QUEENSLAND COAL MINING BOARD OF INQUIRY

Coal Mining Safety and Health Act 1999

Establishment of a Board of Inquiry Notice (No 01) 2020

Before:

Mr Terry Martin SC,
Chairperson and Board Member

Mr Andrew Clough,
Board Member

At Court 17, Brisbane Magistrates Court
363 George Street, Brisbane QLD

On Monday, 22 March 2021 at 10am
(Day 20)

Transcript produced by Epiq

THE CHAIRPERSON: Yes, Mr Rice?

MR RICE: Mr Martin, I call Dr Ray Williams.

<RAYMOND JAMES WILLIAMS, affirmed: [10.03am]

<EXAMINATION BY MR RICE:

MR RICE: Q. Dr Williams, would you just give us your full name, please?
A. Raymond James Williams.

Q. Just a few things about your background. You were tertiary educated at the University of Newcastle?
A. Correct.

Q. You gained a doctorate in geology in 1980?
A. Correct.

Q. You have spent most of your career, I think, working in the areas of coal seam gas related work, including gas reservoir definition, gas drainage and modelling of gas emission and gas production?
A. Correct.

Q. You were the founder, I think, of a business called GeoGAS in 1990?
A. Yes.

Q. You were its managing director for a good number of years, were you not?
A. Yes.

Q. More recently, you are retired, but you still do some consulting work?
A. Yes, a small amount. Not much.

Q. Of relevance, the coal mines inspectorate asked you to do some consulting work, did they not?
A. They did, yes.

Q. You were asked to review documents and data which you understood to have been sourced from Grosvenor mine, which the inspectorate provided to you?
A. Yes.

Q. And that resulted in your preparation of, firstly,

a report dated 29 October 2020 - that's the longer one?
A. Mmm-hmm.

Q. Correct?
A. Yes.

Q. And then there were some features which you were asked to elaborate on that resulted in an addendum report I think dated 24 November?
A. Correct.

Q. You have also prepared a PowerPoint presentation to assist with explanation of some aspects of the work you did; correct?
A. Correct, yes.

Q. I'm going to go directly to the PowerPoint, Dr Williams, and it may be necessary from time to time just to revert back to the text of your report for a bit of elaboration. So that's the process. Okay?
A. Okay.

Q. Your PowerPoint - I will just give the number of it. It's RSH.019.001.0471. I have control of the slides, Dr Williams, and you have a pointer also, which you can use from time to time if you need to do so. Okay?
A. Okay.

Q. Slide 2 contains a short-form depiction of the areas that you were asked to review. Would you like to use that to explain the task that you carried out?
A. Yes. I will start with the gas reservoir. That involved defining the gas reservoir above, including the GM seam, the mined seam, and in the floor strata below it. And by "gas reservoir", I mean certain properties such as gas content, gas desorption pressure, gas saturation, and I think we'll get the opportunity to explain these a bit later. But also important in this are the thickness of these sources and their distance from the mined seam.

Q. As we will see, I think, you have spent some time on making some comparisons between circumstances of mining on longwalls 103 and 104?
A. That's correct, yes. Yes, I needed a base to proceed from, to judge longwall 104 by, so it made sense.

Q. The first of those topics listed is gas pre-drainage

of the GM seam. You reviewed that and formed some conclusions about it, as I think we will find?
A. Yes.

Q. Moving forward to the next slide, you have titled that "Longwall 104 seam stratigraphy", and you have referenced a borehole numbered as DDG295. I think we will see reference to that borehole on a number of occasions as we go through.
A. Mmm-hmm, yes.

Q. That is located within the mined area of longwall 104; correct?
A. Correct. It's pretty well in the centre of the area, yes.

Q. We will see a diagram of it shortly.
A. Yes.

Q. Would you just like to explain what is depicted?
A. It shows the stratigraphy from the working seam, which is the Goonyella Middle, and I'll see if this pointer can work. Okay, it highlights it. The Goonyella Middle seam - maybe without the pointer. Overlying that is the P seam, which is something like 50 to 60 metres above the Goonyella Middle seam and one of the most important seams as far as the gas source is. It is, I recall, about 5.5 metres thick.

Then there are further seams above that, the QB and the QA. I think they are around about 3 metres thick and much more inferior coal; and then a very thick seam, the Fair Hill seam, albeit at a long distance from the Goonyella Middle seam, but it's around 44.5, 45 metres thick, of quite inferior coal. That's the sequence above the GM seam.

Below the GM seam, we've got the Goonyella Lower, and there is an expanded view from the P seam down through the Goonyella Middle to the Dysart seams below. We can see this better now. Yes, the P seam here we see, and we have covered that.

Q. Interestingly, the P seam, as it is commonly called, appears to be a confluence of a number of seams?
A. Yes. The Goonyella Rider, the PL1 and the PL2, but, yes, together they are the P seam, yes.

Q. No particular significance attaching to that for present purposes?
A. Not for present purposes, no, no. The Goonyella Middle seam itself is around 5.5 or 6 metres thick, and they mine a section of about 4.2 metres or more out of it. In the floor of the Goonyella Middle seam quite close to it, we have the Goonyella Middle Lower seam, it is quite thin, about 30cm thick.

Q. And not far below the GM seam?
A. Not far below. It's just a metre or two or three - I'm not sure exactly at this point, but it's quite close. It contains quite inferior coal, but unlike the Goonyella Middle seam, which has been pre-drained quite thoroughly, the Goonyella Middle Lower hasn't been pre-drained, mainly because it is an exceedingly difficult proposition to pre-drain it.

Below the Goonyella Middle Lower, we have the Harrow Creek seams, Lower 1, 2, 3, 4, and then the Dysart Upper seam, and that's the end of the sequence in this borehole. Now, there are more seams further down, but in terms of their influence on the longwall mine, from the work I've done, they are not important. So I'm not including those in the study.

Q. Your assessment of gas reservoir, then, applies to that stratigraphy that we have just observed?
A. Yes, it does.

Q. We will move to slide number 4. The first task was to review the Goonyella Middle seam pre-drainage. One of the features I think was that there had been pre-drainage by Arrow Energy over a number of years. Would you explain what you observed about that?
A. Yes. Arrow Energy undertook pre-drainage for commercial gas reasons some 10 to 15 years ahead of mining, and that was done without any regard to mining at all. They drilled in a manner that was the most efficient and least costly from their point of view.

Q. That was just for commercial purposes?
A. That's correct, yes.

Q. But it had some benefit to Grosvenor mine in terms of pre-drainage of the areas that it drained?

A. It did. It did. But the result was that it had a non-uniform drainage pattern.

Q. Is that to do with the nature of the chevron wells that were used?
A. Yes, it is completely to do with that, yes.

Q. Can you give us an idea of the functionality of those?
A. The chevron wells are indicated here. This is one of them, GM038V. It has two laterals. These laterals are drilled from the surface, enter the GM seam at this point and travel in seam quite a long distance, over a kilometre, and intersect a vertical well, which is the gas and water production well. This lateral here does the same. So they have drilled two laterals into the single production well, which is less costly than drilling a single production well for a single lateral.

Q. What you have just highlighted is an example of a number of such wells?
A. Yes. Yes, that's the general scheme of things. Here is a trilateral down here, GM039V, where they tried to get a bit more gas out in between the wells. Looking at the modelling here, they succeeded. But, yes, the thing with the Arrow wells is that where the chevrons are close, they have reduced the gas content to lower levels, and we'll talk a bit later, maybe, about what I mean by gas content. And where they are far apart, the gas drainage has been less effective.

Q. Leading to what you have described on the slide as non-uniform drainage overall?
A. Yes.

Q. Resulting in a need to achieve some greater uniformity and to reduce gas content; am I right?
A. Very much so, yes. In mining, you have to get the gas content down to - well, I think the mine aim at less than 4 in the development and around 2 in the longwall, so there's usually supplementary pre-drainage needed.

Q. If we move to the next slide, we see a graphical depiction. The first note you make is that there was supplementary pre-drainage required. I think your report makes mention of 10 main boreholes being drilled from 38 cut-through, maingate 103. Is that depicted on the slide there?

A. It is.

Q. Just point that out for us?
A. There is 38 cut-through there, and these are the 10 boreholes. They are branched, they go in seam, and these ones here look like they are drilled to pre-drain ahead of maingate 104 development, but these ones up here are to pre-drain the longwall block itself.

Q. As the legend indicates, there are some holes depicted in blue and a number in red. The red ones depict, do they not, the reduced gas content arising from the further drainage of that area of the mine?
A. Yes, the green ones are the state of drainage before these underground inseam, or UIS, holes were drilled, and that reflects what is left over after Arrow finished. I think quite a decent period of time elapsed before - on drainage for these UIS holes, so that the gas content was further reduced down to around 2 cubic metres a tonne in this longwall block.

Q. That was a level of gas content I think as referred to in the secondary extraction SOP?
A. Yes.

Q. Insofar as that was the target, you reached a conclusion about whether that was achieved or not?
A. Yes, I thought it was achieved. I looked at the flows and material balance analysis, which is a method the mine used as well, and came up with a similar result. It was argued they could have drilled more of these test boreholes, but I'm fairly happy with - you know, I think even getting the gas content down to 2, for reasons we may go into, is not necessary. It is good to get it down as low as you can, but it is very hard for the gas to come out in the GM seam much below 4, so - anyway.

Q. So that was a good result?
A. Yes, yes.

Q. This is to do with drainage of the Goonyella Middle seam, but I'd just like to go to a couple of passages of your report that touch on the subject of drainage of the P seam by Arrow.
A. Yes.

Q. Mr Operator, if we could have Dr Williams' report,

WRA.001.001.0001, and we will be alternating between those two documents. Could we go to .0025, please. If we could highlight the third paragraph down, commencing "The P seam tests". You have given an indication there for the purposes of hole numbered DDH295, which I think is also one in longwall 104?
A. Correct.

Q. You were able to identify the extent of the Arrow pre-drainage of the P seam at that point?
A. Yes.

Q. It appears as though there was a reduction of gas content by 28 per cent, from 10.4 down to 7.4; is that the point?
A. Yes.

Q. Could we go to the final paragraph on the page that appears under the heading "DDH268", which is located in longwall 103, is it not?
A. Yes.

Q. There is a reference there to the extent of pre-drainage by Arrow of the P seam at that location?
A. Yes, there is, yes.

Q. Particularly in the second line, do I read that correctly that there was a reduction of between 62 to 77 per cent from 9.8 cubic metres per tonne down to 2.3?
A. Yes, but the line below says that the Arrow well residual modelling shows a gas content of about 4.5 cubic metres a tonne, and I think the extra bit of gas came out because, fortuitously, what appears on the map as an underground inseam - inseam into the P seam, that is - gas drainage hole was drilled quite close to DDH268. So I think it is somewhat a localised effect.

Q. You make reference to that in the last sentence of that paragraph, that that 2.3 figure may have been influenced by the effect of its location close to the P seam UIS borehole?
A. Yes.

Q. Is the figure of 4.5 more likely to be more generally applicable, or can't you say?
A. Yes, possibly, yes. I mean, the Arrow modelling turned out to be fairly reasonable, quite - with the work

Anglo did subsequently, it more or less confirmed it.

Q. Does that give us an idea, then, of the results of the P seam pre-drainage by Arrow for those two boreholes?
A. Yes. But you raise a good question. I mean, if one is a localised effect, more typically it is probably 4.5 cubic metres in the general area.

Q. Let's go back to the PowerPoint, and at slide number 6 you have moved to another assessment of gas reservoir properties, and I think you explain that by the "gas reservoir" you are talking about each of the seams above and below the GM seam?
A. Yes.

Q. What was the nature of the exercise?
A. The first assumption you make is that the gas is confined in the coaly material, in the carbonaceous and coaly material, within the stratigraphic sequence above and below the Goonyella Middle seam. It can also be contained in sandstones and stuff like that, but we've ignored that for this exercise, and I think in this part of the world it's a fairly trivial amount, anyway.

Q. So you are looking at the gas content of the coal seams?
A. Not just the coal seams. Anything with carbonaceous material in it has the ability to adsorb gas. So, yes, looking at the gas reservoir above and below, we looked at everything that had carbon in it that had a lower density than rock and was low enough to adsorb gas.

Q. You've got three minor dot points, commencing with gas content. Could you perhaps explain each of those?
A. Yes, I did mention that gas is - coal - we will talk about "coal" rather than "carbonaceous material", but it's much the same thing. It has a huge capacity to adsorb gas. So, for example, the Goonyella Middle seam in its raw condition at this location, before Arrow pre-drained it, is around, say, 12 cubic metres a tonne. That's a lot of gas in a piece of coal.

The thing about gas content, though, is that it is quite misleading to use the number on its own. You've always got to qualify it by saying the gas content is, say, 12 at a density of 1.44, for example, because the mineral matter in the coal reduces the gas content.

A good example is the Goonyella Middle Lower seam. It's only a metre or two away and it's got a gas content of probably 3 or 4 cubic metres a tonne, and on the face of it, you would say, "Well, that's not much", but because it's so high in mineral matter, it's a different kettle of fish. This is where gas saturation and gas desorption pressure come in to complete the picture. So gas content on its own can be misleading.

Q. The concept of gas saturation and desorption pressure features in various ways in your assessment, and you have a tab there to explain.
A. Yes.

