document, it would be called 'ABCOO10020312.doc' and will be located in the folder called 'Documents\ABC\001\002\'. It will appear in the directory listing as 'Documents\ABC\001\002\ABC0010020312.doc'

Appendix 7 – Notices

Part I of the Report identified notices issued by Chairperson under section 207 and 213 of the *Coal Mining Safety and Health Act 1999* (Qld) from the start of the Inquiry on 22 May 2020 to the report date of 30 November 2020.

The tables below identify notices issued by the Chairperson from 1 December 2020.

Section 207 Notice of Inquiry

Name	Organisation	Issue Date
The Chief Executive Officer	Dywidag-Systems International Pty Limited	29 January 2021
Redacted	Injured Coal Mine Worker	22 February 2021
Mr Wayne Sellars	Injured Coal Mine Worker	22 February 2021

Section 213 Attendance Notice (Notice to give evidence before the Board)

Name	Organisation	Issue Date
Regional Inspector of Mines Mr Stephen Smith	Resources Safety & Health Queensland (RSHQ)	2 March 2021
Inspector Mr Geoff Nugent	RSHQ	2 March 2021
Mr Murray Nystrom	Australian Forensic Pty Ltd	2 March 2021
Senior Inspector Mr Neville Atkinson	RSHQ	2 March 2021
Mr Marty Denham	QEC Global	2 March 2021
Dr Rob Thomas	Strata2 Pty Ltd	2 March 2021
Mr Sean Muller	Safety in Mines Testing and Research Station (SIMTARS)	2 March 2021
Mr Martin Watkinson	SIMTARS	2 March 2021
Dr Ray Williams	Mahala.com Pty Ltd	2 March 2021
Mr Andrew Self	Australian Coal Mining Consultants Pty Ltd	2 March 2021
Dr Basil Beamish	B3 Mining Services Pty Ltd	2 March 2021
Dr Ting Ren	Faculty of Engineering and Information Sciences, University of Wollongong	9 March 2021
Mr James Munday	Fire Forensics Pty Ltd	25 March 2021
Mr Wayne Sellars	Injured Coal Mine Worker	25 March 2021

Name	Organisation	Issue Date
Mr Bipin Parmar	SIMTARS	26 March 2021

Section 213 Attendance Notice (Notice to produce documents)

Name	Organisation	Issue Date
Chief Inspector of Coal Mines	RSHQ	4 December 2020
		8 December 2020
		4 January 2021
		21 January 2021
		2 February 2021
		8 February 2021
		12 February 2021
		17 February 2021
		18 February 2021
		22 February 2021
		23 February 2021
		26 February 2021
		1 March 2021
		2 March 2021
		2 March 2021
		3 March 2021
		4 March 2021
		4 March 2021
		8 March 2021
		8 March 2021
		17 March 2021
		18 March 2021
25 March 2021		
26 March 2021		
26 March 2021		
29 March 2021		
30 March 2021		
30 March 2021		
6 April 2021		
6 April 2021		
19 April 2021		
The Chief Executive	Anglo Coal (Grosvenor Management) Pty Ltd	29 January 2021
		25 February 2021
		4 March 2021
		18 March 2021
		22 March 2021

QUEENSLAND COAL MINING BOARD OF INQUIRY

Name	Organisation	Issue Date
		29 March 2021 14 April 2021 19 April 2021
The Chief Executive	Anglo Coal (Moranbah North Management) Pty Ltd	5 March 2021
The Chief Executive Officer	Dywidag-Systems International Pty Limited	29 January 2021
The Operator	North Goonyella mine	5 March 2021

Appendix 8 – Interviews, Statements and Submissions

Interviews

Since completing Part I of the Report, interviews and conferences have been conducted with the following persons:

Name	Organisation	Method of Interview	Date/s
Mr Peter Newman Chief Inspector of Coal Mines	Resources Safety & Health Queensland (RSHQ)	Physical Attendance	13 January 2021
Mr Martin Watkinson Executive Mining Engineer	Safety in Mines Testing and Research Station (SIMTARS)	Physical Attendance Physical Attendance	20 January 2021 16 February 2021
Dr Ray Williams Consultant - coal mine gas management	Mahala.com Pty Ltd	Video Conference Video Conference Video Conference	22 January 2021 19 February 2021 12 March 2021
Ms Kate du Preez Commissioner for Resources, Safety and Health	Office of the Commissioner for Resources Safety and Health	Physical Attendance Physical Attendance	22 January 2021 12 April 2021
Mr Andrew Self Consultant - coal mine systems	Australian Coal Mining Consultants Pty Ltd	Physical Attendance Physical Attendance Video Conference	27 January 2021 2 March 2021 23 March 2021
Mr Sean Muller A/Senior Analytical Chemist	SIMTARS	Physical Attendance Physical Attendance	29 January 2021 3 March 2021
Mr Mark Parcell Senior Consultant	Mine Safety Institute of Australia Pty Ltd	Physical Attendance	1 February 2021
Dr Rob Thomas Principal Geotechnical Engineer	Strata2 Pty Ltd	Physical Attendance Physical Attendance	3 February 2021 5 March 2021
Mr Murray Nystrom Forensic Fire Investigator	Australian Forensic Pty Ltd	Physical Attendance Physical Attendance	5 February 2021 3 March 2021
Dr Ting Ren Associate Professor in Mining Engineering	Faculty of Engineering and Information Sciences, University of Wollongong	Video Conference Video Conference	10 February 2021 16 March 2021

QUEENSLAND COAL MINING BOARD OF INQUIRY

Name	Organisation	Method of Interview	Date/s
Mr John Weissman Consultant - gas drainage engineer	Weisstech Pty Ltd	Video Conference	12 February 2021
Mr Shaun Dobson Deputy Chief Inspector of Coal Mines	RSHQ	Physical Attendance	17 February 2021
Mr Geoff Nugent Inspector of Mines			
Injured Coal Mine Worker		Physical Attendance	1 March 2021
Mr Neville Atkinson Senior Inspector of Mines - Electrical	RSHQ	Video Conference	5 March 2021
Mr Geoff Nugent Inspector of Mines	RSHQ	Video Conference	5 March 2021
Mr Marty Denham Electrical Fire Investigator	QEC Global	Video Conference	12 March 2021
Mr Wayne Sellars Injured Coal Mine Worker		Physical Attendance	18 March 2021
Dr Basil Beamish Consultant - spontaneous combustion	B3 Mining Services Pty Ltd	Physical Attendance	25 March 2021
Mr James Munday Senior Fire Investigator	Fire Forensics Pty Ltd	Video Conference	23 March 2021
Mr Bipin Parmar Principal Engineer	SIMTARS	Video Conference	6 April 2021
Mr Aaron Martin Supervisor	Dywidag-Systems International Pty Limited t/a DSI Underground	Teleconference	7 April 2021
Mr Scott Turton Operations Manager			
Dr Rick Brake Principal Consultant	Mine Ventilation Australia Pty Ltd	Video Conference	22 April 2021

Witness Statements

Statements, Affidavits and Statutory Declarations were provided by the following witnesses who were also called to give oral evidence at the Inquiry's second tranche of hearings. These witness statements are available on the website: <https://coalminesinquiry.qld.gov.au/exhibits/>.

Name	Organisation	Statement Date
Mr Stephen Smith Regional Inspector of Mines	RSHQ	1 March 2021
Mr Geoff Nugent Inspector of Mines	RSHQ	2 March 2021
Mr Neville Atkinson Senior Inspector of Mines - Electrical	RSHQ	2 March 2021
Mr Wayne Sellars Injured Coal Mine Worker		7 April 2021

Statements, Affidavits and Statutory Declarations were also provided by the following witnesses who were not required to give oral evidence at the Inquiry's second tranche of hearings.

Name	Organisation	Statement Date
Mr Paul Brown Inspector of Mines	RSHQ	23 February 2021
Mr Malcolm Brownnett Inspector of Mines	RSHQ	24 February 2021
Mr Matthew Kennedy Inspector of Mines	RSHQ	24 February 2021
Mr Wolfgang Djukic Senior Inspector of Mines	RSHQ	24 February 2021
Mr Keith Brennan Inspector of Mines	RSHQ	26 February 2021
Injured Coal Mine Worker		1 March 2021
Mr Guy Harvey Principal Investigations Officer	RSHQ	2 March 2021
Mr John Tolhurst Principal Investigations Officer	RSHQ	3 March 2021
Mr Richard Gouldstone Former Inspector of Mines	RSHQ	11 March 2021
Mr Reece Campbell Coal Mine Worker, Former Site Safety and Health	Employed by FES Coal Pty Ltd, a subsidiary of One Key Holdings Pty Ltd	30 March 2021 13 April 2021

Name	Organisation	Statement Date
Representative at Grosvenor mine		
Mr Peter Newman Chief Inspector of Coal Mines	RSHQ	7 April 2021
Mr Todd Bell Coal mine worker	Grosvenor mine	8 April 2021
Mr Scott Turton Operations Manager	Dywidag-Systems International Pty Limited t/a DSI Underground	8 April 2021
Mr Samuel Priest Emergency Response Coordinator at Grosvenor mine	Anglo American	13 April 2021
Mr Beau Lacy Trainee Deputy (ERZ controller) at Grosvenor mine	Employed by One Key Resources Pty Ltd (One Key)	15 April 2021
Mr Mace Kingston Longwall Maintenance Fitter at Grosvenor mine	Self-employed contractor employed by One Key	21 April 2021

Submissions

Since completing Part I of the Report, public submissions have been received by the Board from the following organisations and individuals:

Name	Statement Date
Mr Stuart Vaccaneo	Various
Mr Waclaw Turek	Various
Board of Professional Engineers of Queensland	16 February 2021

A number of submissions were also received from individuals who requested to remain anonymous or have their name withheld from publication. The Board has received seven submissions of this kind since completing Part I of the Report.

Appendix 9 – Witnesses

Persons who gave oral evidence at the Inquiry’s second tranche of hearings, which were held over five weeks from 9 March to 9 April 2021, were:

Week 1

Name	Organisation	Date
Mr Stephen Smith Regional Inspector of Mines	Resources Safety & Health Queensland (RSHQ)	9 March 2021 10 March 2021
Mr Geoff Nugent Inspector of Mines	RSHQ	11 March 2021
Mr Neville Atkinson Senior Inspector of Mines - Electrical	RSHQ	11 March 2021
Mr Murray Nystrom Forensic Fire Investigator	Australian Forensic Pty Ltd	11 March 2021

Week 2

Name	Organisation	Date
Mr Marty Denham Electrical Fire Investigator	QEC Global	15 March 2021
Dr Rob Thomas Principal Geotechnical Engineer	Strata2 Pty Ltd	15 March 2021
Mr Martin Watkinson Executive Mining Engineer	Safety in Mines Testing and Research Station (SIMTARS)	17 March 2021
Mr Sean Muller A/Senior Analytical Chemist	SIMTARS	18 March 2021

Week 3

Name	Organisation	Date
Dr Ray Williams Consultant - coal mine gas management	Mahala.com Pty Ltd	22 March 2021
Mr Andrew Self Consultant - coal mine systems	Australian Coal Mining Consultants Pty Ltd	24 March 2021
Dr Basil Beamish Consultant - spontaneous combustion	B3 Mining Services Pty Ltd	26 March 2021

Week 4

Name	Organisation	Date
Dr Ting Ren Associate Professor in Mining Engineering	Faculty of Engineering and Information Sciences, University of Wollongong	29 March 2021

Week 5

Name	Organisation	Date
Mr Bipin Parmar Principal Engineer	SIMTARS	7 April 2021
Mr Wayne Sellars Injured Coal Mine Worker		7 April 2021
Mr James Munday Senior Fire Investigator	Fire Forensics Pty Ltd	9 April 2021
Dr Basil Beamish Consultant - spontaneous combustion	B3 Mining Services Pty Ltd	9 April 2021

Appendix 10 – Exhibits

The following documents were tendered as exhibit lists during and following the second tranche of public hearings, held between 9 March and 9 April 2021. Selected exhibits are available on the Board’s website at <https://coalminesinquiry.qld.gov.au/exhibits/>.

Documents received or created by the Board were assigned a unique document identifier (called a Document ID), which supports identification and retrieval of the documents in the electronic document management system. The Document ID follows a standard format (e.g., XYZ.001.001.0001), starting with a three or four letter Party Code. The Party Code identifies the party who was the source for the document. Transcripts of the hearings, and interview transcripts prepared at the request of the Board, are identified with the code TRA.

An index of relevant Party Codes is available at the end of the exhibit lists.

Where a document was admitted as an exhibit in the hearings, the Document ID became the Exhibit Number for that document.

Exhibit Lists

Exhibit List M – 24 March 2021	
DOCUMENT	EXHIBIT NUMBER
Form 1A for Grosvenor LW103 TG - HPI 02/07/2019 (HPI 1)	AAMC.001.009.0255
Form 1A for Grosvenor LW103 TG - HPI 03/07/2019 (HPI 2)	AAMC.001.009.0257
Form 1A for Grosvenor LW103 TG - HPI 11/07/2019 (HPI 3)	AAMC.001.009.0259
Form 1A for Grosvenor LW103 TG - HPI 14/07/2019 (HPI 4)	AAMC.001.009.0263
Form 1A for Grosvenor LW103 TG - HPI 21/07/2019 (HPI 5)	AAMC.001.009.0269
Form 1A for Grosvenor LW103 TG - HPI 22/07/2019 (HPI 6)	AAMC.001.009.0769
Form 1A for Grosvenor LW103 TG - HPI 15/07/2019 (HPI 7)	AAMC.001.009.0266
Form 1A for Grosvenor LW103 TG - HPI 23/07/2019 (HPI 8)	AAMC.001.009.0273
Form 1A for Grosvenor LW103 TG - HPI 24/07/2019 (HPI 9)	AAMC.001.009.0275
Form 1A for Grosvenor LW103 TG - HPI 24/07/2019 (HPI 10)	AAMC.001.009.0277
Form 1A for Grosvenor LW103 TG - HPI 17/08/2019 (HPI 11)	AAMC.001.009.0279
Form 1A for Grosvenor LW103 TG - HPI 19/10/2019 (HPI 12)	AAMC.001.009.0281
Form 1A for Grosvenor LW103 TG - HPI 07/11/2019 (HPI 13)	AAMC.001.009.0283
Form 1A for Grosvenor LW104 TG - HPI 18/03/2020 (HPI 14)	AAMC.001.009.0288
Form 1A for Grosvenor LW104 TG - HPI 19/03/2020 (HPI 15)	AAMC.001.009.0290
Form 1A for Grosvenor LW104 TG - HPI 20/03/2020 (HPI 16)	AAMC.001.009.0294
Form 1A for Grosvenor LW104 TG - HPI 20/03/2020 (HPI 17)	AAMC.001.009.0297

