**GROSVENOR SUBMISSIONS 5 (2) ATTACHMENT SELF REPORT and TRANSCRIPT EXCERPTS**

**WHETHER A RELIANCE ON POST DRAINAGE RATHER THAN PREDRAINAGE CONTRIBUTED TO THE DIFFICULTIES IN MANAGING HIGH OXYGEN LEVELS WITHIN THE GOAF**

**(Difficulties managing methane emissions on the face will be a separate submission)**

**Andrew Self Gas, Ventilation and Spontaneous Combustion Systems Review Report (1)**

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**There is a conflict between the management of high gas make and spontaneous combustion. The requirements of a gas management system in a longwall mine include the following.**

* **High ventilation airflow quantities**
* **High ventilation pressures, required to drive the airflow quantity and to bleed gas from the goaf**
* **High goaf drainage flow rates, likely to encourage air to enter the goaf.**
* **Operation of the goaf gas fringe as far away from the longwall face into the goaf as possible**

**Management of spontaneous combustion requirements include the following**

* **Low ventilation pressures to minimise air Ingress into the goaf and across the pillars**
* **Maintenance of an inert goaf with minimal oxygen concentration**
* **Maintenance of the goaf fringe close to the longwall face**

**Clearly, all of these requirements cannot be met simultaneously.**

**High capacity goaf drainage systems are required where high gas make exist. The gas drawn from the goaf will be mainly inert, methane and nitrogen. Management of spontaneous combustion requires inert gas to remain in the goaf, including introduced inert gas (inertisation).**

**Management of these two major hazards represent a compromise, good practice in mining regarding one of the hazards generally represents bad practice concerning the other.**

**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.**

**These facts cast doubts on the often held belief that pro-active inertisation and high capacity goaf drainage systems can be used in combination to mitigate the risk of manifestation of either hazard or both.**

**The task of managing both of these major mining hazards at Grosvenor is onerous. This would require a robust and reliable risk management process which is capable of responding rapidly to changes in the mining environment.**

TRA.500.021.0035

**Q. This slide refers to post-drainage and it shows some of the goaf wells.**

**A. Yes.**

**Q. What is this diagram designed to show us?**

**A. These are not the only goaf wells, as I think most people would know. There are older goaf wells around here, other goaf wells along here, but that's not the point of this discussion.**

**So the gas fringe, which we've spoken about, which will not be that shape, but the general characteristic is of air entering the goaf at this end, sweeping around here and coming back out the tailgate. So it's just a graphical representation of what the goaf fringe may look like.**

**Q. We've spoken about spontaneous combustion.**

A. Could you go back to that one, please?

**Q. I beg your pardon, I'm sorry.**

**A. I pressed the button twice. What I'm trying to show here is that we've got this back over return thing happening here, which is taking a small quantity of airflow across that triangle piece of goaf there.** **This is the compromise between spontaneous combustion and gas management.**

 **We want to sweep this gas fringe away from this zone here because there are potential ignition sources.**

 **We don't want to put air into the goaf, so we compromise. So there's a spontaneous combustion risk compromise here, which is putting air across this area of the goaf. At the same time, we've got goaf wells here which are quite close to this longwall face, and the purpose of those is similar to the goaf fringe management.**

**So if you look at this situation here, we're drawing goaf atmosphere out through these yellow dots, which are vertical goaf wells, and part of what we're drawing out of there is this back over return here.**

**So that's a good example, I think, of the compromise between the management of the two systems. We can't a hundred per cent manage gas and ignore spontaneous combustion and vice versa, so there has to be a compromise on spontaneous combustion management which says that we acknowledge that we will pull some air into the goaf by this method, and I think that's probably unavoidable.**

**Q. In terms of what it's emitting by way of spontaneous combustion indicators.**

**A. Yes.**

Q**. Is there the risk that rather than reporting to the goaf stream, those spontaneous combustion indicators, or a substantial part of them, will go up the goaf well or through that regulator?**

**TRA.500.021.0037**

**A. Highly likely.**

**THE CHAIRPERSON: Q. Sorry, what did you say?**

A**. Highly likely. Those goaf wells will capture whatever there is there in the goaf, and if that happens to be coming off a spontaneous combustion minor event or early event, or whatever, then it will go into the goaf wells, yes.**

**Perhaps if I could ask, Mr Operator, if we could bring up AGM.002.001.0937. This is the risk analysis for goaf drainage. Could we go to page of that document, please, Mr Operator.**

**Do you see endorsed on that document: Increased spontaneous combustion risk due to increased gas drainage has not been assessed in this WRAC. Additional WRAC required to assess and control spon com risk.**

**A. Yes.**

**Q. Does that surprise you, that that approach was taken in terms of the risk assessment for goaf drainage, bearing in mind that production commenced on this longwall prior to 31 May 2020, which was when that WRAC was to be completed?**

**A. It doesn't say post-drainage.**

**Q. Sorry?**

**A. It does not say post-drainage. It says gas drainage. I don't know that it relates to pre-drainage of the seam, which does increase spontaneous combustion risk. I took that to mean that the increased risk of spontaneous combustion is caused by pre-draining the seam, which is true because it drains the seam of coal and it provides access for oxygen to the coal seam**.

