

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 Thursday, 18 March 2021 at 10am
(Day 19)

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THE CHAIRPERSON: Yes, Mr Hunter.

MR HUNTER: May it please the Board, I call Sean Muller.

<SEAN MULLER, sworn: [10am]

<EXAMINATION BY MR HUNTER:

MR HUNTER: Q. Mr Muller, will you tell us your full name?

A. Sean William Muller.

Q. You work at Simtars?

A. Yes.

Q. What position do you hold there?

A. I am acting senior analytical chemist.

Q. I'll just ask you to keep your voice up nice and loud so we can hear you. So you're an acting senior analytical chemist. Do you have a Bachelor of Applied Science degree?

A. Yes.

Q. And did you major in chemistry and industrial chemistry?

A. Yes.

Q. Did you achieve that qualification in 2008?

A. Yes, I think so.

Q. How long have you been working at Simtars?

A. Over 10 years, maybe 10 to 11 years.

Q. And over that period of time, what have you been doing?

A. Mainly gas analysis, particularly relevant to underground coal mines, a lot of that being using gas chromatographs, tube bundle systems, gas monitors.

Q. I'll get you to explain gas chromatographs to us in a while. Do you have exposure to tube bundle systems?

A. Yes. Yes, we have a mobile laboratory and it has a tube bundle system that we regularly use.

THE CHAIRPERSON: Q. Mr Muller, I'm sorry, but you're going to have to keep your voice up throughout the whole

1 giving of evidence, because it's really very difficult to
2 hear, so please bear that in mind.
3 A. Yes, no worries.
4
5 MR HUNTER: Thank you.
6
7 Q. So you were saying that there's a mobile laboratory
8 that Simtars has?
9 A. Yes.
10
11 Q. What does that mobile laboratory comprise?
12 A. It has a tube bundle system, and it has room for two
13 gas chromatographs.
14
15 Q. Have you been responsible for setting up and running
16 and decommissioning that mobile gas laboratory?
17 A. Yes.
18
19 Q. Have you got experience in responding to mine
20 emergencies, including spontaneous combustion events?
21 A. Yes.
22
23 Q. And have you personally been involved in the response
24 to significant events that have involved extensive loss of
25 production and equipment?
26 A. Yes, that's correct.
27
28 Q. Can you tell us about some of those, please?
29 A. Well, the first emergency I responded to in 2010 was
30 Pike River. I was deployed there to run the gas
31 chromatograph on site and to train others to run the gas
32 chromatograph and also to do up reports, simple reports,
33 and help with sampling.
34
35 Q. Yes, after that?
36 A. After that, Carborough Downs was another deployment
37 that we had where we used the mobile lab for months, using
38 the tube bundle system and gas chromatographs to analyse
39 samples on that mine site.
40
41 Q. What had happened at Carborough Downs?
42 A. I'm not a hundred per cent sure what happened at
43 Carborough Downs. By the time we were deployed, I suppose
44 the problem had already manifested, and back at that time
45 I was more involved in simply ensuring the analysis was
46 correct rather than getting involved in the cause.
47

- 1 Q. Were you deployed to North Goonyella in 2014?
2 A. Yes, that's correct.
3
- 4 Q. In brief terms, what was the nature of that incident?
5 A. It was a seal-up of a longwall, and I provided
6 a second gas chromatograph on site to assist with the
7 analysis.
8
- 9 Q. But what had occurred underground in relation to the
10 seal-up that caused you to be deployed there?
11 A. Again, not a hundred per cent sure of what the cause
12 of that incident was. I do remember there being
13 significant spontaneous combustion gas indicators there
14 that prompted that, that they were looking for.
15
- 16 Q. Were you deployed to Narrabri in 2018?
17 A. Yes.
18
- 19 Q. What sort of incident was that? Did that involve
20 spontaneous combustion?
21 A. Yes, that was a spontaneous combustion incident.
22
- 23 Q. Were you also deployed to North Goonyella for a second
24 time, in 2018?
25 A. Yes, that's correct.
26
- 27 Q. And on that occasion there was a spontaneous
28 combustion and fire?
29 A. Yes, yes.
30
- 31 Q. Most recently have you been deployed to Moranbah North
32 mine in the last few months, or weeks?
33 A. Yes. I was also, before that, deployed to Grosvenor
34 in June.
35
- 36 Q. June of last year?
37 A. Yes.
38
- 39 Q. Moranbah North was this year?
40 A. Yes.
41
- 42 Q. Are you familiar with NATA, the National Association
43 of Testing Accreditation?
44 A. Yes, or "Authorities", possibly.
45
- 46 Q. Do you hold any qualifications with respect to NATA?
47 A. Yes, I'm an approved signatory for our NATA accredited

1 methods on site involving gas analysis at Simtars. That
2 could involve the gas chromatograph analysis or the
3 calibration of instruments, for example hand-held gas
4 monitors or infrared analysers used in a tube bundle
5 system.

6
7 Q. Does your role also involve the delivery of training
8 programs for coal mine workers?

9 A. Yes, that's correct. I deliver gas chromatograph
10 training and spontaneous combustion training in terms of
11 the gas analysis side of things there.

12
13 Q. For how long have you been delivering those training
14 programs?

15 A. Gas chromatograph, most of 10 years, and the
16 spontaneous combustion from about 2014, I'd estimate.

17
18 Q. The mine personnel to whom you deliver this training,
19 particularly about the use of a gas chromatograph, what
20 role or roles do those coal mine workers generally occupy?

21 A. It could be - it's normally a variation. Often it
22 would be control room operators or technical-services-type
23 people. It could also be deputies, and in some cases it
24 could be miners from underground that do that for some
25 reason.

26
27 Q. Do the people that you train generally already have,
28 for example, qualifications in chemistry?

29 A. No. All of the operators we train are staff or
30 workers at the mine site, and as far as I know, I haven't
31 come across anyone I've trained with a chemistry degree
32 before.

33
34 Q. We heard a little bit of evidence yesterday about gas
35 chromatography, but it sounds like you might be the person
36 to ask to explain it to us in terms that we can understand,
37 please.

38 A. Yes.

39
40 Q. Could you tell us what a gas chromatograph is and what
41 it does?

42 A. A gas chromatograph is a scientific instrument which
43 analyses gases. The reason it's called a gas chromatograph
44 is actually because it runs on gas, not necessarily because
45 it analyses the gas.

46
47 It's got columns within the instrument, which you

1 could imagine as being a hollow capillary with some sort of
2 packing, if you'd imagine - they call it a molecular sieve,
3 so you could imagine it being some sort of porous
4 structure. A gas is passed through there called the
5 carrier gas, which provides the instrument with the
6 pressure needed to separate the gases out.
7

8 When the samples are introduced into that stream,
9 they're separated out before they pass over a detector.
10 What this looks like on the output is you get a graph, and
11 it's a time graph where you've got peaks that come out at
12 certain times. Those peaks correlate with the amount of
13 time it took for the sample to pass through the column. In
14 that respect, too, the sample has been separated apart, so
15 each component of the gas is being analysed individually
16 rather than at the same time as other components.
17

18 The height, or the area of the peaks, represents the
19 concentration. So you can tell which gas is which by the
20 time it comes out, and you can tell how much there is by
21 the size of the peak.
22

23 Q. So do you measure the area under the curve?

24 A. Yes.
25

26 Q. How do you know which analyte you're looking at as the
27 results come out?

28 A. So we deliver a span gas for calibration, and we know
29 what's in that span gas. From prior research and set-up,
30 we know what order those gases come out in. So when we put
31 that span gas through, we can identify the precise times
32 that those components are coming out. What we do is we set
33 a - it's called a retention window, where you give a range
34 for anything to come out in that particular time would
35 correlate with that particular gas.
36

37 Q. I'll take you to a graph in due course, but how
38 sensitive is a gas chromatograph?

39 A. It depends on what gas you're trying to analyse.
40 A gas chromatograph uses a thermal conductivity detector,
41 so different gases have different thermal conductivities.
42 As an example, carbon monoxide is not particularly
43 sensitive on a gas chromatograph compared to an infrared
44 analyser, but for something like carbon dioxide, that might
45 be very sensitive; or other gases, for example hydrogen and
46 ethylene, they're very sensitive as well.
47

1 Q. Is there, though, a limit below which you can't
2 reliably say that a particular gas or a particular quantity
3 of that gas is present?

4 A. Yes, that's right. We generally have a limit of
5 detection associated with the different gases so that we
6 can confirm that at that particular concentration we will
7 see a peak. It doesn't necessarily mean the concentration
8 of that peak is exactly that concentration, and certainly
9 below it. However, we do know that we can see it at that
10 concentration, and often you can see it below that
11 concentration as well. But the way we do our limit of
12 detection, we have a relative standard deviation threshold,
13 and for it to pass that, you know, we do a test to make
14 sure it can meet that threshold.

15
16 Q. I'm going to ask you quite a bit about ethylene.

17 A. Yes.

18
19 Q. What's the generally accepted, if there is one, limit
20 of detection for ethylene on a gas chromatograph?

21 A. We would normally do a limit of detection for 1 ppm
22 for ethylene. However, that's not necessarily - you know,
23 because of the capabilities of the instrument, we've also
24 got gas mixing equipment. We have to make sure that our
25 gas mixing equipment can reliably mix something. Mixing
26 below 1 part per million of ethylene is difficult. So
27 because we can mix 1 part per million, and that's a good
28 threshold value for that, we will make sure we get a limit
29 of detection for 1 ppm of ethylene. But below that, you
30 still quite often see a peak - in fact, half a ppm of
31 ethylene is quite clear to see, and below that, it's often
32 visible. There is a threshold possibly below 0.2 or 0.1
33 where it becomes very difficult.

34
35 Also, at, say, levels below 0.1 and, you know, more
36 relatively as you move towards zero, say if you're getting
37 a result of 0.2, that doesn't necessarily mean that's 0.2.
38 That's below the limit of detection and we can't guarantee
39 that that would be the level. It could be 0.3 or 0.4.

40
41 Q. So what sort of skill is required to detect ethylene,
42 for example, at these low levels?

43 A. Because the ethylene is at such a low level in that
44 the computer software cannot easily identify a peak - and
45 this can happen with other gases as well, for example
46 carbon monoxide - the GC operator is trained to zoom in, in
47 our term, on the baseline, where they magnify the response

1 on the graph until they can get a clear idea or a more
2 clear idea of whether that peak in fact is present or not.

3

4 Q. Obviously we're talking about the state of science as
5 it is today. Has it in the past been suggested in
6 scientific literature that the limit of detection for
7 ethylene, for example, using GC analysis, is in fact higher
8 than 1 part per million?

9 A. I don't recognise that. In fact, I've heard stories
10 of different types of GCs being able to see ethylene at
11 lower levels than 0.1 or 0.2. I am not familiar with every
12 different type of GC. GCs are not just something that's
13 used on a mine site. A GC could analyse all sorts of
14 things. It could be heavy metals, toxins, drugs - there's
15 a lot of GCs that do a lot of different jobs. So to be
16 able to say what the limit of detection is on any GC
17 anywhere, I wouldn't be able to give you that answer.

18

19 Q. Obviously what you are looking at is the data that was
20 produced by the mine's GC, not your own.

21 A. Mmm-hmm, yes.

22

23 Q. What you've just told us is that the limit of
24 detection is GC specific, that is, specific to individual
25 instruments or types of instruments?

26 A. That's correct. Different types of instruments with
27 different columns. Even instruments with the same column
28 and the same set-up, at these low levels there can be
29 individual differences between instruments, and that would
30 be expected to an extent.

31

32 Q. What do you know about the specific instrument that
33 was being used at Grosvenor that produced the data that you
34 reviewed?

35 A. We validated that GC to the same specifications as all
36 of our GCs in terms of the limit of detection at 1 ppm.

37

38 Q. So when you say you validated that GC, how did you do
39 that?

40 A. We do tests in the laboratory where we mix gases and
41 we challenge the GC with them to ensure that the GC is
42 responding as we expect.

43

44 Q. And that was done with respect to the GC at Grosvenor?

45 A. Correct.

46

47 Q. All right, I'll probably ask you some more questions

1 about ethylene in due course, but in a general sense, as we
2 will hear, you found quite a number of sub 1 ppm detections
3 for ethylene in samples that had been taken at various
4 locations?

5 A. Yes, that's correct.

6
7 Q. How confident are you, given what you've just told us,
8 that those detections are real, in the sense that you are
9 actually seeing a detection for ethylene as opposed to
10 something that was so small as to not be able to reliably
11 said to be ethylene?

12 A. I'm very confident. We can tell by the amount of
13 noise on the baseline either side of the peak in question
14 as to what the noise level is from the response, and if
15 that peak is significantly above that noise level, then
16 it's fairly straightforward to see with your eyes that
17 there is something there.

18
19 It is usually the same width and it is in the same
20 spot, and it's often repeatable. So if you had a sample
21 with ethylene in it, and then you ran one without, and then
22 you ran another one, the same one, you know, you'd usually
23 see the same thing.

24
25 Q. Can I ask you about the sources of ethylene. We heard
26 a suggestion yesterday that timber, presumably the
27 combustion of timber, might be something that would produce
28 ethylene?

29 A. The combustion of timber?

30
31 Q. Yes.

32 A. Well, I'm sure the combustion of timber would.
33 I think the question could be timber that's not combusting,
34 just timber that's present.

35
36 Q. Does timber of itself give off ethylene?

37 A. I'm not - I haven't seen any conclusive research,
38 although I have seen preliminary ideas that wood can give
39 off ethylene. In my experience I have seen that before.
40 The times I've seen it has been at very low levels and it
41 has been in longwall panels that have been sealed that have
42 no longer ventilation, where the ethylene is allowed to
43 accumulate without being diluted, until the point where
44 it's detectable, and in that case there was also no carbon
45 monoxide or hydrogen.

46
47 Q. What's the significance of the absence of carbon

- 1 monoxide and hydrogen?
- 2 A. Well, carbon monoxide is one of the primary indicators
3 of spontaneous combustion. As oxidation increases, carbon
4 monoxide increases, hydrogen increases, ethylene increases.
5 If I was seeing low levels of ethylene, I'd also expect to
6 see carbon monoxide to go with it and possibly hydrogen.
7 That's not always the case. I have seen instances of
8 spontaneous combustion with relatively low levels of carbon
9 monoxide compared to ethylene, and I suspect that will be
10 more of an issue with dilution and specifics of what is
11 happening with that heating. But generally, the more
12 carbon monoxide you see, the more ethylene you're likely to
13 see.
14
- 15 Q. Are you familiar with some studies that were done with
16 respect to detections of ethylene at the Crinum North mine?
- 17 A. I'm not particularly familiar with it, but I do recall
18 that that's the occasion where I have seen that and that
19 I believe that's what it was.
20
- 21 Q. The amounts being detected in that instance were
22 sub 1 ppm?
- 23 A. I believe so. I can't recall, but I assume so.
24
- 25 Q. Was that a case where the mine had recovered
26 a longwall and used timber cribs to support the roof?
- 27 A. I'm not aware of all the details, but I assume, if
28 they're suspecting that it's from wood, that that would
29 make sense.
30
- 31 Q. Can we go, then, to the PowerPoint, please,
32 Mr Operator. Slide number 2, does that identify the
33 significant locations from which, as you understand it, bag
34 samples were taken?
- 35 A. That's correct. That diagram is missing a few of the
36 gas wells, but for the most part, that's where the samples
37 were taken from that I've analysed.
38
- 39 Q. You've mentioned the goaf stream here?
- 40 A. Yes.
41
- 42 Q. You've said that obviously moves with the longwall
43 face?
- 44 A. Yes.
45
- 46 Q. You've also referred to 96 chock?
- 47 A. Yes.

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Q. Is that an area that became significant after the events of 6 May?

A. That's correct, from memory, it was around the 15th, possibly the 17th of May where samples started coming from that location. I think there might have been a tube set-up there that the samples were being drawn from.

Q. That data suggested that there was a heating occurring?

A. Yes, and also it would be - maybe not my expertise, but I wouldn't expect to see a tube halfway along the face.

Q. We've also got a number of tube bundle locations here at the rear of the goaf. You analysed bag samples that were taken from those locations, or some of them?

A. Yes, that's correct, there were bag samples being taken from 38 cut-through. I think there might have been one from 37 as well, or a couple. All of those seals around the back.

Q. The samples that were taken from there, does the taking of a bag sample in a location such as that involve a person physically going there, or is it done remotely from the surface using a bag?

A. It would be done physically in person. If there is a tube there, it is possible to take the sample from the tube. I think there was a tube at 38 cut-through, but typically samples would only be taken from tubes if they needed to be and they couldn't access that area underground.

Q. I'm going to take you to a summary of some of the significant sample results that included detections for ethylene. Can I ask you, please, to tell us about the significance of ethylene in terms of monitoring for spontaneous combustion?

A. A lot of the gas evolution tests that have been done over the years as part of research or work done for a coal mine seems to indicate that ethylene appears at somewhere around 100 degrees. For some coals it could be before then, and for some it could be after that, maybe 120 or 140. But in general, as a simplification, ethylene is likely to occur around 100 degrees or higher.