Exhibit List M – 24 March 2021

Form 1A for Grosvenor LW104 TG - HPI 20/03/2020 (HPI 18)	AAMC.001.009.0300
Form 1A for Grosvenor LW104 TG - HPI 22/03/2020 (HPI 19)	AAMC.001.009.0304
Form 1A for Grosvenor LW104 TG - HPI 23/03/2020 (HPI 20)	AAMC.001.009.0307
Form 1A for Grosvenor LW104 TG - HPI 04/04/2020 (HPI 21)	AAMC.001.009.0310
Form 1A for Grosvenor LW104 TG - HPI 06/03/2020 (HPI 22)	AAMC.001.009.0319
Form 1A for Grosvenor LW104 TG - HPI 07/04/2020 (HPI 23)	AAMC.001.009.0315
Form 1A for Grosvenor LW104 TG - HPI 21/04/2020 (HPI 24)	AAMC.001.009.0327
Form 1A for Grosvenor LW104 TG - HPI 21/04/2020 (HPI 25)	AAMC.001.009.0325
Form 1A for Grosvenor LW104 TG - HPI 21/04/2020 (HPI 26)	AAMC.001.009.0323
Form 1A for Grosvenor LW104 TG - HPI 21/04/2020 (HPI 27)	AAMC.001.009.0329
Form 5A for Grosvenor LW103 TG - HPI on 02/07/2019 (HPI 1)	AAMC.001.009.0336
Form 5A for Grosvenor LW103 TG - HPI on 03/07/2019 (HPI 2)	AAMC.001.009.0340
Form 5A for Grosvenor LW103 TG - HPI on 11/07/2019 (HPI 3)	AAMC.001.009.0344
Form 5A for Grosvenor LW103 TG - HPI on 14/07/2019 (HPI 4)	AAMC.001.009.0352
Form 5A for Grosvenor LW103 TG - HPI on 21/07/2019 (HPI 5)	AAMC.001.009.0356
Form 5A for Grosvenor LW103 TG - HPI on 22/07/2019 (HPI 6)	AAMC.001.009.0360
Form 5A for Grosvenor LW103 TG - HPI on 15/07/2019 (HPI 7)	AAMC.001.009.0348
Form 5A for Grosvenor LW103 TG - HPI on 23/07/2019 (HPI 8)	AAMC.001.009.0372
Form 5A for Grosvenor LW103 TG - HPI on 24/07/2019 (HPI 9)	AAMC.001.009.0364
Form 5A for Grosvenor LW103 TG - HPI on 24/07/2019 (HPI 10)	AAMC.001.009.0368
Form 5A for Grosvenor LW103 TG - HPI on 17/08/2019 (HPI 11)	AAMC.001.009.0376
Form 5A for Grosvenor LW103 TG - HPI on 19/10/2019 (HPI 12)	AAMC.001.009.0380
Form 5A for Grosvenor LW103 TG - HPI on 07/11/2019 (HPI 13)	AAMC.001.009.0384
Form 5A for Grosvenor LW104 TG - HPI on 18/03/2020 (HPI 14)	AAMC.001.009.0388
Form 5A for Grosvenor LW104 TG - HPI on 19/03/2020 (HPI 15)	AAMC.001.009.0392
Form 5A for Grosvenor LW104 TG - HPI on 20/03/2020 (HPI 16)	AAMC.001.009.0404
Form 5A for Grosvenor LW104 TG - HPI on 20/03/2020 (HPI 17)	AAMC.001.009.0408
Form 5A for Grosvenor LW104 TG - HPI on 20/03/2020 (HPI 18)	AAMC.001.009.0412
Form 5A for Grosvenor LW104 TG - HPI on 22/03/2020 (HPI 19)	AAMC.001.009.0396
Form 5A for Grosvenor LW104 TG - HPI on 23/03/2020 (HPI 20)	AAMC.001.009.0400
Form 5A for Grosvenor LW104 TG - HPI on 04/04/2020 (HPI 21)	AAMC.001.009.0424
Form 5A for Grosvenor LW104 TG - HPI on 06/04/2020 (HPI 22)	AAMC.001.009.0416

Exhibit List M – 24 March 2021

Form 5A for Grosvenor LW104 TG - HPI on 07/04/2020 (HPI 23)	AAMC.001.009.0420
Form 5A for Grosvenor LW104 TG - HPI on 21/04/2020 (HPI 24)	AAMC.001.009.0428
Form 5A for Grosvenor LW104 TG - HPI on 21/04/2020 (HPI 25)	AAMC.001.009.0432
Form 5A for Grosvenor LW104 TG - HPI on 21/04/2020 (HPI 26)	AAMC.001.009.0436
Form 5A for Grosvenor LW104 TG - HPI on 21/04/2020 (HPI 27)	AAMC.001.009.0440
Learning From Incidents (LFI) Investigation Report 16/07/2019 for HPI on 02/07/2019	AAMC.001.003.0219
Learning From Incidents (LFI) Investigation Report 17/07/2019 for HPI on 03/07/2019	AAMC.001.003.0235
Learning From Incidents (LFI) Investigation Report 25/07/2019 for HPI on 11/07/2019	AAMC.001.003.0254
Learning From Incidents (LFI) Investigation Report 02/08/2019 for HPI's on 14/07/2019, 21/07/2019 and 22/07/2019	AAMC.001.009.0462
Learning From Incidents (LFI) Investigation Report 13/08/2019 for HPI on 15/07/2019	AAMC.001.009.0509
Learning From Incidents (LFI) Investigation Report 06/08/2019 for HPI on 23/07/2019	AAMC.001.009.0444
Learning From Incidents (LFI) Investigation Report 07/08/2019 for HPI on 24/07/2019	AAMC.001.009.0478
Learning From Incidents (LFI) Investigation Report 26/08/2019 for HPI on 17/08/2019	AAMC.001.009.0517
Learning From Incidents (LFI) Investigation Report 19/11/2019 for HPI on 19/10/2019	AAMC.001.009.0534
Learning From Incidents (LFI) Investigation Report 20/11/2019 for HPI on 07/11/2019	AAMC.001.009.0552
Learning From Incidents (LFI) Investigation Report 03/04/2020 for HPI's between 18/03/2020 and 23/03/2020	AAMC.001.003.0030
Learning From Incidents (LFI) Investigation Report 20/04/2020 for HPI on 04/04/2020	AAMC.001.003.0002
Learning From Incidents (LFI) Investigation Report 01/05/2020 for HPI's on 06/04/2020 and 07/04/2020	AAMC.001.003.0016
Learning From Incidents (LFI) Investigation Report 19/05/2020 for 4 HPI's on 21/04/2020 and 23/04/2020	AAMC.001.009.0568
GRO-10-PHMP-Spontaneous Combustion	AGM.002.001.0169
GRO-11-PHMP-Machine Interaction	AGM.002.001.0190
GRO-1398-PHMP-Outburst	AGM.002.001.0205
GRO-13-PHMP-Emergency Response	AGM.002.001.0222
GRO-1440-PHMP-Irrespirable Atmosphere	AGM.002.001.0236

Exhibit List M – 24 March 2021

GRO-14-PHMP-Gas Management	AGM.002.001.0251
GRO-15-PHMP-Ventilation	AGM.002.001.0288
GRO-16-PHMP-Methane Drainage	AGM.002.001.0323
GRO-3172-PHMP-Strata Control	AGM.002.001.0341
GRO-5351-PHMP-Fire Management	AGM.002.001.0366
GRO-313-HMP-Reporting and Rectifying Defects	AGM.005.001.0490
GRO-47-HMP-Engine Pollutants	AGM.004.001.0300
GRO-48-HMP-Management of Heat	AGM.002.001.0866
GRO-10068-TARP-Strata Control Outbye	AGM.002.001.0420
GRO-10068-TARP-Strata Control Outbye	AGM.002.001.0698
GRO-5833-TARP-Longwall Strata Control	AGM.002.001.0447
GRO-5833-TARP-Longwall Strata Control	AGM.002.001.0557
GRO-5833-TARP-Longwall Strata Control	AGM.002.001.0662
GRO-5833-TARP-Longwall Strata Control	AGM.002.001.0601
GRO-5833-TARP-Longwall Strata Control	AGM.002.001.0741
GRO-5833-TARP-Longwall Strata Control	AGM.002.001.0810
GRO-5833-TARP-Longwall Strata Control	AGM.002.001.0700
GRO-6953-TARP-Active Goaf Spontaneous Combustion	AGM.002.001.0463
GRO-6953-TARP-Active Goaf Spontaneous Combustion	AGM.002.001.0655
GRO-6953-TARP-Active Goaf Spontaneous Combustion	AGM.002.001.0722
GRO-6953-TARP-Active Goaf Spontaneous Combustion	AGM.002.001.0755
GRO-6953-TARP-Active Goaf Spontaneous Combustion	AGM.002.001.0814
GRO-7780-TARP-Water infusion Utilising UIS Boreholes	AGM.002.001.0481
GRO-7780-TARP-Water infusion Utilising UIS Boreholes	AGM.002.001.0585
GRO-8515-TARP-Longwall Frictional Ignition	AGM.002.001.0483
GRO-8515-TARP-Longwall Frictional Ignition	AGM.002.001.0611
GRO-9584-TARP-Strata Control Longwall Bolt Up and Shield Removal	AGM.002.001.0489
GRO-9584-TARP-Strata Control Longwall Bolt Up and Shield Removal	AGM.002.001.0712
GRO-750-TARP-General Body Contaminant	AGM.002.001.0523
GRO-750-TARP-General Body Contaminant	AGM.002.001.0538
GRO-750-TARP-General Body Contaminant	AGM.002.001.0531

Exhibit List M – 24 March 2021

GRO-750-TARP-General Body Contaminant	AGM.002.001.0571
GRO-750-TARP-General Body Contaminant	AGM.002.001.0573
GRO-750-TARP-General Body Contaminant	AGM.002.001.0470
GRO-750-TARP-General Body Contaminant	AGM.002.001.0619
GRO-750-TARP-General Body Contaminant	AGM.002.001.0630
GRO-750-TARP-General Body Contaminant	AGM.002.001.0671
GRO-750-TARP-General Body Contaminant	AGM.002.001.0641
GRO-750-TARP-General Body Contaminant	AGM.002.001.0651
GRO-750-TARP-General Body Contaminant	AGM.002.001.0688
GRO-750-TARP-General Body Contaminant	AGM.002.001.0706
GRO-750-TARP-General Body Contaminant	AGM.002.001.0737
GRO-750-TARP-General Body Contaminant	AGM.002.001.0765
GRO-160-TARP-Heat Management	AGM.002.001.0525
GRO-160-TARP-Heat Management	AGM.002.001.0543
GRO-160-TARP-Heat Management	AGM.002.001.0570
GRO-160-TARP-Heat Management	AGM.002.001.0564
GRO-160-TARP-Heat Management	AGM.002.001.0763
GRO-160-TARP-Heat Management	AGM.002.001.0437
GRO-3442-TARP-Evacuation Triggers for Underground	AGM.002.001.0544
GRO-3442-TARP-Evacuation Triggers for Underground	AGM.002.001.0439
GRO-3442-TARP-Evacuation Triggers for Underground	AGM.002.001.0583
GRO-4109-TARP-Mato Belt Clip Replacement	AGM.002.001.0547
GRO-4109-TARP-Mato Belt Clip Replacement	AGM.002.001.0458
GRO-4109-TARP-Mato Belt Clip Replacement	AGM.002.001.0613
GRO-5610-TARP-Longwall Hydraulic Integrity	AGM.002.001.0556
GRO-5610-TARP-Longwall Hydraulic Integrity	AGM.002.001.0454
GRO-5610-TARP-Longwall Hydraulic Integrity	AGM.002.001.0681
GRO-5610-TARP-Longwall Hydraulic Integrity	AGM.002.001.0758
GRO-6599-TARP-Mains Development - Headings and Cut Throughs	AGM.002.001.0565
GRO-6599-TARP-Mains Development - Headings and Cut Throughs	AGM.002.001.0566

Exhibit List M – 24 March 2021

GRO-6599-TARP-Mains Development - Headings and Cut Throughs	AGM.002.001.0675
GRO-6599-TARP-Mains Development Strata Control	AGM.002.001.0452
GRO-6599-TARP-Mains Development Strata Control	AGM.002.001.0729
GRO-6599-TARP-Mains Development Strata Control	AGM.002.001.0790
GRO-7317-TARP-Fugitive Leaks on Seamgas Infrastructure	AGM.002.001.0575
GRO-7317-TARP-Fugitive Leaks on Seamgas Infrastructure	AGM.002.001.0467
GRO-7775-TARP-Longwall Respirable Dust and Frictional Ignition	AGM.002.001.0576
GRO-7775-TARP-Longwall Respirable Dust and Frictional Ignition	AGM.002.001.0595
GRO-1430-TARP-Goaf Drainage	AGM.002.001.0586
GRO-1430-TARP-Goaf Drainage	AGM.002.001.0592
GRO-1430-TARP-Goaf Drainage	AGM.002.001.0598
GRO-1430-TARP-Goaf Drainage	AGM.002.001.0622
GRO-1430-TARP-Goaf Drainage	AGM.002.001.0634
GRO-1430-TARP-Goaf and UIS Gas Drainage Management	AGM.002.001.0778
GRO-1430-TARP-Goaf and UIS Gas Drainage Management	AGM.002.001.0692
GRO-1430-TARP-Goaf and UIS Gas Drainage Management	AGM.002.001.0427
GRO-1430-TARP-Goaf and UIS Gas Drainage Management	AGM.002.001.0637
GRO-9737-TARP-Newly Sealed Goaf	AGM.002.001.0645
GRO-9737-TARP-Newly Sealed Goaf	AGM.002.001.0782
GRO-9737-TARP-Newly Sealed Goaf	AGM.002.001.0504
GRO-9736-TARP-Sealed Goaf Spontaneous Combustion	AGM.002.001.0649
GRO-9736-TARP-Sealed Goaf Spontaneous Combustion	AGM.002.001.0501
GRO-9736-TARP-Sealed Goaf Spontaneous Combustion	AGM.002.001.0784
GRO-7774-TARP-Strata Control Longwall Gate end roadways adjacent roadway	AGM.002.001.0658
GRO-7774-TARP-Strata Control Longwall Gate end roadways adjacent roadway	AGM.002.001.0660
GRO-7774-TARP-Strata Control Longwall Gate end roadways adjacent roadway	AGM.002.001.0579
GRO-7774-TARP-Strata Control Longwall Gate end roadways adjacent roadway	AGM.002.001.0677
GRO-7774-TARP-Strata Control Longwall Gate End Roadways Adjacent Roadway	AGM.002.001.0679

