

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)

1 THE CHAIRPERSON: Yes, Ms O'Gorman?
2
3 MS O'GORMAN: Mr Martin, the witness to give evidence this
4 morning is Mr James Munday.
5
6 THE CHAIRPERSON: Mr Munday, can you hear me?
7
8 THE WITNESS: I can, sir.
9
10 <JAMES WILLIAM MUNDAY, affirmed: [11.05am]
11
12 <EXAMINATION BY MS O'GORMAN
13
14 MS O'GORMAN: Q. Mr Munday, could you tell the hearing
15 your full name?
16 A. James William Munday.
17
18 Q. Are you a senior investigator with Fire Forensics Pty
19 Ltd?
20 A. Yes, I am.
21
22 MS O'GORMAN: Mr Martin, there's some feedback, and I'm
23 not sure whether that's occasioned because of the
24 microphone on Mr Munday's end.
25
26 THE CHAIRPERSON: Mr Munday's?
27
28 MS O'GORMAN: Perhaps on his end of the feed, I might just
29 have to check with my solicitor. I'm not sure that there's
30 anything we can do about it. We might just have to press
31 on.
32
33 THE CHAIRPERSON: All right.
34
35 Q. Mr Munday, can you hear Ms O'Gorman okay?
36 A. Yes, I can hear everybody very well. I've just turned
37 my speakers down in case they're interfering with the
38 microphone at this end.
39
40 THE CHAIRPERSON: All right, thank you.
41
42 MS O'GORMAN: Q. Mr Munday, you're a consultant forensic
43 scientist specialising in the investigation of fire and
44 explosions?
45 A. Yes.
46
47 Q. And you hold a degree equivalent in chemistry as well

- 1 as a diploma in fire investigation?
2 A. Yes, I have what's effectively a postgraduate diploma
3 in fire investigation.
4
5 Q. You obtained that in the mid-1990s?
6 A. I did.
7
8 Q. You've worked in the profession of fire and explosion
9 investigations for some 40 years now?
10 A. Yes, since 1979.
11
12 Q. And in 2007 you were made a Fellow of the Forensic
13 Science Society, now known as The Chartered Society of
14 Forensic Scientists?
15 A. Yes, I was.
16
17 Q. And that was done in recognition of your extensive
18 casework experience, your contribution to research and
19 development in the area, peer recognition of you and your
20 extensive qualifications in this area?
21 A. Yes.
22
23 Q. You've been asked to provide the Board with some
24 information related to methane explosions generally and
25 your opinions about how the two pressure waves and the
26 flame front observed by the workers on the longwall face at
27 Grosvenor mine on 6 May 2020 might have occurred?
28 A. Yes, I was provided with a quantity of documentary
29 evidence, photographic evidence, which I've considered.
30
31 Q. And you have arranged to have prepared a PowerPoint
32 presentation to assist in providing your evidence this
33 morning?
34 A. Yes.
35
36 MS O'GORMAN: I might just ask that that be pulled up on
37 the screen. Mr Martin, this hasn't yet been provided to
38 the parties, but it will be uploaded after Mr Munday has
39 given his evidence this morning.
40
41 Q. Mr Munday, are you able to see the PowerPoint on your
42 computer?
43 A. Yes, I can.
44
45 Q. Can we start with some explanation, please, of the
46 characteristics of methane?
47 A. Yes. If we go to the next page of the PowerPoint,

1 methane gas is a colourless and odourless gas. It's
2 a hydrocarbon. It's the simplest of the hydrocarbon gases,
3 in that it has the smallest molecule. It's less dense than
4 air, so it will tend to rise through the air.
5

6 It occurs naturally in coal seams and other natural
7 environments, and the particular characteristics which are
8 of importance in this inquiry - it's flammable and can be
9 explosive when it's mixed with air at concentrations
10 between approximately 5 and 15 per cent.
11

12 Q. Why is it that at concentrations lower than the lower
13 explosive limit it will not ignite?

14 A. The 5 per cent is referred to as the lower explosive
15 limit, or sometimes called the lower flammability limit.
16 Below 5 per cent there's not enough gas to sustain
17 a reaction with the air, with the oxygen from the air, so
18 the reaction won't proceed beyond the ignition source.
19

20 Q. What about when it's present in air at concentrations
21 above 15 per cent, or the upper explosive limit?

22 A. Yes, above the upper explosive limit, there's actually
23 too much gas, if you like, it's too rich. So we often
24 refer to these as lean, below 5 per cent, or rich, above
25 15 per cent, and at that point there's actually too much
26 gas for the amount of oxygen available to react with it.
27

28 Q. Is it the case that significant changes in either
29 temperature or pressure of the gas-air mixture can result
30 in a variation to the lower explosive limit and the higher,
31 upper explosive limit?

32 A. Yes, that can be the case. For example, if the gas is
33 compressed - sorry, if the atmospheric pressure is
34 increased, that will change the lower explosive limit, it
35 will actually decrease the lower explosive limit, and also
36 major variations in temperature will affect the explosive
37 limit. They will be well outside the sort of temperatures
38 at which human activity would be going on.
39

40 Q. You've just mentioned there the temperature. What
41 about pressure - are you aware that Grosvenor was mining at
42 a depth below surface of approximately 300 to 400 metres?

43 A. Yes, I understood that to be the case. The pressure,
44 atmospheric pressure, at 300, 400 metres below the surface
45 wouldn't make a great difference to the explosive limits.
46

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

1 that the lower explosive limit and the upper explosive
2 limit will in fact approximate 5 to 15 per cent?

3 A. Yes, I think in this particular case, they would be
4 pretty close values.

5
6 Q. Thank you. Can we talk about the causes of methane
7 ignition, then, because we've talked about the lower
8 explosive limit and the upper explosive limit. When
9 methane is present between those explosive limits, can you
10 explain for us the circumstances in which an ignition might
11 occur?

12 A. Certainly. If in some way the gas-air mixture became
13 heated to the autoignition temperature of methane, which is
14 540 degrees Celsius, so say, for example, there was
15 a quantity of methane and air in a container which was then
16 placed into a furnace or oven and heated up, when it got to
17 540 degrees Celsius the reaction would start and the
18 explosion would occur or the ignition would occur.

19
20 Alternatively, if it was a hot surface, so, for
21 example, something like an engine turbocharger, which can
22 run at a temperature of about 540 degrees Celsius, if some
23 methane and air mixture came into contact with that
24 surface, then it could ignite. But most probably it's when
25 there's an external ignition source or an introduced
26 ignition source, such as a flame or a spark, that comes
27 into the explosive mixture.

28
29 Q. In respect of that first scenario, the heating to the
30 autoignition temperature of 540 degrees Celsius, is it the
31 case that if the methane-air mixture is heated to or above
32 that temperature, it may well ignite regardless of whether
33 there's an external ignition source present?

34 A. Yes, it would.

35
36 Q. It would ignite. All right.

37 A. If it were within its explosive range or its flammable
38 range and it were heated to that temperature, then it would
39 ignite.

40
41 Q. In respect of the third scenario, that is, the
42 presence of an external ignition source, can you give us an
43 idea of the minimum energy that might be required to ignite
44 methane present within its explosive limits?