Q. So the presence of ethylene, then, in gases coming from the goaf would suggest what?

- 1 A. A heating or a spontaneous combustion developing or -
2 ethylene could possibly even represent a much more advanced
3 heating or a fire, even. Ethylene will come from a fire as
4 well.
5
- 6 Q. Does the amount of ethylene tell you anything about
7 the severity of what's going on?
8 A. Well, generally you'd expect the ethylene to increase
9 with increasing temperature. But it could also be the size
10 of a heating which may influence the amount of ethylene
11 that's being detected.
12
- 13 Q. So how important, in your view, is it that a mine
14 monitor for ethylene?
15 A. I think it's very important. Often when ethylene is
16 detected there's also associated higher CO, as I was saying
17 previously, and I think it's a warning sign that something
18 isn't quite right and it should be responded to or
19 investigated, at the least.
20
- 21 Q. You've seen the spontaneous combustion TARP for
22 Grosvenor?
23 A. Yes.
24
- 25 Q. And, in particular, you've seen that portion of the
26 TARP that relates to the longwall return?
27 A. Yes.
28
- 29 Q. The level 1 triggers that are specified don't include
30 ethylene?
31 A. No. From memory, no.
32
- 33 Q. In your view, should a mine monitoring the longwall
34 return include a TARP trigger for ethylene?
35 A. Yes. However, by the time you are detecting
36 significant ethylene in the tailgate, your CO make would
37 probably be high enough that there would be all sorts of
38 other indicators. I would expect a goaf stream sample to
39 be particularly relevant for ethylene, because you'd be
40 picking up more of a concentrated sample before it gets
41 diluted in the tailgate.
42
- 43 Q. So if you're monitoring for ethylene - we know that
44 there was a monitoring point at 3-4 cut-through here that
45 was about 4 kilometres from the face. Is there much point
46 monitoring for ethylene at that point?
47 A. Well, obviously if there is ethylene at that point,

1 that's a big concern, so it should be picked up and
2 identified. I guess what I'm saying about the TARP is
3 that, you know, I'd expect if you saw that much - if you
4 saw 1 part per million of ethylene in the tailgate, I'd
5 expect all of those other triggers to be triggered,
6 anyway - or at least some of them.
7

8 Q. You reviewed the bag sample data for the goaf stream,
9 because there were regular samples being taken at
10 Grosvenor - yes?

11 A. Yes.
12

13 Q. But there was a point where the taking of samples was
14 less regular than it had otherwise been?

15 A. Yes. There was a few instances where a few samples
16 were missed throughout the period, but there was
17 a particular time where some, or a few consecutive ones,
18 were not taken.
19

20 Q. You put together - and this is an extract from it -
21 a table that identified the various significant sample
22 results?

23 A. Yes.
24

25 Q. And you've seen this document and checked that it
26 accords with your figures?

27 A. Yes.
28

29 Q. Does it show in this case for the goaf stream the
30 significant results that you identified?

31 A. Yes. So anything that's either higher CO compared to
32 other samples either side of it or around from that
33 location, I guess, anything that's got a bit of elevated CO
34 or that's detected ethylene or that's got a Graham's ratio
35 over the mine's TARP level, I've identified that, or, you
36 know, if there's something else, for example a CO/CO2 ratio
37 that might be in a sample, I've added those samples into
38 this list. So this list is not a comprehensive list of
39 samples. There will be two samples taken from this
40 location every day.
41

42 Q. We can see beside the results for ethylene, I think
43 all of them on this page, there's an asterisk. Does that
44 depict or does that indicate that in each instance, the
45 person who operated the gas chromatograph or who reviewed
46 the data didn't note down a detection for ethylene?
47

A. That's right. I've looked at the data as it's been

1 processed and added in to the trending software that goes
2 with it. If I've come across some ethylene that was not
3 originally identified, I've put it in this table and I've
4 put an asterisk next to it to differentiate the ones that
5 had been detected by us compared to the ones that were
6 detected by the mine.

7
8 Q. One of the ones where you did identify ethylene was
9 for 19 March - I think there were two on that date. I'm
10 just going to jump forward a number of slides. Is this,
11 which is slide 11, part of the GC data that's been output
12 for I think it's the second sample taken on 19 March?

13 A. Yes, that's what we would call a chromatogram, so that
14 is a zoomed-in view. Normally, the initial view the
15 operator is presented with is nowhere near as clear as
16 that. They will have to magnify that view several times,
17 possibly five, ten times if necessary, until they can see
18 that level of noise in the baseline, and then they can
19 differentiate a peak from that baseline, if there's one
20 there.

21
22 This can be very difficult to do at low levels of
23 ethylene. It's something that gas chemists from Simtars,
24 which would regularly be involved with looking at these
25 types of levels of ethylene, would be very practised with
26 and proficient at. But an operator on a mine site might
27 not see ethylene very often or they might not run the gas
28 chromatograph very often, and because it is a difficult
29 thing to do, it's not particularly surprising that they
30 might miss some. It's ideal that they would identify it.

31
32 Q. Does the gas chromatograph, in particular the one at
33 Grosvenor, automatically identify the major compounds,
34 major analytes?

35 A. Yes, that's right. Anything, say - on that picture
36 there we've got the carbon dioxide, that peak, you know, it
37 goes right off the top of the screen. You can't see the
38 top of it. That's easily big enough for the software to -
39 it draws that green line from the start to the end of the
40 peak, and that's how it determines where the peak starts
41 and stops, and the area under that curve above the green
42 line is how it determines its concentration.

43
44 So with this ethylene peak there in the middle of the
45 screen, that would - I'd say that is under the threshold of
46 what the instrument will be able to detect by itself, so
47 that green line would not normally be there. That red

1 window would be pink, which would indicate there is no gas
2 being detected there, but it is up to the operator to
3 manually zoom in and confirm for themselves whether or not
4 there is ethylene there. So the gas chromatograph is
5 a very manual process. It's not like another gas monitor
6 which just gives you an automatic readout. This is very
7 visual, very manual, and it's very time intensive for the
8 operators, and I guess that's the nature of it.

9
10 Q. One of the questions, I suppose, consistently with
11 what I was asking you earlier, is how do you tell a genuine
12 result from what might just be background noise? I'll just
13 zoom in on that section of the slide. How there do you
14 differentiate between the noise and the actual?

15 A. To the left and to the right of where that green line
16 starts and stops, you can see a little bit of - what would
17 you call it - texture in that line. It's not a complete
18 straight line. That's the noise from the response of the
19 detector. So we can see to the left and the right of it,
20 and also if you drew a line from the bottom up to the top
21 there, a straight line, it would be in line with that
22 noise. So we can see that that ethylene peak - it sticks
23 up above that noise and it also sticks up above the
24 gradient of that baseline.

25
26 Different GCs have different gradients of baselines,
27 too. You know, sometimes I suspect that's why it can be
28 difficult to determine whether it's a peak or not, because
29 the baseline is already going up on an angle like it is
30 there, but you can see that it does - the response is
31 larger than the noise.

32
33 Q. I'll just zoom in on the top left-hand corner, which
34 shows in the second line the place where the sample was
35 taken, and there's two names there - Michelle Brunker and
36 Glen Perry. Do you know whether one of those names
37 identifies the person who took the sample? If you don't
38 know, tell us.

39 A. Looking at that, it looks to me like Glen has taken
40 the sample, as that's part of the sample description, and
41 normally a deputy's name would be written on the sample if
42 it was taken.

43
44 Q. And it's common for the deputy to write other
45 information pertinent to the sample as well?

46 A. Yes, that's right. They might have velocity
47 measurements or temperature or gas detector - they often

1 write hand-held readings from their gas detector where
2 their sample was taken.

3

4 Q. It there tells you that it was taken at 12am on
5 19 March 2020, and there were diesels in the panel?

6 A. Mmm-hmm.

7

8 Q. What's the significance of that notation?

9 A. Well, often false alarms are detected underground,
10 particularly in the tube bundle and the real-time system,
11 if a diesel is nearby to the sampling point, because
12 a diesel has an exhaust which might give out carbon
13 monoxide and might set off the alarm when it's not a true
14 alarm.

15

16 I suspect that the deputy has identified that there's
17 diesels in the area, and, looking at that, the carbon
18 monoxide is 111, so he may have written down there, you
19 know, in case that had anything to do with that carbon
20 monoxide reading, or maybe just to note that for reference.

21

22 Q. The other entries are "cutting", the barometer 994 and
23 falling, and the "wet and dry" - is that the temperature,
24 wet and dry bulb temperature?

25 A. I believe so. I'm not familiar with how to take those
26 measurements underground or exactly what they do with them.

27

28 Q. All right, we'll go back to the data. We now know
29 that that was taken at midnight on the 19th, so we can see
30 there the table includes data for midnight on the 19th with
31 CO at 88 parts per million, and 0.26 parts per million for
32 ethylene?

33 A. Yes.

34

35 Q. Does a diesel exhaust emit ethylene?

36 A. Oh, I'd say, in general, by the time it dilutes to any
37 significant extent, for practical purposes, no. I could
38 imagine if a diesel engine was not operating very
39 efficiently, maybe there could be some ethylene or ethane
40 in the exhaust, but I would - in most cases, I would expect
41 a bit of extra CO from the diesel.

42

43 But on that note as well, it says there's diesels
44 operating, but no diesels go in the goaf, so maybe they
45 were on the maingate side of the goaf and maybe the deputy
46 suspected that some of the CO could be going into the goaf
47 and that's why that note was written, but I can't be sure.

- 1
2 Q. The one immediately below that identifies data for
3 20 March, and you've noted in notes on the right-hand side
4 that the bottom sample contained 5.4 per cent methane?
5 A. Sorry, which sample was that?
6
7 Q. This is the second one on 20 March.
8 A. 20 March.
9
10 Q. Do you see that here?
11 A. Oh, yes, yes.
12
13 Q. There's no ethylene in that sample, but some was
14 picked up in the sample earlier in the day?
15 A. Yes.
16
17 Q. The calculation for Graham's ratio was 0.95. Is that
18 a significant figure for Graham's ratio?
19 A. Yes, that is a significant figure. I believe in this
20 case it's not quite accurate, because if there really was
21 a Graham's ratio of that high, maybe I would expect there
22 to be more samples with that, with a number like that, and
23 in fact I think further on in my report I've gone through
24 and I've re-analysed all of the Graham's ratios to the best
25 of my ability using fresh air reference points and the most
26 optimal way of determining that, and I don't think that
27 sample was really 0.9. I think it was much lower than
28 that. But the GC can overestimate Graham's ratio in the
29 presence of methane, higher levels of methane.
30
31 Q. Later in your evidence, we'll hear about some methane
32 free calculations that you've done to remove the effects of
33 methane dilution?
34 A. I can't do that for the Graham's ratio. That's more
35 of, you know, the CO data from the gas wells in particular.
36
37 Q. You also tabulated the readings from the goaf seals,
38 and that's the next slide, slide 5.
39 A. Yes.
40
41 Q. You did note on the page that we just saw in a number
42 of areas where the CO/CO2 ratio was above 0.02, or was 0.02
43 or above?
44 A. Yes.
45
46 Q. What was the significance of noting a CO/CO2 ratio of
47 0.02 or above?

1 A. Well, textbook values for CO/CO2 ratio generally start
2 at 0.02 as the level that may be above normal. Gas
3 evolution tests would also have some CO/CO2 ratios. I've
4 chosen, I suppose, a fairly conservative level there, and
5 that's particularly based on the presence of the carbon
6 dioxide as a seamgas. CO/CO2, you're comparing the amount
7 of CO generated compared to the amount of CO2 generated.
8 But because this ratio was done on the raw gas results, the
9 CO2 from the sample will cause that ratio to be vastly
10 underestimated. So if that threshold for the textbook
11 value has been reached with the influence of the seamgas,
12 I've put that as "note".

13

14 Q. You've seen the same TARP that I talked to you about
15 before - that is, the TARP for spontaneous combustion in
16 the active goaf with the sampling point in the longwall
17 return?

18 A. Yes.

19

20 Q. And you've seen that it has as its normal state,
21 according to the TARP, a CO/CO2 ratio of less than 0.2.
22 What do you say about having a normal state for a TARP for
23 the longwall return where the CO/CO2 level is 0.2?

24 A. I don't really understand that. When I first looked
25 at this data, or the TARP, when I first saw the TARP,
26 I thought maybe that was a typo and it was supposed to be
27 0.02. The only reason I can think of having a threshold
28 that high would be specific to some sort of gas monitor,
29 like a real-time sensor for - with a CO2 sensor that could
30 drift out of correct response and give some sort of alarm
31 not based on the extra CO but on an under-reporting of CO2
32 or something, but that seems very detector based.

33

34 I suppose there would be one of those detectors in the
35 tailgate, but for the purposes of the actual gas
36 concentrations expected in the tailgate, I think you would
37 need a lot of CO to trigger 0.2, and I think that if you
38 had that much CO, your CO make alarm would be also
39 a problem, and that TARP would not really alert anyone to
40 anything quicker than any of the other - well, you know.

41

42 Also, the data from the GC results shows that in the
43 lead-up to June, that trigger is not reached, despite there
44 being obvious and problematic spontaneous combustion. So
45 from the gas chromatograph results at least, that's not
46 a relevant number.

47

- 1 Q. So that TARP trigger of 0.2, which, according to that
2 TARP, if you've got a CO/CO2 ratio of less than 0.2,
3 everything's normal - that point of 0.2 wasn't reached even
4 before the explosion that occurred on 8 June?
5 A. Not on the GC data, I'd imagine not on the tube bundle
6 data as well. I just can't remember off the top of my head
7 about the tube data.
8
- 9 Q. We will come to that. And it certainly wasn't reached
10 prior to the events of 6 May?
11 A. No.
12
- 13 Q. This is back to slide 5. You were talking before
14 about whether or not these hits for ethylene were picked up
15 by the operator. We've only got the ones for 31 March and
16 4 April with asterisks beside them. Does that indicate
17 whoever was operating the GC or reviewing the data did spot
18 these small amounts of ethylene?
19 A. Yes, that's right. If it doesn't have an asterisk
20 beside it, it indicates that the operator identified that
21 themselves.
22
- 23 Q. Similarly if we go to the results for the goaf seal at
24 39-40 cut-through, which is at the back left of the goaf,
25 and the one on the maingate side at 38 cut-through, in
26 particular the latter, we can see that whilst there were
27 some that were missed, there were several that were picked
28 up?
29 A. Yes, that's right, and you can note with those samples
30 as well, they have relatively high CO even compared to the
31 other samples that I'd shown in the goaf stream on the
32 earlier table, so 147, 193 ppm CO. I'd imagine that was
33 associated with some sort of TARP and they've identified
34 the ethylene to go along with those samples as well. And
35 there's also CO/CO2 ratios that exceed the 0.02, and some
36 of those Graham's ratios are above 0.3, so you can see the
37 higher or the more of those indicators that are present,
38 they all seem to go together.
39
- 40 Q. So does that suggest to you that those detections,
41 say, for 22 April for ethylene were genuine detections?
42 A. Yes.
43
- 44 Q. Did you undertake the same exercise with respect to
45 data from various of the goaf wells?
46 A. Yes.
47

- 1 Q. Starting with well 3 - we've got on this page wells 3,
2 4.5 and 6.5 - there were a number of hits for ethylene?
3 A. Yes, that's correct.
4
- 5 Q. Including, I should say, two - that is, the last one
6 for well 3 and the only one for well 6.5 that were after
7 the event, that is, after the event of 6 May?
8 A. Yes, yes. Yes, that's right, 22:30 would have been
9 afterwards.
10
- 11 Q. So that figure for well 3 of 0.25, that was picked up
12 by the operator?
13 A. It appears so from this table.
14
- 15 Q. But the others were not?
16 A. That's correct.
17
- 18 Q. Then with respect to wells 7.5, 8, 8.5, 9 and 9.5,
19 there were detections for ethylene as well, although the
20 last two were samples taken after the ignition on 6 May?
21 A. That's correct.
22
- 23 Q. In fact, the one for well 9 was taken only about
24 8 minutes after the ignition, if we assume it occurred at
25 about 2.57pm?
26 A. Yes, that sample seems to be taken very closely after
27 the event.
28
- 29 Q. And it shows a high Graham's ratio, over 1000 ppm CO
30 and 24 ppm ethylene?
31 A. Yes, that's correct.
32
- 33 Q. We were talking before about the frequency with which
34 goaf stream samples were being taken. Starting with the
35 bottom part of the slide first, is that part of a table
36 that you generated showing where you did and did not have
37 samples?
38 A. Yes, that's right. So I've made a table for when the
39 samples were taken from each location but without any of
40 the analysis details.
41
- 42 Q. Therefore, we do have samples for 4 May - that's the
43 one that was taken at 3.30 in the morning?
44 A. Yes.
45
- 46 Q. And we do have one for 5 May that was taken at 3.20 in
47 the morning?