Exhibit List M – 24 March 2021

GRO-7774-TARP-Strata Control Longwall Gate End Roadways Adjacent Roadway	AGM.002.001.0479
GRO-8396-TARP-Faceline 102 First Pass Driveage	AGM.002.001.0669
GRO-8396-TARP-Faceline 102 First Pass Driveage	AGM.002.001.0670
GRO-8396-TARP-Faceline 102 First Pass Driveage	AGM.002.001.0606
GRO-8396-TARP-Longwall Installation and Bleeder Road-First Pass Driveage	AGM.002.001.0687
GRO-8396-TARP-Longwall Installation and Bleeder Road-First Pass Driveage	AGM.002.001.0482
GRO-9966-TARP-MG104 Development Strata Control Domain	AGM.002.001.0685
GRO-9966-TARP-MG104 Development Strata Control Domain A	AGM.002.001.0491
GRO-9966-TARP-MG104 Development Strata Control Domain A	AGM.002.001.0727
GRO-10060-TARP-Installation Road Widening Strata Control	AGM.002.001.0696
GRO-10060-TARP-Installation Road Widening Strata Control	AGM.002.001.0418
GRO-10060-TARP-Installation Road Widening Strata Control	AGM.002.001.0799
GRO-7778-TARP - Daily Weighted Run of Mine Ash Percentage	AGM.002.001.0710
GRO-7778-TARP - Daily Weighted Run of Mine Ash Percentage	AGM.002.001.0711
GRO-7778-TARP - Daily Weighted Run of Mine Ash Percentage	AGM.002.001.0478
GRO-10250-TARP-Strata Control Domain B Shallow	AGM.002.001.0794
GRO-10250-TARP-MG105 Development Strata Control Domain B Shallow	AGM.002.001.0733
GRO-10250-TARP-Strata Control Domain B Shallow	AGM.002.001.0774
GRO-10250-TARP-Strata Control Domain B Shallow	AGM.002.001.0422
GRO-10267-TARP-MG104 Development Strata Control Inbye 27-48 CT	AGM.002.001.0735
GRO-10267-TARP-MG104 Development Strata Control Inbye 27-48 CT	AGM.002.001.0425
GRO-10304-TARP-MG105 Development Strata Control Inbye 8 to 23 CT	AGM.002.001.0750
GRO-10304-TARP-Development Strata Control Domain A	AGM.002.001.0506
GRO-10304-TARP-Development Strata Control Domain A	AGM.002.001.0787
GRO-10304-TARP-Development Strata Control Domain A	AGM.002.001.0792
GRO-10300-TARP-Safety Intervention	AGM.002.001.0747
GRO-10300-TARP-Safety Intervention	AGM.002.001.0752
GRO-10300-TARP-Safety Intervention	AGM.002.001.0776

Exhibit List M – 24 March 2021

GRO-10300-TARP-Safety Intervention	AGM.002.001.0493
GRO-10278-TARP-Fire Water	AGM.002.001.0762
GRO-10278-TARP-Fire Water	AGM.002.001.0495
GRO-10278-TARP-Fire Water	AGM.002.001.0805
GRO-10563-TARP-Longwall Return Methane General Body Contaminants	AGM.002.001.0768
GRO-10563-TARP-Longwall Return Methane General Body Contaminants	AGM.002.001.0498
GRO-10529-TARP-Strata Control Domain B Deep Development	AGM.002.001.0771
GRO-10529-TARP-Strata Control Domain B Deep Development	AGM.002.001.0797
GRO-10529-TARP-Strata Control Domain B Deep Development	AGM.002.001.0496
GRO-10730-TARP-Mine Re-entry After Gas Ignition Event Conservative Limits	AGM.002.001.0513
GRO-10741-TARP-Preservation of LW104 Incident Scene	AGM.002.001.0515
GRO-10759-TARP-Tomlinson Boiler	AGM.002.001.0519
GRO-10769-TARP-Mine Overpressure Event Surface Exclusion Zone	AGM.002.001.0521
GRO-2655-TARP-EPBM Thrust Cylinder TARP	AGM.002.001.0534
GRO-3696-TARP-Outburst	AGM.002.001.0567
GRO-10699-RA-LW104 Goaf Drainage	AGM.002.001.0937
GRO-10699-RA-LW104 Goaf Drainage	AGM.011.001.2051
GRO-10671-RA-LW104 Secondary Extraction	AGM.002.001.1000
GRO-10671-RA-LW104 Secondary Extraction	AGM.003.003.0183
GRO-10208-RA-LW103 Secondary Extraction	AGM.003.001.0539
GRO-10974-RA-Drilling into Roadways Surface Zone LW104	AGM.003.001.2337
GRO-10974-RA-Drilling into Roadways Surface Zone LW104	AGM.003.003.0387
GRO-10698-RA-LW104 Cut Height Above 4.2m	AGM.003.001.2289
GRO-10672-RA-LW104 First Goaf	AGM.003.001.2310
GRO-3632-RA-Methane Drainage	AGM.002.001.0936
GRO-10757-RA-LW104 E-Frame Stub Excavation Utilising Cardox Blasting	AGM.003.003.0305
GRO-10289-RA-First Workings for Inbye of MG104 26CT	AGM.003.003.0321
GRO-10167-RA-MG104 40CT UIS Drilling Activities	AGM.003.003.0341
GRO-10144-RA-MG104 NERZ ERZ1 Boundary Advance	AGM.003.003.0360

Exhibit List M – 24 March 2021

GRO-10259-RA-MG104 NERZ ERZ Boundary Relocation January 2019	AGM.003.003.0371
GRO-10347-RA-Managing Inrush Hazard of MG104 31ct Failed Gas Riser	AGM.003.003.0466
GRO-10348-RA-Managing Inrush Hazard of MG104 Floor Gas Risk Zone	AGM.003.003.0477
GRO-10341-RA-Proactive Interburden Fracturing	AGM.003.003.0497
GRO-10706-RA-LW104 Take-off (PDRR) Business	AGM.003.003.0521
GRO-9883-RA-J Latch Goaf Drainage Borehole Design	AGM.011.001.2128
GRO-3600-RA-Explosions	AGM.011.001.2146
GRO-77-SOP-Underground Workplace Inspections	AGM.004.001.0320
GRO-242-SOP-Check Examine Work Areas	AGM.004.001.0396
GRO-10684-SOP-LW104 Second Workings	AGM.002.001.0019
GRO-56-SOP-Ventilating Underground Workplaces	AGM.002.001.0920
GRO-10684-SOP-LW104 Second Workings	AGM.002.001.1112
GRO-7332-SWI-Drilling of Goaf Drainage Boreholes	AGM.011.001.2113
Enablon Task TS.01065604 for LW103 HPI on 14/07/2019	AGM.003.001.0114
Enablon Task TS.01065605 for LW103 HPI on 14/07/2019	AGM.003.001.0116
Enablon Task TS.01065606 for LW103 HPI on 14/07/2019	AGM.003.001.0118
Enablon Task TS.01065607 for LW103 HPI on 14/07/2019	AGM.003.001.0120
Enablon Task TS.01029425 for LW103 HPI on 23/07/2019	AGM.003.001.0126
Enablon Task TS.01086434 for LW103 HPI on 15/07/2019	AGM.003.001.0149
Red Banner Alert-CH4 Exceedance in TG103 on 21/08/2019	AGM.003.001.0321
Enablon Task TS.01089854 for LW103 HPI on 17/08/2019	AGM.003.001.0335
Enablon Task TS.01148245 for LW103 HPI on 19/10/2019	AGM.003.001.0403
Enablon Task TS.01146930 for LW103 HPI on 07/11/2019	AGM.003.001.0430
Enablon Task TS.01146932 for LW103 HPI on 07/11/2019	AGM.003.001.0434
Enablon Task TS.01146933 for LW103 HPI on 07/11/2019	AGM.003.001.0436
Enablon Task TS.01146934 for LW103 HPI on 07/11/2019	AGM.003.001.0438
Enablon Task TS.01166665 for LW103 HPI on 07/11/2019	AGM.003.001.0444
Enablon Task TS.01166669 for LW103 HPI on 07/11/2019	AGM.003.001.0446
Enablon Task TS.01166671 for LW103 HPI on 07/11/2019	AGM.003.001.0448
Enablon Task TS.1050932 for LW103 HPI on 02/07/2019	AGM.003.001.2408

Exhibit List M – 24 March 2021

Enablon Task TS.01069049 for LW103 HPI on 02/07/2019	AGM.003.001.2447
Enablon Task TS.01065586 for LW103 HPI on 11/07/2019	AGM.003.001.2540
Enablon Task TS.01065591 for LW103 HPI on 11/07/2019	AGM.003.001.2567
Enablon Task TS.01065592 for LW103 HPI on 11/07/2019	AGM.003.001.2585
Enablon Task TS.01075459 for LW103 HPI on 11/07/2019	AGM.003.001.2593
TEM-IMT Meeting Minutes on 11/07/2019 for TG103 CH4	AGM.003.001.2544
TEM-IMT Meeting Minutes on 08/04/2020 for TG104 CH4	AGM.002.001.0011
TEM-IMT Meeting Minutes on 15/07/2019 for TG103 CH4	AGM.005.002.0426
TEM-IMT Meeting Minutes on 04/07/2019 for TG103 CH4	AGM.003.001.2480
Statement by Injured Coal Mine Worker 5	AGM.005.001.0333
GRO-735-FRM-Witness Statement - Martin Aaron	AGM.005.001.0335
ERT Debrief Form - CHRISTENSEN, Aaron 20200506	AGM.005.001.0342
ERT Debrief Form - PRIEST, Sam 20200506	AGM.005.001.0345
ERT Debrief Form - UNDERDOWN, Josh 20200506	AGM.005.001.0348
ERT Debrief Form - ELLEM, Aaron 20200506	AGM.005.001.0351
ERT Debrief Form - HAYES, Jackson 20200506	AGM.005.001.0354
ERT Debrief Form - WOODROW, Stephen 20200605	AGM.005.001.0357
ERT Debrief Form - LACEY, Beau 20200506	AGM.005.001.0363
ERT Debrief Form - MAGGS, Adam	AGM.005.001.0369
ERT Debrief Form - SMITH, Mick 20200506	AGM.005.001.0375
ERT Debrief Form - BADKE, John 2020506	AGM.005.001.0377
ERT Debrief Form - POULTER, Simon 20200506	AGM.005.001.0381
ERT Debrief Form - RYAN, Andy 20200506	AGM.005.001.0387
ERT Debrief Form - GUNN, Matt 20200506	AGM.005.001.0393
ERT Debrief Form - DITCHBURN, Jason 20200506	AGM.005.001.0407
ERT Debrief Form - BELL, Todd 2020506	AGM.005.001.0413
ERT Debrief Form - BARRY, Thomas 20200506	AGM.005.001.0419
ERT Debrief Form - SWEENEY, R 20200506	AGM.005.001.0425
ERT Debrief Form - CHARACHLIS, Aaron 20200506	AGM.005.001.0431
ERT Debrief Form - FRENCH, Grant 20200506	AGM.005.001.0437
ERT Debrief Form - HUTTON, Dylan 20200506	AGM.005.001.0443
ERT Debrief Form - DOWD, Jamie 20200606	AGM.005.001.0449

Exhibit List M – 24 March 2021

ERT Debrief Form - KINGSTONE, Mace 2020506	AGM.005.001.0455
Shift Statutory Report 10/03/2020 Night Shift	AGM.011.001.2193
Shift Statutory Report 17/03/2020 Night Shift	AGM.011.001.2195
Shift Statutory Report 23/03/2020 Night Shift	AGM.003.002.3196
Shift Statutory Report 24/03/2020 Night Shift	AGM.011.001.2200
Shift Statutory Report 31/03/2020 Night Shift	AGM.011.001.2202
Shift Statutory Report 07/04/2020 Afternoon Shift	AGM.011.001.2205
Shift Statutory Report 07/04/2020 Night Shift	AGM.011.001.2207
Shift Statutory Report 14/04/2020 Night Shift	AGM.011.001.2209
Shift Statutory Report 15/04/2020 Day Shift	AGM.011.001.2212
Shift Statutory Report 18/04/2020 Night Shift	AGM.011.001.2214
Shift Statutory Report 21/04/2020 Night Shift	AGM.011.001.2216
Shift Statutory Report 24/04/2020 Afternoon Shift	AGM.011.001.2218
Shift Statutory Report 24/04/2020 Night Shift	AGM.011.001.2221
Shift Statutory Report 25/04/2020 Day Shift	AGM.011.001.2224
Shift Statutory Report 30/04/2020 Day Shift	AGM.003.002.5408
Shift Statutory Report 30/04/2020 Night Shift	AGM.011.001.2231
Shift Statutory Report 02/05/2020 Afternoon Shift	AGM.011.001.2241
Shift Statutory Report 03/05/2020 Day Shift	AGM.011.001.2243
Shift Statutory Report 05/05/2020 Night Shift	AGM.011.001.2245
Statutory Declaration of Keith Brennan	BKE.002.001.0001
Statutory Declaration of Malcolm Brownett	BTM.001.001.0001
Statutory Declaration of Richard Gouldstone	GRO.001.001.0001
Statutory Declaration of Matt Kennedy	KMT.001.001.0001
Statutory Declaration of Wolfgang (Fritz) Djukic	DFR.001.001.0001
Statutory Declaration of Geoff Nugent	NGE.001.001.0001
Statutory Declaration of Stephen Smith	SST.002.001.0001
Statutory Declaration of John Tolhurst	TJO.001.001.0001
MRE on 09/02/2016 - Grosvenor Coal Mine Investigation	RSH.002.241.0001
MRE on 15/12/2016 - Grosvenor Coal Mine Investigation	RSH.002.255.0001
MRE on 03/05/2017 – Inspection Unannounced	RSH.002.257.0001
MRE on 04/05/2017 – Site Meeting	RSH.002.258.0001

Exhibit List M – 24 March 2021

MRE on 18/01/2018 – Inspection	RSH.002.266.0001
MRE on 16/03/2018 – Postal Mine Record Entry	RSH.002.269.0001
MRE on 19/03/2018 – Site Meeting	RSH.002.270.0001
MRE on 09/05/2018 – Subject Audit or Specific System Audit	RSH.002.272.0001
MRE on 09/05/2018 – Site Meeting	RSH.002.273.0001
MRE on 06/08/2018 – Inspection	RSH.002.274.0001
MRE on 21/09/2018 – Inspection	RSH.002.275.0001
MRE on 11/12/2018 – Inspection	RSH.002.276.0001
MRE on 13/03/2019 – Inspection	RSH.002.277.0001
MRE on 03/06/2020 - Grosvenor Coal Mine Investigation	RSH.003.001.1641
MRE on 04/06/2020 - Grosvenor Coal Mine Investigation	RSH.003.001.1642
MRE on 11/06/2020 - Grosvenor Coal Mine Investigation	RSH.003.001.1645
MRE on 06/05/2020 - Grosvenor Coal Mine Emergency Response	RSH.003.001.1651
MRE on 07/05/2020 - Grosvenor Coal Mine Investigation	RSH.003.001.1654
MRE on 08/05/2020 - Grosvenor Coal Mine Investigation	RSH.003.001.1657
MRE on 09/05/2020 - Grosvenor Coal Mine Compliance Action	RSH.003.001.1660
MRE on 09/05/2020 - Grosvenor Coal Mine Investigation	RSH.003.001.1664
MRE on 10/05/2020 - Grosvenor Coal Mine Investigation	RSH.003.001.1667
MRE on 11/05/2020 - Grosvenor Coal Mine Investigation	RSH.003.001.1670
MRE on 20/05/2020 - Grosvenor Coal Mine Investigation	RSH.003.001.1681
MRE on 21/05/2020 - Grosvenor Coal Mine Investigation	RSH.003.001.1682
MRE on 21/05/2020 - Grosvenor Coal Mine Investigation	RSH.003.001.1683
MRE on 22/05/2020 - Grosvenor Coal Mine Investigation	RSH.003.001.1685
MRE on 23/05/2020 - Grosvenor Coal Mine Investigation	RSH.003.001.1687
MRE on 24/05/2020 - Grosvenor Coal Mine Investigation	RSH.003.001.1688
MRE on 25/05/2020 - Grosvenor Coal Mine Investigation	RSH.003.001.1689
MRE on 26/05/2020 - Grosvenor Coal Mine Investigation	RSH.003.001.1690
MRE on 27/05/2020 - Grosvenor Coal Mine Investigation	RSH.003.001.1691
MRE on 29/05/2020 - Grosvenor Coal Mine Investigation	RSH.003.001.1696
MRE on 29/05/2020 - Grosvenor Coal Mine Investigation (2)	RSH.003.001.1694
Venting Trial Report – Grosvenor Mine 26/08/2019	AGM.012.001.0003
Daily Goaf Drainage Report 01/05/2020	AGM.012.001.0021

