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 Wednesday, 17 March 2021 at 10am
(Day 18)

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THE CHAIRPERSON: Yes, Mr Hunter.

MR HUNTER: May it please, I call Martin Watkinson.

<MARTIN WATKINSON, sworn: [10am]

<EXAMINATION BY MR HUNTER:

MR HUNTER: Q. Mr Watkinson, your full name is Martin Watkinson?
A. Correct.

Q. You are currently the executive mining engineer at Simtars?
A. That's correct.

Q. What is Simtars?
A. Safety in mines testing and research station.

Q. Just make sure you keep your voice up.
A. Sorry. It's the safety in mines testing and research station.

Q. You hold the degree of Bachelor of Science with honours in mining?
A. That's correct.

Q. And you also have a number of other technical qualifications both here and in the United Kingdom?
A. That is correct.

Q. How long have you been with Simtars?
A. My current stint, it's seven and a half to eight years.

Q. Overall, how long have you been at Simtars?
A. Fourteen years, I think it is.

Q. Apart from your work at Simtars, you have been involved in the industry?
A. That's correct.

Q. You were underground general manager for a coal mine, for example?
A. Yes, for a proposed coal mine, that's correct.

Q. That was for Adani?

A. Adani, correct.

Q. But you've worked in the industry both here and in the UK?
A. That is correct.

Q. Your CV has been provided to the Board?
A. That is correct.

Q. And that is RSH.019.001.0574. I'm not asking for it to be called up. Could you please tell us about your current role at Simtars and what you do?
A. My current role at Simtars is providing technical advice to coal mines and the mines inspectorate in issues regarding spontaneous combustion, emergency response and some ventilation-related matters.

Q. Have you been assisting the Queensland Mines Inspectorate, or RSHQ as it's now known, in connection with the investigation of the serious accident that occurred at Grosvenor mine on 6 May last year?
A. I have been.

Q. What role have you played in the investigation?
A. My primary focus was in the analysis of the gas data, to analyse the gas data for methane exceedances, and then to look at primarily the tube bundle and real-time data to look at any evidence of spontaneous combustion activity as well.

Q. I'll get you to explain in due course what tube bundle and real-time data is. In what form, though, did the material come to you?
A. The information was supplied to me via the inspectorate back from the mine. The tube bundle data and the real-time data was provided in what was known as an spw file, which is a file which is produced by a Simtars program Safegas. Some of the gas chromatograph data was also in an spw file - again, it's a Simtars program. Some of the data for the goaf wells, some of the initial data, was a 14-day file that was provided as a csv, which was an export from the Citect system, which Grosvenor utilised as a SCADA system.

Q. Can we start with an explanation of what Safegas is?
A. Safegas is a program which was developed after the Moura No. 2 explosion. Its purpose is to focus on all the

records that are needed around setting of alarms, raising of alarms, long-term trending. The program interfaces to another program called Segas Professional.

Q. Segas Professional?
A. Which is again a Simtars program. Now, this is utilised for the trending of the data. Safegas will record the immediate alarm, and then long-term trending and further analysis can be done in Segas Professional.

Q. You mentioned tube bundles. What's a tube bundle?
A. A tube bundle - the system has been available since the late 1960s. It is a bundle of polyethylene tubes which is run underground, so it typically can be a half-inch external diameter or five-eighths external diameter. They run to discrete locations underground. There's no power underground. All that is underground is a flame arrestor and a filter. There are systems of pumps and solenoid valves on the surface. So there's a purge pump which keeps the gas sample in the tube moving all the time to the surface. Then at probably two-minute intervals, the sample sequence switches over to an analysis pump, which pushes the gas sample to the analyser. The gas analyser is a four-gas analyser which analyses for carbon monoxide, carbon dioxide, oxygen, and methane.

Q. Do I understand you correctly that there are tubes going to various locations throughout the mine?
A. There are, yes.

Q. And the analyser on the surface alternates between the various locations?
A. That's correct.

Q. So it takes a sample from one tube, then a sample from another tube?
A. Correct.

Q. Presumably these tube points are, or can be, quite some distance from the analysis point?
A. They are several kilometres, yes.

Q. So how long does it take, or can it take, for a sample of atmosphere at the termination of a tube to get to the analyser?
A. Long runs can take one to two hours.

Q. Is that time lag significant, or can it be significant?
A. The primary objective of a tube bundle system is to detect the onset of spontaneous combustion, so not ideal, but it doesn't have a massive impact on the outcome.

Q. You said real-time?
A. Yes, the real-time system is - and again a lot of this is prescribed in the regulations. They have what they call environmental monitors, which again are the same four gases, which is carbon monoxide, carbon dioxide, oxygen and methane, and these tend to be electrochemical cells and they are located at discrete locations around the mine. The difference with them is that the data is sent via the mine's Wi-Fi system or electronic system to the surface.

Q. So it's instantaneous, or near enough to?
A. Yes, there are - it depends on the sequence of the PLCs talking to each other, but, yes, it's a smaller distance than two hours. It's a matter of seconds.

Q. The PLC being the programmable logic controller?
A. Apologies. Programmable logic controller, yes.

Q. Those real-time sensors, do they all test for the four gases, or do some just test for one?
A. Not all the locations. The legislation prescribes the locations where the four gases have to be. The mine will identify where methanometers are placed - those are what is known as the explosion risk zones, and there's non-explosion risk zones, so the mine has a risk-based policy to determine where they are. There are also discrete carbon monoxide monitors around conveyor belts.

Q. The tube bundles and the real-time sensors feed data into Safegas?
A. Correct.

Q. How is that data conveyed to the mine operator?
A. In the control room, there is a visual display which indicates the mine map. There are individual locators of where the sensor is on that map, and there is a discrete display either side which gives you the location, name and all the four gas readings, along with other ratios.

If an alarm is raised, there is an audible alarm. Then the control room operator will investigate, accept the alarm - so the alarm screen goes red, and then when an alarm state has been accepted, the screen goes yellow. When the alarm state is no longer present, it goes clear.

Q. It goes?
A. Clear. So yellow - it's like a traffic light system.

Q. So is it only the tube bundle and real-time systems that feed data to Safegas?
A. That's correct.

Q. Within Safegas, it's possible to set alarm triggers?
A. Correct.

Q. That's configurable for each tube bundle point or real-time sensor?
A. Correct.

Q. What about the system on the goaf wells - you said that there was data that was fed into the mine's Citect system?
A. Yes, they have a Citect system and they have four gas sensors again on the goaf wells, the same four gas sensors, and that data was sent into the Citect system.

Q. Was the control room operator able to see that data as well?
A. That data is available to the control room operator plus anyone else who has Citect access.

Q. Is it possible to set alarms in Citect?
A. Yes, it is.

Q. With respect to the gas data, I mean.
A. Yes.

Q. You mentioned gas chromatographs?
A. Yes.

Q. What's a gas chromatograph?
A. A gas chromatograph is an instrument that does gas analysis. Its name, the gas - Sean Muller may give you a better and more detailed explanation than this, but you take a sample of the gas and you introduce it to the system. The reason it's called a gas chromatograph is because gas is used as the medium for pushing the sample through, and it will go through a series of columns and the

process works by separation of the gases and it goes over a detector, and the time it takes to get to that detector is the time - how we know which gas it is.

Q. Is it possible using a gas chromatograph, or GC, to identify all of the components of a gas sample?
A. Yes.

Q. Not just the four gases you've spoken about?
A. Yes, you can configure a GC to do all gases. We tend to configure it to the primary gases of interest.

Q. How are samples taken so that they can be analysed by the GC?
A. Samples can be taken either direct from the tube bundle system or underground. They're taken into an aluminium bladder. The mine has a process for how often you fill the bladder and evacuate it. Then the bladder is taken to the gas chromatograph, and the control room operator is normally the GC operator. On that bladder, the person who took the sample will normally identify what the gas readings were on his hand-held gas instrument. So they have that as a reference. If it was a seal sample, it will also indicate whether the seal was breathing in or breathing out.

Q. When you say "breathing in or breathing out", are you referring to barometric pressure?
A. Not just barometric pressure. That can also be mine pressure as well.

Q. You say that the bag samples can be taken from the tube bundles. Is that taken at the surface?
A. That's taken on the surface, yes.

Q. But otherwise someone physically takes one of these bags to a particular point underground?
A. Yes.

Q. And takes a sample of the atmosphere?
A. Yes.

Q. What about with the goaf wells, is it possible to take a bag sample of the goaf wells?
A. It is possible to take a bag sample of the goaf wells. I'm not totally familiar with the operation of that system, but it is possible, and they have taken bag samples from

the goaf wells.

Q. We might ask Mr Muller more about that in due course. Mr Operator, if I could call for a PowerPoint, please. Just while that's being displayed, you have your reports and other notes there with you?
A. Yes, I have, yes.

Q. I assume there's no objection to you referring to any of those if you need to during the course of your evidence, so please feel free to do so. Can I start, though, by asking you to just have a look at this first slide.
A. Yes.

Q. Which sets out the locations of the various tube bundles.
A. Yes, these are the tubes that were relevant to the 104 longwall.

Q. There's tube 22. That was the one that's required to be 400 metres outbye of the face?
A. Yes.

Q. Tube 26, which was located in 3-4 cut-through in the tailgate?
A. That's correct.

Q. That's about 4 kilometres from the face, thereabouts?
A. Yes.

Q. As at the date of the incident it was, at least?
A. Yes.

Q. And then there were three tube bundles that were located at the location of three goaf seals?
A. Correct.

Q. Tube 36 was located on the maingate side at 38 cut-through?
A. Yes. Sorry, 38, correct.

Q. Then tube 38 is in B1 cut-through, which is at the rear of the goaf?
A. Yes.

Q. Then tube 39 was on the tailgate side at 40-41 cut-through?

A. That's correct.

Q. We might just have a look, then, at this next slide, slide 3. Do you recognise that as being part of a plan of the mine showing the outbye end of longwall 104?
A. I do.

Q. We can see the mains at the bottom of the screen, but over on the left-hand side where I'm using the cursor at the moment we can see three markings that indicate some sensors?
A. That's correct.

Q. And those sensors are the four-gas sensor, which is this one here (indicating) with a label starting GM002?
A. That's correct.

Q. The tube bundle number 26, which is over here?
A. Yes.

Q. And there's also a velocity sensor.
A. Correct.

Q. What's the purpose of a velocity sensor?
A. The purpose is, because you know the cross-sectional area, you can calculate the quantity, and that is useful in calculations of CO make, which we'll discuss later.

Q. Just so we're clear about this, this is a tube bundle and this sensor here - they're at what's called 3-4 cut-through?
A. Yes.

Q. That's because there's number 3 cut-through and there's number 4 cut-through?
A. That's correct.

Q. The next slide, does this show the location of the two 400 metre sensors as at April 2020?
A. Yes.

Q. This is, again, taken from a mine ventilation plan?
A. Yes, that's correct.

Q. I should say just for the record that each of these slides identifies the source document in the bottom left-hand corner. The 400 metre sensors are here where I'm

moving the cursor (indicating)?
A. Correct.

Q. One thing I wanted to ask you about was the ventilation arrangement here. We can see on the slide some red arrows over here on what I understand to be C heading?
A. Correct.

Q. Do those arrows depict ventilation away from the goaf, that is, heading outbye?
A. Those arrows would indicate the direction of air movement.

Q. There are some seals on the various cut-throughs that we can see here at 36, 37, 38, 39 and indeed at 40?
A. Correct.

Q. So does that mean, then, that there is ventilation air heading away from the goaf that would not go past this 400 metre sensor?
A. That would indicate that possibility, yes.

Q. Is that a desirable state of affairs?
A. Not really, no.

Q. Why?
A. You're going to miss the relevant gas data.

Q. So there will be gas coming out of the goaf that won't get measured there?
A. It won't get picked up by that sensor, but it does get picked up by the outbye sensor.

Q. But that's 4 kilometres --
A. Four kilometres away, yes.

Q. Is there an issue in terms of dilution, given the quantities of air that are going to be travelling through that roadway?
A. There's no more dilution effects, but it depends on what the gas concentrations were in C heading as opposed to B heading. So, as we don't know those actual values, it's difficult to say.

Q. This next slide, does it show the various sampling points that we're going to talk about?
A. It shows all the goaf wells, as well as the tube

bundle seal locations.

Q. So we've got all of these, the goaf wells, identified here?
A. Correct.

Q. Those that are marked with "V" do you understand to be vertical goaf wells?
A. I'm not sure of why they've called them "V", but I understand they are vertical goaf wells.

Q. And then there's one here that's GRO4 with an "L". Is that a lateral well?
A. I'm not sure.

Q. All right.
A. I defer to --

Q. Then there are some wells that are over closer to the maingate side that are marked with an "M", so GRO4M001, and it's located here where I have the cursor?
A. Correct.

Q. And then 1.5, which is here (indicating)?
A. Correct.

Q. The blue line that we can see that I'm moving the cursor backwards and forwards across at present, does that depict the approximate location of the face as at the date of the incident?
A. It does.

Q. It also shows the location of the tube bundles?
A. Correct.

Q. Tube bundle 39?
A. Correct.

Q. There's tube bundle 38, which is in B1 cut-through?
A. Correct.

Q. Then over here, in 38 cut-through, there's tube 36?
A. Correct.

Q. So there were other goaf seals that we can see in the other cut-throughs, but your analysis was confined to those tube bundles in terms of the goaf seals?