1 A. Yes, that's right. So the way that we've got this
2 data has been exported from the trending software, or also
3 when we've reprocessed it, that will be the time that was
4 put into the instrument for - you know, there's a set-up
5 page, you type in all your sample details like we were
6 looking at before, you put in the time and the date.

7
8 Looking at the deputy report above it, it appears that
9 there was some difficulty accessing the goaf stream around
10 this time, which would explain why they weren't taken.
11 That sample on the 5th doesn't correlate with the deputy
12 reports in terms of when the samples were being taken.
13 I believe that that sample may be from actually the 4th in
14 the afternoon, and not the 5th in the morning, and it could
15 just be a data entry, what do you call it, you know, AM or
16 PM or the wrong date.

17
18 Say if you run that sample after midnight, say you
19 were running them on the 4th, then you've got past
20 midnight, it's now the 5th and if you've forgotten to go
21 back and select the 4th for the date again, or adjust the
22 AM/PM, then it might have been put into the system like
23 that. So I'm not a hundred per cent sure, but I'd suspect
24 that based on those deputy reports that sample from the 5th
25 was actually taken on the 4th.

26
27 Q. So what you did was tried to reconcile the statutory
28 reports that you had with the samples that were taken?

29 A. I didn't really do that. This was actually pointed
30 out to me by someone else that was actually looking at the
31 deputy reports, and then I was made aware of it. Before
32 then, I wasn't aware, and that's why this table in the
33 original report still has the 5th in there.

34
35 Q. One thing that we should have pointed out is that
36 neither the sample that's marked there as 4 May or this one
37 here that's labelled 5 May, whether it was taken then or on
38 the 4th - neither of those contained any ethylene?

39 A. No.

40
41 Q. And if there was ethylene coming out of the goaf, the
42 goaf stream would be the best place to find it?

43 A. You'd expect that. However, I recall before and after
44 the event, I think the methane levels are quite low, like
45 around 1 per cent, 2 per cent, which is what you'd expect
46 more from the tailgate goaf stream. It could be that
47 level, but it could also be more rich, like 5, 10, 15, 20

1 or plus per cent methane in the goaf stream. You'd also
2 expect a bit more CO.

3
4 So in this period before the event, and then after, it
5 would appear that the goaf stream is - or whatever's gone
6 into the goaf stream bag is quite diluted and it's not the
7 same as the goaf streams that were taken earlier on; you
8 know, we were seeing 50 ppm, 30 ppm, 90 ppm. So it makes
9 me suspect that the goaf stream - and because they weren't
10 taken, because it was difficult to access, maybe the goaf
11 stream was difficult to get a hold of during that period.
12

13 Q. The next slide is the one that we've spoken about
14 already. I'll move on. Did you export the data into
15 a series of graphs so as to make it perhaps a bit more
16 intelligible?

17 A. Yes, that's right, because there's a lot of data, so
18 it makes it easier to view.

19
20 Q. Did you, for the goaf stream, calculate the CO/CO2
21 ratio?

22 A. Yes, that's correct. That circled bit there, that's
23 the time period where there were quite a few samples
24 missing. So from the 5th until the 15th, there was only
25 one or two samples taken. There was one taken on the 10th,
26 which is that dot in the middle of that red circle.
27

28 You can see before the event, the CO/CO2 ratio is down
29 relatively low compared to where it is post event, but then
30 there's not much data in between.

31
32 Q. So we've got the CO/CO2 ratio shown on the vertical
33 axis.

34 A. Yes.

35
36 Q. This peak here, is that associated with the ignition
37 that occurred on 8 June?

38 A. Yes, I think from early June you can see that trending
39 upwards there, so that would - that's consistent with other
40 gas data, for example, the CO make, where there was an
41 obvious increase in activity, oxidation activity.
42

43 Q. But the peak, before the ignition of the 8th, got to
44 a CO/CO2 ratio of about 0.088 or thereabouts?

45 A. Yes, something like that. It's below 0.1, certainly.
46

47 Q. But the normal situation according to the TARP was

1 a CO/CO2 ratio of 0.2?

2 A. Yes, that's right.

3

4 Q. This is the long form Graham's ratio for the same
5 data, that is, the same data set, the goaf stream?

6 A. Yes.

7

8 Q. We heard some evidence about Graham's ratio yesterday
9 and understand that it's about measuring the amount of
10 carbon monoxide and comparing that to how much oxygen has
11 been depleted?

12 A. Yes, it's generally used as a measure of intensity of
13 an oxidation.

14

15 Q. So what is "long form"?

16 A. When the oxygen deficiency is calculated for the
17 Graham's ratio, there's several different ways that you can
18 do it and there's several different sources of the - say,
19 for example, if your initial conditions represent fresh
20 air, you could use the theoretical values for fresh air, or
21 you could take the fresh air from the instrument as
22 measured, which would represent the long form of the
23 equation.

24

25 Some systems, for example the tube bundle system,
26 because it measures air quite frequently, it would have
27 a fresh air point in its cycle, so it might measure the
28 fresh air on the surface once every hour or two, or it
29 could measure an intake underground at the same frequency.
30 It has a reference point for what that analyser is actually
31 measuring for fresh air, so it might be measuring 20.8
32 instead of 20.9, so by using that initial measured
33 reference point rather than a theoretical reference point,
34 you can get a more precise or more accurate calculation of
35 the Graham's ratio.

36

37 With a real-time sensor, you can't do that because the
38 real-time sensor is stuck underground. It's got no fresh
39 air reference. It's just measuring whatever air it is
40 being given. So you would have to use a theoretical fresh
41 air.

42

43 For the gas chromatograph, because you're often not
44 taking a bag sample from an intake airway and using that to
45 compare against your sample, you would often use
46 a theoretical value. Also, the gas chromatograph - it
47 doesn't have a lot of fresh air references, although it

1 does have one with the calibration at the start of the day,
2 so it would be fairly unusual, because it's a very manual
3 process - I wouldn't say it's the norm in the industry at
4 all, but I've gone and used the fresh air reference from
5 the calibration when it is being done to use that value to
6 calculate the oxygen deficiency for the Graham's ratio
7 instead of using a theoretical value.
8

9 In this case in particular for the goaf stream, it's
10 given elevated values of Graham's ratio post event. From
11 memory, without the long form of the equation, those values
12 that are up around 0.8 might have been, you know, 0.3 or
13 something like that, but with the long form of the Graham's
14 ratio in this case, those samples are returning around
15 0.8 - between 0.6 and 0.1 until early June, but then they
16 only slightly increase. They don't increase - you know,
17 there's one point there of almost 1.6, which is close to
18 double, but then there's still a lot there that are around
19 0.8 or 0.1 or 1.2.
20

21 So from what we know happened in June, we can see the
22 Graham's ratio that was associated with that, and then we
23 can also see a similar Graham's ratio back on the 20th,
24 17th, 15th. There's one on the 10th there that looks
25 particularly high.
26

27 Q. The 10th of?

28 A. 10 May. From memory, that had a very, very low oxygen
29 deficiency, so it was maybe 0.05, so that could be an
30 unreliable result. In fact, a lot of those Graham's ratio
31 values do have a low oxygen deficiency, below the threshold
32 of 0.3. However, there are also Graham's ratios in there
33 that have an oxygen deficiency of over 0.3. So it's likely
34 that the ones that have - just because a Graham's ratio has
35 an oxygen deficiency below 0.3 doesn't mean that it's
36 wrong. It means it's more likely to be unreliable. But if
37 you've got that many results that close together all from
38 the same spot that are supporting each other, I think in
39 that case that's showing - usually if you had a Graham's
40 ratio where you were getting invalid data, it would be like
41 a scattergram, you'd have Graham's ratios - negative ones,
42 you'd have positive 20, you could have 5, 1, 0.1 - all over
43 the shop, but these are all around 0.8 to 1. There's a few
44 down lower, but they were fairly consistent.
45

46 Q. We know that according to the TARP the normal
47 condition was a Graham's ratio of less than 0.3. What does

1 the data in the lead-up to the incident on 6 May tell us?
2 A. Well, there's a small increase there. Again, I think
3 there's a data point there that might have been from the
4 5th that we know is really the 4th. It looks like it's
5 just above 0.4. From memory, it had a very low oxygen
6 deficiency as well, so whether that's really 0.4 or whether
7 it's slightly lower or slightly higher - like I said, it's
8 unreliable at low oxygen deficiencies. But you can see
9 a little bit of a trend there where it's heading upwards
10 from maybe the 2nd, and certainly those ones on the 4th are
11 a bit higher than those ones on the 2nd.
12

13 If we go back further, we can see an elevated area
14 around mid-April there, looks like from about the 11th or
15 the 12th till about the 23rd, you've got a bit of an
16 increase in Graham's ratio there. And then you've also got
17 that period back in March there when the longwall started,
18 where there's a few slightly high readings. But they're
19 all lower than what we've seen from this graph post event.
20

21 Q. You told us that you used the actual fresh air as
22 opposed to the assumed fresh air, and you've mentioned
23 a scenario where you might have used 20.8 as opposed to
24 20.7 or 20.9.

25 A. Yes.

26
27 Q. What sort of difference can a change in the oxygen
28 percentage that you use in the calculation of 0.1 per cent
29 make?

30 A. Well, particularly in this case, because they are low
31 oxygen deficiencies, having any extra oxygen deficiency
32 that isn't real can cause the ratio to be underestimated.
33 And in fact - you know, a lot of - when the Graham's ratio
34 is calculated, a threshold of 0.3 might not have been - you
35 know, it might have been counted as unreliable, invalid in
36 terms of interpretation. But if you're using the fresh air
37 reference, you can take away more of the variance in
38 results or any artificial extra oxygen deficiency which
39 isn't really there. I've said that twice.
40

41 Q. Can you compare the results for the long form Graham's
42 ratio against a TARP, for example, or should you be using
43 the short form or the assumed level of oxygen?

44 A. Well, ideally you'd use the most accurate and
45 comprehensive version you could, but that's not always
46 available, particularly at the mine site. I wouldn't
47 expect an operator to sit there and calculate out a long

1 form of Graham's ratio. And in fact I've done this just as
2 a process in diligence to see if I can determine whether
3 I can identify anything for the purposes of this
4 investigation, so I wouldn't expect that to normally
5 happen. With TARPs as well, there's the issue of
6 overcomplicating them and making things too hard for the
7 operators to actually follow it.

8
9 Q. We know, though, that the normal condition for
10 Graham's ratio was 0.3 and the level 1 trigger was greater
11 than 0.5. So even on the long form Graham's ratio, the
12 level 1 trigger wasn't reached except for possibly this
13 data point here (indicating).

14 A. The level 1 trigger for Graham's ratio, without the
15 long form, are you saying?

16
17 Q. Using the long form.

18 A. Oh, using the long form. The level 1 trigger was at
19 0.3.

20
21 Q. Was 0.3.

22 A. So it will be in between that 0.2 and 0.4, so there's
23 quite a few there.

24
25 Q. Sorry, what would go to a level 2 TARP, though, would
26 be above 0.5?

27 A. Yes, that's right, I don't believe any of them
28 triggered a level 2 TARP.

29
30 Q. Thank you. Did you do the same exercise with the bag
31 samples that were taken from the tube bundle point at
32 3-4 cut-through?

33 A. I applied a - once I'd done those manual calculations
34 and got an idea of what the oxygen to nitrogen ratio was on
35 that gas chromatograph, I was able to apply that to all of
36 the results for other locations, for example, the
37 3-4 cut-through, to see what difference it made.

38
39 Q. I should have asked you this question, just going back
40 to slide 13: what does that slight increase, as you
41 described it, in Graham's ratio prior to the events of
42 6 May tell us about what was happening in the goaf, if
43 anything?

44 A. Well, it is only a slight increase. If you look at
45 the rest of the trend, you know, if you were looking at the
46 trend as a whole without knowing that anything was wrong,
47 then you might say, "Well, that just all looks the same."

1 But knowing what's happened, there is a small increase
2 there. Maybe it's similar to the increase on 11/12 April
3 there, where it's gone up a little bit there. But not
4 having the next data point I'd say is fairly significant.
5 Having said that, we don't know whether the next data point
6 would have shown anything or not.

7
8 Q. This is on the morning of the 6th, do you mean?
9 A. Yes, yes. Well, the 5th, the morning of the 5th,
10 afternoon of the 5th, morning of the 6th.

11
12 Q. This graph is labelled "Raw Carbon Monoxide" for the
13 3-4 cut-through point.
14 A. Yes.

15
16 Q. And it includes on the horizontal axis a time span
17 from mid-March right through until the time of the second
18 event, on 8 June?
19 A. Yes, that's right.

20
21 Q. We can obviously see a trend upwards in CO in the
22 lead-up to that event?
23 A. Yes.

24
25 Q. But the event with which we're concerned occurred on
26 6 May, here?
27 A. Yes.

28
29 Q. What can you say about this trend here from late April
30 through until the time of the ignition on 6 May? Is there
31 anything significant about the trend that we can see there?
32 A. I'd really say only that it's increasing. That might
33 be significant. The magnitude of it isn't necessarily any
34 higher than what's come previous, although during mid April
35 and late March I believe there were some increased levels
36 of oxidation happening there as well. So that's not to say
37 that just because that's there, then that level's something
38 to be desired. There is a small increase before that
39 point.

40
41 I'd say what's probably more significant is that step
42 change increase afterwards. So you can tell the data after
43 the event, those carbon monoxide readings are higher -
44 still only 10 ppm, but they're higher than they've been
45 previously, and there's data points there on the 17th and
46 20th of May, which is quite a number of days after the
47 event.

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Q. A person looking at that data prior to the event of 6 May would not have looked at it and seen that there was any cause for alarm?

A. Yes, not likely.

Q. Does it, though, offer us any insight into what was actually going on?

A. I think in hindsight you're able to look for these sorts of things, so, you know, a small increase beforehand might mean something. It might not. I suppose if you correlate the events, then - like I said, yes, the increases beforehand - afterwards are more significant, but if nothing had gone wrong and you didn't know that anything was wrong, then that all kind of just looks like a bunch of lines going up and down and there's nothing sticking out that far.

Q. Let's go to the next slide, then, which is the calculation of the CO/CO2 ratio?

A. Yes.

Q. The title of the slide says "ratio as measured". Do you mean as measured at the mine, or was that your calculation?

A. That's the CO/CO2 ratio based on the raw values that I - you know, if you're going to do a CO/CO2 ratio, that's what you'd use. So I assume that's what was available to the mine.

Q. Again, we see a fairly significant increase before the events of June. But going back to 2 May, or commencing on about 2 May, is there anything about what we see there that is of interest in trying to work out what happened on the 6th?

A. Well, the CO/CO2 ratio is increasing there. On that - that's an outdated graph. That first really high point, I think that's on 5 May, but that's not quite correct. I've reviewed that in one of my graphs in the addendum, where that point is more in line with the one after it.

Q. So it should be down here (indicating)?

A. Yes, yes, somewhere around there. But even at that point, you can see that's at a similar level to what was going on in mid-April, and when you look at that graph, it's a bit of a step change up from what we were seeing for the previous week or two. And then at the time of the

1 ignition and afterwards, there's an even higher change
2 there, which persists.

3
4 Q. Focusing on the period leading up to 6 May, what does
5 that data suggest about what was happening in the goaf, if
6 anything?

7 A. It might indicate some increased oxidation activity.
8 CO/CO₂ going upwards would indicate that there's extra CO
9 being produced compared to the amount of CO₂, which could
10 indicate a high temperature.

11
12 Q. You then did an adjusted CO/CO₂ ratio?

13 A. Yes. What the adjusted ratio has done, or what it's
14 doing - it makes the results look a bit more amplified, and
15 the reason for that is because it's taken out the influence
16 of the seamgas. CO/CO₂ is supposed to be based on the
17 amount of carbon monoxide and carbon dioxide being
18 generated from the oxidation itself, but when we've got
19 a large goaf with a lot of seamgas in it and you have
20 carbon dioxide as part of that seamgas, then that can
21 influence that equation.

22
23 So I've taken a number for the ratio of carbon dioxide
24 to methane. Now, that's quite difficult, because if you
25 look in the goaf, at all different places, there's
26 different CO/CO₂ ratios. So I've taken the lowest CO/CO₂
27 ratio I can find, for the purposes of being conservative
28 with the calculation, and applied that to the carbon
29 dioxide readings to make them a little bit more - what's
30 the word? - consistent with trying to compare that to
31 textbook values, which wouldn't compare the - which
32 wouldn't take into account the seamgas associated with the
33 result.

34
35 Q. So looking at that adjusted data, what does that say
36 about what was happening in the goaf?

37 A. There is certainly a step change at the time of the
38 ignition, but also those samples that jump up on the 5th
39 and the 6th there - so I suppose a significant thing about
40 this graph here is because it's from the tailgate and there
41 are samples every day from the tailgate, that maybe
42 provides some information extra to those goaf streams that
43 were missing. Because we don't have the goaf stream
44 samples, so we can't use that, so using the tailgate data,
45 we can see that there is an increase there.

46
47 Q. An increase in what?

