# Report for Ashurst

## Analysis of Gas Exceedances at Anglo Moranbah North and Grasstree Mines

### Introduction

As a consequence of an ignition of gas which occurred at Anglo American's Grosvenor Mine on 6 May 2020 the Minister for Natural Resources, Mines and Energy established under *Part 12 of the Coal Mining Safety and Health Act 1999* a Board of Inquiry (the Board) which among other things under the Terms of Reference (TOR) set for the Board was to inquire into the incidents of;

1. "The 11 high potential incidents that occurred at Grasstree mine (operated by Anglo Coal) (Capcoal Management) Pty Ltd) (sic) involving exceedances of methane (>2.5%) in and around the longwall on various dates between 1 July 2019 and 5 May 2020;

2. The single high potential incident that occurred at Moranbah North Mine (operated by Anglo Coal Moranbah North Management) Pty Ltd) (sic) involving an exceedance (>2.5%) of methane in and around the longwall between 1 July and 5 May 2020."

I have been retained by Ashurst to review and provide advice on the gas exceedances that occurred at Moranbah North and Grasstree Mines.

To assist in the desk top analysis Ashurst forwarded to me a significant volume of documentation from Moranbah North and Grasstree operations covering such matters as management structures, elements of the operations' Safety and Health Management Plans (SHMP) that deal with ventilation, gas drainage, fire and explosions, goaf sealing, audit reports of the SHMP plans and the Mines Inspectorate's Form 1As and Form 5As relating to the specified gas exceedances in the TOR. In addition information on the Management Structure and relevant Group Technical Standards were also forwarded for review.

My analysis and conclusions are specifically directed to the gas incidents specified in the TOR and no other matter.

### Corporate Oversight

Safe and efficient mining of underground coal reserves is dependent on many factors given the hazardous nature of the industry. One of those important factors is the setting of standards and expectations from the corporate level. Everyone in the organisation should be in no doubt what is expected of them regarding compliance to the highest standards of safety and that goal must be set and driven from the executive level down through the ranks such that the whole organisation is aligned to achieving zero harm. Non-compliance with statutory obligations or corporate standards should be non-negotiable.

The Operator must ensure the SSE has a Safety and Health Management System and "*must audit and review the effectiveness and implementation of the safety and health management system to ensure the risk to persons from coal mining operations is at an acceptable level.*"[1]

[1] CMSHA 1999 s41 (1)(f)

Of the information forwarded by Ashurst a review was undertaken of Corporate documentation to determine whether Corporate requirements specified operating standards and that appropriate independent audits had been conducted.

**Safety and Health Management System**[2]

Under the *Coal Mining Safety and Health Act 1999* the SSE is obligated to develop and implement a "*system that incorporates risk management elements and practices that ensure safety and health of persons who may be affected by coal mining operations*." Essentially the SSE must ensure that all hazards are identified and through risk assessment that all identified hazards have, by the utilisation of the hierarchy of controls, been brought to an acceptable level of risk[3].

Integral with the Safety and Health Management System is the requirement to develop Standard Operating Procedures[4] (SOP) if a hazard exists at a mine.

A review was undertaken of the SHMS and SOPs as they relate to longwall operations at both mines.

**Technical considerations**

Prior to perusing and analysing the forwarded documentation I considered the overall best practice management of gas on a longwall coal face such that I could determine whether the two operations in question were operating to those standards.

Generally speaking gas management in the coal seams of the Bowen Basin are unremarkable above the 200 metre level. As coal seams become deeper, below the 200 metre depth, gas contents of the seams gradually increase to some of the highest inherent contents in the country.

The greater the insitu gas content of the seam then the greater the risk that exists. However, it is not only the mined seam that is of concern it is also the SGE (Specific Gas Emission), the gas in the upper and lower seams along with other potential gas reservoirs and the influence they will or, can have once the roof starts to fall or goaf and the floor starts to heave as a consequence of mining stresses.

In certain circumstances, if gas content is too high there is the chance of an outburst occurring, which can be quite violent and has been a fatality risk as well as causing significant infrastructure damage. If the primary gas content is carbon dioxide the risk from outburst is apparent at lower gas content and they are generally much more violent. Fortunately, in the case of both mines the gas composition is primarily methane of 95 to 97 per centum. The propensity for outburst is generally measured on the DRI900 (Desorption Rate Index) and Bulli Seam Benchmark although there are other factors that need to be considered.

Consideration must then be given to the permeability of the coal, in other words how quickly the gas will be given up or released from the coal once mining or gas drainage drilling begins. This is measured according to Darcy's Law and the lower the number the less permeable the coal. If the permeability is low then gas drainage will take longer to reduce gas levels to below the threshold for outbursts and also to drain the reservoir prior to mining thus making gas levels higher when the coal is mined. If the permeability is high then problems maybe experienced with rib emissions making a

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[2] CMSHA 1999 Part 4 Division 3
[3] CMSHA 1999 Part 1 Division 2
[4] CMSHR 2017 Division 2

higher general body reading or causing layering of methane as development headings are driven or in standing roadways.