Q. Perhaps we might go to that. This is slide 42. Have you set out there to explain the functioning of the gas saturation and desorption pressure isotherm; is that what it is?
A. No, well, it's just the isotherm, yes. Yes, I will endeavour to explain it, if I can. The red line is called a gas sorption isotherm. It is a laboratory test that's done. The X axis is the pressure. In this case, it is absolute pressure; that's how it is done. And the Y axis is gas content - or gas sorption capacity, more correctly.

Like I said, it's a laboratory test where in the laboratory you crush coal samples up, you do the whole thing at a constant temperature, hence the word "isotherm", and at different pressure steps you let the gas sorb into the coal until it is in equilibrium. The coal has to be crushed quite fine for it to reach equilibrium, but you do that, and you get maybe five points on the graph and you put a line of best fit through. There is a particular equation to do that. The line of best fit describes this thing called the gas sorption isotherm. Like I said, it's a laboratory thing. On its own, it doesn't mean too much, but when you combine it with depth of mining and measured gas content, it starts to become very important.

For example, if we look at the pressure that the thing is adsorbed in the laboratory, you can use that as an analogy for depth. Instead of, say - we'll look at Qa, for example. That's an unfortunate choice of terms. It's not the QA seam and the QB seam. But the first example is Qa. At a depth of around - not a "depth". At a pressure of about 1800 kPa and approximately a depth of 180 metres, that's what that means. In the case of Qa, we have a desorption pressure of 1800 kPa, and if we measured the gas content in the coal and it plotted there, the coal would be described as being fully saturated. So A over B, in this case, equals 100 per cent fully saturated.

In the case of situation Qb, the gas content is exactly the same, but it's deeper, or at higher pressure, but we'll call it deeper. It's at about 360 metres depth, thereabouts. Here the pressure is 3600 kPa. That's what you call the pore pressure or the head of water lying on top of it. But to get the gas to desorb, you have to reduce that pressure a long, long way, in this case all the way from 3600 down to 1800 kPa, and when it reaches that gas sorption point there, it's called, in coal bed methane, the critical desorption pressure. But that's described as the desorption pressure, and from then on, with gas drainage or gas emission, the gas content and the pressure will track this curve all the way down the bottom. Okay?

Q. Yes, okay. The mechanics of the operation of the isotherm are highly technical to at least one not as expert as you, but in terms of the practical implications of high gas saturation and high desorption pressure, you have said in your report at page 22 - I will just read you a sentence and ask you to comment on it:

Gas desorption pressure magnitude is a driving force behind gas ignition and if the gas saturation is high, it will be enacted more quickly.

A. Yes.

Q. Could you explain what you are getting at there?
A. Yes. One thing - I didn't really mention it in the report much, because it amounts to the same thing, but gas desorption pressure is what drives desorption rate. We see some peculiar things here.

For example, if I can just diverge momentarily, this isotherm here looks, let's say, somewhat typical for the Fair Hill seam. I don't think it is the Fair Hill seam, but if I were to draw the Goonyella Middle seam isotherm on here, it would look very different. It would come up here and be a lot steeper. The Goonyella Middle seam, because it is a lower ash coal, has a much higher capacity to adsorb gas. So you say, wow, that's a lot of gas content. So for the same pressure, it can hold a lot more gas. But the other side is true as well. For example, the Goonyella Middle seam at 4 cubic metres a tonne, let's use this example here, would have a gas desorption pressure of 500 kPa, whereas this seam at 4 cubic metres per tonne has a gas desorption pressure three times that amount.

So this desorption pressure is very important, and we see some peculiar things have occurred. I didn't mention this in the report, but in the Goonyella Middle Lower, for example, the desorption rate of that coal, for the same gas content as the Goonyella Middle seam, is way higher, maybe five or six times higher. The exact number I won't quote.

Q. Just to come back to that quote that I read to you, you have said that if the gas saturation is high, it will be enacted more quickly.
A. Yes.

Q. Is the level of gas saturation and its desorption pressure a material consideration in the extent to which the seam will emit gas once it is relieved of pressure?
A. Yes.

Q. Is that the way it works?
A. It especially works that way in the floor strata. In the roof strata above a longwall, the pore pressure, which might be at 2000 kPa, or 1800 where the Fair Hill seam is, when the longwall goes under, from what we know from rock mechanics, FLAC modelling of pore pressure, it drops to about 200 kPa virtually instantly.

Q. What's the significance of that?
A. You have this big pressure difference between the desorption pressure and the ambient pore pressure, and this is what drives desorption rate, which is gas emission, in other words, in a longwall sense. The gas has to desorb from the coal before it's a problem. If the surrounding pore pressure is quite high in relation to the gas desorption pressure, the desorption rate is quite low, regardless. But if you drop the pore pressure a long way, which is what happens in the strata above a longwall, then what is very important up there is the gas desorption pressure.

I did make the point that the Fair Hill seam was gas saturated, and that makes the process happen more quickly, but I think in a longwall that process would happen pretty quickly, anyway.

Q. Just so that we understand, you mentioned the Fair Hill seam, with high gas saturation and higher desorption pressure?
A. Yes.

Q. Once longwall mining commences underneath it, albeit some distance away, what is the effect of the mining activity at the GM seam on gas liberation at the Fair Hill seam?
A. Well, when the goaf forms in the GM seam, lateral fractures form around the margins of the goaf where the chain pillars are, and they project up into the strata a long, long way and at an angle. The strata movements are most obvious around the margins of these chain pillars. The material between the chain pillars is more or less like a layer cake, but the whole lot goes from having low permeability to having very high permeability. So the process is the pore pressure is nonetheless dropped; the gas desorbs from, let's say, the Fair Hill seam; it can migrate along bedding planes laterally into these lateral fractures surrounding the goaf and, from there, can find its way down into the mine workings.

Now, that process only occurs for a relatively short period of time, because you've got a front abutment zone and a rear abutment zone. The rear - when you take the coal out, you create a void. The stresses have to be redirected around the void, and when the void is large enough, you get what is called a rear abutment occurring, and that recompacts the material above the goaf and probably the goaf itself. That process shuts things down. So everything is happening within this - between the front abutment and, say, the 300 to 400 metres to the rear abutment. That's where the action occurs. Higher up, that effect gets less and less, but nonetheless if the gas desorption pressure is high enough, in the case of the Fair Hill seam, it can happen there.

Q. We will come back to the Fair Hill seam and talk about it some more a little bit later.

Just getting back to slide 6, if we can, which is at page 0476, the assessment that you made involved gas

content testing of the boreholes that are depicted there?
A. Yes.

Q. Being nine in all across a number of longwalls?
A. Correct.

Q. There were gas content testing results available from those boreholes; is that the idea?
A. Yes.

Q. Which you had regard to?
A. Yes.

Q. Were you able to cover the whole stratigraphic sequence from those boreholes?
A. To differing degrees, but yes, yes. They were selected because they did mostly cover the whole stratigraphic sequence.

Q. We will go forward to the next slide, number 7. This represents one of the features that you found, that across those boreholes as a whole you found that gas content - there was no discernible difference between the Fair Hill seam down to the DYU seams?
A. That's right, no discernible difference in inherent gas content.

Q. Is that the same thing as virgin gas content?
A. Yes, it is. It is. But because the seams have varying mineral matter, they have different densities. The gas content would appear to be all over the place, mainly reflecting the densities. But if you take the density out of it, which you can by plotting the gas content against density, you get, as indicated here, this relatively consistent picture here (indicating) of gas content against density for all the seams and all of those boreholes shown before.

Q. Was it surprising to find that?
A. Yes, it's not totally surprising to me, because I'm familiar with this area, but it is surprising to see it compared to most other areas, nearly all other areas. Normally, as you go deeper, the gas content increases, and normally the gas content at distances such as the Fair Hill seam above the Goonyella Middle, 180-odd metres above, isn't such an issue.

Q. This process that you went through, do we take it, shows that that general rule that gas content increases with depth is not necessarily universally applicable?
A. That's correct. In fact, as you go deeper than the seams I've shown in this report, the gas content actually reduces. It's quite a strange phenomenon, but it's quite widespread in parts of the Bowen Basin.

Q. Apart from being perhaps a curious feature that you discovered, what are the practical implications of this conclusion that you identified?
A. One practical application is that - and I have only looked at those boreholes you showed on the previous slide - it makes defining the gas reservoir a whole lot simpler than having gas content vary all over the place. Gas content normally doesn't vary all over the place. You can normally define zones, or I call them gas domains, where it behaves in a sensible manner either with depth or, in this case, with density and being constant with depth.

Q. Does it make identification of properties of the different seams easier because of the relatively uniform gas content?
A. Yes, absolutely.

Q. Does it enable, then, comparisons to be made more readily?
A. Correct. It's one of the reasons why I guess we can look at how the Fair Hill seam fared after the longwall goaf went through. But that also gets down to how well the gas content testing was done, and in this case it was done very well.

Q. In the next couple of slides, you have made mention of conclusions by others which were I think different to yours. Starting with slide 8, you mention Dr Moreby's assessment?
A. Yes, it shows the same overall thing, in that he has - the Goonyella Lower seam, which is maybe 150 metres or so further below, or a bit less than that - the Goonyella Lower seam is quite a low gas content in comparison, and Roy Moreby has calculated the ash out of the coal, which is the correct thing to do, using a method that's dry ash free, which is a typical coal bed methane method applied, but if you are correcting high ash coal, it's really, really inaccurate in the end, so you just don't discern things quite that well.

Q. Why is there inherent inaccuracy in that method?
A. Well, there are a couple of reasons. You assume that the gas content at 100 per cent ash plus moisture is zero, and oddly enough, in this part of the world, the gas content is zero at about 96 per cent ash plus moisture. So if you are correcting a sample from, say, 70 per cent, that has an ash of 70 per cent, ash plus moisture, you generate a large amount of error. The lower the ash, the less the error, in this sort of transformation. Yes, so there is a fair bit of error in that, but that's the way it is.

Q. I take it you prefer the results of your assessment as shown on slide number 7?
A. Yes, I do. The other thing I would say, though, is that Roy Moreby has used a much larger area. I mean, I'm focusing on a smaller area. So if I extend my reach a lot further, I may go into a different gas domain or some such thing, but - yes.

Q. You are making the point, I think, that your assessment of gas content was over the boreholes that you noted?
A. Yes.

Q. Being spread across perhaps four longwalls?
A. Yes.

Q. As opposed to whole of mine, for example?
A. Yes, yes.

Q. Another assessment that you looked at was one by GeoGAS in 2011. What comparison did you observe between your assessment and theirs?
A. Well, see, they've done a correction again. This time - this is a different one again. They've corrected everything to 15 per cent ash, which is better than dry ash free. Again, it runs into problems for very high ash coal, but here it shows nonetheless the sort of thing we've been saying, and that is that the gas content, albeit depth going this way it seems to reduce, but stratigraphically, the shallower seams have the highest gas content for the same depth. The Goonyella Lower seam at 300 metres is down as having only 6 cubic metres a tonne, whereas the Q seam is double that at 12. So they're sort of seeing something there, but there's a hell of a temptation to want to make the gas content increase with depth.

Q. Because that's the normal thing?
A. That's the normal thing, yes.

Q. What is the final comment that you have made on that slide?
A. The increase in gas content with depth on a seam basis is not as clear for borehole coverage. Yes, I mean, on a seam basis, the analysis I did, there is no difference. All the seams look the same.

Q. To that extent, does your assessment differ from some observations made in Dr Moreby's report and also the GeoGAS report of 2011?
A. Yes, yes. It's quite different to the GeoGAS one, where their gas content is varying by seam, whereas mine is not. But, again, the GeoGAS one is whole of mine, and mine is a portion of it.

Q. Is it a bit unsafe to compare apples with oranges in that respect?
A. Yes, yes. But the problem is that you see graphs like this, and you just don't know where the data are from. That's the problem. There is not a whole lot of data points on there, either.

Q. Moving forward to slide 10, you have done an overall assessment of gas content between the two longwalls; is that what that is?
A. That's what this is. It's sort of splitting things pretty closely, but all the other boreholes are indicated by the orange circles here, and longwall 104 is indicated by the crosses. This slide shows that there would appear to be some increase in inherent gas content in longwall 104, and I've sort of indicated it's around 15 per cent at probably 1.5 grams/cc density.

Q. What are the implications of that in a practical sense?
A. Well, it just indicates that there is a bit more gas in longwall 104, but 15 per cent is not a huge amount more. But it does seem to be - there is a measurable difference. That's what it is.

Q. Is that gas content that is released by the activity of mining?
A. No, no. This is all virgin, pre-mining,

pre-pre-drainage gas content that's shown here. How much is released in mining gets down to things like the desorption pressure and all the rest of it. But here we are just defining the gas reservoir, which is a static comparison. We're not talking about mining at this point. We're just trying to see what's there to begin with.

Q. We've returned, at slide 11, to the subject of gas saturation and desorption pressure. Can I take you back to a part of your report near to the passage that I quoted to you earlier. If we could go to page 0023, Mr Operator, it is the third paragraph on that page. Is the comment that is highlighted there relevant to that slide number 11 to do with gas saturation and desorption pressure?
A. Yes, it is.

Q. The comment you make is:

Seams with high gas desorption pressure and high gas saturation in close proximity to the working seam will more readily give up their gas.

