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 Friday, 9 April 2021 at 11am
(Day 25)

Transcript produced by Epiq

THE CHAIRPERSON: Yes, Ms O'Gorman?

MS O'GORMAN: Mr Martin, the witness to give evidence this morning is Mr James Munday.

THE CHAIRPERSON: Mr Munday, can you hear me?

THE WITNESS: I can, sir.

<JAMES WILLIAM MUNDAY, affirmed: [11.05am]

<EXAMINATION BY MS O'GORMAN

MS O'GORMAN: Q. Mr Munday, could you tell the hearing your full name?
A. James William Munday.

Q. Are you a senior investigator with Fire Forensics Pty Ltd?
A. Yes, I am.

MS O'GORMAN: Mr Martin, there's some feedback, and I'm not sure whether that's occasioned because of the microphone on Mr Munday's end.

THE CHAIRPERSON: Mr Munday's?

MS O'GORMAN: Perhaps on his end of the feed, I might just have to check with my solicitor. I'm not sure that there's anything we can do about it. We might just have to press on.

THE CHAIRPERSON: All right.

Q. Mr Munday, can you hear Ms O'Gorman okay?
A. Yes, I can hear everybody very well. I've just turned my speakers down in case they're interfering with the microphone at this end.

THE CHAIRPERSON: All right, thank you.

MS O'GORMAN: Q. Mr Munday, you're a consultant forensic scientist specialising in the investigation of fire and explosions?
A. Yes.

Q. And you hold a degree equivalent in chemistry as well

as a diploma in fire investigation?
A. Yes, I have what's effectively a postgraduate diploma in fire investigation.

Q. You obtained that in the mid-1990s?
A. I did.

Q. You've worked in the profession of fire and explosion investigations for some 40 years now?
A. Yes, since 1979.

Q. And in 2007 you were made a Fellow of the Forensic Science Society, now known as The Chartered Society of Forensic Scientists?
A. Yes, I was.

Q. And that was done in recognition of your extensive casework experience, your contribution to research and development in the area, peer recognition of you and your extensive qualifications in this area?
A. Yes.

Q. You've been asked to provide the Board with some information related to methane explosions generally and your opinions about how the two pressure waves and the flame front observed by the workers on the longwall face at Grosvenor mine on 6 May 2020 might have occurred?
A. Yes, I was provided with a quantity of documentary evidence, photographic evidence, which I've considered.

Q. And you have arranged to have prepared a PowerPoint presentation to assist in providing your evidence this morning?
A. Yes.

MS O'GORMAN: I might just ask that that be pulled up on the screen. Mr Martin, this hasn't yet been provided to the parties, but it will be uploaded after Mr Munday has given his evidence this morning.

Q. Mr Munday, are you able to see the PowerPoint on your computer?
A. Yes, I can.

Q. Can we start with some explanation, please, of the characteristics of methane?
A. Yes. If we go to the next page of the PowerPoint,

methane gas is a colourless and odourless gas. It's a hydrocarbon. It's the simplest of the hydrocarbon gases, in that it has the smallest molecule. It's less dense than air, so it will tend to rise through the air.

It occurs naturally in coal seams and other natural environments, and the particular characteristics which are of importance in this inquiry - it's flammable and can be explosive when it's mixed with air at concentrations between approximately 5 and 15 per cent.

Q. Why is it that at concentrations lower than the lower explosive limit it will not ignite?
A. The 5 per cent is referred to as the lower explosive limit, or sometimes called the lower flammability limit. Below 5 per cent there's not enough gas to sustain a reaction with the air, with the oxygen from the air, so the reaction won't proceed beyond the ignition source.

Q. What about when it's present in air at concentrations above 15 per cent, or the upper explosive limit?
A. Yes, above the upper explosive limit, there's actually too much gas, if you like, it's too rich. So we often refer to these as lean, below 5 per cent, or rich, above 15 per cent, and at that point there's actually too much gas for the amount of oxygen available to react with it.

Q. Is it the case that significant changes in either temperature or pressure of the gas-air mixture can result in a variation to the lower explosive limit and the higher, upper explosive limit?
A. Yes, that can be the case. For example, if the gas is compressed - sorry, if the atmospheric pressure is increased, that will change the lower explosive limit, it will actually decrease the lower explosive limit, and also major variations in temperature will affect the explosive limit. They will be well outside the sort of temperatures at which human activity would be going on.

Q. You've just mentioned there the temperature. What about pressure - are you aware that Grosvenor was mining at a depth below surface of approximately 300 to 400 metres?
A. Yes, I understood that to be the case. The pressure, atmospheric pressure, at 300, 400 metres below the surface wouldn't make a great difference to the explosive limits.

Q. So for the purposes of your evidence, is it the case

that the lower explosive limit and the upper explosive limit will in fact approximate 5 to 15 per cent?
A. Yes, I think in this particular case, they would be pretty close values.

Q. Thank you. Can we talk about the causes of methane ignition, then, because we've talked about the lower explosive limit and the upper explosive limit. When methane is present between those explosive limits, can you explain for us the circumstances in which an ignition might occur?
A. Certainly. If in some way the gas-air mixture became heated to the autoignition temperature of methane, which is 540 degrees Celsius, so say, for example, there was a quantity of methane and air in a container which was then placed into a furnace or oven and heated up, when it got to 540 degrees Celsius the reaction would start and the explosion would occur or the ignition would occur.

Alternatively, if it was a hot surface, so, for example, something like an engine turbocharger, which can run at a temperature of about 540 degrees Celsius, if some methane and air mixture came into contact with that surface, then it could ignite. But most probably it's when there's an external ignition source or an introduced ignition source, such as a flame or a spark, that comes into the explosive mixture.

Q. In respect of that first scenario, the heating to the autoignition temperature of 540 degrees Celsius, is it the case that if the methane-air mixture is heated to or above that temperature, it may well ignite regardless of whether there's an external ignition source present?
A. Yes, it would.

Q. It would ignite. All right.
A. If it were within its explosive range or its flammable range and it were heated to that temperature, then it would ignite.

Q. In respect of the third scenario, that is, the presence of an external ignition source, can you give us an idea of the minimum energy that might be required to ignite methane present within its explosive limits?
A. Certainly. Within the limits, energy which is required to ignite a mixture is very small, it would be less than 10 millijoules. So it could be a flame - a flame

supplies a great deal more than 10 millijoules. A small electrical spark would be a competent or a viable ignition source.

Q. When you were first explaining the amount of energy, I couldn't quite capture what you said. Did you say 10 millijoules?
A. Yes, less than 10 millijoules. You need slightly more energy when it's close to the lower or upper explosive limit. When it's almost in the middle, when it's around about 9.5 to 10 per cent methane in air, that's when you need the least amount of energy to ignite it, and at that point it's around 5 millijoules.

Q. A spark from static electricity, would that be sufficient? Is that the sort of energy that you're talking about?
A. Yes, it can be ignited by a static discharge, yes.