45 A. Certainly. Within the limits, energy which is
46 required to ignite a mixture is very small, it would be
47 less than 10 millijoules. So it could be a flame - a flame

1 supplies a great deal more than 10 millijoules. A small
2 electrical spark would be a competent or a viable ignition
3 source.
4

5 Q. When you were first explaining the amount of energy,
6 I couldn't quite capture what you said. Did you say
7 10 millijoules?

8 A. Yes, less than 10 millijoules. You need slightly more
9 energy when it's close to the lower or upper explosive
10 limit. When it's almost in the middle, when it's around
11 about 9.5 to 10 per cent methane in air, that's when you
12 need the least amount of energy to ignite it, and at that
13 point it's around 5 millijoules.
14

15 Q. A spark from static electricity, would that be
16 sufficient? Is that the sort of energy that you're talking
17 about?

18 A. Yes, it can be ignited by a static discharge, yes.
19

20 Q. Can we talk about, then, what happens initially when
21 methane ignites. What's the first thing that will occur
22 once ignition has taken place?

23 A. So the first thing that occurs is that a flame front,
24 or sometimes called combustion zone, forms immediately
25 around the ignition source, so that's where the reaction is
26 occurring, and that expands outwards through the
27 surrounding gas-air mixture, as long as there is fuel
28 around it. Now, the reason it expands outwards is because
29 as the gas burns in the air, it produces combustion
30 products, which are carbon dioxide and water vapour, which
31 are hot because of the combustion reaction, and they expand
32 and they force the flame front outwards from the point of
33 ignition.
34

35 So the flame front initially proceeds in a spherical
36 manner, but after a very short time due to surface
37 variations in the flame, the combustion zone, due to minute
38 changes in the atmosphere, even things like specks of dust
39 in the atmosphere can have a profound effect, so what
40 happens is that that spherical appearance starts to become
41 turbulent, it becomes - it takes on a wrinkly surface and
42 starts to become turbulent and starts to, at the reaction
43 zone there will be small rotations or turbulence which
44 draws more air into that mixture and accelerates the
45 combustion.
46

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

1 to say we will talk on the next slide about the speed at
2 which that might occur. Before we move to that, you've
3 indicated on this slide that there are essentially two
4 types of methane explosions - deflagration and detonation.
5 Can you explain for us what a deflagration is, please?

6 A. Well, a deflagration is a combustion reaction in which
7 the flame front is moving through the gas-air mixture at
8 less than the speed of sound, whereas a detonation - in
9 a detonation, the reaction proceeds through the fuel
10 mixture or the fuel-air mixture faster than the speed of
11 sound.

12
13 Q. The phrases "deflagration" and "detonation" are not
14 used uniquely in respect of methane explosions, are they?
15 They can be used to describe other gas explosions?

16 A. They can, in all sorts of fuels, not just gases, but
17 in the case of dust explosions or mist, other airborne
18 fuels will normally undergo a deflagration. Generally
19 speaking, detonations are more associated with a high
20 explosive or what are called condensed phase explosions
21 where the fuel and the oxidiser are in a condensed form, so
22 liquid or solid form.

23
24 Q. When you're talking about a methane explosion, is one
25 more common than the other?

26 A. Yes, most - almost all methane explosions are
27 deflagrations.

28
29 Q. If we go over to the next slide, then, we can return
30 to your explanation for us about the speed and, indeed, the
31 shape that a flame front caused by a methane explosion
32 might take.

33 A. Yes.

34
35 Q. If we can talk firstly about the initial point of
36 ignition and what happens in terms of the flame speed
37 immediately after ignition?

38 A. Immediately after ignition, the flame front moves
39 through the air at about 3.5 metres per second for the
40 first fraction of its travel, so a very short time.
41 Possibly under some circumstances in test situations, up to
42 a second, but in most cases in real life it will be
43 a fraction of a second before it becomes turbulent.

44
45 Q. Now, 3.5 metres per second is approximately 1 per cent
46 of the speed of sound, isn't it?

47 A. Yes, approximately, yes.

1
2 Q. After that initial time, after that first fraction of
3 a second, up to a second after the initial ignition, what
4 happens then in terms of the speed of the flame front?

5 A. What happens then is once the flame front becomes
6 turbulent, either because it's drawing in air on that sort
7 of wrinkly surface or it meets an obstacle and the obstacle
8 distorts the flame front from its spherical shape into some
9 other shape, what happens then is that that induces a
10 separation in the reaction rate or the combustion rate, and
11 that causes the reaction to proceed more quickly and the
12 flame front to move through the air much more rapidly.

13
14 Q. When you say "much more rapidly", what sort of speeds
15 does the flame front reach?

16 A. Most of my experience and research has been within
17 building fires, building explosions, and in those
18 circumstances it's fairly typical for the flame front to
19 proceed at around about between 50 and 100 metres per
20 second.

21
22 Q. And in terms of that speed relative to the speed of
23 sound?

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

34
35 Q. Can we talk about your third bullet point there. You
36 indicate that turbulence and interference from surrounding
37 objects or structures can then cause the flame front to
38 travel more rapidly in some directions than others. Does
39 that mean that the flame front might lose its initial
40 spherical appearance?

41 A. Yes, it will do. When it starts to encounter
42 obstacles or boundaries, particularly, the initial
43 spherical shape becomes distorted or becomes confined in
44 one way or another, and then the expanding gases have to
45 travel in a different direction because there's something
46 blocking the spherical expansion, and when they travel in
47 a different direction you can then get, for example,

1 jetting effects.

2

3 Q. Have you obtained a brief video which demonstrates
4 what an initial reaction post methane ignition looks like?

5 A. Yes. This video comes from a series of tests which
6 were carried out at the Fire Research Station in Britain
7 during the late 1980s or early 1990s, when they were
8 looking at various types of explosion involving gaseous
9 fuels, so they used methane, LPG, flammable liquid vapour
10 and various other types of fuels.

11

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

22

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

24

25 (Video played)

26

27 MS O'GORMAN: Q. So in that particular case, it might
28 appear that the spherical shape of that initial ignition
29 took on that wrinkly appearance even less than one second
30 after the ignition?

31 A. It did, yes, that proceeded within a fraction of
32 a second.

33

34 Q. And we could see towards the end of the video some
35 continued burning of the air, or in the air around the
36 ignition point after that flame front had passed through?

37 A. Yes, that would be caused by some residual unburnt
38 methane from the initial reaction. What's happened is that
39 there was probably some methane that didn't react
40 immediately and continued to burn after the flame front had
41 gone outwards.

42

43 Q. Thank you. Now, so far we've been talking about the
44 flame front that's generated when methane ignites. Is it
45 the case that there is always, and necessarily, an
46 associated pressure wave?

47 A. The burning will always cause the - it has two

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

6
7 But immediately in front of the flame front, there's
8 also a zone where the air itself or the gas-air mixture is
9 being heated by the reaction before it actually becomes
10 ignited. So there are two factors which increase the
11 pressure on the surrounding air.

12
13 Now, what happens then is that the flame front -
14 sorry, a pressure wave is formed, which moves ahead of the
15 flame front, and that will happen whenever there is an
16 ignition of a flammable gas-air mixture.