Your slide is directed towards the Fair Hill seam, and it does have high gas saturation and desorption pressure, but is it correct to say that it is one within close proximity to the working seam?
A. No, it's not, no. The first sentence was a general statement. The second one looks more specifically at the Fair Hill seam, and it is clearly not close to the working seam. In the wash-up, it turns out that only 19 per cent of the gas has been emitted from the Fair Hill seam, at least over longwall 103, from testing Anglo has done.

Q. Could we go, Mr Operator, to page 0029 of that report and highlight the paragraphs in the middle of the page. In the second of those highlighted paragraphs, you have made a comment about the importance of a number of factors, proximity to the working seam being one of them. I think you are probably aware there is a - 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 Fair Hill seam, but the gas reservoir size is massive. It's a huge gas reservoir.

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

Q. That's your opinion?
A. Yes.

Q. Just to be clear about that, is it your opinion that the gas desorption from the Fair Hill seam was emitting to the Goonyella Middle seam?
A. Yes. I mean, there is the thought it could have disappeared up to the surface. The Fair Hill seam sits equidistant, virtually, between the surface and the working seam, but the cracks migrate up from below, and I think the greater likelihood is that the gas migrated down into the workings.

Q. Because of cracks between the Fair Hill seam and the GM seam?
A. Yes.

Q. As opposed to from the Fair Hill seam to the surface?
A. Yes. I think the gas is going to go down the path of least resistance. I mean, there are things like ventilation pressures that might induce the gas one way, there is the buoyancy of methane that might induce it another way, but those things are small compared to the gas desorption pressure and the fractures that are in the coal - in the strata. The fractures will be greatest below the Fair Hill seam into the workings. And the whole effect is transient. I mentioned the front abutment and the rear abutment. It all happens within that zone, and then it's shut off. I mean, the Fair Hill seam lost, as maybe we'll see later, 19 per cent of its gas, and the rest of it is

still there. So it comes and it goes, but the gas reservoir size is so high that 19 per cent ends up being a pretty sizeable number.

Q. You have made the point I think in your report that insofar as others, perhaps, Palaris, for example, may have adhered to that 150 metre rule of thumb, there appears to be no reference to the influence of gas saturation and gas desorption in that kind of assessment?
A. Yes, that's right. I think if you look at the literature, maybe with the exception of Klaus Noack, who produced a pore pressure model in Germany, there is never much - I haven't seen any reference to gas saturation or gas desorption pressure in longwall mining at all. I mean, there is the ACARP work done by CSIRO in 2019 that Roy Moreby was a part of, and a huge amount of work was done there, but unless I missed it, that's not mentioned in there at all.

Q. Can we go back to the PowerPoint, Mr Operator. You have made your observations then about the significance of gas saturation and desorption pressure for the Fair Hill seam. If we move on to slide 12, there is apparently lesser gas saturation and desorption pressure at the HL seams. Is that simply for the point of comparison?
A. It is. The calculation to derive these graphs is fairly intensive, so I didn't want to do the whole sequence, although I have a bit of a short summary in another graph, but it is by way of comparison.

The HL seam - I think it's got a higher gas content than the Fair Hill seam. The isotherm is a little bit higher. But you can see, because it is deeper, I mean, it is down around - you can read off that, it is about 420-odd metres deep. To get the gas to desorb - it's got a gas saturation of 65 per cent, meaning that value there over the total value at that pressure is 65 per cent (indicating). But 65 per cent, oddly enough, is a very low gas saturation because of the implication it has on the amount of pressure you have got to reduce to get the gas to come out, and here you see you've got to reduce the pressure a long, long, long way, all the way from 4200 down to around 1600 kPa, to get gas desorption.

Q. For those various reasons, the HL seams are less likely to give up their gas to the GM seam?
A. Yes, but there is one other important reason in it.

They are in the floor of the GM seam, and the reduction in pore pressure in the floor is a whole lot less marked than it is in the roof. I've grabbed a - I don't have access to pore pressure models from FLAC modelling from Strata Control Technology for this situation, but I have used the general one from Noack, yes, and the pore pressure is not reduced that much at that depth.

And remember what I said, that it is the difference between pore pressure. You might get to gas desorption pressure, but if it is only desorbing from 1800 down to 1600, it's not going to come out very fast. All in all, the stuff in the floor is not that important from that point of view.

Also, I mean, the HL, I think it is the HL3 and HL4 - it's a fair thickness, I don't know, I may have it wrong, but maybe 4 or 5 metres, but it's very ashy coal and it has this characteristic of desorption pressure and saturation in an environment where the desorption pressure - where the pore pressure hasn't been lowered very much. Sorry to make that a bit hard.

Q. If we go to slide 13, this is the last of the slides dealing with this subject. Perhaps you might just explain for us the features of note that emerge from the graph that is depicted there?
A. Yes. Beginning with the BA and CA seams, they are above the Fair Hill seam and they are simply affected by proximity to the surface, so their gas content is reduced in that way.

Q. Are those seams then of relevance to --
A. Below that? Yes, the Fair Hill we have talked about - gas saturation is up around the 100 per cent. This is a pretty broad-brush way of looking at it. It needs to be done in a lot more detail, but it gives a reasonable picture, I think, of what's going on. So we've got the Fair Hill seam.

The various other seams - not written on there is the QA and QB seam, for some reason. Down here (indicating), we've got the P seam, which has low saturation and desorption pressure, but that's because it has been partially pre-drained, in the example I used.

Then you get down, these seams here have higher desorption pressures (indicating), so that gas would expect to migrate very quickly, especially as it is close to the GM seam. Here, the GM seam has been pre-drained to a low level, so it has a very low desorption pressure, and compared to the original gas sorption isotherm it has a low gas saturation.

The notable thing here is the GML seam - it's come off the boil a bit because it's deeper, but it's still got a fairly high gas saturation and a fairly high pore pressure. So there is some potential for the GML, the thin seam close to the floor of the GM seam, to create gas and cause problems. Indeed, we know it has caused problems in development.

Below it are these HL seams, where the gas saturation is pretty low - 65 per cent, that's low - and gas desorption pressures are low similarly.

Q. As we go a bit further into your PowerPoint, we will see some estimate made of the degree of emission from these various seams?
A. Yes, yes.

Q. You have attempted, have you not, to identify the gas reservoir size for relevant seams above and below the GM seam? The first thing you have done is offer an explanation of the method. That formula or equation is a fairly standard one, is it not?
A. Yes, it is. Yes, it's quite common in the industry. The gas reservoir size, GRS, is the product of gas content in cubic metres of gas per tonne of material, multiplied by the density, which is tonnes per cubic metre of that same material. So then you have a result of cubic metres of gas per cubic metre of material. Multiply that by the thickness to get the gas reservoir size in cubic metres of gas per unit area, per square metre.

Q. The third and fourth dot points there, are they indications of the kind of material you have had regard to in making this calculation?
A. Correct. The thing is that the gas content testing is only carried out on discrete samples, but we need to assign gas content to the entire stratigraphic sequence, and this is where you asked about the utility of the gas content relationship. We found with density earlier that the consistency of it - well, it makes something like the gas

reservoir assessment quite easy, because all we need to know is the density of everything and we can assign a gas content to it. So that's what we've done using geophysical logs for density.

Q. For the purpose of this exercise, you have selected, have you, the data from two boreholes, DDG268 and DDG295?
A. Yes.

Q. Is there some reason you chose those two?
A. Well, 295 is obvious. It's the best borehole to look at in longwall 104. Longwall 103 - you could argue I could have looked at a lot more boreholes. This gas reservoir size calculation is quite onerous, to be honest, and I didn't want to bog down and I just wanted to get a feel for what the whole thing was, and that's what I got. It's in the middle of longwall 103.

Q. From side to side?
A. Yes - no, middle of the longwall block from end to end, longwall 103.

Q. It looks like both?
A. It's both.

Q. In terms of outcomes, then, if we go to the next slide, we see first of all a table. We see some indication there in the table of the size of the Fair Hill seam reservoir, although somewhat different from the borehole in longwall 103 to that in longwall 104.
A. Yes, but it's still huge. That was the main point. Yes, I think there is plenty of scope to look at the Fair Hill in a lot more detail for every borehole intersection you can get, but the bottom line is that the gas reservoir is huge. In 268, it's kind of interesting that it is quite large and even closer to the GM seam.

The distances between the working seam and these overlying seams obviously varies, and this is part of what needs to be tracked down in the course of the geological assessment. The Fair Hill seam has the highest gas reservoir. The QA and QB seams are fairly reasonable. The GU seam is smaller again. But the interesting one, I guess, is the P seam, which has been partially pre-drained, and the figures in red indicate my estimate of what, based on density, the gas reservoir size was originally compared to what it is now. We see in longwall 103 - bear in mind that that data point is affected by maybe localised pre-drainage, but it's relatively low, 18, whereas in longwall 104 it's quite sizeable and it's relatively in closer proximity to the GM seam.

Q. Is it a reflection of the figures we looked at earlier when we extracted details of the extent of pre-drainage of the P seam from your report?
A. Yes, yes. The other points of note are in DDG295, the gas reservoir size for the GML seam, and 268, it's really quite low. It's around 3 metres below the GM seam, in longwall 104. Very low gas reservoir size, so ordinarily you would just dismiss it and not worry, but it has a high desorption pressure and it's very close to the working seam, so it has the potential to cause some problems. Yes. The HL seam - yes, the gas reservoir size just isn't that great below the working seam, anyway.

Q. The graph on the right, is that a graphical representation of the detail in the table, or is it different?
A. No, it is the same. Yes, it's gas reservoir size here on the X axis and distance above and below the working seam on the Y axis, yes.

Q. We will go forward to slide 16, entitled "Longwall Gas Emission". Would you mind explaining what was the task that you undertook from this point?
A. Well, longwall 103 is important to give you a base of empirical data and to look at what the nature of emission is. I could have looked back at previous longwalls, but 103 is the most important. As I've said here, the approach utilises gas content, gas saturation, all of those things, desorption pressure, gas reservoir size, but it also utilised - and this was fantastic data to have - two gas content test boreholes in the goafs of longwall 101 and longwall 103. These were boreholes drilled after the goaf had passed to see what gas remained in the coal seams above the GM seam, and that's, yes, really good data.

Q. Just to be clear on the scope, having regard to the title of the slide of "Longwall Gas Emission", are you looking at emissions from all sources in the stratigraphic sequence?
A. Yes.

Q. Having regard to the concepts that we've already discussed, including gas content, saturation, desorption pressure and gas reservoir size?
A. That's right, yes, and here you are looking at how it all relates to mine production. Hence the third point there. Gas make is the relationship between gas emission and production. So that's an important one. I go on to map gas make into gas domains.

Q. Why is it important for a mine to know from where gas is emitting and to where?
A. You have to make an initial assessment as to what you think will happen and design a solution from it.

Q. Does it feed in to gas drainage requirements?
A. Yes, yes, if you --

Q. Is that the most direct relevance?
A. And ventilation and - yes, but gas drainage and your strategy --

Q. They are two of the most important control features, are they not, the ventilation and the gas drainage?
A. Yes, yes.

Q. Both of those would be informed by this kind of assessment; is that correct?
A. Yes. I mean, you could make an assessment without any gas drainage, and you would be quite alarmed at what would be going down the tailgate in your model. So then you've got to - you know, you can pre-drain the P seam and do various other things to see what might happen, change your ventilation and do all sorts of things.

Q. All right. You have explained why you have done a degree of analysis on longwall 103. If we go slide number 17, first of all, to the map, you make a note there that - is it a P seam Arrow map?
A. Yes.

Q. You've drawn on that longwall 103; is that correct?
A. Yes.

Q. It is divided into domains. Why is that?
A. If you look at - and Anglo do this; it's pretty commonly done - you look at gas make versus production and you average it over a week to take the variations out of

it. If you just look at the data holus bolus, you end up with a pretty blurry pile of points. You can put a line of best fit through it, but it doesn't help a whole lot, and that's usually as far as things go.

What I've done here, though, is break the area up - and this is something I've found quite commonly, that longwalls can vary in the way their gas make occurs, either due to natural reasons, the geology changes, the gas content increases or something, or due to some remedial action the mine takes. Nonetheless, you can identify large areas in a longwall where the gas behaves quite predictably.

Q. Did you find then that the gas make was not uniform across these different domains that you have drawn?
A. It was uniform within each domain but quite different between the domains, yes.

Q. There is a very technical-looking graph and associated data on the left-hand side. Could you perhaps interpret that for us?
A. Yes. That shows tonnes per week versus gas make. Gas make is cubic metres generated from all the sources - goaf wells, ventilation, the lot - and averaged over a week, plotted against tonnes per week. What you can see there - and this is the standard picture you see - is that the faster you mine, the lower the gas make. You still get more gas per se, if you multiply the two numbers together, you will get more gas, but the gas make does vary. It decreases the faster you mine.

Q. Do those various boxes illustrate different gas make per domain?
A. That's right. It's just a mathematical relationship for each one, which I've gone on to use to calculate return gas emission against what they actually saw.

Q. I think we might find on the next slide, number 18, this looks very busy, but if we take a bit of information at a time, it's actually very useful. Just dealing with the subject of the domains and their gas content, have you identified the five domains just below the top of the graph?
A. Yes. I use the term gas make at 150 tonnes per week. It's sort of an average value. Gas domain A, I'm not quoting a figure, because that's early in the retreat of

the longwall before the goaf is properly formed. But once the goaf has probably established itself, we get a period of consistent gas emission - total emission, that is - and that's characterised by a number there, you can say 19.8 cubic metres per tonne at this 150 tonnes per week.