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A. Correct, I concentrated on the tube bundle data, yes.

Q. Here is a closer view, slide 6. That again shows 39, 38 and 36, as well as two others?
A. Tube 37 and tube 40 are fresh air tubes.

THE CHAIRPERSON: Q. Sorry, Mr Watkinson, can you just keep your voice up, please?
A. Yes, tube 37 and tube 40 are both tubes in fresh air or air that's come down the downcast shaft.

MR HUNTER: Q. What's the purpose of having a tube bundle at a goaf seal?
A. To identify if there is any spontaneous combustion activity.

Q. So the idea is that the termination point of the tube bundle is actually inside the goaf?
A. That is correct.

Q. We can see, as depicted here, that at least, for example, tube 38 has a double seal?
A. Correct.

Q. That's a common arrangement?
A. It's a common arrangement where you're trying to control oxygen ingress into the goaf.

Q. So we can see one is a 35 kPa flexi?
A. Correct.

Q. And the other is a bulkhead, I think it says "10 metres rated"?
A. Yes.

Q. Can you explain what those two labels refer to?
A. Well, the 35 kPa is an explosion resistance, and the bulkhead would be probably rated as a water resistance. There's a possibility of water accumulation against that seal.

Q. You say that the purpose of those seals is to prevent oxygen ingress into the goaf?
A. Correct.

Q. You're familiar with the ventilation arrangements here. Is it the case that the fan that supplies air into

this roadway here is located in this - I'll call it the back left-hand corner of the goaf?
A. It's on the surface, yes.

Q. Sorry, but it supplies air to that point?
A. Yes.

Q. And it's a downcast fan?
A. Correct.

Q. An intake?
A. Intake, yes.

Q. Lastly, then, we have a picture that shows all of those locations, including a red line for the longwall face, as well as that number 96 chock, which in your reports you refer to because of the significance it held in terms of what happened after the events of 6 May?
A. After the event, yes, that's correct.

Q. If we could just go back, we see goaf well M001.5. That's located here (indicating), and it's depicted by that small circle?
A. Correct.

Q. Tell me if I'm wrong, but is it the case that that goaf well is in the same general location as chock number 96?
A. That's correct, it's in the same general location.

Q. All right. Now I'm going to ask you about gas ratios, but before I do that, you mentioned spontaneous combustion and the idea being to avoid - at those goaf seals at the rear of the goaf to detect the ingress of oxygen and prevent spontaneous combustion. What is spontaneous combustion?
A. Spontaneous combustion is a process which coal and other minerals - hay, for instance - can oxidise. The oxidation process is exothermic and it can slowly warm to the point where there can be a fire.

One thing that should be recognised is the word "spontaneous" is from the old English derivation, which means "without external influence", so it's not as it's used colloquially now. So it's a process whereby it changes from normal and will eventually get to the point - it could get to the point of an open fire.

Q. What's required for coal to spontaneously combust?
A. Sufficient oxygen for the reaction to occur and insufficient airflow for the heat to be dissipated.

Q. So how much oxygen is required in terms of - we know that oxygen in the normal atmosphere is 21 per cent or thereabouts.
A. It's difficult to ascertain exactly the amount of oxygen that's needed. One thing that has been identified many times is that the coal retains the heat, so that if you've got hot coal, above ambient, it will react quicker when the oxygen is supplied.

If you go to the New South Wales mine rescue black book, they typically say that all oxidation ceases at 2 per cent oxygen. It's difficult to get below 2 per cent oxygen.

Q. So if you have more than 2 per cent oxygen - we'll see some graphs later today showing that there was at least 2 per cent oxygen in this goaf, at least in the places that were measured.
A. Again, you look at the oxygen you've got with the CO that's being produced to see if any reactivity is occurring.

Q. Is it fair to say this, that it's normal for there to be some level of oxidation going on in, really, any goaf?
A. There is always some level of oxidation going on. It depends on whether it gets to the point where it has sufficient thermal energy to move away, but it's quite normal to see a level and then a decline. As the oxygen drops, the CO drops, and that's normal.

Q. As the coal heats up, does it give off gases?
A. The primary gas of interest is always carbon monoxide because it's not - it doesn't occur naturally.

Q. Please keep your voice up?
A. Sorry. The common gas to use is carbon monoxide. There are other indicator gases, hydrogen and ethylene, which you need a gas chromatograph to identify. When I started in 1997, hydrogen was regarded as one of the - a key indicator, but the gas chromatographs have got better at detecting them.

Q. Hydrogen would be present, at least to some extent, in a normal atmosphere?
A. There's 1 to 2 parts per million, yes.

Q. What about ethylene?
A. Not normal.

Q. So is there any part of the mining process, apart, for example, from the oxidation of coal, that would produce ethylene?
A. It can be seen with - in drilling the boreholes, where the heat from the drilling action has created ethylene. It can be seen in the face of tunnel boring machines. That was the oil breaking down - that was the heat breaking the oil down.

Q. That's oil breaking down?
A. Oil breaking down. When I say "oil", it's the lubrication they were using on the cutter.

Q. So apart from those scenarios, ethylene is not something that you see underground unless there's a heating of coal to some degree?
A. To some degree, yes. It takes an input of heat for the ethylene to be released.

Q. I take it that different coal responds differently to heat?
A. There are a number of tests that have been done on gas evolution. They're all - there are differences in the analysis, but it can be - I've seen ranges between 80 and 120 degrees Centigrade.

Q. That's for ethylene?
A. For ethylene, yes.

Q. But in terms of gas evolution, as you've described it, is that a test whereby you heat coal and work out what gases come off it and at what temperature?
A. That's correct. It's been done for maybe 20 years now - over 20 years.

Q. Is it common for mines to do that sort of testing so that the mine has an understanding of the specific coal that's being mined at that mine?
A. It's very common for each mine to do their own individual tests.

Q. So that the mine would have an understanding of the temperatures at which particular gases are liberated?
A. Yes, that's correct.

Q. Whilst there are generally recognised, I'll call them trigger points, but points of concern, if I can call them that, when you're looking at both raw gas data and ratios, am I right to say that it's always going to be coal or mine specific?
A. It should be mine specific, all TARPs should be mine specific. The presence of ethylene is an indicator of something starting to warm.

Q. We've been speaking about the four gases that are measured by Safegas, and obviously the tube bundle system will measure the raw values for each of those.
A. That's correct.

Q. And so will the real-time sensor.
A. That's correct.

Q. But are the raw values the full story?
A. No. You can use ratios. Ratios have been investigated over a number of years. A common one is Graham's ratio, which originates from 1925 in the UK.

Q. What does Graham's ratio attempt to do?
A. It attempts to identify the intensity of the heating. So we're looking at the carbon monoxide produced by the oxygen which was - the oxygen deficiency, which is the oxygen consumed in that process, and then multiplied by 100 to become a meaningful number.

Q. I beg your pardon?
A. It's multiplied by 100 to become a more meaningful number rather than a small number.

Q. You can see on the screen there's two formulae. The top one, is that a very general description?
A. It's a very general description of the ratio.

Q. What's depicted at the bottom? Is that what's known as the long form of Graham's ratio or something approximating it?
A. That is the traditional form. The long form is when you're trying to take account for dilution of methane.

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That's in the pure form as derived by Mr Graham.

Q. We'll come to methane dilution in due course, but in the ratio that's depicted at the bottom, it talks about the initial and the final levels for oxygen?
A. Correct.

Q. How does one calculate the initial and final figures for oxygen when you're attempting, for example, at 3-4 cut-through at longwall 104 to calculate Graham's ratio?
A. Well, for 3-4 cut-through, the mine was using a fresh air reference tube, which means it takes out any vagaries in oxygen analysis or carbon monoxide analysis, any issues relating to the sensor.

Q. Where was that fresh air reference tube?
A. It was the one on the corner in the maingate, not the one at the bottom of the tube, not at the bottom of the shaft. It was the one at the right-hand side corner.

Q. So at Grosvenor, that first tube would give the mine the reference point for the initial figure for oxygen?
A. And for carbon monoxide as well.

Q. And for carbon monoxide, but if it's fresh air, you would expect there to be no carbon monoxide?
A. It's possible. There should be none. But, again, if you go back to the spontaneous combustion process, all the coal in the roadways is sort of reacting, or it's been cooled, so it doesn't get any hotter. So there is a normal background count, which sometimes can be 1 ppm.

Q. Then the final figure for oxygen - that's measured several kilometres away at, say, 3-4 cut-through?
A. At 3-4 - it's measured at every location.

Q. So you compare the amount of oxygen in the air at those two points, and that tells you how much has been consumed?
A. Correct.

Q. Is it common, though, for the purposes of Graham's ratio to make assumptions about the content of the air?
A. Sorry?

Q. Perhaps if I go over the page, is it common to assume

that the fresh air has a defined initial state?
A. Yes, this is another variation of Graham's ratio where you're using the oxygen to nitrogen ratio in fresh air, and so you use the nitrogen analysis to determine what the oxygen initial was. But the only technique which actually measures nitrogen is a gas chromatograph. A tube bundle doesn't.

Q. The literature identifies what are - I referred a moment ago to the importance of doing your own testing, but there are some nominal values for Graham's ratio that are said to be significant?
A. Those are the textbook values.

Q. You said that this is a measure of a heating intensity?
A. Yes.

Q. So what do you mean by that?
A. You're trying to determine how hot the coal is or where it's at. There's always a danger that this ratio can underestimate, so sometimes absolute values don't always give you the true indication of where it's at. So you're trying to - if you look at the figures there, and those are originally derived by Mr Graham, a serious fire is when you get a Graham's ratio of 2.

Q. Sorry, you'll have to say that again?
A. Sorry. A serious fire, they expect that it's actually on fire at that point. It doesn't try and indicate temperature, whereas CO/CO_2 talks about temperature.

Q. Can I ask you this: is Graham's ratio a useful tool when it's measuring at a point that is a long way from the face?
A. It's not an ideal location to be using Graham's ratio, because of dilution. With the ventilation quantities we have, there is a large - the oxygen final is still very large, so the denominator becomes very small.

Q. Is there an issue in terms of the accuracy of the types of sensors that are used, particularly in terms of the measurement of oxygen?
A. Oxygen has always been a difficult gas, and there is an Australian standard which determines how gas analysers should be maintained, and the accuracies are stipulated in that. That's AS/NZS 2290 part 3.

Q. Sorry, you will have to speak up?
A. Sorry. It's an Australia/New Zealand Standard, 2290 part 3, and it was reissued in 2018. That determines the acceptable limits for the accuracy for when you do calibrations.

Q. So what is the tolerance for the measurement of oxygen?
A. Oxygen, as I remember, is 0.3. I can't remember all the others.

Q. So for oxygen, that's plus or minus 0.3?
A. Plus or minus, yes.

Q. You've told us that the oxygen deficiency at a point that is remote from the goaf, given dilution, is likely to be very small, in any event?
A. Yes.

Q. So is it right, then, that that error in the measurement of oxygen, even though it's only 0.3 of a per cent, could actually be significant in terms of its impact upon Graham's ratio?
A. It can be. That's why it's better with a tube bundle system to use a reference tube to try and take away the vagaries of the oxygen analysis.

Q. And that was occurring here?
A. That was occurring here.

Q. You mentioned the CO/CO2 ratio. What does this ratio tell us?
A. Well, this ratio is looking at the carbon monoxide produced by the activity, divided by the carbon dioxide, because at low temperatures or lower temperatures you get more carbon monoxide than carbon dioxide. When things get to a open fire, the predominant gas is carbon dioxide because of the oxygen availability. One thing that people need to remember is we often talk about parts per million for CO, but in these equations you're using the percentage terms.

Q. So what does the CO/CO2 ratio tell you about what's going on?
A. It gives you an indication of what the temperature of the coal is.

Q. Again, there are some nominal or textbook values that are set out in the slide there?
A. Yes, those are textbook values, and they have been cross-validated with testing as well.

Q. There's no specific value for a figure of 0.2, but obviously it lies somewhere between 0.15 and 0.35.
A. Yes.

Q. So on the textbook values, a CO/CO2 ratio of 0.2 would obviously be above 100 degrees?
A. It's above 100 degrees Centigrade, yes.

Q. We know, though, that CO2 is a seamgas.
A. The bulk of the seamgas is methane, but there is some CO2 in the seamgas, that's correct.

Q. So is it desirable when calculating the CO/CO2 ratio to adjust for dilution?
A. It would be good to adjust for a dilution, but the calculation would not be simple.

Q. Would it be possible to do it using tube bundle or real-time sensors in the way that was being done here?
A. It should be possible, yes. You'd have to look at the mathematics and go and look at the analysis.

Q. Would it simply be a matter of configuring Safegas to do the calculation?
A. Safegas, it could be configured, yes.

Q. It would be good if you didn't talk over the top of me.
A. Sorry.

Q. I'll probably do it to you occasionally. But it's possible to configure Safegas to do that calculation?
A. That is possible.

Q. You also mentioned CO make.
A. Yes. This derived from Germany in the 1960s, and here you use the carbon monoxide in parts per million, times the airflow, in cubic metres per second, and the constant there brings the value to litres per minute.

Q. Is this where that velocity sensor that we saw, for

example, at 3-4 cut-through comes into play?
A. Correct.