1 A. An increase in the CO/CO2 ratio, which would indicate
2 an increase in oxidation. In terms of comparison to June,
3 it's small. Having said that, that could be related to the
4 size of the heating as well, because even though I've done
5 a seamgas adjustment for this, that hasn't taken in all the
6 seamgas into account, because it's a conservative
7 measurement, and the remaining seamgas is still going to
8 dilute the rest of the sample. So it would make sense that
9 if the size of a heating increased, it might be apparent as
10 that dilution factor becomes less with the seamgas.

11

12 Q. You also looked at the data from the goaf seals?

13 A. Yes, yes.

14

15 Q. We can proceed through that reasonably quickly,
16 I think. The data points were quite widely spaced in time?

17 A. Yes, that's right. I think it could be one or two
18 weeks between some of the samples, so those lines on those
19 graphs don't necessarily mean - it probably would have been
20 better represented with just dots instead of lines, but
21 that's what I've done.

22

23 We can see 39-40 cut-through on this one. You can see
24 the oxygen there is around 20 per cent until around
25 23 April, and then it drops off, and there's
26 a corresponding increase in nitrogen, above 80 per cent,
27 which would indicate the use of inertisation, because
28 there's 78 per cent nitrogen in air, so anything over
29 80 per cent has obviously got to be a dilution of a more
30 concentrated source, which would have to be the Floxal, or,
31 sorry, would have to be nitrogen.

32

33 Q. So it's consistent, or generally consistent, with
34 fresh air, or at least the oxygen levels are, until that
35 point?

36 A. I wouldn't call it fresh air, because there's some
37 methane in there. But if we look at that red line for the
38 oxygen there, that's somewhere around 20, so that looks
39 like it's above 15 and below 21 for most of the part, so
40 that's a relatively high amount of - or a relatively low -
41 the predominant portion of that sample is air, yes.

42

43 Q. We also have the raw carbon monoxide for the same
44 spot?

45 A. Yes. At this location, you can see the carbon
46 monoxide is around 50 ppm. That scale is in percentage on
47 the side there. But it's at about 45, 50 ppm around the

1 beginning of April, and then it drops off particularly on
2 the 23rd, which might be associated with the nitrogen, but
3 it looked like it was dropping before that.

4
5 Q. If we go back, it does look as though, if there was
6 inertisation, it commenced on or about 23 April?

7 A. Yes.

8
9 Q. So those coincide. Can we then go to the graphs for
10 38 cut-through, and this is slide 21. Again we see an
11 inverse relationship between nitrogen and oxygen. Does
12 that suggest inertisation?

13 A. Yes, from the 23rd or 24th - I can't tell from the
14 scale there what day exactly, but you can see that the
15 oxygen, it is dropping down to - from looking at that
16 graph, I can't remember exactly - it looks like about
17 15 per cent, maybe lower, and then it's dropped a lot
18 lower, with the influence of nitrogen apparent by the
19 concentration being above 80 and probably about 90, by the
20 look of it.

21
22 Q. The raw carbon monoxide data tells a similar story in
23 terms of it dropping at about the same date, 23 April?

24 A. Yes. Note that the carbon monoxide from this sample
25 is over 150 ppm on 20 April. They were those samples we
26 were looking at in the table before, probably also
27 associated with that ethylene that we saw, the high levels
28 of CO, up to 150 or 190, whatever they were.

29
30 Q. Just two more slides before I'll suggest that we break
31 for morning tea, if that's convenient. Can we look at
32 B1 cut-through. A similar story told here. There appears
33 to have been an increase in the amount of nitrogen from
34 about 23 April and a corresponding drop in oxygen?

35 A. Yes, that's right.

36
37 Q. The dates don't completely line up, but what appears
38 to be a corresponding decrease in carbon monoxide at about
39 the time the nitrogen increases?

40 A. Yes, and also note the highest carbon monoxide there,
41 around 60 ppm, is around 17 or 18, 19 April, something like
42 that, around mid-April.

43
44 MR HUNTER: I'm now going to move to the goaf wells, so
45 I wonder if that's a convenient time.

46
47 THE CHAIRPERSON: Yes. We will adjourn until 11.45.

1 Thank you.

2

3

SHORT ADJOURNMENT

4

5 MR HUNTER: Q. There's one matter in connection with
6 slide 16 that I forgot to mention, and I'll just go back to
7 that. It concerns the scale on the vertical axis. There
8 appears to be a repetition of the same number. Is that
9 because the three digits that were supposed to be there in
10 every second one didn't show up?

11 A. Yes, that's just displaying the amount of decimal
12 points on the scale, so that would be in 0.005 increments
13 rather than 0.01 repeated twice.

14

15 Q. So it should be 0.01, then 0.015 then 0.02, et cetera?

16

A. Yes.

17

18 Q. You looked at the data that was reported from the
19 monitoring equipment that was fitted to each of the goaf
20 skids?

21 A. Yes, that's right. The goaf skids, most of them
22 appear to have four gas sensors or at least are measuring
23 four gases - carbon monoxide, carbon dioxide, methane and
24 oxygen. I was interested to look at the goaf wells
25 particularly considering the goaf stream didn't look like
26 it had a lot of even methane in it or carbon monoxide
27 before and after the event. So all of the goaf wells have
28 been analysed from their raw data that comes out of the
29 Citect system. I've graphed it up from the time period
30 from either the start of the longwall or when the goaf well
31 was commissioned or taking any data.

32

33 Q. You also did reprocessing of that data. What did you
34 do in terms of reprocessing?

35 A. I wouldn't call it reprocessing, maybe more so trying
36 to correct the data in terms of - you know, these are
37 real-time sensors that are on a goaf skid probably subject
38 to difficult environmental conditions in terms of humidity
39 and temperature and that sort of thing. Some of the
40 readings on the goaf skids don't seem to - if there's been
41 a hand-held reading that correlates with it, they might not
42 be the same, or the GC data isn't the same.

43

44 So I've attempted to determine when a sensor is
45 reading incorrectly where it's significant and then apply
46 a response factor to that gas to try and get what the real
47 data should have been out.

1
2 For example, if a carbon monoxide sensor was reading
3 twice as much as it should have, then I've compared that to
4 the GC results, done my best to estimate by what factor it
5 was overestimating and then applied that factor to the raw
6 data so that you get a more representative or accurate
7 measurement of those gases.

8
9 And also, in an attempt to try and get a more
10 meaningful Graham's ratio out of some of those gas wells,
11 in the end I don't think that was very successful, because
12 of the variation in the - well, I suppose the gas well
13 sensors aren't accurate enough to get absolute values of
14 Graham's ratio that are particularly reliable, because any
15 small measurement error in any of the sensors could affect
16 the overall nitrogen, or the nitrogen calculated, which
17 could then affect the entire result. So I did attempt to
18 do some Graham's ratios from the goaf wells with the raw
19 data and the corrected data.

20
21 Q. Can we start with a well that was labelled GRO4M001.5.
22 It's a side-on view, but do you recognise that as being
23 a view from the top down --

24 A. Yes.

25
26 Q. -- a plan of the longwall 104 showing the locations of
27 all the vertical wells along here?

28 A. Yes.

29
30 Q. Adjacent to the tailgate, but also that well
31 GRO4M001.5?

32 A. Yes, that's close to the face there, and then there's
33 also M001 on the maingate side, and then up the back
34 there's a few goaf wells as well.

35
36 Q. This is a graph showing the CO from that well M001.5
37 from 2 May through until the day after the incident.

38 A. Yes, that's right. For the most part, the CO looks
39 like it's undetectable in terms of the sensors either
40 reading a quarter of a part, or maybe that might be the
41 baseline for zero for that detector. The only time it
42 seems to detect anything, and it's only up to about 2 ppm,
43 is on the day of the 6th, which appears to be on the
44 morning of the 6th, and then the reading goes back down to
45 reading baseline or zero.

46
47 Q. So it's only a very small bump, if I can call it that,

1 but what, if anything, does it suggest, particularly
2 looking back on what we know now, about what was going on?

3 A. Well, it's certainly interesting that that small
4 amount is detected on that day and not on another day, or
5 it's not on the 2nd or the 3rd or the 4th or the 5th, but
6 it is on the 6th, so that could be for a reason, or it
7 could be coincidence.

8
9 Q. If it's for a reason, what reason could there be for
10 an increase in the amount of carbon monoxide reporting to
11 that well close to the face on the morning of 6 May?

12 A. Well, carbon monoxide is an indicator of spontaneous
13 combustion. At those low levels, you'd expect that all
14 throughout the goaf at only 2 ppm, but because it's reading
15 zero the whole time, and then all of a sudden it sees
16 something well over what it has been seeing and then it
17 goes away, that might indicate that there was some
18 oxidation activity or something's happened that's caused it
19 at that time to be able to detect something.

20
21 Q. Go forward, then, to vertical well number 3. Do we
22 have there the carbon monoxide that was reporting to that
23 well?

24 A. Yes, that's right.

25
26 Q. We can put I think to one side this data here
27 (indicating), but I'm more interested in this peak here
28 (indicating), which shows about 160 parts per million on or
29 about - I think the date on the X axis is about 22 April.

30 A. Yes.

31
32 Q. That's associated with a sharp rise from about 20 to
33 40 parts per million up to just short of 160?

34 A. Yes. I'm just trying to find the picture in my report
35 for it because I think it's important to compare the flow
36 to the readings. I'm on page 19 of my addendum 2. It
37 looks like the CO was increasing until the 17th or 18th,
38 and then it appears the flow was reduced on that well. And
39 then when the well was turned back on, that's when we see
40 that really high CO reading - when I say "really high",
41 it's higher than anything it's seen before, at close to
42 160.

43
44 Q. So could that be explained simply by an accumulation
45 of carbon monoxide at the base of that well whilst it was
46 turned off?

47 A. Well, if you look at the dates, the carbon dioxide

1 initially seems to drop off --

2

3 Q. Sorry, carbon dioxide?

4 A. Sorry, carbon monoxide. It drops down, but it's not
5 an instant drop as if it had just accumulated in the well
6 and then been evacuated. It seems like it comes - that
7 level reduces over some time. It's hard to say. I'm not
8 an expert on how - you know, the volumes and the flows of
9 the wells and how they start up and stop and that sort of
10 thing. But I suppose there's no flow between the 18th and
11 the 22nd, so there's potentially - you know, that data
12 there is not necessarily representative of what would have
13 been detected if there was a flow.

14

15 Q. Go to well 4.5. Here I'm interested in what's
16 happening on or around 17 or 18 April.

17 A. Yes, so that scale there - it's a bigger scale. So
18 around 17 or 18 April, that is around 140 ppm, by the look
19 of it. You can see on those two particular days the
20 readings there do seem significantly higher than the
21 readings prior to that.

22

23 Q. Go now to well 6.5, which is closer to the face. This
24 is CO from 8 to 25 April.

25 A. Yes.

26

27 Q. What can we see on this graph?

28 A. Around the - I guess from perhaps 11 April we can see
29 a bit of an increase in CO, up to 100 ppm. Then it would
30 appear that the CO drops off. I'm just having a look at
31 the flow again. It looks like it's steady until the 14th.

32

33 Q. Sorry, say that again?

34 A. I was just looking at the flow. It appears that the
35 flow continues until 14 April, and the CO drops off before
36 then, but then the flow appears to restart or is
37 intermittently higher than previous, from the 17th to the
38 18th, so it looks like there was some flow for a short
39 amount of time in that period where those higher CO levels
40 have been detected, and then the flow has been turned off
41 again from the 18th until the 22nd.

42

43 Q. The levels reached, what, just short of 180 parts per
44 million?

45 A. Yes, that's right.

46

47 Q. Did you do a methane free calculation for carbon

1 monoxide on this well?

2 A. Yes, I did.

3

4 Q. Does this slide, slide 35, show the graph that
5 reflects those calculations?

6 A. Yes, that's right. The reason I've graphed the
7 methane free is because these are goaf wells - I assume
8 they're designed to remove methane from the mine, so they
9 will have a significant amount of methane in them, and you
10 could consider that the methane dilutes the oxidising
11 portion - or the portion of the sample that may represent
12 the oxidation activity, because methane - oxidation occurs
13 in oxygen. It doesn't occur in methane. So if you have
14 more methane, that, by a percentage in concentration volume
15 perspective, may drop the amount of CO, which doesn't
16 necessarily mean the CO has dropped or risen; it could be
17 that the methane has diluted it less or more. So I've used
18 this methane free calculation to try to remove the effects
19 of dilution from the methane when interpreting these carbon
20 monoxide readings.

21

22 Q. So varying levels of methane will affect the apparent
23 level of carbon monoxide?

24 A. Yes, that's right.

25

26 Q. And removing methane from the equation enables you to
27 get a much better idea about what's happening in terms of
28 carbon monoxide?

29 A. Yes, and that's with the assumption that the carbon
30 monoxide is not associated with the methane and is more
31 associated with the oxygen or air or remaining goaf gas
32 portion of it.

33

34 Q. Does it show, though, really an amplified version of
35 what we saw in the preceding slide?

36 A. Yes, it shows the same trend, it's just a different
37 scale. It's a bigger number.

38

39 Q. So when we see a number there such as that peak, which
40 is probably, what, about 325 parts per million, is that
41 parts per million in absolute terms or is it only parts per
42 million of whatever was left after you took the methane
43 out?

44 A. That's parts per million in terms of - you know, that
45 number has been multiplied up by a factor depending on the
46 amount of methane that was in the sample. To correlate
47 that exactly with raw readings is, I'd say, difficult, but

1 it's a relative number still.

2

3 Q. Did you also calculate the Graham's ratio for this
4 well?

5 A. Yes, that's right. Having said that, like I said
6 before, even though I've tried to do my best to get the
7 most representative Graham's ratio, I've found that with
8 the wells it is very difficult because there are so many
9 different sensors involved that can affect the readings.
10 So even where I've corrected it, I'm not a hundred per cent
11 sure myself that that is the true reading.

12

13 On top of that, in the wells, where there's methane,
14 you would also expect there to be goaf gases, for example,
15 air that's already reacted with coal, and not necessarily
16 at a higher temperature, but at normal temperature, which
17 would increase the amount of nitrogen, which would in turn
18 increase the oxygen deficiency. So in general I'd say the
19 goaf wells, you're more likely to get a much underestimated
20 Graham's ratio.

21

22 Q. Whatever the limitations are of the Graham's ratio, in
23 terms of analysing the trend, are there limitations of the
24 methane free CO exercise that you did?

25 A. Well, let's say if you had 99 per cent methane and you
26 had 1 ppm of CO and then you removed 99 per cent of that
27 methane and had to multiply that 1 by 100, you'd have 100.
28 But if it was reading 1 instead of 2, then you'd have 200.
29 So if you've got really high levels of methane and low
30 levels of CO, you could kind of - the level of accuracy at
31 those low levels would potentially distort the methane
32 free. And it's similar with air free. If you've got
33 a sample that's mostly air and a very low CO value, you
34 could distort that final reading.

35

36 So I'd say the methane free would probably work better
37 at methane levels that are, say, less than 80 per cent or
38 have reasonable amounts of CO. It's hard to put -
39 I haven't looked at this in enough detail to figure out the
40 exact thresholds that that would work and that it wouldn't,
41 but I'd imagine that would be something to look at.

42

43 Q. What confidence, if any, or comfort, if any, can be
44 taken from a general or a rough correlation between the
45 peaks in the raw CO data and the methane free?

46 A. I suppose that it shows that the reason the methane
47 was lower before wasn't just because there was extra

1 methane diluting it or something. It puts that trend into
2 perspective, so we can take the dilution factor out of it,
3 so we can see that there is an increase in CO at that
4 location with or without the methane involved.
5

6 Q. So does that suggest an increase in oxidation
7 activity?

8 A. Yes, yes.
9

10 Q. Just so it's clear, you understand that this period
11 we're talking about was a period that was associated with
12 a PUR campaign on the longwall face?

13 A. Yes, or a period after.
14

15 Q. Let's go to well 7. This is the raw CO data?

16 A. Yes.
17

18 Q. We see a similar peak around 17 to 19 April?

19 A. Yes, that's right, and we've seen those previous
20 couple of gas wells that show the same pattern there, with
21 the increasing CO around the 17th, 18th, 19th. And also
22 with the flow stopping, it looks like there was a gap in
23 that data. That could be because the flow stopped. I'd
24 have to look at the flow graph here. I think there's
25 some - I've identified some issues here with the flow
26 reading on the skids, so it doesn't seem to match up with
27 what the sensors said compared to what I've seen in the
28 notes that were taken. But all the same, from that data
29 you can see there's a higher CO reading around 18/19 April,
30 which is consistent with the location beforehand and the
31 one before that. So we've got three gas wells that are
32 showing the same sort of trend.
33

34 Q. Going forward, then, to 4 May, do we see a similar
35 trend upwards in the amount of CO?

36 A. Yes, that's right, from the 4th onwards we can see an
37 increase compared to the level previous there, over the
38 previous couple of weeks.
39

40 Q. You did a methane free CO calculation with that data,
41 which led to what we can see here in slide 39?

42 A. Yes.
43

44 Q. But it shows generally the same trend?

45 A. Yes, that's right. It shows a similar trend here.
46 Where the trend is fairly similar, it's probably because
47 there is a fairly consistent level of methane there, so

1 there's not a lot changing with the methane free.