Domain C, it's a ramp-up in gas for some reason, and these are the things we need to sort out why. The total gas has increased, but it is consistent all the way through there, even though a lot of things have been happening in the meantime (indicating).

Domains D and E are where the seam is reducing in depth and mother nature is helping quite a bit. The longwall starts at around 390 metres and it finishes at about 200, I think, so there is a fair change as you retreat.

Q. It reaches its peak gas content, or gas make, at domain C and then tapers off through the balance of the panel?
A. Yes.

Q. Just to look at some of the features of this presentation, on the X axis you have chosen to use chainage rather than date, but we can get an idea of the sequence of events from some events that we can fix in time, one of which is the major ventilation change, which I think we know to have occurred on 15 July 2019?
A. Yes.

Q. You have also drawn there an indication of the time period of what you have described as the maximum goaf rate trial, which we know to have occurred in the first half of August.
A. Yes, I can't recall the exact date, but --

Q. I think other information will tell us that that is so.
A. Okay.

Q. You have made mention there at the top of the slide of the P seam SIS borehole. One of your later slides deals with this in a bit more detail, but for present purposes, so we can make sense of this, could you just explain to us what the P seam SIS borehole was?
A. Yes, the P seam SIS borehole was an attempt at

primarily goaf drainage by drilling a surface to inseam borehole that went into the P seam and then tracked along the P seam for maybe 1300 metres or so. In this case, then they retracted from the borehole. They didn't intersect a vertical riser for production. They retracted from the borehole and did floor touches on the way out. The borehole was very large diameter, 311mm, as I recall, and they got a lot of equipment stuck in the borehole, in the end.

Q. In terms of its functionality, just to be clear, it was not an aspect of pre-drainage of the P seam; am I right?
A. You are right. Correct.

Q. Rather, it was an attempt to capture gas from the P seam once the activity of mining affected the stress and allowed gas to be liberated from the P seam; does that summarise it correctly?
A. Yes, and also, I mean, if it worked properly, it could have caught gas coming from above the P seam as well. But, yes, unfortunately the borehole didn't do much. I mean, it did flow really well when it finally flowed, but as I've indicated here, if you look at where my cursor is going, they mined over the end of the borehole and not much happened.

Q. Can you just explain what you mean by "mined over" it?
A. Yes, the borehole, there is probably a plan somewhere with it, but - mined under the borehole, I should say. They extracted under the borehole, and at that point you would have expected the gas to be released and the borehole to start functioning.

Q. That's what it was intended for, I presume?
A. Designed, yes, yes, but essentially nothing much happened.

Q. Is there some reason that you are able to deduce for that?
A. Not really, other than it was blocked and then suddenly became unblocked. I mean, it's a very large-diameter borehole and they did a lot of branching in it for floor touches, which is a bit of a strange thing to do, I think. In the process, they would have left a lot of rubbish in the hole and - yes, I think it was a difficult proposition. Nonetheless, they mined under the borehole.

Nothing much happened until they got to this point - we are in domain C - and then while they were still mining under the borehole, for about 140-odd metres, it started producing, and it produced quite well and stayed that way until it was finally turned off. But the interesting thing from the sort of analysis I've done in domain C is that the production of the P seam borehole seemed to have no effect on gas make - well, on what was happening in the return, anyway. Maybe that was masked by other things. But it's a strange borehole.

Q. Let's talk about the gas capture, represented by the line at the top. You have drawn a note with an arrow in domain C, which is proximate to the maximum goaf rate trial. The note is "Higher goaf gas capture from here". Were you able to attribute some reason to increased gas capture from the point you have drawn at domain C?
A. Yes, it's starting to rise a bit early, but they were having, by the look of it, a lot of problems with exceedances - these red dots. Production is not shown on here, but the gas actually started tracking down because they slowed production down a fair bit, and that's probably why the gas capture has gone up a bit ahead of the maximum goaf rate trial.

Q. You note that it was on the rise before that goaf rate trial commenced?
A. Yes, I think it was. Yes.

Q. The other lines drawn below that deal with tailgate CH4 and calculated tailgate CH4. Can you tell us what the difference is between the two?
A. These are weekly average numbers. One is calculated using the gas make curve for the particular domain. The gas make curves are sort of gold, because once you've got it, you can produce relationships like this, which are pretty tight. This one here is kind of cock-eyed, but I think what happened here is that the ventilation was different to what I put in the calculation. The calculated number - and it's in the back of the report - uses ventilation as well to arrive at what the gas concentration is going to be. Anyway, it's sort of a reality check, I guess, to see that everything is making sense.

Q. There is a peak drawn on the blue line, actual tailgate CH4, and it's towards the end of that cluster of

exceedances that we know to have occurred in July 2019. Then it starts to tail away - by that, I mean it starts to drop - somewhat in advance of the maximum goaf rate trial. Were you able to attribute a reason for what you have described as significant improvement in tailgate emission from the point drawn?
A. Yes, prior to the goaf rate trial, I think it's just simply related to a reduction in production. They just didn't produce much coal because they were having that many - those sorts of troubles, yes.

Q. The trend was down, and it stayed down, certainly by comparison with the first more than half of the longwall. Were you able to attribute any potential reasons for the generalised reduction of both tailgate and calculated CH4?
A. For this part, in domain C, this improved trend here (indicating) - and I'm not looking at production, but I don't think there were probably too many hiccups in production at this point, but this trend here reflects the better goaf gas capture generally, along here (indicating).

Q. Is the decreasing gas make also relevant?
A. Oh, yes. I'm just talking about domain C. Domain C, the gas make is the same all the way along, and then right here it suddenly drops. So in here (indicating), everything is constant and total gas, so if it is not in the return, it must be going into the goaf wells. In here (indicating), the gas make is reducing, and here it is really quite low, 13. So this is reflecting the more favourable gas/geology --

Q. That's domains D and E?
A. Yes.

Q. All right, let's go forward to number 19. You have given a depiction of a typical goaf well there. What is the significance of the features that you have drawn there?
A. The typical well is drilled around 20 metres - there it is (indicating) - above the GM seam. Ultimately that's where it finds itself, but it is drilled in a couple of stages. Initially, a 17.5 inch hole is drilled. Then it is cased with 13 and 3/8 inch steel casing and then cemented, I think. And then between there a further hole is drilled, and I think it is about 11.5 inches, through which slotted steel liner is emplaced.

Q. How does the slotted steel liner function?

A. Well, I guess it is slotted so that it can - it actually ends up being probably just into the goaf, and its function is to allow gas to migrate through the slots and accommodate strata movement, because while there is no cementing, it is just sitting there; it can move around as the rocks move around a bit.

Q. Is there a normal depth to which the well is cemented?
A. It is not so much the depth as distance above the GM seam. But - yes. And there are variations. Some wells are drilled shorter, as I've indicated here, to 5 metres below the P seam, or, in the same sentence, 45 to 50 metres above the GM seam, with a short slotted liner. So there are some variations, but the general generic well is the one I have described.

Q. The steel slotted liner - you have drawn it there as approximately 40 metres. Is that a standard length for that, for the liner?
A. I believe so - for the standard well, yes. Yes, the variation would come in the length of the 17.5 inch hole to get to the point where you want to put the slotted liner in.

Q. In the establishment of the goaf well, is it a case of drilling and cementing to a point 40 metres above where the slotted liner is designed to fit?
A. Yes. Yes.

Q. And that in turn is likely to be 20 metres above the seam and comes online once the action of goafing collapses that strata to allow the well to draw gas; is that the functionality?
A. Yes.

MR RICE: Mr Martin, I was going to turn to something different. I wonder if that would be a convenient time to stop.

THE CHAIRPERSON: Yes, all right. We will adjourn until 11.45.

SHORT ADJOURNMENT

THE CHAIRPERSON: Yes, Mr Rice.

MR RICE: Q. Can we move to slide 20. This commences

a series of slides dealing in some detail with aspects of goaf drainage at longwall 103. I'm going to pass over some of that, the reason being that there is perhaps more interest in the first 400 metres of the experience of longwall 103 to make it a comparator with longwall 104. If we look at this slide and the next one, we see what is drawn there is what you have described as "type 1" goaf wells in the graph, and there are both face start line wells and tailgate wells. It looks like there are four face start line wells; correct?
A. Correct.

Q. And we commence with the tailgate wells. You make the point on the next slide, having regard to the type 1 wells, that they were applicable for the first 1000 metres or so of retreat. Do I read that correctly?
A. Well, that's where they were. They were for the first 1000 metres of retreat. Then they had to change the well type after that.

Q. But those wells for that first 1000 metres or so were - you have "normal" in inverted commas. Do we take that to mean wells of the kind that were depicted in the earlier slide that was shown?
A. Correct, that's, yes, typically 40 metres or 20 metres above the GM, that sort of thing.

Q. And that they were at a spacing of 50 metres?
A. Correct.

Q. Now, we have seen from one of the earlier slides the point at which exceedances were experienced in longwall 103. It is correct to say, isn't it, that there weren't any exceedances with that goaf well configuration for the first 400 metres of retreat of longwall 103?
A. As far as I'm aware, yes.

Q. You go on in slides 22, 23 and perhaps 24 to consider the performance of those wells. I just want to pass over that and go to slide 25 just to note some of the type 2 wells that you identified. They are referenced by their number in the top right-hand corner, and they featured, did they not, in the operation of the maximum goaf rate trial?
A. They did.

Q. We can get something of the history of their use, can we, from the timing or the dates on the X axis?

A. Correct.

Q. We note, do we, that they were turned off at dates between perhaps the end of May through to towards the end of July progressively?
A. Correct.

Q. Were they performing satisfactorily to that point?
A. They were performing very well. Those were the three best-performing tailgate wells. They had high purity and no trigger action - no TARPs were invoked.

Q. Were you able to discern any reason why they were shut off at the intervals shown on that graph?
A. I can only assume it was because they were getting back from the face a bit and they needed the equipment on the surface to be deployed elsewhere.

Q. Probably a case of distance from the face?
A. Yes, probably, yes, I guess so. I really don't know why they particularly did it, but they did.

Q. At slide 26 we come again to the P seam SIS well, and we've probably touched on the main features of that. In terms of the graphical representation, do we see on the red line what was depicted in a different form on one of the earlier slides where we drew attention to the portion of the slide where the P seam was mined under?
A. Mmm-hmm.

Q. And you might have anticipated gas flow from the P seam SIS well, but there was none?
A. Correct.

Q. Is this a date depiction of that scenario?
A. It is.

Q. So no gas production from that well until some time in May 2019?
A. Correct.

Q. From that point, are you able to comment on the performance of that well from the time at which it commenced to produce?
A. I can't comment much. It performed very well, for whatever reason. I don't know where the gas came from. I think it was shut off artificially at the end, not for

any problem with purity or CO or anything of that type.

Q. It came from the P seam, presumably?
A. Yes, yes.

Q. I'd like to go to the report, Mr Operator, if I could, at page 0046. It is the paragraph underneath the table, if you wouldn't mind highlighting that. You see what is depicted there. The paragraph has now been highlighted, but it appears under a table in which you have listed goaf well geometry. Just have a look at that paragraph, Dr Williams.
A. Yes, we're talking longwall 104 here, though, not the other one.

Q. Yes, correct. I understand that.
A. Yes.

Q. Is the point of that that there was a similar SIS P seam borehole drilled for the purpose of longwall 104 in the same fashion as we saw for longwall 103?
A. I can only presume so. I haven't seen any reasoning other than the P seam well in longwall 103 flowed well. But as I've said before, to what effect?

Q. Just in terms of its existence, though - we will turn to its performance at some other point - was it a well of the same kind as the P seam SIS well for longwall 103?
A. It appears to be, yes. Yes.

Q. That is to say, a well drilled from the surface, down to the P seam and then lateral across the P seam?
A. Yes, and large diameter.

Q. Well, the same diameter, is it not, as the one for longwall 103?
A. Yes.

Q. Perhaps the point is the one in the last sentence of that paragraph, that it produced no gas for the relatively brief lifetime of that longwall?
A. I've seen no records of gas flow. That's all I can say.

Q. Is there any reason that you could advance why it would not have produced gas for the first 400 metres of retreat?

A. Well, presumably - it could well be blocked. I think it was another hole that used floor touches on the way out - I'm not sure. I'm not sure I've even got a lot of records on that particular hole.

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.

Q. From what you say, there could be a range of possible reasons why it didn't produce?
A. Yes.

Q. We can go back to the PowerPoint, Mr Operator, please. We're looking now at slide 27. On the right-hand side is a depiction of the goaf wells that were brought into operation for the purpose of that trial?
A. Yes.

Q. The ones starred in yellow - are they the wells that were connected for the purpose of that exercise?
A. Correct.

Q. Being some at or near to the face line - there are certainly six highlighted there between the two face lines that you have drawn; and then there were several others, at least five, further inbye?
A. Correct.

Q. You have referred to those as the distal wells; am I right?
A. Yes.

Q. You have graphed the performance of the various wells on the left-hand side. Now, are the distal wells the ones that I've highlighted, being the five towards the top of the slide?
A. Yes, essentially those, yes.

Q. What point are you making there, by observing that the distal wells had greater effect? Is that just an observation of fact? Does it have some significance?

A. I think it has a lot of significance. A few slides ago, you showed wells GR3L002, 3 and 4, and they were turned off abruptly. I could have produced graphs of L005 and 006, which were similarly turned off. They weren't as high producing as those other three wells. But the wells were turned off abruptly, and what is not shown on the graph in my report is what was happening at the time with regard to gas exceedances. As those wells were being turned off, that coincides with a good run of gas exceedances.