Another factor that can and usually does affect gas make is the presence of geotechnical abnormalities such as faults, dykes and sills. The methane content around those structures due to the metamorphism that occurred will generally be higher and the methane more occluded in the coal as fissures are blocked.

**Control mechanisms**

There are a number of mining methods or work practices that are utilised to control gas levels and thus reduce the hazard to ameliorate safe mining;

- ***Ventilation;*** the primary method of gas control is ventilation of the longwall face. Effective ventilation is primarily driven by pressure, that pressure being produced by the main ventilation fan/s or auxiliary fans either underground or on the surface. Balance of the pressures developed is essential to ensure the pressure gradient across the face is high enough to cause ventilation flow but not high enough to have velocities so high to cause whatever dust is generated by the coal being cut to be maintained in suspension (usually kept below 4 metres/second) or causing the gasses in the goaf to move out of the goaf primarily at the tail gate end of the face. If tail gate ventilation pressure is too high and it is combined with the diurnal effect or a falling barometer gas make from the waste could exceed the set statutory limits. If ventilation quantities alone are not sufficient to maintain statutory compliance then other control mechanisms can include;

- ***Direction of mining;*** given that methane is lighter than air (SG 0.55) mining to the dip will allow the gas liberated from the coal or surrounding strata to migrate up bank from the face in to the goaf. The disadvantage of this is that water either from the inherent content in the seam or surrounding strata or dust suppression will tend to run with the face, either pooling on the face or low points in roads outbye the face.

- ***Extraction height:*** wherever possible it is advisable to extract the full seam height as this will remove all gas content in the seam from potentially forming in the goaf. Of course, due to seam anomalies, protection of softer roof or floor and overall seam height this is not always possible. Therefore, consideration should be given to how one can manage the potential for gas behind the shield line. Another reason for cutting the full seam height is to remove any combustible material that may be liable to spontaneously ignite.

  Leaving coal at roof level may be undertaken to protect softer strata or strata which may generate frictional sparking when impacted by a metal cutting tool.

- ***Rate of cutting;*** the higher the rate of cutting will increase the tonnage of coal won and obviously the more coal produced the greater the quantity of gas will be released. Thus slowing the speed of the shearer can reduce gas make. This is normally only used over short periods as slowing the rate of retreat of a longwall can create strata control problems particularly if geotechnical anomalies are encountered. Thus it is sound mining practice to keep the wall moving at an optimum rate of retreat.

- ***Gas drainage;*** the principal method of gas drainage is drilling underground in seam holes (UIS) on a pattern and length of holes determined to allow gas to flow through the long holes drilled in to the block of coal to be mined and then connected to a gas range. Then with the aid of suction fans on the surface the gas, which is under natural pressure, can be cleared to the surface through those installed ranges. If the permeability is high, gas will flow fairly freely over a period and reduce the in seam content to below the threshold limits for outbursts to occur and allow mining to occur. As the maximum length of hole that can be drilled effectively below ground is limited and the drilling can only be undertaken from roadways that are already driven to provide drill stubs, at times, if development is behind schedule or cannot be programmed far enough ahead another method of drilling can be utilised to supplement the underground holes.

*Surface to inseam drilling (SIS);* by utilising petroleum technology holes can be drilled from the surface to intersect the coal seam to be mined and long holes directed along the length of the block to capture the gas. This is expensive and will only drain a set distance from the hole dependent on the permeability of the gas. The advantage is, if surface topography and infrastructure permits, holes can be drilled well in advance of mining thus providing sufficient lead times for the block to drain.

One disadvantage of both surface and inseam drilling is that moisture will also be liberated along with the gas making the seam dustier when mined, thus additional dust suppression must be considered when winning coal.

*Surrounding strata:* at times inseam holes can also be drilled in to surrounding strata, above and below the seam. This is to deal with any SGE that maybe present in potential gas reserves in overlying or underlying seams or carbonaceous material. This has been undertaken with varying degrees of success. Much depends on how the stresses develop around the goaf area to liberate gasses. It has also been undertaken from the surface by SIS holes in to overlying seams to reduce gas content.

With any drilling absolute care must be taken if long holes are to be intersected as gas, under high pressure, can be forcibly ejected in to working areas with the consequent danger of explosive levels of gas being released or injury to persons in the vicinity with projectiles.

- ***Gas wells:*** another method of reducing gas levels in the face vicinity is to drill gas wells from the surface in to the projected waste areas. Generally these holes are drilled to within approximately 10 metres of the top of the seam on the tail gate side such that when the goaf forms behind the face, suction pumps located over the wells can extract gas from the goaf area with the intent of clearing the area around the tail gate of the face. These holes also serve a useful purpose as the gas extracted can be analysed for other tracer gasses which may indicate whether the goaf has become inert or whether there may be combustion taking place indicating a potential spontaneous event.

- ***Ignition sources –*** for an ignition of gas or an explosion to occur we consider the fire triangle. The three legs being the components required for an ignition; those being oxygen, a fuel source and an ignition source. By removing one of the sides of the triangle a fire or an explosion cannot occur. Given oxygen is required for breathing that is a necessity therefore, we can either look at removing the fuel, in this case methane and/or the ignition source. Accepting that methane can at times be present we must then ensure there is no ignition source to ignite the methane that maybe produced.