2

3 Q. This is slide 40, the Graham's ratio from the same
4 data. Accepting the limitations you've described, does the
5 Graham's ratio correspond to the spikes in CO that we've
6 identified in the previous two slides?

7 A. Yes, we can see around the 17th, 18th, 19th of April
8 there we've got some increases in Graham's ratio. They
9 seem to be fairly sharp, short. Could be because the well
10 was shut in at that time. And then again at the beginning
11 of May we can see an increase in Graham's ratio there.

12

13 Getting the absolute or the most accurate Graham's
14 ratio from a well is very difficult. Getting a trend is
15 a bit easier. It still has some issues, but we can see
16 that those two coincide with the increased CO.

17

18 Q. You undertook a GC response corrected Graham's ratio.
19 What do you mean here?

20 A. What I would have done here is compared the oxygen,
21 methane, carbon dioxide, carbon monoxide from the GC bags
22 to the skid response or the sensor response from the gas
23 skids and multiplied that by a factor which makes it more -
24 which makes it match the GC data. So in this case - and it
25 shows the same thing without having done that, anyway.
26 There's an increase in Graham's ratio around the 5th.

27

28 Q. So does that suggest an increase in oxidation
29 activity?

30 A. Yes, yes.

31

32 Q. There's also a temperature measurement on these skids.
33 Was this well, well 7, interesting in the sense that it
34 showed a spike in temperature commencing on about 4 May?

35 A. Yes. I'm not that familiar - or I'm not familiar at
36 all with temperature sensors on gas skids. You can see
37 that graph, you know, it's got bits that stick out of it
38 and bits that drop off, but it looks to me like that
39 trend's gradually going downwards over time. I'm not sure
40 whether that's because the sensor's just drifting or
41 whether it's because it's April and it's getting colder,
42 but around the 5th you can see there's a bit of an increase
43 there, which doesn't seem to follow that trend of gradually
44 going downwards. I mean, there is that drop-off
45 beforehand, so that makes it difficult to get a smooth
46 trend, but that does seem to stick out of trend a little.

47

1 Q. The next well closer to the face is well 7.5. Did you
2 graph the oxygen that was being pulled out of the goaf on
3 this well and also the methane?

4 A. Yes, that's right. You can see the oxygen there. The
5 first grid line is 10 per cent. Most of that oxygen from
6 the 20th onwards is above 10 per cent, so I think it looks
7 like it's between, say, 14 and 12 per cent for most of the
8 part there, the oxygen.

9

10 Q. We can see the fluctuation in the amount of methane.
11 Does this graph perhaps highlight the potential
12 significance of doing a methane free calculation when
13 you're looking for a trend in CO?

14 A. Oh, this graph not so much, because if you look at the
15 methane, from about the 20th onwards it's between 30 and
16 40 per cent, so a methane free is not going to really make
17 much difference there. But say if the methane was around
18 30 or 40 per cent and then all of a sudden it jumps up to
19 70 or 80 per cent, then that would have more of an
20 influence on the methane free. But, yes, certainly those
21 increases and decreases in methane is what the methane free
22 would take into account.

23

24 Q. Let's go to the next slide, slide 45. Does this show
25 the carbon monoxide from the real-time data?

26 A. Yes, that's right.

27

28 Q. It shows that the well was shut in from just before
29 2 May?

30 A. Yes, that's correct. I'm not sure what those spikes
31 in the readings are around the 26th. It could just be
32 maintenance tasks, or that second spike coincides with the
33 skid - you know, that data returning, so it could just be
34 the skid's been turned on and that's what happens.

35

36 Q. Did you calculate Graham's ratio for this well?

37 A. Yes. The reason I've tried to adjust the Graham's
38 ratio, or the gas readings to get a Graham's ratio from
39 this well is because from the original data, I recall it
40 was Graham's ratios that were going between negative
41 numbers and, like, Graham's ratio of 2 or something, so it
42 was not making any sense at all.

43

44 So I've corrected the response. I don't know how much
45 difference that's made, but what seemed to make a really
46 big difference is removing the samples between 8 in the
47 morning and 9 o'clock at night. For some reason, that's

1 when the response was going really strange. So I could
2 guess that that may have had something to do with the
3 temperature. Maybe during the day something happens with
4 the sun shining on a sensor or something, and it gives
5 a bad result or an inconsistent result. But, still,
6 whether or not those absolute numbers for that mean a lot
7 is not clear.

8

9 Q. In any event, it had been shut in by some time on
10 2 May?

11 A. Yes.

12

13 Q. Let's go to well 8. Does this show the methane and
14 oxygen?

15 A. Yes, this is the methane and oxygen on skid number 8.
16 You can see from about 27 April onwards the oxygen seems to
17 be around 10 per cent, thereabouts, and the skid has been
18 shut in around 3 May, by the looks of it. The flow should
19 reflect that. Then it was turned back on on the same day,
20 and the oxygen's still around 10 per cent. And then - you
21 can't see it from this graph, but it was shut in again on
22 the 4th, but it continues to receive gas readings. It
23 appears that the sensors are still measuring whatever gas
24 is coming out of that well, even though it might not be on
25 venturi any more.

26

27 Q. So it might have been free venting, do you mean?

28 A. Yes, I suspect.

29

30 Q. Just looking at the 6th, we can see on the 6th that
31 there's a concurrent dip in methane and oxygen. Is that
32 consistent with both of those gases being consumed in what
33 occurred in the incident?

34 A. Oh, I haven't looked at those particular readings in
35 enough detail to comment on that as a really zoomed-out
36 view, kind of, as well.

37

38 Q. Let's go to the carbon monoxide. Did you undertake
39 the corrected carbon monoxide exercise?

40 A. Yes, I did. This graph - actually, there's also an
41 updated version of this in my addendum 2. This was
42 originally done with only GC readings. I couldn't tell
43 exactly where the corrected values should start from. In
44 my more recent version, when I've had access to the
45 hand-held readings that were associated with this, I was
46 able to get a more accurate indication of that. But either
47 way, the graph doesn't look that much different.

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On the original graph, the CO was really high between the 1st and the 6th of May, and when I compared that to the GC results and the hand-held, it seemed that the CO was being overestimated at this point, so I've made sure to try and get a more accurate concentration that that should have been measured at.

Q. We can see, though, a trend on the 6th upwards in terms of CO. Is that same trend replicated on the more recent graph that you did?

A. Yes, it's all the same. It doesn't make a lot of difference visually when you're looking at it like that as to the absolute numbers.

Q. Let's have a look at that, then. You've marked on this slide, slide 50, 3pm?

A. Yes. You can see there's a steady but - you know, it looks like an exponential increase around 6 May prior to the ignition at this location, which may be significant to try and determine what happened.

Q. What does that rise or that trend upwards suggest was going on?

A. It certainly suggests that more carbon monoxide was reporting to this sensor on the morning or the day of 6 May. And in fact that - because this goaf well appears to be free venting and not sucking the gas out at its normal rate, this increase continues until actually after the time of the event, so it's - I'm not the best person to do the calculations on how long it would take the gas to get from the bottom of the well to the top of the well, but it could be half an hour or an hour, something like that. I think Martin might have referenced something in his report. That's an increase in CO and potentially an increase in oxidation activity reporting to that location on that day.

Q. Did you do a graph that shows a more granular look at that data?

A. Yes, that's right. That shows that in the two days prior, at least - we've got a little bump on the 5th there just after the PM, but there's not a lot of other data that looks like it's doing the same kind of exponential increase in that sort of shape earlier on on those two days, and before that, as well. That seems to stand out as being different from the rest of the data.

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Q. But again we can see more clearly the upwards trend on the morning of the 6th?

A. Yes.

Q. Let's go to well 8.5. You've included in this series the flow graph for that well?

A. Yes.

Q. So you can see periods when it was flowing at a touch under 800 litres a second, but also periods when it was in the vicinity of 1000?

A. Yes, that's what it appears.

Q. Dropping back down to somewhere around the 600 mark?

A. Yes, that's right.

Q. Leading up to the time of the incident?

A. Just to point out as well, I'm not an expert on goaf well flows, but this data came with the gas data, so that's why I've trended it.

Q. This is the methane and the oxygen?

A. Yes. The oxygen at this well is similar to wells numbered 8 and 7, 7.5, where that oxygen is around 10 per cent, looks like from about 28 April to 4 May. When the flows are reduced, that correlates with a reduction in oxygen and an increase in methane.

Q. If we go to the next slide, slide 55, is this the methane free carbon monoxide calculation at that well showing a trend upwards commencing on 4 May?

A. Yes, that's correct. The raw data looks like it's increasing slightly, but when you apply the methane free calculation, there's a bit more of a step change involved, and there is that increase in methane that we saw with the reduction in flow on the skid, but there's an increase in carbon monoxide if you take that into account.

Q. Perhaps for what it's worth, you did calculate Graham's ratio?

A. Yes. It seems to be increasing. There's all these little bumps sticking out at strange times. That's likely to be associated with one of the sensors drifting at maybe certain times of the day or something. I'm not sure exactly how to explain that, but the trend seems to go up, not very much, but gradually from the 1st until the 3rd and

1 then it drops off a bit after the 4th, and I'd say that's
2 likely to be associated with the extra methane. There's
3 probably also extra nitrogen or oxygen depleted goaf gases
4 that will be part of that, which would increase the oxygen
5 deficiency and drop the Graham's ratio.
6

7 Q. Let's go to well 9. Again, the first slide, which is
8 slide 58, shows the amount of flow, peaking on about 3 May
9 somewhere north of 1400 litres a second?

10 A. Yes.

11

12 Q. If we go to the next slide, we can see methane and
13 oxygen?

14 A. Yes, that's right. I suppose you can see the methane
15 dropping gradually over time there and you can see the
16 oxygen slowly increasing. Could you take me back to the
17 flow, please? There was an increase in flow on the 3rd and
18 the 4th. We'll just see how that correlates with the
19 oxygen and methane on the next slide, please. So we can
20 see that increase in flow between the 3rd and the 4th
21 there, there's a drop in methane, a little bit more of an
22 increase in oxygen, and then when it returns to what it
23 was, you see more methane and less oxygen.
24

25 Q. Let's go to carbon monoxide. This is the raw data?

26 A. Yes, that's the raw data. I didn't do any GC
27 adjustments on this one, because there were no bag samples
28 taken before the event, and after the event that sensor was
29 exposed to very high levels of carbon monoxide, which makes
30 me doubt the integrity of that sensor from there after,
31 because they can get, I guess, exhausted, or poisoned might
32 be a word with the sensors, when they're exposed to high
33 levels for a prolonged period of time.
34

35 Q. Just looking at the raw data, though, we see a general
36 upward trend in the amount of CO from about 30 parts per
37 million up to about 90 at the time of the event or shortly
38 before?

39 A. Yes, that's right.
40

41 Q. What does that suggest?

42 A. We've seen on a lot of the other goaf wells that from
43 when they're turned on, there is a bit of an increase in
44 CO, and then once the longwall moves past, maybe it drops
45 off again. In this case, I mean, it is increasing, and
46 there's also those extra spikes in that period between the
47 4th and the 6th that looks like a little bit more variation

1 of gas readings as compared to how the sensor was
2 responding previous to that.

3

4 Q. But if you take out the methane, which is what you did
5 in this graph, it looks rather different?

6 A. Yes, it looks like there is a step change there when
7 the methane's taken into account.

8

9 Q. So is that something that we can see from about this
10 point here, the 4th?

11 A. Yes, that looks like an increase in CO and likely an
12 increase in oxidation activity from the 4th.

13

14 Q. The next slide, you've marked on it the timing of the
15 event with the red vertical line but also the point in time
16 at which the skid on well 8 was turned off?

17 A. Yes. Yes, this graph was actually from one of my
18 first drafts, and I was trying to look for a reason why
19 there would be some sort of change after that point, and
20 not being aware of everything that was occurring, that had
21 occurred, around that time, there was that skid number 8
22 that was turned off - that might explain why there was more
23 methane there, although it was associated with a drop in
24 flow on that skid as well. But either way, when the
25 methane free is done, there is a step change in the CO.

26

27 Q. Again, you did do the exercise of calculating Graham's
28 ratio?

29 A. Yes. The Graham's ratio seems to be increasing from
30 the start of May, gradually, and then it - you can see on
31 the 4th there, there's a few spikes which seem a little bit
32 out of the ordinary, and then it seems to maybe plateau out
33 a bit and not continue with that increasing trend. But
34 again that could be associated with the extra methane,
35 which may be associated with excess nitrogen, which may
36 explain why the Graham's ratio is staying the same there,
37 or not increasing.

38

39 Q. We know that there was, perhaps fortuitously, a bag
40 sample taken from this goaf well a matter of about
41 8 minutes after the ignition?

42 A. Yes.

43

44 Q. If we look at this slide, slide 64, we can see that
45 someone took this sample?

46 A. Yes, that's correct, someone's taken this sample from
47 the goaf well at, what is it, 5 past 3 or something around

1 that time. CO readings from the real-time and the skid
2 show CO levels that would indicate that the sensor's been
3 maxed out at that particular time. The hand-held monitors
4 might have a limit of response, or real-time sensors in
5 general, I should say, which could be 500 ppm or 1000 ppm
6 depending on the model, and some might give a reading that
7 says "over range", which might explain why that one says
8 "high", because they don't have a number to associate with
9 it.

10

11 Q. The GC analysis of it, though, showed significant
12 amounts of carbon monoxide in excess of that which had been
13 read by the hand-held?

14 A. Yes, that's right, the GC showed around 1000 parts per
15 million of carbon monoxide; from memory, around 500 parts
16 of hydrogen; the ethylene there, off the top of my head,
17 maybe it was 20 parts - I've got it in my report; and then
18 what we can see there to the right of the ethane is an
19 acetylene peak.

20

21 Q. What's the significance of acetylene?

22 A. Acetylene occurs at temperatures higher than ethylene.
23 Probably closer towards 200 that would begin to appear.
24 But if that's 20 parts of ethylene, that's a significant
25 amount of acetylene to go with it. That's, I'd say, an
26 indication of coal combustion or some sort of combustion
27 process or like.

28

29 Q. The next graph just shows the GC data. There's only
30 a small number of data points, but it shows here the carbon
31 monoxide in excess of 1000 parts per million?

32 A. Yes, that's right, 1000 parts.

33

34 Q. That's post the event?

35 A. Yes. Those sorts of readings would indicate some sort
36 of coal combustion.

37

38 Q. I'm going to ask you some more about that in a moment
39 once we look at the data for well 9.5.

40 A. All right.

41

42 Q. So can we do that now. This is well 9.5, which was,
43 we understand, about 25 metres back from the face?

44 A. Yes.

45

46 Q. The first graph just shows the flow on that well?

47 A. Yes.

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Q. The second shows oxygen and methane?

A. Mmm-hmm.

Q. This is the data from the bag samples, and post event the amount of CO is a bit over 30 parts per million?

A. Yes, the CO, that first sample there, is at over 30 parts per million and then it drops down. That may be associated with the majority of the combustion gases produced by the explosion leaving that area, and then the CO appears to be increasing slightly from below 15 up to over 20 over the next few days, and then there's a sample where it's a bit lower, and then it returns to that trend after that.

Q. We know that 25 metres back, in well 9, the amount of CO that reported to the well was over 1000 parts per million, whereas this goaf well, 25 metres closer to the face, had a dramatically lower amount, just in excess of 30. What does that data tell us about what happened?

A. It tells us that there's a very different atmosphere of gases reporting to those two locations. So the carbon monoxide from the real-time sensor on 9.5 indicates that it goes over range, which would be over 5 per cent for carbon dioxide. So there's a lot of carbon dioxide there, but the carbon monoxide is still relatively low, say below 40 ppm. That would indicate an efficient combustion of methane, to me, where the majority of the methane has been converted to carbon dioxide, and there's not a lot of carbon monoxide associated with that.

In contrast, at hole 9, from the sample taken 5 minutes later, there's a lot of carbon monoxide, at 1000 ppm. We get all the other combustion gases that are associated with that, and it seems interesting to me that those concentrations are so different at two goaf wells that are close together.

There is a bit of extra carbon dioxide in the well number 9 as well. It's difficult for me to tell if that carbon dioxide has been produced as either some sort of prior heating or whether it's been a partial dilution of the efficient combustion gases from hole number 9. And also there's a potential that that burnt - the higher combustion indicators in hole number 9, whether that has come from coal dust being combusted as a result of the explosion or whether it's existed before then and somehow

1 been - that's not - I can't tell that from the data.

2

3 Q. If this is outside your expertise, say so: does it
4 tell us anything about where the combustion process started
5 or the ignition started?

6 A. Possibly. Like I was saying, it's either been
7 produced there as part of the - it's been produced by the
8 explosion or it was produced associated with the ignition
9 of the explosion. So considering that product is being
10 detected in the goaf and at a gas well further back in the
11 goaf, I'd have to think that that gas was generated in the
12 goaf.