Q. Does that suggest to you they shouldn't have been turned off?
A. Yes, it does. And then they turned them back on, and, lo and behold, gas exceedances no more.

Q. So you would attribute the turning off of those particular wells, the distal wells, to the cluster of exceedances around July 2019?
A. Yes, I think it had a lot to do with it, yes. There are other reasons given in the report directly, things like vague things such as SGE higher than anticipated and stuff like this, because I think no-one had thought that if you turned a well off, the gas would do anything other than just stay in place. But if you turn a well off, the gas pressure is still there, and we will cover that a bit later, but it can migrate.

Q. Slide 28 is another representation of features associated with the goaf rate trial. If we start, perhaps, with the number of wells, we see the key on the right-hand side on the Y axis. It looks as though, leading up to the goaf rate trial, there were 10, perhaps 12 or 13, increasing to approximately 20 for the purpose of that trial?
A. Yes.

Q. Looking at the illustration of goaf well gas quantity, it does appear to pick up quite a bit from the commencement of the goaf rate trial; am I right?
A. Yes.

Q. Is it correct to say that that would be the reason for the increase in goaf well gas quantity?
A. Yes, yes.

Q. And is that connected to the number of wells?

A. Yes, those ones were the reconnected wells that were turned off previously, where the ramp-up has occurred.

Q. In the bottom half of that slide, if we take the date 4 August - we know the trial commenced perhaps a couple of days before that. We have seen total gas quantity trending down from towards the end of July, the 25th or thereabouts, prior to commencement of the goaf rate trial in early August, and it looks as though production has dropped as well around the same time; is that correct?
A. Correct.

Q. Have I read that correctly?
A. Yes.

Q. Would that be the reason why tailgate gas quantity had reduced over that period of the dip from, say, 25 July onwards - that it is related to production?
A. I think it is reasonable, yes.

Q. But then even if we take 4 August as an indicator and look ahead in time, it appears as though production increased somewhat significantly; is that correct?
A. Yes.

Q. But the tailgate gas quantity didn't get back to the same levels as prior to the goaf rate trial?
A. Correct.

Q. Does that make the goaf rate trial a success in terms of tailgate gas quantity?
A. Yes.

Q. It does?
A. Yes.

Q. If we go to the next slide, number 29, we see some data selected by way of comparison between the two longwalls, the important parameter being the distance of retreat, being 390 metres in each case. Looking at that, we see production for both longwalls, 814,000 and 866,000 respectively. That's not materially different; would you agree?
A. Agree, yes.

Q. So that any differences in the right-hand columns, which we will turn to, are not really attributable to

differentials in production?
A. Correct.

Q. Moving across to the right, to the column headed "Return CH4", would you, first of all, indicate what those figures represent and how they compare one with another?
A. Yes, in longwall 103, the return CH4 - it is a higher number than in longwall 104, but the ventilation data I've got indicates that there was about 10 cubic metres a second more air flowing down, so I presume that's why they didn't get such an issue in longwall 103 from that extra return gas.

Q. Is that a measure at the tailgate return?
A. Yes, at 3-4 cut-through, yes.

Q. Then moving across to the right, we come to quite a big difference in the comparison, the comparison here being CH4 production. Is CH4 production the measure of what is derived from the productivity of the goaf wells.
A. Yes, it's just pure methane devoid of any air they were pulling up, yes.

Q. We see there more than double for longwall 104. You have made the point in the next column across that there were a total of 20 wells across the 390 metres or so of retreat of longwall 104, but of course the number never actually rose above 12 in operation, according to your plotting of a previous graph; correct?
A. We will assume so, yes.

Q. I don't think we need to assume so.
A. I'm not sure what it rose above in longwall 104, to be honest. There were 20 wells drilled in total.

Q. I beg your pardon?
A. There were 20 wells drilled in total. At the time of the incident, there were 10 of them switched off.

Q. Did you turn your mind to explanations for the difference in goaf well production across the two longwalls as indicated by that parameter?
A. Yes. Yes, I found it quite hard to work out how you could get so much extra gas. Your implication is you've got the actual similar number of wells connected, but that's a lot of extra gas, and I thought if the wells were shut in, the ones that were shut in, the gas should have

come from, say, the P seam, but it wouldn't have accounted for that amount of gas.

So in coming up with an explanation of why that was, it was a case of invoking this idea that the shut-off wells actually build up sufficient - the coal surrounding the wells builds up sufficient pressure that it can migrate down the cement lining, which is fractured because of its being only 20 metres from the goaf edge, and finds its way into the workings, and all that is a product of things like the Fair Hill seam having this high gas desorption pressure, and the QA and QB as well.

Q. Just getting back to that question of the number of wells, your slide 30 depicts the circumstances at longwall 104; am I right?
A. Correct.

Q. You have actually plotted the number of wells online?
A. Yes.

Q. And it appears not to rise above 12 at any point; do you accept that?
A. Yes.

Q. Would it be correct to say, then, that this difference in the CH4 production is not the product of a greater number of available wells for longwall 104, since the number of wells online never rose above 12?
A. Correct.

Q. And there had in fact been 12 at longwall 103 for a similar distance of retreat; correct?
A. Correct.

Q. I think you note that one of those had been turned off?
A. Yes.

Q. Is it correct to say, then, that the number of wells in operation across longwalls 103 and 104 were comparable?
A. Yes, it is, yes.

Q. In the final column on the right-hand side, you have a substantial difference also in gas make. Did you identify to what that may have been attributable?
A. It's directly attributable to the extra goaf wells,

and it gets down to --

Q. How so?
A. The gas make is the total of all the gas that you get in the goaf wells and in the tailgate return. So, I mean, if they've turned off a number of wells in longwall 104, it means the other wells are picking up added gas from, in my belief, the wells that were turned off, which are producing gas and it's being drawn into the adjacent wells.

Q. Is the rate of vacuum applied to the wells a factor in their production? You make the point that:

Extra wells should have meant you could suck with less vacuum and a bit more total quantity.

A. Yes.

Q. Is that what happened?
A. No. I mean, if all 20 wells were kept open and throttled back so that limits on CO and oxygen weren't exceeded, the picture might have looked a fair bit different, I think.

Q. How so?
A. Well, because you haven't turned any wells off. If wells are turned off, then the gas that was originally flowing out of those wells has to flow somewhere. If you turn them off, because the cement casing, in my judgment, isn't going to remain intact on the longwall goaf edge, then the gas flows down that casing and into the goaf and into other goaf wells.

Q. They actually act as conduits to the goaf and not away from the goaf?
A. That's right, yes, and it's a case of - I mean, you can create a problem thinking you're fixing it. "We will drill more wells" - that's good, but you create more conduits for gas to flow down, if you are not careful.

Q. Is that what occurred, in your opinion?
A. I think so, yes.

Q. If we go forward to slide 30, we see something of the history of longwall 104 according to certain criteria. We've noted already that you have depicted the number of

wells increasing, unsurprisingly, from commencement generally upwards with progressive retreat, but you have drawn what you have described as a number of troughs?
A. Yes.

Q. And you have attributed what you have noted as L2 and L3 to the turning off of wells according to TARP triggers?
A. Yes.

Q. Is that your assessment?
A. Yes.

Q. All right. On the next slide, number 31, you have put in table form the performance of the wells, and I just want to ask you about some of the columns of information here. Is what is listed in the "Goaf Well" column all of the goaf wells for which you could find records of production?
A. Yes.

Q. As you noted earlier, we don't see represented there the SIS P seam well, because you saw no records of gas production from it?
A. Correct.

Q. Now, in the first column, it is "Average CH4". What do you mean by average CH4; can you explain?
A. It's the average CH4 concentration for the life of the well.

Q. Well, a feature, is it down to well number V003, which appears highlighted, and you have noted in your legend below that the highlights have above-average values. Does that convey anything other than an objective fact that they were above average? Is there some significance to that?
A. Taken with the next two columns on CO, I think the two go hand in hand.

Q. To reveal what?
A. The early ones had higher purity gas. The ones more recently were affected by oxygen, primarily oxygen, and corresponding CO.

Q. So the more outbye wells, commencing with V004, with one exception, being V006.5, drew less methane and, you would suggest, more oxygen?
A. Yes, I will also point out that the last well, GR04V010, I've left out - that's not part of the 20. That

well came on the day before, and it sucked pretty well air, so I didn't give it a guernsey.

Q. I understand that. 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.

Q. What about the next column, "Average CO ppm"- we see almost directly the converse. How do those two columns interact?
A. Well, I mean, Martin Watkinson or Andy Self are probably better placed to answer the significance of it, but with added oxygen you always seem to see more CO.

Q. Column 2 then fits with column 1, in your estimation?
A. Yes.

Q. What about the third column, CO parts per million - that's just the maximum figure as against the average in the second column?
A. Yes.

Q. In the other highlighted column, which is headed "Average CH4 Flow", is that an average for each well?
A. Yes.

Q. Over its lifetime?
A. Yes.

Q. Expressed in litres per second?
A. Yes.

Q. You have highlighted the inbye wells up to V004 as having above average values but then, with three exceptions, reducing flow. Accepting that reduced average flow is a question of fact, is there some significance or some interpretation that you would put on that?
A. Well, only that they - well, what we're not seeing here is - well, no, we're seeing it well by well. 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. Previously we saw more and more gas delays as they -

I mean, I'm not close to the operations remotely even, but they must have been working really hard to try and contain the gas, and it seems to be getting on top of them, yes.

Q. The wells affected, as you plotted on a previous slide by reference to TARP triggers, are those numbered L2 and L3?
A. Yes.

Q. We see that in tabular form in that column; correct?
A. Yes, in the last column, yes.

Q. The next slide, number 32, is perhaps a simple one. It just illustrates which wells were producing as at 6 May, being those with the yellow star; correct?
A. Correct, yes.

Q. On slide 33, we return to the subject of looking to make a calculation of the degree of emission from other seams in the stratigraphic sequence; is that correct?
A. Correct.

Q. For that purpose, you have analysed data from the two boreholes listed on that slide?
A. Correct.

Q. They being boreholes from longwalls 101 and 103 that have been mined?
A. Yes.

Q. That's the significance?
A. Yes, yes.

Q. The fact that they have been mined enables, through gas content testing, to make an assessment of the degree of emission from surrounding seams; is that the method?
A. Yes, yes, from the seams above the worked seam down to the point where you can't drill any further or you lose circulation.

Q. We see those two selected boreholes depicted in the diagram in red. The ones in blue, are they for comparison?
A. Correct.

Q. If we go, then, to slide 34, do we see a tabular representation of your findings for those two boreholes?
A. Correct.

Q. We did spend some time speaking about the Fair Hill seem. So far as hole DDG267 is concerned, is it the case that you have assessed there was a gas content reduction in the course of mining of 20 per cent?
A. Correct.

Q. Which has to go somewhere?
A. Yes.

Q. The other figures for different seams we can see. For DDG321, the figure for the Fair Hill seam was almost the same, at 19?
A. Yes, you can see the individual readings "% Reduction in Gas Content", though, there is a fair range, especially in DDG267. So that 20 per cent average would have a pretty decent standard deviation attached to it, but, yes, nonetheless, we're looking at that ballpark. I think it's not a problem so much as we're dealing with a 45 metre thick coal seam here, and we're trying to characterise what happened with half a dozen gas content tests. One of the recommendations is, when you do this again, take a lot, lot more tests.

Q. You have made a note of that on the slide. Perhaps you might explain that. Were there a limited number of gas content tests from those boreholes from which you could extrapolate?
A. Yes, there is opportunity to take a lot of samples. You have got to drill the hole. The other thing that seems to be occurring is that where the coal has a lower density, it seems to result in a higher percentage drop in gas content. So things like that you could evaluate better if you took more samples, but - yes.

Q. You have included slide 34. Is that for comparison with seams below the GM?
A. Can we go back one slide?

Q. Yes.
A. Yes, the slide - yes, that one there. No, forward one, sorry. Oh, I'm sorry, I thought we were somewhere different. It's all right.

Q. Just to orientate you, we had looked at that table.
A. Yes.

Q. And we have moved forward. You have indicated "For the Floor", suggesting that that has relevance to the lower seams?
A. Yes, yes. The blue line is a complete guess of what the post-mining pore pressure would be. The orange line is the gas desorption pressure. So where it crosses the line here, there is no degree of emission at all and it gets more and more - the greater the difference between the pore pressure and the desorption pressure --

Q. You would accept, Dr Williams, that your graphical representation is difficult to follow for the uninitiated. Could you tell us what features emerge from that?
A. Okay. We're looking at distance below the GM seam floor, for a start, on the X axis. There are two Y axes. One deals with pressure. The other deals with degree of emission.

So if we look at pressure, we've got two things - pore pressure and desorption pressure. This is showing the pore pressure on the blue line and the desorption pressure on this line here (indicating). Where the pore pressure exceeds the desorption pressure, the gas can't flow, as is the case here with HL3 and 4. Where the desorption pressure is higher than the pore pressure, it can flow, but only in relation to the difference between the two.

So there is not a lot of gas - not a lot of energy driving the gas out here. Here we have the degree of emission shown (indicating), which summarises the effect of both these lines here. The degree of emission here is zero, up to 20 per cent and creeps up. The GML degree of emission is quite high, up around 85 per cent.