Q. Can we talk about, then, what happens initially when methane ignites. What's the first thing that will occur once ignition has taken place?
A. So the first thing that occurs is that a flame front, or sometimes called combustion zone, forms immediately around the ignition source, so that's where the reaction is occurring, and that expands outwards through the surrounding gas-air mixture, as long as there is fuel around it. Now, the reason it expands outwards is because as the gas burns in the air, it produces combustion products, which are carbon dioxide and water vapour, which are hot because of the combustion reaction, and they expand and they force the flame front outwards from the point of ignition.

So the flame front initially proceeds in a spherical manner, but after a very short time due to surface variations in the flame, the combustion zone, due to minute changes in the atmosphere, even things like specks of dust in the atmosphere can have a profound effect, so what happens is that that spherical appearance starts to become turbulent, it becomes - it takes on a wrinkly surface and starts to become turbulent and starts to, at the reaction zone there will be small rotations or turbulence which draws more air into that mixture and accelerates the combustion.

Q. We'll talk on the next - I'm sorry, I was simply going

to say we will talk on the next slide about the speed at which that might occur. Before we move to that, you've indicated on this slide that there are essentially two types of methane explosions - deflagration and detonation. Can you explain for us what a deflagration is, please?
A. Well, a deflagration is a combustion reaction in which the flame front is moving through the gas-air mixture at less than the speed of sound, whereas a detonation - in a detonation, the reaction proceeds through the fuel mixture or the fuel-air mixture faster than the speed of sound.

Q. The phrases "deflagration" and "detonation" are not used uniquely in respect of methane explosions, are they? They can be used to describe other gas explosions?
A. They can, in all sorts of fuels, not just gases, but in the case of dust explosions or mist, other airborne fuels will normally undergo a deflagration. Generally speaking, detonations are more associated with a high explosive or what are called condensed phase explosions where the fuel and the oxidiser are in a condensed form, so liquid or solid form.

Q. When you're talking about a methane explosion, is one more common than the other?
A. Yes, most - almost all methane explosions are deflagrations.

Q. If we go over to the next slide, then, we can return to your explanation for us about the speed and, indeed, the shape that a flame front caused by a methane explosion might take.
A. Yes.

Q. If we can talk firstly about the initial point of ignition and what happens in terms of the flame speed immediately after ignition?
A. Immediately after ignition, the flame front moves through the air at about 3.5 metres per second for the first fraction of its travel, so a very short time. Possibly under some circumstances in test situations, up to a second, but in most cases in real life it will be a fraction of a second before it becomes turbulent.

Q. Now, 3.5 metres per second is approximately 1 per cent of the speed of sound, isn't it?
A. Yes, approximately, yes.

Q. After that initial time, after that first fraction of a second, up to a second after the initial ignition, what happens then in terms of the speed of the flame front?
A. What happens then is once the flame front becomes turbulent, either because it's drawing in air on that sort of wrinkly surface or it meets an obstacle and the obstacle distorts the flame front from its spherical shape into some other shape, what happens then is that that induces a separation in the reaction rate or the combustion rate, and that causes the reaction to proceed more quickly and the flame front to move through the air much more rapidly.

Q. When you say "much more rapidly", what sort of speeds does the flame front reach?
A. Most of my experience and research has been within building fires, building explosions, and in those circumstances it's fairly typical for the flame front to proceed at around about between 50 and 100 metres per second.

Q. And in terms of that speed relative to the speed of sound?
A. That would be - 100 metres per second would be approximately a third of the speed of sound. There are circumstances in which it can travel substantially faster than that. One of the situations in which the flame front could be very accelerated is in long, thin compartments like pipes or tunnels. So, for example, in a sewer explosion, methane can gather in sewer pipes and will accelerate very rapidly and may even, under those circumstances, get to the speed of sound and cause a detonation.

Q. Can we talk about your third bullet point there. You indicate that turbulence and interference from surrounding objects or structures can then cause the flame front to travel more rapidly in some directions than others. Does that mean that the flame front might lose its initial spherical appearance?
A. Yes, it will do. When it starts to encounter obstacles or boundaries, particularly, the initial spherical shape becomes distorted or becomes confined in one way or another, and then the expanding gases have to travel in a different direction because there's something blocking the spherical expansion, and when they travel in a different direction you can then get, for example,

jetting effects.

Q. Have you obtained a brief video which demonstrates what an initial reaction post methane ignition looks like?
A. Yes. This video comes from a series of tests which were carried out at the Fire Research Station in Britain during the late 1980s or early 1990s, when they were looking at various types of explosion involving gaseous fuels, so they used methane, LPG, flammable liquid vapour and various other types of fuels.

In this video, what you see is the thing that's hanging in the centre of the window there is a little spark igniter, and the camera is positioned looking into a test rig which is a cubical compartment approximately 3 metres cubed, and it's filled with a mixture of methane and air at approximately 10 per cent. When the spark igniter ignites that mixture, you can see the flame front moving outwards from it in that spherical manner that I described and then the surface becoming what I described as wrinkly as it accelerates.

MS O'GORMAN: All right, we might play that video.

(Video played)

MS O'GORMAN: Q. So in that particular case, it might appear that the spherical shape of that initial ignition took on that wrinkly appearance even less than one second after the ignition?
A. It did, yes, that proceeded within a fraction of a second.

Q. And we could see towards the end of the video some continued burning of the air, or in the air around the ignition point after that flame front had passed through?
A. Yes, that would be caused by some residual unburnt methane from the initial reaction. What's happened is that there was probably some methane that didn't react immediately and continued to burn after the flame front had gone outwards.

Q. Thank you. Now, so far we've been talking about the flame front that's generated when methane ignites. Is it the case that there is always, and necessarily, an associated pressure wave?
A. The burning will always cause the - it has two

effects. The first effect is that behind the flame front there is a region of hot combustion products, which will expand simply because they're hot, so that's what's driving the flame front outwards. So that would be the carbon dioxide and water, water vapour.

But immediately in front of the flame front, there's also a zone where the air itself or the gas-air mixture is being heated by the reaction before it actually becomes ignited. So there are two factors which increase the pressure on the surrounding air.

Now, what happens then is that the flame front - sorry, a pressure wave is formed, which moves ahead of the flame front, and that will happen whenever there is an ignition of a flammable gas-air mixture.

Q. Finally on that page you indicate the factors which will affect the size of the pressure wave.
A. Yes. The amount of heat being generated by the burning is directly related to how much gas is being burned. So the energy release is limited by the amount of chemical energy contained within the gas. As that gas burns, it releases the heat, and the amount of heat or quantity of heat is what governs the size of the pressure wave or how much energy is imparted in the form of pressure to the surrounding air.

Q. And is the amount or quantity of gas being burned relevant here?
A. Yes. The larger the amount of gas, then the bigger the amount of heat you're generating and therefore the bigger the pressure wave.

Q. If we go to the next slide, we can see you've indicated here that the intensity of the pressure wave is increased when the burning velocity increases.
A. Yes.