13

14 Q. To move to another topic, did you try to undertake
15 some calculations to see if you could work out, if there
16 was a heating of coal, what its size was and what its
17 intensity was?

18 A. Yes, and that's mostly based on data from post the
19 event.

20

21 Q. Just so we know what we're looking at, we're looking
22 at slide 71, which is the adjusted CO/CO2 ratio for
23 3-4 cut-through in the tailgate?

24 A. Yes.

25

26 Q. Is this the same graph as the one we looked at
27 earlier, although without the annotations in red?

28 A. It's the updated version of the graph, where I had
29 a data point that was sticking up earlier than it was for
30 corrected data. But to put this in context, I think it's
31 useful to look at the Graham's ratio in the goaf stream
32 from that period beforehand.

33

34 Q. I don't think I have that on a slide here at the
35 moment. This is the goaf stream, you said?

36 A. Yes, it was one of the first slides.

37

38 Q. Yes, I'm just identifying which one it is. Slide 13.
39 It might be easier for you, Mr Operator, to return to slide
40 13, if we could, please. Is that the one we're talking
41 about?

42 A. Yes, that's right. With the long form Graham's ratio
43 that's been reprocessed post the event we can see Graham's
44 ratio values - between re-entry in May and the second event
45 in June, we can see values around 0.8 and 1. We can see
46 that that ratio does increase in June, and there is one
47 data point where it is 1.6, and that would indicate that

1 during May, and from those earlier samples taken in May, we
2 can see there was an elevated Graham's ratio existing at
3 that time. And that's before the second event - may have
4 become more apparent by the CO make and other things, but
5 then again that's the reprocessed long form that it's
6 unlikely the mine would have seen at the time.

7
8 Q. Should we go back to the CO/CO2 slide?

9 A. Yes, that would be good.

10
11 Q. Could we go back to slide 71, please. Can you
12 continue your explanation, please?

13 A. This graph shows in particular the CO/CO2 ratio after
14 the event, and this is adjusted as well for seamgas, so
15 it's still using the conservative number for that. We can
16 see a step change around 5 and 6 May where the CO/CO2 ratio
17 does increase. Then we see quite a number of elevated
18 ratios, say, in the 10 days post that, after the explosion,
19 and then the CO/CO2 ratio returns down to levels that it
20 was on 5 or 6 May or thereabouts, and it's steady until
21 early June.

22
23 So because we don't have a lot of data for the goaf
24 stream before and after the event, if we were to attempt to
25 use this to determine any sort of intensity, we can see
26 that the Graham's ratios in May correlate with around that
27 level of CO/CO2 at that time.

28
29 CO/CO2 ratio can - initially at lower temperatures, it
30 will show a larger increase in CO compared to CO2, but as
31 the intensity increases, it may be a little bit lower as
32 the level of carbon dioxide production catches up to the CO
33 production.

34
35 But, in general, one of the main takeaways out of this
36 graph is just because the CO/CO2 is at a level, you know,
37 at that, the associated Graham's ratio with that shows that
38 there could be an elevated intensity at quite a significant
39 level with those numbers.

40
41 Q. Are you talking about at both the point of 5 May, or
42 thereabouts, and then also in early June?

43 A. Yes, that's right. It seems like the - well, from mid
44 and late May the CO/CO2 levels are similar to what they
45 were on 5 and 6 May.

46
47 Q. That tells us a bit about the intensity. It doesn't

1 tell us anything about the size of the heat, though, does
2 it?

3 A. Yes, that's right. The size of the heating, the
4 CO/C02 or Graham's ratio increasing could still indicate an
5 increase in size, and that would be because the dilution of
6 the seamgasses or the nitrogen will effectively dilute that
7 ratio, and as the size of the heating increases, it may
8 overcome that dilution more and give a larger number. In
9 this case, we can see an increase in the beginning of June,
10 which peaks around 7 or 8 June.

11
12 Q. The next slide is an adjusted CO/C02 ratio, and it has
13 been done using a carbon dioxide to methane ratio of 0.03.
14 Can you explain why you've done that and what this graph
15 then tells us?

16 A. This is tube bundle data that is just confirming the
17 same trend as the GC data on the previous slide, to show
18 two different ways of measuring the gas - different
19 instrument, I should say, different technique.

20
21 So 0.03 - I've used that as a less conservative
22 measure, as opposed to 0.02 which I've used for most of the
23 others. The graph shows that those CO/C02 levels
24 afterwards are similar to those or lower than the ones that
25 we saw before. That doesn't mean that it has to be the
26 same intensity. There may be several reasons why that
27 could not be the case, but it does coincide with those
28 levels. And the reason I've done the 0.03 is in this case,
29 when I wanted to compare this and I was looking more
30 closely at it, I wanted to see what a less conservative
31 CO/C02 measurement looked like, but there's still not
32 necessarily the maximum CO/C02 ratio. It could have been
33 much higher, like 0.04, 0.05, in other sections of the
34 mine, so it's still fairly conservative.

35
36 Q. For present purposes, does the assumption you've made
37 suggest that this trend that I'm showing here with the
38 cursor is not valid?

39 A. Sorry?

40
41 Q. Is the apparent trend that I'm seeing --

42 A. Yes, there's an increasing trend.

43
44 Q. Is that valid?

45 A. Yes, there's an increasing trend on the tube bundle
46 and as well as the GC - they support each other there.

47

1 Q. In terms of working out the size of the heating, did
2 you look at the CO make figure?

3 A. Yes. CO make is a better indication of the quantity
4 or the extent or the amount of carbon monoxide being
5 produced as opposed to the intensity. CO make that's high
6 could be a result of a large area of coal at a low
7 temperature, or it could be a smaller amount at a higher
8 temperature. But either way, the total amount of CO
9 there's going down the tailgate is being taken into account
10 with the ventilation quantity to give a value there.

11
12 So we can see the CO make on this graph has a bit of
13 a step change after the event, similar to that slight
14 increase that there was on the CO/CO2 graphs, and then it
15 sits around the same level from post event until early
16 June.

17
18 So the Graham's ratio at around 1 shows that that's
19 a significant heating, and the CO make associated with that
20 shows that that heating is not necessarily increasing in
21 size to any extent, or any significant extent, until early
22 June, when it rapidly increases and becomes very obvious,
23 and you can see by the trend there the CO make increases by
24 at least four times in June.

25
26 The fact that the CO make is relatively consistent and
27 it's below 40 litres per minute might indicate - and in
28 comparison to that rapid acceleration in early June, it
29 could indicate that if there's a heating present there,
30 that it's not increasing in size or extent of carbon
31 monoxide production during that period.

32
33 Q. Does it tell us that there was anything materially
34 different occurring in the goaf at those two separate
35 points in time respectively? We've got the period here
36 from April, where CO make is around 20, or thereabouts,
37 just below, and just above 20 litres a minute --

38 A. Yes.

39
40 Q. -- and then it goes to 35 to 40, and so forth?

41 A. Yes, that's right. That is a step change there. You
42 do need to take into account that quite a few of those
43 wells were turned off post event, so those wells may have
44 been removing some CO from the goaf that then ended up in
45 the tailgate, but there is a step change there apparent.

46
47 Also, I should have pointed out with the previous

1 slides as well, with the CO/CO2 ratio, we can see that
2 region around - sorry, the one before that - mid-April,
3 where we can see an increase in CO/CO2 ratio around
4 mid-April, and we can also see an increase around mid to
5 late March, and those increases in CO/CO2 correlate with
6 gas skid data where we see increased CO produced from gas
7 wells close to those locations, or close - they were
8 measuring during those time periods.

9
10 MR HUNTER: That's the evidence of the witness.
11 Thank you.

12
13 THE CHAIRPERSON: Yes, thank you. Mr Holt, are you happy
14 to start now?

15
16 MR HOLT: I can cover one topic easily before 1, if I may.

17
18 THE CHAIRPERSON: Yes.

19
20 <EXAMINATION BY MR HOLT:

21
22 MR HOLT: Q. Good afternoon, Mr Muller. My name is
23 Saul Holt. I'm one of the barristers for the Anglo
24 entities who have been given leave to appear. I will try
25 and deal with one topic before lunch - I know you have had
26 a long morning - and then we will come back after lunch.
27 A. Yes.

28
29 Q. I just want to get clear the way in which the reports
30 that you and Mr Watkinson have completed - the sequence of
31 events in which they worked. I'm right, aren't I, that
32 both you and Mr Watkinson each prepared an initial report?
33 A. Yes.

34
35 Q. And each of you was - I don't mean this critically at
36 all - the reviewer for each other's report?
37 A. Yes, but not the only reviewer.

38
39 Q. I understand that and I'm not being critical. I'm not
40 suggesting that's a problem. It was entirely appropriate
41 and it would be completely normal for someone else at
42 Simtars to review a report created by either you or
43 Mr Watkinson?
44 A. Mmm-hmm.

45
46 Q. So you're obviously familiar with the content of
47 Mr Watkinson's report from your review process?

1 A. Yes.

2

3 Q. And, indeed, the two of you were doing similar things
4 but from a slightly different data set and with obviously
5 a different focus in terms of expertise?

6 A. Yes.

7

8 Q. And just to be clear, in terms of Mr Watkinson's
9 report, as he explained to us yesterday, Mr Watkinson's
10 report was focused essentially on data as it was available
11 to the mine, that is, without any reprocessing or the
12 application of adjustments of the kind that you've been
13 describing today?

14 A. Yes, that's right.

15

16 Q. And your report, by contrast, was looking
17 specifically, given your expertise, at the gas
18 chromatographic data?

19 A. Yes.

20

21 Q. And for the purposes of your first report, some of the
22 reprocessing that you've described was done - yes?

23 A. Yes.

24

25 Q. I'm asking you to say "yes" because of the transcript,
26 so I'm not trying to be rude.

27 A. Sorry.

28

29 Q. And, in particular, in addition, you did some of the
30 adjustments, the methane free adjustments and those other
31 adjustments, you also did to that data for the purposes of
32 your first report?

33 A. That's correct.

34

35 Q. Then, just so we get the sequence right, you and
36 Mr Watkinson do a joint addendum report called "Addendum
37 Report 1"?

38 A. Yes.

39

40 Q. And then you do a second addendum report for these
41 purposes called "Addendum Report 2A"?

42 A. Yes.

43

44 Q. There was a 2, but it was relatively minor issues?

45 A. That's correct. Just those graphs I pointed out to
46 Jeff already.

47

1 Q. I understand. Thank you. And that 2A report
2 essentially asked you to look at the goaf - what you did in
3 addition to what you'd done in your first report was to
4 look at the drainage holes, analysis that had come from the
5 drainage holes?

6 A. That's correct, and also the size and intensity of
7 potential heating as well.

8
9 Q. Yes, you were asked specifically about that question,
10 and in order to do that, you went back and looked at some
11 of the other data you'd previously looked at?

12 A. Yes.

13
14 Q. And also some of the data that Mr Watkinson had looked
15 at as well?

16 A. Yes.

17
18 Q. All right, thank you. Now, if we can just get to this
19 point prior to lunch, if we go to your first report, so at
20 that point you've had chromatographic data reprocessed by
21 analysts or chemists at Simtars - yes?

22 A. On the first report, yes.

23
24 Q. And you've also done some of the adjustments to some
25 of the data that you've explained to us very helpfully
26 today?

27 A. Yes.

28
29 Q. If we can have a look, please, at your report
30 MSE.001.001.0005, Mr Operator --

31 A. Which one is that, sorry?

32
33 Q. Your first report. We'll bring it up on the screen,
34 but you're welcome to use your hard copy, if that's easier.
35 Could we go to 0009, please, Mr Operator. This is your
36 executive summary, a page of your executive summary from
37 that report?

38 A. Yes.

39
40 Q. If we can look down to "Conclusions", please, what
41 you've said there, based on your analysis of that data was:

42
43 *Despite the lack of obvious signs of*
44 *accelerating oxidation immediately prior to*
45 *May 6, the possibility that the ignition*
46 *source for the first event was from*
47 *spontaneous combustion should not be*

1 *dismissed ...*

2

3 And then you give a range of reasons - yes?

4 A. Yes.

5

6 Q. So may we take it, then - it just flows as a matter of
7 logic - that as at the time of your first report there was
8 a lack of obvious signs of accelerating oxidation prior to
9 6 May, on the basis of the data that you'd seen?

10 A. Well, yes, I still - you know "obvious" - the stuff
11 that we'd gone through beforehand, even in the second one,
12 there's nothing that's really obvious that I --

13

14 Q. I was going to come to that, but I want to take it
15 stepwise, though, if we may. On the basis of that set of
16 data that you had looked at, which was the data from the
17 mine, re-looked at by your chemists and with the benefit of
18 the various adjustments that you had made, that was still
19 the conclusion that you came to?

20 A. Yes. After looking at more of the skids a bit
21 closely, there was a few things that I noticed in there.

22

23 Q. I understand. For the second report?

24 A. Yes.

25

26 Q. I understand. We'll come back to the second report,
27 I promise. And you're aware also, I imagine, having
28 reviewed Mr Watkinson's report, of his conclusions about
29 the datasets that he had looked at about the first
30 400 metres of retreat of longwall 104?

31 A. Mmm-hmm.

32

33 Q. Do you take any issues with those, did you disagree
34 with any of his conclusions?

35 A. I'm not familiar with that report. Which report was
36 that, sorry?

37

38 Q. His first report.

39 A. Is that the one on - is that a methane exceedances one
40 or the spontaneous combustion?

41

42 Q. No, spontaneous combustion.

43 A. Yes.

44

45 Q. I have a couple of minutes. I might try to use the
46 time. In terms, then, of the work that you did with the
47 data that had come from the mine, the reprocessing involved

1 actual chemists from Simtars, trained chemists, looking at
2 the gas chromatographic data - yes?
3 A. Yes.
4
5 Q. And looking at it closely, zooming in on places of
6 interest, that sort of thing?
7 A. Yes, that's right. In particular, like, the ethylene.
8
9 Q. In particular at the ethylene?
10 A. Well, yes, yes, checking those sorts of things, yes.
11
12 Q. We'll come back to the ethylene after lunch. The
13 other thing you did was you applied methane free
14 calculations to a number of the ratios in particular, the
15 results of the ratios?
16 A. Methane - I applied methane free to some of the gas
17 skid data.
18
19 Q. In order to effectively take a different approach or
20 which led us to the different sets of results that we've
21 seen because you applied that technique of methane free?
22 A. Yes, that's right.
23
24 Q. And, in addition, specifically in relation to Graham's
25 ratio, you applied a long form of Graham's ratio rather
26 than a short form of Graham's ratio - yes?
27 A. Yes.
28
29 Q. Can we deal with the short form versus long form of
30 Graham's ratio now, because I think I can do that in the
31 minute or two I have before lunch. The system that
32 operates at the mine uses the short form of Graham's ratio;
33 is that right?
34 A. Well, it depends on what system you're talking about.
35 The software that the data can be input to that goes with
36 the gas chromatograph, that would usually give the option
37 of using a Graham's ratio relevant for a tube bundle or for
38 a GC, which would be the short form, or one of the shorter
39 forms that isn't the long form. I'm not sure exactly where
40 those values would come from when they're interpreted by
41 the mine. They could also have a spreadsheet that would
42 calculate that for them.
43
44 Q. Those software packages you're talking about are
45 Simtars software packages are they not?
46 A. Yes.
47

1 Q. And, in fact, you personally do the training of people
2 on the various mine sites in those packages?

3 A. Yes.

4
5 Q. As you've noted, they use the short form of Graham's
6 ratio, and you train people to use that? Or you train
7 people to use the software which has that setting in it?

8 A. Yes, yes, but Graham's ratio could be calculated in
9 many different ways at different mine sites. The software,
10 as far as I know - the software that collects that data
11 might not always be the way that the mine wants to collect
12 that data, if that makes sense.

13

14 Q. Sure, but the way that the software is set up by
15 Simtars at Grosvenor and trained by you uses the short
16 form, does it not?

17 A. Well, yes, the short form is the - you know, you get
18 the tube bundle or the GC form as an option in the
19 software.

20

21 MR HOLT: Is that an appropriate time, Mr Martin?

22

23 THE CHAIRPERSON: It is. We will have to adjourn until
24 2.30 today, if you don't mind. We will be back then.
25 Thank you.

26

27 **LUNCHEON ADJOURNMENT**

28

29 MR HOLT: Q. Mr Muller, just before the break, we had
30 begun talking about the steps that you took with the data
31 that had come out of the mine systems to make the
32 adjustments, and so on, that you made to try to understand
33 the data better - yes?

34 A. Yes.

35

36 Q. In terms of Graham's ratio, as we discussed before
37 lunch, you went to a long form of Graham's ratio?

38 A. Yes, that's right.

39

40 Q. In terms of that, we were talking about the way in
41 which the Simtars systems on site, the software on site,
42 deals with Graham's ratio, and I just want to be completely
43 clear. It's right, isn't it, that the Simtars systems on
44 site only have the capacity to do short form Graham's
45 ratio, and if a mine wants to do long form Graham's ratio,
46 they will need to get someone like you to come along and do
47 it afterwards?