Q. Are there limitations to the usefulness of CO make?
A. Yes, it can either be a small amount of coal giving off a lot of carbon monoxide, or a large amount of coal giving off a small amount of carbon monoxide. It doesn't differentiate. There have been occasions in New South Wales where massive CO makes have been detected with no activity in the goaf.

Q. You mentioned TARPs before. By TARP, you mean trigger action response plan?
A. That's correct.

Q. You've had a look at the TARPs, as you call them, for the active goaf at Grosvenor?
A. Correct.

Q. These are the TARP trigger points for the longwall return?
A. Correct.

Q. Do you understand that to be a reference to data identified at 3-4 cut-through?
A. That's correct.

Q. We can see immediately that the normal state for the CO/CO2 ratio is said to be less than 0.2.
A. Yes, it is that.

Q. And you told us a moment ago that the textbook values would suggest that at a CO/CO2 ratio of 0.2, the coal would have heated to a temperature in excess of 100 degrees?
A. Correct.

Q. What do you say about the appropriateness of the 0.2 as the trigger value for the CO/CO2 ratio?
A. I would say it's not an appropriate normal trigger.

Q. Is a figure of 0.02 something you would expect to see?
A. From the textbook values, yes.

Q. How likely is it that an analysis of this particular coal would have revealed or would have suggested that a CO/CO2 value of 0.2 was appropriate?
A. I've not evaluated that data in that detail, so

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I don't know.

Q. We can see that the level 2 triggers include a detection for ethylene at equal to or greater than 1 part per million?
A. That's correct.

Q. Again, that's something that would be measured at 3-4 cut-through, 4 kilometres from the face?
A. Correct.

Q. Are you able to offer a view - I'm not suggesting a precise calculation, but a view about what sort of ethylene would need to be coming out of the goaf to be registered at 1 part per million at 3-4 cut-through?
A. I can't estimate what it would be. It would be a substantial number for it to be detected at 1 ppm in that location.

Q. If you are going to pick up ethylene coming out of a goaf, where is the best place to find it?
A. The goaf stream.

Q. We know that samples were taken from the goaf stream?
A. That is correct.

Q. Do you understand that that involved someone, presumably a deputy, actually going into the tailgate and taking a sample of the goaf stream as it comes out of the goaf?
A. That's correct.

Q. Is there an art to identifying the goaf stream?
A. There have been training packages put together in the past for how you look for the richest gas. You want the most concentrated gas to give you the best evaluation.

Q. Presumably you'd expect that someone who was a deputy would be skilled at doing that?
A. Yes, you use your hand-held instrument to find where the gas is the most concentrated, as long as it's safe to be there, and then take the sample.

Q. I notice the level 3 triggers talk about, for example, CO make being greater than 93 litres a minute and Graham's ratio being equal or greater than 1 or ethylene equal or greater than 3 parts per million and CO make equal to or

greater than 53 litres a minute.
A. Yes.

Q. What do you say about the desirability of the use of what I'll call "and" statements, that is, requiring a combination of two parameters in a level 3 trigger?
A. "And" statements are not ideal in that situation, and there's actually an "and" statement in the level 2 trigger as well. It's not ideal. If you're looking at the ethylene one, and CO make, that's two different detection techniques you're using. Again, you can trigger one part of it but not the other.

Q. I take it that a level 3 trigger involves evacuation?
A. Yes.

Q. So you could be, for example, at the evacuation trigger for one parameter and just short of the other, for example?
A. That is possible, yes.

Q. What do you say about the effectiveness of this particular TARP to detect - bear in mind that it's based upon the longwall return at 3-4 cut-through - to identify a small but intense heating in the goaf?
A. I've not really evaluated that in detail, but looking at it, with the dilution effects, it may be difficult for it to identify at 3-4 cut-through.

Q. Sorry?
A. I said it might be difficult to identify it at 3-4 cut-through.

Q. This is the TARP for the goaf seals. We've spoken about taking account the effect of dilution with CO2. What do you say about the desirability of the triggers being based upon calculations that were performed either air free or methane free?
A. A lot of people have used methane free - air free calculations in the past and set triggers on them. It's not something I'd necessarily establish a TARP on, but I would expect the ventilation officer or other technical people to evaluate those in conjunction with something else. If one parameter gives you a warning, which would be carbon monoxide, then you start to look at other things, to look at the other parameters. The key thing with TARPs is to keep them simple for a control room operator to operate,

to respond to.

Q. What is a methane free calculation?
A. You look at - you need a total gas analysis, ideally from a gas chromatograph, because it will actually determine what the nitrogen is, and then you take the methane out of the calculation and then you take everything back up - you proportionally increase everything back up to where it is, so you've eliminated the dilution effects from methane.

Q. Is that something that's important when looking at the raw figures, or is it only important when you're looking at a trend?
A. It could be either/or. It depends. The key thing with spontaneous combustion is not necessarily to wait for the TARP to trigger but to respond to a trend or something that's not normal.

Q. That's something I was going to ask you about. In terms of the ratios that we've looked at - and there are others, undoubtedly, but in terms of those ratios and CO make, is the trend something that's of significance as well as whether or not, for example, some TARP trigger points have been reached?
A. The trend over time is important.

Q. Again, we see the use of "and" statements not just in level 3 but elsewhere. Does your opinion differ for this particular TARP in terms of the desirability --
A. I'm not keen on "and" statements.

Q. Sorry?
A. I'm not very keen on "and" statements.

Q. Have you seen a TARP for the goaf stream?
A. No. I have not.

Q. In your view, is a TARP for the goaf stream desirable?
A. It is.

Q. Why?
A. It's the most concentrated source of the gases, so you get less effects - you've got a better chance of detecting the ethylene. Obviously if you've got more methane in it, you'll get dilution effects, but you'll detect the ethylene quicker.

Transcript produced by Epiq

Q. There's also a TARP for the goaf wells.
A. Correct.

Q. We can see that the normal state is said to be oxygen at less than 8 per cent?
A. Correct.

Q. What do you say about the appropriateness or otherwise of 8 per cent oxygen as the normal state?
A. I'd like to defer to Mr Ray Williams, but 8 per cent appears high to me.

Q. What should it be, in your view?
A. You'd be looking less than 5 per cent, but that's speculation on my part. I'd need to go to technical references.

Q. Again, we see the use of "and" statements in the triggers.
A. Mmm-hmm.

Q. You're nodding. Is that a "yes"?
A. Yes, sorry, yes. There's "and" statements on oxygen and methane, yes.

Q. Again, is your opinion about the desirability of the use of "and" statements any different from that which you've expressed in relation to the longwall return and goaf seal TARPs?
A. No. I agree, it's still the same. I'm not keen on "and" statements. My experience in British coal, there was "or" statements. The oxygen level or the methane level were two different triggers.

Q. That TARP doesn't refer to ethylene?
A. It does not.

Q. Should a TARP for a goaf well have a trigger value for ethylene?
A. I believe it should.

Q. And why?
A. Because there's a large proportion of carbon monoxide seen reported to the goaf wells, and there could have been a possibility of ethylene being seen there.

Q. In terms of the calculations that are done with respect to the goaf wells, should there be calculations done to take account of the effects of dilution?
A. You mean on the raw gases?

Q. Yes.
A. Yes, there should be, yes.

Q. Why is that?
A. Because you've got a large - ideally in a goaf well, you've got a large proportion of methane, which will dilute the other gases, particularly carbon monoxide.

Q. Is Graham's ratio a useful tool with respect to a goaf well?
A. Unlikely, because of very low oxygen that you would see there.

Q. What about with respect to determining the total amount of CO that is made? These wells, we know, are 300 or 400 metres in depth. I'm not sure of their diameter, but they're not insubstantial. What sort of volume are we talking about in terms of CO that's in the wells themselves?
A. I can't remember off the top of my head, but I have done calculations on that. The CO make from all the wells combined, using the data from the goaf well monitoring systems, was 10 to 15 litres a minute.

Q. Is that a lot, or not?
A. That is a lot, when you - I have graphs where I've added it to the CO make for the tailgate.

Q. Was that being taken into account?
A. That would not have been a normal operation at that time, no.

Q. You've gone through the exercise of analysing in great detail the data from the tailgate return airway, including the 400 metre sensor, the 3-4 cut-through, four gas sensor and the tube bundles located at 400 metres and at 3-4 cut-through?
A. That's correct.

Q. And using Safegas, you're able to generate graphs that show gas levels?
A. Yes, the Segas Professional software enables me to do

that very quickly.

Q. And you're also able to calculate ratios such as CO/CO2?
A. Yes, that's correct.

Q. The first graph we're going to go to is what is figure 23 from your first report, and it's CO/CO2 as calculated using the Safegas system for both the 3-4 cut-through and the 400 metre sensor?
A. That's correct.

Q. It's a bit difficult to see, but if we look in the bottom left-hand corner, we can see tailgate 104 400 metres, and then this one is tailgate 104 3-4 cut-through?
A. Correct, the blue is the inbye tube.

Q. The two graphs reflect the calculation from mid-April through until 6 May?
A. That's correct.

Q. The peak that it got to was just a touch under 0.04.
A. That's correct.

Q. We know that the TARP trigger for these two tubes was 0.2 for the CO/CO2 ratio; correct?
A. That is correct.

Q. So if we were to draw a line, though, if the TARP value was 0.02 as opposed to 0.2, the TARP level would be approximately where I'm moving the red cursor horizontally across the screen?
A. That's correct.

Q. Which meant that the level 2 TARP trigger would have been reached on multiple occasions?
A. The TARP was --

Q. If it was 0.02, it would have been reached on multiple occasions?
A. It would have been reached on the inbye tube; but the outbye tube, it doesn't appear so.

Q. Can you explain why it might have triggered at the inbye tube and not at the outbye?
A. Because the inbye tube was using a fresh air tube as

a reference, and the outbye tube would have been using a calculation assuming fresh air.

Q. So it would have been using the simple version of the calculation that we had on the screen before, which used the constant of 0.265?
A. Yes, that would assume fresh air values as opposed to actual values from the analyser.

Q. So the inbye tube is, what, a more accurate calculation of the CO/CO2?
A. No, the outbye tube is the more accurate one.

Q. So the outbye tube was more accurate, and it would not have reached the trigger value of 0.02?
A. Yes, there's less variability in the data if you look.

Q. There is a peak here in about 17 April or thereabouts.
A. Yes.

Q. Are you able to explain what that indicates, if anything?
A. I have no idea what could have caused that.

Q. This next slide, slide 19, shows Graham's ratio for the same two tubes?
A. Correct.

Q. Again, the blue is the 400 metre and the red is the 3-4 cut-through?
A. Correct.

Q. What is the significance, if any, about what's displayed on this graph?
A. Well, it shows it never triggers the level 1 TARP of 0.3 per cent.

Q. You were talking before about trends. Is there anything of significance about the trend for Graham's ratio in the lead-up to the events of 6 May?
A. Around 17 April there's a small - there's an increase in Graham's ratio but doesn't trigger the TARP. It then drops away to a lower level. There's a very, very slight increase, but only slight.

Q. We see again this increase in Graham's ratio in around the middle of April?

A. Yes.

Q. What might explain that?
A. It's difficult from just looking at the raw data to try and second-guess. There was some PUR injected around there.

Q. Sorry?
A. There was some PUR injected around there, but I don't know if that was the cause or that was just normal goaf forming or what.

Q. Just on the point of the PUR, you understand that there is some testing currently being undertaken?
A. I understand so.

Q. At Simtars?
A. That's correct.

Q. Involving coal from this particular longwall and also the PUR product, the polyurethane resin injectable being used?
A. I'm aware of the testing but not of the absolute detail of what testing's being done.

Q. I'm not suggesting that you're personally involved in it, but you understand that's being done?
A. Yes, I do.

Q. And the results are yet to be finalised?
A. That's correct.

Q. Did you do a similar exercise of looking at the data for the goaf seals?
A. That's correct.

Q. Just as a reminder, does the next slide show the general location of the goaf seals that we're concerned with?
A. It does.

Q. Just to be clear about it, though, for example, tube bundle 38 is shown on the plan as being located between those two seals?
A. That is what the plan shows, yes.

Q. Is that likely to be how it was in reality?

A. Unlikely.

Q. Would there be any point in having a tube bundle terminating between the seals?
A. No.

Q. It's likely to have been in the goaf itself?
A. It would have been put into the goaf itself.

Q. Similarly with 36, it's depicted as being on the fresh air side of the seal. You would expect it to be on the goaf side of it?
A. I would expect it to be on the goaf side, yes.

Q. We can't really see because of clutter about tube bundle 39, but you would expect it to be measuring goaf atmosphere as well?
A. I would.

Q. Did you look at the levels of carbon monoxide at each of those seals for the period March through until the date of the incident?
A. I did.

Q. Are they depicted on this graph?
A. They are.

Q. The red, which is at a very low level throughout, is B1 cut-through - that's the seal at the back of the goaf?
A. That's correct.

Q. But the green, which has some peaks in early April, that is the tailgate 40-41 cut-through?
A. That's correct.

Q. And the blue is on the maingate side?
A. Yes, it's the 38 cut-through seal.

Q. Have you, on this document, depicted the level 2 TARP for CO parts per million?
A. Yes, I have.

Q. And that's that horizontal line at the top at 200?
A. Correct.

Q. So we can see that on or about 22 May and the days that followed, the CO levels at the maingate goaf seal at

38 cut-through exceeded that trigger point for CO.