Exhibit List M – 24 March 2021

Increased Goaf Drainage email from Trent Griffiths 01/05/2020 at 12:14	AGM.012.001.0024
Increased Goaf Drainage email from Trent Griffiths 02/05/2020 at 12:53	AGM.012.001.0071
Increased Goaf Drainage email from Gary Needham 01/05/2020 at 13:24	AGM.012.001.0140
Increased Goaf Drainage email Trent Griffiths 01/05/2020 at 08:46	AGM.012.001.0151
FORM 1A Notice of Confirmation for LW103 TG Methane Exceedance	RSH.001.002.0304
FORM 1A Notice of Confirmation for LW103 TG Methane Exceedance	RSH.001.002.0309
SSHR Underground Monthly Inspection on 27/09/2019	AGM.004.001.0011
Ventilation Officer Appointment of Haydon Hearne 12/12/2019	AGM.002.001.2155
Recognised Standard 16, Version 1	BOI.019.001.0001
Technical Data Sheet - Bevedol S21 - Bevedan 1F	BOI.020.001.0001
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Longwall 104 Walk-Through	BOI.027.001.0001
Wang, G., T.X. Ren, and C. Cook, Goaf frictional ignition and its control measures in underground coal mines	LOW.001.002.0001
Ward, C., A. Crouch, and D. Cohen, Identification of potential for methane ignition by rock friction in Australian coal mines	LOW.001.003.0001
Crisp Notes on 11/01/2020	RSH.002.057.0001
Directive issued on 07/05/2020 – Emergency Response	RSH.003.001.1540
Directive issued on 09/05/2020 – Compliance Action	RSH.003.001.1544
Directive issued on 15/12/2016 – Inspection	RSH.002.238.0001
Directive issued on 09/05/2017 – Site Meeting	RSH.002.239.0001
Murray Nystrom Qualification Summary	RSH.019.001.0227
Recognised Standard 16, Version 2	RSH.024.035.0001
Grosvenor Leg Pressure Yield Event Map 20200417 060000 to 20200420 000000	RSH.034.001.0001
Grosvenor Leg Pressure Yield Event Map 20200503 200000 to 20200506 160000	RSH.034.002.0001
ACARP report C5031 Better Indicators of Spontaneous Combustion	WMA.003.001.0001
Clarkson F (2005) Results of Self-Heating Tests of Australian Coal Conducted in a 16m ³ reactor	WMA.003.002.0001

Exhibit List M – 24 March 2021

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Cliff, D, Brady, D & Watkinson, M 2018 2nd ed, Spontaneous Combustion in Australian coal mines, referred to as - The Green Book, SIMTARS, Redbank, Australia	WMA.003.004.0001
DYWIDAG Systems International Pty Ltd (DSI Underground) technical data sheet TDS Strata Bond HA EN	WMA.003.006.0001
Mines Rescue Service NSW, Emergency Preparedness and Mines Rescue January 1999	WMA.003.016.0001
SIMTARS report OG420172F1 Report draft which was prepared as a result of testing 16 m3 of Goonyella Middle seam coal - Clarkson F 2010, SIMTARS Draft report OG420172F1. SIMTARS RSHQ	WMA.003.031.0001

Exhibit List N – 7 April 2021

DOCUMENT	EXHIBIT NUMBER
GRO-3533-RA-Development Frictional Ignition	RSH.001.018.0001
GRO-6953-RA-Active Goaf Spontaneous Combustion	AGM.011.001.2519
GRO-10672-RA-LW104 First Goaf	RSH.001.048.0001
GRO-3600-RA-Explosion Bowtie	RSH.033.002.0001
GRO-5901-RA-Ventilation	RSH.997.017.0001
GRO-10684-SOP-LW104 Second Workings	AGM.011.001.2248
GRO-8769-SWI-Installing 140Kpa 20 Psi Concrete Seal	AGM.011.001.2307
GRO-8797-SWP-Installing 140Kpa - 10 Metre Bulkhead	AGM.011.001.2330
GRO-10685-HMP-LW104 First Goaf	RSH.001.049.0001
GRO-8396-TARP-Faceline 102 First Pass Driveage	AGM.002.001.0667
GRO-PMT-LW104-002	AGM.002.001.1170
GRO-8279-FRM-Underground Inertisation Authorisation 03/04/2020	AGM.011.001.2353
GRO-8279-FRM-Underground Inertisation Authorisation 04/04/2020	AGM.011.001.2355
GRO-8279-FRM-Underground Inertisation Authorisation 15/04/2020	AGM.011.001.2359
GRO-8279-FRM-Underground Inertisation Authorisation 15/04/2020	AGM.013.001.0005
GRO-8279-FRM-Underground Inertisation Authorisation 25/05/2020	AGM.011.001.2361
Learning From Incidents (LFI) Investigation Report for serious accident on 06/05/2020	AGM.006.001.0042
LW104 Face Mapping 02/05/2020	AGM.002.001.0014
25001-Ventilation Plan Signed 15/04/2020	RSH.002.385.0001
25001-Ventilation Plan 15/04/2020	AGM.011.001.2518
25001-Ventilation Plan 23/06/2020	AGM.003.001.0451
LW104 Hazard Plan Scan 26/02/2020	AGM.003.001.0607
Shift Statutory Report 24/03/2020 Day Shift	AGM.003.002.3217
Shift Statutory Report 24/03/2020 Afternoon Shift	AGM.003.002.3238
Shift Statutory Report 29/04/2020 Night Shift	AGM.003.002.5384
Shift Statutory Report 30/04/2020 Afternoon Shift	AGM.003.002.5427
Shift Statutory Report 01/05/2020 Day Shift	AGM.003.002.5463
Shift Statutory Report 01/05/2020 Afternoon Shift	AGM.003.002.5492

Exhibit List N – 7 April 2021

Shift Statutory Report 05/05/2020 Night Shift	AGM.003.002.5762
Shift Statutory Report 06/05/2020 Day Shift	AGM.003.002.5779
Ventilation & Gas Advice 02/06/2020	AGM.011.001.0065
Ventilation & Gas Advice 03/06/2020	AGM.011.001.0102
Ventilation & Gas Advice 03/06/2020 – Compliance	AGM.011.001.0104
Ventilation & Gas Advice 3/06/2020 – Compliance Signed	AGM.011.001.0105
Ventilation & Gas Advice 3/06/2020 – Longwall	AGM.011.001.0107
Ventilation & Gas Advice 3/06/2020 – Ventilation	AGM.011.001.0108
Ventilation & Gas Advice 04/06/2020	AGM.011.001.0162
Ventilation & Gas Advice 04/06/2020 – Engineering	AGM.011.001.0163
Ventilation & Gas Advice 04/06/2020 – Compliance	AGM.011.001.0164
Ventilation & Gas Advice 04/06/2020 – Seamgas	AGM.011.001.0165
Inertisation Plan LW104 – 14/06/2020 1600	AGM.011.001.2306
25004 - Inertisation Range 27/04/2020	AGM.011.001.2304
New South Wales Windblast Guide	BOI.031.001.0001
Statement of Wayne David Sellars	SWA.001.001.0001
Statutory Declaration of Paul Brown	BPA.002.001.0001
Statutory Declaration of Guy Harvey	HGU.001.001.0001
Statutory Declaration of Neville Atkinson	ANE.001.001.0001
Coal mine worker statement excerpts	BOI.039.001.0001
GeoGAS Report – Gas Emission, Gas Management Assessment Grosvenor Mine 2011 – Draft	RSH.002.394.0001
LW104 Gas Make	RSH.038.002.0001
Skid Data Export	AGM.011.001.2363
Gas Plant Pressure Trends	AGM.011.001.2517
Gasplant Alarm	AGM.011.001.2535
Email - Increased Goaf Drainage 01/05/2020	AGM.012.001.0001
Goaf Drainage Data - TG104 11/05/2020	AGM.013.001.0018
Summary of Investigative Steps	RSH.044.001.0001
Floxal H07 & H08 Flowrates	AGM.011.001.2305
GRO-9458-FRM-PUR & URS Application Report 03/05/2020	AGM.003.003.0129
GAB Site Visit - 2018 Quarter 4 Summary and Action Report	RSH.019.001.0143
GAB Site Visit - 2019 Quarter 3 Minutes	RSH.019.001.0150

Exhibit List N – 7 April 2021

GAB Site Visit - 2019 Quarter 4 Minutes	RSH.019.001.0161
GAB Site Visit - 2019 Quarter 2 Minutes	RSH.019.001.0167
GAB Site Visit - 2019 Quarter 1 Summary and Action Report	RSH.019.001.0174
GAB Site Visit - 2018 Quarter 3 Summary and Action Report	RSH.019.001.0181
Meeting Minutes – TEM-SMRT - CH4002 02/05/2020	RSH.019.001.0001
Daily GOAF Drainage Report 04/03/2021	AGM.013.001.0007
Amended Daily GOAF Drainage Report 30/04/2020	AGM.013.001.0019
Daily GOAF Drainage Report 06/05/2020 at 5:54am	AGM.013.001.0022
Daily GOAF Drainage Report 05/05/2020 at 17:54pm	AGM.013.001.0025
Daily GOAF Drainage Report 05/05/2020 at 5:32am	AGM.013.001.0028
Daily GOAF Drainage Report 04/05/2020 at 6:00am	AGM.013.001.0031
Daily GOAF Drainage Report 03/05/2020 at 5:59am	AGM.013.001.0034
Daily GOAF Drainage Report 02/05/2020 at 5:59am	AGM.013.001.0037
Daily GOAF Drainage Report 01/05/2020 at 5:44am	AGM.013.001.0040
Daily GOAF Drainage Report 04/05/2020 at 17:56pm	AGM.013.001.0043
Daily GOAF Drainage Report 30/04/2020 at 18:11pm	AGM.013.001.0046
Daily GOAF Drainage Report 30/04/2020 at 5:43am	AGM.013.001.0050
Daily GOAF Drainage Report 03/05/2020 at 18:25pm	AGM.013.001.0053
Daily GOAF Drainage Report 02:05/2020 at 18:05pm	AGM.013.001.0057
Daily GOAF Drainage Report 01/05/2020 at 18:00pm	AGM.013.001.0060
Report of James Munday	JMU.001.001.0001
Further Report of James Munday	JMU.001.002.0001
Grosvenor Mine – Gas Management Assessment 01/05/2020 - Draft	RSH.002.395.0001
Roy Moreby 2010, Grosvenor – Life of Mine Ventilation Strategy	RSH.002.401.0001
Ventilation Pressure/Quantity Survey and Model Rebuild at Anglo's Grosvenor Mine, May 2019 (GRO-19 04)	RSH.002.411.0001
Grosvenor Mine Longwall Geotechnical Modelling Study, Report no. 17750	RSH.019.001.0004
Grosvenor Mine Immediate Roof Strata Characterisation Study, Report no. 18800	RSH.019.001.0041
Grosvenor Mine LW103-104 Take-off Strata Review, Project no. 30033676	RSH.019.001.0088
AAMC SD 23-35-220 Operations Management System Underground Mine Planning, Version 2, 29 January 2016	AAMC.008.018.0003

Exhibit List N – 7 April 2021

Wieckowski & Ors, Effect of flow rates of gases flowing through a coal bed during coal heating and cooling on concentrations of gases emitted and fire hazard assessment	AGM.016.002.0001
Hancock & Ors, Computer Animation of Hot Spot Development in Bulk Coal as an Aid for Training Coal Miners	AGM.016.003.0001
Dr Rao Balusu, Responses to the Questions from the Queensland Coal Mining Board of Inquiry	BAL.001.001.0001
ACARP Report C12020, Proactive Inertisation Strategies and Technology Development by Rao Balusu, Ting X Ren and Patrick Humphries	BOI.036.001.0001
Proactive goaf inertisation for controlling longwall goaf heatings by Ting Xiang Ren and Rao Balusu	BOI.036.002.0001
N. Szlazak, D. Obracaj, J Swolkien, Enhancing Safety in the Polish High-Methane Coal Mines: an Overview	BOI.999.001.0001
ACIRL report, Investigation into the Potential for the Development of Spontaneous Combustion Initiated by the Use of Polyurethane Resin or Cementitious Grout during Strata Stabilisation at North Goonyella Mine, December 1999	RSH.035.002.0001
Reports by Dr Basil Beamish – B3 Technical Report – 2019TR019 Anglo American Grosvenor – FINAL	WMA.003.018.0001
Reports by Dr Basil Beamish – CB3 Technical Report – 2014TR009 Anglo American Grosvenor Mine – FINAL	WMA.003.019.0001
Reports by Dr Basil Beamish – CB3 Technical Report – 2014TR047 Anglo American Grosvenor – DRAFT	WMA.003.021.0001

Exhibit List O – 9 April 2021

DOCUMENT	EXHIBIT NUMBER
GRO-10224-SWI-Application of Phenolic Cavity Resin	AGM.012.001.0194
GRO-10322-SWI-Consolidation Chemical Pod Restocking and Cleaning (Surface)	AGM.012.001.0213
GRO-10826-SWI-Application of Rocsil Foam for Remote Sealing	AGM.012.001.0263
GRO-7857-SWI Pumping Mineral Bond	AGM.012.001.0289
GRO-9456-SWI-Application of Polyurethane Resin (PUR) and Urea Silicate Resin (USR)	RSH.024.003.0001
GRO-7440-SWI- Taking a bag Sample	WMA.003.009.0001
GRO-7612-SWI-Taking Bag Sample	WMA.003.010.0001
GRO-7918-RA-Mineral Bond Strata Support	AGM.012.001.0489
GRO-10460-RA-Minova to DSI Transition	AGM.012.001.0365
GRO-10607-RA-PUR Pumping From DD	AGM.012.001.0379
GRO-10808-RA-Remote Sealing of LW104	AGM.012.001.0391
GRO-1367-RA-Spontaneous Combustion	AGM.012.001.0419
GRO-3596-RA-Fire Fighting Prevention, Resources and Equipment	AGM.012.001.0455
GRO-7918-RA-Mineral Bond Strata Support	RSH.024.054.0001
GRO-1486-RA-Use of Polymeric Chemicals for Strata Consolidation and Sealing	RSH.024.001.0001
GRO-5026-HMP-Use of Polymeric Chemicals	AGM.012.001.0272
GRO-10329-CMR-Application of Cavity Agent Behind Longwall Shields	AGM.012.001.0221
GRO-6953-TARP-Active Goaf Spontaneous Combustion	WMA.003.008.0001
GRO-5431-PRO-Strata Management Procedure	RSH.024.073.0001
GRO-5833-TARP-Longwall Strata Control	RSH.024.056.0001
GRO-1430-TARP-Goaf and UIS Gas Drainage Management	RSH.024.070.0001
GRO-1367-RA-Spontaneous Combustion	AGM.015.002.0035
Longwall 104 Fly Through	AGM.003.001.2271