Q. All right. Perhaps we might go forward to number 36 and might see some of the content of what you have been describing represented in tabular form. Is it the case that once the gas reservoir size has been calculated, which you had done in an earlier slide --
A. Yes.

Q. -- and you know the degree of emission, calculated by reference to the exercise we've already looked at - does that then enable you to identify a quantity of gas emitted in cubic metres per square metre?
A. Correct.

Q. You can go further than that, and you can distribute it to the various seams, including not only the upper seams but also the lower ones?
A. Correct.

Q. Is it a feature of this estimate of gas emissions that the lower seams are actually contributing, really, very little?
A. That's correct. If we used a different pore pressure reduction, it would increase that, but I did some sensitivity studies, and it didn't make huge differences. But, yes, I think it is pretty clear there is not a lot coming from the floor.

Q. What appears in the column "Seam Basis Proportion of Gas Emitted" is your calculation, is it, of the proportion of gas emissions to DDG295 on the basis of the proportion of gas emitted as assessed by the two previously mined boreholes?
A. Correct, but I think I would have taken notice of the one in longwall 103. It amounts to something similar anyway, but yes.

Q. So that although you have said on a number of occasions that the degree of emission from the Fair Hill seam is relatively low at, say, 19 or perhaps 20 per cent, because it is such a large reservoir to begin with, it translates to 29 per cent of gas emissions, potentially, to longwall 104?
A. Correct.

Q. And so on, that same method applies to all the figures we see in that column; correct?
A. Correct, yes. I just make the point at the bottom there, Mr Rice, the degree of emission, nonetheless, is based on longwall 103 post mining gas content tests. I would think that given the extra goaf gas that we saw in longwall 104, we might see higher degree of emissions in longwall 104 when and if the time comes to take cores and see what really happened.

Q. I will just draw attention once again to that figure of gas emitted, being 172 cubic metres per square metre. You have taken that figure and done some further calculation with it and other data. Could we go, Mr Operator, to the report at page 0050, and highlight the paragraph commencing "The 172 cubic metres per square

metre". We've already noted from slide 36 that that was the figure of gas emitted that you came up with.
A.   Mmm-hmm.

Q.   We see there that you have represented that at that part of your report and done some further calculations. Could you talk us through the exercise and the results as depicted there?
A.   Yes, it's sort of a reality check to see that the numbers add up, the gas emitted --

Q.   A reality check for whom - for you?
A.   For me.

Q.   Yes?
A.   Yes. The gas emitted is 172 cubic metres per square metre, as you have said. I have used a mined length that's a bit shorter than what they actually mined, because I've discounted the initial bit of mining because of the lack of the goaf forming all that well. The speed of retreat - so, in any case, you come up with the area mined, the average tonnes mined, and knowing the area and you've got the gas emitted in cubic metres per air, you know the total amount of gas that was emitted over that area, and you divide it by the tonnes mined and come up with a number, in this case 22.8. I've tried to make some allowance for intake gas as well, which is fairly minor. But around 23 cubic metres a tonne, which is sort of ballpark for what we saw in longwall 103.

Q.   You mentioned it was a reality check for you?
A.   Yes.

Q.   What did it reveal?
A.   I think the next little bit, the next few lines down the page here.

Q.   Can we zoom out, Mr Operator. Perhaps if you would highlight that paragraph again, including all above the next heading. Is that the part that you want to draw attention to?
A.   Yes. The actual gas make over the period was a lot higher, at 30 cubic metres a tonne.

Q.   How would that be so?
A.   Well, it literally was. That was the measurement of the gas they received, they made, and we're attributing

that to all these extra goaf well - the goaf well production produced it, yes. The thing is, well, what caused this difference, and that's what the following section seeks to assess.

Q. If we go back to your slides, then, the first bit you have already noted. By itself, you didn't give it particular significance?
A. Well, it adds to it, but --

Q. Yes.
A. Yes, at 15 per cent, yes. That's the P seam, partial pre-drainage of the P seam. I thought that accounted for about 4 cubic metres a tonne of the 23.7.

Q. You return in your third dot point to the shut-in wells potentially acting as conduits. Your postulation is that the wells - the cement exterior became fractured with strata movement; is that correct?
A. Yes, yes.

Q. You have a diagram on the right-hand side. It is not actually from longwall 104. It is from an earlier depiction. It's just used for the purpose of illustration; am I right?
A. Correct, yes.

Q. Could you explain what it is and what it depicts? It looks like some modern art, but I assume there is some more significance to it than that.
A. Yes, well, all the - lots of the little dots - I can't tell you all of them, but along here, this here (indicating) is the edge of the goaf. It's a cross-section, and the fractures occur - the fracturing occurs at an angle as you go up. What it is depicting is that is the level of fracturing occurring in the Fair Hill seam and elsewhere over the length of the cemented casing. The cemented casing is this black section.

The blue dotted line - I will just talk it through. The blue dotted line below the black vertical line is the slotted liner. But the point is the potential for - I would imagine there is quite a lot of strata movement, that differential movement between the rocks and the borehole steel itself, and the cement is the thing in the middle that's got to try to withstand all that, and it's - I'm just using imagination here, but I can't imagine that happening.

But the next point, then, is that those fractures, the last couple of dot points - the Fair Hill seam, by virtue of its high desorption pressure, the gas can find its way down to the goaf. That also applies to the QA and QB.

Q. Is the theory of cracked cement casing necessary for the conclusion that the Fair Hill seam is contributing gas to the GM seam?
A. Not entirely, no. If you never had goaf wells at all, the Fair Hill seem would, because of its high desorption pressure, desorb gas when the pore pressure is lowered and it would find its way down the lateral fractures as well. But it's a case of path of least resistance and conduits, and the implication here is that these goaf wells provide a lot of extra conduits that would seem to be quite significant.

Q. You have made some suggestions for means of verification of this postulation that you have made. Perhaps rather than make it a memory test for you, we might go to your report and you might speak to that?
A. Okay.

Q. Could we go, Mr Operator, to the report at page 0007. In the top half of that page, there are three bullet points with horizontal bullets. Could you highlight those, please. The first of your suggestions, if anyone wanted to verify, would be to drill further boreholes over the mined area of longwall 104; correct?
A. Correct.

Q. And do gas content testing?
A. Correct.

Q. With a sufficient number of samples, presumably?
A. Correct.

Q. In doing so, if your theory is correct, what would you expect that to reveal?
A. If it's correct, I would expect to see a greater reduction in Fair Hill seamgas content than we saw for longwall 103, and --

Q. Greater than, say, 19 or 20 per cent?
A. Yes, yes. It wouldn't necessarily have to be very

much higher, but it might be 25, it might even be 30, but probably not that high - maybe 25. But we'd have a lot more samples, so we can be a lot clearer in what's really happening. I mean, the fact that you can do this at all is because of, as I mentioned at the beginning, the consistency in gas content within the seams; it has made this sort of analysis possible.

Q. The second point relates to making an assessment of strata movement; does that sum it up?
A. Yes, it does.

Q. Potential to fracture, and so forth?
A. Yes. Yes, and I think, yes, people with materials knowledge could use that to assess whether the cement is likely to withstand the movements or not.

Q. The third point is related to that, is it, being the properties of the cement and its susceptibility to fracturing?
A. It is, and whether you undertake bond logs is another thing. That's a petroleum industry standard procedure. It is very important to cement wells in and be sure they are cemented. I see no reason why you couldn't apply it here, but maybe you don't need to go that far.

Q. If we could zoom out, Mr Operator, I just want to take in the next paragraph, commencing "Goaf wells". You commence that by saying, "Goaf wells should not be turned off", as you have assessed that they were, for various reasons, in longwall 104. Is that any sort of controversial view?
A. I don't know. I haven't discussed this. I think it's industry --

Q. I just wondered, from your experience in the industry?
A. No, I - if turning goaf wells off is a controversial view, or if my view is controversial?

Q. Your view that goaf wells shouldn't be turned off.
A. Yes, it probably is controversial, because they require the equipment on the surface to keep up with where the face is.

Q. Equipment on the surface has to be moved, do you mean?
A. Yes, yes. If a new well is put on line, you need the skids and pipework, and that, to hook it up and keep up

with the face, so the older wells drop behind and --

Q. That's what we saw previously with the type 2 wells from longwall 103?
A. Yes.

Q. Probably turned off for that reason?
A. Yes, I'd say so. The bottom line is if they are flowing, you shouldn't turn them off. If you have retreated the longwall quite some distance, say 1000 metres, and the wells at the beginning of the longwall aren't doing much, you probably can turn those ones off, but --

Q. But not for 400 metres of retreat?
A. No, no.

Q. What do you mean by "valves regulated to control oxygen and carbon monoxide"?
A. If you keep the wells turned on, you can't have them sucking too much oxygen and CO, so you would throttle the valves back so that you are only producing reasonable purity gas. I think that should be possible. You mightn't be producing much gas, and if you get to a point where you're not producing much to warrant a single skid, then you can manifold some of these really low-flowing holes up and maybe do it that way. But these are things down the track for people to consider.

Q. Would that scenario of keeping the wells operating but regulated to a low level prevent them from acting as conduits of gas to the GM seam from the likes of the Fair Hill seam?
A. Yes, yes, it should. It should.

Q. Could we go back to the PowerPoint and go then to "Conclusions", some of which we have had a look at. I think we have in fact discussed all of those except perhaps the last one. When you have included there, "Inadequate P seam pre-drainage", are you speaking there about inadequacies of the level of drainage by Arrow, or what content would you give it?
A. You want to reduce it down to as low a level as you reasonably can. I mean, Arrow pre-drained it - well, they didn't pre-drain it; they just produced out of it, and it is what it is. Over longwall 104, there is still a lot of gas there. So, yes, not desirable to have that much gas in

the P seam.

Q. Are you recommending then, in hindsight perhaps, that there ought to have been some further pre-drainage of the P seam?
A. Yes, but it is easy to recommend. 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. I mean, you could drill surface to inseam 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 inseam drilling, and, you know, there are some problems potentially with that.

Q. We will go to slide 39. You have made some recommendations. What do you mean by "Future design /assessment" - for this longwall or for future longwalls or what?
A. For future longwalls in general. That's for Grosvenor especially, but for most mines you can nut out what the gas content is doing and produce a reasonable model of it, tied in with the geological model. I mentioned in the report you could produce slices showing the gas reservoir size above and below the seam at different intervals. It does nothing to help you calculate what ventilation you need, but because you have already mined out a few longwalls it gives you some brilliant empirical data to look on and say, well, this is looking better, or this is looking worse, and by how much, so that's the first point.

The second point is building on empirical evidence - assess past emissions along the lines that I did in longwall 103. I think at the end of each longwall, that's not a hard thing to do.

Q. You mean look at the degree of emission?
A. I mean look at the gas make curves and divide them up and try and nut out what's going on. In what the mine has done in the past, and it's probably similar to a lot of mines, they will produce an overall gas make curve just to get a gas make number for the longwall, but it is a pretty

crude comparison. If you divide it up into recognisable domains as you go longwall to longwall, you will probably see patterns emerge and it helps. If you introduce some quite different method of gas capture, such as what we're moving on to, these relaxed strata wells, you can assess the effectiveness quite well in that regard.

And, yes, combine that with (a) for future designs.

The third point is longwall emission pore pressure modelling. I'm not at all a fan of using European modelling.

Q. The Flugge method?
A. Flugge and others. There is a whole pile of them. I noted it was stated in one of the documents that Anglo had that "the Flugge method shall be used", and stuff like that. Well, it is very, very coarse. It doesn't take into account too much of the local geology.

Q. To be specific, what geology are you speaking about?
A. Well, it's, sorry, not just local geology but mining. The Flugge method goes back into the 1970s in Germany mining greater depths, thinner seams, advancing longwall, lower production rates. Here we find ourselves at Grosvenor with a thick seam, fast mining, yes, gas contents with all the pore pressure and all the rest of it, so it was fine in the past when you knew nothing else, but I think we can do better. That's where I get to saying SGE assessments aren't recommended.

Point (d) about probability modelling, I'm pretty keen. All these things have an element of uncertainty about them which needs to be explored more. Before Dartbrook started mining, I came up with this giant longwall emission model that had thousands of elements and all the rest of it. It was a scary thing. The person in charge of tech services said to me, "Well, how sure are you?" I said, "I haven't got a clue, there's so much going into this." He threw me in the direction of some of these probability modelling packages, and it was a great help, I think. But that's not used much, either. I would recommend that to my consulting buddies as well.

Q. I beg your pardon?
A. To my consulting friends as well, yes.

Q. On the next slide, you have referred to one suggestion, or recommendation, actually, that you make, which is to drill a row of relaxed strata wells. You've mentioned a little more about them in your report. You suggest at page 6 that you drill a row of relaxed strata wells ahead of mining, near the panel centre, 50 metres apart. 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.

Q. How would it do that? How would such wells do that?
A. In this instance, we would drill boreholes down to the base of the QB seam, a slotted liner to the top of the Fair Hill seam. When you mine under the boreholes, they should relax and produce, and produce high-purity gas. Potentially - I know in times past, the Queensland Government wants to see you use your resources better. Well, this is a gigantic gas resource, this Fair Hill seam.