THE CHAIRPERSON: 22 April?

MR HUNTER: Q. 22 April.
A. 22 April, yes.

Q. It exceeded the trigger point for CO. What could explain the production of CO at that point right at the back of the goaf?
A. This isn't right at the back of the goaf. This is in the maingate, immediately behind the --

Q. Sorry, you're quite right, yes.
A. So that would be normal oxygen penetration and waiting for the methane to come forward and drop the oxygen concentration.

Q. What's normal oxygen penetration? What do you mean?
A. There have been CFD studies and studies done in the past which indicate that oxygen can penetrate several hundred metres behind the face in the maingate.

Q. What about the seals themselves, are they permeable to oxygen?
A. They're designed to be leak proof.

Q. In reality, though?
A. The seal will probably be leak proof because it's sprayed concrete, normally. There are chances of leakage through the coal around the seals.

Q. What about the amount of CO, albeit in some lesser amount, that was being produced at the 40-41 cut-through on the left of the goaf back in early April?
A. When the seal is built, there is normal air - as you build the seal, there is normal air either side. So, as you build the seal, there should be no more oxygen penetration from the active side. Then you're waiting for the oxygen to deplete. The longwall was also - that's at the point when - that seal would have been put on very quickly as the longwall was moving away, so there would be oxygen penetration everywhere into the goaf.

Q. So at the point in time when that happened, it would be reasonable to expect that the longwall was somewhere in close proximity to that seal?

A. Yes, it would be reasonable to assume that.

Q. Did you, though, also look at the levels of oxygen that were being detected in the tubes at those seals?
A. I did.

Q. And did you then compare that oxygen with the amount of CO that was being generated?
A. I did.

Q. And there are some graphs that show that. For example, this one, slide 23 - is this a graph that you generated that shows oxygen and CO at 40-41 cut-through seal?
A. It is.

Q. And the red is oxygen?
A. Correct.

Q. The blue carbon monoxide?
A. Correct.

Q. We see that for substantial periods back at the start and then towards the end, the amount of oxygen is somewhere in the vicinity of 21 per cent or thereabouts, which would be the equivalent of fresh air?
A. Fresh air. If you look at that graph, the first - you see a sudden drop in oxygen. That's about 19 March, when the longwall commenced operation.

Q. That's here (indicating)?
A. Yes.

Q. So there's a sudden drop in oxygen when the longwall commences. But, then, over here, commencing around about 3 May or just around the start of May, we see that the oxygen level goes back to fresh air level?
A. That's correct.

Q. Can you explain what's going on there?
A. I don't - my interpretation of that is that the sample was not representative of the goaf atmosphere.

Q. Because if it was representative of the goaf atmosphere, it's consistent with fresh air?
A. Yes, it's not fresh air - I don't expect the goaf atmosphere would be fresh air.

Q. No. So what happens here, though? If we go forward to about 10 May, and there's a drop but a corresponding rise in CO. What might explain that?
A. That was at the point when the mine had re-entered and they would have gone to check the tube bundle systems. If you correlate it across, the oxygen is very similar and the CO is slightly higher than it was before the explosion on 6 May.

Q. Is there a similar sort of activity shown here prior to the explosion? You've got drops in oxygen and small rises in CO?
A. Very, very small rises in CO. In my report, I identified issues with flow to the analysers, there were flow alarms, and that oxygen could be due to the flow alarms or to sampling from fresh air.

Q. We might jump forward a couple of slides, perhaps, because I've got them out of order. You've actually labelled a similar slide to that. I'm now looking at slide 27. You've identified, firstly, 8 April?
A. Yes, because that's when the CO drops.

Q. Can you assist us in terms of what might explain that?
A. From the data, no, I can't. It could be due to inertisation or another action taken at the time, but the CO drops.

Q. Inertisation involving what?
A. Nitrogen gas. They used nitrogen gas.

Q. Why would there be inertisation with nitrogen gas?
A. That's part of the process for stopping the oxygen ingress, but I didn't see a corresponding drop in the oxygen content. So there's an unknown action. I don't know what - I cannot explain why that occurred.

Q. Could the CO have dropped in response to some nitrogen, nitrogen injection?
A. I would have expected a drop in the oxygen as well, so it could have, but unlikely.

Q. On 18 April, you've identified a drop in oxygen.
A. So that is more likely at the point when nitrogen may have been introduced or a change in goaf drainage strategies.

Q. The CO increases.
A. Yes, well, the oxygen has been available for a number of days, and so the coal has reacted so it, so that's the CO that's coming off. And then later on, you'll see the CO drop away in response to the oxygen dropping.

Q. You've got a leak test identified on or about 27 April?
A. I identified that because the tube actually failed the leak test on the day of the test.

Q. What's the significance of that?
A. AS 2290 part 3 requires the tubes to be tested on a monthly basis for leaks. You take a sample of known gas underground and put it into the tube to determine if there's a leak outbye of your sample point, because that can dilute your sample. You're trying to establish that the sample you're analysing on the surface reflects the sample that's behind the seals.

Q. And it failed the leak test?
A. Yes.

Q. What does that tell us, then, about any of the data that precedes that point? Does it affect the reliability of it?
A. There is a small - it only just failed the leak test. It wasn't a massive failure. So it could mean that the oxygen would be overestimated and the CO underestimated.

Q. We'll come to the other goaf seals in a moment. Did you look at the Safegas system for the alarms that had been set?
A. Not every alarm, but I did investigate - oh, for some of the alarms that had been set, yes, I did.

Q. In relation to these goaf seals?
A. In particular for the oxygen alarm, that was one I was interested in, yes.

Q. What was the oxygen alarm set at?
A. Sorry, I remember 21.5 per cent.

Q. Which is fresh air?
A. Fresh air, yes.

Q. Is that how you would normally configure an oxygen alarm for a goaf tube bundle?
A. Not the normal way. You would normally mirror the - on a weekly or bi-weekly process, mirror the fall of the oxygen, because you're interested in oxygen ingress into the goaf.

Q. So what would be a normal level at which you would set an oxygen alarm?
A. It depends on what the normal level is for that seal. You're looking - ultimately, if you're looking around 22 April, you would probably have an alarm around 10 per cent, because that was below 10 per cent.

Q. Is there much point in having the alarm set at the equivalent of fresh air?
A. It's of no use in determining - if you've got the alarm set on fresh air, you will not get an alarm. And if you're reading fresh air, you're unlikely to get a methane alarm, carbon monoxide alarm or carbon dioxide alarm, because you're reading fresh air.

Q. Could we go back to slide 24. Is this the CO and oxygen for the B1 cut-through seal?
A. It is.

Q. It shows from early March through until roughly the end of April, a level of oxygen that's up or around the 20 per cent mark?
A. It does.

Q. But then it steeply falls away at the start of May?
A. It does.

Q. Is there a correlation between those levels of oxygen and the amount of carbon monoxide that we see reflected in the blue graph here?
A. The levels of carbon monoxide are very, very low. They're only 10 ppm.

Q. So what explains or what might explain the oxygen level dropping effectively vertically, as it does at the end of April?
A. Probably the use of inertisation.

Q. Again, that's nitrogen?
A. Nitrogen. Sorry, yes. I apologise.

Q. And is there anything significant about the level of carbon monoxide after that point?
A. Well, it's only showing around less than 5 ppm and there's no rising trend, which is a good thing.

Q. This is the 38 cut-through seal. Again, we've got that period where the level of oxygen is equivalent to fresh air, and that's between about 29 May [sic] and 12 May, but at the same time the level of CO is effectively zero. What does that tell you about what was happening with respect to that tube bundle during that period?
A. That was 29 April to around 10 or 11 May.

Q. Yes.
A. It's reading - it appears to be reading fresh air.

Q. Prior to that period on 29 April or thereabouts, does the data appear to be valid for the goaf atmosphere?
A. It does appear to be valid.

Q. But from 29 April onwards, there was no valid data coming out of the tube bundle for that goaf seal?
A. Not for that location, no.

Q. Now, did you calculate Graham's ratio for the various locations?
A. I did not calculate Graham's ratio. The calculation was done in Safegas.

Q. I beg your pardon, but you've output the data into a graph here for us?
A. Yes.

Q. We have the level 1 TARP of 0.3 for Graham's ratio depicted in this horizontal line?
A. Correct.

Q. Given what we know about the fluctuations or potential fluctuations in reliability of the data for those seals, how useful is this Graham's ratio data?
A. That data goes up where the Graham's ratio is over 0.3 to the - it falls below 0.3 on about 24 April, so it's reasonably reliable, I think. If you look at the B1 cut-through Graham's ratio, those readings were very, very low CO and oxygen close to fresh air, so you see a scatter, a scattergram.

Q. But the figure for Graham's ratio tracks markedly downwards from about 25 April or so?
A. It does.

Q. Through until the time of the incident?
A. It does.

Q. Did you look at the real-time Citect data for the goaf wells?
A. I did.

Q. This didn't involve the use of a gas chromatograph - gas chromatograph data?
A. No, I looked at the raw data from the goaf wells.

Q. In terms of analysis of the GC data, that's been done by your colleague Mr Muller?
A. That's correct, plus other gas chemists, yes.

Q. Just as a refresher to identify the various goaf wells, you understood that the goaf wells were drilled at roughly 25 metre intervals on the surface?
A. That's correct.

Q. You've got number 10 here. The horizontal line indicates the approximate location of the face as at the date of the incident?
A. It does.

Q. Goaf well number 10 - I'll just use the last two digits - was essentially, if not at the face, not far from it?
A. Correct.

Q. But 9.5 was 25 metres back; 9 was 50 metres back; 8.5, 75 metres back, and so forth?
A. Correct.

Q. Did you look at trends in that data over the period from 2 May through until 6 May?
A. I did.

THE CHAIRPERSON: Mr Hunter, since we're going on to the trends, we might have the morning break now, if that's convenient.

MR HUNTER: Of course.

THE CHAIRPERSON: We will adjourn until a quarter to 12.

SHORT ADJOURNMENT

THE CHAIRPERSON: Yes, thank you, Mr Hunter.

MR HUNTER: Thank you.

Q. Mr Watkinson, I've been asked to ask you if you would please endeavour to keep your voice up.
A. I'll try and move forward and do that.

Q. Thank you. The slide, which is slide 31 - and for those who are interested, it's 31 of 53 - depicts the four gas data from the goaf drainage well known as number 7?
A. That's hole number 7, and GMS15 identifies the goaf drainage skid that's on the well.

Q. The goaf drainage skid is a portable device that can be moved from well to well?
A. Correct.

Q. So here we can see the data from 2 May through until a couple of minutes after the incident occurred. We can see that the oxygen level seems to be sitting anywhere between, apart from that spike above 10, somewhere around the 8 to 6 per cent mark?
A. Correct.

Q. Is there anything significant about the trend that we see here in terms of the amount of carbon monoxide?
A. You can see an upward trend in carbon monoxide. It starts to change around 4 to 5 May, you could even say a step change. There's a couple of times it goes above 100 ppm but doesn't trigger the TARP.

Q. What's a step change?
A. If you look --

Q. You're talking about this area here (indicating)?
A. Yes, this area - not an immediate step. If you look between the 5th and the 6th, overall the data seems to be a step, a step upwards. Prior to that, it's running around 40 to 50 ppm, and there it's running around 70 to 80 ppm on average.

Q. What does that trend say, if anything, about the oxidation of coal that's occurring?
A. It would say there'd been a change in the oxidation pattern and maybe there's more oxidation happening, but that's only a raw CO value, of course.

Q. Can you explain what you mean by that?
A. Well, there are - you could have - if you're looking at a step change, there is also a drop in methane about the time of the step change, maybe towards the end of the 4th of the 5th, so that part of step change could be explained by dilution of methane as well.

Q. So if you used a methane free calculation, it might actually not be a step change at all?
A. Correct.

Q. That's not an exercise you did, though?
A. No.

Q. That's something Mr Muller has done?
A. Mr Muller looked at a couple of the wells in particular where he was asked, but I was looking at the raw data and the data that was available to the mine in normal analysis.

Q. The next slide is well 8?
A. Correct.

Q. This relates to the amount of flow from the well as well as the amount of carbon monoxide?
A. That's correct.

Q. Do we see anything about the data that's of significance here?
A. Yes, the goaf well was closed in about - on the 4th of the 5th. There's still a slight flow which can be determined, and you can see an increase in CO trend prior to the event, but again I don't think it triggers 130 ppm, which is the level 1 TARP, until the afternoon of the 6th of the 5th.

Q. And that's after the incident, you mean?
A. Yes.

Q. This is hole 8.5.

A. Correct.

Q. This would be, what, about 75 metres back from the face or thereabouts?
A. About there, yes.

Q. We can see that the oxygen levels again are somewhere between about 5 per cent, maybe 4 per cent, and 10 per cent, apart from that spike?
A. Correct.

Q. We can see a spike in CO at about the same time as that oxygen spike?
A. Correct.

Q. Is that an actual correlation or could they be completely independent events?
A. They could be independent events. I don't know what was the cause.

Q. What do you say, though, about the trend, if any, of carbon monoxide?
A. The trend is going upwards. If you look - I'm thinking just back to the data, when you look, the increase in CO correlates to a decrease in methane, so that could be again an advantage of looking at methane free CO in goaf wells. But it's an upward trend, a slightly upward trend. The absolute numbers are not very high.