**Q. That, to you, is not a reference to the increased suction on the goaf wells, with the risk of introducing further oxygen into the goaf?**

**A. The truth is I don't know. I read it as pre-drainage.**

**Q. If it was about post-drainage, would that be a surprising situation?**

**A. Yes.** TRA.500.021.0046

**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.**

Q. **Could we go back to the PowerPoint, please, Mr Operator. There's nothing further on this page that we need to discuss, but there are some diagrams that we'll come to. In the first dot point on this page you say that gas monitoring systems and spontaneous combustion indicators are flawed. What do you mean by that?**

**A. The slide explains that. 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. It's also TARP driven. When gas monitoring alarms are**

**raised, then that raises a TARP.** **Are people familiar with the term TARP?**

**Q. Can we go to this next slide, then, slide 46. Can you talk us through the points that you make here?**

**A. Yes. This is a conceptual strategy. I've obviously been thinking a hell of a lot, over my career, really, but more so in light of recent events in Queensland. 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.**

**So that first bullet point, if we just do that, that would be an example of managing gas but not managing spontaneous combustion, and we can't be in that situation****. If the planned production rates cannot be achieved commensurate with maintenance of less than 5 per cent, I have said - that number is debatable. Less than 2 per cent oxygen, most people would agree - I'm slowing down without being told - that spontaneous combustion activity is unlikely to occur in all coals.**

**Less than 5 per cent, a lot of coals will not spontaneously combust. Some will. Anything over 5 per cent, I think it's fair to say that most coals will spontaneously combust.**

**My figure is 5 per cent.**

I would like to say 2 per cent, but I don't think we can adequately manage gas at planned production rates and achieve less than 2 per cent oxygen in the goaf.

Q. **We'll come to the TARPs in a moment, but what do you say about a description of a goaf with a maximum of 8 per cent oxygen as being normal?**

**A. I wouldn't do it.**

**THE CHAIRPERSON: Q. Sorry, what did you say?**

**A. I wouldn't do it.**

**Q. Wouldn't do what?**

**A. Run a goaf at up to 8 per cent.**

MR HUNTER: **Q. So if you can't, you say, get that 5 per cent oxygen in the goaf, you talk about these other methods that need to be employed?**

**A. Yes.**

Q**. Now, in terms of pre-drainage, it's a bit late if you discover the problem once you've commenced production?**

**A. Yes, it is.**

**Q. So what sort of time frame are we talking about in terms of identifying the need to pre-drain and actually doing it?**

A**. Lead time typically would be at least three months. It could be 12 months. Certain mines do surface to inseam pre-drainage, so the area is degassed before the longwall or even the mine gets there.**

 **The lead times there could be two to five years, so it's a very long lead time, and not guaranteed that you will pre-drain all of the area in the prescribed time frame.**

Q**. Post-drainage of non-worked seams. For example, the P seam here wasn't pre-drained.**

1. **Yes.**

**Q. It was, though, potentially possible to post-drain it?**

A**. You can drill pre-drainage holes which become post-drainage holes, so those holes would be initiated outbye the longwall face and they would penetrate the seams which were intended to be pre-drained**. **That may be of limited success due to time, permeability, saturation, all sorts of reasons. Those would turn into post-drainage holes. The longwall approaching will fracture and destress other coal seams and the permeability increases as a result can be orders of magnitude, by which I mean 10, 100, 1,000, and they will become post-drainage holes.**

**I said "combinations of the above" - that's fairly obvious, I think, which is what we are talking about now.**

**Horizontal goaf wells is another technique which has worked extremely well at some mines and has flopped at others.**

**Q. What does a horizontal goaf well do that a vertical goaf well doesn't?**

A**. A horizontal goaf well is close to what I've just described. Holes are drilled - it can be from surface but usually it's from underground nearer to the target, so a series of branched holes, probably, will be drilled up into the strata above the worked coal seam, be drilled to a pre-determined horizon, and they will then dip away towards the longwall face. They might be 800 or 1,000 metres long.**

**The dip of the hole is absolutely vital, because if any what we call undulation swillies - if any undulations are in that borehole, they will almost certainly fill with water and suppress the adsorption.**

**As I said, my belief is that where they don't work is because they weren't given enough attention and people didn't try hard enough, but that has probably upset people right now.**