1 A. Not necessarily. The GC as it is, it doesn't do any
2 Graham's ratio. It just prints out raw data. Then there's
3 software called Segas, and there's a software - there's
4 a dump from the GC of that data into Segas, and using
5 Segas, the default equations that you can get from that
6 would involve the theoretical air, oxygen, nitrogen ratios.
7 There is an option to put in a custom ratio.

8
9 In the case of the GC data, that might be a bit of
10 a manual process to have to update frequently.

11
12 Q. Simtars comes on site and sets the software up and
13 does the training, and so on, doesn't it?

14 A. We do GC training, yes, and we would do other
15 training, for example, spontaneous combustion training, but
16 that would be in a separate training session. It's not the
17 same - GC training wouldn't involve training on all these
18 different ratios, and as the control room operators or
19 whoever is using the GC, that might not be as appropriate,
20 and we would go through all of that in a more advanced
21 spontaneous combustion training session.

22
23 Q. Then, in addition, you made some changes to make some
24 of the analysis that you did methane free, as we discussed
25 just before lunch as well?

26 A. Yes.

27
28 Q. What are the downsides of doing that? What are the
29 risks in terms of doing a methane free analysis compared to
30 a raw data analysis?

31 A. If you had a location that was monitoring very high
32 methane - I'm just arbitrarily picking numbers here, but
33 let's say 90 per cent or more - and then you had a low CO,
34 arbitrarily maybe 1 or 2 or 3, the difference between those
35 sensors, and as you've seen with the analysis that I've
36 done for number 8, where I had to correct it to make it
37 lower than it was, you know, that's a 50 per cent
38 difference at, like, 100 ppm, so if you take into account
39 some of the discrepancy that could be on the sensors, if
40 you have a reading very low, like 2 or 3 or 4 or 5, the
41 difference in response for the sensor at those levels is -
42 you could easily magnify that number beyond what would make
43 sense at a high methane concentration.

44
45 Then again, too, if that methane sensor was reading
46 incorrectly and particularly if it was reading incorrectly
47 high, it could magnify that back and give a false alarm.

1 So for that sort of set-up to be practical, I think there
2 would have to be some work done to try and determine some
3 sort of limits as to what ranges that is appropriate and
4 what ranges it's not. I mean, with all ratios, they have
5 their limitations, which is why it's difficult - say for
6 the adjusted CO/CO₂, there's different CO₂ concentration on
7 different sections, or it might change as time changes or
8 it might be hard to distinguish what's from the seamgas and
9 what's not. So --

10
11 Q. That's exactly one of the issues I think that you
12 identified in your report around the adjustment that you
13 made to the CO/CO₂ ratio to account for seamgas?

14 A. Yes. So that's another thing that could be difficult
15 to have an updated, what the best number is for that.
16 Maybe a conservative number would be possible. If you
17 could say what's the - like, when I looked at the data,
18 0.02 was about the lowest that I could find, so that's what
19 I used. If you were using numbers that were much higher
20 than that, then you could distort the ratio if they were
21 too high by mistake, and then you could get false alarms in
22 that sense.

23
24 Q. I understand. In terms, then, if we can come out of
25 that detail for a moment and just talk about the markers or
26 the tools that are used by site and the tools that have
27 been used by you and Mr Watkinson in your report to look
28 for signs of oxidation, if we work through them as a list,
29 we have Graham's ratio, as we've been discussing?

30 A. Yes.

31
32 Q. CO/CO₂ ratio?

33 A. Yes.

34
35 Q. CO make?

36 A. Yes.

37
38 Q. CO concentration?

39 A. Yes.

40
41 Q. And we've been discussing, or you've been discussing
42 this morning, also the presence of ethylene?

43 A. Yes.

44
45 Q. Any others of significance - I think I've covered them
46 all?

47 A. Hydrogen is often relevant.

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Q. One of the reasons, though, why hydrogen has become less relevant over time is because quite a while ago, 10, 20 years ago, it was thought genuinely that the presence of any hydrogen indicated a very high temperature of coal, didn't it?

A. Mmm.

Q. One of the things that's happened over time as gas evolution testing has got more sophisticated and been able to test for lower and lower levels of hydrogen is that it's become clear that hydrogen is present at much lower temperatures of coal than was originally thought?

A. Yes, that certainly hasn't - I haven't been in the industry long enough to have been around at that time, but from what I understand, say if the lower limit of detection for hydrogen used to be 50 ppm, if we look at this data now, by the time there's 50 ppm, that's big trouble.

Q. Exactly.

A. So that doesn't mean that it's not useful. It just means that we are looking at different numbers and we're looking at trends. So there might be a base level of hydrogen in goaf or in air, or whatever, that could be between 1 and 10, depending on the mine and depending on the gas and that sort of thing, so increases beyond whatever would be normal there are still appropriate. And in terms of when an oxidation increases to possibly a fire or something very, very hot, then you'd expect to see that hydrogen ratio shoot right off, and then it's very obvious and it's almost - when it equals the level of CO, that's often a sign that something's --

Q. Yes, and what this shows is the sensibleness, if that's even a word, of using these multiple tools to look at the same environment in lots of different ways through lots of different lenses?

A. Yes, that's right.

Q. What it allows you to do is to look at combinations of locations and combinations of results of those tools; right?

A. Combinations of locations?

Q. Locations of, for example, where gas is taken from, so you can see relationships physically between different results from different places in a longwall?

1 A. Yes, yes. There's different locations. There's also
2 the same - you could use different techniques to measure
3 the same location - for example, the real-time versus the
4 gas chromatograph is a different technique --
5

6 Q. I talked with Mr Watkinson yesterday about TARPs and
7 the development of TARPs and how those levels are developed
8 in the kind of structure that's presently used in
9 Queensland. Have you had any involvement yourself in your
10 career with the development of TARP levels and the design
11 of TARPs in longwall mines?

12 A. Not in longwall mines. I've done some simple TARPs,
13 say, for open-cut or more hygiene related things, which
14 general body contaminants --
15

16 Q. You understand I'm sure the basic proposition, which
17 is you have TARP levels, and each level has within it
18 certain triggers, basically, that tell you whether you're
19 in normal or TARP 1, TARP 2 or TARP 3?

20 A. Yes, I'm familiar with looking at TARPs.
21

22 Q. Part of the process of developing TARPs is to make
23 sure that you have measures or triggers which are robust
24 enough to identify the abnormal, but at the same time you
25 don't want to have TARP levels that are just going to be
26 triggering off all the time because people get sensitised
27 to them?

28 A. Yes, that's right. I think there's a balance with
29 that.
30

31 Q. In terms of spontaneous combustion TARPs, one of the
32 techniques in the sophisticated development of TARPs is to
33 say, "Well, at each TARP level, what do we want these
34 different measures to be telling us about the temperature
35 of the coal" - yes?

36 A. Yes, I suppose, yes.
37

38 Q. That's where gas evolution testing comes in, right?
39 Because gas evolution testing is aimed to tell us
40 particularly at a site-specific level, what the CO/CO2
41 ratio might be when the coal is at 70 degrees or 80 degrees
42 or 100 degrees?

43 A. The gas evolution could be used as a guide - for
44 example, I pointed out before that the ethylene might
45 appear on the gas evolution at 100 degrees or 80 or 120,
46 depending on the gas. I think the limitation with the gas
47 evolution is that it's an artificial test in terms of it's

1 a very small amount of coal that's put in a little kind of
2 oven that's used to heat it all uniformly, with a set
3 airflow, and the numbers that you get out of that might not
4 always correlate to the numbers that you would see in the
5 coal mine.

6
7 Q. And that's exactly why you would also use other
8 datasets like, for example, textbook values to compare
9 against what you're getting from your gas evolution testing
10 locally?

11 A. Yes, but also real data. In my experience, I've seen
12 a lot of spontaneous combustions where I look at the gas
13 ratios and then I look at the textbook and then I look at
14 the gas evolution, and none of it adds up, so --

15
16 Q. If you just give me a chance. And you'd also look at
17 the mine specific data, for example, where you've had
18 previous longwall panels - you'd get data from as many of
19 those different sources as possible to identify what your
20 various TARP trigger levels would be? It's a pretty basic
21 proposition, isn't it?

22 A. Yes.

23
24 Q. Sensibly, you'd also get expert assistance in, as well
25 as using your own internal expertise, as a mine?

26 A. Sorry, say again?

27
28 Q. Sensibly, you'd also get external expertise in, as
29 well as using your own internal expertise, as a mine
30 operator --

31 A. If you're the mine, you would get --

32
33 Q. -- to develop your spontaneous combustion TARP. You
34 would get external expertise, as well as using your
35 internal expertise, to help you develop, using all of those
36 various data sources, a TARP specific to your local
37 environment?

38 A. Well, yes, if you're the mine I suppose you'd get any
39 expertise you can to help you with that sort of thing.

40
41 Q. Let's just talk for a moment, please, about ethylene.
42 Can we test this proposition: similar to hydrogen, it was
43 once widely thought, wasn't it, that ethylene only appears
44 at all when coal is at about 100 degrees?

45 A. I'm not sure what you mean by "once".

46
47 Q. Once thought, as in the knowledge in that area has

1 developed since people held that view, and it's becoming
2 clear, in fact, that ethylene is produced potentially at
3 lower temperatures than that?

4 A. I wouldn't necessarily agree with that.

5
6 Q. I don't know what that means. What do you mean
7 "I wouldn't necessarily agree"?

8 A. Well, I haven't been shown any data that says that
9 ethylene is produced at a lower temperature and "here it
10 is". Like I was talking about, before, there could be
11 different GCs that are set up differently and could detect
12 it at much lower levels, but with the particular GCs that
13 we use, which would be similar to the ones that the gas
14 evolution would be done on, it seems to appear around that
15 temperature. And if we are comparing what tool is used in
16 the mine site compared to what tests are done, I think
17 that's a relevant thing there.

18
19 So I haven't seen any references where that particular
20 GC is identifying ethylene at a lower temperature than
21 that.

22
23 Q. Mr Hunter was referring you to timber, green timber,
24 in particular, I think he referred to green timber
25 underground. Are you aware of that work that's being done
26 by Simtars at the moment in the development of what's
27 ultimately to be an ACARP report?

28 A. Yes.

29
30 Q. Are you aware that one of the reasons for doing that
31 wasn't just related to the presence of green timber but was
32 part of an exploration of the fact that ethylene is being
33 found regularly at very low levels in coal mines in
34 circumstances where there are no other indicators of 100
35 degree temperatures, for example?

36 A. I think that ethylene has - from what I've seen, there
37 might be something to show that ethylene can come off from
38 wood. I'm slightly concerned that it could become an
39 excuse, as to, you know, an explanation, "Why are we seeing
40 ethylene?" "Oh, it's from the wood."

41
42 The circumstances where I've seen it have been in
43 a goaf that's been sealed and there has been no other
44 carbon monoxide associated with that ethylene, so it was
45 fairly clear that there was ethylene there, but there was
46 no indication of other oxidation activity and there hadn't
47 been any for some time, so that's a bit of a different

1 circumstance to when you could be getting a sample that has
2 100 ppm of ethylene and then - sorry, 100 ppm of carbon
3 monoxide and then it has ethylene associated with it.

4
5 Q. I see. Thank you. Just dealing, then, with ethylene
6 itself and the way in which you detect ethylene on the gas
7 chromatograph, you spoke with Mr Hunter about a concept
8 called - I think he raised it with you - the limit of
9 detection?

10 A. Yes.

11
12 Q. And the limit of detection for ethylene for Simtars, a
13 NATA accredited laboratory, is 1 part per million - that's
14 what you said this morning?

15 A. The limit of detection is - yes, that's what we would
16 use if that's what the instrument is validated at, which is
17 what we would normally validate the instruments at.

18
19 Q. So the answer to my question, is the limit of
20 detection at Simtars for ethylene 1 part per million - is
21 the answer to that question "yes"?

22 A. If I were able to mix half a ppm or lower, I might be
23 able to get a limit of detection out of that. But with the
24 mixing equipment available, we're mixing 1 ppm, so it's not
25 necessarily based on the instrument itself, either. It's
26 the limits of our mixing, because to get that reference
27 point, we have to have a proper reference gas to be able to
28 test that against.

29
30 Q. Let's try another concept and see if we can make it
31 a bit easier. As well as limit of detection, there's
32 a concept called limit of reporting?

33 A. Yes.

34
35 Q. And limit of reporting is what a NATA accredited
36 laboratory like Simtars identifies as the level at which it
37 will report, by its own chemists, people like you and your
38 team, no doubt, to clients when they get it to do a report
39 on a gas sample; right?

40 A. Yes, but generally the NATA accreditation and the work
41 we would do under our NATA accreditation is not for coal
42 mines, because the coal mine GC is set up on the coal mine
43 site. They don't send us samples, so --

44
45 Q. I'm not asking that question. For NATA accreditation
46 you identify, don't you, when you're providing results,
47 a limit of reporting and a limit of detection, and they are

1 two different things - yes?

2 A. We specify limit of reporting.

3

4 Q. And what is Simtars' limit of reporting for ethylene
5 from a GC?

6 A. Well, on our current reports, it's 20 ppm, which is
7 far in excess of what the capability is of the instrument
8 and what we would provide to the mine site.

9

10 Q. I understand that, but part of the process of NATA
11 accreditation and ensuring that there is a level of
12 confidence in results is that the limit of reporting is
13 intended, isn't it, to identify effectively the practical
14 limit of quantification of a particular --

15 A. Yes, for the quantification, and, like I said before,
16 when you've got lower levels of ethylene, like 0.2 or 0.3,
17 it might not really be that number. So at 20 ppm, it's
18 a lot easier to say under those NATA accredited procedures
19 that that level has a certain uncertainty associated with
20 being able to guarantee that to --

21

22 Q. And that uncertainty, what's called the measurement
23 uncertainty, that must be reported in relation to that, for
24 Simtars, even at that 20 ppm, is 15 per cent, isn't it?

25 A. I can't remember off the top of my head, but it's not
26 really relevant to - it's very different work from what
27 happens in the laboratory under the NATA accredited - not
28 very different, but that's like a kind of part of the
29 paperwork for the NATA process. It's not really relevant
30 to what we do on the mine site.

31

32 Q. You use the same GCs for the purposes of doing your
33 Simtars reports which have the 20 ppm limit of reporting as
34 are on the mine sites, don't you?

35 A. Well, we have different GCs in the Simtars lab.
36 They're not all the same, so that's part of the reason. We
37 could be using a different GC that's not capable of doing
38 that. We could have different GCs that are optimised for
39 different purposes that might be more appropriate for
40 a particular job that's done in the laboratory.

41

42 Q. In any event, sitting below the limit of reporting is
43 the limit of detection, which is 1 part per million?

44 A. Yes.

45

46 Q. Can you tell me, please, because there are two ways,
47 aren't there, in which a limit of detection is determined

1 through the NATA process - one is a method detection limit
2 and the other one is an instrumental detection limit - do
3 you know which the 1 ppm stems from?

4 A. I'm not sure that I understand what you're asking. We
5 would test each instrument individually for a 1 ppm limit
6 of detection.

7
8 Q. We'll move on and try to practicalise that. Can we
9 have up Mr Hunter's PowerPoint, please, and could we have
10 a look - we'll just go through a few of these slides. I'll
11 identify some issues related to things I've already talked
12 to you about. Could we go first to slide 4.

13
14 You were taken through a series of slides - and I'll
15 go through them briefly as well - by Mr Hunter of this
16 table, which sets out what were put to you as effectively
17 significant combinations of results of those various tools
18 that have been used over the period relevant to this
19 Inquiry?

20 A. Yes.

21
22 Q. And you very helpfully identified that some of these
23 measures in fact have since changed - some of these results
24 have since changed by virtue of the later work that you did
25 particularly around the Graham's ratio?

26 A. You mean I've reprocessed to get a different value for
27 the Graham's ratio, for example?

28
29 Q. Yes.

30 A. Yes.

31
32 Q. Let's have a look at that. We can see if we look at
33 the table we have obviously got date and time - that's easy
34 enough - and then we have the Graham's ratio, 0.2 and so on
35 and so forth. Let's just take the top line, CO parts
36 per million at 42, and then where there's an ethylene
37 detection, you've noted that as well, and then notes for
38 other reasons; right?

39 A. Yes.

40
41 Q. A Graham's ratio at - you've used as the significant
42 cut-off for normal for your analysis Graham's ratio 0.3?

43 A. Yes, but I've still mentioned it there if there's
44 something else that's been - like, for example, if there's
45 something that's high in CO or I've detected ethylene, I've
46 still put the Graham's ratio there as well for reference.