17
18 Q. Finally on that page you indicate the factors which
19 will affect the size of the pressure wave.

20 A. Yes. The amount of heat being generated by the
21 burning is directly related to how much gas is being
22 burned. So the energy release is limited by the amount of
23 chemical energy contained within the gas. As that gas
24 burns, it releases the heat, and the amount of heat or
25 quantity of heat is what governs the size of the pressure
26 wave or how much energy is imparted in the form of pressure
27 to the surrounding air.

28
29 Q. And is the amount or quantity of gas being burned
30 relevant here?

31 A. Yes. The larger the amount of gas, then the bigger
32 the amount of heat you're generating and therefore the
33 bigger the pressure wave.

34
35 Q. If we go to the next slide, we can see you've
36 indicated here that the intensity of the pressure wave is
37 increased when the burning velocity increases.

38 A. Yes.

39
40 Q. Can you explain for us what burning velocity is,
41 please?

42 A. Okay, so burning velocity - I'll just pull up
43 a definition. So I'll read this out for you. Burning
44 velocity is defined as the speed at which a flame front
45 propagates relative to the unburned gas. It's tested as
46 a thing called the laminar burning velocity, which is the
47 speed at which a wave in the form of a plane or a flat

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

7
8 Q. You've indicated on that slide that, in the open,
9 a deflagration may not cause a pressure wave. By that, do
10 you mean an "identifiable" pressure wave, one that might
11 not be discerned or observed by a human in the area?

12 A. Yes, sorry, I should have said it's really
13 a discernible pressure wave. There will always be a rise
14 in pressure, but it may not be immediately apparent if it's
15 in the open, because the pressure can just dissipate into
16 the atmosphere.

17
18 Under some circumstances, it can be felt in the open.
19 If anybody's had the misfortune to try to start a bonfire
20 or a barbecue with some ignitable liquid, like petrol,
21 they'll probably feel the whoosh even though it's in the
22 open air when it lights. Many people have been burned by
23 that sort of activity. But generally speaking, if it's
24 actually in the wide open area, fully open to the
25 atmosphere, it may not be very discernible.

26
27 Q. That situation can be contrasted to a methane
28 deflagration that occurs in an enclosed or even
29 a semi-enclosed space?

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

37
38 Q. A deflagration will cause an effect like a gust of
39 wind?

40 A. Yes, like a very strong, brief but strong gust of wind
41 or push, it's a pushing effect, but it would be - it could
42 be similar in some circumstances to, for example, the
43 pressure that you might get in a cyclone, from cyclonic
44 wind.

45
46 Q. That can be contrasted to the sorts of effects that
47 might be caused by a detonation, which, as I understand it,

1 might have the effect of tearing or bursting objects apart
2 rather than displacing them?

3 A. Yes, that's correct, a detonation has a shattering or
4 tearing effect on objects and materials immediately around
5 it, whereas a deflagration tends to push things. The
6 reason is that the rate of pressure rise in a deflagration
7 is lower, so although the pressure may go up as high as in
8 a detonation, it does it over a longer time period.

9

10 Q. Can you give us an idea of the sorts of factors that
11 will impact on the magnitude of the pressure wave?

12 A. Yes, as we mentioned, one is the amount of gas which
13 is being burned, so the amount of fuel which reacts.
14 Another one is the geometry of the situation. So, for
15 example, a long, narrow compartment will - there will tend
16 to be a larger pressure wave felt than in a wide open
17 compartment.

18

19 Q. And what about the quantity of the fuel?

20 A. Sorry, yes, so the quantity of the fuel - I thought
21 I mentioned this. The larger the quantity of fuel, the
22 bigger the pressure wave.

23

24 Q. Venting? The available venting - will that have an
25 impact?

26 A. Yes. Sorry, say again?

27

28 Q. Will the venting that is available have an impact on
29 the magnitude of the pressure wave?

30 A. Yes, it will. If there are vents available or venting
31 can occur as a result of some surrounding structure
32 failing, then the pressure wave can disperse through those
33 vents, whereas if there's no available venting and the
34 pressure wave is confined, it doesn't lose any energy, so
35 it will continue strongly.

36

37 Q. Now, to this point we've been talking about the flame
38 speed and shape associated with a methane explosion and
39 also the associated pressure wave. Can we speak briefly
40 now about the variations of methane explosions that can
41 occur? You've listed three there on your slide, the first
42 being a hybrid explosion. Could you explain for us what
43 a hybrid explosion is, please?

44 A. A hybrid explosion is when there is more than one fuel
45 involved. It may be that one fuel is initially involved
46 and then involves a second fuel. An example of this would
47 be - in the sorts of circumstances we're talking about,

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

6
7 We also see this in agricultural situations in silos,
8 quite often, where there's a gas explosion caused by gases
9 being released by decomposition of the silo contents, which
10 then also raises the dust from the agricultural product,
11 which ignites, and a hybrid explosion occurs.

12
13 Q. In either of those occasions, will there be an
14 increase in the energy associated with the explosion?

15 A. Yes, there will. We're now talking about a situation
16 where you've got more than one fuel involved. So even
17 though the original fuel may then be exhausted, the
18 original gas may then be exhausted, the second fuel or
19 subsequent fuels can continue to burn, depending on what
20 they are and how plentiful they are. So a hybrid explosion
21 can actually be more powerful and it can also burn longer.

22
23 Q. The second variation that you've listed is one you've
24 described as either a multiple or a cascade explosion.
25 Could you explain what you mean by that?

26 A. Yes. In a situation, there might be separate areas or
27 volumes of gas-air mixture, then what could happen is that
28 the flame front from the first ignition can travel into
29 another area where there's another concentration of gas
30 which is separated from the first one. If they're all
31 within a single compartment, but they're separated, if you
32 like, pockets of fuel, then we generally refer to that as
33 a multiple explosion.

34
35 Sometimes in buildings you get this effect where there
36 are a number of different rooms which are separated by
37 doors or walls, which each have separate explosive
38 concentrations within them, and they ignite one after
39 another because the pressure wave exposes the next
40 compartment, and that's what we generally call a cascade
41 explosion.

42
43 Q. In either case, that is, in the case of multiple
44 explosions or cascade explosions, will they be observable
45 as a closely linked in time series of explosions,
46 essentially?

47 A. Yes, usually they're described as a rapid series of

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

6
7 Q. Given what you've already told us about the speed of
8 the flame front associated with a methane explosion, will
9 either multiple or cascade explosions necessarily occur
10 very close in time rather than separated in time by numbers
11 of seconds?

12 A. Yes, generally they will be very close together in
13 time. It would be unusual for them to be more than
14 a second apart.

15
16 Q. You've indicated on the slide there that it's also
17 possible to have essentially a combination of a hybrid
18 explosion and the multiple or cascade explosion scenario.

19 A. Yes.

20
21 Q. Are you able to explain that a little for us?

22 A. Yes. In effect, what can happen, you can have
23 a multiple explosion in which the first explosion - the
24 first ignition causes a pressure wave to then produce
25 a hybrid explosion somewhere else.