Q. **The last point, number 4, is spontaneous combustion. The dot point at the foot of the page that you've included is that that is the source of ignition that requires discussion. Why do you say that?**

**A. Simply because I think it's most likely.**

**Q. We know, though, from Mr Watkinson's work that he found no evidence of spontaneous combustion activity accelerating.**

**A. I think if you ask Martin Watkinson that question today, you would get a different answer, and that would be based on the work that Sean Muller has done, which I think is extremely thorough. It's retrospective and it's hindsight, I understand that, but there are signs in the work that Muller's done that there was evidence of spontaneous combustion.**

**Q. What in particular about what Mr Muller did –**

**A. I think the goaf wells carbon monoxide on a methane free basis work was quite compelling.**

**Q. I won't go to the graphs here, but we're talking about those graphs that show a rise on the morning of 6 May?**

 **A. Yes.**

**Q. In terms of methane free carbon monoxide?**

**A. I have to say, those graphs were quite confusing.**

**TRA.500.021.0058**

Prior to the event, there was increasing carbon monoxide, but at the same time, methane was increasing at a very similar rate and oxygen was decreasing conversely, **and it looked very much like a well had been turned down, so the flow rate being reduced, the ingress of oxygen had decreased, so the dilution of carbon monoxide and methane had reduced, causing the increases.**

**But Sean has done some analysis we don't think coal mines would do routinely, and he has done the analysis on the basis of methane free CO, and he still sees the increase.**

**Q. So the question that you pose at dot point 2, then, when you say "without detection", do you mean without detection by the conventional methods of analysis?**

**A. I mean without detection prior to the incident by the mine**. We've got repetition here.

TRA.500.021.0064

**Q. Would the detection of ethylene in a goaf well be a matter of concern?**

**A. Yes.**

TRA.500.021.0067

**Q. We've probably covered most of what appears here.**

A**. Yes. I think it's important to recognise and acknowledge that we can't a hundred per cent manage spontaneous combustion if we are managing gas.**

 **In other words, we can't keep the goaf completely inert. We've got 70 cubic metres running alongside one side of it. We've got penetration to the goaf, which is a known phenomenon,**

**and we can't keep goaf wells down to 2 per cent oxygen, because if we did, then we would not really capture much gas.**

**So I think there has to be a risk taken, but that risk has to be managed and it has to be as small as possible.**

**Q. So is a 5 per cent target figure realistic, in your view?**

**A. I believe so.**

TRA.500.021.0069

**Q. As far as you're concerned, is there any connection between the earlier HPIs and the events of 6 May?**

**A. Two comments to make. The fact that we're getting HPIs means that the gas make is not being managed as it should, so it's hard to disassociate an outpouring of gas - it's not an outburst. It's probably - you could term it an inrush of gas from the goaf into the ventilation on the longwall face. It's hard to 100 per cent separate those two issues.**

**But I have to say the mechanism I've seen with the HPIs generally involves something completely different from the goaf fall. So it's things such as excessive production for a period of time or barometric pressure changes or failure of goaf wells, things such as that.**

**I think the event on 6 May in the afternoon was a completely different event from the HPIs in terms of mechanism.**

**Q Do you understand that to be a spreadsheet that details the vacuum pressure being applied at the various goaf wells on longwall 104?**

**A. Yes.**

**Q. What can you tell us about what we see on the screen there? Are there any matters of significance, as far as you're concerned?**

**A There are some numbers that are quite high, up to 28.675 or so. In the right-hand column, that's the average, and the average of the average is just over 14 kPa below atmosphere. That's a little bit above what you'd expect but not dramatically so. It's a post-drainage system which I would assume was being worked quite hard.**

**Q. I beg your pardon?**

TRA.500.021.0071

**A. It's a post-drainage system which I would assume was being worked quite hard.**

**Q. Were those numbers consistent with it being worked quite hard, to use your words?**

**A. Not really. 10 to 15 kPa would be fairly typical, I'd say.**

**Q. What about - you say that there are some numbers that are as high as 28?**

**A. Yes.**

**Q. I'm looking at well 7 on 18 April, for example. This number here, for example, just above where I'm holding the cursor now, is that the 28 you were talking about before?**

**A. Yes.**

TRA.500.021.0095

**Q. I thought basically we're restricted by what you can pull up the goaf wells?**

**A. If you want to run those calculations at 14.4, both those lines would move 40 per cent-ish downwards. So the 6000 litres per second you mentioned would equate to a higher number of tonnes.**

**Q. So if we just go off this table, then, for 25 cubic metres per second at 6300 litres per second, what does that equate to in terms of goaf capture efficiency?**

**A. I can't give you a figure from that chart.**