- ***Statutory legislation:*** over the years there have been a number of high potential and actual incidents in underground mining and some of those have been in and around longwall faces. In an attempt to prevent those incidents from occurring legislation has been promulgated demanding certain hard and administrative controls. In the incidents under review the legislative controls are directed toward ventilation[5], electrical equipment[6] and gas monitoring[7].

  One other critical factor under statutory legislation is the requirement for all persons to be competent and particularly that there are sufficient statutory officials appointed to comply with legislation.

**Existing mining conditions at Moranbah North and Grasstree Mines;**

- **Moranbah North[8] –** in the L/W 604 block this operation mines the Goonyella Middle seam and in some area the this is combined with the Goonyella Middle Lower when the lower parting is <0.3m
  - Depth of seam – 270 to 370m over the L/W604 block length.
  - Seam height- 5.4 to 6.5m. Maximum cutting height is defined by seam thickness and the need to maintain approximately 1 m of coal roof beam as a control for cavity formation, no coal is left in the floor.
  - Insitu gas content – 6.5 – 10 $m^3$/tonne
  - SGE for L/W808 – ˜5$m^3$/tonne
  - Permeability – 10 to 50 mD, therefore from relatively tight to tight.
  - DRI900 – 7.2$m^3$tonne
  - Face ventilation – 71$m^3$/s
- **Grasstree[9] -** in the L/W 909 and L/W 808 blocks this operation mines the German Creek seam which is in the German Creek measures, a part of the Bowen Basin.
  - Depth of seam - in the current area of mining the seam is located at an average depth of 370 metres.
  - Seam height - height is 2.65m to 3.00m and is mined to the full extraction height.
  - Insitu gas content - 6$m^3$/tonne to 16$m^3$/tonne
  - SGE for L/W808 – predicted to be between 10 to 20$m^3$/tonne

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[5] CMSHR 2017 Part 11
[6] CMSHR 2017 Part 5
[7] CMSHR 2017 Part 7
[8] MNM_51137.604_SOP
[9] SOP.GTM.409

- Permeability - stated as good, thus gas is given up relatively easily
- DRI900 - 7.6m³/tonne this lower contents will not be prone to outburst
- Face ventilation – 45 to 55 m³/s

**REVIEW and ANALYSIS**

**Corporate Documents**

My review of corporate documentation satisfies me that Anglo had set high standards of operational requirements[10] for the "Prevention of underground gas and coal dust explosions". Aside from the extensive utilisation of qualified technical consultants, many preeminent in their field, Moranbah and Grasstree also have access to well-resourced Technical Services Teams both at a Corporate and Group level who have a number of well qualified and experienced engineers.[11] [12]

Given an unfortunate number of fatalities across the Anglo American organisation there has been a significant amount of work undertaken to ensure safety and health standards are such that all fatalities are eliminated from the business. A number of management documents have been sighted driving the goal of Zero Harm and as part of that drive a number of audits have been undertaken across Anglo operations raising the awareness levels and whilst those initiatives are excellent they do not directly relate to the incidents referred to in the TOR save for commitment for statutory compliance and ensuring standards are met and maintained.

The requirements of the Coal Mine Operator to undertake an independent review of the SHMS was complied with and undertaken at Moranbah Mine in October 2019 by Reed Mining Consultants[13] [14] with a number of administrative anomalies found related to ventilation and gas management as they relate to the longwall. The first of these relates to the appointment of a ventilation officer[15]. Whilst the appointments of the two ventilation officers could be found elsewhere the appointments were not in the Mine Record. A number of risk assessments could not be found as they related to SOPS required under the *Coal Mining Safety and Health Regulation* 2017 (CMSHR 2017), those being r249 - *methane detected in a ventilation split or main return airway*; r347 - *ventilating workplaces* and r349 *action if ventilation system fails*. Two SOPs were found to be overdue for review, those being r250 *action to be taken if a methane detector activates or is non-operational* and r252 *general backup for gas monitoring system*.

Two Principal Hazard Management Plans (PHMPs) as required under the *CMSHR 2017 reg 149*, Methane drainage and Outburst PHMPs were found to be overdue for review.

The SOPS were in place and operational and the administrative anomalies found did not, in my opinion, contribute in any material way to the gas exceedance[16] referred to in the TOR.

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[10] AA TS 403 001
[11]AAMC.001.007.003
[12] AAMC.001.011.0430
[13] AAMC 001.005.0203
[14] AAMC 001.005.0353
[15] CMSHA 1999 s61 (2)
[16] CMSHA 1999 Part 11 Divison 1 S198

The requirements of the Coal Mine Operator to undertake an independent review of the SHMS was complied with and undertaken at Grasstree Mine in November 2019 by Reed Mining Consultants[17] [18] and in broad terms Grasstree was generally in compliance. There were four non compliances of an administrative nature, both the Methane Drainage and Outburst Principal Hazard Management Plans[19] were out of date and the SOPs required for *action to be taken when methane was detected in a split or main return airway*[20] and the SOP for *action to be taken if a methane detector activates or is non-operational*[21] were recommended to have separate WRACs (Workplace Risk Assessment and Control) even though they were covered in a general risk assessment. Whilst those non compliances were identified I do not believe they were in any way related to the gas exceedances reported[22] at Grasstree.