Q. Commercially useful?
A. Yes, pipeline quality, it could be. It's a lot better than sticking it in a power plant. But that's all by and by. The thing is, the Fair Hill, QA and QB, in my emission estimate, accounted for just over 50 per cent of the gas. So if you can take that out before it gets downstairs, it's a big advantage. You know, you are not relying on horizontal goaf wells and stuff. That's tricky stuff. It's expensive. Technically, it is brilliant to be able to do it, that they did it at all, but hell's bells, vertical holes are the way to go. And then with goaf wells, it puts less pressure on your goaf wells. You may need to just go back to 50 metre spacing. I mean, I'm talking about Utopia a bit here, but it may be possible.

Q. In terms of the way in which these so-called relaxed

strata wells would operate, you have been somewhat critical of the difficulties and so forth associated with the lateral type inseam - the horizontal ones, the horizontal P seam wells?
A. Yes.

Q. But the concept is similar, is it not, that once mining commences, the seam will liberate its gas and can be captured as a form of post-drainage; is that correct?
A. Yes, yes.

Q. But you favour the vertical wells for the reasons you have described?
A. I have to - years ago at Appin Colliery, I drilled a borehole down into the Balgownie seam, which is just below the Bulli seam, and instead of doing all these down holes they used to do - which is for post-drainage, it is a similar function to a goaf well, but only it is drilled down because that's where the gas is - this hole produced really well and we drilled more and more and got nothing. They are just hit and miss, unfortunately.

But here in Queensland, you have that opportunity for vertical wells. I mean, you have rivers and things in the way, that doesn't help, up there, but - and just how many you need I don't know. There's all these sums to do. But there is a path to follow to validate what I'm saying or otherwise, and then get on and design it and hopefully it will all work.

I go on to mention these gas sorption isotherms. I made an awful lot of just three isotherms on the Goonyella Middle seam and adjusting them to the vagaries of the Fair Hill and the other seams. One of the peculiarities at Grosvenor is not just that the gas content is pretty much the same all the way down, but the coal rank gradient - that's the degree of maturation of the coal - it's very high. I think I mentioned in the report the numbers for vitrinite reflectance, but it goes from something like medium-volatile bituminous to low-volatile bituminous. Coal rank has a big effect on isotherms as well. So there is a room to do a lot more of that sort of testing and fine-tune desorption pressures and things for the seams below as well as above.

Q. Just one point I don't think we've made clear: you have mentioned the likely significance, in your view, of

the Fair Hill seam to the emissions to the mined seam. You are not suggesting, are you, that the Fair Hill seam is a candidate for pre-drainage?
A. No.

Q. It is not, is it?
A. It isn't. I was involved with CH4, which became Arrow Energy, so that's one reason why I know this area pretty well, and we knew the Fair Hill seam had a lot of gas. But as a target for getting it out of the ground, permeability tests showed it was just as tight as could be, so we never went down that route. No, it is not. In fact, as the coal seams get more and more ash in them, it attracts stress, and the stress reduces permeability and they become harder to drain.

So that's why it's only the GM seam. The P seam has higher - the P seam for other conditions equal would have lower permeability, a bit harder target, but the others are out of question for pre-drainage.

Q. Just one thing I will take you to and invite you to comment on if you can, that's not actually to do with your PowerPoint. It concerns one of your working spreadsheets, LW104 Gas Make.XLSX. Mr Operator, could we have that if we can? It's document RSH.038.002.0001.

Now, I don't know what you'd call the X axis, but on the various tabs, some are presently hidden, I think. Is it possible to scroll across? Yes, that's sufficient. You see there the tab "Vac"? Are you able to tell us, Dr Williams, what data is represented in that tab?
A. Yes. This data came from manual goaf flow measurements. There were usually two measurements a day done, sometimes more. What you see here is a pivot table condensing those to one measurement a day.

Q. All those inscriptions across the top are the labels of wells for longwall 104 that we've already looked at, commencing with GR04L001?
A. Yes. I'm looking at the highlighted wells. I'm not sure why I've highlighted them. There are comments there, too, which you would have to put the cursor on the comments to see what some of them are.

Q. It is a list of data per well of longwall 104; correct?

A. Yes, it is, yes. Yes.

Q. I only wanted to draw attention to the final column. You've got "Avg Vac". If we go across the various rows we see different figures. What is it an average of in that final column?
A. Well, if you just clicked on one of the cells over there you would see what the formula is. It is just the simple average of those boreholes. All I'm trying to do here is to get a picture of what the wells are doing without necessarily attaching great significance to it.

I've mentioned in the report the vacuum seems pretty high. That comes from my point of view of not having direct operational experience in goaf wells. I've had a lot of experience in inseam boreholes and post-drainage holes on the South Coast - a lot of hands-on experience. But I would have thought with a goaf well, you would have a situation - and I can understand why the vacuum is that high. If the wells are producing so much gas and you've got to handle it, you've got to just keep sucking it up and up. But if you have enough goaf wells, keep them online, or you've got wells of large enough diameter that you can handle the gas without a huge vacuum, I'm thinking that - all you are overcoming is ventilation pressure down the bottom, you shouldn't need to suck the daylights out of things. But because you are sucking so hard, in my uneducated way - not uneducated, but inexpert way, because I defer to Andy Self and Martin on this, you've got more potential to pull oxygen back into the goaf rather than just take the gas out straight out the way you want to.

Q. Well, the measure is in kilopascals; correct?
A. Yes.

Q. The figures represented there are kilopascals of, in effect, suction applied to each well?
A. Yes.

Q. Accepting the limitations you put on yourself with respect to your experience with goaf wells, what comment do you have on the rate of vacuum that we see represented in that average column?
A. I guess we have to think about what sort of pressure loss would you expect to see down the well itself for the sort of flow you are putting in a borehole of that diameter. It probably wouldn't be a lot of pressure lost

to that point. But when you get mixed up with the slotted liner you may see a bit more; quite a bit. I don't know. You would have to do the sums. These are the vacuums at the surface. How that translates to the vacuum you see underground I'm not sure. It could be, you know, totally the way to go. But it just seems high.

Dealing in my experience with inseam drilling, those were the sorts of vacuums you had on inseam drill collars, which wasn't necessarily a great thing either, by the way, but that's what it was.

MR RICE: I notice it is 1 o'clock, Mr Martin. I expect that that concludes my questions but I will just reflect on it over lunch.

THE CHAIRPERSON: All right. 2.15.

LUNCHEON ADJOURNMENT

THE CHAIRPERSON: Yes, Mr Rice.

MR RICE: I've completed my questions, thank you, Mr Martin.

<EXAMINATION BY MR HOLT:

MR HOLT: Q. Good afternoon, Dr Williams. My name is Saul Holt. I'm one of the barristers for the Anglo companies. I just have a few questions.

One of the things that you have taken us through and which is very helpfully set out in your report was your analysis based on the available data of the gas reservoirs, relevantly the gas reservoirs for longwall 103 and longwall 104; that's right?
A. Correct.

Q. I'm going to ask you to verbalise your answers, only for the benefit of the transcript, not for any other reason. Now, if we could go to page 51 of your report, which is at 0052, Mr Operator, one of the things that you refer to in your report are the various other reports that you were provided with from what are described there as other consultants?
A. Yes.

Q. Could we call out, please, the first set of dash points under the heading "Consideration of Other Consultants Findings". You refer there to what we have come to know as the Moreby 2010 report.
A. Yes.

Q. And what we will call a GeoGAS report in 2011?
A. Yes.

Q. And then the Palaris report in 2020?
A. Yes.

Q. If we can come out of that, Mr Operator, and go back down to the paragraph that starts "The Moreby 2010":

The Moreby 2010 and Blanch et al 2011 studies were very broad and undertaken prior to experience of actual mining ...

Obviously enough?
A. Yes.

Q. You note, though, that the 2020 report was able to build on actual mining experience?
A. Yes.

Q. Can we then go out of that, please, Mr Operator, and call up the paragraph with the dot points that starts, "There are also a number of memoranda". You refer here to a number of memoranda also from Dr Roy Moreby that update the specific gas emission estimate files, and you have noted the files there?
A. Yes.

Q. The 17, 18, 19 - each of those relates to a year?
A. Yes.

Q. For example, the 2019 memorandum that you have referred to, which you also refer to in a bit more detail later in your report, was dated - I have it, so it is not a trick - September 2019; would you accept that?
A. I accept that.

Q. Thank you. What those memoranda from Dr Moreby do is to update, obviously as at the date of each of those memoranda, the specific gas emissions models based on the kind of lived experience of the mine up until that point?

A. Well, I don't know his basis for it, but I can --

Q. It is obvious on the face of the reports, though, isn't it? He talks about actual comparisons with real data that has come from the mine and core samples, and so on, on each occasion?
A. Well, he talks about specific emission - specific gas emission. My recollection is they are just curves of specific gas emission, or numbers, rather, on a plan.

Q. I see. Well, let's have a look. If we go over to your page 0053, please, so the next page, can we call up the paragraph that starts, "In the most up to date memorandum". Here you are referring to one of those memoranda of Dr Moreby; do we see that?
A. Yes.

Q. It includes there him reporting SGEs by "minimum", "likely" and "potential all"?
A. Yes.

Q. The "likely", as you have noted, all appear too low, but you then note that Dr Moreby's "potential all" includes the Fair Hill seam and appears closer to actual experience; do you see that?
A. Yes.

Q. So it is the case, isn't it, that in September 2019, Dr Moreby had provided a report which included a discussion of the potential impact of the Fair Hill seam and then included in one of his scenarios the results of that contribution, if there was to be one, from the Fair Hill seam?
A. Yes, when you say "report" --

Q. I'm happy to call it a memorandum.
A. Yes, it wasn't all that detailed. It was just results and - but, yes, it includes - but he has included the Fair Hill seam as "potential all", yes.

Q. One of the things that the report also does is to refer back to the core samples that were taken from above the goaf in longwall 103 and analyse those; do you recall that?
A. I don't, actually, but if you can refresh my memory --

Q. I'm happy to pull it up. I haven't given notice of

that, so I don't want to put you in a difficult position.
A. No, that's all right.

Q. All right, thank you. Could we call up, please - it may only have been given to RSHQ.

MS HOLLIDAY: It hasn't been given to us. It won't be in the public book.

MR HOLT: Mr Martin, I may be at an advantage for once. I have a document that's referred to in Dr Moreby's report, so I had made some assumptions about others having it. I don't think it is going to be a problem. Might I proceed by reading and promising, obviously, to you and to the witness that I'm reading it faithfully, just a couple of passages. I don't need to go much beyond that. If there is a difficulty, obviously our friend can raise it.

THE CHAIRPERSON: Yes. Are you happy with that, Ms Holliday?

MS HOLLIDAY: Yes, thank you, Mr Martin.

MR HOLT: I'm grateful. Thank you.

Q. I don't mean to have you at a disadvantage, Dr Williams. I'm sorry. When we talk about the core samples that were taken from above the goaf in longwall 103, that is some of the data that you had access to to make your own conclusions?
A. Correct, yes. I don't ever recall reading anything from Dr Moreby on the goaf samples from longwall 103, so --

Q. To be fair, I understand that you were provided with many thousands of documents. It's not a memory test.
A. Yes.

Q. When we're talking about that core sample from longwall 103, this is the work that had been done by Anglo, which you describe at page 45 of your report in these terms:

> *Anglo has taken cores from above the GM seam over previously mined goafs and this provides an excellent assessment of where, and by how much, the gas has migrated - at least for seams above the GM.*

A. Yes.

Q. In that memorandum of Dr Moreby's, he refers to that core sampling, and I will read it, as I have said I would:

Based on core samples drilled over the goaf at Grosvenor and Moranbah, there is evidence that the limit of depressurisation and consequential gas release is about 150 metres. This indicates that the Fair Hill seam does not contribute significantly (zero to about 15 per cent) to longwall gas emission at least during the production phase.

A. Are you sure that's longwall 103 you're talking about, not longwall 101?

Q. Look, it may be --
A. Because he mentions Moranbah North in the same breath, and that was done back in the time when longwall 101 was cored.

Q. In any event, may we take it for present purposes, because I don't want to spend too long on a document that others don't have, but for present purposes you would expect, would you not, someone like Dr Moreby to be looking at those sorts of core samples, as he updated his analysis, to test the predictions against reality?
A. Yes.

Q. In addition, you have referred, as I took you to before, to the 2019 memorandum with the "potential all" including the Fair Hill seam, which appears closer to actual experience. That means actual experience of the mining; right?
A. Yes.

Q. In other words, one of the predictions that was reported in Dr Moreby's 2019 memorandum, the highest-end one, included the Fair Hill seam and in fact appeared to be closer to actual experience?
A. Yes.

Q. Then I will note some of the comments that Dr Moreby makes about that, again undertaking, of course, that I'm reading it verbatim. He notes among other things:

The problem here is the large GRS --

that's gas reservoir size --

contained in the Fair Hill plies meaning that, say, 10 per cent either way makes a significant difference to SGE.

I imagine you agree with that; right?
A.   I do.

Q.   So the point, in other words, in Dr Moreby's 2019 report is to recognise the existence of the Fair Hill, its capacity to contribute, and that, if it does, it could have a significant impact in the way that you have described?
A.   Yes.

Q.   He says:

Therefore, having additional drainage capacity for gas management is essential.

Again, I have read that verbatim from his memorandum.
A.   Yes.

Q.   Are you aware that between longwall 103 and longwall 104, there was a significant increase in gas drainage capacity put into place by Anglo at Grosvenor?
A.   Not in great detail, but happy to assume there was.