Q. Does this exercise highlight the importance, for example, of using a methane free calculation when you're assessing this data?
A. I believe this is something we should be doing in the future, yes.

Q. At the time of the incident, was the Citect system set up to do a methane free calculation for CO?
A. I don't have that information. I've not seen it.

Q. Methane free calculations were not part of any of the suite of data that you were given?
A. Not - none of that - I was given raw gas data. That's all I was given.

Q. Hole 9. This is about 50 metres back from the face. What are we seeing, if anything, in terms of the trend for carbon monoxide?

A. There's a slight increase in carbon monoxide trend over the period.

Q. But, again, is there a trend downwards in the amount of methane, or was that after the explosion?
A. That's - no, from the middle of the 5th to the - there's a sudden change in methane and carbon monoxide, I don't know what the cause of that was, around the middle of the 5th of the 5th, midday.

Q. This is then hole 9.5, which is the closest operating well to the face at the time of the incident; correct?
A. That's correct.

Q. The data is a bit all over the place, but is there anything significant that we can see here? Can I ask you firstly about the amount of oxygen?
A. The oxygen is a concern. It's gone above 10 per cent about the time of the incident. Methane is dropping. If anything, carbon monoxide appears to be trending down.

Q. Why is the amount of oxygen a concern?
A. Well, it's up above 10 per cent, and looking at the graph it's probably 13, 14 per cent just immediately before - around the time of the incident, the explosion.

Q. That's around about 25 metres back from the face?
A. Yes.

Q. You've seen some of the methane free calculations that were done by Mr Muller; correct?
A. Correct.

Q. In fact, you reviewed his report as part of the peer review process; is that right?
A. That's correct.

Q. I'm just going to show you some of them. Just before we do that, are you satisfied with the methodology that Mr Muller employed in doing these calculations?
A. Yes, I am.

Q. Is there anything unusual or remarkable about doing a methane free calculation for carbon monoxide?
A. It's not common practice, but again in a methane rich environment it can give you some additional information to evaluate.

Q. This is the methane free calculation for hole number 8 that we were looking at earlier, so the effect of methane dilution had been taken out - yes?
A. That's correct.

Q. What does it show us in terms of the trend in the lead-up to the incident?
A. It shows a sudden increase in methane free CO, which is very similar to the absolute values in CO as well.

Q. So what does that tell you about what's going on in the vicinity of hole 8 in the goaf?
A. Well, it says that the gas is reporting to that location. There is indication of an increased activity.

Q. What sort of activity?
A. Spontaneous combustion activity, sorry.

Q. If we go to the next slide, which is methane free calculation at goaf hole 8.5. What do you say about what we see here?
A. Well, what you can see here is like a small step change. The reading is averaging around 100, and then it appears to be reading averaging around 150, and then you see the rapid increase around the time of the explosion.

Q. Again, what does that tell us about what was happening in the goaf in the vicinity of where this well was situated?
A. Again, with the gas that's reporting to it, it will be indicating increased activity or an increased level of activity, spontaneous combustion activity.

Q. This is hole 9?
A. That shows a similar graph again. It's not as clear, the step change, but the step change is there from around 100 to around an average of 150, but there is variability in the data.

Q. Can you just explain something for me. With the methane free calculation, let's say you've got an atmosphere that contains 80 per cent methane and you remove that 80 per cent from the calculation. If you're detecting 3 parts per million, say, 2 per cent - 3 parts per million carbon monoxide in that remaining 20 per cent, is the figure that you see exaggerated?

A. That is the danger of using that - you can exaggerate the final number. That's similar for air free samples or anything else you're doing. Again, you're down looking at the accuracies of the instrument.

Q. Let's say you've got 100 parts per million CO in that remaining 20 per cent. Is the figure reported, such as we see here, parts per million, or is it parts per 20 per cent of a million?
A. It's air free parts per million - oh, sorry, methane free parts per million. Again, I prefer to look at the long-term trends, so I try and look at the variability in the analysis and try to draw a line through where the average is and see if that is increasing or decreasing.

Q. My question is this, though: if you were going to take methane free CO, can you use the figure calculated and compare it to the TARP trigger values, or are the TARP trigger values inapplicable for methane free CO?
A. You would have to have a methane free CO TARP established.

Q. Again, tell me if I have this right: does the use of the methane free CO calculation take out any potential variability in the results because of fluctuations in the amount of methane?
A. That's the purpose, yes.

Q. So it enables you to look at a trend much more clearly?
A. Correct.

Q. Now can I ask you to have a look at some of the trends for the day of the incident itself. The first slide is for goaf hole number 10. You understood that because this was a new hole, it hadn't yet been connected to the Citect system?
A. That's correct.

Q. So the only data we have is from manually collected bag samples that were taken?
A. These aren't bag samples; these are analyses done by the field technicians with a hand-held instrument

Q. But again they're manually collected?
A. Manually collected, yes.

Q. But they showed that at 5 minutes to 3 on the morning of 6 May what was coming out of hole 10, which was the one that was either at the face or very close to it, was 17 per cent oxygen and 14 per cent methane?
A. That's correct.

Q. That would be in the explosive range, would it?
A. It would, yes.

Q. The data you've seen shows that that well was shut off?
A. Yes, they were in the process of trying to commission it or see if they could bring it online. I'd imagine they saw that data and then shut it in again.

Q. The next slide is for the first well back in the sequence, 9.5, and we can see a spike in the amount of CO at about the time of the incident, which we know was at 2.57 or 14:57, so about here, and we see at the same time as the spike in CO, we can see a drop in the amount of methane?
A. Correct.

Q. The amount of CO, though, only goes up to 35 parts per million?
A. Correct.

Q. The oxygen also, I should say, drops?
A. Correct.

Q. The drop in methane, drop in oxygen, consistent with them being consumed in the ignition?
A. That's what I would take, yes.

Q. And the CO is a product of the ignition?
A. And the CO2 as well.

Q. There's a spike in the CO2 at the bottom there?
A. Yes, where it flatlines, the data in the csv file was reading N/A, or not applicable, and I'm assuming that that was maxed out at 5 per cent.

Q. I see, okay. If we go back one hole, so this is 25 metres back, we see that at the time of the incident, the methane hits 500 parts per million?
A. CO, yes.

Q. It was 35 parts per million at 9.5, and 500 at hole 9?
A. Correct.

Q. It seems to flatline. Is there a limit --
A. There's a limit on that analyser at around 500 ppm. They sometimes will give a reading just above that, but it's 500 ppm.

Q. Have you seen that there is bag sample data that was taken, just fortuitously, a few minutes after the explosion that showed CO at over 1000 parts per million?
A. I am aware of that, yes.

Q. So we have that spike in CO, a drop in methane, a drop in oxygen and a rise in CO_2?
A. Correct.

Q. Can you explain, if you can, why we might see such markedly different outcomes at hole 9 as opposed to what we saw at hole 9.5, particularly in terms of the amount of CO reporting to the goaf well?
A. It's not my total area of expertise, but that would be due to the combustion process. For CO_2 to be produced would mean that there was more oxygen available, so the conversion process was to carbon dioxide, and here indicating a less efficient combustion process, because more CO was produced.

Q. A less efficient combustion process that reported to hole 9 than the one that reported to 9.5?
A. Yes. Again, it's not my direct area of expertise, but that's what it indicates to me.

Q. If we then go back 25 metres to hole 8.5, we see a similar series of events, but the CO is lower; it's at about 320, or thereabouts, parts per million?
A. That's correct.

Q. But there are concurrent drops in methane and a lesser drop in oxygen and a small bump in carbon dioxide?
A. That's correct.

Q. Going back to hole number 8, again the effects are even less pronounced, but there is a bump in carbon monoxide to about 250?
A. Correct.

Q. Is the little decrease in methane consistent with the combustion?
A. At this level, you would say yes. And that's a longer time scale as well for the period of the graph.

Q. But there's no particular impact upon oxygen or CO2?
A. Not discernible in the data, no.

Q. This is hole 7. The incident occurred at about this point here (indicating) where I'm holding the cursor.
A. Yes.

Q. There are some impacts in the hour or so after the event showing an increase in carbon monoxide?
A. That's correct.

Q. And a small decrease in oxygen, as well as a small decrease in methane?
A. Yes.

Q. Is that consistent with some level of combustion?
A. It would be, yes.

Q. Going further back again, 6.5, there are some indicators here consistent with combustion, including the rise in CO and the dip in methane?
A. Correct.

Q. But it's a bit hard to tell from the oxygen and the CO2?
A. It's very difficult to tell when - the further you get back in the goaf, the whole dynamics change.

Q. You undertook the exercise of calculating the combined CO make for the goaf wells and also the tube 26 located at 3-4 cut-through?
A. That's correct.

Q. In this graph, you've removed what would have been shown at the time of the explosion in this gap here, because the amount of CO produced would have completely dominated the graph and we wouldn't have been able to see what else was going on?
A. I was more interested in the long-term trends.

Q. So what do the trends show in terms of CO make, firstly for the 3-4 cut-through tube?

A. Well, if - the data for 3-4 cut-through, which is in the reddy-brown colour, pre the event, is the data as calculated in Safegas. If anything, you could pick a slightly downward trend over the period up to about 29 April and a slightly upward trend, but it would be difficult to pick in long-term trending.

The blue line is a combined - the dark blue line is a combined graph adding the average CO make per goaf well for all the goaf - I combined all the goaf wells. I calculated the average CO for the day, the average flow for the day, to give me an average CO make for the day, which I then combined to the Safegas data to draw that graph, and again it's not showing an upward trend per se.

Q. But when you look at what happened afterwards, and obviously we know there was an ignition event on I think 8 June --
A. 8 June.

Q. If we look at the data post the event, what does that show?
A. Well, there the yellow line is the Safegas line and the blue line is the combined line. Post the event, more and more goaf wells were shut in, and so the CO was not reporting to the goaf wells. It was reporting to 3-4 cut-through. You see a very similar trend to what was immediately before the first explosion. Other indicators were found of spontaneous combustion activity around 96 shield, so actions were taken, and you can see how late the carbon monoxide trend responds to that activity. It only starts to - and again you'd be looking maybe about early June to say, well, yes, it's starting to go away.

Q. So what do you say to this proposition: what do you say as to whether - let's say there was a small but intense area of heating in the area of the goaf perhaps just behind the shields, is that something that would be picked up in the CO make data?
A. Not likely, no.

Q. Where would you pick it up?
A. In the goaf stream, or even possibly the goaf wells.

Q. What would you be looking for would be, what, ethylene?
A. I'd be looking for ethylene, probably looking at

absolute values of CO, hydrogen, and other values, and seeing what - and trending things over time.

Q. Did you look at the data from the goaf stream?
A. Very briefly, I think I did.

Q. Did you identify that there were some bag samples - bag samples ought to have been taken at least once per shift, if not twice per shift?
A. Yes, I'm aware of that with reading Mr Muller's report.

Q. And some in fact weren't taken because of an apparent concern about the conditions in the roof of the tailgate?
A. There were adverse conditions at the time in the tailgate, yes.

Q. Now can I move to a separate topic, then, and that's testing for spontaneous combustion and PUR, and again can I reiterate that you understand testing is being undertaken by others, perhaps as we speak, but you went through the available information to consider the hypothesis that what might have occurred was that the polyurethane resin that was injected into the face may have triggered a spontaneous combustion event?
A. When I'd reviewed all the data, the last thing I did, I reviewed the spontaneous combustion testing reports in my report, and there it was identified that if you step-heat, or as Dr Beamish identified, if you - PUR could create a spontaneous combustion event. That's the only way he identified it could occur in the Goonyella Middle seam. The last thing I checked is the dates of PUR injection, and I found a correlation that they were very close to the date of the first explosion.

Q. You found in amongst the material some advice that Dr Beamish had given to the mine itself?
A. That's correct.

Q. Both in 2014 and in 2019?
A. That's correct.

Q. What we see on the page here is an extract from I think the first of those?
A. That's correct.

Q. Where Dr Beamish speaks of the coal coming into

contact with an external heat source?
A. That is correct.

Q. Just so we're clear about this, you're not suggesting that the PUR would take the coal all the way to the heat required for ignition, but, rather, it would initiate a self-heating?
A. That is a possibility, yes.

Q. You've included in your report, and we'll go to it over the page, an extract from Dr Beamish's 2014 report?
A. That is correct.

Q. This is figure 11 that you referred to on the previous page, where he said that if you step-heat the coal and then wait long enough, it will gradually heat in the logarithmic curve as depicted on this page?
A. That is correct.

Q. He went on in the 2019 report to describe it in these terms?
A. That's correct.

Q. As per this diagram?
A. Yes.

Q. This isn't yours; this is Dr Beamish's report?
A. That is correct.

Q. A report that was commissioned by and supplied to Grosvenor?
A. That is correct.

Q. This is figure 119 from your report, and it's the carbon monoxide readings for the 3-4 cut-through tube bundle from 15 to 21 April and we know that there was the injection of PUR, I forget the exact dates, but in the middle of that period. What does this data show?
A. That's showing me, using the terminology from us, a slight step in the CO, and that's absolute CO, not CO make. I was looking to see if there was any evidence of --

Q. Are you talking about this here (indicating)?
A. Yes. If you draw horizontally across there, the tailgate return is around 8 ppm as opposed to running between 5 to 6 ppm prior.