**Safety and Health Management System**

As above, the SHMS at both mines have been audited by an independent auditor and apart from some administrative anomalies in SOPs and PHMPs; risk assessments that were covered in other SOPS, or could not be found on the system or were out of date, there was nothing of significant non-compliance that would, in my opinion, have affected the gas exceedances specifically mentioned in the TOR.

The operational SOPs for both mines, Moranbah North L/W 604[23] and Grasstree[24] I found to be particularly commendable and amongst the best I have viewed. They were technically competent and addressed all of the issues I would have expected from a gas management perspective in operations where methane in quantity could be problematic.

**Technical Considerations Addressed**

When comparing and analysing the technical considerations as outlined above I am satisfied that both operations have taken in to consideration and effectively addressed those issues that I advocated as being best practice to manage gas emissions;

- **Ventilation –** both mines utilise auxiliary shafts and ventilation fans at the rear of the longwall blocks to control ventilation pressures and to direct intake air to critical points of the ventilation circuit in an attempt to dilute any fugitive emissions of methane. Reviewing the monthly ventilation readings, pressures and quantities they appear to be well under control and in the main diluting and rendering harmless methane makes.

- **Direction of mining** – given the layout of the mines both longwalls do not mine to the rise. In the case of Moranbah the seam dips to the main gate and in the case of Grasstree the seam dips to the tail gate, thus methane should move to the high point meaning in the case of Moranbah it should migrate away from the main gate toward the tail gate but in the case of Grasstree it should move toward the main gate.

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[17] AAMC.001.005.0505
[18] AAMC.001.005.0534
[19] CMSHR 2017 Chapter 4 Part 2 R149
[20] CMSHR 2017 R249
[21] CMSHR 2017 R250
[22] CMSHA 1999 Part11 Division 1 S198
[23] MNM_51137.604_SOP
[24] SOP.GTM.409

- **Extraction height –** in the case of Grasstree no coal is left therefore, there should be no residual gas in the waste from face coal. With Moranbah the one metre of coal left to protect the roof could result in some gas being generated in the goaf area from the face coal.

- **Rate of cutting –** Moranbah normally shears at a rate of 13m/min with a variation of 8 to 14 m/min. Grasstree has a variable speed dictated by conditions and that speed is set by the Longwall Coordinator. Both mines have the ability to slow cutting speeds depending on gas make and the ERZ Controllers have the authority to slow the shearer if gas rates are increasing.

- **Gas drainage –**

    - UIS (in seam) – both mines utilise in seam drainage to a significant extent. The drilling patterns have been developed in consultation with a number of recognised consultants in the field and are constantly being refined. The main focus is on reducing the insitu level of gas to below the outburst threshold levels based on the DRI900. The DRI900 or Desorption Rate Index is a method adopted and utilised as a primary method to assess outburst risk and to determine gas content threshold values for outburst risk management in Australian coal seams.

      Gas levels are, of course, as a consequence, also lowered to reduce the gas emissions from normal mining operations. Prior to mining commencing both mines have Permit to Mine (PTM) authorisation procedures in place where effectively mining cannot commence unless a committee of mining officials have signed off to state that gas levels are such that mining can be undertaken safely with gas levels below the outburst threshold levels.

      On reviewing the PTMs for Moranbah's L/W 604 and Grasstree's L/W 909 and L/W 808, all PTM documentation was duly signed and all cores were below the threshold level and it most instances had substantially reduced the insitu gas content in many instances by well over 50%.

    - SIS (surface to inseam holes) – as discussed above, UIS holes must be driven from pre-driven roads ahead of longwall extraction and at times due to development constraints those in seam holes cannot be driven. In those occasions SIS holes are considered and are driven from the surface, those holes being able to be drilled well in advance of underground development headings. Both Moranbah and Grasstree employed SIS holes to assist in pre-drainage of the longwall blocks in question.

      Gas holes in surrounding strata – Grasstree in the past have trialled holes in to the overlying Corvus 1 and Corvus 2 seams and that trial was continued during the pre-extraction of L/W 808. Previous attempts at what the mine called HGH (high horizontal holes) was undertaken post mining. The holes were drilled from the Tailgate in the German Creek seam and located between the Corvus 1 and 2 seams. The purpose of HGH is to capture gas similarly to the vertical Tail gate and Main gate vertical gas drainage holes. Results from those HGH holes was poor and a decision was made to drop those holes but it does demonstrate that Grasstree are continually looking for means to reduce gas levels wherever and however possible.

Trials were also undertaken on L/W 808 following issues on L/W 909 with floor bursts. This was undertaken by drilling post drainage holes in to the Lower German Creek seam. These holes were designed to capture gas from the floor seam as it destressed and to prevent floor bursts occurring on the longwall face where gas is rapidly emitted onto the face. Two such events did occur on L/W 909 and it was planned that those holes would hopefully eliminate a similar occurrence on L/W 808.