Exhibit List O – 9 April 2021

Footage – Camera recording at the time of the serious accident – Roadway 4 Inbye	AGM.003.001.2150
Footage – Camera recording at the time of the serious accident – Roadway 4 Outbye	AGM.003.001.2158
Footage – Camera recording at the time of the serious accident – Bretby	AGM.003.001.2166
Email from Wouter Niehaus to Keith Brennan Re Notice of Confirmation for HPI 1 and HPI2	AAMC.001.009.0745
Incident Notification 23/07/2019	RSH.002.116.0001
Incident Notification on 02/07/2019	RSH.002.109.0001
Grosvenor Production Forecast 31/07/2019	AGM.003.001.0025
Action Plan Status with Completion Comments	AGM.003.001.0342
Action Plan AP.00798281 – Spontaneous Combustion on 12/08/20	AGM.015.002.0001
Future goaf drainage upgrade vacuum plant Aug 2019	AGM.003.001.0128
Enablon Task TS.01086436 for LW103 HPI on 15/07/2019	AGM.003.001.0151
Enablon Task TS.01080969 for LW103 HPI on 23/07/2019	AGM.003.001.0209
Enablon Task TS.01086346 for LW103 HPI	AGM.003.001.0300
Enablon Task TS.01148244 for LW103 HPI on 19/10/2019	AGM.003.001.0401
Enablon Task TS.01148247 for LW103 HPI on 19/10/2019	AGM.003.001.0406
Enablon Task TS.01380164 for sampling on 12/08/2020	AGM.015.002.0004
Enablon Task TS.01055409 for DSI vs. Minova Product comparison	RSH.024.067.0001
Enablon Task TS.01055411 on 27/06/2019 for DSI trials of polymeric chemicals	RSH.024.069.0001
Enablon Task TS.01150023 for PHMP Methane Drainage 13/11/2019	AGM.015.001.0031
Email from Gary Needham on 28/01/2020 Re: Enablon Actions	AGM.010.003.0031
Email from Trent Griffiths on 23/07/2020 Re: Enablon Action extension	AGM.010.003.0033
Email from Trent Griffiths on 26/02/2020 Re: Enablon Action extension	AGM.010.003.0036

Exhibit List O – 9 April 2021

Email from Gary Needham on 23/10/2020 Re: Enablon Action Extensions	AGM.015.001.0034
Production Reports 17/04/2020 – DS and AS	AGM.003.001.1053
Production Reports 01/05/2020 – NS	AGM.003.001.1254
Production Reports 02/05/2020 – DS and AS	AGM.003.001.1259
Production Reports 02/05/2020 – NS	AGM.003.001.1269
Production Reports 03/05/2020 – DS and AS	AGM.003.001.1274
Production Reports 03/05/2020 – NS	AGM.003.001.1283
Production Reports 04/05/2020 – DS and AS	AGM.003.001.1288
Production Reports 04/05/2020 – NS	AGM.003.001.1298
Production Reports 05/05/2020 – DS and AS	AGM.003.001.1303
Production Reports 05/05/2020 – NS	AGM.003.001.1313
Production Reports 06/05/2020 – DS	AGM.003.001.1320
Shift Statutory Report 16/04/2020 – AF	AGM.003.002.4597
Shift Statutory Report 16/04/2020 – AF	RSH.024.027.0001
Shift Statutory Report 17/04/2020 – DS	AGM.003.002.4635
Shift Statutory Reports 03/05/2020 – NS	AGM.003.002.5629
Shift Statutory Reports 03/05/2020 – NS	RSH.024.050.0001
Shift Statutory Reports 05/05.2020 – AF	AGM.003.002.5749
Email from Trent Griffiths to Logan Mohr Re Grosvenor Gas Plan	AGM.005.002.0434
Form 5A for Grosvenor LW103 TG – HPI on 14/07/2019 (HPI 4)	RSH.001.002.0020
Email dated 02/04/2020 from Stephen Smith to Grosvenor Mine re CH4 Monitors	RSH.002.029.0001
Email dated 04/07/2019 Grosvenor Mine to Keith Brennan re CH4	RSH.002.095.0001
Email from Stephen Smith on 02/04/2020 Re. Gas Monitors	RSH.002.043.0001
Directive on 06/10/2016 – Compliance Action	RSH.002.237.0001
Directive on 09/04/2020 – Non-compliant gas monitoring	RSH.002.032.0001
MRE on 09/04/2020 – Postal Mine Record Entry	RSH.002.034.0001

Exhibit List O – 9 April 2021

MRE on 09/04/2020 – Postal Mine Record Entry	RSH.002.036.0001
MRE on 02/07/2019 – Inspection	RSH.002.137.0001
MRE on 19/02/2020 – Inspection Unannounced	RSH.002.160.0001
MRE on 19/03/2020 – Inspection	RSH.002.163.0001
MRE on 15/04/2020 – Inspection	RSH.002.164.0001
MRE on 21/09/2016 – Inspection	RSH.002.253.0001
MRE on 21/09/2016 – Inspection	RSH.002.254.0001
MRE on 13/10/2017 – Postal Mine Record Entry	RSH.002.262.0001
MRE on 20/10/2017 – Site Meeting	RSH.002.263.0001
MRE on 09/01/2018 – Inspection	RSH.002.265.0001
MRE on 20/02/2018 – Inspection Unannounced	RSH.002.267.0001
MRE on 08/08/2019 – Site Meeting	RSH.002.141.0001
Grosvenor Mine Plan	RSH.036.058.0001
GRO-PMT-LW104 Permit to Mine 001	AGM.002.001.1167
Grosvenor Organisational Management Plan	AGM.002.001.2256
Mine Fill LF Component A – DSI Safety Data Sheet	DSI.001.001.0001
Mine Fill LF Component B – DSI Safety Data Sheet	DSI.001.002.0001
Mine Fill LF II Cured Material – DSI Safety Data Sheet	DSI.001.003.0001
Mine Fill – DSI Technical Data Sheet	DSI.001.043.0001
Mine Fill LF II German Test Report – 23/07/2018	RSH.024.066.0001
Strata Bond HA – DSI Technical Data Sheet	DSI.001.008.0001
Strata Bond HA – DSI Technical Data Sheet	DSI.001.096.0001
Strata Bond HA Component A – DSI Underground Safety Data Sheet	DSI.001.098.0001
Strata Bond HA Component B – DSI Safety Data Sheet	DSI.001.099.0001
Strata Bond Cured Material Resin – DSI Safety Data Sheet	DSI.001.102.0001
Strata Bond German Test Report – 03/04/2014	RSH.024.074.0001

Exhibit List O – 9 April 2021

DSI Transport, Handling and Application of MineFill Phenolic Foam Cavity Filler – Risk Assessment Report	DSI.001.010.0001
Mastermyne Risk Assessment on Handling and Application of MineFill Phenolic Foam Resin for Cavity Filling – November 2014	DSI.001.011.0001
DSI Underground Risk Assessment on Transport, Handling and Application of Strata Bond HA and Mineral Bond LV Polymeric Injection Resins – July 2017	DSI.001.014.0001
DSI Underground Risk Assessment on Handling and Application of Polymeric Injection Resins for Strata stabilisation – August 2014	DSI.001.015.0001
DSI SWP Storage and Pumping of Mine Fill	DSI.001.016.0001
DSI SWP Storage and Pumping of Mine Fill	DSI.001.065.0001
DSI SWP Storage and Pumping of PUR-USR	DSI.001.017.0001
DSI Underground Installation of bolts packers and feedpipes	RSH.024.007.0001
Resin Injection Lance	DSI.001.020.0001
DSI Injection Products – Mechanical Data and Reaction Temperature	DSI.001.035.0001
DSI Underground management structure	DSI.001.048.0001
DSI Polymeric Product Trial Report 17/06/2019	RSH.024.068.0001
DSI Management Plan	DSI.001.051.0001
DSI Contractor Management Procedure	DSI.001.053.0001
DSI Underground Risk Assessment on Transport, Handling and Application of Strata Bond HA and Mineral Bond LV Polymeric Injection Resins – July 2017	DSI.001.054.0001
DSI Risk Assessment Change Analysis on Surface Pumping of Polymeric Chemicals for Underground Applications – March 2018	DSI.001.055.0001
DSI letterhead – Resin Injection Report	RSH.024.046.0001
DSI Installation of GRP Bolts, Packers and Feedpipes	DSI.001.068.0001
NSW Test Report – DSI Strata Bond HA – 17/07/2014	DSI.001.089.0001
NSW Test Report – Grey Sheeting – 09/05/2014	RSH.036.040.0001
NSW Test Report – Mine Fill – 14/02/2019	RSH.024.065.0001
NSW Test Report – Strata Bond – 17/11/2014	RSH.024.010.0001

Exhibit List O – 9 April 2021

NSW Polymeric Licence – MLA 0004883 – 01/072019	RSH.024.009.0001
Approval notification for Strata Bond – Arnsberg	RSH.024.008.0001
Approval notification for Mine Fill – Arnsberg	RSH.024.064.0001
LW104 Face Profile MG Ch4100 20/04/2020 - AS	RSH.024.012.0001
LW104 Face Profile MG Ch4112 18/04/2020 - AS	RSH.024.013.0001
LW104 Face Profile MG Ch4119 15/04/2020 - AS	RSH.024.014.0001
LW104 Face Profile MG Ch4121 14/04/2020 - DS	RSH.024.015.0001
LW104 Face Profile MG Ch3997 04/05/2020 - DS	RSH.024.029.0001
LW104 Face Profile MG Ch4002 02/05/2020 - DS	RSH.024.030.0001
TEM-SMRT Meeting Minutes LW104 CH4122 12/04/2020	RSH.024.016.0001
TEM-SMRT Meeting Minutes LW104 CH4122 13/04/2020	RSH.024.018.0001
TEM-SMRT Meeting Minutes LW104 CH4122 14/04/2020	RSH.024.021.0001
TEM-SMRT Meeting Minutes LW104 CH4118 15/04/2020	RSH.024.023.0001
TEM-SMRT Meeting Minutes LW104 CH4104 19/04/2020	RSH.024.025.0001
TEM-SMRT Meeting Minutes LW104 CH4002 02/05/2020	RSH.024.031.0001
LW104 Ch4121 Void Fill 13/04/2020 – 20707b	RSH.036.038.0001
LW104 Ch4122 Void Fill 12/04/2020 – 20696	RSH.024.017.0001
LW104 Ch4122 Void Fill 12/04/2020 – 20696	RSH.024.020.0001
LW104 Ch4122 Face Consolidation Plan 12/04/2020 – 20705	RSH.024.019.0001
LW104 Ch4121 Void Fill 13/04/2020 – 20705b	RSH.024.022.0001
LW104 Ch4118 Face Consolidation Plan 15/04/2020 – 20707	RSH.024.024.0001
LW104 Ch4104 Void Fill 19/04/2020 – 20709	RSH.024.026.0001
LW104 Ch4002 Face Consolidation Plan 02/05/2020 – 20715	RSH.024.032.0001
LW104 Ch4002 Face Consolidation Plan 02/05/2020 – 20715	AGM.002.001.0017
LW104 Ch4002 Void Fill 02/05/2020 – 20715	RSH.024.033.0001
LW104 Ch4002 Void Fill 02/05/2020 – 20715	AGM.002.001.0018
FRM-PUR & URS Application Report – 03/05/2020	RSH.024.028.0001

Exhibit List O – 9 April 2021

FRM-PUR & URS Application Report – 16/04/2020	RSH.024.011.0001
FRM-Phenolic Cavity Fill Application Report – 14/04/2020	RSH.024.041.0001
FRM-Phenolic Cavity Fill Application Report – 14/04/2020	RSH.024.042.0001
FRM-Phenolic Cavity Fill Application Report – 16/04/2020	RSH.024.043.0001
FRM-Phenolic Cavity Fill Application Report – 02/05/2020	RSH.036.034.0001
GRO-2985-FRM-Permit To Work Pump Strata Consolidation Chemicals	RSH.024.057.0001
GRO-5168-FRM-Contractor Permit to Work 09/03/2020 to 09/06/2020	RSH.024.047.0001
GRO Polymeric Chemical Evaluation – DSI vs. Minova 16/07/2019	RSH.024.039.0001
Use of Polymeric Chemicals in QLD Coal Mines 2010	RSH.024.052.0001
Increased Goaf Drainage email from Russell Packham to Gary Needham and Chris Williams	RSH.024.075.0001
Operations Management System – Underground Geotechnical – Issue 4	RSH.036.041.0001
Shift Statutory Report 05/05/2020 Night Shift	WMA.003.027.0001
Tube bundle worksheet 2020	WMA.003.033.0001
Grosvenor Mine Undermanager Shift Report 02/05/2020	WMA.003.014.0001
Grosvenor Mine Undermanager Shift Report 03/05/2020	WMA.003.015.0001
Report by Dr Basil Beamish – CB3 Technical Report 2014TR014 Grosvenor Mine SponComGAS – FINAL	WMA.003.020.0001
Report by Dr Basil Beamish – CB3 Technical Report 2019TR018 Grosvenor Mine SponComGAS – DRAFT	WMA.003.022.0001
Report by Dr Basil Beamish – CB3 Technical Report 2019TR018 Grosvenor Mine SponComGAS – FINAL	WMA.003.023.0001
Report by Dr Basil Beamish – CB3 Technical Report 2019TR018 Grosvenor Mine SponComGAS – FINAL	AGM.015.002.0006
Report by Dr Basil Beamish – Spontaneous Combustion Technical Report Hazard assessment of Coal samples July 2019	RSH.024.040.0001
SIMTARS - Spontaneous Combustions in Australian coal mines – Cliff Brady Watkinson May 2018	RSH.024.051.0001

Exhibit List O – 9 April 2021

Cliff D, Hester C and Boffinger C. 1999. Interpretation of Mine Atmospheres.	WMA.003.005.0001
Grosvenor Mine SGE Analysis 30/06/2017	AGM.015.001.0041
Grosvenor Mine SGE Analysis 27/06/2017	AGM.015.001.0055
Grosvenor Mine SGE Analysis 29/06/2017	AGM.015.001.0097
SIMTARS Review of Frictional Ignition Information	RSH.999.006.0001
FRM-Roadway Dust Sampling Register 30/04/20	AGM.016.001.0003
Grosvenor Results – Roadway Dust Analysis Report No. OM30311	AGM.016.001.0007
Work Scope review DSI Techserve 28/05/2020	RSH.024.058.0001
Work Scope Review DSI Techserve 14/01/2020	RSH.024.059.0001
Work Scope Review DSI Techserve 31/03/2020	RSH.024.062.0001
Outgoing Geotech Handover Sheets – March, April, May 2020	RSH.036.045.001
Contract for Major Services – For Underground Fault Consolidation and Stabilisation Services	RSH.024.053.0001
Contractor Risk Assessment Workshop 15/08/2019	RSH.024.060.0001
Excel figure: GMS15_GA1014D_PV_AT between 17/04 to 26/04	RSH.024.071.0001
Gas Alarm Register 19/04/2020	RSH.024.072.0001