26
27 Q. If we move to the next slide, can we talk now about
28 the kinds of fire damage that might be caused in the case
29 of a methane explosion?

30 A. Yes. Generally speaking, if it's a pure methane
31 explosion, depending on the concentration of the methane,
32 the flame front that follows immediately behind it produces
33 just a superficial heat damage, if it's on the lean side.
34 So a 5 to 15 per cent methane will generally be a transient
35 flame contact and superficial heat damage. By
36 "superficial" I mean, for example, it can singe hair, it
37 can scorch fabrics, it can cause reddening or first degree
38 burns on skin.

39
40 Q. What about the effects that it might have on either
41 synthetic or natural fibres or fabrics?

42 A. So that type of heat transfer will cause - can cause
43 melting of synthetic fibres; it can cause scorching of
44 natural fibres such as cotton or linen. But sometimes what
45 we find is that if it's been a very brief contact and
46 a fairly small flame front, then sometimes that damage may
47 only be visible under a microscope.

1

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

4

A. Yes.

5

6

7 Q. What are the factors which will influence whether or
8 not the flame front causes either superficial heat damage
9 on the one hand or the more significant radiant heat on the
10 other?

11

12 A. One of the most common reasons for having a larger
13 amount of heat damage is if the gas-air mixture is on the
14 rich side, so somewhere between 10 and 15 per cent. That
15 produces a longer-lasting and a more radiant heating, and
16 the effects of that generally include the fact that
17 combustibles, such as clothing, can actually ignite rather
18 than just be scorched or melted, and it's more likely to
19 cause significant burns to exposed skin.

20

21

22 Q. We were just talking a little while ago about the
23 variations of methane explosions that can occur - that is,
24 those hybrid explosions or the multiple or cascade
25 explosions. Would the presence of either of those
26 variations have an impact on the sort of fire damage that
27 might be caused to a person or to clothing?

28

29 A. Yes, it could well do. For example, if there was an
30 additional fuel which would continue to burn longer, such
31 as, for example, in this case coal dust, so if there were
32 initially a methane explosion, which then ignited airborne
33 coal dust, that would continue to emit much more radiant
34 heat for probably significantly longer and be more likely
35 to cause the ignition of combustibles and be more likely to
36 cause significant burns to skin.

37

38

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

44

A. Yes.

45

46

47 Q. Is a scenario like that necessarily going to cause
48 more fire damage to whatever object or person is in the
49 area, in the vicinity?

50

51 A. Yes. That would cause the person or the object or
52 whatever to suffer, or to be exposed to more radiant heat
53 and for a longer period, so that would increase the
54 severity of the damage.

1
2 Q. We've been talking so far about the general
3 characteristics of a methane explosion and its associated
4 flame front and pressure wave and the damage that might be
5 caused. Can we turn now to a consideration of the events
6 of 6 May 2020. You've been provided with a number of
7 documents, you indicated at the outset of your evidence.
8 One of those documents was a document which contained the
9 extracts of a number of workers' accounts of the explosion
10 that occurred at the Grosvenor mine. Do you recall seeing
11 that document?

12 A. Yes, I do.

13
14 Q. And have you read that and taken account of what it is
15 that the workers observed, felt, saw, that kind of thing?

16 A. Yes, I actually had two sets of documents. One was
17 short extracts of statements or accounts of the workers,
18 and then subsequently I had some more detailed
19 (indistinct).

20
21 Q. I'm sorry, we've just had difficulty hearing the last
22 part of your answer there, Mr Munday. Would you mind
23 repeating that?

24 A. Yes. I said I've had two lots of documents - one lot
25 with my first letter of instruction, which contained some
26 extracts from some statements or records of interview, and
27 then subsequently I was given some slightly more detailed
28 material from some of the workers, who were identified by
29 number, that I understand were the more severely injured.

30
31 Q. Now, from those documents that you were provided with,
32 you were made aware that the workers on the face
33 essentially experienced two pressure waves?

34 A. Yes.

35
36 Q. That there was one pressure wave, the first pressure
37 wave, which was not associated with a flame front?

38 A. That's my understanding, yes.

39
40 Q. And then some time later, approximately 15 seconds
41 later, a further pressure wave, this time accompanied by
42 a flame front?

43 A. Yes, that was certainly my understanding of the
44 sequence, yes.

45
46 Q. And was it the case that at that time, based on that
47 information, your opinion was that the first pressure wave

1 was unlikely to be associated with a methane deflagration,
2 because there was no flame front?

3 A. Yes, that was my initial thought on the matter.
4 I thought that the first pressure wave may have come from
5 some kind of mechanical source --

6
7 Q. Sorry, again, it's just cut out a little bit at the
8 end of your answer there. If you could just repeat it for
9 us, please?

10 A. Sorry. So I was saying that my initial consideration
11 was that because of the lack of a flame front associated
12 with the first pressure wave, that may have been due to
13 some kind of mechanical cause for the pressure, and that
14 the second pressure wave was the result of a deflagration.

15
16 Q. Indeed, knowing that the workers in this case were
17 talking about a pressure wave caused on the longwall
18 situated near a goaf underground, you considered it at
19 least possible, based on that information, that the first
20 pressure wave was a result of a goaf fall or some kind of
21 strata collapse?

22 A. Yes, I made that observation.

23
24 Q. Now, subsequent to forming that initial opinion, it's
25 the case, isn't it, that you were provided with some
26 further material in the form of reports from Sean Muller,
27 in the first instance, and Martin Watkinson, in the second?

28 A. Yes, that's correct.

29
30 Q. The letters that were provided to you seeking further
31 opinion are indeed annexed to the reports that you've
32 provided to us?

33 A. Yes.

34
35 Q. So we can see that, in addition to being provided with
36 those reports, you were asked to proceed on the basis that
37 there was evidence that there had been an advanced heating
38 in the tailgate area of the goaf prior to 6 May 2020?

39 A. Yes.

40
41 Q. And in that respect it was identified, or you were
42 asked to proceed on the basis that ethylene had been
43 detected in samples taken from the goaf prior to that day?

44 A. Yes.

45
46 Q. And you were directed to Mr Muller's report in that
47 regard and particularly to page 50 of his report?

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

5
6 Q. Now, in addition to being provided with Mr Muller's
7 report and having those aspects of it pointed out to you,
8 you've already indicated that you were provided with
9 Mr Watkinson's report, and indeed you were informed in the
10 letter that was given to you that there were products of
11 combustion observed in samples taken from some of the goaf
12 wells immediately after the serious accident?

13 A. Yes.

14
15 Q. And asked to proceed, essentially, on the basis that
16 that information was suggestive of an ignition of methane
17 in the goaf?

18 A. Yes, that's correct.

19
20 Q. Now, for the purpose of providing you with information
21 about those matters, you were again referred to Mr Muller's
22 report at page 50, but also to page 55 of Mr Watkinson's
23 report?

24 A. Yes, that's right.

25
26 Q. As a result of being provided with that further
27 information, you have reviewed your initial opinion about
28 the potential cause of the first pressure wave. We can see
29 there that you consider that there are, in fact, two
30 possibilities for the cause of that first pressure wave,
31 the first being the mechanical air compression, such as
32 a goaf collapse - yes?