Moranbah drill cross measures holes in to the Goonyella Middle (L) seam where the lower portion of the middle seam approaches to within 0.5 metres. As with all holes of this type they have had mixed success, some holes being high flowing and others yielding limited gas, much depending on how the strata fractures as a consequence of mining stresses.

- Gas wells - both Moranbah and Grasstree utilise gas wells. In the case of Moranbah their holes were drilled at 50 metre spacing set at 20 metres from the tail gate rib for the first 300 metres and the holes would then be under review as to their effectiveness and then drilling would be considered at distances of 75 to 100 metres.

  Grasstree holes were 380mm diameter set on 50 metre centres and 40 metres from the tail gate side. 20 such holes were also drilled on the main gate side at up to 150 metre spacing.

- **Ignition sources –** as previously indicated without an ignition source fire or explosion is impossible. The major ignition sources in and around a longwall face are;

  - Electrical – all electrical equipment on a longwall face by statutory regulation are either of the FLP (Flameproof) or IS (Intrinsically Safe) design, thus all but eliminating the chance of an electrical ignition given the equipment is correctly designed, tested, installed and maintained. All the face equipment at Moranbah and Grasstree are statutorily certified.

  - Frictional ignition – frictional ignition can occur when cutting picks contact strata where there are either pyrite nodules or if there is a basal layer of fine quartz conglomerate embedded in sandstone. It would appear that neither of these is present but in any event Moranbah leaves a band of 1 metre of coal in the roof.

  - Cables and pipes running in to the goaf – at both operations these are routinely broken as the face retreat.

  - Lightning strikes – whilst still controversial this would not appear to be an issue at either operation as the seams being won are below the consider bench mark of 260 metres and as above all pipes, cables and conduits are regularly broken and are not permitted to run through seals.

  - Spontaneous combustion – Grasstree has a low propensity to spontaneous combustion and all coal is mined from the seam, nothing being left to enter the waste. In addition they have a comprehensive spontaneous combustion management plan[25].

Moranbah has a higher propensity for spontaneous combustion to occur and a number of previous incidents have refined a comprehensive principal hazard management plan[26] with extensive gas monitoring of the active wastes.

- **Statutory legislation –** as discussed previously, both Moranbah and Grasstree, according to independent audits, appear to have, apart from some minor administrative non compliances sound and compliant SHMSs.

  One of the main aspects of statutory compliance in and around a longwall face is the correct disposition of automatic methane monitors and gas detectors. From all accounts both operations are fully compliant although the most recent Regulation Amendment earlier this year (January 2020) as to the placement of an automatic methane detector as required under Regulation 243A (2) did create some compliance issues with Grasstree, more on this when specific gas exceedances are discussed. It is interesting to note that the *Coal Mining Safety and Health (Methane Monitoring and Ventilation Systems) Amendment Regulation 2020* clarifies the confusion and this legislation commenced on July 3, 2020.

**GAS EXCEEDANCES – High Potential Incidents[27]**

As part of the TOR there was one incident noted at Moranbah North Mine and eleven incidents at Grasstree mine between 1 July 2019 and 5 May 2020.

As I have indicated above, it is my opinion, from the documentation I have reviewed that both Moranbah North and Grasstree have compliant, robust systems that strive to meet industry best practice as it relates to gas management in longwall sections. Why there have been gas levels that have exceeded the statutory limit of 2.5% is, of course, a concern as that level is classified as an HPI (high potential incident). As I reviewed each of the twelve occurrences I believe that all were without negligence or reckless intent, although it could be argued in six instances where problems arose at Grasstree with the confusion over the placement of a methane detector required under *243A(2)* of the *Coal Mining Safety and Health Regulation 2017* as amended in January 2020 that there was an element of foreseeability.

Taking each of the reported exceedances in turn;

[25] PHMP.GTM.005.2

[26] MNM 50018.5 PHMP

[27] CMSHA 1999 s198(2)(b) – CMSHR 2017 Schedule 1C r10(b)Schedule

**Moranbah North**

The reportable incident at Moranbah North occurred on 20 July 2019 on L/W 604. From the reports it would appear there was an electrical power trip back to the DCB (Distribution and Control Box) in the Main Gate. When investigating the ERZ Controller identified methane was issuing from floor blowers at the rear of shields 105 to 110 i.e. toward the tail gate end of the face. The general body concentration in that area of the face was reported as being up to 2.3%, enough to trip the power as it was in excess of the mandatory 2%. In other words all electrical equipment was powered down removing that potential ignition source. The general body reading in the tail gate road never exceeded explosive levels as the monitoring system recorded a maximum peak of 3.36% and it took one hour and thirteen minutes for the general body reading to return below 2.5% after it had first gone in to alarm. The face floor blowers were successfully diluted by the ERZ controller utilising cool tubes and brattice sails to direct ventilation in to the rear walkway of the shields where the blowers were issuing.

It has to be stated that floor breaks toward the rear of shields are not uncommon as stresses are generated around the working face and with $72m^3$/sec there was sufficient ventilation on the face however, the gas make still exceeded the then design capacity. The contributing factors were that the Goonyella Middle Seam (Lower) [GM (L)] was within close proximity to the floor horizon 0.2 to 0.3 m and this is a gas reservoir. At the time of the incident there were five goaf drainage wells on line however the nearest hole was off line as the oxygen levels were still high and the methane levels low. It was also found that some of the UIS holes were blocked and thus not removing gas and some holes could have been better placed.