Exhibit List P – 9 April 2021

DOCUMENT	EXHIBIT NUMBER
Frictional Ignition Testing On A Drill Core Sample (DDG214_FI101) From Grosvenor Mine by Thomas Spring, GeoChemPet Services	GEO.001.001.0001
Frictional Ignition Testing On A Drill Core Sample (DDG214_FI102) From Grosvenor Mine by Thomas Spring, GeoChemPet Services	GEO.001.002.0001
Frictional Ignition Testing On A Drill Core Sample (DDG214_FI103) From Grosvenor Mine by Thomas Spring, GeoChemPet Services	GEO.001.003.0001
Frictional Ignition Testing On A Drill Core Sample (DDG214_FI104) From Grosvenor Mine by Thomas Spring, GeoChemPet Services	GEO.001.004.0001
Frictional Ignition Testing On A Drill Core Sample (DDG214_FI105) From Grosvenor Mine by Thomas Spring, GeoChemPet Services	GEO.001.005.0001
Frictional Ignition Testing On A Drill Core Sample (DDG214_FI106) From Grosvenor Mine by Thomas Spring, GeoChemPet Services	GEO.001.006.0001
Frictional Ignition Testing On A Drill Core Sample (DDG214_FI107) From Grosvenor Mine by Thomas Spring, GeoChemPet Services	GEO.001.007.0001
Frictional Ignition Testing On A Drill Core Sample (DDG214_FI108) From Grosvenor Mine by Thomas Spring, GeoChemPet Service	GEO.001.008.0001
Frictional Ignition Testing On A Drill Core Sample (DDG214_FI109) From Grosvenor Mine by Thomas Spring, GeoChemPet Services	GEO.001.009.0001
Frictional Ignition Testing On A Drill Core Sample (DDG295_FI107) From Grosvenor Mine by Thomas Spring, GeoChemPet Services	GEO.001.010.0001
Frictional Ignition Testing On A Drill Core Sample (DDG295_FI106) From Grosvenor Mine by Thomas Spring, GeoChemPet Services	GEO.001.011.0001
Frictional Ignition Testing On A Drill Core Sample (DDG295_FI105) From Grosvenor Mine by Thomas Spring, GeoChemPet Services	GEO.001.012.0001
Frictional Ignition Testing On A Drill Core Sample (DDG295_	GEO.001.013.0001

Exhibit List P – 9 April 2021

FI104) From Grosvenor Mine by Thomas Spring, GeoChemPet Services	
Frictional Ignition Testing On A Drill Core Sample (DDG295_ FI103) From Grosvenor Mine by Thomas Spring, GeoChemPet Services	GEO.001.014.0001
Frictional Ignition Testing On A Drill Core Sample (DDG295_ FI102) From Grosvenor Mine by Thomas Spring, GeoChemPet Services	GEO.001.015.0001
Frictional Ignition Testing On A Drill Core Sample (DDG295_ FI101) From Grosvenor Mine by Thomas Spring, GeoChemPet Services	GEO.001.016.0001
Desktop Review into the Plausibility of Mechanical Interactions Causing the Grosvenor Mine Explosion by Ray Low, UQ Materials Performance	LOW.001.001.0001
Report prepared for SIMTARS: Microscopic analysis of coal particulates collected from Longwall 104, Grosvenor Mine	DAW.001.001.0001
Petrographic investigation of Grosvenor Coal Samples for SIMTARS at UQ June - July 2020	DAW.001.002.0001
SEM investigation of Grosvenor Coal Samples for SIMTARS at UQ on 7th July 2020	DAW.001.003.0001
SEM investigation of Grosvenor Coal Samples for SIMTARS at UQ on 18th June 2020	DAW.001.004.0001
Electrical Fire Examination Report by Marty Denham, QEC Global	DEN.001.001.0001
UQ Fire Report by Martyn McLaggan and Jeronimo Carrascal, Fire Safety Engineering Research group, University of Queensland	MCM.001.001.0001
Assessment of Gas Chromatographic Data - Grosvenor Explosion by Sean Muller, SIMTARS	MSE.001.001.0001
Addendum 1 Assessment of Gas Chromatographic Data - Grosvenor Explosion by Sean Muller, SIMTARS	MSE.002.001.0001
Fire Investigation Report by Murray Nystrom, Australian Forensic Pty Ltd	NMU.001.001.0001
Fire Investigation Report by Murray Nystrom, Australian Forensic Pty Ltd	NMU.001.002.0001
Ignition Testing Report by Mark Parcell, Mine Safety Institute of Australia Pty Ltd	PAR.001.001.0001

Exhibit List P – 9 April 2021

Grosvenor Mine Equipment Assessment – Inspection and electrical tests	PBI.001.001.0001
Rob Thomas - PowerPoint Board of Inquiry	RSH.019.001.0188
Nystrom Report Image 05.jpg	RSH.019.001.0242
Nystrom Report Image 06.jpg	RSH.019.001.0246
Nystrom Report Image 07.jpg	RSH.019.001.0249
Nystrom Report Image 08.jpg	RSH.019.001.0244
Nystrom Report Image 09.jpg	RSH.019.001.0255
Nystrom Report Image 10.jpg	RSH.019.001.0253
Nystrom Report Image 11.jpg	RSH.019.001.0254
Nystrom Report Image 12.jpg	RSH.019.001.0239
Nystrom Report Image 13.jpg	RSH.019.001.0256
Nystrom Report Image 14.jpg	RSH.019.001.0250
Nystrom Report Image 15.jpg	RSH.019.001.0235
Nystrom Report Image 16.jpg	RSH.019.001.0238
Nystrom Report Image 17.jpg	RSH.019.001.0248
Nystrom Report Image 18.jpg	RSH.019.001.0257
Nystrom Report Image 19.jpg	RSH.019.001.0252
Nystrom Report Image 20.jpg	RSH.019.001.0234
Nystrom Report Image 21.jpg	RSH.019.001.0243
Nystrom Report Image 22.jpg	RSH.019.001.0236
Nystrom Report Image 23.jpg	RSH.019.001.0240
Nystrom Report Image 24.jpg	RSH.019.001.0237
Nystrom Report Image 25.jpg	RSH.019.001.0241
Nystrom Report Image 26.jpg	RSH.019.001.0245
Nystrom Report Image 27.jpg	RSH.019.001.0247
Nystrom Report Image 28.jpg	RSH.019.001.0251
Nystrom Photo (1).jpeg	RSH.019.001.0277

Exhibit List P – 9 April 2021

Nystrom Photo (1).jpg	RSH.019.001.0303
Nystrom Photo (2).jpeg	RSH.019.001.0283
Nystrom Photo (3).jpeg	RSH.019.001.0437
Nystrom Photo (4).jpeg	RSH.019.001.0405
Nystrom Photo (5).jpeg	RSH.019.001.0415
Nystrom Photo (6).jpeg	RSH.019.001.0455
Nystrom Photo (7).jpeg	RSH.019.001.0403
Nystrom Photo (8).jpeg	RSH.019.001.0296
Nystrom Photo (9).jpeg	RSH.019.001.0370
Nystrom Photo (10).jpeg	RSH.019.001.0316
Nystrom Photo (11).jpeg	RSH.019.001.0313
Nystrom Photo (12).jpeg	RSH.019.001.0287
Nystrom Photo (13).jpeg	RSH.019.001.0376
Nystrom Photo (14).jpeg	RSH.019.001.0300
Nystrom Photo (15).jpeg	RSH.019.001.0450
Nystrom Photo (16).jpeg	RSH.019.001.0378
Nystrom Photo (17).jpeg	RSH.019.001.0299
Nystrom Photo (18).jpeg	RSH.019.001.0329
Nystrom Photo (19).jpeg	RSH.019.001.0409
Nystrom Photo (20).jpeg	RSH.019.001.0309
Nystrom Photo (21).jpeg	RSH.019.001.0453
Nystrom Photo (22).jpeg	RSH.019.001.0344
Nystrom Photo (23).jpeg	RSH.019.001.0445
Nystrom Photo (24).jpeg	RSH.019.001.0434
Nystrom Photo (25).jpeg	RSH.019.001.0379
Nystrom Photo (26).jpeg	RSH.019.001.0349
Nystrom Photo (27).jpeg	RSH.019.001.0447

Exhibit List P – 9 April 2021

Nystrom Photo (28).jpeg	RSH.019.001.0307
Nystrom Photo (29).jpeg	RSH.019.001.0351
Nystrom Photo (30).jpeg	RSH.019.001.0372
Nystrom Photo (31).jpeg	RSH.019.001.0371
Nystrom Photo (32).jpeg	RSH.019.001.0360
Nystrom Photo (33).jpeg	RSH.019.001.0404
Nystrom Photo (34).jpeg	RSH.019.001.0364
Nystrom Photo (35).jpeg	RSH.019.001.0465
Nystrom Photo (36).jpeg	RSH.019.001.0402
Nystrom Photo (37).jpeg	RSH.019.001.0399
Nystrom Photo (38).jpeg	RSH.019.001.0259
Nystrom Photo (39).jpeg	RSH.019.001.0276
Nystrom Photo (40).jpeg	RSH.019.001.0374
Nystrom Photo (41).jpeg	RSH.019.001.0456
Nystrom Photo (42).jpeg	RSH.019.001.0264
Nystrom Photo (43).jpeg	RSH.019.001.0350
Nystrom Photo (44).jpeg	RSH.019.001.0429
Nystrom Photo (45).jpeg	RSH.019.001.0383
Nystrom Photo (46).jpeg	RSH.019.001.0270
Nystrom Photo (47).jpeg	RSH.019.001.0260
Nystrom Photo (48).jpeg	RSH.019.001.0400
Nystrom Photo (49).jpeg	RSH.019.001.0317
Nystrom Photo (50).jpeg	RSH.019.001.0263
Nystrom Photo (51).jpeg	RSH.019.001.0363
Nystrom Photo (52).jpeg	RSH.019.001.0390
Nystrom Photo (53).jpeg	RSH.019.001.0295
Nystrom Photo (54).jpeg	RSH.019.001.0315

Exhibit List P – 9 April 2021

Nystrom Photo (55).jpeg	RSH.019.001.0289
Nystrom Photo (56).jpeg	RSH.019.001.0438
Nystrom Photo (57).jpeg	RSH.019.001.0388
Nystrom Photo (58).jpeg	RSH.019.001.0341
Nystrom Photo (59).jpeg	RSH.019.001.0467
Nystrom Photo (60).jpeg	RSH.019.001.0338
Nystrom Photo (61).jpeg	RSH.019.001.0430
Nystrom Photo (62).jpeg	RSH.019.001.0266
Nystrom Photo (63).jpeg	RSH.019.001.0331
Nystrom Photo (64).jpeg	RSH.019.001.0394
Nystrom Photo (65).jpeg	RSH.019.001.0354
Nystrom Photo (66).jpeg	RSH.019.001.0362
Nystrom Photo (67).jpeg	RSH.019.001.0418
Nystrom Photo (68).jpeg	RSH.019.001.0468
Nystrom Photo (69).jpeg	RSH.019.001.0401
Nystrom Photo (70).jpeg	RSH.019.001.0421
Nystrom Photo (71).jpeg	RSH.019.001.0466
Nystrom Photo (72).jpeg	RSH.019.001.0417
Nystrom Photo (73).jpeg	RSH.019.001.0413
Nystrom Photo (74).jpeg	RSH.019.001.0288
Nystrom Photo (75).jpeg	RSH.019.001.0444
Nystrom Photo (76).jpeg	RSH.019.001.0290
Nystrom Photo (77).jpeg	RSH.019.001.0391
Nystrom Photo (78).jpeg	RSH.019.001.0395
Nystrom Photo (79).jpeg	RSH.019.001.0423
Nystrom Photo (80).jpeg	RSH.019.001.0431
Nystrom Photo (81).jpeg	RSH.019.001.0335

Exhibit List P – 9 April 2021

Nystrom Photo (82).jpeg	RSH.019.001.0424
Nystrom Photo (83).jpeg	RSH.019.001.0439
Nystrom Photo (84).jpeg	RSH.019.001.0320
Nystrom Photo (85).jpeg	RSH.019.001.0397
Nystrom Photo (86).jpeg	RSH.019.001.0352
Nystrom Photo (87).jpeg	RSH.019.001.0269
Nystrom Photo (88).jpeg	RSH.019.001.0427
Nystrom Photo (89).jpeg	RSH.019.001.0275
Nystrom Photo (90).jpeg	RSH.019.001.0324
Nystrom Photo (91).jpeg	RSH.019.001.0463
Nystrom Photo (92).jpeg	RSH.019.001.0406
Nystrom Photo (93).jpeg	RSH.019.001.0461
Nystrom Photo (94).jpeg	RSH.019.001.0419
Nystrom Photo (95).jpeg	RSH.019.001.0333
Nystrom Photo (96).jpeg	RSH.019.001.0332
Nystrom Photo (97).jpeg	RSH.019.001.0446
Nystrom Photo (98).jpeg	RSH.019.001.0334
Nystrom Photo (99).jpeg	RSH.019.001.0292
Nystrom Photo (100).jpeg	RSH.019.001.0258
Nystrom Photo (101).jpeg	RSH.019.001.0410
Nystrom Photo (102).jpeg	RSH.019.001.0407
Nystrom Photo (103).jpeg	RSH.019.001.0298
Nystrom Photo (104).jpeg	RSH.019.001.0451
Nystrom Photo (105).jpeg	RSH.019.001.0261
Nystrom Photo (106).jpeg	RSH.019.001.0293
Nystrom Photo (107).jpeg	RSH.019.001.0297
Nystrom Photo (108).jpeg	RSH.019.001.0436

Exhibit List P – 9 April 2021

Nystrom Photo (109).jpeg	RSH.019.001.0353
Nystrom Photo (110).jpeg	RSH.019.001.0416
Nystrom Photo (111).jpeg	RSH.019.001.0285
Nystrom Photo (112).jpeg	RSH.019.001.0330
Nystrom Photo (113).jpeg	RSH.019.001.0286
Nystrom Photo (114).jpeg	RSH.019.001.0452
Nystrom Photo (115).jpeg	RSH.019.001.0358
Nystrom Photo (116).jpeg	RSH.019.001.0458
Nystrom Photo (117).jpeg	RSH.019.001.0357
Nystrom Photo (118).jpeg	RSH.019.001.0301
Nystrom Photo (119).jpeg	RSH.019.001.0420
Nystrom Photo (120).jpeg	RSH.019.001.0369
Nystrom Photo (121).jpeg	RSH.019.001.0337
Nystrom Photo (122).jpeg	RSH.019.001.0380
Nystrom Photo (123).jpeg	RSH.019.001.0412
Nystrom Photo (124).jpeg	RSH.019.001.0302
Nystrom Photo (125).jpeg	RSH.019.001.0314
Nystrom Photo (126).jpeg	RSH.019.001.0348
Nystrom Photo (127).jpeg	RSH.019.001.0265
Nystrom Photo (128).jpeg	RSH.019.001.0443
Nystrom Photo (129).jpeg	RSH.019.001.0365
Nystrom Photo (130).jpeg	RSH.019.001.0322
Nystrom Photo (131).jpeg	RSH.019.001.0280
Nystrom Photo (132).jpeg	RSH.019.001.0311
Nystrom Photo (133).jpeg	RSH.019.001.0326
Nystrom Photo (134).jpeg	RSH.019.001.0345
Nystrom Photo (135).jpeg	RSH.019.001.0392