Q. So it's a small increase?
A. A small increase and not easy to pick unless you're looking for it.

Q. If we then go to your analysis for the 2nd to the 6th of May for the same parameter, that is, CO in the tailgate at 3-4 cut-through, what do we see?
A. I don't see the same sort of variation. There's a sudden peak, which I explained, on the 6th of the 5th - I think that's the time of the explosion, I think. Oh, no, that's the early in the morning one, when the - I've explained in my report, which was down to diesel vapours in the tailgate.

Q. Diesel in the tailgate - that's this spike that we see here?
A. Yes, I believe that's the one I refer to in the report where there was diesel activity.

Q. So taking that out of the equation, what do we see, though, in this area here?
A. There's a slight step, but it wouldn't be as easily discernible as the earlier one.

Q. You're not suggesting that the mine should have been looking at this data with this level of granularity, are you?
A. No. It's the benefit of hindsight to go back and look at it.

Q. In terms of identifying what actually was going on at the time the incident occurred?
A. Yes.

MR HUNTER: Those are the questions that I have.

THE CHAIRPERSON: Thank you. Yes, Mr Holt.

<EXAMINATION BY MR HOLT:

MR HOLT: Q. Good afternoon, Mr Watkinson. My name is Saul Holt. I'm one of the barristers for the Anglo companies, entities that have been given leave to appear in the Board of Inquiry. I just have a few questions for you.

You helped us with the meaning of particularly the

"spontaneous" aspect of spontaneous combustion earlier. You explained that "spontaneous" really meant unassisted in that context.
A. That is the correct way, yes.

Q. And the "combustion" component of that phrase spontaneous combustion, that relates to the end result of a process which results in the ignition of coal, doesn't it?
A. That's the very end process, yes.

Q. But the combustion, as the name suggests, is the ignition of the coal at that point, which follows a process?
A. Yes.

Q. What has happened to get to that point is that you have coal sitting underground at its ambient temperature, which you would accept would be normally about, what, 40, 45 degrees in this context?
A. It depends on the virgin rock temperature, but it's around that number.

Q. Around that kind of figure; right?
A. Yes.

Q. What happens, as you've indicated very clearly, thank you, in your report, is that even with coal at its ambient temperature and slightly above it, you're going to start seeing the effects of oxidation when oxygen is introduced to the coal?
A. You are.

Q. And the signs of oxidation that we see, in fact, because of the gas evolution testing that's happened a lot over the last 20 years, a lot of the gases that are produced when heat is applied are happening even at those very low ambient or tepid temperatures of coal - starting to happen?
A. There are temperatures determined in the gas evolution test, yes.

Q. The gases that start being liberated from the coal, effectively, even at those ambient and slightly above ambient temperatures - we can start seeing them, as our capacity to test has got better, at lower and lower temperatures?

A. There have been improvements in detection limits, yes.

Q. One of the examples you gave, which is probably the quintessential example, is hydrogen; right?
A. That's correct.

Q. Twenty years ago, you reasonably would have thought that any presence of hydrogen at all not only would indicate hot coal but even coal at 200, 220 degrees, something like that?
A. I can't answer the question on the temperature, but I remember that I was told hydrogen was bad.

Q. We now know, of course, that almost every sample from an underground coal mine will have hydrogen in it?
A. It will have 1 to 2 ppm, so there will be a level of hydrogen in every sample. There's probably 1 to 2 ppm in this room here.

Q. What you're talking about, when you talk in your report about the early signs of spontaneous combustion in that first 400 metre retreat of a longwall, as I think you kept explaining, which was very helpful, are signs of oxidation of coal?
A. Yes.

Q. The producing of gas from the process of oxidation of coal?
A. Correct.

Q. Coal typically ignites at about what kind of temperature?
A. I think it's around 600, but don't quote me on that.

Q. I was going to say the same. About 600 degrees Celsius is the point at which the actual combustion happens if coal has gone through that process to get to the point of spontaneous combustion?
A. Yes, correct.

Q. Ballpark?
A. Ballpark.

Q. But, as we've already discussed, the process of the oxidation can happen right down at 45 degrees and a little bit above 45 degrees?
A. The oxidation process is occurring all the time, yes.

Q. Absolutely. Then in between those two things, we have this notion of heating; right? We have coal that's heating, getting hotter from that oxidation process?
A. People have used different terminologies to try to differentiate heating and deep-seated oxidation and everything else, but it's --

Q. I understand. I know there are different phrases and terminology used, but let's see if we can get on the same page just for the purposes of the discussion.
A. Okay.

Q. It's right, isn't it, as I think you indicated, that coal at, say, 45 degrees oxidating as it does isn't necessarily going to shoot up to 600 degrees; there's a process that it's going to have to go through in between?
A. Yes.

Q. You used the phrase I think "take-off", and what's used sometimes is "runaway", the point at which coal gets to a particular temperature where, on its own, that process of oxidation is going to lead it upwards if it's not interfered with?
A. That's correct. There are a couple of points there.

Q. Yes, and what's generally considered to be one of the really important temperatures in that regard is 100 degrees Celsius?
A. Yes.

Q. The reason for that is probably obvious once we think it through, which is that that's the temperature at which water boils?
A. Correct.

Q. And, as a result, that's the point at which the moisture comes out of the coal, making it much easier, because the coal is drier, for that temperature to increase?
A. That's correct.

Q. Before that point, that kind of runaway point, in effect, you can see, and will see, a process of oxidation and signs of oxidation happening but in circumstances where it will then resolve itself or the coal will not continue to heat?

A. That can occur, yes.

Q. Indeed it does occur regularly; right?
A. That's a regular occurrence, yes.

Q. Indeed, the unusual thing, fortunately, is the temperature running away up to and past 100 degrees?
A. That's correct.

Q. Now, the heating process is simply that the heat generated by the oxidation process is exceeding any dissipation of that heat from the coal?
A. That's correct.

Q. And that dissipation can happen through convection, conduction or evaporation?
A. Correct.

Q. Again, as we've noted, when the heat generated by that oxidation process exceeds the dissipation of that heat, the generation can become self-sustaining?
A. Correct.

Q. And that's exactly what we're trying to avoid in spontaneous combustion management processes, systems and TARPs in an underground coal mine?
A. That is correct.

Q. Thank you. Again just to be absolutely clear, when we read your report and you talk about early signs of spontaneous combustion, what you're talking about are indicators of oxidation of coal?
A. Correct.

Q. You've helped us, and we'll talk a little bit more about this, to understand, firstly, the types of indicators that we might be looking for - Graham's ratio, CO/CO2 ratio, CO2 make - sorry, CO make, absolute CO?
A. Correct.

Q. And the extent to which to a greater or lesser extent it's possible to correlate the results of those different techniques with the likely range of temperature of the coal that we're trying to find out about?
A. That's the objective behind Graham's ratio and CO/CO2, yes.

Q. Absolutely, because, for example, Graham's ratio is generally thought to be, when it's operating validly, a pretty good measure of intensity of heating?
A. That's correct.

Q. And CO/CO2 of course again, based on the validity of the results, is showing heating and increase in temperature?
A. Yes, detecting those early stages.

Q. As you've noted and were taken through - I won't need to do it in detail because of the very thorough job that our learned friend Mr Hunter did - one of the primary ways in which spontaneous combustion risks are managed in a longwall coal mine is through the use of TARPs?
A. Well, the TARP - the controls are actually the things you put in place. The TARP is you're responding to see if your controls have been effective.

Q. You're exactly right, I am sorry. My language was imprecise. A TARP is an important response measure, as the name suggests or as the acronym suggests, to signals or signs of that oxidation that we've been talking about?
A. Yes.

Q. You'd know that one of the critical things associated with the development of a TARP in relation to spontaneous combustion is to establish what are called for those purposes "normal" levels of the indicators that you are interested in?
A. The key thing is what is normal at your mine in your conditions.

Q. You've jumped ahead and, thank you, that's saved me some time. One of the ways that's done, as Mr Hunter was asking you about, by competent coal mine operators is to have testing of their own coal done?
A. That's one of the things, yes.

Q. Also, I'm sure you'd agree, to bring in expert assistance when and as required?
A. You'd use expert assistance and, also, use long-term trending from your previous panels.

Q. And you did some of that in this, which was really cool, through 101 and 102, but particularly 103 and 104?
A. I looked at - I compared 103 to 104.

Q. In terms of these values that might represent normal in a particular coal mine, because of the conditions, because of the nature of the coal, because of the depth, because of mining techniques, everything else, "normal" could be an order of magnitude different, depending on what coal mine, region or area you're in?
A. Definitely, depending on the coal seam, definitely. Normal can be substantially different.

Q. Up to and including even more than an order of magnitude on some measures, which we'll come to?
A. It's possible, yes.

Q. Again, in terms of the kind of expert assistance that you would expect a competent coal mine operator to engage, someone like Dr Beamish would be an appropriate person to be doing some of these tests?
A. Correct.

Q. Mr Darren Brady, whom I'm sure you know?
A. Yes, I know Darren.

Q. A former Simtars person?
A. Correct.

Q. Again, the kind of person who you would want to be brought in to do a full review of a spontaneous combustion TARP?
A. Darren has done a lot of work on spontaneous combustion TARPs, yes.

Q. And the sort of person who it would be good to bring in to somewhere like Grosvenor to do that kind of work?
A. I always talk to Dr David Cliff a lot about spontaneous combustion.

Q. Excellent. In terms of, again, the TARPs, you've agreed - thank you; in fact you just volunteered it - that it's a site-specific exercise?
A. Yes, it has to be.

Q. And a balance in developing your spontaneous combustion TARPs is that you want to set levels, especially that "normal" question, the question of what's normal or not - you want to set a level that's meaningful so that it genuinely identifies abnormal situations; right?

A. That's correct.

Q. But at the same time that it's not set so low that it normalises alarms?
A. Yes, correct.

Q. You don't want to be in TARP 1 all the time, because then you just normalise the idea that it's not weird to be in TARP 1; right?
A. Yes. My take on that is we should have "normal", "not normal", and "evacuate".

Q. Absolutely. We see the three levels of the TARP process which were developed, as you will know, following the Moura No. 2 disaster?
A. Yes.

Q. Including by the expert panel that was set up following that horrific incident?
A. That's correct.

Q. And the kind of philosophy that underpins the TARP very much still resonates with the findings of that Inquiry, the way TARPs are set up, doesn't it?
A. It does.

Q. One of the key things that it does is to have these three levels - TARP 1, which is based around "We're just out of normal", so the idea in this is that we should be checking and validating the results that we're seeing; that's what we should be doing at TARP 1 level?
A. That's what's currently happening. I believe we should be taking action once we're not normal. If we accept we're not normal, we should be doing something about it.

Q. To be fair, that might be a recommendation for the future, which is entirely valid. But for present purposes, the way in which that level 1, 2, 3 TARP operates is that once you get into TARP 1, the focus of the way in which the system is intended to work is on confirmation of what's happening, increased intensity of sampling, type of sampling, those sorts of things?
A. That's normal in a level 1 TARP, yes.

Q. Then in level 2, on the standard structure, it's about implementing actions to control whatever situation the TARP

is indicating that the mine is in?
A. That's normal, yes.

Q. Then level 3, as you say, no longer an acceptable level of risk; everyone goes to the surface, because the surface is the only safe place to be?
A. That's correct.

Q. Again, you would want and expect, particularly given the continued development of knowledge around gas evolution testing and limits of detection, and so on, for there to be regular reviews of spontaneous combustion TARP levels?
A. I would also use real-time data from the gas analysis system at the coal mine.

Q. Absolutely, and you would expect that when you were doing those reviews and getting your experts in, and so on, they would be doing precisely that?
A. That's what I'd be doing as well.

Q. One of the things that you were asked a question about by our learned friend Mr Hunter was, again, the nature of the coal in any particular seam and, in essence, how reactive or unreactive it is - you'll understand that scale?
A. Yes, I do.

Q. If coal is very reactive, a particular kind of coal is very reactive, then it's more susceptible to that process of oxidation, heating and ultimately spontaneous combustion?
A. Are you talking about laboratory tests now?

Q. Yes, so applying what I think is - and you will know better than me - the R70?
A. The R70 is a test that's been used for numerous years for identifying the different reactivity of different coals.

Q. I know you know this as a matter of instinct, but just so I'm clear, what I'm trying to establish is that what that R70 test is attempting to identify is how reactive the coal is, that is, how easily it will heat and burn, effectively?
A. Yes, it's a test to compare coal against coal, yes.

Q. But for that parameter; right?

A. For that parameter, yes, exactly. For the parameter, yes.

Q. It's right, isn't it, that the coal at Grosvenor is, on the assessments you would have seen, very unreactive?
A. On the R70 test, yes.

Q. By way of example, the R70 level seems to be, depending on the test, anything between 0.02 and about 0.15, something like that?
A. Yes.

Q. In terms of black coal, some coals are up to 16 as a measure on the R70 test?
A. Some overseas coals are, yes.

Q. Victorian brown coal, just so we can give another example, is about 60, so much, much more reactive?
A. Very reactive.

Q. Again, thank you, you assisted us earlier with the various tests that might be used as indicators of oxidation of coal, and it's right, isn't it, that, as I noted before, the technology and testing that underpins those tests is being constantly reassessed by organisations like your own with new testing, new experimental data and new work being done?
A. There's new work being done. I know Dr Beamish is doing new work with his moist adiabatic test, and he's even doing a test with just using air as the - as a source. But he's been involved and reassessed - and detections - the detection abilities of GCs has improved over the years.