47

- 1 Q. I can see that. I'm just asking the question, the
2 threshold that you've used for normal for the purposes of
3 your analysis for Graham's ratio is 0.3?
4 A. Yes.
5
- 6 Q. You've done that because that's the level that the
7 mine has chosen for its TARP?
8 A. Yes.
9
- 10 Q. Though you note that the textbook value for that is in
11 fact higher, at 0.4, than the mine site has chosen to use,
12 at 0.3?
13 A. Yes, that's correct.
14
- 15 Q. So in that context you've chosen to go with the mine's
16 number rather than the textbook value?
17 A. Yes.
18
- 19 Q. We'll just work down. If we look, then, at Graham's
20 ratio at 0.2 for 17 March, on either measure - that is, 0.3
21 or 0.2 - that is sitting - well, if it's, sorry, 0.3 or
22 0.4, it's sitting in the normal range?
23 A. Sorry? Oh, is the 0.2 in the normal range?
24
- 25 Q. Yes.
26 A. Yes, according to the TARPs.
27
- 28 Q. And CO parts per million, the normal range in the
29 TARPs is 100 parts per million?
30 A. For what parameter?
31
- 32 Q. I think for all. I can't see anything lower than
33 that.
34 A. Is this the goaf stream? Because I don't see
35 a specific goaf stream on the TARP.
36
- 37 Q. So what's the point that's trying to be made by having
38 the 42 - what's the significance of 42 in CO parts per
39 million in this table in relation to the goaf stream?
40 A. That could be - on 17 March?
41
- 42 Q. Yes.
43 A. So that could have been because when I've reprocessed
44 it, maybe the Graham's ratio is higher, because when
45 I originally did this table, I kept everything together,
46 but then we decided that maybe it was better to separate
47 out what I had done and what the mine had done. So it

1 could be either that or, otherwise, if that's not down in
2 the other table down the bottom, then I'm not sure.

3

4 Q. The Graham's ratio as you've reprocessed it using your
5 table 5.5 for that measure is 0.23, so it's barely
6 different?

7 A. Yes, that's right, I'm not sure why that's there,
8 then.

9

10 Q. Thank you. Could we then go to 19 March, where
11 there's a note about diesel operating. Do you see that?

12 A. Mmm-hmm.

13

14 Q. I may have misheard you: was it actually your
15 evidence that diesel engines don't produce ethylene or that
16 you wouldn't expect to see the consequence of the ethylene
17 produced by a diesel engine, or don't you know?

18 A. Yes, by the time dilution occurred, I wouldn't expect
19 to detect it unless there was something majorly wrong with
20 the engine or something.

21

22 Q. Because diesel engines do produce ethylene, don't
23 they?

24 A. I haven't seen a lot of - well, I haven't analysed
25 a lot of gases from a diesel engine.

26

27 Q. So how would you then possibly be in a position to
28 proffer an opinion about whether the ethylene that came
29 from a diesel engine might be diluted such that you
30 wouldn't see ethylene in that parts per million in this
31 result if you don't know what that concentration would look
32 like?

33 A. Well, I have analysed gases from some engines on cars,
34 and the amount of ethylene that comes out, if you see any,
35 and I've rarely seen it, but it might be not very high, so
36 considering the - maybe it's not my expertise being
37 a ventilation person, but the amount of exhaust coming out
38 compared to the ventilation quantities --

39

40 Q. If we go to 20 March - we're not doing all of them,
41 I'm just going to pick some examples - you can see 0.95 is
42 the Graham's ratio?

43 A. 20 March?

44

45 Q. Yes, at 14:15 hours. Can you see that?

46 A. Yes.

47

- 1 Q. That was one that you pointed out to Mr Hunter had in
2 fact been reprocessed to what you considered to be a more
3 accurate result, which by reference to your table 5.5 is in
4 fact 0.31?
- 5 A. Yes, that's correct.
6
- 7 Q. And indeed we'll do this a little more on the next
8 page, but if we keep going down the ethylene column, we can
9 see there 0.14 ethylene, 0.19, 0.25, 0.18, 0.09 - do you
10 see those?
- 11 A. Sorry, say again?
12
- 13 Q. Down the ethylene column, I'm reading out the
14 numbers - 0.14, 0.19, 0.25, 0.18, 0.09?
- 15 A. Yes.
16
- 17 Q. They are all below 1 part per million, that is, the
18 limit of detection?
- 19 A. Yes.
20
- 21 Q. And they're obviously enough something in the order of
22 two orders of magnitude lower than Simtars' own limit of
23 reporting?
- 24 A. Well, that's not really relevant to this.
25
- 26 Q. Are they or not?
27
- 28 MR HUNTER: With respect, the witness gave an answer
29 before about this and he explained that the limit of
30 reporting related to reporting made by Simtars using its
31 equipment. He's talking about, that is, the witness, is
32 talking about reporting based upon data taken from the mine
33 itself.
34
- 35 MR HOLT: I'm happy to leave it, Mr Martin.
36
- 37 THE CHAIRPERSON: Yes, thank you.
38
- 39 MR HOLT: Q. In terms of the capacity to pick up
40 ethylene at those kinds of levels, the people in the
41 control room are the people who are trained by Simtars and
42 often by you?
- 43 A. Yes, there's other people. It's not only control room
44 operators.
45
- 46 Q. Sure, but they're trained by Simtars and often by you?
47 A. Yes.

- 1
2 Q. If we then go down, please, to the next page,
3 Mr Operator, we're now at tailgate 104, C heading,
4 40-41 cut-through. Can you see that?
5 A. Yes.
6
7 Q. We can see here again a series of Graham's ratios, the
8 0.38 is above normal, so it will be in TARP level 1 for the
9 mine - yes?
10 A. If the - what - oh, this is the - yes, this is the
11 seal, so yes.
12
13 Q. We can see there CO parts per million, 139 parts per
14 million?
15 A. Yes.
16
17 Q. And again that would take us up, wouldn't it, into
18 TARP level 1?
19 A. I believe so. It's 130, is it, for level 1?
20
21 Q. Yes, so 9 over that. And then the ethylene again we
22 can see, less than 1 part per million?
23 A. Yes.
24
25 Q. Almost an order of magnitude less than 1 part
26 per million?
27 A. Yes.
28
29 Q. A CO/CO2 ratio of 0.02; we see that, don't we?
30 A. Yes.
31
32 Q. You've taken that, as you've noted in your report,
33 purely from a textbook value of 0.02?
34 A. Yes.
35
36 Q. Now, you would expect, wouldn't you, that a CO/CO2
37 ratio for the mine would be derived, unquestionably, with
38 reference to textbook values but also paying significant
39 regard to the testing of the actual coal on the site?
40 A. Yes, but also the seamgas effect as well.
41
42 Q. If it turns out that 0.02, as a CO/CO2 ratio, would in
43 fact, on the analysis done, end up something in the order
44 of 50 degrees for coal, would that change your view as to
45 the appropriateness of simply grabbing the textbook value
46 of 0.02?
47 A. Well, not really, because there's so much dilution

1 involved in any of the samples, potentially, it's hard to
2 tell. I mean, this sample is being taken from a point
3 underground that could be any distance away from where this
4 is being generated, and there's a lot of other gas that it
5 would mix in with. So just to go, "Oh, that's the number
6 that adds up with the table", I think that would - you
7 know, I'd see that as an "at least" number, not an
8 indicator of what temperature it actually is.

9

10 Q. But again, one of the last things that you want to do
11 with a TARP is to be in TARP all the time, because that
12 means that people get normalised to it?

13 A. Well, that's true too, but like I said before, there's
14 a balance, too. So you also need to be able to recognise
15 data that is important.

16

17 Q. Unquestionably. Can we have a look, please, at
18 slide 12. No, I'm sorry, could we go down to slide 13,
19 please. This is showing long form Graham's ratio, so this
20 is the work that was done by you with the data that had
21 come from the systems on the mine, but afterwards, right?

22 A. Yes, that's correct.

23

24 Q. With the complexities associated with that that we've
25 already discussed?

26 A. Yes.

27

28 Q. Could you tell me this, please: with the short form
29 ratio - that is, with the data as it came out from the
30 mine, which Mr Watkinson talked to us about yesterday - we
31 don't see, do we, the big step-up, or the step-up that
32 occurs either side of that big point?

33 A. I don't believe so.

34

35 Q. Can you explain why that might be so in terms of the
36 way in which the long form Graham's ratio might have
37 affected those outputs?

38

39 MR HUNTER: With respect, Mr Watkinson's evidence did not
40 relate to the gas chromatogram data from the goaf stream.
41 If my friend is going to make assertions like this to the
42 witness, he should take him to the output or the data that
43 was referred to by Mr Watkinson yesterday.

44

45 There was a distinct divergence between the two of
46 them. One looked at the real-time and tube bundle data and
47 one of them looked at the gas chromatograph data. This is

1 gas chromatograph data.

2

3 MR HOLT: I'm happy to approach it in a different way.

4

5 Q. Mr Muller, I think you said - whether it was
6 Mr Watkinson or whether it was you - do you agree with me,
7 and if you don't, it's fine, that before you did the
8 change, that is, before you turned this into a long form
9 Graham's ratio, when you used the short form Graham's
10 ratio, we didn't see that step-up change?

11 A. I think there was a step-up change, but not as
12 significant.

13

14 Q. Now, can I then move forward, please, to page 16.
15 I just want to be clear about this. Mr Hunter pointed out
16 to you, and you agreed, that there is a difficulty with the
17 vertical axis here where numbers appear to be repeated?

18 A. Yes.

19

20 Q. You had indicated that that was a consequence of the
21 number of decimal places which were shown effectively in
22 the way in which this graph is presented?

23 A. That's correct.

24

25 Q. Then Mr Hunter took you to, or I think summarised, the
26 way in which in fact the step-ups should happen, and you
27 agreed with that summary, but it all happened quite
28 quickly, so I want to make sure we have it right. The
29 increments ought be, am I right, in increments of 0.005?

30 A. Yes.

31

32 Q. So from zero, what says 0.01 should be 0.005 - yes?

33 A. I believe so, yes.

34

35 Q. Then the next one up, which currently says 0.01, is
36 correct?

37 A. Yes.

38

39 Q. Then the next one up should be 0.015?

40 A. Yes.

41

42 Q. Then the next one up is correct at 0.02?

43 A. Yes.

44

45 Q. Then again the next one up should be 0.025 - yes?

46 A. Yes.

47

1 Q. And then the final one should be 0.03?

2 A. Yes.

3

4 Q. So for present purposes, and recognising that you've
5 taken 0.02, the textbook value for CO/CO2 ratio, it's
6 actually the second one of those lines, isn't it?

7 A. Yes, that's right.

8

9 Q. That represents the 0.02 normal --

10 A. That would be 0.015, that line above most of the graph
11 there.

12

13 Q. And so obviously enough, if it's the second 0.02, then
14 the values that we can see below the line are further down
15 than they might otherwise initially have appeared - further
16 below the line?

17 A. Yes, yes.

18

19 Q. Again, we see the same issue, don't we, in the next
20 graph, on page 17, which is effectively the same output;
21 it's measuring CO/CO2 ratio at tailgate 104,
22 3-4 cut-through, but this is adjusted for seamgas in the
23 way that we discussed before?

24 A. Yes, that's correct, and that's got the same issue
25 there with the axis that you pointed out there. So it
26 looks like that that should be 0.025 that most of that data
27 is underneath, until it gets to the June data.

28

29 Q. So essentially, if I can short-form this rather than
30 going through the process of correcting each one, it's the
31 highest, that is furthest up the page, 0.02, the second
32 entry of that, which actually represents 0.02 in the
33 context of that diagram?

34 A. Yes.

35

36 Q. Just finally, please, could we go to page 73 of the
37 PowerPoint presentation, which is the very last page.
38 Again, this is CO make, tailgate 104, 3-4 cut-through,
39 March to June. You can see that?

40 A. Yes.

41

42 Q. I just want to focus on the period of time to the left
43 of the ellipse that you've drawn on the right-hand side, so
44 essentially that earlier part of the longwall progression.
45 Do you see that?

46 A. Yes.

47

1 Q. You've identified a line there, 30 to 35 litres per
2 minute?
3 A. Yes.
4
5 Q. I haven't heard or seen you say anywhere how that
6 compares to, for example, TARP levels of normal or textbook
7 values of normal?
8 A. I wasn't comparing that to anything from the textbook
9 or the TARP. I was comparing it to the rest of the data
10 there for a relative indication.
11
12 Q. But in fact it assists us, doesn't it, if we look at
13 that 30 to 35 litres per minute line, to understand that
14 it's less than the 42 litres per minute identified in the
15 TARP?
16 A. Yes, that line is just to give everyone an idea, if
17 the scale is too hard to read, where - not that the small
18 text is any easier to read.
19
20 Q. I understand, but in terms of CO make and
21 understanding what that data might mean in terms of the
22 actual numbers, it's, obviously enough, less than 42 litres
23 per minute?
24 A. Yes, I'm taking the 42 - you're talking about the TARP
25 level?
26
27 Q. Yes.
28
29 MR HOLT: Thank you, Mr Martin.
30
31 THE CHAIRPERSON: Mr Crawshaw?
32
33 MR CRAWSHAW: I don't have any questions, thank you.
34
35 THE CHAIRPERSON: Ms Grant?
36
37 MS GRANT: No questions, Mr Martin.
38
39 THE CHAIRPERSON: Mr O'Brien?
40
41 MR O'BRIEN: No, thank you.
42
43 THE CHAIRPERSON: Ms Holliday?
44
45 **<EXAMINATION BY MS HOLLIDAY:**
46
47 MS HOLLIDAY: Q. Mr Holt asked you in relation to the

- 1 training that the operators receive in relation to the GC
2 operation.
- 3 A. Yes.
- 4
- 5 Q. And he made the point that the operators were trained
6 by Simtars and made the further point that the operators
7 were trained by you.
- 8 A. Mmm-hmm.
- 9
- 10 Q. When you train the operators, you expect them to zoom
11 in on the relevant graphs?
- 12 A. Yes, that's a major focus of the training.
- 13
- 14 Q. Mr Operator, if we can go to MSE.001.001.0024. Could
15 we zoom in on figure 14, please, and zoom in on the peak of
16 the ethylene underneath the red bar. You train the
17 operators to zoom in on the line, so to speak?
- 18 A. Yes. That zoom - I'd probably say that's maybe one
19 too far, what's on the screen there, but if you can see
20 that noise to the left there and then maybe the same
21 distance to the right, then that would give a good
22 perspective.
- 23
- 24 Q. We might go back out slightly, Mr Operator, and we'll
25 leave it at that for the time being. So you train the
26 operators to look at the peaks; that's correct?
- 27 A. Yes.
- 28
- 29 Q. You also train them to cut out the noise, as you call
30 it?
- 31 A. I train them to try to differentiate between the noise
32 and a peak, which can be difficult, the lower the - you
33 know, the less that peak sticks out of the baseline, it can
34 be difficult, until there's a point where you can't see it
35 any more. But, yes, we spend a lot of time repeating that
36 process.
- 37
- 38 Q. If an operator had a standard of competence retained
39 from their training, should they have picked up more
40 readings of ethylene than have been detected here in your
41 analysis?
- 42 A. Yes, I'd hope so. I wouldn't expect all of them to be
43 picked up, and maybe some of the smaller ones not, but
44 certainly more of them.
- 45
- 46 Q. To be clear, going back to the PowerPoint - we don't
47 need to bring it up at the moment, but you made the point

1 with Mr Hunter that the asterisks in those first tables
2 were the readings of ethylene that were not picked up by
3 the operators; that's what the asterisks represented?

4 A. Yes, yes.

5

6 Q. The effect of your evidence now is that if the
7 operator had retained from their training the level of
8 competence, you would have expected more of those asterisks
9 to not appear as asterisks?

10 A. Yes.

11

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

14

15 THE CHAIRPERSON: Yes, Mr Hunter?

16

17 MR HUNTER: I have no further questions, thank you.

18

19 THE CHAIRPERSON: Mr Clough?

20

21 MR CLOUGH: Q. Mr Muller, I only have one question, and
22 it's a bit outside what we've discussed, but it's something
23 I've come across in reading papers, and it's the notion of
24 adsorption of gases as they flow through a bed of broken
25 coal, like the goaf. I had seen some reference
26 particularly to carbon monoxide and to ethylene. Would you
27 be able to share with us what this concept is of adsorption
28 of these gases and what the impact is on the monitoring for
29 signs of spontaneous combustion?

30 A. I don't have a lot of experience with that, and
31 I haven't - I'm not up to date with the research in that
32 area, so I'm not in a position to give anything meaningful,
33 to comment on that at the moment.

34

35 MR CLOUGH: Fair enough. No more questions from me.

36

37 THE CHAIRPERSON: Thank you. Might Mr Muller be excused?

38

39 MR HUNTER: May it please, yes.

40

41 THE CHAIRPERSON: Mr Muller, thank you for your
42 attendance. You are excused.

43

44 <THE WITNESS WITHDREW

45

46 MR HUNTER: That is all we have by way of evidence
47 arranged until Monday.

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THE CHAIRPERSON: Yes, all right. We will adjourn until Monday at 10am. Thank you.

**AT 3.11PM THE BOARD OF INQUIRY WAS ADJOURNED
UNTIL MONDAY, 22 MARCH 2021 AT 10AM**

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