Exhibit List P – 9 April 2021

Nystrom Photo (136).jpeg	RSH.019.001.0304
Nystrom Photo (137).jpeg	RSH.019.001.0271
Nystrom Photo (138).jpeg	RSH.019.001.0274
Nystrom Photo (139).jpeg	RSH.019.001.0306
Nystrom Photo (140).jpeg	RSH.019.001.0381
Nystrom Photo (141).jpeg	RSH.019.001.0267
Nystrom Photo (142).jpeg	RSH.019.001.0342
Nystrom Photo (143).jpeg	RSH.019.001.0328
Nystrom Photo (144).jpeg	RSH.019.001.0425
Nystrom Photo (145).jpeg	RSH.019.001.0411
Nystrom Photo (146).jpeg	RSH.019.001.0310
Nystrom Photo (147).jpeg	RSH.019.001.0291
Nystrom Photo (148).jpeg	RSH.019.001.0343
Nystrom Photo (149).jpeg	RSH.019.001.0339
Nystrom Photo (150).jpeg	RSH.019.001.0366
Nystrom Photo (151).jpeg	RSH.019.001.0368
Nystrom Photo (152).jpeg	RSH.019.001.0268
Nystrom Photo (153).jpeg	RSH.019.001.0262
Nystrom Photo (154).jpeg	RSH.019.001.0384
Nystrom Photo (155).jpeg	RSH.019.001.0361
Nystrom Photo (156).jpeg	RSH.019.001.0281
Nystrom Photo (157).jpeg	RSH.019.001.0278
Nystrom Photo (158).jpeg	RSH.019.001.0457
Nystrom Photo (159).jpeg	RSH.019.001.0359
Nystrom Photo (160).jpeg	RSH.019.001.0321
Nystrom Photo (161).jpeg	RSH.019.001.0435
Nystrom Photo (162).jpeg	RSH.019.001.0294

Exhibit List P – 9 April 2021

Nystrom Photo (163).jpeg	RSH.019.001.0389
Nystrom Photo (164).jpeg	RSH.019.001.0319
Nystrom Photo (165).jpeg	RSH.019.001.0325
Nystrom Photo (166).jpeg	RSH.019.001.0373
Nystrom Photo (167).jpeg	RSH.019.001.0449
Nystrom Photo (168).jpeg	RSH.019.001.0448
Nystrom Photo (169).jpeg	RSH.019.001.0318
Nystrom Photo (170).jpeg	RSH.019.001.0340
Nystrom Photo (171).jpeg	RSH.019.001.0393
Nystrom Photo (172).jpeg	RSH.019.001.0464
Nystrom Photo (173).jpeg	RSH.019.001.0386
Nystrom Photo (174).jpeg	RSH.019.001.0272
Nystrom Photo (175).jpeg	RSH.019.001.0375
Nystrom Photo (176).jpeg	RSH.019.001.0347
Nystrom Photo (177).jpeg	RSH.019.001.0442
Nystrom Photo (178).jpeg	RSH.019.001.0433
Nystrom Photo (179).jpeg	RSH.019.001.0382
Nystrom Photo (180).jpeg	RSH.019.001.0459
Nystrom Photo (181).jpeg	RSH.019.001.0385
Nystrom Photo (182).jpeg	RSH.019.001.0346
Nystrom Photo (183).jpeg	RSH.019.001.0336
Nystrom Photo (184).jpeg	RSH.019.001.0440
Nystrom Photo (185).jpeg	RSH.019.001.0408
Nystrom Photo (186).jpeg	RSH.019.001.0426
Nystrom Photo (187).jpeg	RSH.019.001.0305
Nystrom Photo (188).jpeg	RSH.019.001.0282
Nystrom Photo (189).jpeg	RSH.019.001.0308

Exhibit List P – 9 April 2021

Nystrom Photo (190).jpeg	RSH.019.001.0422
Nystrom Photo (191).jpeg	RSH.019.001.0414
Nystrom Photo (192).jpeg	RSH.019.001.0367
Nystrom Photo (193).jpeg	RSH.019.001.0428
Nystrom Photo (194).jpeg	RSH.019.001.0273
Nystrom Photo (195).jpeg	RSH.019.001.0441
Nystrom Photo (196).jpeg	RSH.019.001.0398
Nystrom Photo (197).jpeg	RSH.019.001.0377
Nystrom Photo (198).jpeg	RSH.019.001.0327
Nystrom Photo (199).jpeg	RSH.019.001.0454
Nystrom Photo (200).jpeg	RSH.019.001.0462
Nystrom Photo (201).jpeg	RSH.019.001.0460
Nystrom Photo (202).jpeg	RSH.019.001.0355
Nystrom Photo (203).jpeg	RSH.019.001.0284
Nystrom Photo (204).jpeg	RSH.019.001.0356
Nystrom Photo (205).jpeg	RSH.019.001.0387
Nystrom Photo (206).jpeg	RSH.019.001.0279
Nystrom Photo (207).jpeg	RSH.019.001.0396
Nystrom Photo (208).jpeg	RSH.019.001.0323
Geotechnical Factors Associated with the Methane Ignition on LW 104 in Grosvenor Mine by Rob Thomas, Strata2	TRO.001.001.0001
Grosvenor Mine May 2020 Incident - Gas, Ventilation and Spontaneous Combustion Systems Review by Andrew Self, Australian Coal Mining Consultants Pty Ltd	SAN.001.001.0001
Comment on the Quantity of PUR Injected into LW 104's Face at the 4005m in the TG by Rob Thomas, Strata2	RSH.022.002.0001
Assessment of Methane Exceedances on LW 104 part of Inspectorate Investigation M20-0007 Grosvenor Explosion by Martin Watkinson, SIMTARS	WMA.001.001.0001
Assessment of Real Time, Tube Bundle and Goaf Skid Data for Signs of Spontaneous Combustion - Grosvenor Explosion by	WMA.001.002.0001

Exhibit List P – 9 April 2021

Martin Watkinson, SIMTARS	
Addendum 1 Assessment of Methane Exceedances on LW 104 part of Inspectorate Investigation M20-0007 Grosvenor Explosion by Martin Watkinson, SIMTARS	WMA.002.001.0001
Addendum 1 Assessment of Real Time, Tube Bundle and Goaf Skid Data for Signs of Spontaneous Combustion – Grosvenor Explosion by Martin Watkinson, SIMTARS	WMA.002.002.0001
Final Report - Supporting Investigation - Gas Reservoir, Emission and Drainage, Grosvenor Coal Mine - methane ignition of 6th May 2020 by Ray Williams, Mahala.com Pty Ltd	WRA.001.001.0001
Addendum 1 to Final Report - Supporting Investigation - Gas Reservoir, Emission and Drainage, Grosvenor Coal Mine - methane ignition of 6th May 2020 by Ray Williams, Mahala.com Pty Ltd	WRA.001.002.0001
Andrew Self CV	RSH.019.001.0513
Sean Muller CV	RSH.019.001.0615
Martin Watkinson CV	RSH.019.001.0574
Rob Thomas CV	RSH.019.001.0185
Ray Williams CV	RSH.019.001.0469
PowerPoint presentation for Board of Inquiry by Ray Williams, Mahala.com	RSH.019.001.0471
PowerPoint presentation for Board of Inquiry by Murray Nystrom, Fire Forensics	NMU.001.003.0001
PowerPoint presentation for Board of Inquiry by Martin Watkinson, SIMTARS	RSH.019.001.0583
Andrew Self - PowerPoint	SAN.001.002.0001
Sean Muller - PowerPoint	BOI.037.001.0001
Martin Watkinson – PowerPoint	BOI.034.001.0001
Basil Beamish PowerPoint	BBA.001.003.0001
PowerPoint presentation SIMTARS - PUR Testing, Bipin Parmar	PBI.999.002.0001
Polyurethane Material Testing - SIMTARS Report E21_0006	PBI.999.001.0001
Queensland Coal Mining Board of Inquiry - A report by Ting Ren of UOW 2021	RET.001.001.0001

Exhibit List P – 9 April 2021

Report of Dr Basil Beamish - 2021TR007 - Goonyella Middle seam	BBA.001.001.0001
Schematics of Ground Conditions Prior to and After Ignition on LW104 by Rob Thomas, Strata2	RSH.022.004.0001
Joint Addendum 1 for reports MT51000010007F2 B and MT510000100070001F3 by Martin Watkinson and Sean Muller, SIMTARS	RSH.032.002.0001
Addendum 2 MT510000100070001F3 by Sean Muller, SIMTARS	RSH.037.002.0001
Addendum 2A MT510000100070001F3 by Sean Muller, SIMTARS	RSH.037.003.0001
LW seal CO and oxygen graphs prepared by Martin Watkinson	RSH.031.002.0001
Addendum Grosvenor Mine May 2020 Incident Gas, Ventilation and Spontaneous Combustion Systems Review by Australian Coal Mining Consultants	RSH.022.001.0001
Bowen Basin Bituminous Coal Animation	AGM.016.001.0001
Ray Williams Addendum Report 16/03/2021	RSH.043.001.0001
Hazard & Incident Report Form from Anglo Coal for loss of PPD Proximity Device on 30 April 2020	RSH.999.026.0001
Screen shot showing date and time PDD 322EA1D (GUNN) was lost on coal face	RSH.999.027.0001
Questions asked by Andrew Clough re achievable annual production rate at Grosvenor mine	BOI.999.015.0001
Response from Andrew Self to questions from Andrew Clough re achievable annual production rate at Grosvenor mine raised	SAN.999.003.0001
Email from Andrew Self re fan pressure monitoring 21/04/2020	SAN.999.002.0001_R
Testing of fixed gas monitors at Grosvenor by SIMTARS	HAA.001.001.0001

Exhibit List Q – 28 May 2021

DOCUMENT	EXHIBIT NUMBER
Statement of Reece Campbell	CRE.001.001.0001
Addendum Statement of Reece Campbell	CRE.001.002.0001
CFMMEU submission regarding the statement of Mr Reece Campbell	CMU.011.001.0001
Email from CFMMEU 15 May 2019 – URGENT Underground SSHR Conference Registration	CMU.010.001.0001
Email from CFMMEU 1 July 2019 – News Flash Fatal accident as open cut coal mine pit wall failed	CMU.010.002.0001
Email from CFMMEU 26 August 2019 – Draeger Customer Statement	CMU.010.003.0001
Email from CFMMEU 26 August 2019 – CABA Safety Newsflash Draeger PSS 5000 air loss	CMU.010.004.0001
Email from CFMME 23 September 2019 – SAVE THE DATE November forums and doctor sessions	CMU.010.005.0001
Email from CFMMEU 26 September 2019 Verification of training records and competencies	CMU.010.006.0001
Email from CFMME 9 January 2020 – Legislation amendment notice 4 Context and explanation of unsupervised access to security sensitive explosives	CMU.010.007.0001
Email from CFMME 14 January 2020 – Legislation amendment notice 5 Security plan requirements	CMU.010.008.0001
Email from CFMMEU 17 January 2020 – Legislation amendment notice 6 Listed corporations must nominate a responsible person after 1 February 2020	CMU.010.009.0001
Email from CFMMEU 28 February 2020 – Combined SSHR Conference 2020	CMU.010.010.0001
Email from CFMMEU 3 March 2020 – Mine Dust Health Support Flyer	CMU.010.011.0001
Email from CFMMEU 18 March 2020 – Mine Safety and Health Matters March 2020	CMU.010.012.0001
Email from CFMMEU 26 March 2020 – SSHR Conference	CMU.010.013.0001
Industry Safety and Health Representative notification of inspection 12 October 2018	CMU.012.001.0001

Exhibit List Q – 28 May 2021

Industry Safety and Health Representative inspection report 24 October 2018	CMU.012.002.0001
MRE on 15/10/2019 - Inspection	RSH.002.145.0001
Email from Mining Inspector Stephen Smith to Shaun Dobson 8/04/2020	RSH.002.030.0001
Email from Inspector Geoff Nugent to DNRME Inspectors 17/04/2020	RSH.002.041.0001
Table of LW103 methane exceedances	AAMC.008.018.0001
Mine Record Entry on 02/07/2019 to inspect LW103 at Grosvenor mine	AAMC.008.017.0003
Mine Record Entry on 08/08/2019 to attend a safety reset meeting at Grosvenor mine	AAMC.008.017.0001
Diagram showing goaf area of LW104	AAMC.008.014.0001
Table of LW104 methane exceedances	AAMC.008.018.0002
Mine Record Entry on 19/03/2020 to conduct an inspection at Grosvenor mine	AGM.002.001.2164
Email from RIOM Stephen Smith to CICM Peter Newman 09/04/2020	RSH.002.040.0001
Footage – Camera recording at the time of the serious accident – Crusher Transfer Point	AGM.003.001.2142
Transcript of interview with Adam Maggs	TRA.510.003.0001
Appointment of ERZ Controller – LANCASTER, Joshua	AGM.002.001.1736
Red Banner Alert for LW103 HPI on 07.11.2019	AGM.003.001.0432
Red Banner Follow Up for LW103 HPI on 07.11.2019	AGM.003.001.0440
Red Banner Alert for LW103 HPI on 14.07.2019	AGM.003.001.0104
Red Banner Alert for LW103 HPI on 22.07.2019	AGM.003.001.0106
Red Banner Alert for LW103 HPI on 21.07.2019	AGM.003.001.0108
Red Banner Follow Up for LW103 HPI on 15.07.2019	AGM.003.001.0122
Red Banner Alert for LW103 HPI on 23.07.2019	AGM.003.001.0173
Red Banner Alert for LW103 HPI on 11.07.2019	AGM.003.001.2530
Red Banner Follow Up for LW103 HPI on 11.07.2019	AGM.003.001.2536

Exhibit List Q – 28 May 2021

Red Banner Alert for LW103 HPI on 11.07.2019	AGM.003.001.2587
UMM Monthly Inspection February 2020	AGM.004.001.0020
UMM Monthly Inspection April 2020	AGM.004.001.0024
Statement of Neal Bryan	AGM.005.001.0339
Appointment of Ventilation Officer – MILNER, Ben	AGM.002.001.2454
Notice to Commence Second Workings LW104 S320 06/03/2020	AGM.002.001.1111
Shift Statutory Report 18/03/2020 – DS	AGM.003.002.2896
Shift Statutory Report 19/03/2020 – DS	AGM.003.002.2953
Shift Statutory Report 20/03/2020 – DS	AGM.003.002.3007
Shift Statutory Report 22/03/2020 – DS	AGM.003.002.3115
Shift Statutory Report 23/03/2020 – DS	AGM.003.002.3166
Shift Statutory Report 04/04/2020 – DS	AGM.003.002.3815
Shift Statutory Report 29/04/2020 – DS	AGM.003.002.5348
Shift Statutory Report 11/03/2020 – DS	AGM.003.002.2533
Shift Statutory Report 21/04/2020 – DS	AGM.003.002.4901
Shift Statutory Report 22/04/2020 – DS	AGM.003.002.4952
Shift Statutory Report 23/04/2020 – DS	AGM.003.002.5021
Shift Statutory Report 05/05/2020 – DS	AGM.003.002.5719
Shift Statutory Report 26/04/2020 – DS	AGM.003.002.5153
Shift Statutory Report 19/03/2020 – DS	AGM.005.002.0383
Shift Statutory Report 22/03/2020 – DS	AGM.005.002.0396
Shift Statutory Report 23/03/2020 – DS	AGM.005.002.0402
Shift Statutory Report 04/04/2020 – DS	AGM.005.002.0404
Shift Statutory Report 21/04/2020 – NS	AGM.005.003.0005
Shift Statutory Report 19/03/2020 – NS	AGM.003.002.2986
Shift Statutory Report 20/03/2020 – NS	AGM.003.002.3037
Shift Statutory Report 21/03/2020 – NS	AGM.003.002.3091