33 A. Yes, that's right.

34
35 Q. And the second being that there was in fact
36 a deflagration that occurred in the goaf, either as
37 a result of heating to the autoignition temperature or some
38 other ignition source being present in the goaf?

39 A. Yes, those are the two most likely - well, they're
40 the - they're the only two possibilities that I can think
41 of which would produce a pressure wave in the goaf.

42
43 Q. The information or data that you've been provided is
44 really limited to the sorts of things we've already talked
45 about, that is, the workers' accounts and some of the data
46 referred to by Mr Muller and Mr Watkinson; correct?

47 A. Yes, that's correct.

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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

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

9
10 If it were possible that some methane were contained
11 in an area which was separate from where the first ignition
12 occurred, then it's certainly feasible that that methane
13 would have been pushed by the overpressure in the goaf
14 through to the longwall.

15
16 Q. Thank you. You've just indicated some limitations to
17 your ability to form opinions about the precise mechanism
18 by which a deflagration might have occurred in the goaf and
19 resulted in the scenario that we've been discussing.

20
21 If we move to the next slide, we can see that you've
22 set those out. You've adverted to the fact that you don't
23 know the size and shape of the goaf as it was at the time
24 of the explosion on 6 May 2020?

25 A. That's correct.

26
27 Q. And similarly you don't know the location of each of
28 the rocks, the fallen strata and the voids within the goaf
29 at that precise point in time?

30 A. Yes, that's correct. It's also - sorry, go on.

31
32 Q. No, you please continue.

33 A. I was going to say, it's also not possible for me to
34 know, if an ignition did occur in the goaf, whereabouts in
35 the goaf that occurred and therefore in which direction and
36 at what speed the flame front from that would travel.

37
38 MS O'GORMAN: Mr Martin, I'm mindful of the fact that we
39 would normally take a morning break. Were you intending
40 to, or should we just continue?

41
42 THE CHAIRPERSON: I'm happy to. We'll just take
43 10 minutes?

44
45 MS O'GORMAN: Thank you.

46
47 THE CHAIRPERSON: Mr Munday, we will just adjourn for

1 10 minutes. We will see you shortly.
2

3 **SHORT ADJOURNMENT**
4

5 MS O'GORMAN: Q. Mr Munday, are you able to hear me?

6 A. Yes, I can.
7

8 Q. We spoke a little earlier about multiple or cascade
9 explosions in a general sense. Can we talk now about the
10 likelihood of the two pressure waves observed by the
11 workers on the longwall face at approximately 15 seconds
12 apart being an example of a multiple or cascade explosion?

13 A. Yes, certainly. I think the first and second pressure
14 waves are unlikely to have been a cascade or a multiple
15 explosion, because the 15 seconds or so time lag between
16 them is too great, in my experience and in my opinion, for
17 that to be a directly connected ignition event.
18

19 Q. You've indicated on the slide that a flame front
20 originating from approximately 30 to 40 metres back in the
21 goaf would have travelled to the longwall face in
22 significantly less time than 15 seconds, more like 1 to 2
23 seconds, you indicate?

24 A. Yes, generally speaking. The problem I have is that
25 almost all of the information that I know and that I've
26 been able to find relates to experimental explosions in
27 structural situations, say, buildings and plant and
28 factories, and generally speaking, because the typical
29 flame front speed is in that order of around 50 to 100
30 metres per second, as we briefly spoke about earlier,
31 I think it's unlikely that a flame front coming from the
32 goaf, if it was travelling 30 to 40 metres, which is what
33 was suggested to me, I don't think it would be likely that
34 it would take more than a couple of seconds to reach the
35 longwall.
36

37 Q. So the two pressure waves, assuming for the moment
38 that the first one was a deflagration in the goaf, are,
39 however, not a cascade of one upon the other; they're
40 separate events?

41 A. That's my opinion, yes.
42

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

45 A. Yes.
46

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

1 that associated flame front has all the characteristics of
2 a deflagration?

3 A. Yes, I would agree with that. The descriptions of the
4 workers which I've seen and the damage which was apparent
5 in the photographs in Mr Nystrom's report all indicate to
6 me that the second pressure wave was a deflagration on -
7 sorry, within the longwall.

8
9 Q. When you say you would agree with that, are you
10 referring to the fact that you were provided with Murray
11 Nystrom's report previously and you've seen the conclusions
12 that he reached in that report?

13 A. Yes, that is correct. I didn't examine the mine first
14 hand, so I was dependent on his examination and his
15 photographs in the report.

16
17 Q. And having done so, you indicate in one of your
18 reports that you accept his methodology?

19 A. Yes, I do. I think it was - his appears to be sound
20 and thorough.

21
22 Q. Whilst it's difficult for you to form any independent
23 view about the direction of the flame front travel based on
24 those photographs alone, because they're taken close up and
25 not in context, you proceed on the basis that his
26 methodology was appropriate and his conclusions appear
27 sound?

28 A. Yes, that's correct.

29
30 Q. Can we move to the second bullet point on that slide,
31 then, please, and could you give us some explanation of
32 what you mean by that?

33 A. What I meant by that was that if the first pressure
34 wave which came from the goaf - sorry, if the first
35 pressure wave pushed methane from the goaf on to the
36 longwall, so that there was then a flammable concentration
37 or ignitable concentration within the longwall, then if
38 there was also some coal combustion going on close to the
39 longwall directly behind the shields, then that methane-air
40 mixture could be ignited, potentially could be ignited, by
41 that heat source within the goaf immediately behind the
42 shields.

43
44 Q. In terms of the explosion that occurred - that is, the
45 second pressure wave and the associated flame front -
46 you've indicated at the third bullet point that you don't
47 consider it's possible to be able to say definitively

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

9
10 Q. If we could go to the next slide, then, you've
11 indicated in the first bullet point that the flame front -
12 and we're still talking about the second pressure wave and
13 the associated flame front - would have stopped when there
14 was no longer sufficient fuel in the atmosphere, but the
15 pressure wave would have continued.

16 A. Yes, that's correct.

17
18 Q. So when there is a methane explosion and a flame front
19 travels outwards from the point of ignition, it will
20 necessarily stop or cease once there's no further fuel in
21 the surrounding atmosphere?

22 A. Yes.

23
24 Q. But the pressure wave itself won't necessarily cease
25 at that point in time; is that what you're indicating?

26 A. Yes, because the combustion products, the hot carbon
27 dioxide and water vapour, will still be expanding behind
28 where the flame front would have been if it had continued.
29 So the combustion products are still expanding and still
30 generating pressure on the air, even though the flame has
31 now gone out. It will gradually dissipate, it will
32 gradually cool off and the overpressure will drop, but that
33 will take some seconds.

34
35 Q. In this particular case, we know from workers who were
36 working quite some distance from the longwall that they
37 observed a pressure wave but not a flame front. Is that
38 explicable because of the phenomenon that you've just
39 described?

40 A. Yes, that would be a fairly normal thing for witnesses
41 further away to observe, yes.

42
43 Q. Looking at your second bullet point there, do
44 I understand it to be the case that you're not in
45 a position - that is, it's outside your area of expertise -
46 to determine definitively the ignition source of either the
47 first event, if it was a deflagration, or the second event?