Q. Can you explain for us what burning velocity is, please?
A. Okay, so burning velocity - I'll just pull up a definition. So I'll read this out for you. Burning velocity is defined as the speed at which a flame front propagates relative to the unburned gas. It's tested as a thing called the laminar burning velocity, which is the speed at which a wave in the form of a plane or a flat

surface propagates through to an unburned gas mixture. So it's actually slightly different from the flame speed that we've been talking about. So the burning velocity, if you like, is a test parameter, so something experimental, whereas flame speed is something which is measured in real life.

Q. You've indicated on that slide that, in the open, a deflagration may not cause a pressure wave. By that, do you mean an "identifiable" pressure wave, one that might not be discerned or observed by a human in the area?
A. Yes, sorry, I should have said it's really a discernible pressure wave. There will always be a rise in pressure, but it may not be immediately apparent if it's in the open, because the pressure can just dissipate into the atmosphere.

Under some circumstances, it can be felt in the open. If anybody's had the misfortune to try to start a bonfire or a barbecue with some ignitable liquid, like petrol, they'll probably feel the whoosh even though it's in the open air when it lights. Many people have been burned by that sort of activity. But generally speaking, if it's actually in the wide open area, fully open to the atmosphere, it may not be very discernible.

Q. That situation can be contrasted to a methane deflagration that occurs in an enclosed or even a semi-enclosed space?
A. Yes, that's correct. In an enclosed space or a semi-enclosed space, which in technical terms we call a vented confined gas explosion, the deflagration pressure wave can actually be felt. It can produce physical effects like moving or displacing objects. In structures, such as buildings, it can cause building elements to fail, so, for example, windows or doors might blow out.

Q. A deflagration will cause an effect like a gust of wind?
A. Yes, like a very strong, brief but strong gust of wind or push, it's a pushing effect, but it would be - it could be similar in some circumstances to, for example, the pressure that you might get in a cyclone, from cyclonic wind.

Q. That can be contrasted to the sorts of effects that might be caused by a detonation, which, as I understand it,

might have the effect of tearing or bursting objects apart rather than displacing them?
A. Yes, that's correct, a detonation has a shattering or tearing effect on objects and materials immediately around it, whereas a deflagration tends to push things. The reason is that the rate of pressure rise in a deflagration is lower, so although the pressure may go up as high as in a detonation, it does it over a longer time period.

Q. Can you give us an idea of the sorts of factors that will impact on the magnitude of the pressure wave?
A. Yes, as we mentioned, one is the amount of gas which is being burned, so the amount of fuel which reacts. Another one is the geometry of the situation. So, for example, a long, narrow compartment will - there will tend to be a larger pressure wave felt than in a wide open compartment.

Q. And what about the quantity of the fuel?
A. Sorry, yes, so the quantity of the fuel - I thought I mentioned this. The larger the quantity of fuel, the bigger the pressure wave.

Q. Venting? The available venting - will that have an impact?
A. Yes. Sorry, say again?

Q. Will the venting that is available have an impact on the magnitude of the pressure wave?
A. Yes, it will. If there are vents available or venting can occur as a result of some surrounding structure failing, then the pressure wave can disperse through those vents, whereas if there's no available venting and the pressure wave is confined, it doesn't lose any energy, so it will continue strongly.

Q. Now, to this point we've been talking about the flame speed and shape associated with a methane explosion and also the associated pressure wave. Can we speak briefly now about the variations of methane explosions that can occur? You've listed three there on your slide, the first being a hybrid explosion. Could you explain for us what a hybrid explosion is, please?
A. A hybrid explosion is when there is more than one fuel involved. It may be that one fuel is initially involved and then involves a second fuel. An example of this would be - in the sorts of circumstances we're talking about,

would be where a gas explosion occurs and the pressure generated by it raises dust, or the turbulence caused by it raises dust, such as coal dust, into the air, and the dust then is a fuel as well, so that there's effectively two fuels going on.

We also see this in agricultural situations in silos, quite often, where there's a gas explosion caused by gases being released by decomposition of the silo contents, which then also raises the dust from the agricultural product, which ignites, and a hybrid explosion occurs.

Q. In either of those occasions, will there be an increase in the energy associated with the explosion?
A. Yes, there will. We're now talking about a situation where you've got more than one fuel involved. So even though the original fuel may then be exhausted, the original gas may then be exhausted, the second fuel or subsequent fuels can continue to burn, depending on what they are and how plentiful they are. So a hybrid explosion can actually be more powerful and it can also burn longer.

Q. The second variation that you've listed is one you've described as either a multiple or a cascade explosion. Could you explain what you mean by that?
A. Yes. In a situation, there might be separate areas or volumes of gas-air mixture, then what could happen is that the flame front from the first ignition can travel into another area where there's another concentration of gas which is separated from the first one. If they're all within a single compartment, but they're separated, if you like, pockets of fuel, then we generally refer to that as a multiple explosion.

Sometimes in buildings you get this effect where there are a number of different rooms which are separated by doors or walls, which each have separate explosive concentrations within them, and they ignite one after another because the pressure wave exposes the next compartment, and that's what we generally call a cascade explosion.

Q. In either case, that is, in the case of multiple explosions or cascade explosions, will they be observable as a closely linked in time series of explosions, essentially?
A. Yes, usually they're described as a rapid series of

explosions which increase in intensity and, depending on how many there are, they may all merge into one large event at the end. So people sometimes refer to a series of noises or fires which get closer and closer together and bigger and bigger.

Q. Given what you've already told us about the speed of the flame front associated with a methane explosion, will either multiple or cascade explosions necessarily occur very close in time rather than separated in time by numbers of seconds?
A. Yes, generally they will be very close together in time. It would be unusual for them to be more than a second apart.

Q. You've indicated on the slide there that it's also possible to have essentially a combination of a hybrid explosion and the multiple or cascade explosion scenario.
A. Yes.

Q. Are you able to explain that a little for us?
A. Yes. In effect, what can happen, you can have a multiple explosion in which the first explosion - the first ignition causes a pressure wave to then produce a hybrid explosion somewhere else.

Q. If we move to the next slide, can we talk now about the kinds of fire damage that might be caused in the case of a methane explosion?
A. Yes. Generally speaking, if it's a pure methane explosion, depending on the concentration of the methane, the flame front that follows immediately behind it produces just a superficial heat damage, if it's on the lean side. So a 5 to 15 per cent methane will generally be a transient flame contact and superficial heat damage. By "superficial" I mean, for example, it can singe hair, it can scorch fabrics, it can cause reddening or first degree burns on skin.

Q. What about the effects that it might have on either synthetic or natural fibres or fabrics?
A. So that type of heat transfer will cause - can cause melting of synthetic fibres; it can cause scorching of natural fibres such as cotton or linen. But sometimes what we find is that if it's been a very brief contact and a fairly small flame front, then sometimes that damage may only be visible under a microscope.

Q. You've indicated that sometimes there will be more significant radiant heat associated with the flame front.
A. Yes.

Q. What are the factors which will influence whether or not the flame front causes either superficial heat damage on the one hand or the more significant radiant heat on the other?
A. One of the most common reasons for having a larger amount of heat damage is if the gas-air mixture is on the rich side, so somewhere between 10 and 15 per cent. That produces a longer-lasting and a more radiant heating, and the effects of that generally include the fact that combustibles, such as clothing, can actually ignite rather than just be scorched or melted, and it's more likely to cause significant burns to exposed skin.