Q. But some of the key tests remain, and they all focus, effectively, on understanding what it is that the process of oxidation of coal produces from the coal; right?
A. Yes, looking for the gases that come off from the coal.

Q. CO is one of the main things?
A. It's an early indicator, and because it's easy to detect and we've got lots of good detection processes for that, yes.

Q. We've already talked about some of the others - hydrogen and ethylene as well?
A. Yes.

Q. There are others, but for present purposes --
A. There are others, yes.

Q. And the ratios that you've described - we've already talked a little bit about Graham's ratio. The essence of Graham's ratio is that it measures how much carbon monoxide you produce for how much oxygen you have used to produce that carbon monoxide?
A. That's correct.

Q. As that ratio increases, and it's expressed as a ratio, as it increases to 1, in essence, recognising the variability between coals and everything else, in essence, rule of thumb, the closer you get to 1, the closer you get to that 100 degree mark?
A. I don't know if 1 relates to the 100 degree mark. I don't know. But it's been valid for all coals that as it increases, you are increasing the reactivity; the intensity increases.

Q. The idea that 1 is about 100 degrees, that's just not something you're familiar with?
A. No. 2 is deemed as being an open fire, so --

Q. Yes, but it's not necessarily a --
A. So the key factor, as you've identified, is the 1 00 degrees Centigrade, because that's when all the moisture will be boiled off and the reactivity can occur very rapidly. The CO/CO2 ratio gives you an estimation of that.

THE CHAIRPERSON: Q. Mr Watkinson, please speak up.
A. Sorry. The 100 degrees Centigrade is a key figure in the spontaneous combustion reaction curve. Once you've got to that point, the moisture of the coal is being driven off, and the reaction can occur rapidly after that. That period can be very, very quick, dependent upon the nature of the coal involved.

MR HOLT: Q. Again, that's one of the reasons why it is so important to have site-specific analysis of the coals and so on that you're talking about, so you understand those processes?
A. Everything has got to be relevant to your coal mine, in your conditions, on the face you're on.

Q. Segueing from that, from Graham's ratio, then, into

the CO/CO2 ratio, you were asked some questions about the value in the TARP of 0.2.
A. It appears high.

Q. You were asked also some questions about what is described as a textbook value of 0.02.
A. Yes, that is from the textbook value and the testing, yes.

Q. A textbook value of 0.02 - tell me if you can't answer this question - if you applied that to longwalls 101, 102 and 103, you would have been in level 1 TARP for the entirety of the operation?
A. I can't answer that. I have a graph that showed the CO/CO2 ratio for the outbye end of the 3-4 cut-through. See, 0.02 is 60 degrees Centigrade.

Q. Let's go back to that. Are you familiar with some work that was done by Simtars in about 2006 that in fact had 0.02 at closer to 50 degrees?
A. Again, it's down to the accuracy of the equipment at the time, and the VRT at Grosvenor may be of that order, so you'd have to get an alarm that supports that level.

Q. I guess that's the point, isn't it?
A. Yes.

Q. As you say, it's an intensely site-specific exercise?
A. Very. You've got to look at your raw data, not rely on textbook data so much, but what is your raw data telling you is normal, and then you've got to detect a change from normal.

Q. In terms of ethylene, just briefly, the capacity for gas detection equipment, and I guess gas chromatographs in particular, to detect ethylene has got better and better and better over time?
A. It has.

Q. What, though, is currently the limit of reporting for Simtars on ethylene in terms of parts per million when it's --
A. I'm not sure of the limit of reporting.

Q. You gave a couple of examples of why you might find ethylene at very small levels in underground coal mine environments without it being an indication of heating.

A. Correct, yes.

Q. You would be aware also of work being done by Simtars on foreign bodies, like green timber, for example, underground in coal mines and whether that might itself be a source of very low levels of ethylene?
A. Correct.

Q. Now, you were taken through data from various sources by our learned friend Mr Hunter, and indeed you've set out the data from those various sources in your report, by which I mean real-time data underground, tube bundle data, real-time goaf skid data and then later there was some discussion of bag samples?
A. Correct.

Q. One of the things that Mr Hunter was pointing out to you was where in relation to a particular goaf well, for example, or a particular monitoring area on a cut-through there was a problem for a period of time with the data set that you were looking at?
A. There were data issues, yes.

Q. You see those data issues in underground coal mines, don't you; it's the nature of the environment at times?
A. It's the nature of the sampling and recording system, not necessarily the nature of the - I wouldn't expect there to be lots of data issues.

Q. But my point is the reason why, as we've seen, there are so many different data sources is that if the system is working, then even if there is an issue, for example, with a goaf well going offline, you've got other data sources that you can look at to identify trends and do cross-checking of particular data points?
A. Not from the goaf well. You've only got the twice-daily record. If a goaf well goes offline, you've only got the data that's done twice per day by the surface personnel.

Q. Exactly, but you have that to be able to do the comparison to?
A. It's not real-time data.

Q. But you've got other goaf wells as well potentially, the ones that are online, to look at too?
A. You've got the other ones, yes.

Q. You've got the real-time data from underground?
A. You do.

Q. Again, what that is allowing you to have, as I think we've seen, is effectively a suite of data where someone like you can look at it and go, "These are the weaknesses, these are the strengths, these are the trends"?
A. You could look at all the data overall, yes.

Q. If we just deal briefly with that real-time data underground, I think you were saying that for the purposes of spontaneous combustion assessment, it's the monitoring points where you're measuring all four gases - methane, oxygen, carbon monoxide and carbon dioxide - which are important from that perspective?
A. For spontaneous combustion, yes.

Q. Here that was the 3-4 cut-through?
A. Correct.

Q. Then we have the tube bundle data, which again literally, as you described, is taking the gas out from under the ground to allow it to be analysed on the surface?
A. Correct.

Q. The technique by which that is examined is twofold - firstly, using infrared for analysis of the methane, carbon monoxide and carbon dioxide?
A. That's correct.

Q. And paramagnetic analysis for the oxygen, that is, the O_2?
A. That's correct.

Q. Those kinds of tools for analysis are particularly good for trend analysis?
A. Very good.

Q. The goaf skids, as you've identified, taking real-time data from the goaf wells, flows into the Citect system?
A. Correct.

Q. Again, that has the four gases - others as well, but those four gases?
A. Those four gases, plus other parameters.

Q. As we see those outputs going forward, we can see that it also measures purity, flow, temperature and pressure?
A. It does.

Q. The bag samples - I know your analysis wasn't particular to this, but the bag samples, as Mr Hunter noted, are literally bag samples taken in a bag that looks a bit like a wine bladder?
A. It actually is a wine bladder.

Q. It is a wine bladder, there you go. Analysed through a gas chromatograph?
A. That's correct.

Q. The advantage is that it also allows you to look at other gases apart from those four, and other compounds, particularly hydrogen, ethylene and ethane, in this context?
A. And nitrogen and helium as well.

Q. That data set that's coming in from those different locations is available on site in the control room through different skids, different kinds of software, different kinds of analysis packages?
A. That's correct, yes.

Q. There's Citect, which you've already discussed?
A. Correct.

Q. There's Safegas?
A. Correct.

Q. Safegas I think, as you noted, collects the data and manages alarms in particular?
A. Correct.

Q. Safegas is a Simtars system?
A. Correct.

Q. There's Segas?
A. Correct.

Q. That is an analytical package?
A. Correct.

Q. Again, that's provided by Simtars?
A. Correct.

Q. And again with both of those, I should have said, with the Safegas, the training is also provided by Simtars?
A. That is correct.

Q. There's also EzGas?
A. Correct.

Q. EzGas is effectively a software wizard to allow the onsite analysis of the gas chromatographic data?
A. That is correct.

Q. Because you guys have fancy chemists and stuff, as we've seen in this case, who are looking at all the gas chromatograph lines and the peaks and everything else and figuring them out?
A. Yes, they do.

Q. That's what Mr Muller talks about a lot in his report, that process?
A. Yes, we had a look at all the data. He'll talk in detail. He'll reprocess the data.

Q. The reprocessing, that's it. That involved chemists actually looking at the outputs of the gas chromatograph and using their expertise to be able to identify little peaks and the timings and everything else?
A. That's correct.

Q. But on site, using EzGas allows people with training from Simtars but who are in the control room to see the results of the gas chromatograph on site?
A. That's correct.

Q. So things like identification of the peaks and so on is happening effectively on an automated or semi-automated basis?
A. No, the process is they're supposed to zoom and check for peaks. That's the training.

Q. I understand, but it's intended to simplify that process quite dramatically?
A. Yes, the software should integrate the peaks, and you zoom the graph to ensure that the integration occurred.

Q. Mr Muller's report deals with, as we've noted, that process of chemists at Simtars looking at that gas

chromatographic data afresh?
A. What do you mean "fresh"?

Q. Afresh, so actually looking at the data again and analysing it themselves?
A. Yes, they looked at each individual chromatograph to identify what had been - if anything had been missed.

Q. But for the purposes of your report, you were effectively looking at data that came out of those systems almost as the mine would have seen it?
A. Correct.

Q. As the mine workers would have seen it --
A. Correct.

Q. Can we please pull up a PowerPoint that you did for the purposes of this Board of Inquiry, which is at RSH.019.001.0583. Could we please go to 0591, Mr Operator. In this PowerPoint, you pulled out verbatim some of the conclusions from your report?
A. Correct.

Q. I will read this one:

> *There were signs of the early onset of spontaneous combustion activity on both longwall 103 and longwall 104 in the first 400 metres of retreat. This is common as this is the process when the longwall goaf is forming and stabilising and full [subsidence] starts to occur once the longwall has gone through "square". That is when the longwall has retreated a greater distance that it is wide.*

A. That's correct.

Q. Again, as we discussed at the outset of this session, signs of the early onset of spontaneous combustion activity relates to the work that you've taken us a bit through with Mr Hunter of identifying signs of oxidation of coal?
A. Correct.

Q. You've identified that the patterns that you saw in longwall 104, in effect, were similar to the patterns that you'd seen on 103?

A. That's correct.

Q. And they were common, from your experience; they were not a pattern that was anything other than something that you would expect in that first 400 metres of longwall retreat?
A. It can vary from mine to mine. I just compared 103 with 104.

Q. But you describe that as being --
A. It is a common process. We'll expect early signs of oxidation, and then as the oxygen reduces, the absolute value of CO will decline.

Q. Can we then go to page 0594 in that PowerPoint presentation. As well as having made that conclusion, you then noted:

> *There was no evidence of the spontaneous combustion activity ...*

That is, the signs of oxidation; right?
A. Yes.

Q.
> *... accelerating prior to the first explosion.*

A. Correct.

Q. But we saw - and one of the last sides you were shown showed it graphically - clear signs of that acceleration before the second incident, in June?
A. Correct.

Q. I just want to see if we can deal with this aspect of it reasonably briefly. In your report, you go through a number of the data sources that you've identified, and in the course of your conclusion you identify a series of numbered subconclusions, effectively?
A. Yes.

Q. A number of those, as Mr Hunter has taken you to, involved you looking at data sets and identifying these signs of oxidation that you've been talking about?
A. Yes.

Q. That you've described in your report as being, effectively, common, not unexpected in that first 400 metres of progression of the longwall?
A. In the early start of a longwall, I expect some signs of spontaneous combustion activity.

Q. And, effectively, the signs that you saw, which you describe in more detail in your report, are all signs which are consistent with that description, that is, of being common in the first 400 metres retreat of a longwall?
A. Longwall 103 is very similar to longwall 104, so that's my comparison for normal for that mine.

Q. And both didn't show you anything that, in your vast experience, was out of the ordinary?
A. It showed normal - it showed an - what I would expect, an oxidation process occurring and an oxidation process declining.

Q. Then in terms of the absence of any evidence of acceleration of that oxidation activity, again even though your report, very properly, goes through all of those data sets, presents all the graphs and so on, your conclusion remains that there were no signs of acceleration prior to --
A. There was no signs of acceleration, no.

Q. Can I just deal, then, with a couple of very specific issues. The first is if we could go, please, to your first report, WMA.001.002.0009. Might we go, please, to 0104 of that report, and might we call out, please, number 4 at the top of the page. This is one of that series of numbered subconclusions that you and I spoke about a moment ago?
A. Yes.

Q. I just want to be clear, you note here:

The maximum Graham's ratio seen on the tube bundle system at 0.72 at longwall 104 B1 cut-through seal on 30 March 2020 prior to the first explosion.

A. That's correct.

Q. Just while we're talking about Graham's ratio, in terms of the validity of an output of the application of Graham's ratio, it's right, isn't it, that to be valid, the

oxygen deficiency needs to have a value of at least 0.2; that's generally accepted?
A. 0.2 or 0.3, yes.

Q. So if it's less than that, essentially, we start seeing - I think maybe Mr Muller or maybe you describe it this way - gross errors?
A. Yes, in Safegas it's normally determined as invalid.

Q. If I suggested to you that the 0.72 Graham's ratio, the one that's identified as the highest, had an oxygen deficiency calculation for that sample of 0.078, that would make it an invalid sample - an invalid result?
A. Yes, if you look at the graphs at that period in time, there's very, very low CO and high oxygen, so those are unreliable. In fact, I said that earlier.