On reading the corrective action report (Learning From Incidents)[28] I was encouraged by the diligence shown in identifying the causal elements and the corrective actions to be taken. Essentially there was a revised drilling plan enacted specifically to target and drain the GM (L) when in proximity to the GM Seam, ensuring UIS holes are flowing and not blocked and where possible to bring gas wells on line.

These action can be considered to have been effective as to date there has been no further gas exceedances at Moranbah North. With respect to safety measures taken on the day, gas levels were being monitored and shearer cutting speeds were being controlled to reduce gas make, the gas monitoring systems worked by dropping power, the crew were immediately taken to the main gate end until the ERZ Controller conducted an inspection to discover the cause of the power outage. Thus, in my opinion, there was little danger.

**Grasstree**

As stated and reported there were eleven exceedances at Grasstree between the specified dates. Eight of those exceedances were, in my opinion, directly related to the placement of the methane detector the mine thought to be required under *r243A (2)* of the *CMSHR 2017 as amended in 2019.* Five of those eight instances occurred over a period of 5 days, three being on one day alone. Whilst there were other contributing factors involved in the gas exceedances, and these will be discussed, they were essentially of a recurring theme.

[28] LFI – IN.00205770 – AAMC.001.0824

**Incident 1** – 28 July 2019 L/W 909[29]

From about 9:00hrs on that morning methane levels had started to rise at a steady rate in in the tail gate roadway reaching 1.9% at about 11:00hrs. This was also coincident with a falling barometer. At this time longwall production ceased. The general body concentration in the tail gate continued increasing and levelled off at 2.25% at around 12:40 to 12:50hrs. At around 13:10 there was a sudden increase with general body concentration rising to 2.5% at 13:15 reaching a maximum of 2.98% at 14:48.

On inspection of surface gas drainage arrangements a compressor operating a surface venturi was found to have had a blown radiator hose thus that hole was essentially off line. When repaired and the hole brought back on line at 15:00 the tail gate general body concentration rapidly reduced to below 2.5%.

Given production had ceased on the 'wall well before the exceedance and the crew removed to the main gate there was little danger to the operation, in other words the systems worked.

On reviewing the LFI of the incident there were effective corrective actions to prevent a recurrence by placing all holes on to fixed plant to remove the potential of a compressor failure and also to monitor holes in real time through CITEC to ensure early warning of a hole failure. These are sensible precautions and it would appear a similar incident has not occurred.

**Incident 2 – 25 October 2019 L/W 808[30]**

Shortly after commencing production on L/W 808, with some roof still having to cave, "the shearer was latched" when the tail gate roadway methane detector registered 1.9% methane. Whilst the face was stood the ERZ Controller decided to conduct a tail gate inspection and detected 2.56% methane on his personal gas detector.

Previously at the commencement of longwall blocks the ventilation with three heading development had been set up to provide some ventilation through the tail gate goaf area to the last line of open cut through, thus keeping gas away from the tail gate return. As the ventilation had not been set up correctly to accommodate this control and given the placement of the automatic methane detectors a true indication was not being given of gas present. Once the ERZ Controller had discovered the anomaly the correct ventilation was established to dilute the gas and a recurrence did not occur.

Given the future mine layout this will not occur again as the mine will no longer have this design of longwall block where there is either three headings or two headings in a fresh block on the tail gate side.

Whilst there was a break down in standards as the correct and effective ventilation system had not been established in the tail gate area other systems did work, the value of multi-layered controls. The power was disconnected, men withdrawn and by mandatory routine inspection the error was discovered and again no danger ensued.

[29] IN.206200 – AAMC 001.001.0675
[30] IN.0211887 AAMC.001.001.0810 – note there is a discrepancy between the Fom1A and the Form 5A and LFI. The Form 1A sates the incident occurred on 26/10 whilst the other two state it occurred on 25/10.

**Incident 3 – 11 January 2020 L/W 808[31]**

Whilst mining toward a gas drainage niche an additional quick cut was undertaken (3 cuts and pushes as opposed to the normal 2) in an attempt to catch suspect roof to prevent it from falling in front of the tail gate. In doing so additional goaf roof was left open which then fell expelling methane from the goaf over the TG drive sensors. The goaf fell with 2.55% being initially recorded and then a peak of 3.6% with the total time in excess of 2.5% being four minutes.

Given this is a very rare occurrence it was felt that to modify cutting sequences would be inappropriate and I concur. Longwall ERC Controllers need to be trained in balancing the requirement to catch potentially bad roof with the requirement to ensure there is no additional goaf hang up by taking an extra cut/s and thus increasing the possibility of small plugs of dangerous gas concentrations to be expelled from the waste.