Q. We were just talking a little while ago about the variations of methane explosions that can occur - that is, those hybrid explosions or the multiple or cascade explosions. Would the presence of either of those variations have an impact on the sort of fire damage that might be caused to a person or to clothing?
A. Yes, it could well do. For example, if there was an additional fuel which would continue to burn longer, such as, for example, in this case coal dust, so if there were initially a methane explosion, which then ignited airborne coal dust, that would continue to emit much more radiant heat for probably significantly longer and be more likely to cause the ignition of combustibles and be more likely to cause significant burns to skin.

Q. A little earlier we were looking at that video that you provided to us of the initial ignition of methane, and we saw towards the end of the video that there was some fire which effectively continued in the air after the flame front had passed through.
A. Yes.

Q. Is a scenario like that necessarily going to cause more fire damage to whatever object or person is in the area, in the vicinity?
A. Yes. That would cause the person or the object or whatever to suffer, or to be exposed to more radiant heat and for a longer period, so that would increase the severity of the damage.

Q. We've been talking so far about the general characteristics of a methane explosion and its associated flame front and pressure wave and the damage that might be caused. Can we turn now to a consideration of the events of 6 May 2020. You've been provided with a number of documents, you indicated at the outset of your evidence. One of those documents was a document which contained the extracts of a number of workers' accounts of the explosion that occurred at the Grosvenor mine. Do you recall seeing that document?
A. Yes, I do.

Q. And have you read that and taken account of what it is that the workers observed, felt, saw, that kind of thing?
A. Yes, I actually had two sets of documents. One was short extracts of statements or accounts of the workers, and then subsequently I had some more detailed (indistinct).

Q. I'm sorry, we've just had difficulty hearing the last part of your answer there, Mr Munday. Would you mind repeating that?
A. Yes. I said I've had two lots of documents - one lot with my first letter of instruction, which contained some extracts from some statements or records of interview, and then subsequently I was given some slightly more detailed material from some of the workers, who were identified by number, that I understand were the more severely injured.

Q. Now, from those documents that you were provided with, you were made aware that the workers on the face essentially experienced two pressure waves?
A. Yes.

Q. That there was one pressure wave, the first pressure wave, which was not associated with a flame front?
A. That's my understanding, yes.

Q. And then some time later, approximately 15 seconds later, a further pressure wave, this time accompanied by a flame front?
A. Yes, that was certainly my understanding of the sequence, yes.

Q. And was it the case that at that time, based on that information, your opinion was that the first pressure wave

was unlikely to be associated with a methane deflagration, because there was no flame front?
A. Yes, that was my initial thought on the matter. I thought that the first pressure wave may have come from some kind of mechanical source --

Q. Sorry, again, it's just cut out a little bit at the end of your answer there. If you could just repeat it for us, please?
A. Sorry. So I was saying that my initial consideration was that because of the lack of a flame front associated with the first pressure wave, that may have been due to some kind of mechanical cause for the pressure, and that the second pressure wave was the result of a deflagration.

Q. Indeed, knowing that the workers in this case were talking about a pressure wave caused on the longwall situated near a goaf underground, you considered it at least possible, based on that information, that the first pressure wave was a result of a goaf fall or some kind of strata collapse?
A. Yes, I made that observation.

Q. Now, subsequent to forming that initial opinion, it's the case, isn't it, that you were provided with some further material in the form of reports from Sean Muller, in the first instance, and Martin Watkinson, in the second?
A. Yes, that's correct.

Q. The letters that were provided to you seeking further opinion are indeed annexed to the reports that you've provided to us?
A. Yes.

Q. So we can see that, in addition to being provided with those reports, you were asked to proceed on the basis that there was evidence that there had been an advanced heating in the tailgate area of the goaf prior to 6 May 2020?
A. Yes.

Q. And in that respect it was identified, or you were asked to proceed on the basis that ethylene had been detected in samples taken from the goaf prior to that day?
A. Yes.

Q. And you were directed to Mr Muller's report in that regard and particularly to page 50 of his report?

A. Yes, that's right. As a result of reading that, the presumption that I made based on that report was that there was evidence of combustion or at least heating in the goaf prior to the incident on 6 May.

Q. Now, in addition to being provided with Mr Muller's report and having those aspects of it pointed out to you, you've already indicated that you were provided with Mr Watkinson's report, and indeed you were informed in the letter that was given to you that there were products of combustion observed in samples taken from some of the goaf wells immediately after the serious accident?
A. Yes.

Q. And asked to proceed, essentially, on the basis that that information was suggestive of an ignition of methane in the goaf?
A. Yes, that's correct.

Q. Now, for the purpose of providing you with information about those matters, you were again referred to Mr Muller's report at page 50, but also to page 55 of Mr Watkinson's report?
A. Yes, that's right.

Q. As a result of being provided with that further information, you have reviewed your initial opinion about the potential cause of the first pressure wave. We can see there that you consider that there are, in fact, two possibilities for the cause of that first pressure wave, the first being the mechanical air compression, such as a goaf collapse - yes?
A. Yes, that's right.

Q. And the second being that there was in fact a deflagration that occurred in the goaf, either as a result of heating to the autoignition temperature or some other ignition source being present in the goaf?
A. Yes, those are the two most likely - well, they're the - they're the only two possibilities that I can think of which would produce a pressure wave in the goaf.

Q. The information or data that you've been provided is really limited to the sorts of things we've already talked about, that is, the workers' accounts and some of the data referred to by Mr Muller and Mr Watkinson; correct?
A. Yes, that's correct.

Q. And so, as I understand it, it's not possible for you to rate one of those two possibilities as more or less likely than the other, because you have incomplete data?
A. That's correct, yes.

Q. Dealing with the second of those possibilities, then, an obvious problem with that possibility is that that first pressure wave was not associated with a flame front observed by the workers on the longwall face. Are you able to explain for us how it might be possible that there could be a deflagration in the goaf which resulted in a pressure wave observed by the workers in the longwall face but not a flame front?
A. Yes. There are a couple of possibilities. One is that a deflagration occurred sufficiently far back in the goaf that the available methane in the area of ignition was consumed and that the flame front therefore didn't progress any further, but the expansion of the hot combustion products was sufficient to push - was sufficient to pressurise the longwall. So that's one possibility.

A second possibility is that there was a flame front, but it was so dissipated through fractured rock that it was not immediately visible to the workers in the longwall.

Q. In respect of that second possibility that you've mentioned, is the presence of the backs of the shields separating the workers on the longwall face from the goaf relevant at all?
A. Well, it is, because that would potentially stop a certain amount of - or the majority of any flame from coming through. But my understanding is that there were some gaps between the shields and there were also gaps at the tailgate, so if there was a flame which reached from the goaf towards the longwall, then if - it would possibly have been visible coming through those gaps.