- 1 A. Yes, I wouldn't say it's outside my expertise. It's
2 outside the range of information that I have available.
3
- 4 Q. I understand.
- 5 A. There's definitely not enough solid information to say
6 that it was one thing or another thing.
7
- 8 Q. Nonetheless, there is one ignition source which, in
9 your opinion, can be ruled out, and that is static
10 electricity discharge?
- 11 A. Yes, I think that's highly unlikely. The reason is
12 that I looked through the information or the environmental
13 information that I was given for the period leading up to
14 the incident, and the lowest relative humidity figure that
15 was present was 71 per cent. Generally speaking, a static
16 electrical discharge will only occur if the relative
17 humidity is below 50 per cent.
18
- 19 Q. Just for completeness, you were able to calculate the
20 relative humidity from data provided to you, which included
21 the wet and dry bulb temperature data from the day?
- 22 A. Yes, that's correct. So there's a method for
23 calculating from the wet and dry bulb temperatures the
24 relative humidity.
25
- 26 Q. Your conclusion was that given that the lowest
27 humidity you were able to calculate was I think you said
28 71.1 per cent, or thereabouts --
- 29 A. Yes.
30
- 31 Q. -- there was too much humidity for static electricity
32 discharge to be the cause of an ignition?
- 33 A. Yes, certainly between - for example, a static
34 electricity discharge between items of clothing or between
35 clothing and the shields or anything of that nature.
36
- 37 Q. I know you've indicated that you haven't been provided
38 with enough information for you to form an opinion about
39 the potential ignition source, but you've indicated on this
40 slide possible ignition sources. Can you just talk us
41 through those?
- 42 A. Possible ignition sources. I've considered here
43 spontaneous combustion within the coal, so that can work in
44 two ways. One way is that the actual coal surface could be
45 above the autoignition temperature of the gas-air mixture,
46 or, alternatively, it could be that a spontaneous - or
47 sorry, a self-heating event in the coal was combined with

1 some ventilation to then cause a small flame to be produced
2 at the surface of the coal. So either of those could be
3 situations which would produce heat for the gas-air
4 ignition.
5

6 I thought about friction spark. Particularly if the
7 initial overpressure was something to do with a goaf
8 collapse, I wondered whether - and it's no more than
9 speculation, because I've got no information to indicate
10 whether it's probable or not probable, but whether
11 something could have occurred within the goaf which caused
12 some piece of rock to become unstable and then fall and
13 strike some metal, like part of a shield, to cause a spark
14 or small piece of hot material.
15

16 Another possibility that I considered was whether the
17 first pressure wave in some way caused a compromise to some
18 electrical cabling or equipment, and I noted that the
19 workers reported that the power went out after the first -
20 or at the time of the first pressure wave, and it seemed to
21 me that there must be a reason for that to have occurred.
22 I couldn't eliminate the possibility that some mechanical
23 damage had occurred to a cable or a piece of equipment.
24

25 Q. You've indicated already, I think, that the
26 descriptions that you've seen of the workers, in particular
27 in relation to the intensity and duration of the two
28 pressure waves, are consistent with a methane deflagration?
29

30 A. Yes. Yes, in my opinion, they are.

31 Q. What about noise? Would there necessarily have been
32 a particular noise able to be heard by any one of those
33 workers, and, if so, would it necessarily have been of one
34 kind or is there a range? Might there not be a noise?

35 A. Generally speaking, a pressure wave does - most
36 witnesses report a noise associated with a pressure wave.
37 The descriptions vary a lot depending on the particular
38 speed and intensity of the pressure rise. So, very often
39 people will describe - sometimes people will describe it as
40 being a whoosh, like a gust of wind; sometimes they'll
41 describe it as being more like a bang or a louder or a more
42 violent noise; sometimes people talk about things like the
43 sound of thunder. In fact, the sound of thunder is
44 actually quite a good description of a reasonably high
45 -speed pressure wave.
46

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

1 vary?

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

7
8 Q. I'm going to take you to another video that you've
9 provided us with and play it now, and I'll ask you to
10 comment on the noise that you can hear associated with this
11 video, but before it's played, are you able to indicate
12 whether this originates from the same material that the
13 other video came from?

14 A. Yes, it does. It's the same series of tests. In
15 fact, this particular test, I was present when it was
16 conducted. I was one of a number of observers at the test
17 site. This particular one - if I'm correct, this
18 particular one involves LPG rather than methane, so liquid
19 petroleum gas, which is propane, rather than methane. But
20 the effect is the same. So there's very, very little
21 difference between igniting propane or igniting methane,
22 except that propane is more dense than air rather than less
23 dense than air.

24
25 Q. In terms of the ignition itself, where did it happen
26 relative to what we can see on the screen there?

27 A. What you're seeing on the screen is a test compartment
28 which is in the shape of a room, so approximately
29 2.5 metres square and 2.5 metres high. It has a door which
30 you can see, and for the purposes of this test it was
31 fitted with a glazed window, a single glazed window. The
32 compartment had a flammable mixture of gas and air in it,
33 introduced into it, and then the same kind of spark igniter
34 that you saw in the first video was used. What we'll see
35 here is a slow-motion recording of what happens as that
36 pressure builds up and then a flame front follows it.

37
38 Q. Is the purpose of your having provided this video to
39 demonstrate what the pressure wave might look and sound
40 like as it moves in front of the flame front?

41 A. Yes.

42
43 MS O'GORMAN: All right, let's play the video.

44
45 (Video played)

46
47 MS O'GORMAN: Q. Did we see there the disturbed air, the

- 1 pressure wave coming out from the window ahead of the flame
2 front?
- 3 A. If you want to replay it, I can talk over it and
4 describe what's going on, if that would be helpful?
5
- 6 Q. Thank you. (Video played).
7 A. Here, first of all, the glass starts to flex. Some
8 curtains that were hanging inside are blown outwards. Then
9 the flame comes out behind it. And then you can see
10 there's some residual burning going on inside the test room
11 there, with the rest of the gas burning off.
12
- 13 Q. We didn't hear in that video the noise of a boom or
14 a bang but perhaps more of a windy noise.
15 A. Yes, bear in mind that that was in slow motion. In
16 real time, it's a shorter, sharper noise.
17
- 18 Q. In terms of the flame front, then, and the
19 descriptions that you've seen from the workers who were on
20 the longwall and experienced that flame front as part of
21 the explosion, is it the case that, in your opinion, those
22 descriptions are consistent with a methane deflagration?
23 A. Certainly those descriptions which included a blue
24 flame or being a blowtorch or those sorts of descriptions
25 are very much consistent with a methane deflagration. The
26 duration, the very short or the relatively short duration,
27 are consistent with exposure to a deflagration, yes.
28
- 29 Q. Have you had an opportunity to review Mr Sellars'
30 evidence given here in the hearings?
31 A. Yes, I watched that piece of evidence this morning,
32 and what he's describing is - it's consistent with
33 a methane deflagration, but it could also be consistent
34 with a hybrid event.
35
- 36 Q. One of the other workers you will have seen in the
37 extracts referred to a yellow-coloured flame rather than
38 a blue-coloured flame.
39 A. Yes.
40
- 41 Q. Is that of any significance?
42 A. Yes, what happens with flames is that the blue colour
43 is what happens when there's very efficient combustion, so
44 all of the gas is very well mixed with air - sorry, the gas
45 is very well mixed with the air, it's the right
46 concentration and it burns very efficiently, so that the
47 only combustion products are carbon dioxide and water, and

1 the flame is very blue.