Exhibit List Q – 28 May 2021

Shift Statutory Report 22/03/2020 – NS	AGM.003.002.3145
Shift Statutory Report 04/04/2020 – AS	AGM.003.002.3842
Shift Statutory Report 06/04/2020 – AS	AGM.003.002.3978
Shift Statutory Report 20/04/2020 – NS	AGM.003.002.4874
Shift Statutory Report 22/04/2020 – NS	AGM.003.002.4988
Shift Statutory Report 01/05/2020 – NS	AGM.003.002.5498
Shift Statutory Report 04/05/2020 – AS	AGM.003.002.5679
Shift Statutory Report 05/05/2020 – AS	MSE.003.001.0001
Shift Statutory Reports 16/04/2020 – NS	AGM.003.002.4609
Red Banner Alert for LW103 HPI on 05.07.2019	AGM.003.001.2398
Enablon Task TS.01072788 for LW103 HPI on 23.07.2019	AGM.003.001.0181
Enablon Task TS.01072789 for LW103 HPI on 23.07.2019	AGM.003.001.0183
Enablon Task TS.01072790 for LW103 HPI on 23.07.2019	AGM.003.001.0203
Enablon Task TS.01072791 for LW103 HPI on 23.07.2019	AGM.003.001.0205
Red Banner Alert for LW103 HPI on 24.07.2019	AGM.003.001.0244
Enablon Task TS.01073570 for LW103 HPis on 24.07.2019	AGM.003.001.0256
Enablon Task TS.01073572 for LW103 HPis on 24.07.2019	AGM.003.001.0258
Enablon Task TS.01073575 for LW103 HPis on 24.07.2019	AGM.003.001.0260
Enablon Task TS.01073577 for LW103 HPis on 24.07.2019	AGM.003.001.0294
Enablon Task TS.01059030 export for LW103 HPis on 02.07.2019 & 03.07.2019	AGM.003.001.2406
Enablon Task TS.01059304 export for LW103 HPI on 02.07.2019	AGM.003.001.2410
Enablon Task TS.01059035 for LW103 HPI on 02.07.2019	AGM.003.001.2428
Enablon Task TS.01059020 export for LW103 HPis on 02.07.2019 & 03.07.2019	AGM.003.001.2476
Enablon Task TS.1059021 for LW103 HPis on 02.07.2019 & 03.07.2019	AGM.003.001.2478
Enablon Task TS.01059022 export for LW103 HPI on 03.07.2019	AGM.003.001.2485
Enablon Task TS.01059023 export for LW103 HPI on 03.07.2019	AGM.003.001.2508

Exhibit List Q – 28 May 2021

Enablon Task TS.01065588 for LW103 HPI on 11.07.2019	AGM.003.001.2542
Enablon Task TS.01069050 for LW103 HPI 19.07.2019	AGM.010.001.0127
Enablon Task TS.01069031 for LW103 HPI 19.07.2019	AGM.003.001.2510
Enablon Task TS.01069051 for LW103 HPI 19.07.2019	AGM.003.001.2449
Email from Rob Nowell 02/07/2020 re closing overdue Enablon Tasks assigned to Dr Bharath Belle	AGM.008.001.0276
Email from Trent Griffiths to RIOM Stephen Smith on 09/04/2020 re Postal MRE and Directive	AAMC.001.009.0838
Postal Mine Record Entry on 09/04/2020 – Directive to suspend operation of LW104 until the methane monitoring system in the return roadway is compliant	AAMC.001.009.0842
Directive issued 09/04/2020 by RIOM Stephen Smith – Non-compliant gas monitoring	AAMC.001.009.0844
Postal Mine Record Entry on 09/04/2020 – Directive satisfied	AAMC.001.010.0012
SSHR Underground Monthly Inspection 05/09/2019	AGM.004.001.0005
SSHR Monthly Inspection 03/09/2019	AGM.004.001.0007
August SSHR Meeting Minutes 02/08/2019	AGM.004.001.0026
GRO-3303-HMP-Control of Frictional Ignition	RSH.001.021.0001
GRO-3303-HMP-Control of Frictional Ignition	RSH.001.022.0001
GRO-62-SOP-Changing Gas Alarm Levels	RSH.001.053.0001
GRO-68-SOP-Acknowledging Gas Alarms	RSH.001.054.0001
GRO-69-SOP-Action Taken if Methane is Detected	RSH.001.055.0001
GRO-57-SOP-Mine Ventilation Control Devices	RSH.001.020.0001
ARCHIVED-GRO-8427-Intersecting UG gas drainage boreholes_2	RSH.001.039.0001
ARCHIVED-GRO-8427-Intersecting UG gas drainage boreholes_2	RSH.001.043.0001
GRO-71-SOP-General Backup for Gas Monitoring System	RSH.001.056.0001
LW 104 Panel	AAMC.008.015.0001
Adam Maggs ERZ Controller Appointment 11/02/2015	AGM.002.001.1804
Hazard and Incident Form on 06/05/2020 for ignition of gas on LW 104 face	AGM.006.001.0038

Exhibit List Q – 28 May 2021

TEM-IMT Meeting Minutes for LW104 Spontaneous Combustion – 20/06/2020	AGM.011.001.1337
GRO-8279-FRM-Underground Inertisation Authorisation – Turn On MG103 Chdg 40-41 ct Seal – 17/04/2020	AGM.013.001.0003
GRO-8279-FRM-Underground Inertisation Authorisation – Turn Off MG103 Chdg 40-41 ct Seal – 17/04/2020	AGM.011.001.2357
Stephen Smith Notes 23/03/2020	RSH.002.104.0001
Peter Newman statutory declaration 07/04/2021	RSH.999.019.0001
Bowen Basin Bituminous Coal Animation	AGM.016.004.0001
James Munday Powerpoint presentation	JMU.002.001.0001
Notice of Review Decision for non-compliant gas monitoring from Peter Newman to Trent Griffiths 12/06/2020	RSH.002.042.0001
Email from Kenneth Brennan to DNRME Inspectors 20/02/2020	RSH.002.058.0001
GRO-5026-HMP-Use of Polymeric Chemicals	RSH.024.002.0001
DSI Underground Risk Assessment on Transport Handling and Application of Strata Bond – July 2017	RSH.024.004.0001
DSI Underground risk assessment for Transport Handling and Application of Minefill – June to July 2017	RSH.024.063.0001
DSI Underground Management System Transport Application and Handling Cavity foam and PUR – 05/04/2018	RSH.024.005.0001
DSI Underground SWP Storage and pumping PUR-USE – 09/04/2018	RSH.024.006.0001
GRO-10460-RA-Minova to DSI Transition – 19/07/2019	RSH.024.038.0001
Barometric and Collar Pressures 14 days prior between 23/04/2020 – 06/05/2020	RSH.999.035.0001
Table setting out when LW101, 102, 103 and 104 commenced, ceased and were sealed	AGM.010.002.0001
MRE on 15/10/2019 – Inspection	RSH.002.144.0001
MRE on 15/10/2019 – Inspection	RSH.002.145.0001
Grosvenor Production Forecast 02/03/2020 to 29/03/2020	AGM.003.001.0063
Grosvenor Production Forecast 30/03/2020 to 26/04/2020	AGM.003.001.0068
Grosvenor Production Forecast 27/04/2020 to 05/05/2020	AGM.003.001.0073

Exhibit List Q – 28 May 2021

Email from Trent Griffiths to Logan Mohr FW: Grosvenor Gas Plan	AGM.005.002.0434
Reports by Dr Basil Beamish – B3 Technical Report 2019 TR019 Anglo American Grosvenor DRAFT	WMA.003.017.0001
Grosvenor LW104 Gas Monitoring powerpoint	AGM.002.001.0075
Timeline calculated from CITECT, joy and camera on 06/05/2020	AGM.003.001.2140
TEM-IMT Meeting Minutes for LW 104 CH4 02/05/2020	AGM.013.002.0135
Email forwarding TEM-IMT Meeting Minutes for LW 104 CH4 02/05/2020	AGM.013.002.0173
Learning From Incidents (LFI) Investigation Report 20/11/2019 for HPI on 07/11/2019	AAMC.001.009.0552
25001 Ventilation Plan 16/04/2020	AGM.003.001.0461
25001 Ventilation Plan 16/04/2020	RSH.002.222.0001
Learning From Incidents (LFI) Investigation Report 24/01/2021 for ignition of gas on 08/06/2020	RSH.027.005.0001
GRO-1367-RA-Spontaneous Combustion	RSH.005.001.0200
Weatherzone Details 06/05/2020	AGM.008.002.0002
Bureau of Meteorology – storm confirmation results for 06/05/2020, Moranbah	AGM.008.001.0011
Bonus Spreadsheet – July 2019	AGM.003.005.0008
LW104 Fly Through	AGM.003.001.2271
Footage of serious accident from all location points – normal speed	AGM.003.001.2258
Footage of serious accident from all location points – slow speed	AGM.003.001.2264
Footage of serious accident – Crusher transfer point	AGM.003.001.2142
Footage of serious accident – Roadway 4 inbye	AGM.003.001.2150
Footage of serious accident – Roadway 4 outbye	AGM.003.001.2158
Footage of serious accident – Bretby	AGM.003.001.2166
Darren Brady Final Report on Spontaneous Combustion TARP Triggers	AGM.014.001.0250
CITEC data for the real time sensor GM002-07-34-37 located at the 3-4CT on 5-6 May	RSH.021.002.0001

Exhibit List Q – 28 May 2021

Affidavit of Mace Kingston 21/04/2019	KIM.001.001.0001
First-second pressure wave screenshots	AGM.003.001.2174_2
NGC Timeline	RSH.002.421.0001_2
Response to questions for Dr Bharath Belle – Fan pressures diagram	AGM.999.020.0001
James Munday Report 2.0	JMU.001.003.0001
Worker Accounts of 6 May 2020	BOI.039.002.0001

Party Code Index

Party Code	Party Name
Organisations & Entities	
BOI	Board of Inquiry
RSH	Resources Safety & Health Queensland
AAMC	Anglo American Metallurgical Coal
AGM	Anglo Coal (Grosvenor Management) Pty Ltd
CMU	Construction, Forestry, Maritime, Mining and Energy Union (CFMMEU)
DSI	Dywidag-Systems International Pty Limited t/a DSI Underground
OKR	One Key Resources Pty Ltd
QRC	Queensland Resources Council
OCH	Oaky Creek Holdings Pty Ltd
GEO	Geochempet Services
Individuals	
ANE	Neville Atkinson
BAL	Rao Balusu
BBA	Dr Basil Beamish
BJO	Joe Barber
BKE	Keith Brennan
BTM	Malcolm Brownnett
BPA	Paul Brown
CRE	Reece Campbell
DAW	Grant Dawson
DEN	Marty Denham
DFR	Wolfgang Djukic
DGR	Greg Dalliston
GRO	Richard Gouldstone
HAA	Aaron Heck
HGU	Guy Harvey
HJI	James Hoare
HRI	Richard Harris

QUEENSLAND COAL MINING
BOARD OF INQUIRY

JMU	James Munday
KIM	Mace Kingston
KMT	Matthew Kennedy
LBE	Ben Lewis
LOW	Ray Low
LJH	Jason Hill
MCM	Dr Martyn McLaggan
MSE	Sean Muller
NGE	Geoff Nugent
NMU	Murray Nystrom
PAR	Mark Parcel
PBI	Bipin Parmar
RET	Dr Ting Ren
SAN	Andrew Self
SST	Stephen Smith
SWA	Wayne Sellars
TJO	John Tolhurst
TRO	Dr Rob Thomas
WMA	Martin Watkinson
WRA	Dr Ray Williams
WST	Stephen Woods
Other	
TRA	Transcripts
ASIC	Australian Securities & Investments Commission (ASIC) Searches

Appendix 11 – Additional documents referenced

This table identifies the written submissions that were provided by parties to the Board in relation to the second tranche of hearings and draft chapters of this report. Selected excerpts from these documents are available on the Board’s website.

SUBMISSIONS re TRANCHE 2 HEARINGS		
PARTY	DATE	DOCUMENT ID
Construction, Forestry, Maritime, Mining and Energy Union (CFMMEU)	8 April 2021	CMU.011.001.0001
	9 April 2021	CMU.013.001.0001
Resources Safety & Health Queensland (RSHQ)	9 April 2021	RSH.999.031.0001
	9 April 2021	RSH.999.032.0001
	14 April 2021	RSH.999.033.0001
Anglo American <ul style="list-style-type: none"> Anglo Coal (Grosvenor Management) Pty Ltd Anglo Coal (Capcoal Management) Pty Ltd Anglo Coal (Moranbah North Management) Pty Ltd Individual members of the Senior Leadership Team at Grosvenor mine 	12 April 2021	AGM.999.013.0001
Dywidag-Systems International Pty Limited t/a DSI Underground	14 April 2021	DSI.999.001.0001

SUBMISSIONS re DRAFT CHAPTERS OF PART II REPORT	
DOCUMENT TITLE	DATE
CFMMEU and ISHRs – Submission in response to ISHR and SSHR draft chapters	4 May 2021
Anglo American– Reply submission – draft chapters on ISHRs and SSHRs	4 May 2021
CFMMEU – Submission in response to revised draft chapter on Labour Hire and Contractor Arrangements	21 May 2021

Natural justice submission on behalf of Resources Safety & Health Queensland in response to the draft chapters of the Board's Part II Report	21 May 2021
Anglo American – Submission on draft chapters	21 May 2021
DSI Underground – Submission in response to draft chapters 6, 7 & 8	23 May 2021
Queensland Resources Council – Submission in response to the draft chapter on Labour Hire	24 May 2021

Appendix 12 – Acknowledgements

The Board would like to thank the following people who have assisted in the Inquiry's work:

- His Honour Judge Terry Gardiner, Chief Magistrate, for allowing the Board to use the Brisbane Magistrates Court to conduct public hearings.
- Mr Mark Stone, Chief Executive Officer, Resources Safety & Health Queensland and his team as the ongoing administering agency for the Inquiry.
- Ms Trudy Abdurhman, Ms Isabella Young, Mr Mijo Brdjanovic and Ms Natalie Coker of Queensland Courts who have supported the Board in the provision of courtroom facilities and technologies required during public hearings.
- Those organisations and individuals who made a submission to the Inquiry.
- The chief executive officers and supervisors of government agencies who approved the release of their staff to work in the Inquiry team. These agencies include the Department of Resources, Department of Environment and Science, Department of Communities, Housing and Digital Economy, and the Department of Justice and Attorney-General.
- The service providers and third-party vendors who provided services to support the functions and activities of the Inquiry, including:
 - EPIQ Australia Pty Ltd – Mr Jason Woolridge and his team for the provision of the Inquiry's document management system and enabling the electronic display of documents during the hearings. Also, Ms Kathy Robertson and Ms Sally Hicks for their transcription services.
 - Corrivium Pty Ltd – Ms Natalie Azzi, Mr Steve Jones, Mr Jan Ellis, Mr Mark Cheney, Mr Paul Tierney, and Mr Tim Jarvis who facilitated the production and broadcasting of the Inquiry's public hearings.
 - Creative Curiosity – for providing web hosting, publishing and creative services.
 - Law Image Services (Aust) Pty Ltd – for printing and copying services.

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