Q. In either case, and here I'm talking about either of the two possibilities that are there on the slide - that is, the first pressure wave was a result of a strata collapse or that it was a result of a deflagration in the goaf which did not result in a flame front visible to the workers - you've indicated that methane, if present in the goaf, would necessarily have been pushed towards the longwall face?
A. Well, if there were unreacted methane, then, yes - the

problem is that if the goaf was a continuous void, then any methane that was burning in there would likely ignite any other methane that was also in there. But my understanding is that the goaf was not necessarily a continuous void and that it was broken up into separate sections or areas because of the rock or the nature of the rock. So that particular - I can't comment on that, because the nature of the rock strata is outside of my expertise.

If it were possible that some methane were contained in an area which was separate from where the first ignition occurred, then it's certainly feasible that that methane would have been pushed by the overpressure in the goaf through to the longwall.

Q. Thank you. You've just indicated some limitations to your ability to form opinions about the precise mechanism by which a deflagration might have occurred in the goaf and resulted in the scenario that we've been discussing.

If we move to the next slide, we can see that you've set those out. You've adverted to the fact that you don't know the size and shape of the goaf as it was at the time of the explosion on 6 May 2020?
A. That's correct.

Q. And similarly you don't know the location of each of the rocks, the fallen strata and the voids within the goaf at that precise point in time?
A. Yes, that's correct. It's also - sorry, go on.

Q. No, you please continue.
A. I was going to say, it's also not possible for me to know, if an ignition did occur in the goaf, whereabouts in the goaf that occurred and therefore in which direction and at what speed the flame front from that would travel.

MS O'GORMAN: Mr Martin, I'm mindful of the fact that we would normally take a morning break. Were you intending to, or should we just continue?

THE CHAIRPERSON: I'm happy to. We'll just take 10 minutes?

MS O'GORMAN: Thank you.

THE CHAIRPERSON: Mr Munday, we will just adjourn for

10 minutes. We will see you shortly.

SHORT ADJOURNMENT

MS O'GORMAN: Q. Mr Munday, are you able to hear me?
A. Yes, I can.

Q. We spoke a little earlier about multiple or cascade explosions in a general sense. Can we talk now about the likelihood of the two pressure waves observed by the workers on the longwall face at approximately 15 seconds apart being an example of a multiple or cascade explosion?
A. Yes, certainly. I think the first and second pressure waves are unlikely to have been a cascade or a multiple explosion, because the 15 seconds or so time lag between them is too great, in my experience and in my opinion, for that to be a directly connected ignition event.

Q. You've indicated on the slide that a flame front originating from approximately 30 to 40 metres back in the goaf would have travelled to the longwall face in significantly less time than 15 seconds, more like 1 to 2 seconds, you indicate?
A. Yes, generally speaking. The problem I have is that almost all of the information that I know and that I've been able to find relates to experimental explosions in structural situations, say, buildings and plant and factories, and generally speaking, because the typical flame front speed is in that order of around 50 to 100 metres per second, as we briefly spoke about earlier, I think it's unlikely that a flame front coming from the goaf, if it was travelling 30 to 40 metres, which is what was suggested to me, I don't think it would be likely that it would take more than a couple of seconds to reach the longwall.

Q. So the two pressure waves, assuming for the moment that the first one was a deflagration in the goaf, are, however, not a cascade of one upon the other; they're separate events?
A. That's my opinion, yes.

Q. Can we go, then, to the second pressure wave observed by the workers and the flame front associated with that.
A. Yes.

Q. You've indicated that the second pressure wave and

that associated flame front has all the characteristics of a deflagration?
A. Yes, I would agree with that. The descriptions of the workers which I've seen and the damage which was apparent in the photographs in Mr Nystrom's report all indicate to me that the second pressure wave was a deflagration on - sorry, within the longwall.

Q. When you say you would agree with that, are you referring to the fact that you were provided with Murray Nystrom's report previously and you've seen the conclusions that he reached in that report?
A. Yes, that is correct. I didn't examine the mine first hand, so I was dependent on his examination and his photographs in the report.

Q. And having done so, you indicate in one of your reports that you accept his methodology?
A. Yes, I do. I think it was - his appears to be sound and thorough.

Q. Whilst it's difficult for you to form any independent view about the direction of the flame front travel based on those photographs alone, because they're taken close up and not in context, you proceed on the basis that his methodology was appropriate and his conclusions appear sound?
A. Yes, that's correct.

Q. Can we move to the second bullet point on that slide, then, please, and could you give us some explanation of what you mean by that?
A. What I meant by that was that if the first pressure wave which came from the goaf - sorry, if the first pressure wave pushed methane from the goaf on to the longwall, so that there was then a flammable concentration or ignitable concentration within the longwall, then if there was also some coal combustion going on close to the longwall directly behind the shields, then that methane-air mixture could be ignited, potentially could be ignited, by that heat source within the goaf immediately behind the shields.

Q. In terms of the explosion that occurred - that is, the second pressure wave and the associated flame front - you've indicated at the third bullet point that you don't consider it's possible to be able to say definitively

whether that one was a standard methane-air deflagration, a coal dust-air ignition or a hybrid event; is that right?
A. That's correct. One of the pieces of reasoning I adopted in that was to consider whether the first pressure wave could actually have raised sufficient coal dust that the second event was actually a dust ignition rather than a methane ignition. On the material that I've seen, I can't actually rule that out.

Q. If we could go to the next slide, then, you've indicated in the first bullet point that the flame front - and we're still talking about the second pressure wave and the associated flame front - would have stopped when there was no longer sufficient fuel in the atmosphere, but the pressure wave would have continued.
A. Yes, that's correct.

Q. So when there is a methane explosion and a flame front travels outwards from the point of ignition, it will necessarily stop or cease once there's no further fuel in the surrounding atmosphere?
A. Yes.

Q. But the pressure wave itself won't necessarily cease at that point in time; is that what you're indicating?
A. Yes, because the combustion products, the hot carbon dioxide and water vapour, will still be expanding behind where the flame front would have been if it had continued. So the combustion products are still expanding and still generating pressure on the air, even though the flame has now gone out. It will gradually dissipate, it will gradually cool off and the overpressure will drop, but that will take some seconds.

Q. In this particular case, we know from workers who were working quite some distance from the longwall that they observed a pressure wave but not a flame front. Is that explicable because of the phenomenon that you've just described?
A. Yes, that would be a fairly normal thing for witnesses further away to observe, yes.

Q. Looking at your second bullet point there, do I understand it to be the case that you're not in a position - that is, it's outside your area of expertise - to determine definitively the ignition source of either the first event, if it was a deflagration, or the second event?

A. Yes, I wouldn't say it's outside my expertise. It's outside the range of information that I have available.

Q. I understand.
A. There's definitely not enough solid information to say that it was one thing or another thing.

Q. Nonetheless, there is one ignition source which, in your opinion, can be ruled out, and that is static electricity discharge?
A. Yes, I think that's highly unlikely. The reason is that I looked through the information or the environmental information that I was given for the period leading up to the incident, and the lowest relative humidity figure that was present was 71 per cent. Generally speaking, a static electrical discharge will only occur if the relative humidity is below 50 per cent.