2

3

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

13

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

17

A. Yes.

18

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

23

A. Yes.

24

25 Q. And you had regard to those photographs?

26

A. Yes, I did. From what I could see, the damage to the
27 clothing and personal equipment, such as the pouches, was
28 very consistent with exposure to a high-energy
29 deflagration, one with a high degree of radiant heat.

30

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

34

A. Yes.

35

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

39

A. Yes.

40

41 Q. What does that tell you, if anything, about the flame
42 front or the mechanism by which they sustained those
43 injuries?

44

A. It suggests to me that those injuries weren't caused
45 by the flame front alone and it is likely that some of
46 their clothing or personal equipment actually continued to
47 burn after the flame front had passed and continued to

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

3

4 Q. Is that something that can commonly occur in the case
5 of a methane deflagration?

6 A. Yes, it's more common if the concentration is at the
7 rich end, so between 10 and 15 per cent, rather than the
8 lean concentration, but, yes, it can occur. And it
9 depends, as well, to a certain extent on the nature of the
10 materials and the clothing and so on.

11

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

17 A. Yes.

18

19 Q. Do you recall seeing those descriptions?

20 A. Yes, I do.

21

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

26 A. Yes.

27

28 Q. And you will recall that in the extracts given to you,
29 none of the workers on the longwall face talk about
30 a suck-back effect between the two pressure waves or
31 a reverse pressure wave. Are you able to give us an idea
32 of how those two things might sit comfortably with each
33 other?

34 A. Yes. What happens with a pressure wave is that
35 obviously there's a displacement of pressure which
36 eventually at some point is vented to atmosphere, and then
37 what's called replacement air has to come back in from
38 atmosphere to replenish what has been displaced in order to
39 maintain atmospheric pressure.

40

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

1
2 MS O'GORMAN: Thank you for that. Mr Martin, those are
3 all of the questions that I have for Mr Munday.
4
5 THE CHAIRPERSON: Yes, thank you. Mr Holt?
6
7 MR HOLT: No questions, thank you, Mr Martin.
8
9 THE CHAIRPERSON: Mr Crawshaw?
10
11 MR CRAWSHAW: No questions, thanks, Mr Chair.
12
13 THE CHAIRPERSON: Thank you. Ms Grant? It would seem
14 not. Mr O'Brien?
15
16 MR O'BRIEN: No, thank you.
17
18 THE CHAIRPERSON: Ms Holliday?
19
20 MS HOLLIDAY: No questions, thank you, Mr Martin.
21
22 MS O'GORMAN: I have no further questions.
23
24 THE CHAIRPERSON: Mr Clough?
25
26 MR CLOUGH: No questions from myself.
27
28 THE CHAIRPERSON: All right. Mr Munday, thank you for
29 your evidence. You are now excused.
30
31 **<THE WITNESS WITHDREW**
32
33 MS O'GORMAN: Mr Martin, there is one more witness lined
34 up for today. Dr Basil Beamish is going to be recalled.
35 I understand he is available at 2.15 this afternoon.
36
37 THE CHAIRPERSON: Yes, all right. Thank you. I take it
38 there will be at least one extra party for 2.15?
39
40 MS O'GORMAN: That's our understanding.
41
42 THE CHAIRPERSON: All right. Nothing else until then?
43
44 MS O'GORMAN: No.
45
46 THE CHAIRPERSON: Thank you. We will adjourn until 2.15.
47

1 **LUNCHEON ADJOURNMENT**

2
3 THE CHAIRPERSON: Yes, Mr Hunter?

4
5 MR HUNTER: May it please the board, I recall Dr Beamish.

6
7 THE CHAIRPERSON: Yes, thank you.

8
9 <BEVAN BASIL BEAMISH, on former oath: [2.16pm]

10
11 <EXAMINATION BY MR HUNTER:

12
13 MR HUNTER: Q. You will recall that we adjourned on the
14 last occasion when you were here in order that you might
15 properly review the report prepared by Simtars in
16 connection with the testing of the PUR product that we're
17 concerned with?

18 A. Yes.

19
20 Q. Have you now had an opportunity to review that report
21 to your satisfaction?

22 A. Yes, I've been able to go through that.

23
24 Q. Were you also able to see Mr Parmar, or if not see
25 him, at least read a transcript of the evidence that he
26 gave?

27 A. I have.

28
29 Q. Was there anything that you read or heard in
30 connection with that testing that has caused you to alter
31 the views that you already told us about and expressed in
32 your report?

33 A. No, there's nothing changed there.

34
35 Q. Did you, though, draw to my attention something that's
36 contained in DSI's own risk assessment for this product?

37 A. It's not only the risk assessment. It's available on
38 the internet. It was a pictorial that caught my attention.

39
40 Q. Mr Operator, could we please have RSH.024.004.0001,
41 and could we go to the 12th page, I believe it is. Could
42 we zoom in on the bottom of those two images, please. What
43 we're looking at here appears to be an idealised view of
44 how the face and roof might look after the injection of the
45 product?

46 A. Yes, but in this case it's a rock roof that's there,
47 but in the situation at Grosvenor it's actually coal in the

1 roof.

2

3 Q. What is it about what we see here, though - let's
4 assume that the roof is a beam of coal, not rock. What is
5 it about what we see here that's of significance, in your
6 view?

7 A. The thing that caught my attention was in this area
8 here, coming away from the hole, how the PUR is depicted as
9 moving into multiple fractures, and in some circumstances
10 what we're seeing is the PUR then obviously accumulating at
11 fracture intersections as well, so you're ending up with
12 a larger mass of PUR than what is just shown as going
13 through the hole. So it's actually moving out into the
14 fractured rock material in this case, but it would be coal
15 otherwise.