**Incidents 4 through 11 – 22 February 2020 L/W 808[32]; 20 March 2020[33]; 20 March 2020[34]; 20 March 2020[35]; 24 March 2020[36]; 26 March 2020[37]; 6 April 2020[38] and 11 April 2020[39]**

Following the above incidents Grasstree Mine personnel undertook a comprehensive investigation of all the above incidents on 22 April 2020[40], this was in addition to the investigations carried out as required by legislation on each of the individual incidents and reported within one month[41] utilising the Form 5A. The reports of these incidents have formed the basis of my opinions.

In 2019 there were a number of Amendments to the Regulation and those became law in January 2020, the *Coal Mining Safety and Health Regulation 2019.* As part of that amendment there was a new *Regulation 234A* which required an automatic methane detector to be located in the return airway within 400 meters of the intersection with the longwall face. Grasstree's understanding was that this detector could be placed on the canopy of the last shield above the tail gate sprocket of the AFC (armoured flexible conveyor). Other operations had other understandings and it would appear there was some element of confusion around the industry as to where this detector should be placed for compliance purposes.

In the position determined by Grasstree, on the last shield on the face, the location of the sensor had a very high likelihood of detecting localised layering of methane and this would particularly be the case if the last shield (in this instance #157) protruded in to the tail gate roadway and there was a variation in roof horizon between the gate road and the coal face. If the gate roof was higher than the line of face roof the canopy of the adjacent shield #156 could prevent a flow of air over the sensor and create a stagnant area of ventilation where layering of methane could occur.

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[31] IN.00216236 – AAMC.001.001.0691
[32] IN.00219432
[33] IN.00221991
[34] IN.00221998
[35] IN.00222011
[36] IN.00222360
[37] IN.00222495
[38] IN.00222988
[39] IN.00223278
[40] AAMC.001.006.0080
[41] CMSHA 1999 s201 (1) (c)

This in my opinion was foreseeable and action should have been taken to ensure this would not occur, however it took some time before action was taken to place ventilation curtains to direct air to the sensor head and keep the area clean. Another issue that should have been apparent is that when shields are lowered and advanced the dynamics of air flow currents are significantly altered and that is particularly true as shields are advanced out of turn or are left back in relation to an adjoining support. A consistent and uniform system of shield advance should have been developed but it took some time for that to eventually occur.

The new monitor required under *234A* was installed on 6 February and almost immediately saw a trip when the methane level reached 2%. This methane detector, designated the "0m $CH_4$" from that time proved problematic reading high methane levels when other detectors in the tail area trended consistently, rarely tripping power at 2%. Almost all of the 2.5% exceedances trips were of relatively short duration the maximum being for just under an hour on the 11 April incident and one of 23 minutes on the 6 April incident. The maximum peak was also recorded on the 6 April incident when 4.21% was detected.

On the 6 April incident a number of other factors were at play, the goaf was hanging back some 8 metres and when the goaf fell it knocked over ventilation sails moving air around the '0m $CH_4$' sensor. The shields were staggered and the nearest goaf drainage well was not on production. Tellingly no other gas monitors registered high levels of methane.

The recommendations made in the 22 April report were sensible and would have sufficed to control the issues faced with the position of the then '0m $Ch_4$' detector. Had the detector been placed in the gate road at any distance between 0 and 400 metres from the face and not on the canopy of the last shield, it is arguable that these reported exceedances would likely not have occurred. This in no way should be understood to overlook the lack of sound mining practice applied through ventilation controls and face operations that would have greatly reduced the likelihood of exceedances.

Interestingly I note that the *Coal Mining Safety and Health (Methane Monitoring and Ventilation Systems) Amendment Regulation 2020* and which came in to effect on 3 July 2020 amended the position of the 234A methane detector requiring it to be in the longwall return airway and within 150 metres of the tail gate block side rib line and the longwall coal face.

In all of these eight instances there was no real increase in general body concentrations of methane to reportable levels as demonstrated by the readings on all other monitors other than the '0m $CH_4$' and in each incident the face was shut down by the removal of power and the crew removed until ventilation controls were put in place. Thus no condition of danger existed. It was still concerning however, that layering in the vicinity of the tail gate shield canopy was occurring and it took some time for this to be effectively brought under control and one would hope that now the sensor will be moved under the Regulation Amendment that ventilation controls in this area will continue.

**Conclusion**

Anglo American has a highly developed safety and health ethos that is being directed from Executive Management through to the coal face. The standards set by Corporate for gas management are strict and they have the technical resources to assist operations in meeting those standards.

Both Moranbah and Grasstree have, on review of independent audits, robust and generally complaint safety and health management systems although there are some administrative anomalies that require to be addressed.

The SOPs of both operations as they relate to gas management are first class although their standards regarding on face ventilation, particularly at Grasstree left something to be desired. I did have issues at times with standards not being enforced which can, if not addressed, lead to dangerous conditions existing.

Both operations conduct honest and detailed investigations through their 'Learning from Incidents' system and they do utilise outside expertise when required to ensure a higher standard of compliance.

It is almost impossible to prevent methane from entering the work place, particularly around a longwall face with high insitu gas concentrations. They can be significantly reduced through gas drainage and efficacious ventilation systems, should, in the main control the remnant gas makes. However, there will always be an instance where gas could create issues and that is why there are other controls to remove ignition sources and to shut systems down and remove persons from harm. All of these systems worked at Grasstree and Moranbah and never, at any time, did I have the thought in reading the documentation suppled that there was ever any real danger to persons.