Q. Just for completeness, you were able to calculate the relative humidity from data provided to you, which included the wet and dry bulb temperature data from the day?
A. Yes, that's correct. So there's a method for calculating from the wet and dry bulb temperatures the relative humidity.

Q. Your conclusion was that given that the lowest humidity you were able to calculate was I think you said 71.1 per cent, or thereabouts --
A. Yes.

Q. -- there was too much humidity for static electricity discharge to be the cause of an ignition?
A. Yes, certainly between - for example, a static electricity discharge between items of clothing or between clothing and the shields or anything of that nature.

Q. I know you've indicated that you haven't been provided with enough information for you to form an opinion about the potential ignition source, but you've indicated on this slide possible ignition sources. Can you just talk us through those?
A. Possible ignition sources. I've considered here spontaneous combustion within the coal, so that can work in two ways. One way is that the actual coal surface could be above the autoignition temperature of the gas-air mixture, or, alternatively, it could be that a spontaneous - or sorry, a self-heating event in the coal was combined with

some ventilation to then cause a small flame to be produced at the surface of the coal. So either of those could be situations which would produce heat for the gas-air ignition.

I thought about friction spark. Particularly if the initial overpressure was something to do with a goaf collapse, I wondered whether - and it's no more than speculation, because I've got no information to indicate whether it's probable or not probable, but whether something could have occurred within the goaf which caused some piece of rock to become unstable and then fall and strike some metal, like part of a shield, to cause a spark or small piece of hot material.

Another possibility that I considered was whether the first pressure wave in some way caused a compromise to some electrical cabling or equipment, and I noted that the workers reported that the power went out after the first - or at the time of the first pressure wave, and it seemed to me that there must be a reason for that to have occurred. I couldn't eliminate the possibility that some mechanical damage had occurred to a cable or a piece of equipment.

Q. You've indicated already, I think, that the descriptions that you've seen of the workers, in particular in relation to the intensity and duration of the two pressure waves, are consistent with a methane deflagration?
A. Yes. Yes, in my opinion, they are.

Q. What about noise? Would there necessarily have been a particular noise able to be heard by any one of those workers, and, if so, would it necessarily have been of one kind or is there a range? Might there not be a noise?
A. Generally speaking, a pressure wave does - most witnesses report a noise associated with a pressure wave. The descriptions vary a lot depending on the particular speed and intensity of the pressure rise. So, very often people will describe - sometimes people will describe it as being a whoosh, like a gust of wind; sometimes they'll describe it as being more like a bang or a louder or a more violent noise; sometimes people talk about things like the sound of thunder. In fact, the sound of thunder is actually quite a good description of a reasonably high -speed pressure wave.

Q. What about lower-speed pressure waves, will the noise

vary?
A. Yes, it can vary. It will depend a bit on the speed. The rate of pressure rise at the eardrum is a big determining factor, and also the surroundings, because it depends on whether the pressure is being reflected back off surroundings.

Q. I'm going to take you to another video that you've provided us with and play it now, and I'll ask you to comment on the noise that you can hear associated with this video, but before it's played, are you able to indicate whether this originates from the same material that the other video came from?
A. Yes, it does. It's the same series of tests. In fact, this particular test, I was present when it was conducted. I was one of a number of observers at the test site. This particular one - if I'm correct, this particular one involves LPG rather than methane, so liquid petroleum gas, which is propane, rather than methane. But the effect is the same. So there's very, very little difference between igniting propane or igniting methane, except that propane is more dense than air rather than less dense than air.

Q. In terms of the ignition itself, where did it happen relative to what we can see on the screen there?
A. What you're seeing on the screen is a test compartment which is in the shape of a room, so approximately 2.5 metres square and 2.5 metres high. It has a door which you can see, and for the purposes of this test it was fitted with a glazed window, a single glazed window. The compartment had a flammable mixture of gas and air in it, introduced into it, and then the same kind of spark igniter that you saw in the first video was used. What we'll see here is a slow-motion recording of what happens as that pressure builds up and then a flame front follows it.

Q. Is the purpose of your having provided this video to demonstrate what the pressure wave might look and sound like as it moves in front of the flame front?
A. Yes.

MS O'GORMAN: All right, let's play the video.

(Video played)

MS O'GORMAN: Q. Did we see there the disturbed air, the

pressure wave coming out from the window ahead of the flame front?
A. If you want to replay it, I can talk over it and describe what's going on, if that would be helpful?

Q. Thank you. (Video played).
A. Here, first of all, the glass starts to flex. Some curtains that were hanging inside are blown outwards. Then the flame comes out behind it. And then you can see there's some residual burning going on inside the test room there, with the rest of the gas burning off.

Q. We didn't hear in that video the noise of a boom or a bang but perhaps more of a windy noise.
A. Yes, bear in mind that that was in slow motion. In real time, it's a shorter, sharper noise.

Q. In terms of the flame front, then, and the descriptions that you've seen from the workers who were on the longwall and experienced that flame front as part of the explosion, is it the case that, in your opinion, those descriptions are consistent with a methane deflagration?
A. Certainly those descriptions which included a blue flame or being a blowtorch or those sorts of descriptions are very much consistent with a methane deflagration. The duration, the very short or the relatively short duration, are consistent with exposure to a deflagration, yes.

Q. Have you had an opportunity to review Mr Sellars' evidence given here in the hearings?
A. Yes, I watched that piece of evidence this morning, and what he's describing is - it's consistent with a methane deflagration, but it could also be consistent with a hybrid event.

Q. One of the other workers you will have seen in the extracts referred to a yellow-coloured flame rather than a blue-coloured flame.
A. Yes.

Q. Is that of any significance?
A. Yes, what happens with flames is that the blue colour is what happens when there's very efficient combustion, so all of the gas is very well mixed with air - sorry, the gas is very well mixed with the air, it's the right concentration and it burns very efficiently, so that the only combustion products are carbon dioxide and water, and

the flame is very blue.

A yellow flame is caused when soot or other particles in the hot gases are heated up to the point where they radiate at visible spectrum, and that usually indicates a less-efficient combustion. So in this instance, it could mean that in that particular area there was a higher concentration of methane, which would produce some soot, and the soot particles were glowing and that produced the yellow flame colour. It could also be that the yellow flame colour relates to combustion of actual coal dust caught up in the explosion as well.

Q. Now, you indicated earlier that you were, for the purposes of preparing your evidence, provided with Murray Nystrom's report.
A. Yes.

Q. And there were contained within that report, were there not, a number of photographs of the clothing worn by workers who were on the longwall at the time of the explosion?
A. Yes.

Q. And you had regard to those photographs?
A. Yes, I did. From what I could see, the damage to the clothing and personal equipment, such as the pouches, was very consistent with exposure to a high-energy deflagration, one with a high degree of radiant heat.

Q. Some of the material provided to you included descriptions of the injuries sustained by some of those workers on the longwall face?
A. Yes.