16

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

22

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

36

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

40 A. Yes.

41

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

46 A. It is a plausible scenario, yes.

47

1 Q. And in terms of this process of fracturing, when, in
2 terms of the advance of the shield, is that fracturing that
3 would expose the PUR-affected coal to air likely to occur?
4 A. It's highly likely because of the stresses involved in
5 the fracture zone as you move forward.
6
7 Q. But at what point is that fracture likely to occur, in
8 terms of the movement of the shield? Are we talking about
9 this area back here above the hinge at the rear of the roof
10 shield or is it some other point?
11 A. Certainly as it's getting closer back to the rear of
12 the canopy there, it's going to be a much better
13 opportunity for the fracturing to occur.
14
15 MR HUNTER: They were the only questions I had for
16 Dr Beamish.
17
18 THE CHAIRPERSON: Mr Holt, anything?
19
20 MR HOLT: No, thank you, Mr Martin.
21
22 THE CHAIRPERSON: Mr Crawshaw?
23
24 MR CRAWSHAW: No, thanks, Mr Chair.
25
26 THE CHAIRPERSON: Ms Grant or Mr Cowan? Mr Telford?
27
28 **<EXAMINATION BY MR TELFORD:**
29
30 MR TELFORD: Q. Good afternoon, Dr Beamish.
31 A. Good afternoon.
32
33 Q. Do you recall that when we spoke on I think it was
34 Friday the 26th --
35 A. Two weeks ago, yes.
36
37 Q. -- yes, and at that stage we had only just received
38 the Simtars report, within a matter of hours, and I was
39 attempting to ask you a series of questions about that
40 report.
41 A. Mmm-hmm.
42
43 Q. You indicated that you weren't comfortable answering
44 questions about that report, and in response to a question
45 from Mr Martin - this is at transcript page 2019 - you said
46 that you were not comfortable talking about other people's
47 data; you would rather talk to the authors about that

- 1 particular work. Do you remember saying that?
2 A. I did, yes.
3
4 Q. This particular document that you've raised with us
5 this afternoon - who was the author of that?
6 A. The document?
7
8 Q. Yes. The one we've just been talking about.
9 A. The pictorial there? It's freely available on the
10 net.
11
12 Q. Who was the author of that report, Dr Beamish?
13 A. It's not a report. It's just an image that's on the
14 web.
15
16 Q. Do you know who prepared it?
17 A. No, I don't.
18
19 Q. The same image is in the risk assessment of
20 DSI Underground; are you aware of that?
21 A. Yes, I am.
22
23 Q. Have you spoken with the author of that document?
24 A. No.
25
26 Q. But you're comfortable, notwithstanding what you told
27 us on 26 March about your preference to speaking with the
28 author of the report before you comment on the report - are
29 you comfortable --
30 A. That was about data, the data that was there.
31 I needed to know where the data - and how it was obtained.
32
33 Q. And that's different when you come to comment on this
34 idealised schematic, is it?
35 A. I'm looking at a picture. A picture's worth
36 a thousand words.
37
38 Q. Is it an accurate picture, Dr Beamish?
39 A. It's a reasonable representation, I would imagine.
40
41 Q. You imagine, did you say?
42 A. I would pick it as a reasonable representation, yes.
43
44 Q. And on what basis do you say that?
45 A. In terms of the fracture mechanics that takes place in
46 the face.
47

- 1 Q. Do you remember telling us on 26 March that you
2 weren't familiar with the in-mine conditions as at
3 Grosvenor on 6 May 2020?
- 4 A. The in-mine conditions?
- 5
- 6 Q. Yes.
- 7 A. I was referring to the background that led up to the
8 event, not the actual mine face condition.
- 9
- 10 Q. Are you familiar now with the face conditions when the
11 PUR was applied at Grosvenor mine in 2020?
- 12 A. Not the specific conditions in the mine, no.
- 13
- 14 Q. So you can't make any comparison whatsoever between
15 what actually occurred at Grosvenor mine and this idealised
16 depiction in this report, or this diagram prepared by
17 somebody else?
- 18 A. But I can make some reasonable assumptions as to how
19 that particular outcome would eventuate.
- 20
- 21 Q. It's the case, isn't it, Dr Beamish, that you've
22 chosen this particular image because it supports your
23 hypothesis about the very particular circumstances that
24 need to occur in order for there to be a spontaneous
25 combustion event involving the application of PUR?
- 26 A. No, I've chosen it because it's a very good pictorial
27 representation of possibility.
- 28
- 29 Q. Of a possibility?
- 30 A. Possibility.
- 31
- 32 Q. Not a probability; a possibility?
- 33 A. Possibility.
- 34
- 35 Q. According to whoever drew or designed or prepared this
36 diagram?
- 37
- 38 THE CHAIRPERSON: Sorry, what's the question?
- 39
- 40 MR TELFORD: That the possibility as depicted in this
41 diagram bears no correlation whatsoever to what was
42 happening on the coalface at Grosvenor in May 2020?
- 43
- 44 THE CHAIRPERSON: The possibility of what, Mr Telford?
- 45
- 46 MR TELFORD: Of the circumstances as they are presented by
47 this diagram, Mr Martin.

1
2 THE CHAIRPERSON: As in the picture?

3
4 MR TELFORD: Yes.

5
6 THE CHAIRPERSON: And the possibilities being that the
7 roof was injected in that form - is that what you mean?

8
9 MR TELFORD: Yes, and, in particular, that there is
10 a piece of coal which has been identified by Dr Beamish
11 surrounded by PUR of that particular size and
12 characteristic.

13
14 THE CHAIRPERSON: Yes, okay. All right.

15
16 MR TELFORD: Q. Do you understand the question?
17 A. Yes, in a sense, but I can picture this because I've
18 worked underground. I've worked underground in roof
19 falls - I've seen roof falls, I've understood, I can see
20 what the fractures are and so on, so, to me, that
21 representation is a fairly good pictorial of fractured roof
22 in front of a mine face.

23
24 Q. But what you can't assist the Board with is whether
25 that is an accurate depiction of what actually occurred on
26 this occasion, and by that I mean May 2020?
27 A. There are degrees of accuracy. The main thing is it's
28 a possibility.

29
30 MR TELFORD: No further questions, thank you, Mr Martin.

31
32 THE CHAIRPERSON: Thank you. Mr O'Brien, did I leave you
33 out? No questions. Ms Holliday?

34
35 MS HOLLIDAY: No questions, thank you, Mr Martin.

36
37 THE CHAIRPERSON: Mr Hunter?

38
39 MR HUNTER: No re-examination, thank you.

40
41 THE CHAIRPERSON: Mr Clough?

42
43 MR CLOUGH: Q. Dr Beamish, I do have one question. It's
44 something I thought of after the last evidence you gave,
45 when I asked you about gas drainage and its effect on the
46 propensity for spontaneous combustion. Correct me if I've
47 got this wrong, but I understood that gas drainage could

1 increase the propensity for spon com by basically opening
2 up the coal fractures so there's more oxygen. Is that
3 correct?

4 A. Not quite. It's twofold. When you do gas drainage,
5 you're removing coal - you're removing gas from the pore -
6 coming off the pore surfaces, and as it comes out, it
7 brings moisture with it, so now you're reducing basically
8 moisture, which is a heat sink in itself, and the process
9 of gas liberation is also endothermic, so it's a cooling
10 effect as well, as it comes out. But the main thing is
11 then you're creating an opportunity for air access to the
12 sites. But, having said that, the other side of that is
13 that if the air accesses those sites, the coal has to be
14 reactive enough to take the opportunity to use the oxygen
15 to create the heat.

16
17 Q. So the question was actually in regard to the sample
18 you tested, and if I recall rightly, I believe it was said
19 that it came from around the longwall 108 area at
20 Grosvenor.

21 A. That's correct.

22

23 Q. Do you know if that area had been pre-drained?

24 A. No, I don't.

25

26 MR CLOUGH: No more questions, thanks.

27

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

30

31 <THE WITNESS WITHDREW

32

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

35

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

44

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

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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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