Q. It's just that one --
A. Yes, it's just - all I did was I looked at: that was the data, that's what's reported.

Q. Exactly, and so I'm just trying to link the very proper caution that you indicate needs to be exercised with Graham's ratio figures to that very number.
A. Yes.

Q. And it would be identified, effectively, as invalid?
A. Yes.

Q. You identify in your report, and indeed it was referred to you by Mr Hunter, what you describe as products of combustion found post event in some of the goaf wells?
A. Yes, there was carbon monoxide and carbon dioxide, yes.

Q. We looked at some of those graphs with Mr Hunter earlier, where we saw the big spike of carbon monoxide occurring --
A. Yes.

Q. -- at or around the time of the incident on 6 May?
A. Yes.

Q. In terms of those, you described those as products of combustion. Equally - and please just give whatever answer you need to on this - equally, on the assumption that there was, as we know, effectively a methane-generated explosion

in the longwall --
A. Correct.

Q. -- the heat and flame generated by that in the vicinity of coal would be likely, would it not, to pyrolyse the coal and, as a result, to create some products that would look the same, effectively, such as CO, that might report to the goaf wells?
A. Yes, any heat on the coal at those hot temperatures from a methane ignition would - and there could be small particles of coal burnt within the combustion process, because that dust would be raised.

Q. Exactly. I guess the point out of all of that is the presence of products of combustion, like CO, in a spike like that at the point of or immediately following a methane explosion underground may well simply be consistent with the methane explosion heating the coal?
A. It could be. I just looked at the data.

Q. I understand. Thank you. Can we then finally go, please, to Mr Hunter's PowerPoint. I'm sorry, I don't have a number for this one, but I'm sure you have it. Could we go, please, as an example - it's noted as page 31 in the bottom right-hand corner, Mr Operator. As we're getting to that, when you're looking at data sets such as these, you're looking for a number of things, but you're looking for absolute values - yes?
A. Correct, yes.

Q. And you're also looking for trends; right?
A. Trends is the important thing.

Q. Well, trends is the important thing, but absolute values are important as well, particularly for CO; right?
A. Well, you trigger a TARP normally on an absolute value. You can trigger on rates of change, but that's complex calculations.

Q. I understand, but it's something one should definitely consider; right?
A. Yes, if you're looking at - you're looking for changes, a change from normal, that's where the trend is useful.

Q. Sure. But if you want to work out, as we are in this process, what was actually going on, then as we understand

it - not "as we understand it" - if we assume that spontaneous combustion occurred here, we assume that as the theory is put, we know that methane ignites only at 550 degrees?
A. 540, yes, thereabouts.

Q. 540, 550 degrees. Understanding what the data is telling us about the temperature of any event or oxidation process or anything that was going on is important; right?
A. Correct.

Q. If we look just by way of example at page 31, Mr Hunter was taking you to graphs like this and identifying rates of change or trends?
A. Yes, we were looking at the increase in CO.

Q. You made the point, I think, that when you're looking at trends, it's also important to be very conscious of the scale of the graph you're looking at, that is, you want to see the trends over a long term?
A. Yes, the careful thing is the longer the term, the better it is. And also, you have to be careful of the Y axis, because that can exaggerate things as well.

Q. Absolutely. And when you zoom in on just a particular area or piece of time like this, you can see what look like the Himalayas, but when you look at it over a reasonable period of time, that doesn't actually necessarily happen?
A. Long-term trends are important.

Q. In addition, here, for example, absolute values are important as well; right?
A. Yes.

Q. And here, if we look at the right-hand side, we can see carbon monoxide in parts per million?
A. Correct.

Q. And there, as you've noted previously, we can see 100 parts per million, which is the level 1 TARP trigger mostly? On one of the TARPs, it's 130?
A. It's 130 on the goaf wells, I believe.

Q. On the goaf wells, and 100 on the others?
A. Yes.

Q. Again, quite apart from the trend that we see there,

what we're seeing in terms of absolute CO are levels that are sitting within normal for that mine as assessed?
A. Yes.

MR HUNTER: Thank you. That's the cross-examination.

THE CHAIRPERSON: Mr Crawshaw?

MR CRAWSHAW: No questions, thank you, Mr Chair.

THE CHAIRPERSON: Ms Grant?

MS GRANT: No questions.

THE CHAIRPERSON: Mr Trost?

MR TROST: No questions, Mr Martin.

THE CHAIRPERSON: Mr O'Brien?

MR O'BRIEN: No questions.

THE CHAIRPERSON: Ms Holliday?

<EXAMINATION BY MS HOLLIDAY:

MS HOLLIDAY: Q. I have only one question, so I will be finished by lunchtime. It concerns nitrogen inertisation and, more particularly, what effect it has on ratios. If I could focus firstly on Graham's ratio?
A. Depending on the calculation you're doing, it can create an underestimation of the absolute value of Graham's ratio.

Q. So it affects the reliability, then, of Graham's ratio?
A. It affects the absolute value when you're looking at absolute values, yes.

Q. Should that be taken into account, for example, in relation to TARPs if you are using nitrogen inertisation?
A. Yes, it should.

MS HOLLIDAY: I have no other questions, thank you, Mr Martin.

THE CHAIRPERSON: All right. Mr Clough does have some questions, so we will take the luncheon break and be back at 2.15.

LUNCHEON ADJOURNMENT

<EXAMINATION BY MR HUNTER:

MR HUNTER: Q. You were asked some questions about the idea that there was a flame that propagated on the face, if I recall the way it was put to you, and I want to ask you about that in the context of what we can see reported to the two closest goaf wells to that point, so 9.5 and 9.

It might help if we went back to the PowerPoint, please, in particular to slide numbers 41 and 42. Do you see that? You might recall that I was asking you some questions about the difference between what reported to this goaf well, which was CO at a maximum of a bit over 35 parts per million, and what reported to the next well, which is number 9 - if we could go to the next slide, please, Mr Operator - where what reported was, at least on that data, 500 ppm and we know from a bag sample over 1000 ppm.

I'm just wondering whether there is a plausible explanation for a scenario whereby there was an initiation of the event at or close to the face and it propagated back into the goaf, with the result that more products of coal combustion reported to goaf hole 9 50 metres from the face and fewer to 9.5, about 20 metres from the face?
A. That's a very good question. You would have to look at all the goaf dynamics with the effects of the negative pressures from the goaf wells, explosion propagation. An explosion propagates in all directions from the source of ignition, and the variety on that will depend on the gas concentrations.

The further into the goaf you go, the more methane there is and there's less oxygen. As you come on to the face, there is more oxygen and less methane. The explosive ranges of methane are well known, but 12 per cent oxygen, there or thereabouts, is the acknowledged nose point - that's the lowest point that oxygen will propagate an explosion.

So, I mean, as I was asked earlier, there could have been products - the heat from the flame will obviously combust the methane. Any coal dust which is lifting into that flame will be combusted as part of that process as well, and there will be other gases emitted from the coal, and the products of combustion are from both coal and methane at that time.

Q. Does the combustion of methane produce CO?
A. It would tend to be in a low oxygen atmosphere, but, I mean, in normal combustion it's carbon dioxide plus water in full combustion.

Q. But combustion of coal will give you CO?
A. Yes, it - open flame will give you more CO2, but there will be a larger proportion of CO, yes.

Q. So the high levels of CO reporting to well 9 would suggest that there was greater combustion of coal in the vicinity of that well, as opposed to 9.5, where there were relatively low levels of CO?
A. Yes, and again dependent on the oxygen concentration for what the combustion process was there at that time.

Q. Do the data from those two wells tell us anything about where the ignition occurred?
A. On their own, no. You'd have to use other parameters and even look at investigating CFD, computer fluidised dynamics, of the goaf well and put all the parameters in. I can only go from the data we have, as the gases reported, and my original analysis - the explosion will radiate in all directions from the point of ignition, and it will cease when it runs out of oxygen or fuel.

MR HUNTER: That's the only question I have in re-examination.

THE CHAIRPERSON: Yes. Mr Clough.

MR CLOUGH: Q. Mr Watkinson, I have a couple of questions. You spoke a number of times about how trends are often more important than absolute TARP levels or triggers. Did I hear you correctly on that?
A. That is correct.

Q. So is there actually an issue at mine site level where TARPs are actually based on absolute values, and is it realistic that a control room operator would examine trends?

A. It's not realistic that a control room operator would be looking at trends all the time. He'd need an absolute number to look at. Some mines only have one control room operator, so he's not only got the gas monitoring data to look at, but he's also looking at the remainder of the mine operational parameters, so he's very, very busy, and as already identified, he also has to run the gas chromatograph data as well.

Q. So again the question, is it realistic that a site would actually be examining trends, or would that be a job that somebody external to the site would do?
A. I would envisage it's a job that the ventilation officer or someone under his command would do, not necessarily the control room operator.

Q. The second question is in relation to the practice of setting TARP levels based on historical performance from previous longwalls, particularly establishing what is normal. We had a conversation about that, I believe.
A. Yes, that's correct.

Q. So how do we actually know if the historical trends are actually anywhere near a thermal runaway event? Just because the previous longwalls have had a certain gas emission rate, is there any way to know what the factor of safety is between the previous longwall performance and an accelerated heating?
A. No, that's the problem. What is normal at the mine might be abnormal in the context of spontaneous combustion activity. That sort of shows in the CO make graph. When I drew that, for a period of time, I relied on CO make. That was what we were asked to do in the first approved standard that came out from the regulator in 1997. But when you look at that graph, there's a very discernible difference, so you'd have to react very, very quickly to a change.

Q. Do you have any suggestions on perhaps a better methodology of establishing what's normal?
A. It's got to be mine specific. The problem comes when you're in a - I think as our mines have got deeper, their "normal" has become more high up on the activity curve. An example of that is when I was at Moranbah North in the early days, we had a very, very low CO make trigger, and I can't remember the absolute number, but I believe it was low.

I was at 5 South when we sealed - at North Goonyella when we sealed 5 South in, and the trigger level there was 20 litres make, which was a direct derivation from the Moura No. 2 data. As we're going deeper, our CO make appears to be increasing. So the key thing is to detect a change from "normal", which could be other parameters which you need to investigate. There could be other ratios which need to be - as we now have all this data to analyse. I don't know which one will show the best data. The appearance of ethylene could be one.

Q. So correct me if I'm wrong, what I've heard is that the deeper we go, the more difficult it is to establish TARPs?
A. No, it's not just in relation to depth. I'm just giving you an example of the Goonyella Middle seam. If you look at - personal experience, Moranbah North, longwall 101, we had zero seamgas. We measured seamgas in parts per million on our gas chromatograph. I had higher levels of oxygen in the goaf, and we didn't have a spontaneous combustion.

Q. The next question. We spoke about the CO/CO2 ratio within the active goaf spontaneous combustion TARP. Did you analyse the data up to the event on 8 June, the gas trends data?
A. I can't remember whether I did or not, sorry. In the graphs, I think I looked at the CO - I looked definitely at the CO make. I'd have to look at my report.

Q. So you're not aware of whether the CO/CO2 ratio in the TARPs was triggered before the event on 8 June?
A. I don't recall drawing the graph. Again, when I looked at the CO make, I used the - the reason I looked at the CO make up to 8 June was because I derived the total CO make for the longwall panel using the data from the goaf wells, and I was looking to see if there was any difference in it. That's all I did. The focus of our inquiry was primarily on event number one.

Q. Mr Holt mentioned that heat can cause pyrolysis of coal and create gas products that resemble those that were measured in the goaf well, so I'm just seeking your opinion on how likely it is that a methane ignition confined to the longwall face would create pyrolysis of coal some 25 to 50 metres back into the goaf.

A. Any methane explosion will go in all directions, and it's more likely that with oxygen concentration in the goaf, the explosion went back into the - either started in the goaf or went back into the goaf.

Q. So potentially there was an ignition of gas at the bottom of those wells or close to the bottom of those wells?
A. There was an ignition of methane somewhere and it travelled in all directions. Where it initiated from, I'm not sure.

Q. I'm not asking where it initiated from but whether or not it potentially propagated back to around the base of those wells?
A. I would say the first two or three wells, yes, and then the pressure wave would push the gases back into the goaf, further in.

Q. I have just one last question, and it's in relation to the interaction of the goaf wells with the longwall return. Is it possible that a small heating around the base of a goaf well that most, if not all, of the evolved gases could actually be drawn up the goaf well and not report to the goaf stream and the longwall return?
A. That's quite possible, yes, with a vacuum pressure on the goaf wells.

MR CLOUGH: I have no more questions, Mr Martin.

THE CHAIRPERSON: Yes, thank you. Mr Hunter?

MR HUNTER: Might Mr Watkinson stand down? There is some possibility that he might be required to return later in this schedule of hearings.

THE CHAIRPERSON: All right. Mr Watkinson, thank you. I won't excuse you at this stage. You may be back, it sounds, but we'll see.

<THE WITNESS WITHDREW

MR HUNTER: The next witness is Mr Sean Muller. He was to be called after lunch tomorrow, but given that we've moved at a pace faster than anticipated, he has been arranged for 10 o'clock tomorrow.

THE CHAIRPERSON: Yes, thank you. We will adjourn and resume at 10 o'clock tomorrow.

AT 2.28PM THE BOARD OF INQUIRY WAS ADJOURNED TO THURSDAY, 18 MARCH 2021 AT 10AM

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