Q. You've seen that some of the workers sustained burns to up to 70 per cent of their body, and one of the workers lost fingers, for example?
A. Yes.

Q. What does that tell you, if anything, about the flame front or the mechanism by which they sustained those injuries?
A. It suggests to me that those injuries weren't caused by the flame front alone and it is likely that some of their clothing or personal equipment actually continued to burn after the flame front had passed and continued to

expose their skin and bodies to high levels of radiant heat and to open flame.

Q. Is that something that can commonly occur in the case of a methane deflagration?
A. Yes, it's more common if the concentration is at the rich end, so between 10 and 15 per cent, rather than the lean concentration, but, yes, it can occur. And it depends, as well, to a certain extent on the nature of the materials and the clothing and so on.

Q. There's one final topic that I want to ask you about, Mr Munday. You will recall that a little earlier we were talking about the fact that some workers quite a considerable distance from the longwall face nonetheless felt a pressure wave or pressure waves?
A. Yes.

Q. Do you recall seeing those descriptions?
A. Yes, I do.

Q. Some of those workers referred to a suck-back effect or a reverse pressure wave occurring between the first and second of the pressure waves observed by those workers on the longwall face?
A. Yes.

Q. And you will recall that in the extracts given to you, none of the workers on the longwall face talk about a suck-back effect between the two pressure waves or a reverse pressure wave. Are you able to give us an idea of how those two things might sit comfortably with each other?
A. Yes. What happens with a pressure wave is that obviously there's a displacement of pressure which eventually at some point is vented to atmosphere, and then what's called replacement air has to come back in from atmosphere to replenish what has been displaced in order to maintain atmospheric pressure.

So what's commonly encountered is that the air which is coming back is being drawn in from the entire atmosphere and therefore is more energetic at the venting end than it is at the end where the pressure originated. So it's a difficult thing to describe, but what we commonly hear from witnesses is that the suck-back effect is more observable near the vents than near the origin.

MS O'GORMAN: Thank you for that. Mr Martin, those are all of the questions that I have for Mr Munday.

THE CHAIRPERSON: Yes, thank you. Mr Holt?

MR HOLT: No questions, thank you, Mr Martin.

THE CHAIRPERSON: Mr Crawshaw?

MR CRAWSHAW: No questions, thanks, Mr Chair.

THE CHAIRPERSON: Thank you. Ms Grant? It would seem not. Mr O'Brien?

MR O'BRIEN: No, thank you.

THE CHAIRPERSON: Ms Holliday?

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

MS O'GORMAN: I have no further questions.

THE CHAIRPERSON: Mr Clough?

MR CLOUGH: No questions from myself.

THE CHAIRPERSON: All right. Mr Munday, thank you for your evidence. You are now excused.

<THE WITNESS WITHDREW

MS O'GORMAN: Mr Martin, there is one more witness lined up for today. Dr Basil Beamish is going to be recalled. I understand he is available at 2.15 this afternoon.

THE CHAIRPERSON: Yes, all right. Thank you. I take it there will be at least one extra party for 2.15?

MS O'GORMAN: That's our understanding.

THE CHAIRPERSON: All right. Nothing else until then?

MS O'GORMAN: No.

THE CHAIRPERSON: Thank you. We will adjourn until 2.15.

LUNCHEON ADJOURNMENT

THE CHAIRPERSON: Yes, Mr Hunter?

MR HUNTER: May it please the board, I recall Dr Beamish.

THE CHAIRPERSON: Yes, thank you.

<BEVAN BASIL BEAMISH, on former oath: **[2.16pm]**

<EXAMINATION BY MR HUNTER:

MR HUNTER: Q. You will recall that we adjourned on the last occasion when you were here in order that you might properly review the report prepared by Simtars in connection with the testing of the PUR product that we're concerned with?
A. Yes.

Q. Have you now had an opportunity to review that report to your satisfaction?
A. Yes, I've been able to go through that.

Q. Were you also able to see Mr Parmar, or if not see him, at least read a transcript of the evidence that he gave?
A. I have.

Q. Was there anything that you read or heard in connection with that testing that has caused you to alter the views that you already told us about and expressed in your report?
A. No, there's nothing changed there.

Q. Did you, though, draw to my attention something that's contained in DSI's own risk assessment for this product?
A. It's not only the risk assessment. It's available on the internet. It was a pictorial that caught my attention.

Q. Mr Operator, could we please have RSH.024.004.0001, and could we go to the 12th page, I believe it is. Could we zoom in on the bottom of those two images, please. What we're looking at here appears to be an idealised view of how the face and roof might look after the injection of the product?
A. Yes, but in this case it's a rock roof that's there, but in the situation at Grosvenor it's actually coal in the

roof.

Q. What is it about what we see here, though - let's assume that the roof is a beam of coal, not rock. What is it about what we see here that's of significance, in your view?
A. The thing that caught my attention was in this area here, coming away from the hole, how the PUR is depicted as moving into multiple fractures, and in some circumstances what we're seeing is the PUR then obviously accumulating at fracture intersections as well, so you're ending up with a larger mass of PUR than what is just shown as going through the hole. So it's actually moving out into the fractured rock material in this case, but it would be coal otherwise.

One thing that did catch my attention is how this little block here is shown as being isolated, and if that were actually a block of coal being isolated like that, it's now surrounded significantly by material that's going off exothermically.

The second thing is that presumably if this layer here is also coal as well, it's heavily insulated, so it's not going to lose heat in a hurry. Then the second thing that I was looking at was, as you move across here, if you can imagine the wall is now moving, and it's moving forward and the canopy is coming underneath this particular zone, you see the fractures that start to appear back here, this material starts to fracture in that particular zone area there, then there's going to be availability for air to get to that coal, which is now at an elevated temperature and it can then start to react a lot more - a lot faster than what it would have done in the actual normal mine environment.

Q. Looking at that same area that I've now enlarged, obviously this is just a diagram that has been prepared for information purposes.
A. Yes.

Q. But in your view, assuming that the roof is a coal beam, is the isolation of a section of coal in that way so that it would be completely encapsulated by PUR a plausible scenario?
A. It is a plausible scenario, yes.

Q. And in terms of this process of fracturing, when, in terms of the advance of the shield, is that fracturing that would expose the PUR-affected coal to air likely to occur?
A. It's highly likely because of the stresses involved in the fracture zone as you move forward.

Q. But at what point is that fracture likely to occur, in terms of the movement of the shield? Are we talking about this area back here above the hinge at the rear of the roof shield or is it some other point?
A. Certainly as it's getting closer back to the rear of the canopy there, it's going to be a much better opportunity for the fracturing to occur.

MR HUNTER: They were the only questions I had for Dr Beamish.

THE CHAIRPERSON: Mr Holt, anything?

MR HOLT: No, thank you, Mr Martin.

THE CHAIRPERSON: Mr Crawshaw?

MR CRAWSHAW: No, thanks, Mr Chair.

THE CHAIRPERSON: Ms Grant or Mr Cowan? Mr Telford?