**In preparing the report, I have made all the inquiries that I believe are appropriate. The factual matters stated in the report are, to the best of my knowledge, true, the report contains reference to all matters that I consider to be significant and I genuinely hold the opinions that I have stated in the report. I understand my duty to the board of inquiry and have complied with this duty.**

[redacted]

***Gavin Taylor***
**30 July 2020**

# Curriculum Vitae

## Robert Gavin Taylor

Gavin entered the coal industry on leaving high school in Wollongong, New South Wales in 1967. As a cadet with BHP (Australian Iron and Steel Collieries) he worked at a number of their Illawarra operations studying coal mining and gaining his statutory certificates of competence.

After working as a Deputy (1972-1974) and Undermanager (1974-1977) at Corrimal Colliery he joined Gullick Dobson International (headquartered in Wigan, England) on secondment in 1977 for a 12 month period. Gullick at that time was the largest supplier of longwall roof supports in the western World. Electing to remain with Gullick in his 13 year career with them he went on to work on longwall installations as a mining engineer in most of the major mining countries before becoming Export Sales Manager and then Vice President of the company's North American operations.

On joining Atlantic Richfield in the USA in 1991 he chose, for family reasons, to return to Australia at the company's new Gordonstone Mine in Central Queensland, where he over saw the purchase and installation of the first of that operation's longwall units. For a short period he was the "Underground Leader" (operations manager) before re-joining BHP in 1993 at their Crinum Mine which was in the planning stage.

At Crinum Gavin was initially the Longwall Manager and oversaw the purchase, installation and operation of the longwall system. Gavin became Registered Manager at Crinum which was recognised as having the highest standards with regard to safety and health and was at the time the highest producing underground mine in the country.

In 2000 Gavin returned to the Illawarra coal field with BHP as manager at West Cliff Colliery. West Cliff was one of the gassiest mines in the country and in its early days led the field in outburst management and gas drainage in Australia. West Cliff at the time was about to enter a transition period mining in to a new lease area with in situ virgin gas contents of up to $20m^3$/tonne and with a very complex ventilation network. With the team at West Cliff Gavin oversaw the installation of three underground booster fans, the first in Australia in decades and also a new gas drainage regime that also incorporated the first trial in NSW of SIS (surface to in seam) gas holes and the first surface goaf gas drainage holes in the Illawarra. From a mine, prior to Gavin's arrival, that had suffered a number of notices from Inspectors West Cliff went on to enjoy a solid reputation with the NSW Inspectorate as to the management of gas.

In 2005 Gavin joined Centennial Coal as General Manager of the newly created Southern Region. One of the mines Gavin was responsible for was the recently acquired Tahmoor Colliery which was recognised as being extremely gassy with the main seam content being carbon dioxide and with in situ contents of up 18 to $19m^3$/tonne. Tahmoor was suffering extensive 'gas outs' with the notoriously difficult to manage carbon dioxide. Along with the newly installed mine management team a comprehensive review and analysis of the ventilation system was undertaken to address those gas issues. With a change in the ventilation network to address pressure differentials across the mine a significant reduction in issues with gas was achieved, thus increasing overall productivity levels at the mine producing operational profits for the first time in many years. Subsequently a new mine fan was installed, again greatly increasing ventilation efficiency.

In 2008 Gavin joined the Queensland Department of Mines and Energy as Chief Inspector of Coal Mines. During that tenure, in 2011, he was seconded to the New Zealand Department of Labor in the aftermath of the Pike River disaster to act as Chief Inspector and assist in the setting up of a new High Hazards Unit. This secondment lasted ten months with Gavin continuing to provide advice for a further three months with an ongoing membership of an Expert Review Group that rewrote the New Zealand Legislation as it applied to Extractive Industries.

Since retiring in 2013 Gavin has kept an active role in the industry becoming President of the Mine Managers' Association of Australia in 2013 and being appointed as the inaugural Chair of the New Zealand Extractives Industry Advisory Group (EIAG) in 2014 which provides advice to the Board of New Zealand's WorkSafe. Both positions are still held.

*Industry memberships*

Past;

- Export Committee, ABMEC (Association of British Mining Equipment Companies).
- Mining Society of Nova Scotia
- Mine Manager's Oral Examination Panel, Queensland.
- Audit member on the first three Level One Exercises in Queensland
- Inaugural member representing the Queensland Minerals Council, Minister's Safety and Health Advisory Council, Queensland,
- First Class Mine Manager's Examination Panel, NSW
- NSW Coal Competence Board
- Vice President, Southern Region, Mine Managers' Association of Australia
- Chair, Board of Examiners, Queensland
- Minister's Mine Safety and Health Advisory Committee, Queensland

Current;

- President, Mine Manager's Association of Australia
- Chair, Extractive Industries Advisory Group, New Zealand

*Qualifications*

- Third, Second and First Class Certificates of Competence (NSW and Queensland)
- Certificate of Competence in Mines Rescue (NSW)
- Associate Diploma in Coal Mining
- Certificate in Mine Surveying