Q.   Thank you. And you understand - and we will come back and talk about it briefly in a few minutes - that part of that strategy was the closer-spaced goaf holes, that is, the 25 metre goaf holes that you have been talking about in your evidence?
A.   Yes.

Q.   But in addition, the increased actual drainage capacity, including changes to the infrastructure on the surface, for example, to increase the litres per second drainage capacity? You may not know the detail, but do you understand?
A.   No, but, yes, that's okay.

Q.   Thank you. In addition, if we could go back to

page 0053 in Dr Williams' report - we don't need to call it out, because I will go to the next page in a moment - the Palaris 2020 report you refer to there at the very bottom of the page?
A. Yes.

Q. If we go over the page, we can see at the bottom of that paragraph, after you have discussed some of the technical features of the report, the very last sentence:

> *They have likely given a lot more weight to the seams below the GM and this has compensated leaving out the [Fair Hill] seam, such that their gas make figures aren't too different from those in this report.*

A. Yes.

Q. So we have the Moreby 2019 updated memorandum and then the Palaris report, which obviously was very close to the incident, but nonetheless, even using a methodology different from yours, ended up at about the same kinds of figures?
A. Yes, but very - yes, arrived at completely different ways. They had a lot of gas coming out of the floor, as I take it, and none out of the Fair Hill.

Q. Yes, and these are all models attempting to predict emissions of gas; right?
A. Yes.

Q. The thing about models - and it's not my phrase, as you would well know - is that all models are wrong and some are useful?
A. Yes, I would go along with that.

Q. And so the idea is, as you say, you want to understand the sensitivity of the model that you are using - yes?
A. Yes.

Q. You want to test it against real-world data as much as you possibly can?
A. Yes.

Q. And gradually improve the model over time, such that you can get as close as possible as you can to predicting

results?
A. Correct.

Q. Thank you. If we can then, please, understanding that, come back to your PowerPoint. Might we go to page 29 of the PowerPoint. Sorry, I only have the actual PowerPoint page. Yes, thank you, this one. Perfect. For the record, this is RSH.019.001.0499. This was one of your PowerPoints where you're describing a comparison between longwall 103 and longwall 104 for the first 390 metres of face retreat?
A. Yes.

Q. What you identify there, if we look at the table, in the first column under "Goaf Wells", we can see there a significant difference between the 8.36 for longwall 103 and the 19.05 for longwall 104?
A. Yes.

Q. Just so it saves me coming back to it later, if we look at the methane at the return, it is basically the same but in fact very slightly lower for longwall 104?
A. Yes.

Q. The question you ask at the bottom is, "So where is the extra gas coming from?" - yes?
A. Yes.

Q. Part of what you then do in your report - and I don't mean this pejoratively at all - is to think about where it might be coming from and to put forward a hypothesis, which you then explain, as to where it might be coming from?
A. Correct.

Q. That hypothesis is that it's coming from the Fair Hill seam or predominantly from the Fair Hill seam?
A. Yes - no, well, Fair Hill, QA, QB - that bracket of seams up there.

Q. Should we just say overlying seams some distance from the workings?
A. Yes.

Q. If I use the "Fair Hill seam" just as a shorthand for that, so that I don't have to use all three names, is that okay with you for the purposes of these questions?
A. Yes, okay, thank you.

Q. So we're talking about the Fair Hill seam, understanding that slightly expanded meaning, and the hypothesis that you put forward is that gas is coming from the Fair Hill seam once the workings start and the caving starts happening and that it's making its way then, obviously, down into the goaf?
A. Correct.

Q. And then it is making its way to the tailgate?
A. Correct.

Q. How is it doing that, getting to the tailgate?
A. The goaf is overloaded with gas. It's got to go somewhere.

Q. Now, as part of your hypothesis, you have proposed a mechanism by which a gas might get from the Fair Hill down to the goaf as it is forming, through cracked casings in wells that are shut off?
A. In addition to the natural fractures down the goaf edge, but, yes, the cracked casing is the difference, yes.

Q. The cracked casing is the difference?
A. Is the difference, yes.

Q. What do you mean, "the difference", in that context? What do you mean by that phrase?
A. Well, it is an added source of conduit for the gas, so --

Q. Now, as you, with respect, very carefully point out in your report, there isn't any physical evidence of cracked casing or of that mechanism occurring?
A. No, no.

Q. So it's an hypothesis about which you offer some ways of testing that hypothesis?
A. Correct.

Q. But it is the proposition that it is the shutting goaf wells - I'm sorry, I withdraw that. It is that mechanism, that proposed mechanism, which is a hypothesis without physical evidence at this point, which is the reason why you suggest that 25 metre spaced goaf wells are problematic in this case; is that right?
A. Yes, not the spacing per se, but the fact that you

have a whole pile of goaf wells, you have more than normal because you have made them at 25 metre spacings and you have shut half of them off.

Q. The only difficulty with that is if your hypothesis about the gas migrating its way down the cement casings is correct?
A. The only, did you say --

Q. The only difficulty with having those closer-spaced goaf wells and shutting them off in the way that has been described - the only difficulty with that is if your hypothesis about the gas migrating down the cement casing is correct?
A. Mmm-hmm. Yes.

Q. Obviously when you are dealing with an hypothesis, you want to identify the lines of evidence that might support that hypothesis?
A. Correct.

Q. Equally, you want to identify any lines of evidence that might falsify that hypothesis?
A. Correct.

Q. It is just a regular part of the scientific method; right?
A. Yes.

Q. Stepping out, before we go through a little bit of that process, the idea of closer-spaced goaf wells in longwall 104 following the trial of those things in longwall 103 - did you understand from the material that you read the reason why that was being done?
A. Yes. Yes, I understood - well, I formed the opinion that the mine believed the more goaf wells you put on, the better it's going to be.

Q. Can we be a little bit more precise than that, because might I suggest to you that the reasoning behind the spacing of the goaf wells at 25 metres was not so much about having more goaf wells, and we discussed this in the first tranche of hearings - not so much about having more goaf wells to draw gas out like it was a big bathtub, but, rather, to ensure that every next goaf well in the early stages of caving is coming on really quickly, so there isn't a delay in the next goaf well coming on stream; do

you understand that as a rationale for it?
A. No, well, you're pointing it now, and I can understand that's how they thought, but I didn't know that up until now.

Q. No difficulty. A lot of documents. Does that make sense as a rationale? And if I'm taking you out of your area of expertise, please tell me and we will stop, but does that make sense to you as a rationale, that it is important that goaf wells are coming online quickly during that first caving, especially when you have had problems with that in previous longwalls?
A. I would say you are taking me out of my realm of expertise in that one.

Q. We have Mr Self coming. I suspect I can speak with him about that. Understood.
A. Yes.

Q. Thank you so much. Just, then, to test a couple of things about that hypothesis, though, about the Fair Hill seam and the migration down the wells, the cracked casing wells, you are aware, because you point out, that there were a number of exceedances during the first 100 metres of retreat on longwall 104?
A. Yes, I will accept that, yes.

Q. And, indeed, you refer to the number of exceedances and the nature of those exceedances as being, in some ways - I don't mean this critically - a kind of marker of difficulties in managing gas?
A. Say that again, please?

Q. I will put it a different way. In your report you describe the HPIs or the exceedances that occur as kind of, in essence, a marker of too much gas, if I can put it that way?
A. I also mention the gas delays --

Q. Yes.
A. -- in addition to the exceedances, and the gas delays were increasing and increasing, so they just seemed to be getting - it seemed to be getting harder and harder as time went on.

Q. You would accept I'm sure that it is important to understand and analyse the reasons for different

exceedances, to understand the reasons why they occurred or were caused?
A. Yes, that would be good.

Q. In any event, if we just come back to that first 100 metres, there were a number of exceedances in the first 100 metres, but might I suggest you couldn't expect caving or effect to have reached all the way up to the Fair Hill seam within that first 60 to 100 metres of the retreat of the longwall?
A. No, you wouldn't, no.

Q. So within that first 100 metres of the longwall, there is likely to have been no effect from the Fair Hill, even if there is ultimately an effect from the Fair Hill; is that fair?
A. Correct, yes.

Q. Thanks. And then in addition, and it possibly doesn't matter in light of that answer, would you accept - I think it is simply so, there may be no dispute about it - that within those first 100 metres when those exceedances were occurring, there were no goaf wells turned off?
A. Yes, but didn't they have problems with goaf wells off due to flame arrestor maintenance?

Q. That happens after that point, so that first 100 metres - I think the point is made. Now, in the course of answering some questions from our learned friend Mr Rice, you were talking about the goaf wells and you noted that - and I don't mean this disrespectfully at all - the operation of goaf wells is not something that is particularly within your expertise?
A. True.

Q. If I ask you any questions that take you outside of your area of expertise, please say. I'm not trying to press you outside your area of expertise.

As we head towards 6 May last year, as you have identified, there were a number of wells that went off because they were in TARP, in effect?
A. Yes.

Q. And that was in large measure because of the level of oxygen, in particular, in the particular wells - yes?
A. Yes.

Q. Are you in a position - and this is a question borne out of what I was just saying to you about expertise - to assist me with effectively what it means for what is called the goaf fringe as to how much oxygen there might be in goaf wells that are close to the longwall face or not?
A. No.

Q. Thank you. What I want to ask you about now, please, if we could have a look at table 4 on page 43 of your report - which, Mr Operator, is 0044, thank you. You went through this table in some detail with Mr Rice, so we don't need to revisit it at any level of detail, but we can see there, can't we, that it is showing effectively what is happening in relation to each of the goaf wells that we can see along the left-hand side?
A. Yes.

Q. And in particular, do you understand that goaf well V002A and V002A.2 - that's actually the same goaf well; it was that high-performing well we were talking about earlier? You are nodding. That's a "yes"? If you are not sure, please just say so.
A. Yes, well, I'm not sure, but on the plan there's no 2A and 2A.2, so you presume it is the one well.

Q. Yes. So we look at average methane flow, and if we assume for present purposes that it is the same well on that basis, we are seeing 883 plus 465, so we are seeing a very high-flowing well on that basis?
A. No, if the two wells are - if one is separated in time by the other, then the average is - it is not correct to just sum the average.

Q. In any event, let's focus on the 883. Unless I'm misreading it, that's the highest-flowing well?
A. Yes.

Q. Now, are you aware that that well, GR04V002A - let's just refer to it as that for present purposes - is the well in respect of which the flame arrestor issues, as they have been described, were associated?
A. I can't recall, no.

Q. Would you accept that from me for present purposes?
A. For present purposes, yes.

Q. Thank you. Now, was it in any of the material that you reviewed, given the high-flowing nature of it and the description of it - are you aware that it was partially drilled to about 10 metres above the GM seam and in fact ended up being connected to what is called the Dom fault that ran along the face line of the longwall 104 panel?
A. No, I'm not aware of that.

Q. And in any event, it obviously ended up being a high-flowing goaf hole. We've heard that on repeated occasions?
A. Yes.

Q. If it be the case that that hole was connected with the Dom fault plane and an unusually large tributary region of the P seam, that might help to explain anomalous gas levels on 104, might it not?
A. It could.

Q. Thank you. And because ultimately, as you have pointed out in your report, there was nothing like the issues associated with that first 100 metre retreat that we saw on longwall 104, with 103 - they were unique in that sense?
A. Yes.

MR HOLT: Thank you, Mr Martin.

THE CHAIRPERSON: Mr Crawshaw?

MR CRAWSHAW: Thanks, Mr Chair, no questions. Thank you.

THE CHAIRPERSON: Ms Grant?

MS GRANT: No questions, thank you, Mr Martin.

THE CHAIRPERSON: Thank you. Mr O'Brien?

MR O'BRIEN: No, thank you.

THE CHAIRPERSON: Ms Holliday?

MS HOLLIDAY: No questions, thank you, Mr Martin.

THE CHAIRPERSON: Mr Rice?

MR RICE: None from me, thank you.

THE CHAIRPERSON: Mr Clough?

MR CLOUGH: None from me, thank you.

THE CHAIRPERSON: Doctor, thank you for your attendance. You are excused.

<THE WITNESS WITHDREW

MR RICE: Dr Williams is the witness scheduled for today and indeed for tomorrow, Mr Martin, so I was going to ask if you would adjourn to Wednesday.

There is one administrative matter we can deal with. There is a list of documents described as a tender list, dated today's date, bearing the letter M. I think the parties are aware of its contents. It's to reflect documents to be tendered, drawn from the reservoir in the public book which the parties have access to. I presume that all the parties have notice of this document.

THE CHAIRPERSON: All right. Thank you.

MR RICE: I tender the documents in that list.

THE CHAIRPERSON: That document will be admitted into evidence.

MR RICE: I should say, it is apt to be supplemented as we proceed.

THE CHAIRPERSON: Mr Rice, does this matter have to be attended to at this stage?

MR RICE: It doesn't, no.

THE CHAIRPERSON: I'd just like to have a look at the list in a little more detail firstly, if that's all right.

MR RICE: By all means. We can deal with it in the interim between now and Wednesday morning, perhaps.

THE CHAIRPERSON: Is that all right?

MR RICE: Yes.

THE CHAIRPERSON: It won't be admitted into evidence at this stage. I will have a further look at it.

All right, we will adjourn until 10am on Wednesday.

AT 2.46PM THE BOARD OF INQUIRY WAS ADJOURNED TO WEDNESDAY, 24 MARCH 2021 AT 10AM

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