<EXAMINATION BY MR TELFORD:

MR TELFORD: Q. Good afternoon, Dr Beamish.
A. Good afternoon.

Q. Do you recall that when we spoke on I think it was Friday the 26th --
A. Two weeks ago, yes.

Q. -- yes, and at that stage we had only just received the Simtars report, within a matter of hours, and I was attempting to ask you a series of questions about that report.
A. Mmm-hmm.

Q. You indicated that you weren't comfortable answering questions about that report, and in response to a question from Mr Martin - this is at transcript page 2019 - you said that you were not comfortable talking about other people's data; you would rather talk to the authors about that

particular work. Do you remember saying that?
A. I did, yes.

Q. This particular document that you've raised with us this afternoon - who was the author of that?
A. The document?

Q. Yes. The one we've just been talking about.
A. The pictorial there? It's freely available on the net.

Q. Who was the author of that report, Dr Beamish?
A. It's not a report. It's just an image that's on the web.

Q. Do you know who prepared it?
A. No, I don't.

Q. The same image is in the risk assessment of DSI Underground; are you aware of that?
A. Yes, I am.

Q. Have you spoken with the author of that document?
A. No.

Q. But you're comfortable, notwithstanding what you told us on 26 March about your preference to speaking with the author of the report before you comment on the report - are you comfortable --
A. That was about data, the data that was there.
I needed to know where the data - and how it was obtained.

Q. And that's different when you come to comment on this idealised schematic, is it?
A. I'm looking at a picture. A picture's worth a thousand words.

Q. Is it an accurate picture, Dr Beamish?
A. It's a reasonable representation, I would imagine.

Q. You imagine, did you say?
A. I would pick it as a reasonable representation, yes.

Q. And on what basis do you say that?
A. In terms of the fracture mechanics that takes place in the face.

Q. Do you remember telling us on 26 March that you weren't familiar with the in-mine conditions as at Grosvenor on 6 May 2020?
A. The in-mine conditions?

Q. Yes.
A. I was referring to the background that led up to the event, not the actual mine face condition.

Q. Are you familiar now with the face conditions when the PUR was applied at Grosvenor mine in 2020?
A. Not the specific conditions in the mine, no.

Q. So you can't make any comparison whatsoever between what actually occurred at Grosvenor mine and this idealised depiction in this report, or this diagram prepared by somebody else?
A. But I can make some reasonable assumptions as to how that particular outcome would eventuate.

Q. It's the case, isn't it, Dr Beamish, that you've chosen this particular image because it supports your hypothesis about the very particular circumstances that need to occur in order for there to be a spontaneous combustion event involving the application of PUR?
A. No, I've chosen it because it's a very good pictorial representation of possibility.

Q. Of a possibility?
A. Possibility.

Q. Not a probability; a possibility?
A. Possibility.

Q. According to whoever drew or designed or prepared this diagram?

THE CHAIRPERSON: Sorry, what's the question?

MR TELFORD: That the possibility as depicted in this diagram bears no correlation whatsoever to what was happening on the coalface at Grosvenor in May 2020?

THE CHAIRPERSON: The possibility of what, Mr Telford?

MR TELFORD: Of the circumstances as they are presented by this diagram, Mr Martin.

THE CHAIRPERSON: As in the picture?

MR TELFORD: Yes.

THE CHAIRPERSON: And the possibilities being that the roof was injected in that form - is that what you mean?

MR TELFORD: Yes, and, in particular, that there is a piece of coal which has been identified by Dr Beamish surrounded by PUR of that particular size and characteristic.

THE CHAIRPERSON: Yes, okay. All right.

MR TELFORD: Q. Do you understand the question?
A. Yes, in a sense, but I can picture this because I've worked underground. I've worked underground in roof falls - I've seen roof falls, I've understood, I can see what the fractures are and so on, so, to me, that representation is a fairly good pictorial of fractured roof in front of a mine face.

Q. But what you can't assist the Board with is whether that is an accurate depiction of what actually occurred on this occasion, and by that I mean May 2020?
A. There are degrees of accuracy. The main thing is it's a possibility.

MR TELFORD: No further questions, thank you, Mr Martin.

THE CHAIRPERSON: Thank you. Mr O'Brien, did I leave you out? No questions. Ms Holliday?

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

THE CHAIRPERSON: Mr Hunter?

MR HUNTER: No re-examination, thank you.

THE CHAIRPERSON: Mr Clough?

MR CLOUGH: Q. Dr Beamish, I do have one question. It's something I thought of after the last evidence you gave, when I asked you about gas drainage and its effect on the propensity for spontaneous combustion. Correct me if I've got this wrong, but I understood that gas drainage could

increase the propensity for spon com by basically opening up the coal fractures so there's more oxygen. Is that correct?
A. Not quite. It's twofold. When you do gas drainage, you're removing coal - you're removing gas from the pore - coming off the pore surfaces, and as it comes out, it brings moisture with it, so now you're reducing basically moisture, which is a heat sink in itself, and the process of gas liberation is also endothermic, so it's a cooling effect as well, as it comes out. But the main thing is then you're creating an opportunity for air access to the sites. But, having said that, the other side of that is that if the air accesses those sites, the coal has to be reactive enough to take the opportunity to use the oxygen to create the heat.

Q. So the question was actually in regard to the sample you tested, and if I recall rightly, I believe it was said that it came from around the longwall 108 area at Grosvenor.
A. That's correct.

Q. Do you know if that area had been pre-drained?
A. No, I don't.

MR CLOUGH: No more questions, thanks.

THE CHAIRPERSON: Yes. Dr Beamish, thank you for your attendance again. You are now excused.

<THE WITNESS WITHDREW

MR HUNTER: Mr Martin, that concludes the witnesses to be called in this tranche of the hearings.

There are two matters that I would seek to deal with. The first concerns the two tender lists that have been handed up to you in this tranche. The documents in those lists have been admitted into evidence, but documents received or determined to be relevant since the last tender list was submitted have not yet been admitted, and this afternoon special counsel, Ms Kirk, will be sending two further tender lists to the parties.

We understand that you have agreed to allow the parties some time to consider those new tender lists before the documents are admitted into evidence.

THE CHAIRPERSON: Yes.

MR HUNTER: That being so, I simply wanted to place that on the record, so that the parties all understood what will be occurring.

THE CHAIRPERSON: Yes, all right. Just so everyone understands, the tender lists and the documents referred to therein will eventually be received into evidence by the Inquiry. It just won't be done publicly, that's all.

MR HUNTER: The other matter, Mr Martin, concerns the progress of the Inquiry from here. Today is the last of the opportunities that the Board will have to hear evidence in this environment.

It is not presently expected that there will be any further witnesses, but if there are, then we understand that arrangements will be made for those hearings to be conducted virtually.

THE CHAIRPERSON: All right. Thank you. So the public will still be included in those?

MR HUNTER: Yes, absolutely.

THE CHAIRPERSON: All right. Thank you. Ladies and gentlemen, anything else from anyone before we adjourn? Thank you.

AT 2.33PM THE BOARD OF INQUIRY WAS ADJOURNED ACCORDINGLY

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